**Ecosystems and Land Use Policy Exchange Group (ELPEG) Bulletin**

**Issue 4, May 2017**

## What is this document?

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

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

This edition of the Bulletin does not try to cover all of the research being undertaken in the Biodiversity and Ecosystems and the Integrated Natural Assets work packages. It focuses on the work where there will be policy-related outputs and stakeholder engagement during the period April 2017 to December 2017, and which we believe will be of direct interest to policy makers working in these areas.

Some of you may note changes to the work planned for 2017 when compared to the work set out in previous versions of the Bulletin. This is a result of resource realignment within the Strategic Research Programme.

The text below includes information on what has happened to date and what is planned up until December 2017; note this includes some work with end dates beyond December 2017 but where activity will be underway this year. The researchers involved would welcome and 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.**

## 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** will be explored through focussed experimental studies (1.3.1, O1.1a). We will undertake further analysis of data from our 2016 experimental study of barley-weed interactions, assessing how barley diversity effects propagate across trophic levels and impact on ecosystem function; we will explore experimentally the effects of barley genetic diversity on **resilience of ecosystem functions** (**February 2018**; intended audience SG, academics, land managers; Alison.Karley@hutton.ac.uk).
- Understanding the **impacts of genetic factors on reintroduction success** is critical for the conservation of threatened plants and animals. Building on foundation fieldwork undertaken in 2016, we will undertake - for the threatened alpine plant species *Cicerbita alpina* - controlled long-term cross-pollination experiments at a RBGE nursery (1.3.1, O1.2a). This will

involve crosses between material already sampled from UK populations (**August 2017**; intended audience SG, SNH, academics; a.finger@rbge.ac.uk).

- The **impact of management regimes on biodiversity, ecosystem function and ecosystem service delivery** (1.3.1, O1.3a) is being examined in upland ecosystems. Field survey data from 2017 will be integrated into a long-term dataset prior to final analysis. This will focus on the vegetation dynamics across the first fifteen years of a controlled grazing experiment at Glen Finglas, identifying the functional impacts of removing or intensifying grazing (**September 2017**; intended audience SG, SNH, academics; Robin.Pakeman@hutton.ac.uk). Larger-scale studies in upland management systems (1.3.2, O2.2) will explore how **changes in management regime alter ecosystem service** supply; data gathering will include interviews with stakeholders to collect data on ES benefits, disbenefits and their linkages (**October 2017**). This new data will be combined with that gathered during 16-17 for the development of maps of ecosystem services (including uncertainties) for use by stakeholders such as SNH, LLTNP, SG, and will facilitate their translation into guidance for land managers (intended audience SG, agencies, land managers; Davy.McCracken@sruc.ac.uk).
- The development of **Ecosystem Health Indicators** (EHI) (1.3.1, O2.1) will continue to be supported through work in the Strategic Research Programme (SRP), and collaboration between SRP researchers and key stakeholders (e.g. SNH staff). Likewise we will further work on refinements of the **Natural Capital Asset Index** (NCAI) (1.4.1, biii), including building on developments with the Natural Asset Register to plug gaps in the NCAI dataset. Support for EHI and NCAI development will include an initial planning meeting (**June 2017;** intended audience agencies, SG, SRP researchers; Rob.Brooker@hutton.ac.uk).
- One central element of ecosystem health is **habitat connectivity**. Building on work in 16-17 (1.3.1 O3.2), where a number of connectivity measures were applied to some of the main Scottish habitats, the results of this analysis will be mapped (1.4.2cii) and a paper detailing results will be produced and discussed with key stakeholders (**January 2018)**, intended audience: SG and agencies, land managers; Alessandro.Gimona@hutton.ac.uk). At a more detailed scale, and again building on work undertaken in 16-17, **connectivity metrics for temperate rainforest systems** (1.3.1, O3.3) will be used to identify areas that make a disproportionately high contribution to spatial connectivity for key (or a wide range of) species in that they (a) already harbour many species with large-scale isolation problems and function as spatial "bridges", or (b) the restoration of their natural vegetation would result in large overall connectivity gains (**January 2018**, intended audience: SG and agencies, land managers; C.Ellis@rbge.ac.uk).
- **Animal diseases and the spread of INNS** are a threat to Scotland's natural environments. Work within the SRP (1.3.3, O3.2b) examines in particular the role of squirrelpox virus (SQPV) in the replacement of native red squirrels by invasive grey squirrels. SRP researchers will provide blood testing as required by SWT and other landowners to track the progression of squirrelpox virus and 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 direct to appropriate stakeholders (**March 2018**; intended audience SG, NGOs, agencies; Colin.Mcinnes@moredun.ac.uk). Other invasive species include **non-native trees and woody shrubs**. The invasive behaviour of this group will be assessed using meta-analytical techniques (1.3.3, O3.1a; **December 2017**; intended audience SG, agencies; Stephen.Catterall@Bioss.ac.uk).
- **System – including ecosystem – resilience** (1.3.3, O1.1) is an emerging focus for research and policy. To enable the development and targeting of management actions to enhance resilience we will build on foundation work undertaken in 16-17. We will undertake a consultation with a key stakeholder - SNH - to identify and report on main gaps in knowledge of ecological resilience in Scotland's biodiversity and ecosystems (**October 2017**; intended audience SG, agencies, NGOs, land managers; Glenn.Iason@hutton.ac.uk).

