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PHOTOGRAPH: SCHOOL FOOD MATTERS, WWW.SCHOOLFOODMATTERS.ORG

Engaging with the next generation

Few things are as important as making sure that young people consider a career on the land, says Prof Stuart Monro, scientific director of SCRR

RURAL RESEARCH IS important to Scotland. It is concerned with ensuring sustainable food supplies, produced in an ethical way and to the highest standards; it is about ensuring the resilience of our natural environment and the landscapes, plants and animals that characterise it; and it is about the communities that live and work in the rural areas.

Young people are therefore key as we look forward to an uncertain future. At a recent SCRR seminar, many of those engaged in rural research came together to share views on engaging with young people, their teachers and the educational system, helping to

bring contemporary science into the classroom. Much is being achieved but there is more to be done with a greater degree of coordination.

The Royal Highland Show, which in 2017 is in its 177th year, is a great place to see how interested young people are in the land-based industries – but how can we encourage more of them to consider it as their career?

SCRR, together with the Scotia Agricultural Club, is conducting an essay competition for schools and holding a public lecture to raise awareness of the land-based industries. Let's hope this helps engage the next generation.

Above: children on a school visit to a fruit farm

This issue in species

Beavers (the Eurasian kind, *Castor fiber*) are to be allowed to remain in Scotland – **page 2**

Fungi species worldwide might number as many as 50 million, though it's anyone's guess – **page 2**

Lobaria pulmonaria is a lichen found in the 'temperate rainforest' of Scotland – **page 3**

Goshawk (*Accipiter gentilis*) is one of the raptor species affected by forest practices – **page 4**

Ixodes ricinus is the species of tick that transmits Lyme disease to humans – **page 5**

Saxifraga likiangensis is a rare flower found in the mountains of China – **page 7**

1,100 plant species were found by Dr Francis Buchanan-Hamilton in Nepal in 1802 – **page 8**

About SCRR

THE SCOTTISH CONSORTIUM FOR RURAL RESEARCH exists to promote sharing of ideas and techniques among a group of organisations active in research into land, freshwater, coastal and marine resources, and their uses.

Our member organisations have bases throughout Scotland and are at work all over the world: details on the back page.

Members' reports

James Hutton Institute

PHOTOGRAPH: SNH



Left: beaver at Knapdale Forest

Decision to keep beavers in Scotland is welcomed by scientists

Researchers at the James Hutton Institute have been studying the impact of animals reintroduced from North America to a forest on the west coast

SCIENTISTS AT THE James Hutton Institute have welcomed the Scottish Government's decision to allow beavers to remain in Argyll and Tayside as a protected species; but they also warn that continued long-term monitoring and active management in sensitive areas will be essential. The James Hutton Institute joined with

three project partners – the Royal Zoological Society of Scotland, Scottish Wildlife Trust and the Forestry Commission – to measure the impact of beavers on woodland during the official five-year beaver trial reintroduction at Knapdale forest, near Lochgilphead, Argyll. This work formed part of an intensive monitoring

programme coordinated by Scottish Natural Heritage, and contributed important scientific information required for the Scottish Government's recent decision.

Professor Glenn Iason of the James Hutton Institute, a contributor to the report, said: 'It was a pleasure to be able to contribute our expertise in browsing by woodland herbivores to

'Knapdale beavers focused their activity very close to the water's edge, and their preferred tree species were those that recovered best'

the official beaver trial. The intensive monitoring programme allowed us to show that the Knapdale beavers did not affect coniferous tree species, focused their activity very close to the water's edge, and their preferred tree species were those that recovered best by re-sprouting following felling or browsing.

'Our research in Knapdale also highlighted that the recovery of trees from beaver browsing or felling was slow and appears to be dependent upon the presence of other animals that browse the re-growing shoots, particularly deer.

'These results mean that we can foretell their effects on trees elsewhere to some extent, but we still need better tools to predict which new areas will be colonised by beavers, their effects on woodlands, and how these effects are modified by subsequent deer browsing.'

The decision by the Scottish Government marks the first time a mammal has been reintroduced to the UK. Beavers were native to Scotland until hunted to extinction in the 16th century.

