



**Where have all the flowers gone?**

Kate Holl

Churchill Fellow of 2017

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**“Where flowers bloom, so does hope”**

*Lady Bird Johnson*



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*We are fundamentally connected to nature and when it is in poor condition we suffer also.*

*So, if we heal nature, we too will thrive.*

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## Acknowledgements

**Julian Holbrook** my partner who has always encouraged and supported me to go that extra mile, to dare to go outside my comfort zone, and without whose help holding everything together during the 6 weeks of my travelling (as well as during the many nights of burning the midnight oil writing papers and reports once back home again) I could not have done this Fellowship.

**Helen Armstrong** for all the hours we have spent together walking through so many of Scotland's woods looking at herbivore impacts and thinking about how things might be different with fewer munching mouths that has been the inspiration for this project. And for coming to Norway with me – I am so glad that we were able to see those amazing un-grazed woods together! Thanks also for taking the time to review and provide constructive criticism on an earlier draft.

**Claudia Rowse** my Scottish Natural Heritage (SNH) Unit manager who encouraged me and made it possible for me to take the time out from my day job to go on this quest for knowledge.

**Professor R. Bunce** for his seemingly endless knowledge of European habitats, and useful contacts without which there would not have been a French dimension to this project.

**Des Thompson** (SNH) and **Alison Hester** (James Hutton Institute) for their encouragement and kind words of support for my initial application.

**Manu (Dr Emmanuel Menoni)** of the ONCFS (Office National de chasse et de la Faune Sauvage) for giving me a week of his time to share his incredible knowledge of the ecology of the region and to take me to little known old growth forests deep in the French Pyrenees where few deer are permitted to set foot! and for introducing me to his committed and inspiring colleagues (and excellent cooks!) **Kevin Foulche** and **Philippe Xeridat**; **Jean-Paul Molinier** forester with the ONF (Office National Forestiere); and **Claude Berducou** retired expert on the ecology and management of Pyrenean “mega-fauna” for his kind hospitality and extensive knowledge of the forest.

**Jamie Marsh** and **Steve Reid** of the Hampshire & Isle of Wight Wildlife Trust for organising such an inspiring day of visits to different woods managed by the Trust and meeting the apprentices at Martin's Wood.

**Richard Grogan** for a most informative stroll through Parkhurst Forest and the history of woodland management and deer on the Isle of Wight – most enlightening!

**Jon Cox** of the People's Trust for Endangered Species (PTES) for taking time out of his holiday to show me round Briddlesford Copse SSSI and explain why the understorey is so important for the rare species there.

**Duncan Halley** of NINA, Trondheim Norway for being such a tireless source of information, evidence, contacts, locations and proof that if there are no large herbivores, woodlands just grow! Also for giving up a weekend to show us round some very inspiring, un-grazed woods and for teaching us how to cook reindeer with cowberries – delicious!

**May Britt Jensen**, Head of Rogaland Department of the Environment for her warm and infectious enthusiasm, and a fascinating tour of the woods on the island of Rennesoy (and the secret of the reindeer recipe!).

**Auden Steinnes** and **John Inge Johnsen**, ecologists with the Rogaland Department of the Environment for showing us an ancient Scots pine forest near Stavanger.

**Ragni Nordas** of Statens Naturoppsyn (SNO) for an amazing day island hopping and eating crispbread on ferries and for showing me an un-grazed wood with an understory such as I have never seen before (or since!)

**Professor Gunnar Austrheim** - plant ecologist at the Department of Natural History, Norwegian University of Science and Technology for his kindness and for sharing his knowledge and experience visiting some very interesting wood pastures, cultural landscapes and montane scrub in Budalen near Trondheim.

**Scott Riddell** and **Gloey Finnsdottir** for their incredibly warm welcome to Iceland, for their delicious Icelandic cooking and tips about Icelandic food (such as smoked lamb – Hangi!), and for sharing their very impressive knowledge of Þingvellir with us on a long and utterly amazing Icelandic summer day. And for introducing us to the woods of Iceland that are literally dripping with flowers.

**Borgþór Magnusson** of the Icelandic Institute of Natural History for an exciting jeep trip on dirt tracks to Vatnshornsskógur, a remote ancient birch forest that was also literally carpeted with flowers, and full of the song of astonishing birds.

**Dr Bjarni Sigurdsson**, Professor of Forestry at the Icelandic Agricultural University and his daughter for giving up a day of their holidays to show us the utterly amazing flower-full birch woodland of Bæjarstaðarskógur, and for his comprehensive and fascinating knowledge of the ecology and history of woodland management on Iceland. Such an incredible inspiration.

**Sigthrudur Jonsdottir** of the Icelandic Land Healing Institute, a “land doctor” for telling us about land healing in Iceland – the process of ecological restoration of badly eroded land following overgrazing by sheep.

**Ragnhildur Helga Jonsdottir** of the Icelandic Agricultural University who also founded the Agricultural Museum for a fascinating introduction to land management on Iceland.

And last, but not least, my sister **Lorna Holl** for her belief in me and especially for accompanying me on the Icelandic leg of the trip, for sharing the awe and amazement of Iceland and of all the flower-full woods, for finding all the Icelandic orchids, and for cooking and navigating and keeping me on the road and especially for reading the Icelandic sagas and passing on all those interesting ecological references!

I am also immensely grateful to the Winston Churchill Memorial Trust for this tremendous opportunity.

## Glossary

**Basal shoot** – a type of shoot which grows from a bud at the base of a tree or shrub

**Coppice** - a traditional method of woodland management which exploits the capacity of many species of trees to put out new shoots from their stump or roots if cut down. This type of management is frequently used to produce firewood and small round-wood timber.

**Ecological productivity** – the rate of generation of biomass, or living things, in an ecosystem

**Exclosure** – an area (of woodland) from which grazing animals are excluded by fencing

**Field layer** – the layer of herbs, grasses and small shrubs in a woodland

**Herbivore impacts** – the impacts of large herbivorous animals on vegetation; normally through grazing, browsing and trampling

**Lower plants** – are the mosses, lichens, fungi and algae

**Natural capital** - is the world's stocks of natural assets which include geology, soil, air, water and all living things

**Old growth forest** - is a forest that has attained great age without significant (human) disturbance, and so has certain unique ecological features

**Refugia** - an area where special environmental circumstances such as inaccessibility or remoteness, have enabled a species or a community of species to survive after extinction in surrounding areas

**Snowbeds** – an area of ground favouring long duration of snow cover

**Structural diversity** – the different layers in a woodland, i.e. canopy, sub-canopy, understorey, field and ground layers

**Temperate** – the climatic zone between the tropics and polar regions where conditions are never extremely hot or cold

**Tree regeneration** – the process by which trees replace themselves, normally through seed, basal shoots or root suckers

**Understorey** – the normally shade-tolerant vegetation growing beneath the forest canopy, but above the forest floor

## About Kate Holl

My interest in travelling goes back a long way, as my parents were a bit like nomads – never staying more than a few years in any place before upping sticks and moving on. By the time I was 12, I had already lived in seven different places. As a child, I had to learn to adapt to the local “culture”, even if that sometimes meant learning a new language! As a teenager, my parents emigrated from the UK to South America in a yacht, taking over a year to complete the journey and stopping at many countries en route. During this time, I was home-educated, but the life-education of visiting so many different places, learning to sail and navigate a 46 foot ketch, deal with the challenges of being a teenager on the high seas was of course a far greater formative influence during those years. My family settled in Venezuela and I learned Spanish and attended a local school; but when the time came I decided to return to Scotland to study ecology at Edinburgh University. I am sure that my desire to pursue this career was influenced by my love for wild and natural places that I developed during my time on the boat, and later exploring the coral islands, steamy rain forests and stunning mountains of beautiful Venezuela.

After completing my degree, I worked for a few years in the agricultural prairies of Buchan in the far north-east of Scotland for a small tree planting NGO. We planted trees that we had grown, often with school children, from seed that they had collected, in un-improved corners of the countryside. From this I went to a job with the Nature Conservancy Council, habitat mapping in Badenoch & Strathspey. This job was a real education, as it was here that I learned much of the knowledge of the natural heritage that I still rely on in my current job as a woodland advisor with Scottish Natural Heritage. In 1991, the Nature Conservancy Council was split up, and became SNH, and I have worked ever since that time as a woodland advisor, so have been hugely privileged, in the course of my career to have seen an amazing number of woodlands across the country, both protected and un-protected. It is precisely because I have this perspective – both spatially and temporally - on Scotland’s woodland resource that I decided I wanted to bring my insights on herbivore impacts to public scrutiny with the help of this Churchill Fellowship.



The author, Kate Holl and Jane Mackintosh in the wildflower meadow at Damhead



With my husband and family of 4 daughters, I manage a 5 acre small-holding on the edge of Edinburgh applying organic and biodynamic principals. We produce fruit and vegetables and have sheep, chickens and bees. As well as providing much of what we eat as a family, the small-holding is vitally important for teaching me that through making small adjustments in the way we do things, it is possible to produce food and at the same time, really create space for nature. It is possible. We have seen the biodiversity return to our small-holding during the 10 years we have been managing it: the hay meadow has more flowers in it every year, the trees we have planted are now big enough to provide hunting perches for the growing number of buzzards, kestrels and owls that hunt over the tall grass which is now home to a great number of voles and other small mammals. Last summer a pair of sky-larks nested in the meadow. The one year-old pond already heaves with frogs, toads and newts and even occasionally, dragonflies. The butterflies, moths and insects generally are pitifully few in number, here as they are elsewhere, but at least here there is some habitat now for them to live in and feed on.

## Executive summary

The idea behind this Churchill Fellowship was to visit woods in other parts of Europe where there are few large herbivores.

There are now very few woods in Scotland that are free of current and historic herbivore impacts. Consequently, they have very few flowers, little or no understorey and depleted productivity and biodiversity.

The purpose of the Fellowship was to find out whether there are more flowers in woods that have had very low herbivore impacts for decades, and whether the associated biodiversity and productivity is affected.

