Growing together

research-practice exchange for woodland restoration

Marc Metzger

Centre for Sustainable Forests and Landscapes

Ailsa Watson, Alastair Seaman, David Edward, Darren Moseley

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Forest Research


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2025 project

To understand practitioners' knowledge needs

To consider the co-development of future research strategies

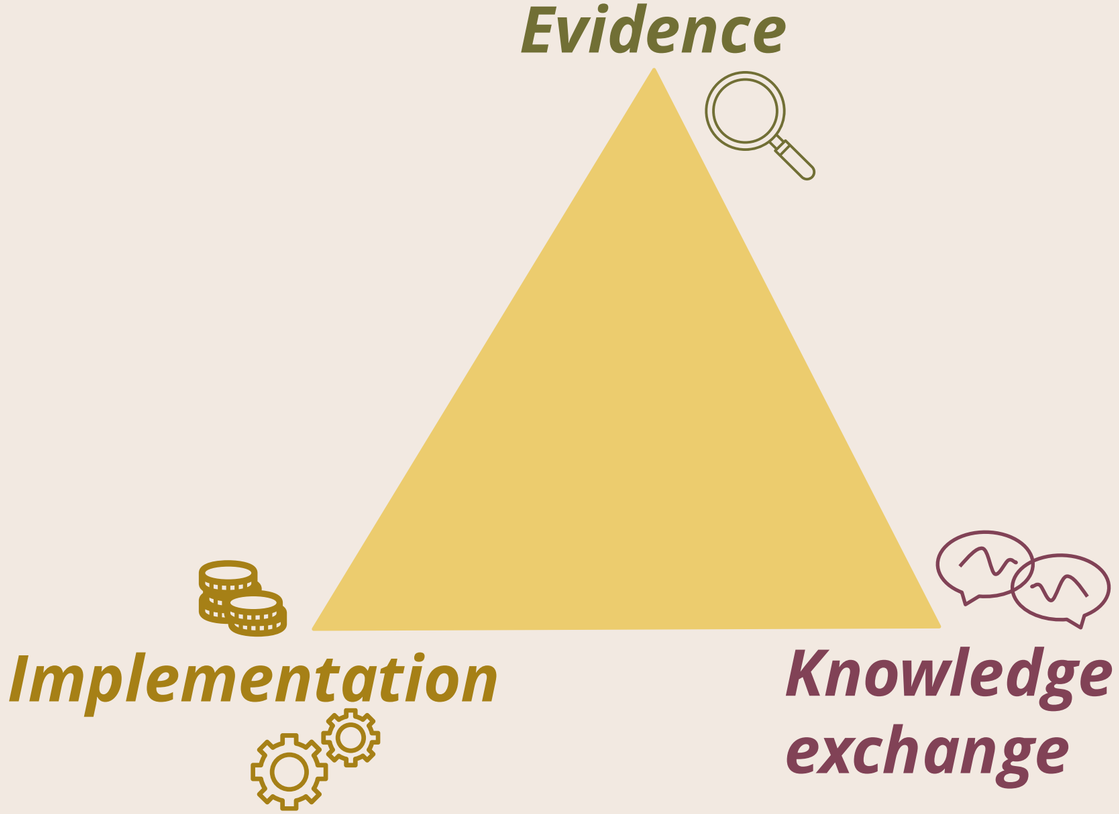
http://dx.doi.org/10.7488/era/6548

Unpacking knowledge needs

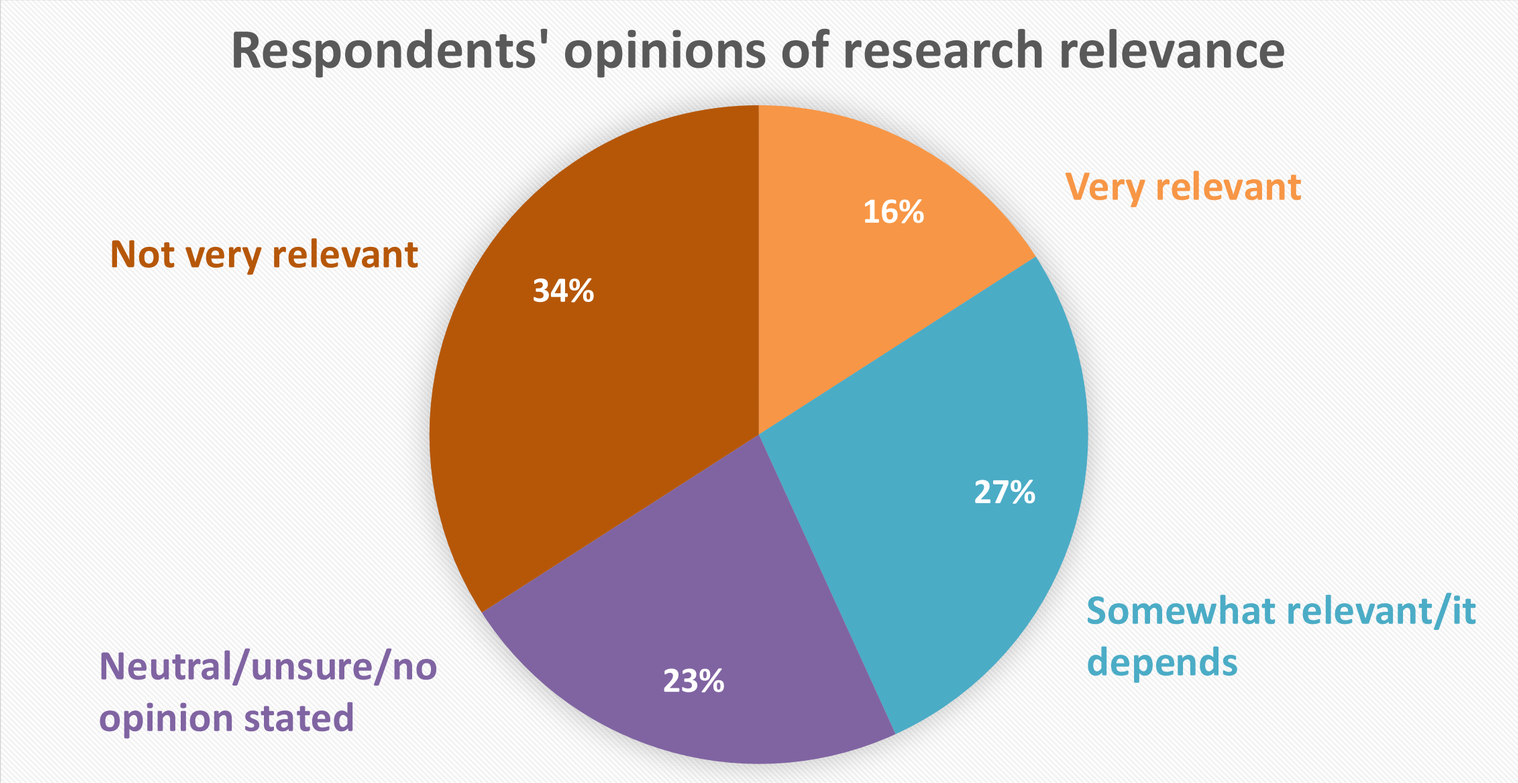
Evidence gap:
due to lack of scientific understanding