Fungi database shines light in dark corners

Dr Andy Taylor of the James Hutton Institute reports on the increasing importance of an online reference work

FUNGI ARE IMMENSELY important to humanity and the planet we live on. They belong to their own kingdom, provide powerful medicines including antibiotics, regulate many processes in soils and also provide society with numerous food and drink staples. However, despite their extraordinary impact, scientists are still largely ignorant of the true diversity of fungi on Earth, with estimates ranging from five million to 50 million species.

In 2001, to improve upon current available resources, researchers from a group of organisations including the

James Hutton Institute set up their own reference database called the User-friendly Nordic ITS Ectomycorrhiza Database (UNITE).

The initial aim behind this initiative was to create a reliable DNA sequence database, which included only high-quality sequences obtained from

expertly identified fungi. Thus, these identification 'barcodes' could be used to identify unknown sequences derived from

'Scientists are still largely ignorant of the true diversity of fungi on Earth, with estimates ranging from five million to 50 million species'

THEORETICALLY, THE IDEA of increasing habitat connectivity for species conservation is simple. The more connected the habitats, the greater the chances of having larger, interconnected populations that are more resilient to change. Building connectivity can be thought of as the antidote to fragmentation, which is well known to put biodiversity at risk.

However, there are numerous data gaps that prevent us from using this as a conservation strategy. First, information about the current distribution of a species, as well as its habitat, must be sought; and second, the ability of a species to move amongst available habitat patches must also be well understood. Such information becomes particularly scarce in the case of small and cryptic species which are of particular importance to Scottish biodiversity such as lichens, bryophytes and fungi.

Information about the distribution of such species is only available at scales that are too coarse to be of use, such 10km mapping schemes. Also, we frequently have only a basic understanding of a species' habitat requirements. Finally, their dispersal ability is largely unknown.

Funded by Scottish National Heritage (SNH), RBGE carried out a study of epiphytic lichens in the temperate rainforests of Western Scotland, in order to better understand what a more connected landscape might look like for these internationally important species.

The study used niche modelling methods to better understand the habitat requirements of the species; then the results were projected onto the Native Woodland Survey Scotland in order to identify where suitable habitat currently occurs for each species

'Land managers can now reasonably ask: how will the epiphytes in the glen respond if tree regeneration remains low?'

environmental samples with a high degree of confidence.

Dr Andy Taylor, a fungal ecologist at the James Hutton Institute and current UNITE board member, said: 'Initially UNITE fulfilled the needs for a small group of researchers with a common interest in Nordic forests. But now it is used by researchers all over the world in a huge range of ecosystems. Recently there has been growing interest in using the database in man-made systems as well.'

Pictured right: *Mycena inclinata*



'Habitat connectivity' and species conservation in temperate rainforest

Sally Eaton, Scottish plant conservation officer at the Royal Botanic Garden Edinburgh, describes how studying lichens in a Scottish forest will improve our understanding of the way a species moves to a new suitable habitat

Above: temperate rainforest at Glen Creran

within a real-world wooded landscape (Glen Creran).

In addition, dispersal studies have been carried out, combining propagule trapping and molecular techniques to produce information about the dispersal ability of the species.

These predictions about habitat requirements and dispersal ability were then combined into a set of simulation models which allow management scenarios to be tested prior to

implementation. For example, land managers can now reasonably ask: how will the epiphytes in the glen respond if tree regeneration remains low? Where would regeneration blocks or exclosures be best placed within the glen? What is the biodiversity risk if ash dieback infects the woodland?

These simulation models will ultimately improve the nature conservation value of Scotland's temperate rainforests.



PHOTOGRAPH: WIKIPEDIA

From its simple origins, the UNITE database has grown to become a global one-stop shop for dealing with all fungal sequence data from environmental samples.

At frequent intervals, all available sequence data from international depositories are uploaded automatically into UNITE, screened for quality and then added to the existing data. In this way the database is kept up to date at a global scale.

The UNITE database is available online at <https://unite.ut.ee/>

Members' reports

Inverness College UHI

RAPTORS BREEDING IN forests may be exposed to disturbance from human activities such as recreation and forest operations. Scottish Natural Heritage (SNH) provides advice on measures for reconciling human activities with conservation of protected bird species, and Forestry Commission Scotland (FCS) has produced a guidance note to provide advice on how to plan forestry operations such as thinning, clear felling and road building in a manner that minimises disturbance of protected bird species.