I found that woods in other European countries that have been free of large herbivores for many years have, irrespective of woodland type:

- abundant flowers
- high ecological productivity
- astonishing biodiversity and bio-abundance
- a well-developed understorey with shrubs such as dog rose or low shrubs such as blaeberry, stone bramble and northern bilberry, and trailing and climbing species such as honeysuckle and bramble; all of which produce flowers and edible fruit
- regenerate themselves with little or no costly management intervention
- support foraging and economic activity

As a result of the Fellowship, my main conclusion is that there is an urgent need to significantly reduce herbivore numbers across Scotland. To help deliver this objective, it should be a priority to:

- articulate and share the story about the current ecological condition of Scotland's native woodlands
- develop in a collaborative way a new, inspiring and ecologically regenerative vision for a more ecologically and hence also economically productive environment
- share this "Re-flowering of Scotland" vision widely amongst all citizens
- set targets to help us start to move towards delivering the vision
- monitor progress



## Introduction to the project



“As a species, we (humans) have probably never been sustainable, but there are now so many of us on the planet that it is imperative that we learn to live more sustainably. We need to learn to use our woodlands in an integrated, appropriate and resilient way because we need our woodlands for social, environmental and economic purposes.” *Mike Robinson, chief executive - Royal Scottish Geographic Society*

Large numbers of sheep and deer graze the Scottish uplands, but in order to secure the shelter, cover and food that they need these animals spend much of their time in the few remaining woodland fragments. This results in little tree regeneration and lots of degenerate, overgrazed woods. A less obvious consequence of this “system” of land management is that many woodland flowering plants have almost entirely disappeared from the woods; while those that remain rarely flower.

In the course of doing my job as a land-use advisor with Scottish Natural Heritage (SNH) over the past 30 years, I have become increasingly aware just how extensive the damage that is being brought to bear on Scotland’s natural heritage by the increasing numbers of herbivores. And more recently, since becoming a beekeeper 6 years ago, I have begun to see the countryside through the “eyes” of a bee and realised how few flowers there are. In the arable lowlands this is largely because of the intensification of agriculture – with loss of field margins, hedgerows and arable weeds; the felling or simply loss without replacement of boundary trees; and hedgerows themselves cut too frequently so they never get a chance to flower and fruit. In the uplands it is even worse. There are hundreds of square miles where munching jaws have reduced the natural biodiversity and bio-abundance to a landscape dominated by a handful of species grazed to the point where they mostly don’t flower.



Since the 1960s, deer numbers in Scotland have been steadily increasing. According to SNH's recently published Deer Review, between 1961 and 2016 red deer densities in Scotland have increased by 60% (SNH, 2016), and grazing by deer and other herbivores is considered to be a major cause of the unfavourable condition of biodiversity in protected areas. In the woods, deer browse on plants such as bramble, honeysuckle, and other flowering plants so that these are unable to flower and set seed or fruit. As a consequence there is very little nectar, and no fruit or seeds to feed all the insects, small mammals and birds that might otherwise be there.

I had been thinking about grazing impacts on woodlands for a number of years, but the idea for this project grew out of an excursion to the island of Mull in 2015. I had visited this island many times before, but on this occasion it was as if I was suddenly seeing the island with new eyes. Mull is one of the larger islands off the west coast of Scotland, and fairly typical of the Scottish uplands in that it is mostly comprised of sheep walk and deer "forest" (typically with no trees in it at all) – and a lot of rather uninteresting acid grassland and peatland with a smattering of small, overgrazed woods.

Travelling around the island, I noticed an old house around which was a well maintained fence to keep the sheep in their place. Inside the fence the grassland was a carpet of flowers, while on the sheep's side of the fence – the same grassland – there was not a single flower. I suddenly realised what we are missing in Scotland. As far as the eye could see, the grazed grassland had almost no flowers in it. I had previously thought nothing of this, just accepted it as "normal". Suddenly I thought: "*Where have all the flowers gone?*"



View towards Jura and Mull from Argyll

On the same excursion we went to a small woodland that I had first visited two years previously. This wood had been protected from sheep and deer grazing by a robust fence since the 1970/80s, and remarkably, it had remained deer and sheep-proof all that time. This small bit of woodland immediately stood out from all the others I had seen during my 30 years as a woodland advisor with Scottish Natural Heritage. This small wood was like a little bit of paradise. Here there was an understorey of shrubs and young trees, and a profusion of flowers. The sound of birds and insects filled the air.





Deer fenced wood on the Isle of Mull

This little bit of woodland (picture above) may not look particularly special, but there are very few woods left in Scotland now that have few enough deer and sheep in them that flowers like this can flourish. Returning to that small wood on Mull in 2015, I was shocked to discover that the fence had been taken down. It was considered that “enough” trees had regenerated, and it was time to restore grazing to the woodland, and let the deer and livestock back in. In the space of less than 2 years, much of that ecological richness that had taken over 30 years to develop had been completely wiped out. Apart from a few sapling trees, you would have never known what abundance of flowering plants this wood had come to support, for they had all been eaten or trampled into oblivion. The photo below shows the same spot, same time of year – all the flowers have gone!



Same bit of woodland after the fence was taken down



Woodland managers and advisors in Scotland have for so long been so focussed on achieving tree regeneration in the presence of so many herbivores, that we seem to have failed to notice that woods are actually much more than just the trees. For even if the trees regenerate, without all the flowering, climbing and trailing plants, shrubs, fruit bushes and tall herbs they will never be “woodland”; just a lot of trees. (And that’s not even mentioning the impacts on the below-ground biodiversity of all the fungi and micro-organisms about which we know so little). Without the brambles, raspberries, blaberries, ivy and honeysuckle flowers there is very little food for the insects; very little food for the small mammals, very little food for the birds and few places for them all to make their homes. In spite of this, the current received wisdom of many ecologists in this country is that without grazing, woodland ecosystems become rank and species poor (at least in relation to higher plants).

A recent survey by the Forestry Commission of native woodland in Scotland found that 87% of our native woodlands are subject to herbivore impacts that are preventing or restricting tree and shrub regeneration, as well as substantially reducing tree and shrub species diversity (Patterson et al 2014). These same woods will also be lacking a shrub layer, and have very few trailing or climbing plants, and those species that are present will be grazed so heavily that they produce little in the way of flowers or fruit. Don’t just take my word for it – go and look for yourself! Another study which looked at long term ecological change in woodlands across Britain from 1971 to 2001, found that overall species richness in the ground flora had declined markedly during this time, with notable reductions in the frequency of woodland specialists such as wood sorrel, primrose and sanicle. (Dolman et al, 2010).

Research at Wytham Woods and elsewhere in the UK has shown that deer can significantly affect woodland shrub and field-layer vegetation, and increasing deer numbers are associated with a reduction in the cover and frequency of woody shrub species leading to a more open or (often) eliminated mid-canopy layer (Corney, P.M. et al 2008). It has also been shown that deer can profoundly affect the composition of the woodland field-layer by selectively grazing palatable species such as wood anemone, bluebell and dog’s mercury (Dolman, P. et al 2010). In the same study, grazing on flowers of common spotted orchid was found to be so severe that only 4% reached seeding, and other flowering plants such as herb Paris and primrose were similarly impacted. Species likely to benefit from increased grazing are primarily the grasses, and not the flowers (Pollard, E. et al 1998). A review by the BTO and RSPB found that changes in woodland structure linked to increased deer browsing were the most likely driver for many reported declines in woodland breeding birds such as blackcap and dunnock (Amar, A., et al 2008). There have been similar declines in bank vole and wood mice populations linked to the loss of the understorey. So, pressure from deer seems to be driving woods towards becoming more open and grassy with fewer flowers, birds and mammals.

Experience from the Scottish Rural University College (SRUC) upland farm at Kirkton, near Crianlarich, has shown that many of the tall herb and dwarf shrub species do manage to persist within the grazed vegetation, but never flower (Holland, J., *pers. comm*); and it is only when the grazing pressure is removed that they begin to flower and spread. But if grazing is suppressing these more palatable plants within the sward so that they never get to flower, then there will be fewer flowers available for insects (so less nectar, pollen etc.), and fewer flowers to produce fruit and therefore seed. This matters not just because the seeds and fruit are a source of food for a whole range of associated biodiversity, but also because if plants only rarely reproduce sexually (through seed production), then there must be consequences for the genetic diversity and hence resilience of these plants. With pressure now from climate change and the spread of new pests and pathogens, our native species need to be as diverse genetically as they can be. They can only evolve and adapt through

sexual reproduction. So if few of these plants in this grazed landscape ever, or very rarely, get to flower this has surely got to matter from the point of view of ecosystem resilience.

Results from the Countryside Survey which examined changes in the British countryside between 1978 and 2007, indicate that our woodlands are losing their plant diversity, and becoming more homogenous (Carey, P.D., et al 2008).

The reason that we haven't picked up on this degradation in Scotland is that it happened so long ago, we do not have the data to show how things have changed. Scotland's semi-natural habitats: the woods, heaths, peatlands and semi-natural grasslands - much of which is to be found in the uplands cover more than 70% of the total land area. Few people realise how ecologically degraded this huge area of land is, there are almost no flowers left. It has been like this for so long, that there is no cultural memory of it being any different. The lack of flowering plants actually *flowering* in Scottish semi-natural habitats is an indicator of poor ecological health. As a result, these areas are also economically and socially degraded too. People are beginning to ask questions about the so-called "traditional" land-use of the uplands, particularly in relation to global imperatives such as food security and climate change.

The majority of our woods have had herbivores sheltering and grazing in them for so long, there are virtually no woods left in Scotland where it is possible to see what a woodland understorey looks like when it is being grazed at a sustainable level. We have become so used to seeing woods with barely any understorey it doesn't occur to us that these woods could look any different. This phenomenon is known as the shifting baseline syndrome and is defined as is a type of change to how a system is measured, usually against previous reference points (baselines), which themselves may represent significant changes from an even earlier state of the system (Dayton et al 1997).



Typical Scottish oak woodland with no understorey and few flowering plants

The picture above shows a typical upland oak woodland in Scotland, completely lacking any regeneration, any flowers, any shrub layer or understorey. It is little more than a cohort of oak trees in a grassy field layer dominated by bracken, and yet this wood is part of a Special

Area of Conservation – supposedly one of a suite of premiere sites for nature conservation in Scotland.

However, in England the degradation due to overgrazing is happening right now, so scientists are able to monitor and measure these changes. Recent reports have warned of alarming declines in biodiversity globally over the past 40 years (WWF, 2016), and we all know from our clean car-windcreens and the absence of flies in our houses that insect bio-abundance has similarly declined. The recent publication of the results from long-term monitoring of nature reserves in Germany has shown that invertebrate bio-abundance there has declined by over 75% in the past 25 years (Hallman et al 2017). It is likely that there has been a similar decline in our invertebrate biodiversity and abundance.

I felt certain that our woods should have more flowering plants *flowering* in them than they do. No other country in Europe has such high numbers of wild herbivores as we do in Scotland, and consequently the habitats look very different from here. I wanted to go to woods in other parts of Europe where herbivore impacts are much lower, where the climate and geology is still comparable to Scotland, and find out how that space under the forest canopy compares.