- Understanding the **relationships between biodiversity and cultural ecosystem services** is a key current research priority. We will work towards publishing our rapid evidence assessment literature review on the effects of biodiversity enhancement on the delivery of cultural ES (1.3.2, O1.1), focussing on "does the ecology of a place matter in terms of cultural ecosystem services being delivered" (**March 2018**; intended audience SG, SNH, researchers; Katherine.Irvine@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. Work during 16-17 on developing a participatory GIS (PGIS) will be continued to assess the impact of human disturbance and mitigation measures on resilience of Capercaillie within a study area in the Cairngorms National Park (**December 2017**). Secondly the PGIS will be extended to a second policy-relevant case study system, which will be chosen through consultation with stakeholders (**February 2018;** intended audience National Park Authorities, NGOs, agencies Scott.Newey@hutton.ac.uk).
- The extent to which **biodiversity of insects associated with Ecosystem foundation tree species depends upon the provenance of the tree** and the effect of climate change (1.3.3, O2.1) will be investigated using native Scots pine trees, in a long-term experiment. Initial assessments will be made in July 2017 (intended audience: agencies; Glenn.Iason@hutton.ac.uk).
- The review of **biodiversity management mechanisms** developed in 2016/17 will be used as the basis to explore with stakeholders the potential for using different governance mechanisms (including market, non-market and hybrid mechanisms) for biodiversity management in Scotland (1.3.4, O1.2). Using different qualitative research methods, this research will assess Scottish stakeholders' attitudes to and support for different types of mechanisms, and their design, implementation, and metrics for measuring the 'value' of biodiversity and ecosystem services. Findings from qualitative work will be summarised as reports and also discussed directly with key policy stakeholders (Scottish Government, SNH, SEPA, etc.). We aim to do this through ELPEG or ELSEG (**March 2018**; intended audience: SG and agencies, land managers; Paula.Novo@hutton.ac.uk) Additionally, work developed during year 1 (review of biodiversity governance mechanisms) will be discussed at a joint 1.4.2 – 1.3.4 ESCom event on 23rd May.
- Modelling approaches will explore the **consequences of habitat** loss. A metapopulation model (1.4.2cii) will be developed to investigate the theoretical consequences of loss and gain of habitat in a spatially explicit and dynamic manner. This will also allow the investigation of time-lags (**March 2018**, intended audience: SG and agencies, land managers; Alessandro.Gimona@hutton.ac.uk).
- Assessments of **habitat/species distributions and impacts of habitat loss and gain** in the context of urban planning will be developed (1.3.4, O3). This work will consider both habitats at risk from different types of development (identified at local and national levels) and where habitats might be created (e.g. green infrastructure investments such as in the Central Scotland Green Network). ES maps developed during 16-17, and refined through stakeholder consultation, will be used to prepare a research paper on biodiversity and ES impacts from proposed development. This will inform the integration of valuation data (from RD1.4.1) for the development of offsetting assessment tools in years 3 to 5 (Alistair.Mcvittie@sruc.ac.uk, **March 2018**).