One possible mitigation measure is to designate buffer zones around nests within which human activity is restricted. This mitigation measure is often based on an assessment of

'The Scottish Government has ambitious targets for forest expansion, which will require better understanding of the use of forests by raptors and their responses to forest management'

birds' alert distances or flight initiation distances. The advice provided is, however, largely based upon expert opinion, rather than robust empirical evidence. Three independent reviews of buffer distances (commissioned by SNH in 2006 and 2016, and Forest Enterprise Scotland in 2016) have highlighted that there is a severe shortage of empirical studies on disturbance distances.

The Scottish Government has ambitious targets for forest expansion, which will require better understanding of the use of forests by raptors and their responses to forest management activities. At the same time, government targets to increase visits to the outdoors may lead to an increase in wildlife conflicts. So a robust evidence base to inform



PHOTOGRAPH: IOSTO DONEYDU / WIKIPEDIA

How birds of prey cope with disturbance in Scotland's forests

As Scotland aims to increase its forests, Dr Louise de Raad, a researcher at Inverness College UHI, is looking at ways in which forestry operations can minimise the disturbance of protected bird species, particularly raptors

Above: a goshawk

assessment and mitigation is crucial. UHI is leading a study that aims to fill the knowledge gap on the response from key protected raptor species, when breeding, to human disturbance.

The study will also investigate the effectiveness of mitigation measures undertaken during forest operations and assess forest habitat use by key protected raptor species. To do this, there will be close collaboration with members of the Scottish Raptor

Monitoring Scheme and the British Trust for Ornithology's nest recording scheme to tag birds with GPS collars and set up cameras at nests. The study will enable SNH, FCS, FES and other agency staff to provide evidence-based advice on the management and conservation of key protected bird species.

To find out more about the study, contact Louise.de-raad@uhi.ac.uk

What's the future of conservation? Actually, it depends who you're asking...

Dr Janet Fisher at Edinburgh University (GeoSciences) describes her project which aims to access a wider range of views on conservation

'THE FUTURE OF Conservation' is a joint project with Chris Sandbrook (UNEP-WCMC), George Holmes (Leeds University) and Rogelio Luque-Lora (Cambridge University), which seeks to explore the views of

conservationists on a range of issues affecting conservation globally, as a way of informing debates on the future of conservation.

Recent debates about the future of conservation have been dominated by a

few high-profile individuals whose views seem to fit fairly neatly into polarised positions. In our survey, we are trying to get away from this limited range of opinions, by exploring the range of views that exist within the conservation movement globally, and how this varies by key demographic characteristics such as age, gender, geography and educational background.

We have been delighted that the survey has had a lot of coverage on social media and we have now had more than 8,000 responses, from all over the world. This gives an exciting

Members' reports

James Hutton Institute

Conservation plans should consider risk of infections such as Lyme disease

Researchers at James Hutton Institute are investigating the relationship between deer population density, tick numbers and the transmission of disease to humans

LYME DISEASE IS a bacterial infection that can be contracted from the bite of an infected tick. It is an important emerging disease in the UK, and is increasing in incidence in the human population in large parts of Europe and North America.

A research team led by the University of Glasgow, in collaboration with the James Hutton Institute and

Scottish Natural Heritage, has found that some types of conservation action could increase the abundance of the ticks (*Ixodes ricinus*) that transmit diseases such as Lyme disease.

The study examined how conservation management activities can affect tick populations; wildlife host communities; the transmission of *Borrelia burgdoferi* bacteria, which

cause Lyme disease; and ultimately the risk of contracting Lyme disease.

Scientists found that managing the environment for conservation and biodiversity has many positive effects, including benefits for human health and wellbeing from spending time in

'Our research demonstrates a clear relationship between deer densities and tick abundance in Scotland, and that deer management can help reduce ticks'

nature. However, the researchers suggested that there should be consideration of disease vectors such as ticks and mosquitoes in conservation management decisions.

Professor Lucy Gilbert of the James Hutton Institute, a co-author of the study, said: 'Our research so far demonstrates a clear relationship between deer densities and tick abundance in Scotland, and that deer management can help reduce ticks.'

'However, deer do not transmit the Lyme disease bacteria, so current work at the Institute is testing for Lyme disease risk at a lot of sites with widely varying deer densities to test the impact of deer densities on Lyme disease risk.'

Left: more deer means more ticks, but deer do not transmit the Lyme disease bacteria

Below: different development stages of *Ixodes ricinus*, the tick that causes Lyme disease



PHOTOGRAPH: SHARP PHOTOGRAPHY / WIKIPEDIA



PHOTOGRAPH: JAMES HUTTON INSTITUTE

new dataset to understand a more detailed and nuanced picture of the views held by conservationists.