The SRUC report *Retreat from the Hills* showed that sheep numbers have fallen dramatically since 1999, most notably in the north-west of Scotland, with some areas seeing reductions of between 35 and 60 percent (Thomson et al 2011). Unfortunately, any benefit to the woods and the biodiversity that might have accrued as a result of this reduction in sheep numbers is not happening, because at the same time deer numbers are expanding to fill the niches left by the retreating sheep.

Red and roe deer are an important part of the natural heritage, held by some to be “iconic mammals”. It is important to remember that deer grazing can have both positive and negative ecological impacts, e.g. it can maintain woodland glades and species rich grasslands, but also prevent woodland regeneration, and damage habitats such as blanket bogs by grazing and trampling.

The Forestry Commission Scotland manages around one-third of forests and woodland in Scotland. In 2009/10, the net cost of forest protection in Scotland to FCS (predominantly deer management) was £9.4m. Assuming the demand remains the same going forward, *that's £100 million of public expenditure every 10 years!* For how many decades will this expenditure be affordable to society? For unless herbivore numbers are significantly reduced, the need for forest protection will be on-going. There are very few data available on the impacts of deer on agriculture in Scotland, but they undoubtedly impact on both arable and root crops, as well as grass grown for hay or silage. Roe deer may also damage orchards and soft fruit crops, which may be of high value at a farm level.

Scottish Natural Heritage (SNH) currently monitors the condition of semi-natural habitats across Scotland and reports on the state of the natural heritage to the Scottish Government. The Herbivore Impact Assessment method (Armstrong, et al., 2014) that has been developed with support from SNH and the Forestry Commission Scotland, enables woodland habitat condition, in relation to herbivore impacts, to be monitored, and the results used to set targets for herbivore reduction.

SNH, through existing legislation, can require landowners to reduce their deer numbers where they are considered to be impacting upon public interests in order to restore habitat condition. Currently this legislation has been rarely used. One of the outcomes of the 2016 SNH Report to Scottish Government of Deer Management in Scotland (SNH, 2016) was that



going forward, the Scottish Government expects SNH to use this legislation more frequently when protected habitats are identified as negatively impacted by deer.

So browsing by large herbivores in Scotland is having a very significant impact on the environment. They determine the distribution, quality and quantity of woodland, the structure and composition of semi-natural habitats, and the ecological productivity of ecosystems. Through this, large herbivores affect biodiversity, carbon sequestration, river flooding, and forest and agricultural productivity. All of this inevitably has economic consequences as all economic prosperity ultimately depends on environmental prosperity.

I believe that Scotland's semi-natural habitats could be far more productive than they currently are. Furthermore, as this "natural capital" ultimately underpins the economic and social prosperity of our country, restoring it to a more favourable state would also provide the people of Scotland new opportunities to develop meaningful livelihoods and lives in rural areas connected to this restored ecological abundance. They would also be more flower-ful and more resilient and thus better able to provide sanctuary and renewal for an increasingly urbanised population.

## Aims, objectives and purpose of the project

The aim of my project was to explore and understand the dimensions of the question "Where have all the flowers gone?" in Scotland.

I planned to do this by gathering information about the understorey and flowering plants in un-grazed (or little grazed) woods in other parts of Europe where the climate and geology is comparable to Scotland.

To do this, I needed to find some un-grazed woods in countries that are ecologically comparable to Scotland. I chose to visit south-west France, the Isle of Wight, south-west Norway, and Iceland as the woods in all these places are all influenced by the Atlantic Ocean. This means that they, like Scottish woods, are wet and temperate.

The purpose of the project was to gain an insight into what a woodland that has had decades of low herbivore impacts looks like, and to experience what it feels like to be in a wood that has not been ecologically depleted by centuries of overgrazing. I wanted to study woods that not only have few large herbivores in them currently, but which also have a history of at least several decades of low herbivore numbers. I needed to find out whether and how such woods differ from ours so I could help inspire others to see how our "ecological productivity" could be greater than it currently is, and what the consequences of this would be.

I wanted to find out whether there would be

- more flowers, more insects, birds and mammals?
- more people being supported by healthier, more productive ecosystems?
- more young trees getting established, thus avoiding the need for costly tree planting and protection?
- and therefore more sustainable employment linked to healthy natural resources?

There are now very few places in Scotland where it is possible to see how habitats might look in the presence of much lower herbivore impacts, so we really lack the examples that could inspire us. By visiting comparable woods in other countries, I hoped to collect stories and images to bring back to Scotland to share and hopefully inspire people to start to see

how things could be very different here. I wanted to be able to contribute to the conversation that has already begun about how we might achieve this change and deliver greater resilience and prosperity for the sake of nature itself, but also for the economic and spiritual well-being of all the people who live, work and play in and around them.

I identified a number of objectives I wanted to achieve through the project while travelling, and these included:

- To see as many different un-grazed or lightly grazed woods as possible
- To record using photography the abundance and diversity of flowers in the forest understorey
- To record visual, aural and anecdotal evidence from the woods visited
- To record using photography the structural complexity of the woods
- To talk to woodland managers to learn about how the woods are used by local people
- To learn how local people manage their herbivore populations

On returning to Scotland I would use the evidence I have collected to:

- Share my experience and any insights gained as widely as possible with key stakeholders such as land managers, researchers, policy makers and the wider public
- Start some conversations about how semi-natural woods in Scotland might differ from their current state, and in particular how they could have more flowers in them
- Begin to co-create, with key stakeholders, a vision for a *Re-flowering of Scotland*

At a deeper level the following motivations were important:

- I wanted our generation to be able to hand on Scotland's natural resources to our children in a better condition than they were in when we inherited them
- I wanted people to be able to travel within Scotland and be inspired and uplifted by the land healing that is happening, by the regeneration of rural communities, by the abundance of biodiversity, and in particular to see flowers everywhere, and to thus be re-assured about the future

## Methods

I approached scientists, ecologists and foresters working in the four different countries of France, Norway, England and Iceland to help me identify a series of un-grazed woods across Europe that I could visit.

In France it proved particularly difficult to find un-grazed woods, and all the contacts I wrote to initially responded that they were not able to help with my request. Then finally only two weeks before I was due to travel, through Dr Larrieue, a contact of Professor R. Bunce's in Toulouse, I found out about Dr Emmanuel Menoni (Manu) who was working in the Pyrenees on the role of herbivore impacts on the breeding success of capercaillie. Manu wrote that he could help me find woods where the current impacts of herbivores were low and had been for a long time, so on the strength of this I boarded a plane to Toulouse.

Through Emma Goldberg, a Natural England colleague, I had first found out about there being no deer in the Isle of Wight, and resolved to visit this part of the UK where there were

woods with no deer in them. Emma also helped me to find contacts on the island who were willing to show me round their lovely, and little-grazed island.

In Norway, I was greatly assisted in the task of planning an itinerary of woods to visit by Dr Duncan Halley, a Scottish expat living in Trondheim and working for the Norwegian nature organisation NINA, who has a personal interest in trying to help regenerate Scottish woods through sharing knowledge and information about Norway's woods and their historical management. Duncan provided me with a lot of contacts, and through these contacts I met others and was able to plan a full and very busy two weeks.

Before embarking on this project, I knew very little about Iceland. I wasn't even sure if there were woods on Iceland! A decade or so previously, Sigthrudur Jonsdottir had visited Scotland from the Icelandic Land Healing Institute and had spent some time working with SNH where I met her and learned about the erosion on the island due to overgrazing by sheep. I tracked her down on Iceland – and arranged to meet up with her. With a population of only 350,000 everyone knows everyone on Iceland, and Sigga was able to provide some useful contacts in addition to those I had already identified through the internet.

The best time to look at woodland flowers is in the spring when the trees are just coming into leaf, because later in the year when the woodland canopy has closed over, little light reaches the forest floor and there are few flowers to be seen as they have mostly completed their seasonal cycle, and died back. I wanted to be able to compare the woodland ground flora in the four countries at the same stage of its seasonal development, and as spring comes earlier in France, I planned to start in France and travel northwards following spring, reaching Iceland in July.

I wanted to collect evidence of flowers (as well as floristic and structural diversity) from comparable woods in Iceland, Norway, the Isle of Wight and France to inspire others to imagine what woodlands in Scotland could look like if they were less overgrazed.

As I wanted to visit as many woods as possible in the time available, I decided that for each wood visited I would collect:

- A vascular plant species list
- Photographic documentation of the structural and species diversity
- Sound recordings
- Video footage
- Information about the history of the wood, its current management and value to local people

All of the woods that I visited on my trip and a summary of the discussions are described in more detail in the Blog:

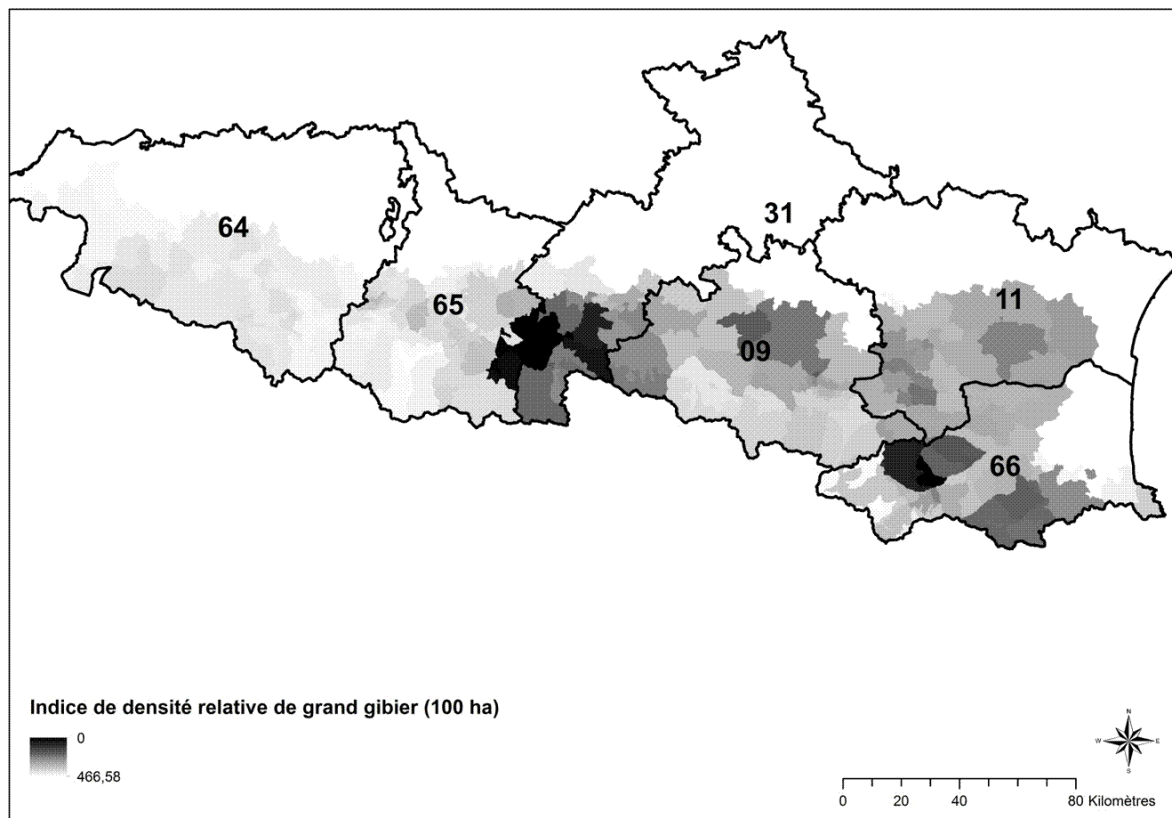
<https://wherehavealltheflowersgonesite.wordpress.com/author/wherehavealltheflowersgonesite/>