Knowledge exchange gap:
due to ineffective sharing of scientific understanding

Implementation gap:
due to wider contextual factors that limit required action



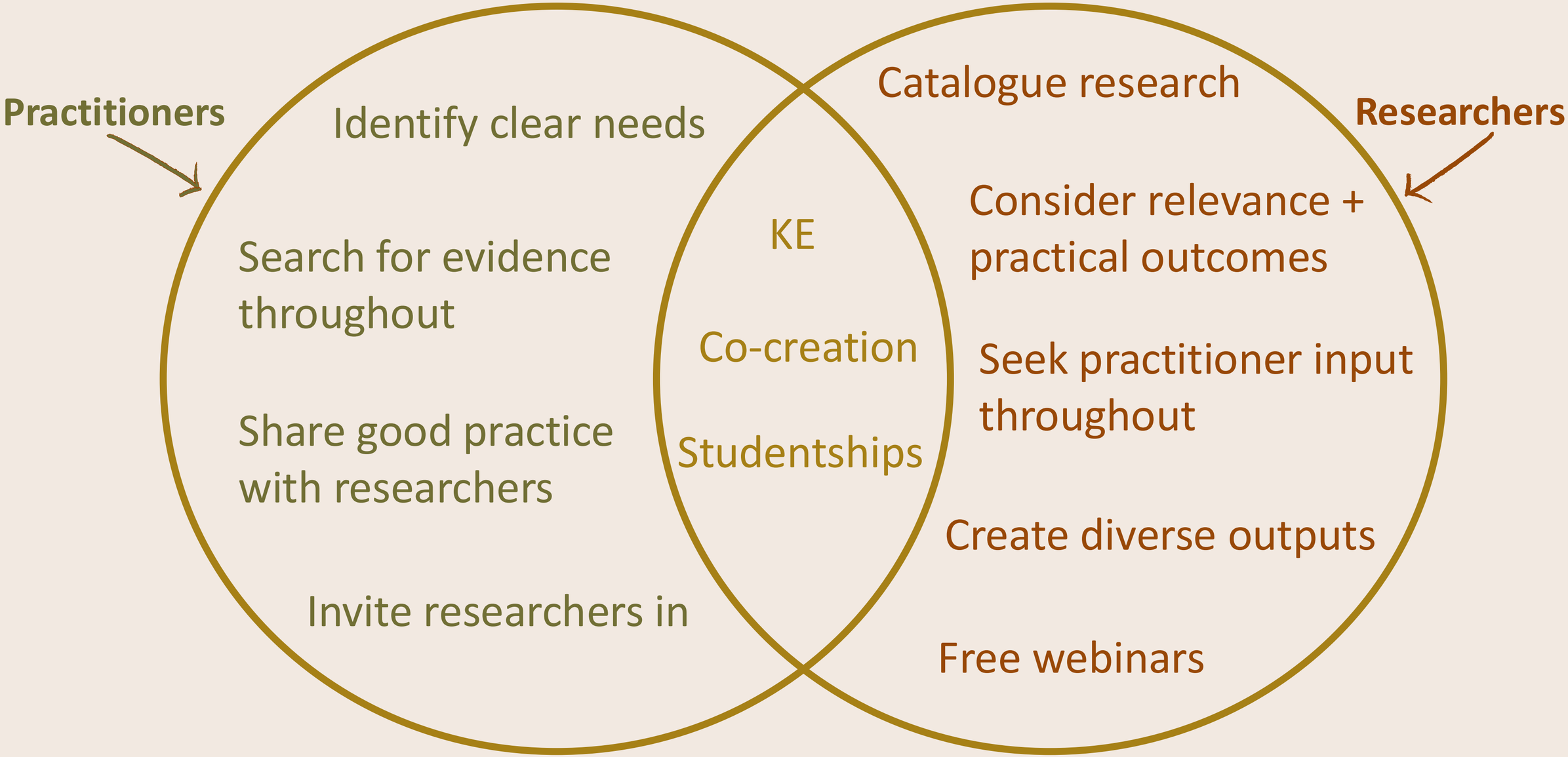
Practitioner-researcher dynamics



Lack of…

- Application
- Accessibility
- Practitioner input

Practitioner-researcher dynamics



Aims for today

To bring together woodland restoration professionals with researchers to strengthen collaboration and knowledge exchange.

- Provide insight into Forest Research’s new science innovation strategy and their relevant research and expertise related to woodland restoration
- Showcase practitioner expertise and knowledge needs
- Facilitate knowledge exchange between practitioners and researchers.
- Reflect how collaboration between researchers and practitioners can be supported and encouraged.

Programme

9.30	Welcome and aims of the day (Marc Metzger)
9.40	Practitioner knowledge needs (Ailsa Watson & Alastair Seaman)