The survey interface engages respondents a bit more than conventional surveys by presenting them at the end with a representation of their views on a plot with two axes: how people-centred or nature-centred your views are; and how pro-markets or anti-markets they are. We chose these two axes based on the results of our earlier studies into the views of conservationists which identified them as important dimensions that



distinguished between respondents. This interactive method has proven a great way of getting a large number of people to engage with research

Left: the Future of Conservation survey is online now

methods, and we have had interesting feedback from a number of groups that have used the tool to debate the issues. We now have a lot of analysis to do and we intend to make our findings widely available to help inform debates about the future of conservation.

If you wish to learn more about the project, or take the survey yourself, visit <http://futureconservation.org/>

Our earlier studies are online at <http://onlinelibrary.wiley.com/doi/10.1111/cobi.12811/abstract>

Members' reports

Moredun, University of Stirling



flocks, and again a vaccine for louping ill was developed. Those hill sheep farmers today who still remember the devastation caused by louping ill, tell us it is the most important vaccine they have in their 'tool kit'.

Parasitology was always an important part of Moredun's research and back in the day the fortunate

'Moredun was set up almost a century ago by a group of far-sighted Scottish farmers to research serious disease problems in their flocks'

scientists got to tour Scotland in the 'Moredun laboratory' (pictured) to analyse samples brought in by local farmers. There is a rumour that many of these sample collection points were in fact whisky distilleries!

Moredun has remained committed to working with livestock farmers to improve animal health and welfare. Most of the research is carried out at custom-built facilities in the Pentland Science Park; but true to its heritage, sampling on-farm remains an important part of our work.

So what of the future?

New and emerging technologies are starting to change the way we think about 'pen-side' diagnosis of disease, carried out right on the farm. These technologies enable the transfer of tests previously restricted to the laboratory into the field environment. This can provide accurate diagnosis of disease in minutes to hours, transforming treatment decision times. These portable technologies offer rapid pen side detection of pathogen DNA. Could this be the technology to put Moredun back on the road with a new kind of mobile laboratory?

To find out more, visit us at the Moredun stand at the Royal Highland Show 2017

History with a message for the future

Beth Wells and Stewart Burgess take a look into Moredun's past, which is the theme of the research organisation's stand at this year's Royal Highland Show

AS PART OF Scotland's Year of Heritage, History and Architecture, Moredun has prepared a stand for the Royal Highland Show with a historical theme looking at how, over the last century, it has helped farmers across the world to prevent and control endemic diseases of livestock.

To balance this, a futuristic vision of research and development will also be showcased to explain how the way we do some of our research could

Above: the original Moredun mobile field laboratory

change over the years ahead, which may suggest we're heading full circle!

Moredun was set up almost a century ago by a group of far-sighted Scottish farmers to research serious disease problems in their flocks. The cause of many of these diseases was found to be infection by species of clostridial bacteria and vaccines soon followed. Attention was then turned to tick borne diseases, which were devastating Scottish hill sheep

Soil fertility legacies in Coigach-Assynt

Louisa Habermann of the University of Stirling describes a project that will check the health of soils in the north-west Highlands

IN RURAL COMMUNITIES sensitive to environmental and social change, soil fertility must be considered a vital resource for future resilience. Therefore, understanding soil nutrient trajectories of current land management practices (or lack thereof) is crucial to allow land managers to make good decisions for their soils which will benefit future generations.

In the case of Coigach-Assynt, this requires investigation and interpretation of both environmental and archaeological evidence, as well as social parameters.

'Little is known about the present status of soil nutrients on sites associated with past land use in the north-west Highlands, such as abandoned settlements or former shieling sites'

Little is known about the present status of soil nutrients on sites associated with past land use in the north-west Highlands, such as abandoned settlements or former shieling sites; nor is there information

on how current land management practices are affecting the ability of the dominant Gleysols of the region to retain nutrients. Our research aims

Botanic Garden increases cooperation with China

Agreements with two leading institutes will lead to more work on plant diversity and undiscovered species

WITH MORE THAN 20 per cent of plant species considered at risk of extinction, and many tens of thousands still awaiting discovery, the Royal Botanic Garden Edinburgh (RBGE) has signed collaboration agreements with two world-leading research institutes in China to address the challenges of understanding and conserving plant diversity.