## Findings

### Phase 1 – The French Pyrenees

For the first phase of my Fellowship, I travelled to the French Pyrenees. Although much further south than Scotland, the climate there is comparable to that in Scotland – particularly in the western Pyrenees which experiences a wetter, more Atlantic-influenced climate than does the eastern Pyrenees. Most of the woods in the Pyrenees are (and have been) grazed by livestock and wild herbivores (which include red deer, roe deer, wild sheep and chamois) for centuries. As in many other parts of continental Europe, due to agricultural land abandonment in recent decades, the numbers of domestic livestock are currently in decline whilst wild deer numbers are increasing dramatically. The map below shows the relative densities of wild herbivores in the Pyrenees. The darker shaded areas have the lowest densities, and as can be seen, only a very small part of the region has low herbivore densities. Since I really wanted to experience woods with low herbivore impacts, the black areas on the map was where I was headed!



Map showing relative density of large herbivores in the French Pyrenees per 100ha (Menoni, E. 2017) map compiled using data from the hunting bags of the different species ( red deer , roe deer, wild boar, chamois, mountain sheep)

Much of the Pyrenean forest was completely cut over in the 18<sup>th</sup> century for a variety of reasons including the need to meet the demand for timber from the French navy to build ships to fight the British! It has been estimated that since that time, the forest area in France has more than trebled, and this increase has been almost entirely due to natural regeneration that has happened through agricultural land abandonment as a result of the rural exodus of people moving to urban centres.

With the help of Professor Bunce, I made contact with a team of ecologists working in the western Pyrenees, looking at the impact of herbivores on the Pyrenean capercaillie population. Dr Emmanuel Menoni (Manu), who works for the ONCFS (Office National de chasse et de la Faune Sauvage) and has spent many years in the Pyrenean forests studying the impact of red deer grazing on vegetation biodiversity kindly agreed to show me some of his study areas which have been selected for their lower herbivore impacts. His work is focussed on identifying appropriate habitat management requirements for capercaillie, and then working with others to get the right management implemented. The capercaillie is a forest bird which needs a very biodiverse field layer as their diet typically includes up to 120 plant species, so it is very sensitive to the impacts of overgrazing. (Menoni et al, 2008)



Philippe, Jean Paul, Kate and Manu in Pyrenean beech forest

Manu has set up some experimental exclosures to measure the effects of browsing on plant diversity, and results clearly show that certain plants (mainly the flowering plants) which are normally common, become rare when browsing pressure is high. (Menoni et al, 2008)

I was very fortunate to have had the chance to spend some time in Manu's company. This man was literally a walking encyclopaedia of all things to do with the natural history of the Pyrenees. Anything Manu didn't know about the plants, animals and birds of the Pyrenees, and the functional relationships that connect them, as well as how they could be of use to humans, was probably not worth knowing!

The forest in this part of the Pyrenees between 700m altitude up to 1800m is dominated by beech and silver fir. Above this zone is Scots pine, and above that juniper which gives way to mountain pastures. Lower down in the valleys are the richer ash, lime, hazel and elm woods.

During my week-long visit, Manu introduced me to some of his friends and colleagues working on different aspects of forest management and conservation, and I learned that French foresters seem to work on a much more ecological basis than their British counterparts, resulting in some very different management outcomes, such as an unwillingness to use herbicide to manage unwanted vegetation. We covered a lot of ground, saw some very beautiful landscapes, and visited many different and interesting forest types in the mountains from Castera near Castillon-en-Couserans in the east, to Isaux in the Basque Country near the western end of the Pyrenees. I want to focus here on two different woodland types that we visited, and use these to illustrate what I felt were the most obvious consequences of the lack of herbivore impacts on the woodland understorey in these Pyrenean forests.



### Old growth beech and silver fir forest – Cauterets, Marcadau Valley

As the map on page 16 shows, herbivore densities vary enormously across the Pyrenees, and consequently, so did the impacts on the vegetation. Many of the woods we visited showed signs of herbivore impacts. But in the heart of the Pyrenees National Park at Cauterets in the Marcadau Valley there was a very special old growth forest of ancient beech and silver fir that has never been logged, and where herbivore impacts have been, and remain very low.

There are no red deer in this part of the Pyrenees, and roe deer are only occasional within the forest; chamois come down into the upper edges of the forest in winter for shelter and to browse on the woodland understorey, but in the lower part of the forest, there is very little browsing damage from herbivores. As the forest has developed on a very steep slope, plenty of light reaches the forest floor, and so the vegetation there is well developed.



Silver fir and beech forest – Cauterets

In the clearings there were many flowering plants and shrubs including red-berried elder, mountain currant, hazel, bramble, rowan, blaeberry, raspberry, dog-rose, nettles, spurge laurel, spiraea and honeysuckle. There were also many un-browsed ferns including holly fern, oak fern and bracken.



A forest glade full of flowering plants and shrubs where the light penetrates to the forest floor



On the deeper, richer soils there were lots of flowering plants such as herb Paris, woodruff, yellow turk's cap lilies and sanicle. All of these species are palatable and sensitive to browsing, so their abundance within the lower forest confirmed the low level of herbivore impacts there.



Typical spring plants emerging in the forest

The glades within the forest were amazingly rich and busy places full of flowers, insects and birds. It was still quite early in the season, the snow had not long melted, and so not many plants were yet flowering, but the insects were busy on the early flowering saxifrages:



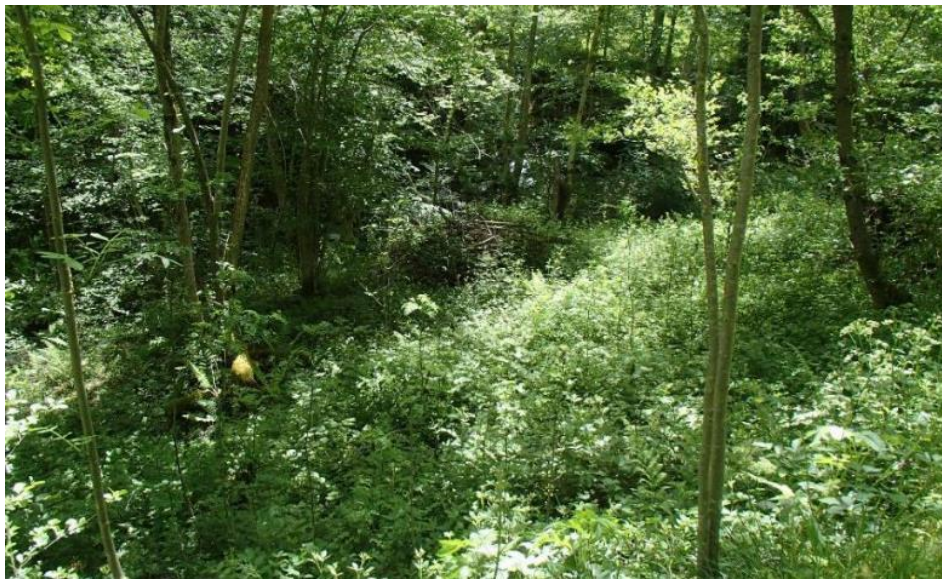
Insects feeding on the early flowering saxifrages

What impressed me most about the old growth forest at Cauterets was the diversity of structure and plant species in the understorey. This, according to Manu, was partly due to a lack of historical management intervention, together with low herbivore impacts sustained over the long term, which could be discerned from examining the vegetation.

### Ash woodland – Lesponne Valley

The woodland type in Scotland most impacted and altered by herbivores is the ash, elm, hazel woodland type of damper, richer soils typically found in valleys or at the bottom of slopes. This woodland type is characterised by having many flowering plants which tend to be palatable and grazing-sensitive so in Scotland there are rarely any flowers in them. I was keen to see what this woodland type would look like where there were fewer herbivores.

The pictures below say it all. The understorey in this ash woodland was largely unscathed by herbivore impacts, and young ash, hazel and oak trees were regenerating vigorously. Where the sun reached into the forest, the field layer was full of flowers including early purple orchid, herb bennet, herb Robert, scilla, garlic mustard, bladderwort, meadow buttercup, bramble and bugle. All of these were flowering:



Ash woodland with a lush field layer and abundant regeneration



A diverse and flower-full field layer in the ash woodland



### Economic activity linked to forest condition and productivity

As part of the project, I was interested to investigate to what extent productive forests in good condition were supporting economic activity, as well as being good for biodiversity.

Pyrenean forests are an important source of non-timber forest products for the local population. There is a significant honey “industry”, which was supplying the local market as well as the tourists. A particular speciality of the region is the now increasingly rare honeydew honey or Fir Tree Honey, which comes from bees harvesting the honeydew excreted by aphids feeding on the sap of the fir trees. Years ago, beekeepers could expect a successful honeydew harvest every three years, but with recent declines in aphid populations, there has been a corresponding drop in production of Fir Tree Honey. Honey producers in the region offer over 20 different kinds of honey – including hazel honey, wild raspberry honey and mountain wild flower. This diversity of honey is an indicator of the health of the ecosystem, because it is directly connected to the huge number of flowering plants in the Pyrenees.



Beekeeper inspects his hives

Jam produced from berries locally foraged in the woods and meadows provides a small amount of economic revenue, with the produce being sold both locally and to the tourist market. Many people still gather the berries and make their own jams for home consumption.

