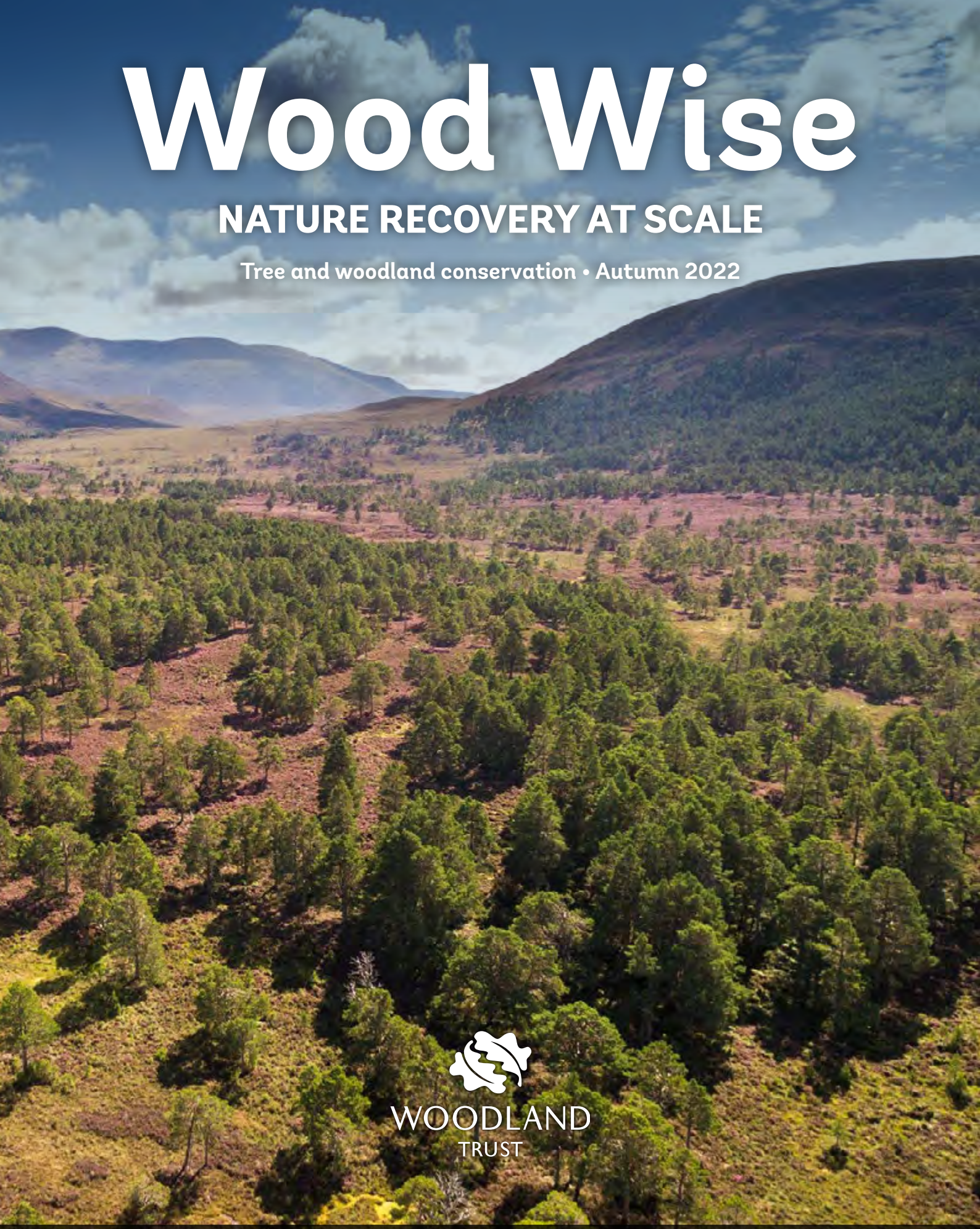
Wood Wise

NATURE RECOVERY AT SCALE

Tree and woodland conservation • Autumn 2022



WOODLAND TRUST

NATURE RECOVERY TARGETS | **LATEST RESTORATION SCIENCE** | NATURE FRIENDLY FARMING | **RESTORATION IN ACTION**

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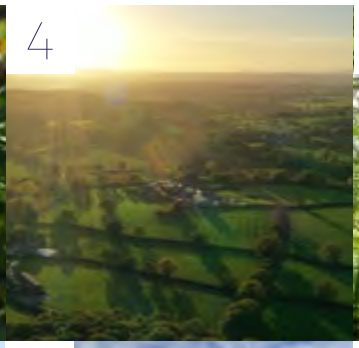

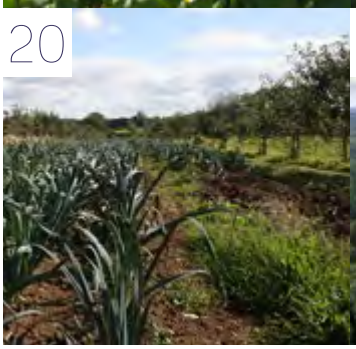

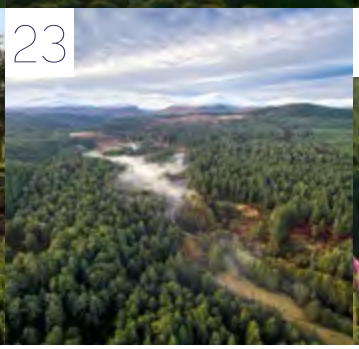

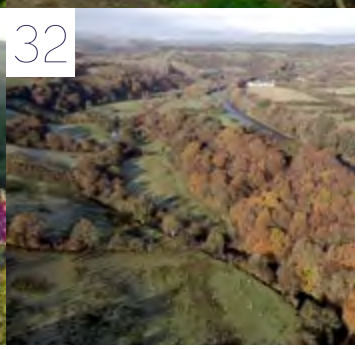

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Nature recovery: a new narrative

Hazel Jackson

Dr Hazel Jackson is head of conservation outcomes and evidence, with responsibility for ensuring the Woodland Trust's work is led by the latest science and evidence.

The world is facing an escalating ecological crisis, with the 2019 Global Assessment Report[1] warning that nature is in free fall. Biodiversity is declining faster than at any other point in human history and the UK is one of the world's most nature-depleted countries. Agricultural intensification, development, and major infrastructure schemes are causing increasingly fragmented and isolated remnants of wildlife habitat across our landscape. We need a new narrative for our ecologically impoverished landscapes to drive nature's recovery.

The world waits with bated breath for COP15 in Canada this December, where decadal targets are set by governments to restore the natural world as part of the Convention on Biological Diversity. We are currently in the UN Decade of Ecosystem Restoration, but given that only 53% of UK biodiversity remains[2], we'll need more than just a decade if we are to reverse the decline. Since 1970, 41% of UK species' populations have decreased in abundance, with 15% of species under threat of extinction[3]. There has been a 41% decline in the UK woodland butterfly index since 1990, and a 29% decline in the woodland bird index since 1970[4].

On the international stage, the UK has failed to reach 17 out of the 20 Aichi biodiversity targets. The Natural Capital Committee concluded that the UK Government in England is not on track to achieve it's 25-year environment plan objective to improve the environment within a generation. Similarly, the Scottish Government has missed many of its biodiversity strategy targets, particularly around native woodland condition.

Despite all of this, there is hope. Woods and trees have a fundamental role in supporting nature recovery. In this issue of Wood Wise, we're zooming out to look at what this means at the landscape scale. It's from this viewpoint that practical conservation and policy decisions go beyond reversing declines in populations of species, to restoring resilience, connectivity and ecological functioning of our ecosystems.

Where better to start than with reflections from the latest ialeUK conference on the Landscape Ecology of Forests, Woodlands and Trees, which underscored that landscape restoration requires evidence, negotiations and long-term support. But how do we encourage politicians to "turn the warm words into reality"? Our conservation policy experts explore the ever-shifting political landscape and the need to ensure that noble ambitions for woods and trees don't become hollow rhetoric.

It's imperative that policymakers and practitioners keep track of emerging science that underpins the role of woods and trees in nature recovery. In this issue, researchers from the Restoring Resilient Ecosystems (RestREco) project illuminate the need for ecological complexity – aiming to shift perspectives about landscape restoration, define resilient ecosystems and explore how we can secure them for the future.

Of course, it is essential that any conservation interventions implemented at scale benefit both nature and people. Perhaps the biggest opportunity for trees to help solve the biodiversity crisis is in agricultural environments. Ben Raskin from the Soil Association explains how agroecological farming systems that include trees can achieve this on a huge scale if the right financial support and incentives are available.

Landscape-scale restoration can be both complex and inspiring. It can't be done alone. Collaboration, investment, and long-term thinking all underpin the inspirational examples of UK wide landscape-scale nature recovery projects featured in this issue. Each project, from the uplands of Scotland to the southwest of England and the Faughan Valley in Northern Ireland, had unique challenges and solutions.

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Thinking at landscape scale: bottlenecks and opportunities

Vanessa Burton and Marc Metzger

Dr Vanessa Burton is a conservation adviser at the Woodland Trust, specialising in woodland creation, and **Prof Marc Metzger** is director of the Edinburgh University Centre for Sustainable Forests and Landscapes and works with a wide range of partners to provide interdisciplinary knowledge to deliver sustainable landscape management.

Initiatives encouraging action at a landscape scale have proliferated over the past decade or two, whether from environmental NGOs or Government. Such actions include trials of Regional Land Use Partnerships in Scotland and Nature Improvement Areas in England. While a great deal has been achieved – not least the inspiration provided by a new approach that has moved away from a focus on conserving small reserves – challenges remain. Change is still not happening at the scale and speed required to address the nature and climate emergencies. If we can overcome the challenges to implementing landscape-scale approaches, the opportunities and benefits are huge.

Taking an ecosystem approach

Society is currently facing the intertwined challenges of the nature and climate emergencies. Meeting these crises head on requires significant changes to the status quo, particularly in terms of the way we use our land. Co-ordinating action at a landscape scale is often touted as a solution. This sort of thinking has its origins in conservation theory, beginning with 'cores and corridors' of habitat, and is most succinctly summarised by the oft-quoted Lawton principles of 'bigger, better, more, and joined'.

Given the wider sustainability agenda, perceptions of conservation and restoration have evolved over time, with the 'ecosystem approach' (often seen as synonymous with landscape-scale action). This aims to link nature and culture, emphasising adaptability and interdisciplinarity (integrating the social and ecological sciences). Landscape approaches focus on including people in ecological restoration and encouraging true participation in environmental decision making.

This necessitates moving away from previous traditional, sectoral and project-based approaches. It requires reconciling trade-offs and encouraging collaboration between multiple different parties, spanning practitioners, policymakers and scientists. It offers opportunities for positive change over much larger scales – allowing space for natural processes and giving ecosystems the chance to develop the complexity required for resilience. However, despite the potential benefits and the urgency required, there remain huge challenges to implementation.