Species repatriation, shared research into plant pathogens and extensive skills transfer are on the agenda after the agreements with Xishuangbanna Tropical Botanical Garden (XTBG) and Kunming Institute of Botany (KIB), of the Chinese Academy of Sciences (CAS).

Experience of working in China for more than a century has allowed RBGE to collect the largest living collection of Chinese plants in cultivation outside their native country.

The new agreements are regarded as the logical next steps in the race to understand and conserve China's globally important flora, consisting of some 30,000 species, and lay the foundation for new work on the vast but poorly understood plant diversity of the neighbouring countries of Myanmar, Laos and Vietnam.

The commitments were made during an intensive 14-day visit to China by Prof Simon Milne MBE, Regius Keeper at RBGE, with Prof Pete Hollingsworth, RBGE's director of science, and horticulturists Martyn Dickson and David Tricker. 'These agreements are ambitious and broad-

Yulong Xue mountain (right) and (below) a local endemic species, *Saxifraga Likiangensis*, first collected by Pere Delavay in 1886



ranging,' explained Prof Milne. 'While designed to further scientific research and best practice in horticulture and to enhance plant conservation, the strategy also has an emphasis on education and public engagement, and development of botanic gardens.'

Joint expeditions and education programmes will be undertaken, and a conservation genetics workshop is

planned, to provide a conceptual framework for pragmatic integration of genetic thinking into conservation planning.

There will be funding

for joint supervision of PhD students as well as opportunities to share experience on botanic garden management and profile-raising.

The agreements extend an already active programme of partnership, a key feature of which has been management of the Jade Dragon field station, designated the UK's first joint scientific laboratory in China in 2005, and Lijiang Alpine Garden on the Yulong Xue Shan.

KIB and RBGE have also played a lead role in coordinating global efforts in plant DNA barcoding – including techniques to understand which bamboos are eaten by giant panda, to help habitat restoration programmes. Other initiatives have involved evaluating biodiversity risks from rubber plantations, and encouraging sustainable rubber production.

For further information please contact Shauna Hay on 0131 248 2900

'This is seen as the logical next step in the race to conserve China's globally important flora, consisting of some 30,000 species'



to establish the current soil nutrient status resulting from both past and present land management regimes at Glenleraig, Nedd, Clachtoll and Achlochan in Assynt-Coigach. Research will integrate field survey and mapping with laboratory analysis.

The project will also support education opportunities for local high schools and engage local communities and young people with soils-based earth sciences. Community

Left: croft-type farming landscape in Coigach-Assynt

engagement will involve the participation of Assynt Field Club and Ullapool High School pupils in field work and laboratory analysis.

This PhD project will report on long-term soil sustainability in the region and this knowledge will help inform land management and policy strategies, with the aim of strengthening more resilient and adaptive communities in the future. The project is part of the Coigach and Assynt Living Landscape Partnership Scheme, funded by the Heritage Lottery and the University of Stirling.

Members' reports

Royal Botanic Garden Edinburgh; Scotland's Rural College

The wonders of Nepal brought to life in Edinburgh

A new audio trail at the Royal Botanic Garden Edinburgh celebrates the extraordinary biodiversity of one small Himalayan country

A YEAR-LONG PROGRAMME of events at the Royal Botanic Garden Edinburgh (RBGE) to celebrate the bicentenary of the relationship between Britain and Nepal is concluding with the launch of a new audio trail.

When the 1816 Treaty of Sugauli was signed to end conflict between the British East India Company and Nepal, RBGE already had scientific links with the Himalayan kingdom. These links extended back to 1802, when Scottish surgeon-naturalist Dr Francis Buchanan-Hamilton made the first natural history collections in Nepal. Buchanan-Hamilton spent a year there, collecting and documenting over 1100 plant species, and he is now known as 'the father of Nepalese botany'.

Taught botany by Prof John Hope in RBGE's classroom of the Scottish Enlightenment – recently rebuilt as the Botanic Cottage – Buchanan-Hamilton carried out research that established a collaboration which continues today

Pictured L-R are Dr Mark Watson, Dr Alan Forrest, Dr Colin Pendry and Bhaskar Adhikari

'Many of the plants at RBGE come from the Himalayas and this trail tells the stories of twelve – some familiar, others less so'



with the Flora of Nepal programme. Now, the history of RBGE's work in Nepal is captured in the new audio trail, available via a mobile app.