Firewood is still a very important forest product in the region. Many of the forests are communally managed, with the sale of timber generating a significant proportion of the commune’s budget, in places up to 20%, so the forest products do make an important contribution to the local economy! Some parts of the forest are designated for firewood and people can collect their own. It is estimated that at least 50% of people in the region still heat their homes with wood as they are allowed to take up to 10m<sup>3</sup> a year for their own consumption without paying. The number of people that do this is currently increasing, no doubt influenced by the rising cost of oil, the main alternative fuel in rural areas.





Beautifully stacked piles of firewood like this were a common sight

Many people in the mountains still supplement their domestic meat supply through hunting, although this too is becoming rarer, as people here, like everywhere else are increasingly turning to the supermarkets to meet their household needs. In state forests the hunting rights are let to local people, and it costs €70 for a year's hunting permit in a communal forest, for which you might typically expect to shoot around two red deer, a wild boar and a chamois to keep your freezer stocked.

#### **Main findings from the Pyrenean phase of the project**

- There are now very few areas with low herbivore impacts (see p17: evidence and map provided by Manu)
- There is a huge area of semi-natural forest, most of which is re-growth following the widespread felling of the 1800s (*pers. com.* 2017, Dr Emmanuel Menoni)
- Where deer and livestock are managed at a beneficial level, the forest productivity and biodiversity is high, and the forest understorey is full of flowers
- This ecological productivity now directly supports only limited economic activity as people's lives are becoming less closely bound up with the natural environment

#### **Phase 2 – The Isle of Wight**

The second phase of the project was to the Isle of Wight, an island less than 5 miles off the south coast of England. The reason for including this destination within the project was because the Isle of Wight is fairly unique in the British Isles for it has almost no wild deer. It is therefore a very special place where it is possible to study woodland processes in the absence of herbivore impacts.

According to historical records, deer had been hunted to extinction on the island by the 1870s, and since that time, the woodland on the island has developed in the total absence of the impacts of large herbivores. Approximately a third of the island is wooded with some large areas of native as well as plantation woodland, but in general the landscape is a mosaic of small woods, fields and hedgerows.

The woodlands that I visited mostly fell into the lowland mixed deciduous category or lowland base-rich ash hazel woods, so in general they had quite a dense canopy and were

shady on the forest floor. The trees were already in full leaf at the time of my visit, and so many of the plants had already finished flowering and were beginning to die back. However, despite this it was quite clear that the diversity and abundance of flowering plants was much higher than in equivalent Scottish woods. As many of these plants are very palatable, they tend not to be so abundant in Scottish woods, or else if they are present, then the flowers are often eaten. The woods on the Isle of Wight were full of plants such as bluebell, wild garlic, primrose and enchanter's nightshade, and that's not to mention the astonishing abundance of ferns – the like of which I had never before seen in a British wood.

Three things really stood out about the woods on the Isle of Wight:

1. The understorey
2. The ferns
3. The forest productivity

I spent a whole week on the Isle of Wight, and visited all of the main protected woodlands. With help from Emma Goldberg, Natural England's woodland advisor, I met up with Jamie Marsh and Steve Reid from the Hampshire and Isle of Wight Wildlife Trust that owns and manages several reserves on the island. They very kindly devoted a day to showing me round, and introducing me to the interesting work that the Trust is doing on the island, and answering my long list of questions. We could learn so much from studying the woods on this island I thought. It should be a compulsory part of any forestry course in the UK as there are so few places on the mainland where it is possible to study woodland processes in the absence of herbivore impacts.

I was also really grateful for Jon Cox of the People's Trust for Endangered Species and Richard Grogan's time and vast knowledge of the ecology and history of management of woods on the island. Much of what was discussed is in the Blog. I am particularly grateful to Jon for confirming that the main reason why the Isle of Wight's woods have so many of the rare species which have steadily declined and disappeared from similar woods on the mainland, is all to do with herbivore impacts.

### **The understorey**

Due to the almost complete absence of large herbivores, the woods on the Isle of Wight typically have a very well developed understorey with abundant and un-browsed climbing and trailing plants that create a thicket in the understorey. Species such as bramble, honeysuckle and ivy are all palatable to deer, and in most Scottish woods they are normally suppressed through browsing and confined to the ground layer where they never flower or fruit – or are simply just absent!

As well as being unique for their lack of deer, the woods on the Isle of Wight are unique in Britain for their dormouse and red squirrel populations. 70% of the woods on the island have dormice in them and 96% have red squirrel. Critical to this is the amount of bramble, honeysuckle and ivy in the scrubby understorey of the woods which provides both cover and food for the dormouse. Dormice make their nests in the old clumps of honeysuckle and ivy that grow up the stems of trees, and feed on the flowers which provide a rich source of nectar and protein. They also like to strip the bark off the honeysuckle to build their nests!





A tangled and productive understorey provides ample habitat for the many associated species

This understorey is also a really important factor in the importance of the Isle of Wight woods for bats, and in particular the rare Bechstein's bat, by providing habitat for the insects which the bats which feed on. Bechstein's bat is now one of the UK's rarest bats having previously been one of the commonest, and its decline is almost certainly linked to the loss of understorey from many of Britain's woodlands due to the increasing impacts of large herbivores.

The abundance of these three rare mammals in the Isle of Wight woods seemed to be proof of the importance of woodland understorey for biodiversity. Few Scottish woods have any understorey. In particular, there has grown up around our having got used to woods without an understorey a perception that a woodland filled with bramble, ivy and honeysuckle is undesirable, and the presence of this within woodlands is often described using pejorative terms (even by woodland ecologists) such as "rank growth". It seemed to me from what I saw in the Isle of Wight that far from being undesirable, this woodland understorey was critical to the importance of these woods for a number of nationally rare mammal species. The absence of this "filling" from many woods in the UK seemed to me to be implicated in the rarity of these species elsewhere.

### The ferns

Not only do large herbivores completely change the structure of woods by removing the plants that make up the understorey, but they also change the species composition by selectively eating more of the palatable species, and suppressing the more grazing-sensitive species.





Due largely to the absence of herbivores, the abundance of ferns in the field layer of these woods was impressive

The woods of the Isle of Wight were notable for their abundance of ferns – none of which were particularly rare, but many are palatable to deer, and therefore rarely seen in the understorey of Scottish woods, except in inaccessible places and out of reach of grazing mouths.



An un-browsed field layer rich in ferns and other shade tolerant plants

The understorey of these woods was so luxuriant that in places it resembled a huge botanical garden!



### Forest productivity underpins economic productivity

Because of the absence of deer, there is no need for costly protective fencing or deer management in these woods. You can cut down trees, harvest the timber, walk away and return 18 years later in the sure knowledge that there will be another crop of round-wood to be harvested. It was a bit of a shock to realise just how easy it could be to manage a wood for a useful return if you don't have to spend so much time and resources battling to keep the deer impacts to an acceptable level. The newly coppiced hazel in the pictures below had already grown more than 30cm this season at the time of my visit at the end of May!



Coppiced (left) and pleached (right) hazel re-grows very quickly in the absence of large herbivores. “Pleaching” involves cutting the hazel shoots almost right through and laying them onto the ground where they can root and shoot.

The hazel in the photo below was cut just 5 years ago, and the re-growth of bramble, nettle, ash and hazel is already well over Jamie’s head. Clearly the mild climate is an important factor, but because of the total lack of herbivore impacts this growth is all “net gain” and there is no cost to protecting this productivity....it all just grows!



Jamie Marsh in a hazel stand that was cut only 5 years ago!



Many of the woods that I visited are being managed on a coppice rotation of 20 years to produce round-wood that is used to generate income through the sale of fencing, firewood, charcoal etc.



Firewood, charcoal, gates and hurdles – renewable by-products from a productive managed forest

At Borthwood Copse, a hectare of 25 year old sweet chestnut was cut recently generating an amazing 1500 4 x 4 fence posts.

In the absence of herbivores there are almost no management costs, and the resulting productivity is impressive. The trees simply grow!!



Sweet chestnut stand harvested recently yielded 1500 4x4 fence posts

#### Main findings from the Isle of Wight phase of the project:

- Woodland understorey is really important in providing homes for a wide range of species, many of which are now nationally rare
- Un-grazed woods are not necessarily rank, species poor and uninteresting, contrary to the widely accepted received wisdom amongst British woodland ecologists
- Economic returns from timber can be significant when productivity and tree growth is not limited by herbivores, and there is no need for costly deer protection



### Phase 3 – South-west Norway



View of wooded islands, Hidrasund, south-west Norway

South-west Norway is a very interesting place to visit coming from Scotland because prior to the 1950s, this part of Norway was largely deforested due to burning and grazing by livestock and deer. It looked then much like the Scottish uplands do today: largely devoid of trees. This is really hard to believe because today south-west Norway is a very afforested region. The vast majority of this woodland has arisen through natural regeneration.

The explanation for this dramatic transformation in land cover is that between 1860 and 1920 many of the small farms in the area were abandoned as people left the land in their thousands. They were mainly emigrating to America, leaving the land to slowly heal under nature's direction. At around the same time, deer (red and roe) and moose had become extinct in the region through over-hunting. Their numbers have steadily increased since that time, and in 2012 there were estimated to be about 150,000 roe deer and a similar number of red deer and moose in Norway (Halley, NINA). Woodland regeneration began around 1969 when herbivore numbers were still low, and has continued since then. The rate of woodland expansion is likely to be at its peak currently. (D. Halley, *pers. com*) There is now so much forest and consequently so much browse in the forest understorey for the deer to eat that, for the most part, the deer have little obvious impact. However, in the last few years carcass weights, body condition and calving percentages of shot red deer shot have started to decline suggesting that the growing population has now exceeded the level at which deer health and productivity is at its highest. Having increased to this level, deer are now beginning to impact on agriculture and forestry, and numbers of road and rail collisions are also increasing. Consequently in response to this situation and to bring carcass weights back up, deer management groups are increasing their culls. This action should help to bring deer numbers and their impacts back down.

The climate in south-west Norway is almost identical to that of the west coast of Scotland, if anything, it is slightly windier and rainier, but average temperatures and snowfall are very similar. Geology and soils are also comparable, being mainly acidic gneiss and granite. (D. Halley, *pers. com*)

So where did all the woodland come from? How did it manage to regenerate? Presumably woodland refugia clinging to the precipitously steep slopes of the fjords provided a source of seeds and plant material from which the lower slopes could be fairly rapidly re-vegetated:



Birch woodland on boulder scree at Gloppedalsura, south-west Norway

It is not absolutely certain how long this transformation of the landscape from “largely unwooded” to “predominantly wooded” has taken, but the predominant land-cover in south-west Norway has been completely transformed over the past 100 years. The biggest changes have taken place in the second half of this period, as the process of restoration is most likely not linear. As more trees reach seed producing age the process of woodland regeneration and expansion becomes exponential.