Evidence-based action

Conservation has always recognised the importance of monitoring – looking for ways to record management interventions and assess outcomes. The scale of potential change across landscapes, as well as external changes exerted by climate change, makes this imperative, if also more challenging.

The scientific theory behind landscape and ecosystem restoration is sound, but becomes complex as you seek to understand and monitor change. There are multiple potential units for study: from observing large-scale land-use changes and studying specific species (whether this is observing indicator and target species, managing for flagship wildlife, or reintroducing keystone species), to monitoring micro-scale plant and soil community interactions.

Given the multiple scales involved, complexity itself has been suggested as both a key metric and an

objective for ecosystem restoration[1] (see article on page 12). Crucially, it is a concept which can be assessed at the landscape scale, by studying metrics like structural heterogeneity (which captures variation in the height and density between and within habitats), beta diversity (the number of different communities of species in a region), and connectivity. We need to build our understanding of complex ecosystems and approaches to restoring nature and natural processes. The more we can think of change in this way – and the development of ecosystems as diverse mosaics, instead of as binary choices between one habitat over another – the better.

This isn't to say that finding common indicators to measure change is not hugely challenging – as is finding funding and developing cross-institutional capacity for hosting and sharing data. Approaches which can quantify the multiple ecological and cultural benefits of ecosystems across landscapes are lacking and need developing further[2].

Making better use of models

Spatial models can help, and often aim to identify opportunity areas for habitat creation or restoration. However, they are only as good as the underlying data they are built on and any assumptions they make. Also, once the data are presented, people are still left to interpret outputs and make decisions.

The past couple of decades have seen the emergence of the concepts of natural capital and ecosystem services. An array of spatial methods have been developed that can model the effect of land-use change on the 'stocks and flows' of nature's benefits to society (see Figure 1). A 'stock', often described as natural capital, can be seen as an ecological asset (e.g. a woodland), from which 'flows' valuable benefits to society (e.g. a reduction in peak flood flows due to the woodland intercepting and storing water). These flows are more commonly known as ecosystem services. Despite a proliferation of maps

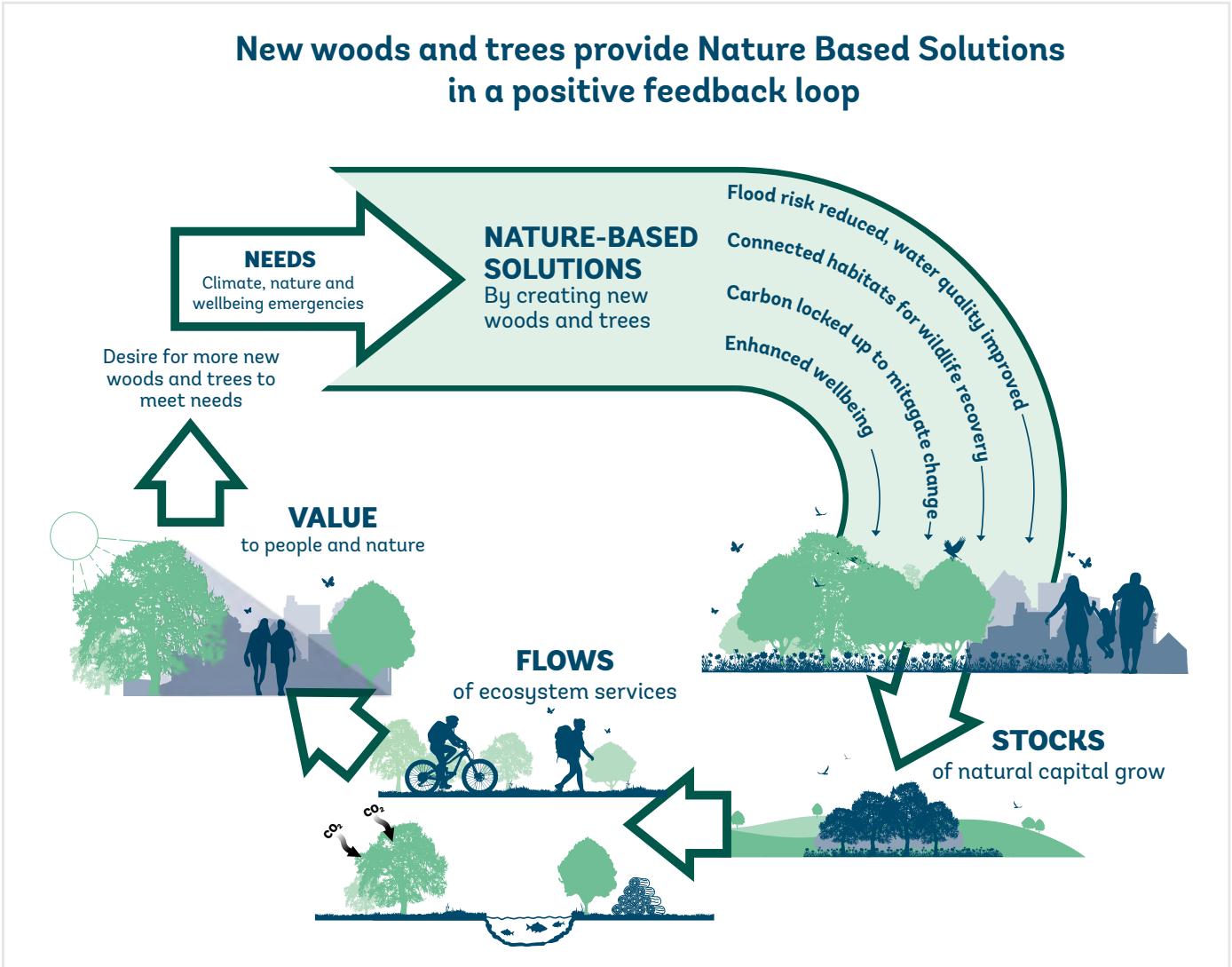

Figure 1. The 'flow' of ecosystem services (benefits to people) provided by woods and trees. Reproduced from the Woodland Trust's *Woodland creation guide*[5].

(the outputs of spatial models), these assessments have rarely been found to play an instrumental role in influencing decisions at the landscape scale[3]. Many models have been overly sectoral, based on theory that presumes human decisions are purely economically rational (as opposed to being based on social values and beliefs). Or they are focused on 'optimising' benefits, or on ecological metrics which feel too separate from the social issues – such as health or air quality – that policymakers are often more interested in[4].

Essentially, these models fail to either capture or consider the social norms and values which continue to hold landscapes in stasis. Social science methods can, however, be used alongside these spatial approaches, that explore participatory and deliberative approaches to environmental decision-making. Their use has demonstrated the importance of including people and highlight alternative ways to value nature. Frameworks that involve stakeholders in the development of scenarios for landscape change can make them more relevant to stakeholder needs and priorities, ensure detailed local knowledge is considered, and ultimately have more impact by informing decision making across landscapes.

Empathy, common ground and trust

Landscape-scale approaches have developed from being focused on ecological theory to becoming arenas for tackling the central challenge of sustainability – reconciling environmental, social and economic concerns between multiple parties, from individuals to sectors. But this hasn't been fully successful in stopping sectoral, often almost tribal approaches, from prevailing.

Land-use change is an emotive issue. The increasingly popular framing of landscape restoration as rewilding can evoke joy and hope in some, but vulnerability and anger in others. The dominance of anger in debates makes conflict intractable[6]. Scientific evidence, models and maps have no power here. Landscape approaches

V. Burton and M. Metzger

Participatory approaches which develop visions, such as this visual representation, can help to find common ground between stakeholders.

need to be built on empathy to speak to hearts and minds[7]. By understanding the concerns of a diverse range of land managers, common ground can be found and built upon. Landscape restoration has the potential to support new forms of subsidies which could, among other things, help make land-based businesses more resilient, benefit animal welfare, and provide ethical products.

There are many examples of collaborating with or influencing land managers at scale. In Scotland, Cairngorms Connect is often cited as an inspirational model which demonstrates how several organisations, with large landholdings, can co-ordinate (see article on page 23). In central England, the National Forest has an alternative model, encouraging change across a huge area of post-industrial landscape, on land which isn't necessarily its own. The success of the large projects which have captured people's imagination often seems unique. For example, Cairngorms Connect sits in an upland, rural area, in the context of Scotland's unusual pattern of highly concentrated large-scale landownership. But many of the underlying factors of its success come from its governance and can perhaps inform principles for landscape-scale success. A good financial foundation is key, along with consistency of people involved (ideally with budget control and leverage), and the time to build trust between partners, stakeholders and communities.

Long-term support and skills for nature

Restoring biodiversity takes time, as does land-use change. Land-based adaptation targets need time to implement due to the requirement of carrying out monitoring, developing effective communication, navigating conflicts between governance levels and sectors, and developing policy. Given the timescales involved, long-term support is required – not just for initial habitat creation or restoration, but also for continued establishment and management.

Post-Brexit, it seemed there was a silver lining in the form of rhetoric around 'public money for public goods'. We have begun to see this enacted, although with some teething problems, via the England Woodland Creation Offer, which provides targeted funds if public benefits are achieved. However, political instability and changing ministers in the English context could risk this sliding down the agenda.

This returns us to the age-old dilemma as to whether economic arguments should outweigh non-economic justifications for nature. Creating markets for ecosystems runs the risk of perverse outcomes. Biodiversity Net Gain policies to date have led to the loss of green space overall, with most improvements being made on sites, and very small (literally and proportionally overall) disjointed areas of habitat created off site[8]. If payment systems for public goods are to be designed (ideally as just one tool in the nature recovery toolbox), then regional or place-based payment schemes are recommended. They have been found to better integrate cultural values, negotiate trade-offs between different ecosystem services, and engage with and empower diverse stakeholders in scheme design and governance[9]. Schemes like Local Nature Recovery should learn from research on pilot schemes which have identified best practice. For more on nature recovery strategies and policies, see page 8.

It's also not just about grants and regulations. We need investment in training to develop the knowledge and skills required for facilitating nature recovery. As James Rebanks articulates in his book *English Pastoral*, "education is divided by specialism, and sorts young people into separate tribes who can barely understand each other", with farmers taught to view the land like economists, and ecologists often knowing little about farming and rural lives. This continues into professional development and the proliferation of sectoral advisers. Perhaps landscape restoration requires us to develop multi-sectoral advice, guidance and training, which will only come through creating positive partnerships between sectors and organisations.

This article was influenced by reflections on the latest ialeUK conference on the Landscape Ecology of Forests, Woodlands and Trees. For more information on the conference and recordings of sessions go to iale.uk/conference2021.

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Putting restoration at the heart of nature recovery

Nick Phillips and Rebecca Pullinger

Nick Phillips is the principal forestry policy advocate and **Rebecca Pullinger** the lead policy advocate for planning at the Woodland Trust.