Many of the plants grown at RBGE originally came from the Himalayas, and this trail tells the stories of 12 Nepalese plants, some of which may be familiar, but others probably less so. The plants have been chosen to illustrate the continuing importance of Nepal's biodiversity to its people, the stories of the collectors who brought them back to the UK and RBGE's ongoing research programme in Nepal. RBGE is coordinating the Flora of

Nepal project to produce the first comprehensive catalogue of the plants of this biodiverse Himalayan country. The project is an international collaboration with partners in Nepal and Japan, and involves more than 100 botanical experts worldwide.

The stories are told by Dr Mark Watson, Dr Colin Pendry, Bhaskar Adhikari and Dr Alan Forrest, four of the Edinburgh botanists working on the Flora of Nepal.

For further information or images please contact Sandra Donnelly on 0131 248 1037

Sorting out the sheep and goats

Researchers at Scotland's Rural College are involved in a European project to help farmers to achieve sustainable production

RESEARCHERS AT SRUC recently hosted the annual meeting of iSAGE, a multi-million pound EU-funded research project aiming to future proof our sheep and goat farming industry.

More than 60 scientists and industry executives from seven countries across Europe gathered in Edinburgh to attend the Innovation for Sustainable Sheep and Goat Production in Europe (iSAGE) meeting. iSAGE, of which SRUC is a core

Right: Soay sheep

partner, is a £6 million consortium of 33 organisations who are doing research to assess the key factors which could impact the sector over the coming decades, such as climate change, and consumer preferences. They will then develop tools to help sheep and goat producers adapt to and thrive through the predicted changes.

The conference featured presentations, breakout sessions and discussions on how to make the sheep and goat sector more sustainable, competitive and resilient.

Professor Georgios Banos and PhD candidate Martha Dellar made presentations on behalf of SRUC on the genetics of animal resilience and climate modelling, respectively.

Professor Banos said: 'The conference was a great success. There was an equal balance of active attendance amongst academia and



industry representatives creating an environment conducive to exchange of ideas and knowledge.

'The project is on track to deliver innovations that will support the sheep and goat industry face future socio-economic and environmental challenges.'

The next annual meeting of the project will take place in May 2018 in Bilbao, Spain.

Why Scotland's researchers are going on SEFARI

Graeme Cook, director of SEFARI Gateway, explains an initiative that unites six prominent research institutes

ON 29 MARCH 2017, Roseanna Cunningham MSP, the Scottish Government cabinet secretary for environment, climate change and land reform, went for a walk up a hill. Nothing spectacular in that, you might think – Ms Cunningham is known for her love of the outdoors. However on this occasion, the walk was a little different. Ms Cunningham was taking to Castletaw Hill in the Pentlands, to launch a new initiative known as SEFARI – Scottish Environment, Food and Agriculture Research Institutes.

SEFARI is the collective of six research institutes, each with their own distinctive identities and specialisms, but working together to deliver unique and globally distinctive multi-disciplinary research, much of which is funded by the Scottish Government. These institutes are:

- Biomathematics and Statistics Scotland;
- The James Hutton Institute;
- Moredun Research Institute;
- The Rowett Institute, University of Aberdeen
- Royal Botanic Garden Edinburgh;
- Scotland's Rural College.

SEFARI works across a wide variety of inter-linked topics, and carries out this work in environments stretching from Scotland's mountaintops to beyond the coastline. Whilst much of the research is drawn from our natural world, this is all underpinned by an ethos of 'Leading Ideas for Better Lives' – that the research must be of value to individuals and wider society. In that context, SEFARI also delivers 'Leading Ideas' across:

- Plant and animal health;
- Agriculture;
- Land and communities;
- Climate and the environment;
- Rural economy;
- Food and drink innovation;
- Healthier foods;
- Science education.

There has been collaboration between the research institutes who make up SEFARI over many years – perhaps most notably in the delivery, since 2005, of the Scottish Government's Strategic Research Programme on environment, food, agriculture and land.

The challenge set for SEFARI is for its research and expertise to be better aligned towards national and global



'Our research is underpinned by an ethos of 'Leading Ideas for Better Lives' – which means it must be of value to individuals and wider society'

challenges – and for this work to be of more relevance for, and more recognisable to, audiences across policy and business as well as for individuals in Scotland and beyond.