So, in common with the Pyrenees, there is very little “ancient” woodland in Norway; most of the trees are less than 100 years old. Yet, despite their apparent young age, the woodland ecosystem seems to be well on the way to recovering a full assemblage of woodland species and processes. It was very encouraging to see the outcome of such extensive ecological restoration. It should be an inspiration for us that, given the right level of herbivore impacts, a similar healing process could take place in Scotland.

### **Notable differences in plant abundance and distribution between SW Norway and Scotland**

It was very interesting to observe that plants such as dwarf cornel and northern bilberry, which in Scotland are largely confined to mountain heaths and snow beds and very rarely found in woodland, are abundant in Norwegian woods regardless of woodland type. Presumably they are particularly palatable and/or sensitive to grazing, and so can only survive in the Scottish landscape in snowbeds where they are protected by the snow from winter grazing.





Dwarf cornel



Northern bilberry

As with the woods on the Isle of Wight, woodland ferns in Norway attain a presence, not just in terms of their abundance and diversity, but also their vitality. Many ferns are palatable to deer and sheep – particularly in the early summer – so, apart from the unpalatable bracken which can, and often does attain an exclusive dominance in Scottish woods, many fern species are often absent or sparse in Scottish woods.



Abundant ferns in the field layer. Garden Li, south-west Norway

### Montane scrub

Montane scrub, or mountain woodland, is widespread in Norway, and not confined to one or two locations as it is in Scotland. Instead it is part of that ecological continuum of woodland with increasing altitude that eventually peters out into heathland where conditions for tree growth become too environmentally challenging. The dwarf birch and woolly willow montane scrub that is prolific in south-west Norway is only browsed in the summer. This is because in contrast to the Scottish hills where the sheep are out grazing all year round, Norwegian sheep spend their winters either in sheds or grazing on snow-free coastal pastures, and are only brought up to the hills to graze the newly flushing vegetation once this has emerged



from the protection of the melting snow over the summer months from June to September. This difference in climate which results in long snow-lie means the Norwegian uplands are largely un-grazed during the winter months, and in this respect, they are very different to the Scottish uplands. This seasonal grazing is most likely a major causal factor in the extensive distribution of montane scrub in south-west Norway compared to Scotland where it is rare.



Montane scrub at Budalen, near Trondheim, Norway

Consequently, the Norwegian uplands appear to be in much better condition and contain a great many more species than its Scottish equivalent. Furthermore a great many more of these species were flowering than you would expect to see in the Scottish uplands.

Deer grass, for example, although common on Scottish upland heaths is rarely seen flowering as the flowers are preferentially eaten by the deer and sheep. In Norway it was commonly seen flowering. Other flowering plants such as bog rosemary, cloudberry and dwarf cornel were abundant and flowering – again a rare sight on a Scottish heath. As the flowers are high in nitrogen, they are therefore favourite titbits for the deer and sheep, and are frequently the first things to be eaten.



Cloudberry

The tasty fruits of cloudberry are a much relished seasonal treat for mountain hikers in Norway. People have their favourite patches keeping the knowledge of their whereabouts a closely guarded secret!

We in Scotland are clearly missing out on something good!



### Understorey development after 70+ years of no grazing

In base rich woods such as the ash alder wood that I visited at Hystad Wood which has been completely un-grazed since the 1940s, palatable species such as valerian, wood avens, wild garlic, sanicle, wood anemone, woundwort and wood cranesbill were flowering in the field layer, while the shrub layer contained abundant dog rose, honeysuckle, ivy, hazel and even some holly.

A question relevant to woodland restoration in Scotland was to understand how had all these species survived during the historical period when the woods had been so heavily grazed? Presumably some species had persisted in “refugia” out of reach of grazing mouths on inaccessible ledges, whilst others are likely to have subsequently blown in or been brought in by birds or other seed vectors. The species-rich woods that we visited around Stavanger are at about the same latitude as the Orkney Isles in Scotland, yet the diversity of species and structure in the Norwegian woods, not to mention the overall productivity far exceeded what you would find on the Scottish mainland, never mind on Orkney! Could all this difference really be attributed to herbivore impacts alone?



An un-grazed understorey – Hystad Wood, south-west Norway

Hystad Wood, south of Bergen which has been free of large herbivores since the 1940s was a particularly inspiring wood. The complex structural diversity is obvious in the photo above, but one of the most astonishing features of this wood was the ancient honeysuckle. In Scotland, this plant rarely makes it out of the field layer, and consequently rarely flowers or fruits – but as its name suggests, this plant is an important source of nectar for many species. In Hystad the wildly looping ancient honeysuckle vines snaked along the ground before pulling themselves up into the woodland canopy where they literally burst into a mass of sweet-scented flowers absolutely alive with insects:



Honeysuckle in the understorey – Hystad Wood, south-west Norway

### Main findings from the Norwegian phase of the project:

- There has been incredible landscape-scale ecological restoration across much of south-west Norway over the past 100 years entirely as a result of a dramatic reduction in large herbivore numbers (Halley, D. 2017 *pers. com.*)
- The landscape has been transformed from an open grazed landscape to a predominantly wooded landscape entirely through natural regeneration as a result of the reduction in browsing pressure (Halley, D. 2017 *pers. com.*)
- The woodlands have expanded from the cliff and gully refugia to which they had retreated on cliffs and in gullies to the extent that forest is now the predominant vegetation cover in south-west Norway (Halley, D. 2017 *pers. com.*)
- As a result of reduced browsing pressure, the understorey species and structural diversity of Norwegian woods greatly exceeds that of equivalent Scottish woods, despite being at a higher latitude and subject to more extreme weather
- There are many more flowers and berries in Norwegian woods than there are in Scottish woods as a direct consequence of lower herbivore impacts
- Species such as dwarf cornel and northern bilberry, which in Scotland are largely confined to mountain heaths and snow beds and are very rarely found in woodland, are abundant in Norwegian woods regardless of woodland type
- Norwegian farmers meet their own fencing and firewood requirements from their own scrub woodland. This represents a significant economic saving



## Phase 4 – Iceland



A view across Pingvellir National Park, Iceland

When I found out that there are woods in Iceland that have been free of herbivore impacts for more than 100 years, it seemed really important that I should visit these woods as part of the project. Located 700 miles north of Scotland in the North Atlantic, woodland plant communities in Iceland have to deal with more challenging environmental conditions than woods in Scotland. When Dr Bjarni Sigurdsson, Professor of Forestry at the Icelandic Agricultural University sent me some pictures of the un-grazed Icelandic birch woods I could hardly believe it – they were literally full of flowers!

Iceland was first settled by the Norse in about 870AD. Pollen records show that at that time Iceland was largely wooded with birch, willow and rowan scrub. A tiny amount of aspen is present in the pollen record, and there have been 6 separate stands recorded recently from around the island but somewhat surprisingly there has never been any hazel recorded on the island. And juniper, which was quite common in the pollen record, although common on the island, is quite rare within woodlands. Tea-leaved willow (*Salix phyllicifolia*), is an abundant shrub in the understorey, and occasionally reaches tree size. All of these species more often grow as large shrubs than trees in Iceland and none of them ever gets very big, roughly 15 meters in height being the maximum for the birch, rowan and aspen.

In a pamphlet published by the Icelandic Forest Service in 2013 there is a quote:

*“Among the first things that visitors to Iceland usually notice are that it is not as warm as where they came from and there is a lack of forests in the landscape. Logically they connect these two facts and come to the conclusion that Iceland is too cold for forests. This impression is often reinforced when they see the “forests” of low-growing and crooked native birch. However, it is past land-use and not climate that explains the treeless landscape. In fact, forests grow as well in Iceland as they do in parts of the world where forestry is a major industry.”*

Iceland has not always been as treeless as it is today. The Icelandic Sagas that were written in the 13th and 14th centuries describe the process of the settlement of Iceland by the Norse. One of the Sagas (The Book of Icelanders) describes Iceland at the time of

settlement as being “Wooded from firth to fell”. Elsewhere in the Sagas it is also mentioned that the island was “...so thickly wooded (at that time) that travel into the interior was too difficult, and so exploration of the island had to be via incursions from the sea...”

Iceland has no native herbivores apart from geese and ptarmigan, but the Norse settlers brought sheep, cattle, pigs and goats, and the loss and degradation of the Icelandic woodland dates from that time. By the early 1900s the overgrazing had led to the almost total depletion of Iceland’s forests, and other habitats were so degraded that there was serious soil erosion, and associated vegetation loss and sandstorms because Icelandic soils are very shallow and fragile due to their volcanic origin. The extent of Icelandic birch woods probably reached a post-glacial minimum of less than 1% of the total land area around the mid-20th century. By that time, several woodland remnants had been protected from grazing and birch had started to spread within these enclosures. Afforestation by planting had also started.



Sheep grazed uplands, eastern Iceland

Sheep reign supreme in Iceland. They have been for centuries, and still are, the backbone of Iceland’s rural culture. Sheep numbers in Iceland reached a maximum in the 1980s of around 1 million, encouraged by the subsidy system, but since that time their numbers have been falling. There are currently less than 500,000, and all over Iceland where the sheep have been removed, the native birch trees are starting to come back. They grow slowly, but ecological restoration in the shape of birch forest regeneration is definitely underway in many parts of the country.



Regenerating birch scrub in eastern Iceland



Some of the protected birch woodland remnants that survived the period of overgrazing have now been free from sheep grazing for up to 100 years, and with the help of local experts I was able to explore these woods to see how they have developed in this time, and to what extent the ground vegetation and understorey has recovered. Given that the growth rates in Iceland are slower than in Scotland, this knowledge could help give us an idea of how long woodland restoration like this might take in Scotland.

Somewhat surprisingly, the weather around the coast of Iceland is not that different to the weather in Scotland. The pattern of precipitation in Iceland reflects the passage of atmospheric low pressure cyclones across the North Atlantic from the south-west, exposing the south coast to heavy precipitation. Rainfall around the coast varies between 1200 – 4000 mm /annum, and winters in Iceland are generally very mild for this northerly latitude. The coastal lowlands have mean January temperatures close to 0°C, and only in the highlands of central Iceland do the temperatures stay below -10°C. So despite its proximity to the Arctic Circle, it did seem reasonable to compare woodland development in Iceland to Scotland. Particularly since, almost without exception, the woodlands in Iceland are confined to the coastal lowlands.