The role of expanding tree cover in response to the nature and climate crises has received welcome attention in recent times. However, the fundamental role of caring for existing trees and woods has been largely relegated to the shadows. There is a need for new political ambition and targets on native woodland restoration for nature that are backed by credible plans and financial support.

The current evidence shows that while woodland cover has been slowly increasing, woodland wildlife largely continues to decline. It is particularly concerning that only 7% of native woodlands in Great Britain are classed as being in good ecological condition[1].

Why is ecological condition important?

The ecological condition of native and non-native woodlands underpins their ability to provide benefits to people and wildlife, both now and in the future. Some of these benefits are:

Ecological condition provides the foundation of these benefits, while underpinning the resilience of woodlands themselves and their ability to cope with pressures, such as climate change and pests and disease.

The latest British-wide woodland ecological condition assessments, carried out by the Forestry Commission, clearly show that the majority of woodlands are in poor health. Some of the key attributes – where the report card says 'must do better' – include the levels of deadwood, open space and veteran trees (Figure 1). Despite the importance of wood pasture and parkland for veteran trees, the majority are performing badly for this indicator, having less than one veteran tree per 20 hectares. Almost half of our ancient woodlands are also still in decline because of historic conversion to plantation forestry. For such a rare and irreplaceable habitat, this is a vast area of potential for improvement to help tackle the nature crisis. But the longer we wait, the more likely it is that the necessary conditions, and seedbank required for restoration, will disappear for ever.

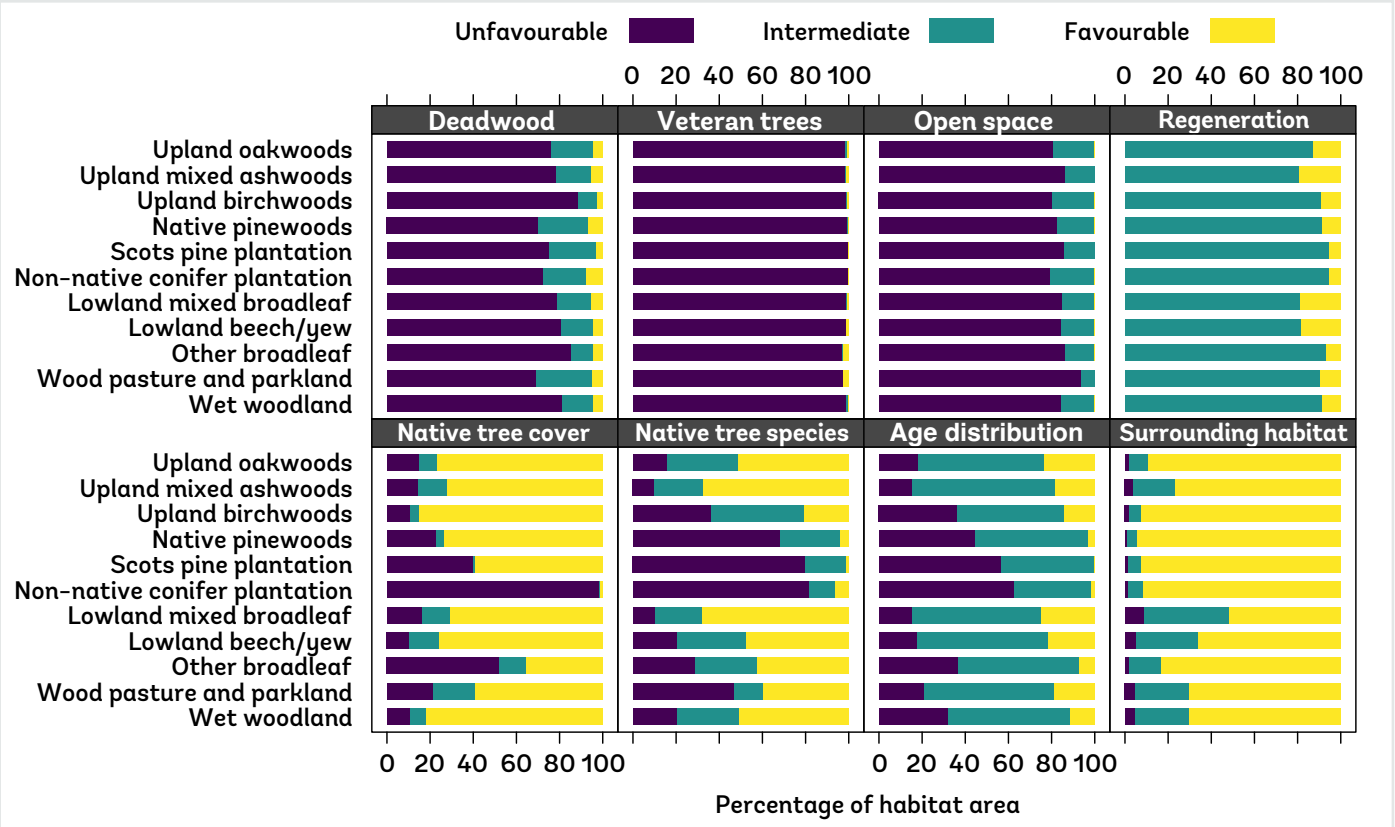

Figure 1. Woodland condition by type, showing the percentage in unfavourable, intermediate or favourable condition for eight of the woodland condition indicators[1].

Targets and commitments

Government targets on woodland expansion are well publicised, although these are not written into legislation. There is, however, potential for a statutory target for increasing tree canopy cover in England – through the Environment Act 2021, and statutory nature recovery targets in Scotland, within the future Environment Bill. Conversely, statutory targets on restoration and improving ecological condition of existing ancient and native woodlands, are either non-existent or amalgamated with general commitments to nature recovery, and are not yet backed by credible plans and sufficient grant funding.

In England, the Government has just committed to new ambitious targets for ancient and native woodland in a refreshed policy called Keepers of Time[2]. This policy was developed with the Woodland Trust, Forestry Commission England, Natural England and several other partners. It commits to bringing the majority of native woodland and planted ancient woodland sites (PAWS) into good or improving condition by 2030. In addition, the policy commits Forestry England – by far the largest owner of PAWS in the UK – to restoring all of their PAWS.

In Scotland, the new biodiversity strategy provides a key opportunity to commit to similar targets, focus vital resources and deliver on-the-ground, alongside multi-purpose sustainable forestry. In Wales and Northern Ireland there is a need for the introduction of new political ambition and targets on native woodland restoration. This includes the urgent need to bring protected woodland sites into shape[1]. In Northern Ireland, only 1% of statutory protected woodland area is in favourable condition, with 61% in unfavourable condition. Scotland also has a large proportion of protected woodland area in unfavourable condition (40%), with an equal area in favourable condition. Two-thirds of woodland Special Areas of Conservation in Wales are in unfavourable condition.

In Wales, there is a policy commitment to restore ancient woodlands on the public estate, but progress is slow. No grant support is currently available to support the restoration of ancient woodlands in private ownership.

Thinking globally

As part of international efforts to combat the nature and climate crises, the UK Government has committed to protecting 30% of UK land for nature by 2030 – the 30 by 30 target. Each of the UK countries has individually endorsed the target and each government is expected to set out plans on how it will be delivered. These plans are still in development. However, UK-based environmental stakeholders increasingly recognise

that land included in the 30% target should meet two fundamental criteria if it is to spearhead nature recovery. Firstly, land must be protected for the long term, free of any environmentally damaging activities. Secondly, that land must be well-managed for nature, with evidence demonstrating that they are delivering effective conservation of important biodiversity. These are supported by the IUCN Protected Areas Working Group[3].

Evidence indicates that there is a long way to go before this target is reached, with as little as 5% of the UK effectively protected for nature[4] (see box 1). This is despite previous targets; the Aichi Biodiversity Targets, adopted in 2010, called for at least 17% of terrestrial land and inland waters to be protected and effectively managed by 2020. Hence the UK is far from being on target.

Box 1: The extent of UK land area that can be said to contribute towards the 30 by 30 target[4].

28% of UK land area is reported as being protected by UK Government

11.4% of UK land is within protected areas primarily designated for nature conservation

4.9% of UK land is within protected areas primarily designated for nature conservation that is in favourable condition.


Mix of tree sizes and ages


Standing and fallen deadwood


Diverse ground flora


Abundant natural regeneration


Mix of tree species


Open habitats/glades and rides

Some of the attributes of woodland in good ecological condition.

Implications for woods and trees

Woodland covers about 13% of UK land area, around half of which comprises predominantly native tree species. However, as discussed, just 7% of our native woodland is in good ecological condition. Woodland can, and should, provide a significant contribution to meeting the 30 by 30 target, but only if restoration is at the heart of action.

Ancient woodland, which covers only 2.4% of UK land area, provides an obvious place to start strengthening both long-term protection and support to enable good ecological management of sites. There will be challenges to including all ancient woodland within the 30%, because most ancient woodlands across the UK are outside the legally protected area network. Furthermore, as many small sites are scattered across private ownership (some of them not yet identified), one approach is unlikely to suit all.

Completing the legally protected sites network – particularly the Sites/Areas of Special Scientific Interest network – so that high-level protection is given to ancient and long-established woods, and other woodland habitats, will help to support the target. Alongside expanded protection, restoration of ancient woodland (including of PAWS) must be a priority, so sites meet both the protected and well-managed criteria. New tools through the mechanism of other effective area-based conservation measures (OECMs) could work alongside the legally protected site network, to support and guide the protection and good management of woodland sites.

Local strategies to support nature recovery

To deliver nature's recovery, action is needed locally as well as nationally. Engaging a range of stakeholders, including farmers, local authorities and the public, will be important to ensure that 30 by 30 is inclusive and that there is buy-in to local targets and priorities[5].

Local strategies to support nature recovery and the development of local nature networks are emerging. For example, in England, the Environment Act legislated for new Local Nature Recovery Strategies, and in Scotland, Local Nature Networks are being created. In Northern Ireland, the Woodland Trust, RSPB, the National Trust and Ulster Wildlife are working with a range of stakeholders to create the first set of national habitat-network maps. This is with a view to better understand the current habitat cover and its level of connectivity and identify where there is potential to make more space for nature, including woodland creation and restoration. Bringing data on existing woodlands, and evidencing potential for hedgerow and woodland expansion through tools such as 'buffering' (planting or allowing natural regeneration next to existing woodlands) and creation of new woodland sites, will help map where future action and funding can be targeted to deliver on 30 by 30 and nature's recovery.

Nature is in crisis

The 'Making Space for Nature' report[6] created fundamental principles for delivering nature's recovery: more natural habitats that are better, bigger and more joined up. Done well, 30 by 30 can help to deliver these principles. However, nature recovery cannot just happen in isolated protected areas. To deliver nature recovery at a landscape scale we need to establish connections ('hedges and edges') between habitats to create a joined-up network that allows species to move between habitat patches. The habitat corridors themselves must also be resilient to change.