A crucial aspect of SEFARI's work is in ensuring that the right research and expertise gets to and from the right people, at the right time, in the right format. SEFARI also has a fundamental role to improve the impact of research: there is little point carrying out great work if it is not used effectively. This is a role for what we are calling the 'SEFARI Gateway'.

Mechanisms we employ include funding staff from across SEFARI to consider particular challenges – examples include genetic diversity of species in Scotland; urban food; how we can get protein from plants; and how to identify where carbon prices can work to allow farming and food to play the fullest role in mitigation of greenhouse gas emissions. We also fund innovative ways of exchanging research and knowledge – for example, a new film to be shown at the John

Hope Gateway at the Royal Botanic Garden Edinburgh, and 'Grazing on the Edge', communicating the value of common grazings and grasslands through screenings of a collaboratively produced film.

Whilst processes and funding mechanisms are important, our work on 'key conversations' is critical. This is about identifying where, and with whom, SEFARI research can be of most use, and so have greatest impact. Most certainly this includes the Scottish Government, but we are in dialogue with government agencies, the Scottish Parliament, UK Parliament, business, farming and rural leaders, and many others in this territory. We are acutely aware that partnership working is key. To this end we have also funded SEFARI fellowships with Scotland's Futures Forum, and Cairngorms National Park Authority. We also actively link with the existing Centres of Expertise on climate, animal health and water.

Many SEFARI members are also part of the Scottish Consortium for Rural Research – and we look forward to conversations on maximising future collaboration.

You can follow our activities on Twitter at [@SEFARIScot](https://twitter.com/SEFARIScot) and on our blog at <https://sefari.blog.wordpress.com>

Members' reports

Forest Research; Centre for Ecology and Hydrology

Using laser sensing to capture forest structure

Juan Suarez of Forest Research describes how new technology is used to produce models of forest canopies

ESTIMATION OF FOREST structure to support management decisions has typically been achieved through a combination of aerial photography and ground survey, but the latest developments in remote sensing are providing new opportunities.

In particular, they offer the chance to estimate spatial patterns in the vertical structure of the canopy and the horizontal variation in stand volume. These characteristics provide important information for choice of silvicultural system and harvesting operations. In addition, by combining LiDAR estimates with models it is possible to provide managers with vulnerability maps showing areas at risk of wind damage, and an estimation of timber quality for use in forecasting production.

LiDAR (Light Detection and Ranging) is a sensor that emits laser pulses and measures the return time for each beam to travel between the sensor and the target using ultra-accurate clocks. The location of every laser return within a precise coordinate system is achieved using differential GPS, while a record of the orientation of the sensor (roll, pitch, compass heading) gives the direction of the pulse. With this data, we can calculate the position of the returning surface (eg tree canopy or ground).

Forest Research have been exploring the use of LiDAR instruments to generate canopy surface models and then provide accurate estimations of important parameters such as canopy heights, stand volume and the vertical structure of the forest canopy.

The estimation of tree heights is performed by the subtraction of bare ground values from the canopy layer. We then combine the LiDAR measures with outputs from our growth models to estimate the spatial distribution of Yield Class for five commercial softwood species. Comparison with

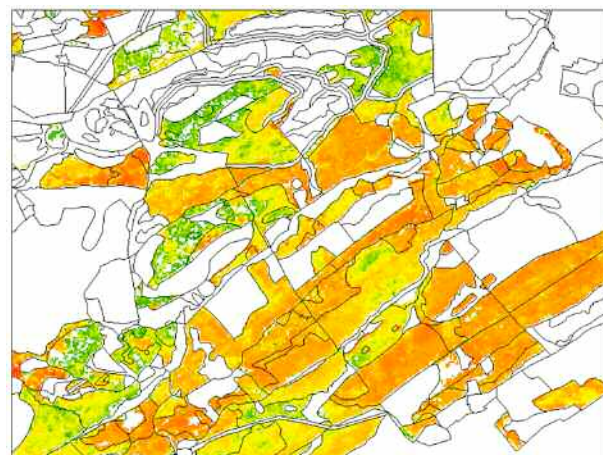
'We can provide managers with vulnerability maps showing areas at risk of wind damage, as well as an estimation of timber quality'

Below left: a map of tree heights (derived from LiDAR)

Below right: critical wind speed (CWS) for wind damage derived from the combination of LiDAR data and the ForestGALES model

field trials suggests an accuracy of 90 to 95 per cent for these estimates. We now plan to calculate site productivity and forest structure in those areas of Britain where LiDAR is available (most of England and Wales, and about 20 per cent of Scotland).