## 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.

- A draft prototype **Natural Asset Register** (NAR) (1.4.1a) for use in helping assess where agri-environmental action could be targeted will be developed by late **Spring 2017**. Design choices with regard to content, structure and interfaces will be discussed with key stakeholders resulting in a consultation report due **June 2017** (intended audience: SG, agencies, NGOs and academics involved in developing and using web-based databases). Following iterations and improvements based on the consultation, the NAR will be put online for testing in **November 2017,** with work continuing towards the launch of the NAR as a publicly accessible and spatially explicit collection of data on natural assets **in late spring 2018.** (David.Donnelly@hutton.ac.uk).
- **Cultural Ecosystem Services (CES) indicators and mapping** (1.4.1bvi) will use participatory research methods to fill in the data gaps identified during year 1. Data generated by these methods will be combined with existing data to generate draft maps for CES (particularly landscape, spiritual and experiential services) in Scotland to be discussed in **September 2017** and finalised in **November 2017**, supplemented by a research briefing on methodological insights due **January 2018**. The original 'gap analysis' deliverable will be updated in **March 2018** (Inge.Aalders@hutton.ac.uk).
- Following on from draft maps to be explored with ELPEG in Spring 2017 showing **current status and historic trends associated with delivery of ecosystem services** (1.4.2a), future work will focus on trade-offs between provisioning, regulating and cultural ecosystem services; and the historical pathways that resulted in these trade-offs, providing further maps and research brief (**November 2017,** Alessandro.gimona@hutton.ac.uk**).**
- **Policy option appraisal for delivery of multiple benefits** (1.4.2ci) aims to take the trade-of analysis further to extend it beyond ecosystem services by combining bio-physical data with farm data (farm type, farm payments etc.) and/or socio-demographic data to generate Maps illustrating ES delivery from policy scenarios (**November 2017**, audience: SG and agency staff working on agri-environment measures including woodland expansion). Based on results from these maps, and premised on availability and engagement of these policy stakeholders, we plan to develop a policy briefing on impacts of land use change on ES by **January 2018** (Alessandro.gimona@hutton.ac.uk).
- The application of stakeholder evaluation methods (1.4.2 biii & 1.4.1c), will **improve our understanding of multi-functional changes to forest ecosystem services (**and the trade-offs). Knowledge of social innovation, including its definition in the context of rural development, will be improved. We will come up with a draft of the systematic framework for categorising and understanding **(March 2018),** with an ultimate goal of operationalizing social innovation in decision-making for multiple benefits for different/selected settings and scales (1.4.2 biii linked to 1.4.3), with associated journal articles by **March 2018.** (Intended audience SG and EU policy makers, land-use planners and managers in Scotland: Maria.Nijnik@hutton.ac.uk).
- Initial case studies of **Natural Capital Accounting** (1.4.1c) will be agriculture and forests and woodland. To support these, primary valuation studies are underway on forest recreation (pan European, with Scottish element funded by the SRP) and water quality and biodiversity impacts of agriculture (funded by H2020 PROVIDE). The insights gained will be shared at a natural capital valuation seminar (**March 2018**, intended audience OCEA, Alistair.McVittie@sruc.ac.uk).
- Research **assessing economic impacts of changes in Ecosystem Services** (1.4.2ciii) will present progress to OCEA and other stakeholders such as SFNC, ONS, in **April 2017** (Dominic.Moran@sruc.ac.uk). Using the methodology agreed December 2016 and published in two briefing papers by Fraser of Allander Institute available on request, the results from a case study will be presented in a technical report in **September 2017**. The stakeholders will then be consulted on the next case study for development in **November 2017** (the case study results will be shared in year 3).

## ELPEG SPOTLIGHT

### Mapping hot and cold spots of services (RD 1.4.2a) and connectivity (RD 1.4.2cii) for targeted management action

Mapping ecosystem functions and the delivery of ecosystem services is essential for targeting management action - for example through future agri-environment schemes – to those locations where the greatest benefit could be achieved. This might be through the maintenance of high levels of service delivery, or by restoring heavily degraded habitats. Here we describe two related and linked pieces of work which have a common focus of identifying target areas for management action.

*Mapping services*

Work in 1.4.2a focussed on mapping areas with high and low provision of ecosystem services (ESS), in particular looking at the provision of multiple ecosystem services. Overall, we quantified and mapped 11 indicators of service provision including three provisioning services, four regulation and maintenance services, and three cultural services. We tested for statistically significant co-occurrence of services and were able to identify areas with consistently high total indicator scores.

We also quantified the contribution of land cover types to ESS provision, and showed that the same type of land cover can provide different amounts of a given service according to its spatial context: the same land cover type can be present both in hot spots and cold spots. This indicates that land cover per se can be insufficient to quantify natural capital and ecosystem services (stocks and flows) and that the spatial and environmental context is important. Care should therefore be taken in assuming that land cover is *per se* a good indicator of Natural Capital or ESS provision, but it is useful if used together with other contextual variables.

*Mapping connectivity*

Enhancing and maintaining habitat connectivity and decreasing fragmentation is important to improve the conservation of biodiversity and adaptation to climate change. Highlighting areas in Scotland were these can be improved is therefore important for biodiversity policy (for example the Scottish Biodiversity Strategy), and is clearly of high relevance to ongoing discussions concerning development of a National Habitat Network.