As the owners or managers of much of the land in the UK, the farming sector will be particularly important. It is crucial that farming support schemes in each country, alongside other policy tools such as in planning and forestry, recognise the importance of protecting and restoring nature. Spatial targeting of identified priority activities, such as through the Local Nature Recovery option of the new Environmental Land Management Scheme in England, is key to ensure a sustainable future that supports the delivery of both 30 by 30 and nature's recovery everywhere.

Ultimately, targets are one thing, but turning the warm words into reality is the key metric of success. This includes sufficient financial support to land managers, funding to restore ancient woodland on public land, advice, training and support to grow those with the forestry skills needed. There is no silver bullet, but what is clear is that the value of this investment in the care of our existing woods and trees, will repay current and future generations many times over.

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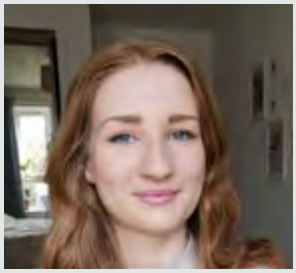
Rethinking woodland restoration

Emily Waddell, Kirsty Park,
Elisa Fuentes-Montemayor and Kevin Watts

Restoration projects frequently aim to re-create target species lists found within reference communities. But will this approach lead to ecosystems that can withstand the effects of our rapidly changing environment, such as the prolonged droughts we've experienced this summer? A consortium of researchers is undertaking a project aiming to deliver a step change in restoration science.




Dr Emily Waddell is an ecologist from the University of Stirling, focusing on the impact of anthropogenic change and ensuring forest ecosystems are protected and resilient to future environmental change. **Prof Kirsty Park** is an applied ecologist from the University of Stirling, interested in the effects of anthropogenic change on biodiversity and developing solutions to mitigate the impacts of humans on wildlife. **Dr Elisa Fuentes-Montemayor** is an ecologist and conservation biologist from the University of Stirling, investigating the impacts of anthropogenic disturbances and the effectiveness of conservation actions for biodiversity. **Prof Kevin Watts** is an applied landscape ecologist from Forest Research, focusing on understanding the impacts of land use and climate change on the biodiversity and resilience of wooded landscapes.


Ross Barnett

Wooded habitats are among the most ecologically diverse, species-rich areas of our planet and store more above-ground carbon than non-wooded ecosystems. In the UK, our temperate woodlands support thousands of species – more than any other habitat type – and collectively store around 213 million tonnes of above-ground carbon[1].

The restoration of wooded landscapes is a key tool in the global mitigation of climate change and recovery of biodiversity. This is evident in the many international initiatives to enhance carbon stocks and biodiversity, including: the 2008 United Nation's REDD+ initiative to reduce emissions from deforestation and forest degradation; the 2011 Bonn Challenge to restore 350 million hectares of degraded and deforested lands by 2030; and the recent start of the UN Decade on Ecosystem Restoration (2021–2030). The UK Government's 25-year environment plan sets out a vision to secure a more biodiverse, connected and resilient landscape, and includes ambitious tree planting targets. Will these restoration initiatives ensure the long-term stability of wooded landscapes?

Moving beyond traditional ecological restoration

The goal of traditional restoration projects is typically to re-establish species community compositions found within reference habitats, with the success of a project often measured as similarity to target communities (e.g. using ancient woodland indicator species out of context, independent of other habitat characteristics). However, this approach can be problematic as there may be no true 'undisturbed' reference habitat left to compare against, and therefore, no way of knowing exactly what species were present in a particular community before disturbance occurred.

Crucially, even if we do have information on the historic species composition, there is no guarantee that reference communities will ensure the long-term stability of an ecosystem in the face of future environmental change.

This summer of record-breaking temperatures and prolonged periods of drought across the UK has highlighted the immediacy of the challenge we face

Pollination is an important ecosystem function and service in wooded landscapes.

Sam Rogerson

Lowest complexity

- Plantation of one tree species
- Very poor connectivity as no woodland in surrounding landscape
- Supports low numbers of animal species with few functional traits represented and species interactions
- Vulnerable to perturbations

Moderate complexity

- A few woodland patches containing one tree genus
- Some connectivity between neighbouring woodland patches
- Moderate species and functional trait diversity of animals and species interactions
- Less vulnerable to perturbations

Highest complexity

- Many woodland patches containing several tree genera
- High connectivity between neighbouring woodland patches due to hegderows and 'stepping stone' trees
- Support high species richness of animals, with different functional traits and many species interactions
- Least vulnerable to perturbations

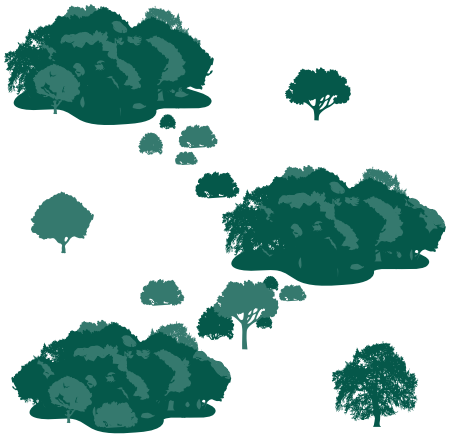


Figure 1. A conceptual depiction of increasing degrees of ecological complexity across spatial scales.

with our changing environment. Thus, it is vital that the fundamental goal of restoration projects is to restore habitats that will be resilient to current and future environmental change[2]. By 'resilience' we mean the ability of an ecosystem, or an aspect of an ecosystem, to remain unchanged (resistance) or to bounce back rapidly (recovery) following a perturbation, such as a drought[3]. We believe there is a need to move beyond the traditional reference system approach as the fundamental goal of restoration projects, towards restoring complex, high-functioning and resilient ecosystems.

The Restoring Resilient Ecosystems project

The Restoring Resilient Ecosystems, or RestREco, project (restreco.com) proposes that enhancing ecological complexity should be the fundamental target of restoration projects.

We define ecological complexity as 'the number of components in a system and the number of connections among them'[4] (see Figure 1). At local scales (e.g. a discrete patch of woodland), complexity could be measured simply by the number of species present (components) and the number of trophic interactions between them (connections): such as pollination or

predator-prey relationships. At a landscape scale, complexity could be measured by how many different habitat types are present (components) and how easily species can move through the landscape (connections): for example, hedgerows or trees acting as 'stepping stones', connecting larger patches of woodland.

To gain a holistic view of how complex a particular habitat or landscape is, it is important to measure several components and connections in combination. For example, to capture how complex a woodland is, we could measure the woodland structure (representing the 3D niche space available to species), the species present above and below ground (both the different number of species and functional groups represented), and the number of interactions between species, such as links in a food web.

The conservation interventions to achieve high complexity may be the same as, or overlap with, traditional approaches (e.g. tree planting), but the key difference is not focusing on a fixed end point (i.e. target species composition), which changes how the success of restoration projects is measured. We argue that our proposed approach of high complexity as the target is a more flexible and pragmatic aim for restoration projects, and can be applied at both local and landscape scales.

RestREco is testing these ideas on two of the major habitat types for restoration and conservation efforts in the UK – calcareous grasslands and broadleaved woodlands – to examine how the complexity approach can be applied in two very different habitats. Within this four-year project, we hope to answer the following research questions:

- What drives ecological complexity in UK woodlands?
- How does ecological complexity influence the functioning of a woodland (e.g. pollination and nutrient-cycling functions performed by a range of species) and its resilience to droughts?
- Can we speed up ecological complexity with management interventions?

What drives ecological complexity in restored woodlands?

As time is considered to be a major driver of complexity, we have adopted a 'natural experiment' approach to answer our research questions within our four-year project (see Watts et al.[5] for a similar approach used in the formation of the Woodland Creation and Ecological Networks (WrEN) project). We have selected 60 woodland creation sites in Scotland and England to represent a gradient in woodland age (10–60 years since tree planting or after other activities, such as agriculture or extractive industries, ceased and enabled subsequent natural colonisation by trees). These sites also represent different starting points, with former land use being either agricultural or industrial, and a gradient in the amount of woodland in the surrounding landscape.

Through this natural experiment, we will be able to answer the questions:

- To what extent do the starting conditions (e.g. post-agriculture vs post-industrial) affect different metrics of complexity?
- Is the amount of woodland in the surrounding landscape important for driving complexity?
- Do some complexity measures accrue faster than others?

These results will help to inform restoration practice by identifying priority areas and approaches for restoration.

Restoring high-functioning and resilient woodlands

How ecological complexity influences ecosystem functions and resilience to disturbances remains largely unstudied in real-world landscapes, thus this is another key question we are tackling in RestREco.

We expect complexity to enhance multiple ecosystem functions (i.e. multi-functionality), such as decomposition, carbon capture and pollination. For example, the more structurally complex a woodland is (i.e. different ages of trees, variation in canopy openness), the more opportunities, or niches there are to support a diverse range of species. The more species a woodland supports, the higher the likelihood that multiple species perform similar functions, and so essential functions are maintained even if a disturbance causes the loss of one species from the woodland. For example, if a woodland has lots of species of fungi present, all of which decompose deadwood, then the loss of one species of fungus, while not desirable, wouldn't mean the loss of this ecosystem function within this woodland. This is known as functional redundancy and is a key mechanism linking complexity and resilience[6].

In the UK, droughts are a major environmental disturbance exacerbated by global climate change and are predicted to become more frequent in the future. Therefore, it is vital to restore woodlands and other UK habitats that are resilient to the effects of droughts. We are going to experimentally test how complexity influences resilience, by installing small-scale rainout shelters to mimic a drought in a subset of woodlands selected to represent a gradient of complexity. We predict that the more complex a woodland is, the more ecosystem functions are maintained and the higher its resilience to the effects of drought.

Can we speed up the development of complexity?

Here we are interested in how we could speed up the development of high complexity in woodlands. We are going to test this by carrying out management

Emily Waddell

Fungi, as decomposers, have a vital ecosystem function.