For further information contact Juan.Suarez@forestry.gsi.gov.uk



Better science with increased OpenNESS

A project involving the Centre for Ecology and Hydrology is gauging the impact of citizen science and interdisciplinary research

SCIENTIFIC KNOWLEDGE IS used to inform conservation policy. However, in the past, science and conservation have not necessarily been integrated,

with the science being considered the domain of academics. This is changing.

With the increasing delegation of research to self-directed networks, as well as the growth of trans-disciplinary research, transformational change is expected which will lead to a more just, sustainable and equitable future. However, studies to determine if this new direction is working are scarce.

This is the aim of OpenNESS (Operationalisation of natural capital and ecosystem services), a trans-European project which aims to translate the concepts of Natural

Capital (NC) and Ecosystem Services (ES) into operational frameworks that provide tested, practical and tailored solutions for integrating ES into land, water and urban management and decision-making.

Twenty seven case studies have been carried out over the last four years, and one of these has been done by scientists at the Centre for Ecology and Hydrology. Work over four years in the Cairngorms National Park has provided tailored evidence on recreational potential and rare species distribution using a scaled-down

Members' reports

Forest Research



PHOTOGRAPH: PATRICIA AND ANGUS MACDONALD/AEROPHICA

Providing an 'ecological network' mapping service

Darren Moseley of Forest Research explains how spatial analysis can help planners with biodiversity and green infrastructure

THE NATIONAL PLANNING Policy Framework (NPPF) advises local authorities to plan 'for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure'. Explicit in this framework is the need to identify and map components of the local ecological networks and of particular importance are European Protected Species (EPS), which are covered under UK law.

The current guidance and national-scale distribution maps for broad habitats fail to provide the detailed information required for planners and developers to minimise the ecological impact of necessary development.

Many local authorities also lack the time and expertise to identify ecological networks themselves.

Forest Research, with support from the Genomia fund, has developed an ecological network mapping service for protected species. This can provide planning authorities, conservation agencies and developers with the necessary information to take account of their legal duty of care. The service builds on spatial analysis which has advanced regional green infrastructure strategies; this network analysis enabled planners and conservation agencies to influence development sites to minimise impact on green infrastructure, identify opportunities for

Above, left and right: planning challenges in the form of housing in the Lothians and a rural landscape

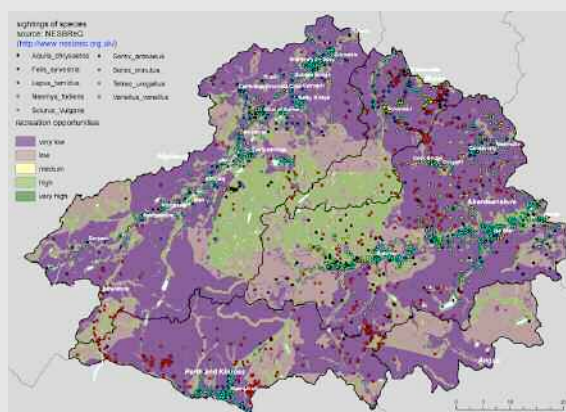
enhancing landscape connectivity, and target surveys for key species.

A range of analyses can be produced, from ecological networks for EPS to more tailored products focusing on species of particular conservation concern within a region. We have also developed approaches to consider emerging ecological network science concepts such as the coherence of the ecological networks, and the resilience of these networks to threats.

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European model (ESTIMAP) and citizen science data. The work was directed by the Cairngorms Nature group in conjunction with the Cairngorms National Park Authority. Two evaluations of the work ensured it delivered to their needs.

An evaluation across all 27 OpenNESS case studies (n=246) showed that the new paradigm can lead to a change in the hearts and minds of individuals and a change in human behaviour, two of the transformational changes suggested necessary for a more sustainable



Left: the map combines citizen science biodiversity data on rare species (the coloured dots) with recreational potential (purple for low to green for high) in the Cairngorms

future. There was, however, limited evidence of a change in social institutions across Europe, which suggests it is necessary to promote a shift to transdisciplinary working.

For more details contact Jan Dick, jand@ceh.ac.uk. The OpenNESS project is at www.openness-project.eu

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