Our work concentrated on understanding the use of certain analytical techniques, in particular methods based on circuit theory, which provide a more general alternative to least-cost path methods and account for the intervening 'matrix' i.e. the resistance of non-habitat to movement. We also quantified habitat connectivity using multiple metrics based on the arrangement of different habitat patches in the landscape, providing a more robust assessment capturing different aspects of fragmentation and connectivity. Finally, our innovative use of percolation theory predicts that a habitat is well connected if it has 60% occupancy, to provide bench-marks against which the connectivity/fragmentation of landscapes can be compared.

In our presentation for the ELPEG meeting on 2nd May 2017 we will show results for some example landscapes and habitats to illustrate the approaches followed; this presentation will be circulated afterwards to the ELPEG group.

**Overall, hot spots and cold spots, if correctly interpreted, can contribute to improving spatial targeting** of incentives and regulation and to the implementation of strategies such as the Biodiversity Strategy and the Land Use Strategy. Information from these mapping activities will inform ongoing discussions in 1.4.1 biii focussed on identifying new datasets, and the refining of the NCAI. This approach can be expanded and improved by also investigating hotspots and cold spots for biodiversity and by incorporating the results of the on-going connectivity work.

For further information contact: Alessandro.gimona@hutton.ac.uk

- **Opportunities to increase multiple benefits through policy and industry delivery mechanisms** (1.4.2bi) will continue to focus on the alignment of existing policy mechanisms governing soil, water and biodiversity. Based on criteria identified in year 1, we will use secondary data to analyse of instruments, and we will seek stakeholder feedback on the outputs and insights arising from this by **September 2017** with final summary reporting due **March 2018**. (Kirsty.Blackstock@hutton.ac.uk). This work will complement the work in 1.3.4 on biodiversity governance, and also help to frame the research on **Using Monitoring and Evaluation to deliver multiple benefits** (1.4.2bii). This work will analyse existing data sets used to manage soil, water and biodiversity against international good practice for adaptive management of natural assets. There will be an international workshop in **June 2017**, leading a good practice summary report in **March 2018** (Kirsty.blackstock@hutton.ac.uk).
- The **adaptive management approach to facilitate the evaluation and coordination of measures to deliver multiple benefits (**kit.macleod@hutton.ac.uk) (1.4.3a) will be applied to evaluate our agri-environment (O1.4.3b) and woodland expansion (O1.4.3c) case studies and initial insights presented at an SNH Sharing Good Practice Event or equivalent in **February 2018** (intended audience: SG and agency staff, SE-LINK, ESCom members).

## Climate Change Plan & Climate Change 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.

- Research **assessing multiple land use options** (1.4.2cii) is focussing on climate adaptation and mitigation impacts when trading off agriculture against woodland expansion. National-scale multi-criteria models of trade-offs based on the exploration of intensification and extensification scenarios (for 2050) will lead to maps of future trade-offs (**November 2017**). Further scenarios will be run to look at national-scale multi-criteria models of trade-offs based the exploration of scenarios of afforestation and peatland restoration result in maps of these scenarios by **January 2018** generating, if requested, policy briefings summarising opportunity mapping results by **March 2018** (Alessandro.Gimona@hutton.ac.uk).
- Further research on new methods to improve our understanding of **ecosystem service flows and our inventory of natural assets** (1.4.1bii) will focus on developing improved habitat maps based in the EUNIS classification (**September 2017**). These maps will be consulted on (intended audience: SG and agencies with an interest in modelling ES delivery) and a report on the potential of the methodology will be published **March 2018**, (Alessandro.gimona@hutton.ac.uk).
- Work to understand the **response of key pest species to climate change** will focus on analysing data collected during 16-17 (1.3.3, O2.2a). Specifically a database on altitudinal and latitudinal limits of ticks will be combined with climate data to build models to predict current altitudinal and latitudinal tick distribution over the UK and Europe (**January 2018**; intended audience: SG and agencies with an interest in tick distributions, Lucy.Gilbert@hutton.ac.uk).
- Peatland systems are a key component of the natural environments contribution to climate change mitigation. We will produce a model of **peatland condition** based on MODIS satellite images (1.3.3, O2.2c). The results of this modelling exercise will be written up as a research paper along with associated targeted summary material (**March 2018**; intended audience: SG and agencies/NGOs with an interest in peatland systems, Rebekka.Artz@hutton.ac.uk).
- Many projects listed under other headings include an aspect of climate change adaptation including: **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)**; woodland supply of ecosystem services** (1.3.2a).