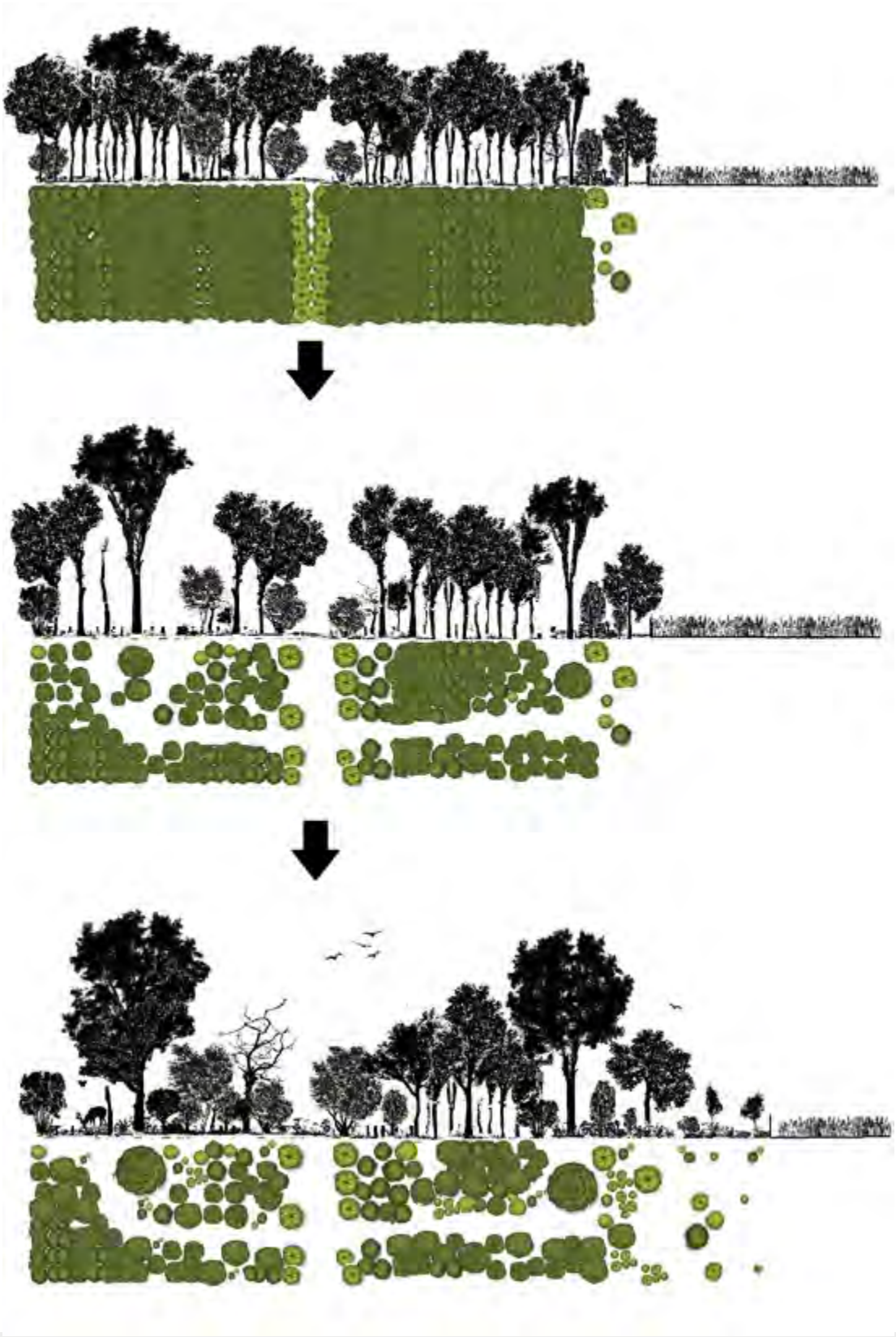


Figure 2. Time sequence (top to bottom) showing variable density thinning to increase structural complexity in a uniformly planted woodland. The green parts represent a top down view of the canopy for the stand of trees illustrated directly above. Reproduced from the Woodland Trust's *Woodland creation guide*[7].

interventions, specifically, the thinning of tree stems and the addition of deadwood. By opening up the canopy of planted woodlands through thinning, we hope to increase variation in tree size (i.e. structural complexity) as saplings and seedlings colonise these gaps (see Figure 2), and increase the number of species by encouraging more ground flora and invertebrates, as well as species interactions (e.g. pollination).

These interventions have been used for decades in the management of woodlands and forests globally. However, what is novel is using these management interventions with the goal to speed up complexity, and it is currently unknown whether this will be effective on the different metrics of complexity.

Informing future woodland restoration

After centuries of woodland loss in the UK, it is vital that we restore woodlands that will be resilient to future environmental change. The results from RestREco will help inform policy and practice when restoring temperate woodlands and grasslands. This new information will help us determine the value of focusing on complexity as the target for restoration – to support ecosystem resilience in an ever-changing world.

As we are focusing on fundamental characteristics of diverse habitats such as grasslands and woodlands, we will be able to inform how a focus on system complexity can be applied to other ecosystems. Specifically, these results will inform how previous land use (agriculture vs. industrial), the amount of woodland in the landscape, and time since restoration influence the development of complexity, and whether we can speed up complexity through simple management interventions. This will aid decision making when prioritising the best ways to successfully restore complex woodlands in the UK.

Restoring Resilient Ecosystems project is funded by the Natural Environment Research Council (NERC), and the consortium brings together expertise from Cranfield University, University of Stirling, UK Centre for Ecology & Hydrology (UKCEH), Forest Research and the National Trust.

Consortium members:

- **Cranfield University: Prof Jim Harris (Lead Principal Investigator), Dr Mark Pawlett (Co-PI), Dr Daniel Simms (Co-PI), Prof Ron Corstanje (Co-PI), Dr Paul Burgess (Co-PI), Dr Faisal Rezwan (Co-PI), Dr Oscar Aguinaga Vargas and Lynne Roxbee Cox.**
- **University of Stirling: Prof Kirsty Park (PI), Dr Elisa Fuentes-Montemayor (Co-PI), Dr Emily Waddell, Ross Barnett and Sam Rogerson.**
- **UK Centre for Ecology & Hydrology (UKCEH): Prof James M. Bullock (PI), Dr Ben A. Woodcock (Co-PI) and Maico Geert Weites.**
- **Forest Research: Prof Kevin Watts (Co-PI) and Dr Matt Guy.**
- **National Trust: Prof Rosie S. Hails (PI) and Ben McCarthy (Co-PI).**

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Leek and apple trees growing together in an agroforestry system.

Scaling up agroecosystem restoration

Ben Raskin

Ben Raskin is head of horticulture and agroforestry at the Soil Association.

Over the past few decades, sustainable production systems have been gaining traction. In farming, organic and biodynamic farming principles have been around for a long time. More recently, the terms 'regenerative' and 'agroecological' are being used to describe how land is managed in ways that not only work with nature, but start to heal the damage we do as a species. What unites them and how might trees fit into that vision?

In the UK, the divide between farming and forestry is deep and ingrained. Land classification, taxation and support payments, as well as practical skills and markets, have all helped to create an ideological and functional split between foodplants, animals and woody outputs from the land. Farmers grow food and foresters grow trees, and it can be rather confusing at the place where the two meet. Yet with over 70% of the UK classed as agricultural land, there is a huge opportunity and need to better integrate the two.

What is agroecological farming?

It all starts with the soil. How can farmers protect, nurture and even build their soil? Reducing tillage or pesticide use can benefit cropping systems, as will increasing the use of cover crops and lengthening rotations. Even better is to include livestock within the rotation. Herbal leys and improved quality and quantity of organic matter into soils can also be hugely beneficial. I like the term Functional Agricultural Biodiversity

(sometimes called FAB). These FAB practices or techniques enhance biodiversity and also work for the farmer to benefit their system's productivity and resilience.

Trees are a crucial component of agroecological farming systems. Deliberately integrating trees into farming, also known as agroforestry, can bring a range of benefits to the farm as well as those greater goods they provide to the wider world. Let's leave exact definitions of what constitutes an agroforestry system aside (for example, do hedges count, and can a single tree in a field qualify?). For me, it's about intention. If you deliberately manage the trees as part of your farming system and think about how the two interact, then that's agroforestry. Of course, there are many farmers that have been doing this instinctively forever, but not thinking of it in these terms.

Another strong argument for agroforestry is a historical one. Agroforestry represents the return to something lost from the British landscape. Once common traditional practices such as pollarding and woodland grazing are now a rarity. Similar losses have occurred to the number of in-field trees and traditional orchards. These environmental (and societal) transformations are widely associated with declines in rural biodiversity. Agroforestry, therefore, is an important tool to help arrest or reverse these declines in biodiversity across the UK's countryside, alongside other sustainable farming practices.

The benefits of trees on farms

There are, of course, many benefits of trees. But more specifically, what can trees on farms deliver? I'd argue that the quickest win is for livestock farmers. Shade and shelter for animals reduces heat and cold stress, decreases mortality and improves productivity. For example, if animals don't have to use lots of energy keeping warm, they can use that energy for putting on weight or producing more milk. Trees even improve animal wellbeing[1], with one study showing increased social cohesion between animals[2], and more positive interactions between animals and humans when trees are present.

Trees create microclimates, reducing wind speed and moderating temperature extremes. This can help extend the season for a range of crops, including grass, which could enable farmers to bring out animals sooner after winter, harvest crops early or late, increase yields, or perhaps even grow a crop that might traditionally not thrive in our short summers.

The increased infiltration that trees usually bring can also be an advantage on heavy soils, allowing earlier cultivation, or perhaps permitting stock to graze earlier and later in the year without damage to soil.

The increased wildlife that comes with trees is not only important for combatting the biodiversity crisis, but also provides greater numbers of pollinators and predatory insects of crop pests, benefitting the crops and farm productivity.

Trees have deeper roots than most annual plants and so can exploit deeper soil levels. For example, they bring nutrients up from the lower soil and redistribute them on the soil as their leaves drop. They capture more light than short plants and make better use of rainwater. This capturing and recycling of natural resources on the farm is a crucial factor in the success of agroforestry systems. The term 'farming in 3D' is sometimes used to describe this extra dimension that trees offer.

Increased productivity

Added together, these various benefits usually result in a significant increase in farm productivity. This increase in production is quantified using the Land Equivalent Ratio (LER). It measures the difference between growing the crop or livestock and trees in a monoculture and cultivating those same enterprises mixed in an agroforestry design. Typically, agroforestry systems are at least 30% more productive than single enterprises, though with so many variables at play it is not always easy to quantify exactly.

This increased productivity is usually a relatively crude calculation based on biomass or crop yield. Turning that

Dairy cows browsing.

extra productivity into profit is the key to a successful agroforestry system. For most livestock farms, increased milk or meat yields or reduced mortality could be enough to justify the cost of tree planting. In cropping farms, it is sometimes harder to find robust economic data that shows it works, particularly since farmers will be required to give up higher-value cropping land during the establishment phase. However, there are farmers making it work and I have no doubt that more will become convinced that trees can contribute to the success of their farming business.

Opportunities and risks

Many governments and other organisations (including the Woodland Trust), have ambitious tree-planting targets. It will be impossible to meet these targets if the focus is entirely on bringing land out of farming and into woodland and forestry, not to mention the risk to food security of losing productive land and the social impact on farming communities. The opportunity of bringing some trees onto almost all farming land changes the whole conversation. There are clearly many positives to bringing trees back into farming, but what are the risks, if any?