So I came to the land of the midnight sun to visit some of their amazing and very beautiful woods.

### Woodland productivity

Dr Scott Riddell is a Scottish ecologist who lives with his family in Iceland. Scott had previously worked as a wildlife ranger at Þingvellir National Park, so knew it well and kindly spent one of those incredible long Icelandic summer days giving us a very comprehensive tour of the woods of the park. In Þingvellir we saw birch woods with a field layer full of flowering plants the like of which I had never seen the like of in Scotland.

It has been estimated that the annual production of the ground vegetation and trees in these woodlands in Þingvellir that have been protected from herbivores for many decades, is **up to four times higher** than the average for the open treeless rangelands (Jonasson 1992). Scott showed us an area of woodland that has grown up on a spit of land which, just 10 years ago was treeless, and which is now well on the way to becoming a birch woodland (see photo below):



Regenerating birch woodland, Þingvellir National Park

Within the National Park, the soils are mostly postglacial lava covered with shallow, dry and nutrient poor soils so the growth rates are not high. Birch saplings that we looked at were

only putting on about 10cm of growth per annum. In spite of this, it was clear that woodland expansion and development was steadily progressing across the valley.

This is an amazing turn-around given recent levels of herbivore pressure in Iceland. I could not help wondering how many of our overgrazed Scottish birch woods could, given the chance, could develop as these woods have? And if they did, how much more biodiversity and economic activity could be supported through the greatly enhanced rates of productivity?

### Flowers

I had embarked on this Fellowship asking the question “Where have all the flowers gone?” The answer was more obvious in the un-grazed northern birchwoods of Iceland, than in any of the other woods I had visited. I have never been in woods so full of flowers. Where the woods have been protected from grazing, the woodland floor was literally a carpet of flowers. Fruiting shrubs were common and there was amazing structural diversity. The understorey vegetation in these protected woods is lush and consists of shrubs, grasses and tall growing flowering plants such as wood cranesbill, hawkweed, dandelion, buttercup, stone bramble and lady’s mantle. As in Norway, northern bilberry is a constant associate of these birch woods, seemingly occupying the niche in Scotland taken by blaeberry – and providing an important source of food in the form of nectar, pollen and fruit for a wide range of associated and dependent species. All of these plants can be found *flowering* under the canopy of the dwarf woodland across the valley, and the nectar and pollen provided by the flowers are valued by the many bumble bees and other insects. This abundance of flowers is all the more remarkable since Iceland has less than a third of the vascular plant species that occur in the UK. This is because Iceland spent the last Ice Age under a glacier which erased all or most of the vegetation that had previously established itself on the island, and presumably it was a lot harder for plants to get back to Iceland than it was for them to get back to Britain.

Importantly, whilst most of the woods that we visited had been protected from herbivore impacts for many decades, we did find a wood that had clearly been recently grazed by horses and sheep, and consequently looked very like our overgrazed Scottish birch woods. The heather and other dwarf shrubs were greatly reduced in stature, the basal shoots of the birch were grazed into oblivion and there were very few flowers – just some clover:



Grazed birch woodland in eastern Iceland



Compare the previous woodland with the wood in the photo below that has had no grazing for >100 years:



Flower-full understorey in Baejerstadskogur birch woodland, southern Iceland

Most of the plants growing in these woods are highly palatable to sheep, and so very vulnerable to grazing. They are therefore hardly found in the open range vegetation in Iceland that is grazed by sheep. Interestingly, these species are all widely distributed in Scotland (with the exception of stone bramble which has a more restricted distribution) but are rarely seen. They are *completely absent* as flowering plants from our native birch woodlands, almost certainly due to our long history of using the birch woodlands for grazing sheep and now for sheltering deer.

### Woodland restoration

At Laugarvatn there is an area of birch woodland that has been protected from grazing for over 100 years! At the time of enclosure there were reported to be some scattered birch woodland remnants 1-2 metres tall within the area, but in between it was still mostly un-forested grasslands and eroded land. Since 1912, the birch woodland has greatly expanded from 75ha (the original area of protected land containing patches of birch woodland) to become, at over 35km<sup>2</sup>, one of the largest continuous birch woodlands in Iceland extending from the foothills of the mountains in Laugarvatn to Geysir (Haukadalur).

The ground flora here was lush and very diverse – especially in comparison to that of similar woods in Scotland. The flora of the wooded areas, which tended to be on deeper soils and a bit damper than the open areas, was a mix of tall herbs such as meadow buttercup, wood horsetail, wood cranesbill, hawkweed, tufted hair grass, meadowsweet, lady's mantle, dandelion, and water avens but there were also rarities such as herb Paris and common wintergreen. These plants have a very restricted distribution in Scotland, but having found them in un-grazed woods in Iceland I have started to wonder whether, with lower grazing pressure, these species might actually be more common in Scottish ash and hazel woods than they are at present.

### Ancient Icelandic un-grazed woodland

We visited Bæjarstaðarskógur in the company of Dr Bjarni Sigurdsson, Professor of Forestry at the Icelandic Agricultural University and his daughter. Bjarni has been studying this wood for most of his life, and so there was no-one better suited to tell us its story. Bjarni was like an Icelandic geyser of knowledge about Iceland, its woods and grazing ecology, and I struggled to keep up and write notes as we headed off across the lava flow towards the woodland some 5 miles distant.

The woodland at Bæjarstaðarskógur was heavily utilised for firewood until about 1830, with all the big trees in the forest having been felled by that time. Wood cutting ceased altogether in 1850 when coal started to be imported from the UK, and by 1910 a botanist visiting Bæjarstaðarskógur wood felt moved to describe it as the most lush forest in Iceland. The oldest trees there are now believed to be 150-180 years old, so it is unique in Iceland as it is the only place where there are very old trees and any quantity of deadwood. It is interesting to speculate on what the deadwood invertebrates of this wood might be like, since saproxylic invertebrates are not normally known for their dispersal capabilities. Today the birch trees in Bæjarstaðarskógur reach 10-12 metres in height so they are substantial forest trees by any standards.

The ground flora in the wood was rich in flowering plants and young birch trees were regenerating throughout. Young rowan trees were beginning to colonise, most likely from just two mature trees in a nearby gully. It was surprising, given the age of these rowans, that there was not more rowan regeneration within the wood, and not clear why this might be.

As there is no browsing pressure at all in this wood, and most of the trees produce basal shoots; when a mature tree falls down it gets replaced by basal shoot re-growth which can be up to 30cm/year! Growth like this from basal shoots even on birch (see picture on right) is something you rarely see on birch in Scotland due to the browsing pressure.

On Bjarni's recommendation, we also visited Vaglaskógur, which is a 300-hectare forest in Fnjóskadalur, and the second largest forest in the country. The Vaglir birch grow straighter and taller than other birches in Iceland reaching well over 10 metres, but the flowering plants in this wood were the most impressive of all the woods we visited on Iceland. The usual wood cranesbill and buttercup were abundant, but there was also masses of flowering small cow-wheat – an extremely rare plant in Iceland and not previously recorded from this woodland. It was growing in vast drifts of bright yellow flowers. I have never seen cow-wheat growing like this in such a profusion of flowers, mixed in with the cranesbill. Frog orchids, moonwort, common wintergreen, yarrow, stone bramble, lady's bedstraw, autumn hawkbit, alpine bartsia and northern butterfly orchid were also flowering in profusion throughout the wood. The floor of the forest was quite literally carpeted with flowers!







A flower-rich field layer in Vaglaskógur, northern Iceland

Vaglaskógur is another wood that we visited, of about 690 hectares, that has been protected from herbivore grazing by a forest conservation fence since 1905. No other birch forest in Iceland has been the subject of strategic conservation as long as Vaglaskógur.





Biodiverse and flower-full Baejerstadskogur

The vitality, lushness and productivity of the vegetation in these Icelandic woods, together with the abundance of flowers, was overwhelming, being used as we were to our over-grazed and unproductive Scottish equivalents. If woods can develop such impressive structural and botanical diversity at this latitude, and under the Icelandic environmental conditions, then surely, it should be possible to recreate some of what we saw in Iceland in Scotland?

### **Economic productivity in Icelandic woodlands**

Because most Icelanders have grown up with there being very little woodland, there isn't a culture of woodland foraging in Iceland. Recently, Bjarni and others have run some courses in foraging for woodland fungi, and these have proved to be very popular, but there is still much work to be done to establish a foraging culture.



Currently just over 1% of the area of Iceland is native birch forest, but birch woods in Iceland are not yet economically important as a source of wood, so Iceland still imports virtually all of its timber. However, there are a growing number of niche markets on the island, that are now being supplied with wood from selective felling in the larger Icelandic birch forests and thinning of the plantations. Examples include:

- Annual firewood production of around 200 tonnes
- Fuelwood for heating buildings in non-geothermal areas
- Larch fence posts
- Small quantities of larch and spruce timber

We visited the first building to be constructed from Icelandic timber in eastern Iceland. The building in the photo below, on Vallanes Farm, is grown entirely from native aspen that took 40 years to grow:



The Aspen Building, Vallanes Farm, eastern Iceland

### Main findings from the Icelandic phase of the project

- Despite a depleted flora in comparison to Scotland, Iceland's un-grazed birch woods are full of flowers
- Long-term herbivore exclusion (>100 years) does not appear to have impacted negatively on vascular plant species and structural diversity
- Reductions in sheep numbers is leading to widespread woodland regeneration at a landscape scale (Sigurdsson, B. 2017. *Pers.com.*)
- Plants and communities that are confined to snowbeds and inaccessible ledges in Scotland such as dwarf cornel, northern bilberry and stone bramble, are common and abundant in Icelandic woods
- Bird species such as golden plover, whimbrel and ptarmigan which are confined to upland moorland in Scotland are found in mosaics of birch woodland in Iceland
- Where herbivore impacts are not managed, the woods look just like their Scottish overgrazed counterparts
- Wild foraging and timber production are just beginning to emerge as sources of economic revenue or contributing to domestic consumption in Iceland, but the new forestry strategy published in 2013 has targets for woodland expansion through planting and natural regeneration, and for the forest to have an increasing role as a resource for people and nature alike

## Relating project findings to the UK

During my 6 week long Fellowship I visited many woods in the four countries I travelled to, across a range of latitude, topography and soil types. The woods I visited had all had a long history of very little or no browsing impacts from large herbivores, and they all had:

- abundant flowers
- high ecological productivity
- astonishing biodiversity and bio-abundance
- a well-developed understorey with shrubs such as dog rose or low shrubs such as blaeberry, stone bramble and northern bilberry, and trailing and climbing species such as honeysuckle and bramble; all of which produce flowers and edible fruit
- abundant regeneration with little or no costly management intervention
- the capacity to support foraging and economic activity

Iceland, south-west Norway and the French Pyrenees have all experienced ecological degradation due to overgrazing during the past few hundred years, which has resulted in a loss of woodland and ecological productivity. Consequently there has been a loss of economic productivity and social and cultural disintegration, as there has been in Scotland. For different reasons, in each of Iceland, south-west Norway and the French Pyrenees during the past hundred years, there has been a significant reduction in herbivore numbers. This has permitted ecological restoration to take place. Woodland has regenerated at a landscape scale, with the return of ecological productivity, and all of the many related environmental, economic and social benefits.