## 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.

- Work to assess **new management options for agri-environment schemes** (1.3.4, O1.2) will bring together existing evidence, and information gathered from engagement with stakeholders, to propose new management measures for inclusion in agri-environment schemes in Scotland. Work within year 2 of the Programme will focus in particular on understanding stakeholder experiences with different biodiversity management measures. Interviews and workshops will explore opportunities and barriers for the implementation of novel mechanisms, and the social acceptability of these mechanisms. Stakeholders will include representatives from government, agencies, developers, consultants, local communities and NGOs (**December 2017**). This work will be linked to the establishment of new experimental investigation(s) of novel management options (1.3.4, O2) to assess their suitability and cost-effectiveness for future inclusion in the SRDP (**March 2018**; intended audience: SG and agencies involved in Agri-Environmental Climate Scheme (AECS) implementation; 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 (earth worms and tipulidae) for breeding and over wintering waders. We will monitor the effects of lime on soil characteristics, invertebrates and vegetation to investigate the effects of lime addition on soils processes and how these affect the availability of key invertebrate prey for upland waders, and habitat characteristics. Breeding and over-wintering wader numbers will be combined with sward diversity data, invertebrate data, and soil characteristics (pH, bulk density and water regime) to assess the effects of liming on farmland waders. Liming trials will be established during the summer of 2017 (**March 2018**; intended audience: SG, agencies, land managers; Scott.Newey@hutton.ac.uk).
- An associated activity is the development of methods for **targeting SRDP payments for biodiversity** (1.4.1bv). A consultation on how to refine SRDP AECs targeting and how species respond to targeting will be carried out in **Autumn 2017**; intended audience: SG and agencies, involved in AECs implementation post 2021, Robin.Pakeman@hutton.ac.uk), leading to a potential new scoring system outlined in a paper (**March 2018**).
- Research is **assessing the potential for Environmental Focus Areas (EFAs), Agri-Environmental Climate Schemes (AECS) and the Environmental Cooperation Action Fund (ECAF) to deliver multiple benefits at a landscape scale** (1.4.3b) within case study catchments based around i) the arable Balruddery Centre for Sustainable Cropping and ii) the three MRP grassland research farms (Glensaugh, Hartwood and Kirkton/ Auchentyre) and the Game and Conservation Wildlife Trust farm at Auchnerran. Initial results from year one will be shared at an annual demonstration day, provisionally at Glensaugh, looking a soil liming and woodland expansion issues (**Autumn 2017**) (intended audience: local farmers, NFUS, Scottish Land & Estates). (Justin.Irvine@hutton.ac.uk). Initial analysis of cooperation data will be presented in a report (**September 2017**) and refined based on discussions in the catchments, resulting in a conference paper (**October 2017**). Maps of catchment scale

delivery of ecosystem services based on new high resolution data will be available **December 2017**, and these will be used as a baseline for scenarios illustrating gains in ecosystem service delivery given the landscape scale adoption of EFA or AECS measures, generating simulations by **March 2018**.

- Research will also consider how to **integrate SRDP interventions with Natural Flood Management (NFM) and General Binding Rules (GBR) for the delivery of multiple benefits** (1.4.3d). (Kit.Macleod@hutton.ac.uk). National stakeholders have been consulted about their choices for a new case study starting in year 3. This work has also been bolstered by the addition of another case study looking at the delivery of multiple benefits from innovative and collective approaches to water management (Andy.Vinten@hutton.ac.uk). This work will report on options for water quality and water quantity management (reports due September 2017, intended audience: policy, agencies, land managers) and on the changes in monitored parameters by March 2018.

- Work on **improving the environmental performance of beef supply chains** (1.4.2biv) will continue in year 2 with the quantification of the main material/energy flows along the supply chain. The analysis will provide assessments of environmental impacts at national and regional scales to illustrate the potential of interventions in the supply chain to deliver multiple benefits ('hotspots'), resulting in a corresponding database of material flows of beef production at farm level **(March 2018)** (Ilkka.Leinonen@sruc.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 will continue to be the focus of work considering how management interventions, and their effect on the relationship between people and the environment, can alter the **supply of ecosystem services**. Using case studies of woodland management in the Cairngorms National Park, and the Central Scotland Green Network (Cumbernauld Living Landscape), initial activities have included developing a joint conceptual framework for assessing the production of woodland ecosystem services, and the outcome of management interventions (e.g. ecosystem restoration). We will build on this work in year 2 of the SRP, collecting data on the human role in and perceptions of ES production, as well as assessments of service delivery at three points in time (past, present and future) and across study sites, in close interaction with stakeholders in these areas (1.3.2, O1.1-O1.9). Scenarios reflecting contrasting future woodland management priorities will be developed in collaboration with stakeholders (**September 2017**; intended audience: land managers; Antonia.Eastwood@hutton.ac.uk).
- Data analysis undertaken in 16-17 will be used to produce a paper on **drivers of change in woodland diversity** at different scales (local, regional, national), including consideration of the implications of these drivers for conservation management (1.4.2cii). Findings will also be discussed directly with relevant SG policy and agency staff (**February 2018**; intended audience: SG and agencies, land managers; Alison.Hester@hutton.ac.uk).
- The **impacts of tree pests and diseases** will be considered, in particular the wider environmental risks from tree diseases. This work will explore 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). A draft protocol will be discussed with stakeholder