Most importantly there are some soils where trees may be inappropriate altogether. For some sites, there is a risk to biodiversity – for instance, on species-rich wildflower meadows or some Sites of Special Scientific Interest (where this could result in an unfavourable condition of their notified feature). In peatland landscapes, soils have the potential to store more carbon than trees do[3]. The International Union for Conservation of Nature (IUCN) lays out the risks of tree planting on peat soils in their position statement[4]. Draining peat bogs to plant productive forests results in huge carbon release. It is imperative that these areas are rewetted and restored to peatland as the timber is harvested, and that the establishment of any new native trees and shrubs in peatland landscapes considers impacts on both soil carbon and biodiversity and always protects the deepest peats.

In order to better understand the potentials and risks in the carbon effort, woodland and peatland carbon codes have already been developed, and hedgerow and soil carbon codes are currently under development. To help support and inform increased agroforestry planting, funding has recently been approved to develop an Agroforestry Carbon Code focusing on in-field trees, which will be influenced by and complement the other carbon codes. It is important to acknowledge the risks also associated with these codes in terms of mitigation deterrence – i.e. if people can offset their carbon emissions by purchasing carbon credits, they may put less effort into vital actions to reduce their emissions in the first instance.

Though the carbon imperative is important, there is of course a risk of viewing tree planting entirely through one lens. If carbon sequestration is the sole objective, with funding channelled for that purpose, we could end up with the wrong trees in the wrong place, potentially owned by those whose only motive is profit. When farmers grow trees that have been designed to enhance their farming system rather than replace it, they are more likely to choose the right tree and look after it properly to ensure it delivers the promised benefits. This is what could happen if we get agroforestry right.

Financial support

There are an increasing number of funding opportunities for farmers to help them plant and manage trees. They are still focused on permanent woodland and forestry opportunities, and mostly specifically exclude farming activity where the trees are planted. However, the slightly different requirements for agroforestry are being increasingly recognised and supported. The Woodland Trust's Trees for Your Farm scheme was at the forefront of funding agroforestry plantings, and the latest proposals under the Government's Environmental Land Management Schemes in England (the Sustainable Farming Incentive and Local Nature Recovery scheme) look promising. Also, the recently published Welsh Government Sustainable Farming Scheme proposals include a requirement that all farms in the scheme meet a threshold of 10% tree cover.

Many farmers want to plant more trees but need more technical and financial support to make it happen. With attitudes changing and more money on the table, we now need to spread the knowledge beyond the small number of pioneering farmers that have so far established agroforestry systems in the UK. We must scale up their efforts to meet the urgent need to restore nature across whole landscapes.

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A 200-year vision for a landscape restored

Sydney Henderson

scotlandbigpicture.com

Abernethy Forest is one of the largest remnants of Caledonian pinewood, found in the Cairngorms National Park.

Sydney Henderson is the communications and involvement manager for the Cairngorms Connect Partnership.

Scotland has seen its once-expansive Caledonian pine forest become disconnected and drastically reduced in size over the centuries, largely due to human actions. Today, only 1% of Scotland's original pine forest remains. Stretching over 600 square kilometres of sparkling rivers and lochs, vast tracts of blanket bog and the largest remaining remnant of ancient Caledonian pine, the Cairngorms Connect Partnership has ambitious aims to deliver ecological restoration on a landscape scale.

The Cairngorms Connect Partnership

In 2016, four neighbouring land managers (Wildland Limited, Forestry and Land Scotland, NatureScot and RSPB Scotland) gathered around a map and hatched a plan to work in partnership, collaborating on a landscape-scale restoration project. With funding from the Endangered Landscapes Programme, the Cairngorms Connect Partnership (hereafter just 'Partnership') was born. The strength of the Partnership is in creating a seamless landscape for nature that is resilient to the effects of climate change, through a bold and ambitious shared 200-year vision.

This vision charts plans to double the native woodland in size, and restore peatlands, wetlands and rivers, accompanied by an extensive science and monitoring programme.

This shared vision for habitat restoration is unparalleled in its scope, scale and timeframe in the UK. Milestones over the next 200 years aim to restore native woodlands to their natural limits, including high-altitude montane woodland; restore peatlands, wetlands and rivers; and build support for and understanding of landscape-scale ecological restoration locally, nationally and internationally.

Currently in the 'interventions' stage, the Partnership organisations are delivering projects to restore ecosystems and habitats to a healthier state. By 2065, Cairngorms Connect envisions that the effects (and corresponding benefits for people, climate and nature) of woodland regeneration, and floodplain and peatland restoration, will be abundantly clear and, with the exception of on-going herbivore control, all of the principal interventions will be completed. At this stage, natural processes will be driving and maintaining natural characteristics.

By 2216, Cairngorms Connect aspires for woodland habitats that act as model examples of oceanic boreal forest for northwest Europe. These woodlands (including montane woodland) will extend well towards their natural altitudinal limit. Based on mapping by the Cairngorms National Park Authority (a supporting partner of Cairngorms Connect), the Partnership has ambitious aims to double the forest in size – from 13,000 hectares to 26,000 hectares. This is being achieved through two main projects: 1. improving the condition of existing forests, and 2. expanding forests to their natural limit, primarily through natural regeneration enabled by deer management and reduced grazing pressure.

Improving the condition of existing forests

Removing non-native conifers, such as Sitka spruce and lodgepole pine, is key to improving the condition of forests where these are present. Widespread planting of these species in the 20th century is credited as one of the major factors which contributed to the degradation of the ancient Caledonian forest. With an ability to rapidly expand into areas of native woodland, these species can threaten the quality and diversity of native woodland.

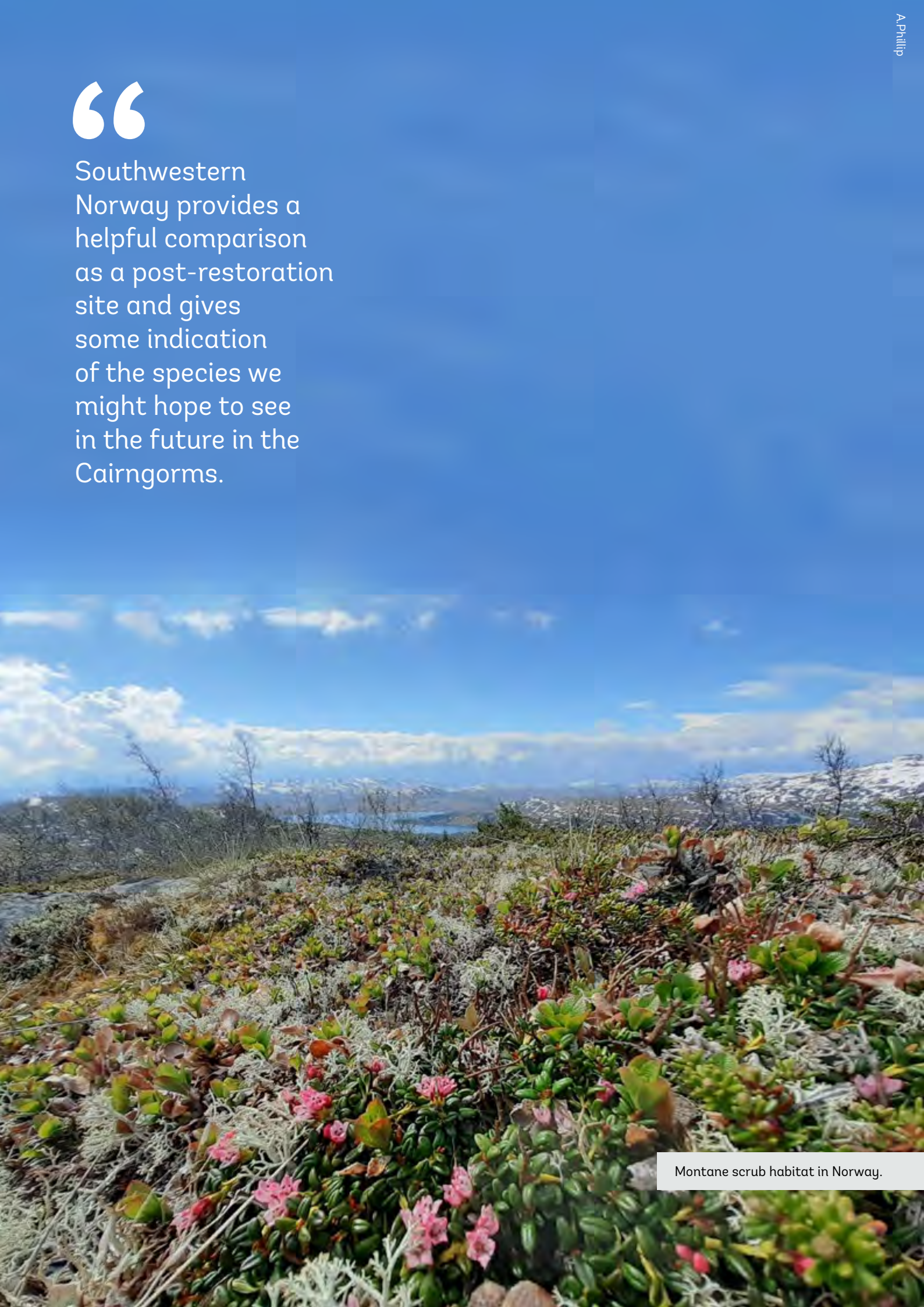
Removing non-native species, with the support of local contractors and volunteers, opens space up for native woodland regeneration and a diverse multi-storied forest of Scots pine, juniper, rowan and birch, which will support local wildlife and hold high local cultural value. To date, 2,471 hectares of non-native conifers have been removed from the Partnership area.

Staff and volunteers carrying downy willow saplings into the Cairngorms.

Top: Volunteers removing non-native conifer trees to allow native species to regenerate. **Bottom left:** Cairngorms National Park Authority Junior Rangers helping out in the Tree Nursery. **Bottom right:** Ringbarking Scots pine trees in an even-aged stand to accelerate the creation of valuable standing deadwood habitat.

A.Phillip

Southwestern Norway provides a helpful comparison as a post-restoration site and gives some indication of the species we might hope to see in the future in the Cairngorms.



Montane scrub habitat in Norway.

Another key project to improve the condition of existing forests involves plantation restructuring – creating a mosaic of habitats, with a mix of native conifers and broadleaf species and, in turn, a healthier and more climate-resilient woodland for people and wildlife. A variety of techniques, including felling and ringbarking to create standing deadwood, are used to improve forest diversity, allowing light to reach the forest floor and opening up a patchwork of habitats. This work is monitored through deadwood beetle community assemblage, in an interesting example of the smallest invertebrates indicating the health of the wider habitat.

Expanding forests to their natural limit

The potential for natural regeneration in the area is huge. However, a key factor holding back peatland and forest restoration in Scotland is grazing pressure from deer. While red and roe deer are part of Scotland's ecosystem, a human-induced absence of predators means deer numbers are artificially high, giving native woodland and peatland ecosystems little chance to recover.