In Scotland, recent survey by the Forestry Commission has shown that less than 46% of our semi-natural woodlands are in satisfactory condition for biodiversity due to a similar history of overgrazing. Furthermore, due largely to current levels of herbivore impacts, the amount and distribution of regeneration is not yet enough to sustain all of our native woodland resource in the long term (Patterson et al 2014). The findings from my Fellowship provide some evidence for what our woods could look like if herbivore impacts were lower. The numbers of large herbivores in Scottish woods, whether sheep or deer, have been so high for so long that few of us have any idea what a wood would look like if there fewer herbivores. The received wisdom is that without herbivores woods become rank and low in biodiversity, but this is not at all what I found in the lightly or un-grazed woods I visited. On the contrary, the evidence I gathered suggested very strongly that a similar reduction in herbivore numbers across the landscape in Scotland would lead to a similar outcome to what has been achieved in Iceland, south-west Norway and the French Pyrenees.

There are few woods in Scotland currently that compare in terms of their ecological diversity and productivity with woods I visited in Iceland, south-west Norway and the French Pyrenees. However, there are now a growing number of successful landscape scale herbivore reductions in Scotland that are resulting in ecological restoration such as at Creag Meagaidh National Nature Reserve, Glen Feshie, Abernethy Forest, Carrifran Glen, Knoydart, Kirkton Glen and Alladale Forest to name some of the larger sites. These sites demonstrate that where there is commitment to a sustained and significant reduction in wild herbivores over a number of years, the ecosystem responds with green shoots of hope. Trees are beginning to grow in these places again, and as they grow and become established, other associated species slowly return. The more mobile species are the first to return, but work at Carrifran (Adair, S., 2016) and Kirkton Glen has shown that over a period of 10 years or so, the vegetation has already significantly changed in structure and composition, with the return of grazing sensitive and rare plant communities such as willow scrub and tall herb. In time, other ecosystem associates will hopefully recolonise these



restored areas. Eventually the hope is that these regenerating landscapes will once again be able to support and sustain real livelihoods and sustainable communities of people.

## Conclusions

My aim had been to find woods in different parts of Europe that are not subject to overgrazing by large herbivores which can be compared ecologically with Scotland. In all of the countries I visited I managed to find woods with very low or no impacts from large herbivores currently (although in both France and Norway, more recently increasing deer and livestock numbers are once again beginning to threaten the ecological health of the woodlands).

As a result of what I saw and learned on my Fellowship, I have reached the following conclusions in relation to Scottish woods:

1. Scotland's woods should be more “flower-full”
2. the understorey or woodland “filling” is missing from most woods
3. and because there are so few flowers, there are also few woodland berries such as raspberries, blaberries, rosehips and brambles

The implications of these conclusions are that:

1. Due to the flowers being preferentially browsed, few flowering plants are able to complete their reproductive cycle, and many are therefore “obliged” to reproduce vegetatively. Therefore there will be no new genetic types emerging. If current genotypes are adapted to current conditions, then this lack of ability to produce new genotypes may limit resilience to change, and therefore potentially resilience to novel pests and pathogens.
2. Many dependent species (insects, birds and mammals) are missing from our woods because there is not enough food for them to eat and few places for them to live
3. Woodlands characterised by palatable and grazing-sensitive species and communities may be highly modified by herbivore impacts. In Scotland, the distribution, extent and composition of these species-rich woodland communities has been greatly altered in landscapes that have a long history of supporting large numbers of herbivores.
4. Due to the restored productivity of woods in rural areas of south-west Norway and the French Pyrenees, most people still get their firewood from the woods, and foraging for woodland berries and mushrooms is still a big part of the culture. However, nowadays it is generally for domestic consumption rather than as an economic activity, as fewer and fewer people supplement their income through foraging from the woods. The number of people that procure their domestic meat supply (or part of it) through hunting is in decline in the French Pyrenees, but in Norway hunting is still a culturally important activity and an important source of the meat consumed domestically.

The focus of my Fellowship was on woodland flowers, but it was impossible not to notice the consequences of herbivore impacts on the wider landscape. These are some additional conclusions that I have reached in relation to the wider landscape that have significant

implications for ecological diversity and productivity, and therefore inevitably also on Scotland's natural capital:

- Due to grazing by domestic stock and the **imbalance between wild herbivores and predators**, habitats in Scotland have been depleted over hundreds of years by overgrazing, and are now functioning at a very low level of ecological productivity. This means that our **natural capital** is currently considerably less than it could potentially be.
- Vegetation communities that in Scotland currently have a very restricted distribution, such as **tall herb vegetation and communities of snow-beds and cliff ledges** have most likely "retreated" to inaccessible places, because they are palatable and/or sensitive to grazing. I believe they would have once been much more abundant in the landscape. In the other countries visited, where grazing pressure is much lower, these vegetation communities are much more frequent and extensive, and not confined to inaccessible places.

- Bird and mammal species which here are associated with open moorland habitats may be using these areas only because there is little alternative. In the other countries that I visited, where herbivore pressure is lower, **moorland birds** such



Golden plover in regenerating birch scrub (photo: Lorna Holl)

as golden eagle, ptarmigan, whimbrel and golden plover (left amongst regenerating birch scrub) **seem to thrive in woodland mosaic landscapes**. Additionally, where deer have access to woodland for food and shelter, they tend to be significantly larger.

- My findings did not support the received wisdom of many ecologists in this country, which is that without grazing, woodland ecosystems become rank and species poor (at least in relation to higher plants). I did not look at lower plants, and it is possible that the return of a woodland understorey as a result of reduced grazing, would make conditions less favourable for some woodland lower plants in some situations. Lower plants, which need open, light-filled conditions, have probably benefitted from the centuries of overgrazing that has resulted in so many woodlands without "filling". However, what I found through this Fellowship, contrary to the received wisdom, was that woods that had been free of grazing for the longest appeared to be the most flower-ful and biodiverse.



## Recommendations

Following on from these conclusions, my main recommendation is that there is now an urgent need to significantly reduce large herbivore numbers across Scotland in order to allow ecological restoration of over-grazed habitats.

I believe that ecological restoration would begin to happen if we could get our wild herbivore numbers down low enough for long enough – which could be about 50 years. When the annual increment of plant growth exceeds the biomass removed by herbivores every year, and the seed rain from plants and trees is everywhere then ecological productivity would increase.

Under these conditions, we could expect that deer would be bigger and in better condition because of having access to more and better quality forage and shelter. Livestock would be more productive for the same reasons. There would be timber, firewood and other non-timber forest products. Biodiversity would increase. And people, through having access to healthy, productive woodlands, could be healthier and better provisioned.

The first steps in starting to work towards this vision, might include:

1. articulating and sharing the story about the current ecological condition of Scotland's native woodlands
2. developing, in a collaborative way, a new and inspiring vision for a more ecologically and hence also economically productive environment
3. sharing this vision of a "Re-flowering Scotland" widely
4. setting targets to help us start to move towards delivering the vision
5. monitoring progress

## Further work

I want to disseminate the findings from my Fellowship as widely as possible, and to use what I have learned to feed into a public conversation about the Re-Flowering of Scotland. I plan to do this through:

- The blog that I wrote during the travel phase of my Fellowship, which at the time of writing, has already been viewed by over 1000 people from 12 different countries. Some of the key findings have been posted on other websites around the world.
- Publishing the story of "Where have all the Flowers Gone?" in popular journals such as British Wildlife, Reforesting Scotland, Scottish Forestry,
- Using the findings from my Fellowship to stimulate conversations about "Re-flowering Scotland":
  - Contribute a session to an SNH Sharing Good Practice workshop on Woodland Wildflowers
  - Run a workshop with SNH and Forestry Commission staff
  - Get an MSP to sponsor a session on "Re-Flowering Scotland" at the Scottish Parliament
- producing a short film to help communicate the main messages from my Fellowship

The Scottish Government has recently consulted on the development of a Strategic Review of the Uplands. I am keen for the findings from this Fellowship to feed in to the development of this new Upland Vision for Scotland.

## Challenges in implementing the recommendations

- **People's perceptions** Most people believe that the treeless hills of Scotland are natural, glorious and to be celebrated. Few people who have lived all their lives in the UK realise that the Scottish uplands are extremely ecologically degraded, and that the bare hills are a consequence of centuries of extractive management and overgrazing. It has been like this for so long that we think it is “normal” and even “natural”. Before the publication of the results of the Forestry Commission's Native Woodland Survey, few people realised that there was anything wrong with our woods. There is a lot of cultural and emotional baggage around the so-called “traditional management” of the uplands connected to the way the land is currently managed that results in it looking the way it does today.
- **People are resistant to change**
- **Political sensitivity** around challenging the land-owning minority to change the current dominant land management paradigms
- **Prevailing land-use** in large parts of Scotland is about large herbivores whether deer or sheep.
- **Lack of a clear understanding of the need for change** to do with establishing a public and political consensus around the ecological condition of our semi-natural woods and the uplands generally, which is to do with biodiversity decline but has implications for economic decline, social inequality and deprivation.
- **Land ownership patterns** – currently half of Scotland is owned by just 500 people who determine land-use over large parcels of land. The majority of people in Scotland are therefore landless and disconnected from the process of decision-making that determines how the majority of the land is used.

## Addendum

Since returning to Scotland in July 2017, I have been sharing findings from my Fellowship widely to stimulate a discussion about re-flowering Scotland. An exchange about the loss of woodland flowers with Neil Mackenzie, a well-known Scottish woodland ecologist, resulted in him sharing a photo with me of a wood on a tiny island off the west coast of Scotland that he had visited the previous year:





As you can see from the picture above, the woodland is carpeted with flowers, just like the woods in Iceland. It would seem that although the wood could be easily reached by herbivores, the local people make strenuous efforts to keep them off, and so, although unfenced, it is essentially free of herbivores!

Learning about the existence of this wood has been a great outcome, and I would be really interested to hear of any other similar un-grazed woods that you might know of.

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