(**February 2018**; intended audience: SG and agencies, land managers; Ruth.Mitchell@hutton.ac.uk). **Detailed studies of key pathogens** will also be undertaken. These will include (1.3.3, O3.1b) establishing a monitoring programme for detecting and managing the spread of *Phytophthora ramorum* particularly in conservation nurseries and botanic gardens (**March 2018**; intended audience: land managers; K.Hayden@rbge.ac.uk ) and (1.3.3, O3.1c) assessing techniques for detecting the presence of the pathogenic *Phytophthora* fungi in landscapes via water sampling, as well as the impact of environmental factors in regulating *Phytophthora* species diversity (**February 2018**; intended audience: SG and agencies, land managers; David.Cooke@hutton.ac.uk).

- Related work to develop **approaches that reconcile woodland expansion with other land use priorities** (1.4.3c) will address processes of adaptive management i) in Cumbernauld (Central Scotland Green Network) and ii) the Cairngorms National Park. Maps of woodland expansion options and consequences of these options for ecosystem services and biodiversity are being developed (alessandro.gimona@hutton.ac.uk). In addition we will draw on the findings from the digital storymapping exercise with communities of interest in the Cairngorms National Park (katrina.brown@hutton.ac.uk). These will be integrated with the woodland expansion mapping exercise in order to connect the social knowledge from interviews, observation and video ethnography with ecological knowledge on habitat quality and connectivity. The results from this will be evaluated by key stakeholders during participatory mapping workshops **(September 2017).** Using insights from this approach and further model iterations, the results of woodland expansion options will be published **December 2017**. (Proposed audience: SG agency staff; justin.irvine@hutton.ac.uk).

## Summary of activities

| Topic | Contact | Activities and Due dates |
|---|---|---|
| **Scottish Biodiversity Strategy** | | |
| **Resilience of ecosystem functions** (1.3.1, O1.1a) | Alison.Karley@hutton.ac.uk | Explore in more detail the effects of barley genetic diversity - **February 2018** |
| **Impacts of genetic factors on reintroduction success** (1.3.1, O1.2a). | a.finger@rbge.ac.uk | Controlled long-term cross-pollination experiment - **August 2017** |
| **Impact of management regimes on biodiversity, ecosystem function and ecosystem service delivery** (1.3.1, O1.3a) | robin.pakeman@hutton.ac.uk | Identification of the functional impacts of removing or intensifying grazing – **September 2017** |
| **Impacts of management regime on ecosystem service supply in upland ecosystems** (1.3.1, O1.3a) | Davy.McCracken@sruc.ac.uk | Interviews with stakeholder – **October 2017** |
| **Ecosystem Health Indicators** (1.3.1, O2.1) **& Natural Capital Asset Index** (1.4.1, biii) | Rob.Brooker@hutton.ac.uk | Initial planning meeting with SNH – **June 2017** |
| **Habitat connectivity mapping** (1.4.2cii) | Alessandro.Gimona@hutton.ac.uk | Habitat connectivity results discussed with key stakeholders - **January 2018** |

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| **Connectivity metrics for temperate rainforest systems** (1.3.3, O3.3) | C.Ellis@rbge.ac.uk | Identify areas that make a disproportionately high contribution to spatial connectivity for key species - **January 2018** |
| **Animal diseases and the spread of INNS** (1.3.3, O3.2b) | Colin.Mcinnes@moredun.ac.uk | Data and advice on the general problem of SQPV provided direct to appropriate stakeholders -**March 2018** |
| **Meta-analysis of the invasive behaviour of non-native trees and woody shrubs.** (1.3.3, O3.1a) | Stephen.Catterall@Bioss.ac.uk | Meta-analysis – **December 2017** |
| **System – including ecosystem – resilience: identifying gaps in knowledge for Scotland's biodiversity and ecosystems** (1.3.3, O1.1) | Glenn.Iason@hutton.ac.uk | Consultation with SNH – **October 2017** |
| **Relationships between biodiversity and cultural ecosystem services** (1.3.2, O1.1), | Katherine.Irvine@hutton.ac.uk | Rapid evidence assessment literature review on effects of biodiversity enhancement on cultural ES – **March 2018** |
| **Consequences of environmental and climate change for ecosystem resilience** (1.3.3, O2.2b) | Scott.Newey@hutton.ac.uk | Assess consequences of scenarios for target species (Capercaillie) – **December 2017**<br>Stakeholder consultation on 2nd case study choice – **February 2018** |
| **Biodiversity management mechanisms:** (RD 1.3.4, O1.2) | Paula.Novo@hutton.ac.uk | Report on stakeholder perceptions and preferences – **September 2017** |
| **Biodiversity management mechanisms:** (RD 1.3.4, O1.2) | Anja.Byg@hutton.ac.uk | Report on attitudes and perceptions of different ways of designing and implementing biodiversity management mechanisms in Scotland – **March 2018** |
| **Consequences of habitat loss** (1.4.2cii) | Alessandro.Gimona@hutton.ac.uk | Develop a meta-population model - **March 2018** |
| **Assessment of habitat/species distributions and impacts of habitat loss and gain** (1.3.4, O3) | Alistair.Mcvittie@sruc.ac.uk | Research paper on biodiversity and ES impacts from urban development - **March 2018** |
| **Development of specific test cases to examine feasibility of offsetting for woodlands** (1.3.4, O3) | C.Ellis@rbge.ac.uk | Chronosequence of sites identified and first phase of field sampling – **March 2018** |