Working collaboratively, stalkers carry out deer management across the whole Partnership area. They act in the role of 'predator', keeping deer moving across the landscape. The recently launched Cairngorms Connect Venison project aims to increase understanding and involvement in this vital habitat restoration work, encouraging local communities and visitors to support a forest doubled in size, simply through purchasing a local, highly sustainable venison burger.

The 200-year vision for the Cairngorms Connect landscape will outlive everyone currently living and working in the landscape. To be sustainable in the long term and resilient against future challenges, Cairngorms Connect needs to have importance and meaning for people, both now and in future generations. Projects like Cairngorms Connect Venison act as just one example of a local benefit of habitat restoration and involves a wider audience in our work.

Science and monitoring

The Cairngorms Connect Partnership area is a landscape full of potential for ecological restoration. It's also a great place to demonstrate the science of ecological restoration. The size of the area, plus the huge depth of ecological and practical knowledge among the Cairngorms Connect partners and collaborators, is a great basis for an applied science programme to overcome the barriers in novel large-scale restoration. This can help us answer questions like "How can we best restore landscapes?" and "If we restore landscapes, what do we gain?".

There are three main ways in which science supports the restoration work:

1. Providing an evidence base to support our management approaches in the Cairngorms Connect area.
2. Monitoring the restoration process to see if we are achieving our intended outcomes. This monitoring is further broken down into:
   - ecological responses: measuring the changes in plant and animal communities
   - ecosystem services: measuring changes in things of value to society, like flood risk or climate regulation
   - societal benefits: measuring changes in our own attitudes, wellbeing or economic opportunities, associated with ecological restoration.
3. Testing interventions to see if there are alternative management techniques that might improve restoration success.

Recently, Partnership staff travelled to southwestern Norway in collaboration with NINA (Norwegian Institute for Nature Research), to conduct ecological surveys in an area that is very similar geologically and climatically to the Cairngorms. In this part of Norway, native woodland is the dominant land cover, but it wasn't always this way – much of the woodland has regenerated naturally since emigration in the late 19th/early 20th century led to a reduction in grazing pressure. In a relatively short space of time, diverse woodland habitats with lush ground cover and understoreys have developed, with extensive montane scrub habitat in the higher reaches.

This fieldwork – conducted using the same methodology as that used in the Partnership area as part of the monitoring ecological responses project – provides a helpful comparison as a post-restoration site and gives some indication of the species we might hope to see in the future in the Cairngorms.

Long-term commitment

Working towards a 200-year vision for landscape-scale ecological restoration takes time, money and – most importantly – a deep, shared commitment to this long-term process. The benefits, from climate change mitigation and adaptation to local employment opportunities and boosts for biodiversity, are huge and dependant on this collaboration and commitment.

The long-term and large-scale vision of Cairngorms Connect makes it unusual in a UK conservation context. This bold ambition, which rises to meet the scale of the nature and climate emergencies, has been key to capturing the imagination of Partnership staff, local communities, national media and beyond.

What will this landscape look like in 200 years? We have no way of knowing, but we do know that the support and involvement of a wide range of people will be key to the long-term success of this wild landscape in the making.

For more information, visit the Partnership website, cairngormsconnect.org.uk and stay up to date on social media **@CairngormsConnect**.

Partnerships for impact in Dartmoor

Eleanor Lewis and David Rickwood

Eleanor Lewis is the Woodland Trust's Devon partnership lead, and **David Rickwood** is the site manager for Fingle Woods and other Woodland Trust woods in Devon.

Paul Glendell/WTML

Dartmoor is best known for its undulating moors and granite-topped hills. But it is also home to many ancient woodlands in the deep clefts and valley sides, including Fingle Woods – a 334-hectare site in the Teign Gorge. In July 2013, the site was purchased by the Woodland Trust in partnership with the National Trust. The two organisations have since combined their expertise, contractors, and volunteer networks to restore the damaged ancient woodlands, helped through a sizeable grant from the National Heritage Lottery Fund.

A century or so ago, Fingle looked very different. A local beauty spot, the woods played a key role in the charcoal making and leather tanning industries and were full of oak trees and other native species. However, in the 1930s, like many ancient woodlands, they were converted to non-native conifer plantations for the timber industry. Time is of the essence to restore them back to native woodland for biodiversity and for their historic and cultural value.

An ambitious partnership

When Fingle came onto the market, the Woodland Trust and National Trust realised that coming together and working collaboratively would be the best solution to ensure this ancient woodland was protected and restored. This was the first time the two organisations had co-purchased a site and attempted such a large-scale restoration project together. It allowed combined expertise and resources to be harnessed across the entire project. This promoted cross-pollination of ideas, and enabled innovation and experimentation.

A set of ambitious aims were agreed for the project, focusing on conservation, restoration, knowledge sharing and engagement. These included:

- restoring 214 hectares of ancient woodland
- identifying and protecting veteran trees
- enhancing habitats for priority species such as pearl-bordered fritillary butterflies, dormice and barbastelle bats
- conducting archaeological excavations at Fingle Mill, Wooston Castle and other areas of interest
- linking with higher education providers and the academic community

- engaging with landowners, forestry businesses and the local community through, for example, training and open days.

Restoring the woods was clearly going to be a long-term process and requires both the Woodland Trust and the National Trust to learn from each other and adapt their usual ways of working. For example, the Woodland Trust predominately uses contractors for woodland management work, whereas the National Trust mainly relies on employees.

The project was overseen by the Woodland Trust, aided by staff from both organisations and a number of contractors. In total, 79 contractors and local businesses came together, including forestry and timber companies, ecologists, civil engineers, historians and conservationists. Key to success was ensuring that each person understood the bigger picture and the role they would play in the restoration. Rather than operating individually, the contractors worked as a team alongside staff from the National Trust and the Woodland Trust.

A gradual transformation

A key part of the restoration work has been to gradually thin out the conifers utilising traditional forestry methods, such as horse logging and hand tools, alongside modern machinery. Unlike modern forestry, which uses large and heavy machinery, traditional methods have less impact on the soil (which is better for natural regeneration), and can be used on steep slopes. Over the last few years, the dense lines of conifers have slowly been transformed into a more natural mosaic of habitats, from native closed canopy woodland to younger copses, scrubland and open grasslands. Priority plant species, such as ivy-leaved bellflower, royal fern, lesser skullcap and toadflax-leaved St John's-wort are increasing in numbers as more light is able to reach the forest floor.

Removing the conifers has increased open habitat area by 40 hectares. While some of these spaces will gradually succeed to woodland, others will be maintained as grassland or scrubland, providing vital habitats for certain species of invertebrates, reptiles, birds and mammals. Dormice, for example, welcome the shelter provided by bracken and other plants in scrubland, while large gorse mining bees feast on the wild flowers of Ross Meadow. The meadow is also home to the Roesel's bush-cricket, which is mainly found in grasslands along the east coast of England and was first recorded in Devon in 2014.

Conifer removal as part of ancient woodland restoration.

Benefitting biodiversity

There have been several major wildlife success stories since the formation of the partnership. Numbers of the highly threatened pearl-bordered fritillary butterfly are now increasing at Fingle and there are at least 13 species of bat, including the barbastelle bat – a priority species only found in southern England and Wales – and lesser and greater horseshoe bats. The lichen running-spider has recently been spotted at Fingle – quite a discovery as this tiny spider is well camouflaged and there are just 100 records of it across the UK.

Management interventions (such as ringbarking) to increase the volume of dead and decaying wood has led to the return of saproxylic (i.e. decaying wood dependent) invertebrates such as the nationally scarce golden-haired longhorn beetle. Indeed, dead and decaying trees provide vital habitats for a wide range of species. The lesser spotted woodpecker drills cavities into old decaying trees to lay their eggs, and there are at least four nesting sites at Fingle – a major conservation win for one of the UK's rarest birds, with only around 800 breeding pairs in total.

Lesser spotted woodpecker.

Pearl-bordered fritillary.

Since restoration started, several other bird species have been spotted, including the pied flycatcher, redstart, tree pipit, cuckoo, firecrest and nightjar. Many of the birds found at Fingle are relatively rare in the UK and almost unheard of in Devon. Of the 79 species of bird recorded here, nine are on the *Birds of Conservation Concern* 5 red list and 14 are on the amber list.

Of course, we can only do so much. Many species are still in decline at Fingle due to factors outside our control. After the 'Beast from the East' extreme weather event of 2018, for example, there was a drop in migratory birds such as the pied flycatcher. The ever-increasing effects of climate change will undoubtably affect many species, regardless of how hard we work at Fingle to boost resilience.

Regenerating the wider landscape

Fingle is a large site in itself, but is also important in the wider landscape context. It contains fragments of temperate rainforest – a highly biodiverse, nationally rare woodland type characterised by high levels of rainfall and relatively mild temperatures year round – which provide just the right conditions for some of the world's rarest bryophytes and lichens. These fragments are part of the wider temperate rainforest resource across the southwest.

To protect these habitats, we need to restore the wider landscape. Since the successful partnership with the National Trust at Fingle, the two organisations have joined forces again to protect and restore nearby Ausewell Wood. The Woodland Trust also owns and manages three woods along the River Bovey. It is vital to create connections between these habitat patches to give the UK's complex ecosystems a fighting chance against the uncertainty of climate change.

The restoration of Fingle Wood is even contributing to Dartmoor peatland restoration. Low-quality conifer timber from the ancient woodland restoration work is being used to create dams to slow the flow of water and re-wet the moor, meaning carbon-rich peat can regenerate.

Far reaching impacts

Fingle has acted as a test ground of sorts, allowing the Woodland Trust and National Trust to trial different restoration approaches. The knowledge gained is being shared with other projects, as well as with the wider conservation and woodland management sectors. In addition, many of the small businesses that have worked together on the project have embraced the experience and forged relationships beyond the project. They now call on each other's expertise for other restoration work in the area. Some contractors have also taken on apprentices, who are learning on the job at Fingle.

The project has involved several local education providers, including Plymouth University. Since the partnership began, Fingle has played an instrumental role in five PhDs and two MScs, as well as in the studies of 82 undergraduates. In short, the Fingle project is already leading to improved conservation and forestry work across Devon and helping to train and inspire the next generation.

Impacts on the local community have been significant. The long-term nature of the project has provided economic stability to many of the smaller companies involved, enabling them to grow, buy new equipment and take on more staff. We also want to enable as many people as possible to experience and enjoy Fingle. Restoration and the creation of paths allows local people to enjoy this former beauty spot once again, and we've welcomed people to open days, lectures and demonstrations. The project has benefitted from a wealth of local volunteers, who have supported us in everything from clearing scrub to monitoring key species. Without them, these woods would look very different.

> "Together, we've achieved far more than we could ever have done working separately.

Future collaboration

It could take a lifetime to fully restore Fingle. Ongoing management and monitoring are crucial. However, it is heartening to see that just a few years of work can result in so many improvements for our native flora and fauna.

The Woodland Trust's partnership with the National Trust has been a vital part of the Fingle project. Together, we've achieved far more than we could ever have done working separately. We've also learnt how to manage such a partnership, which will be invaluable over the next few years as we forge new collaborations with other organisations.

Read the Fingle Woods blog to find out more at finglewoods.org.uk.

Ancient woodlands of Killaloo and Brackfield in the Faughan Valley, Northern Ireland.

Ancient jewels in a Northern Irish landscape

Dave Scott

Dave Scott is the Woodland Trust's estate and project manager in Northern Ireland.

Against a backdrop of centuries of catastrophic woodland loss in Northern Ireland, a concentration of ancient woodland fragments has clung on in the Faughan Valley. Now a protected landscape but suffering from modern day pressures, these internationally significant woodlands are a priority for restoration by the Woodland Trust.

Woodland clearance on the island of Ireland has been ongoing since the Neolithic period around 5,500 years ago[1]. By 1600, about 12.5% of the island was still covered with natural forest[2]. However, as we enter the more recent past, an increasing range of economic, political and social pressures resulted in accelerated clearance and the almost complete destruction of our natural woodlands. By 1800, 2% of Ireland was forested. Today, in Northern Ireland, the remnants of the great post-glacial forest account for only about 0.04% of the land area[3].

The Faughan Valley

Situated in the North Sperrin Hills, southeast of the City of Derry/Londonderry, the Faughan Valley, covering 207 square kilometres, is vitally important in terms of its natural heritage. The Faughan Valley sits in an open, sweeping landscape with high flat-topped hills providing extensive views, cut into by narrow valleys and river corridors with wooded glens. This variety of landscape patterns creates a unique environment that represents a mosaic of habitat types and species diversity as well as archaeological and historical features. The significance of the natural heritage of the Faughan Valley is recognised in a Northern Ireland, UK and wider European context.

The River Faughan, which runs through the heart of the valley, was designated an Area of Special Scientific Interest in 2008 and an EU Natura 2000 Special Area for Conservation in 2009. It is one of the highest quality salmon rivers in Europe. The wider Sperrin Mountains catchments are designated as Environmentally Sensitive Areas and Areas of Outstanding Natural Beauty.

The history of woodland clearance for agriculture, timber and other human pressures in the Faughan Valley was, broadly speaking, no different than elsewhere in Ireland. However, sufficient differences in geography, natural environment, topography, logistics and land ownership have allowed a concentration of fragments of ancient semi-natural woodland to persist in the landscape. While these fragments present critical building blocks in the restoration and conservation of the natural heritage in the Faughan Valley, their current ecological condition is very mixed. Most have survived by being overlooked, i.e. the sites' potential for productive agriculture, and therefore economic value, was considered low.

Many of these ancient semi-natural woodlands were planted with exotic timber-producing species, converting them into Planted Ancient Woodland Sites (PAWS). Those that were used for sporting activities in the past (mainly game shooting), at a time when a range of aggressive exotic shrub species were introduced as game cover, have since been overlooked. An ongoing lack of conservation management, together with increasing deer and other damaging mammalian herbivore populations, and the virtually uncontrolled spread of invasive exotic shrubs, have presented the ancient semi-natural woodland fragments of the Faughan Valley with a whole new range of challenges.

The significance of the Faughan ancient woodlands

From information gleaned from the NI Ancient Woodland Inventory, and independently assessed by Northern Ireland Environment Agency (NIEA), the Faughan Valley is recognised as strategically important for its fragments of ancient woodland. Without intervention, these fragments will become increasingly isolated and degraded. Conversely, securing their ecological stability through appropriate conservation management interventions, and seeking to utilise them as the building blocks for the development of an extended native woodland resource, can greatly enhance the biodiversity, productivity, scenic and natural heritage value of the Faughan Valley and its wider environment.

Laurel invasion in an ancient woodland.

This old oak is a remnant feature in a conifer plantation, now being shaded out by non-native spruce trees.

Significant pockets of ancient semi-natural woodland are found along sections of the Faughan Valley, namely Ness Wood, Ervey Wood and Bonds Glen. These are all designated ASSIs (Areas of Special Scientific Interest) for their priority woodland habitats and associated rare woodland species, and all are included within the River Faughan and Tributaries SAC (Special Area for Conservation). Oaks Wood and Killaloo Wood are both Local Nature Reserves. Ness and Ervey Woods both contain UK Biodiversity Action Plan oakwood and mixed ash wood habitats. Bonds Glen is one of the few remaining areas in Northern Ireland with an unbroken range of woodland, from wet woodland to mature dry woodland. It also contains rare species, such as the parasitic plant toothwort and a grass called wood fescue. These woodlands are also important habitat for mammals such as otters, badgers, and red squirrels, and birds including the cuckoo, willow warbler, dunnock and goldcrest.

The semi-natural woodlands in the Faughan Valley have clearly been decimated by centuries of clearance and exploitation. Nevertheless, they represent our most biodiverse habitats and are a refuge for a range of threatened flora and fauna. The woodland ecosystems themselves are threatened not only outside their boundaries (by clearance and fragmentation), but also within, particularly by a range of invasive exotic species which prevent native tree regeneration. Habitat and species loss and the degradation of our cultural landscape will be catastrophic if semi-natural woodland decline is allowed to continue.

Restoration at scale

The ancient semi-natural woodland fragments concentrated in the Faughan Valley represent the building blocks with which to create a vibrant, biodiverse and resilient natural landscape. These fragments along the Faughan contain in themselves the necessary elements – tree species and local genetic adaptations of herbaceous species, native fauna, and soil mycorrhiza required to populate a wider, interconnected new native woodland resource. The valley provides the ideal geographic unit in which to achieve this.

The priority habitat of ancient woodland is of prime importance in the Faughan Valley, as it's where the benefits of restoration can be demonstrated to other landowners – inspiring them to restore their own woodlands. Work to connect the existing fragments of ancient and semi-natural woodland is on-going through hedgerow restoration, expanding existing woodland and riparian planting, forming the basis for building wider landscape resilience. This will also provide opportunities to make the case for trees and woods as providers of ecosystem services, such as enhancing water quality or increasing productivity on farms, and as an economically viable resource.

To date, the Woodland Trust – thanks to funding and support from the National Lottery Heritage Fund – has restored over 30 hectares of ancient woodland in partnership with local landowners. This has involved the clearance of rhododendron, laurel and Himalayan honeysuckle and follow up treatments by our Faughan Valley volunteers and contractors. A targeted approach to increasing the structural connectivity of the ancient woodland fragments through riparian (riverside) planting, has led to over eight kilometres of planting along the River Faughan and its tributaries. In addition, the Trust has recently purchased another 61 hectares of land to increase woodland cover in the valley and is engaging with local landowners to plant over 60 hectares of new woodland. This is all part of the Trust's vision for the Faughan Valley, to restore and connect ancient woodland for people, wildlife and the economy.

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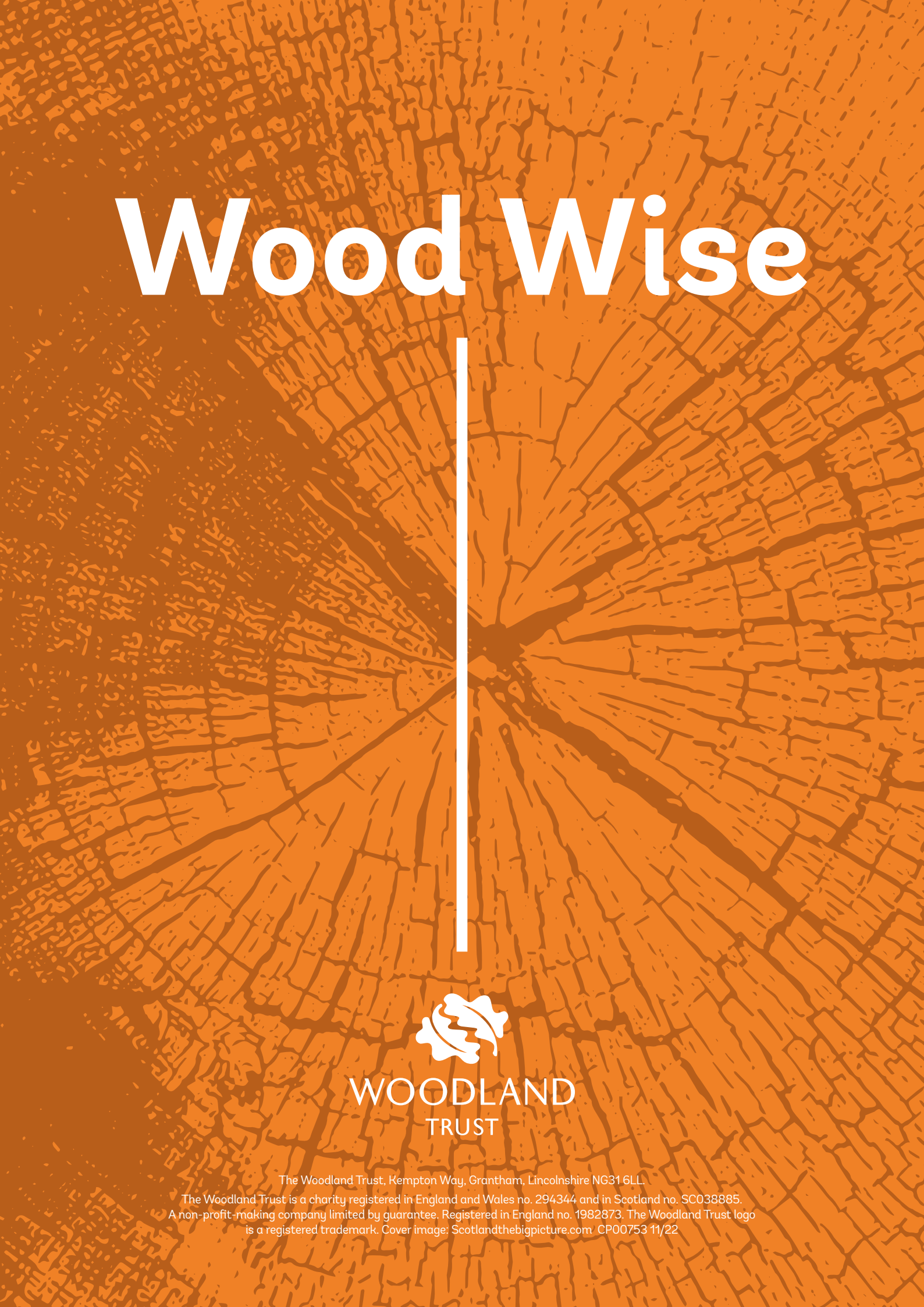
Wood Wise



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