| Land Use Strategy for Scotland | | |
|---|---|---|
| **Natural Asset Register** (1.4.1a) | David.Donnelly@hutton.ac.uk | Consultation report - **June 2017**<br>Testing online NAR – **November 2017** |
| **Cultural Ecosystem Services indicators and mapping** (1.4.1bvi) | Inge.aalders@hutton.ac.uk | KE meeting – **September 2017**<br>Draft maps for CES in Scotland - **November 2017**<br>Research briefing - **January 2018**.<br>Updated Gap Analysis Report – **March 2018** |
| **Current status and historic trends associated with delivery of ecosystem services** (1.4.2a) | Alessandro.gimona@hutton.ac.uk | Maps and research brief - **November 2017** |
| **Policy option appraisal for delivery of multiple benefits** (1.4.2ci) | Alessandro.gimona@hutton.ac.uk | Maps illustrating ESS delivery from policy scenarios - **November 2017**<br>Policy brief – **January 2018** |
| **Natural Capital Accounting** (1.4.1c) | Alistair.McVittie@sruc.ac.uk | Natural capital valuation seminar - **March 2018** |
| **Assessing economic impacts of changes in Ecosystem Services** (1.4.2ciii) | Dominic.Moran@sruc.ac.uk | Progress presented to OCEA and other stakeholders **April 2017**<br>Technical report - **September 2017**.<br>Stakeholder consultation on the next case study - **November 2017** |
| **Opportunities to increase multiple benefits through policy and industry delivery mechanisms** (1.4.2bi) | Kerry.Waylen@hutton.ac.uk | Stakeholder feedback summary **September 2017**<br>Final summary reporting - **March 2018**. |
| **Using Monitoring and Evaluation to deliver multiple benefits** (1.4.2bii) | Kirsty.blackstock@hutton.ac.uk | Summary report - **March 2018** |
| **Using social innovation to deliver multiple benefits in forestry** (1.4.2biii) | Maria.Nijnik@hutton.ac.uk | Framework for categorising and understanding SI - **March 2018**<br>Journal Paper - **March 2018.** |
| **Adaptive management approach to facilitate the evaluation and coordination of measures to deliver multiple benefits** (1.4.3a). | kit.macleod@hutton.ac.uk | Case studies and initial insights presented at an SNH 'Sharing Good Practice Event' or equivalent - **February 2018** |

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|---|---|---|
| **Climate Change Plan & Climate Change Adaptation Programme** | | |
| **Assessing multiple land use options** (1.4.2cii) | Alessandro.Gimona@hutton.ac.uk | Maps of future trade-offs- **November 2017**.<br>Maps of scenarios - **January 2018**<br>Policy briefings (if requested) - **March 2018** |
| **Ecosystem service flows and our inventory of natural assets** (1.4.1bii) | Alessandro.Gimona@hutton.ac.uk | Improved habitat maps - **September 2017**.<br>Published report on the potential of the methodology - **March 2018** |
| **Response of key pest species to climate change** (1.3.3, O2.2a) | Lucy.Gilbert@hutton.ac.uk | Models to predict current altitudinal and latitudinal tick distribution over UK and Europe – **January 2018** |
| **Model of peatland condition** (1.3.3, O2.2c). | Rebekka.Artz@hutton.ac.uk | Research paper and associated targeted summary material - **March 2018** |
| **SRDP and CAP greening** | | |
| **New management options for agri-environment schemes** (1.3.4, O1.1 & O1.2) | Robin.Pakeman@hutton.ac.uk | Stakeholder consultation on novel measures and associated policy brief – **December 2017**<br>The establishment of new experimental investigation(s) - **March 2018** |
| **Impact of liming** (1.3.1, O1.3b) | Scott.Newey@hutton.ac.uk | Liming trials established – **March 2018** |
| **Targeting SRDP payments for biodiversity** (1.4.1bv) | Robin.Pakeman@hutton.ac.uk | Potential new scoring system outlined in a paper – **March 2018** |
| **Assessing the potential for Environmental Focus Areas (EFAs), Agri-Environmental Climate Schemes (AECS) and the Environmental Cooperation Action Fund (ECAF) to deliver multiple benefits at a landscape scale** (1.4.3b) | Justin.Irvine@hutton.ac.uk | Demonstration Day – Glensaugh – **Autumn 2017**<br>Report on barriers to cooperation - **September 2017**<br>Maps of catchment scale delivery of ES - **December 2017**<br>Simulations of catchment scale delivery of ES -**March 2018.** |

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| **Integrating SRDP interventions with Natural Flood Management (NFM) and General Binding Rules (GBR) for the delivery of multiple benefits** | Andy.Vinten@hutton.ac.uk | Reports on innovative options for water management – **September 2017**<br><br>Reports on changes in parameters – **March 2018** |
| **Improving the environmental performance of beef supply chains** (1.4.2biv) | Ilkka.Leinonen@sruc.ac.uk | Spatial database – **March 2018** |
| **Scottish Forestry Strategy** | | |
| **Human-environment interactions in the supply of ecosystem services** (1.3.2, O1.1-O1.9) | Antonia.Eastwood@hutton.ac.uk) | Scenarios developed –**Sept 2017** |
| **Drivers of change in woodland diversity** (1.4.2cii) | Alison.Hester@hutton.ac.uk | Research paper and discussion of findings with stakeholders – **February 2018**). |
| **Impacts of tree pests and diseases - risk assessment for service provision** (1.3.3, O3.1a). | Ruth.Mitchell@hutton.ac.uk | Draft protocol discussed with stakeholders - **February 2018** |
| **Detailed studies of key pathogens – *Phytopthora* monitoring programme** (1.3.3, O3.1c). | K.Hayden@rbge.ac.uk | Detailed studies completed – **March 2018** |
| **Detailed studies of key pathogens – *Phytopthora* detection and diversity** (1.3.3, O3.1c). | David.Cooke@hutton.ac.uk | Detailed studies completed - **February 2018** |
| **Approaches that reconcile woodland expansion with other land use priorities** (1.4.3c) | Katrina.brown@hutton.ac.uk | Participatory workshops completed **- September 2017**<br>Woodland expansion options - **December 2017**. |

## Table of Acronyms

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|---|---|
| AECS | Agri-Environmental Climate Scheme |
| CAP | Common Agricultural Policy |
| CES | Cultural Ecosystem Services |
| ECAF | Environmental Cooperation Action Fund |
| EFA | Environmental Focus Area |
| EHI | Ecosystem Health Indicators |
| ELPEG | Ecosystems & Land Use Policy Exchange Group |
| ELSEG | Ecosystems and Land Use Stakeholders Engagement Group |
| ES | Ecosystem Services |
| ESCom | Ecosystem Service Community Scotland |
| EU | European Union |
| EUNIS | European Nature Information System |
| GBR | General Binding Rules |
| GIS | Geographical Information System |
| H2020 PROVIDE | EU project on public goods and bads from agriculture and forestry in Scotland. |
| INA | Integrated Natural Assets |
| INNS | Invasive Non-Native Species |
| LLTNP | Loch Lomond and The Trossachs National Park |
| MODIS | Moderate Resolution Imaging Spectroradiometer |
| NAR | Natural Asset Register |
| NCAI | Natural Capital Asset Index |
| NFM | Natural Flood Management |
| NFUS | National Farmers Union Scotland |
| NGO | Non-Government Organisation |
| NPA | National Park Authorities |
| OCEA | Office of the Chief Economic Advisor |
| ONS | Office for National Statistics |
| PGIS | Participatory GIS |
| QMS | Quality Meat Scotland |
| RBGE | Royal Botanic Gardens Edinburgh |
| SE-Link | Scottish Environment Link |
| SEPA | Scottish Environment Protection Agency |
| SFNC | Scottish Forum for Natural Capital |
| SG | Scottish Government |
| SI | Social Innovation |
| SLE | Scottish Land and Estates |
| SNH | Scottish Natural Heritage |
| SQPV | Squirrel pox virus |
| SRDP | Scottish Rural Development Programme |
| SRP | Strategic Research Programme |
| SWT | Scottish Wildlife Trust |