10.05	Woodland restoration research at Forest Research (Bianca Ambrose-Oji)
10.30	Coffee break
11.00	Overview of FR expertise (chaired by David Edwards) • Native woodland establishment - Kevin Watts • Woodland management for nature recovery - Katty Baird & Alice Broome • Genetic diversity and adaptation - Joan Cottrell • Monitoring impacts of mammals - Cally Ham • Soil ecology - Ainoa Pravia
12.30	Lunch
13.15	Intro (Ailsa Watson) followed by 4x 30 minutes carousel of case-study discussions (Mike Daniels, Ian Dow, James Rainey & Henry Dobson)
15.30	Coffee break
15.45	Report back 4x 5min
16.05	Reflection - how collaboration between researchers and practitioners can be supported and encouraged? (Marc Metzger)
16.30	Closure

Connecting Woodland Restoration Research and Practice - 9th June 2026

Practitioner Knowledge Needs

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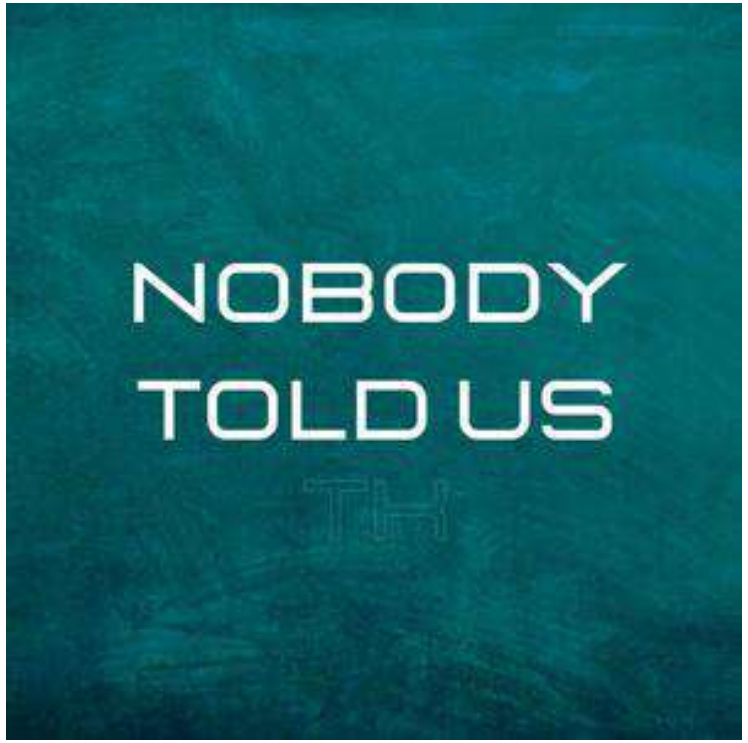
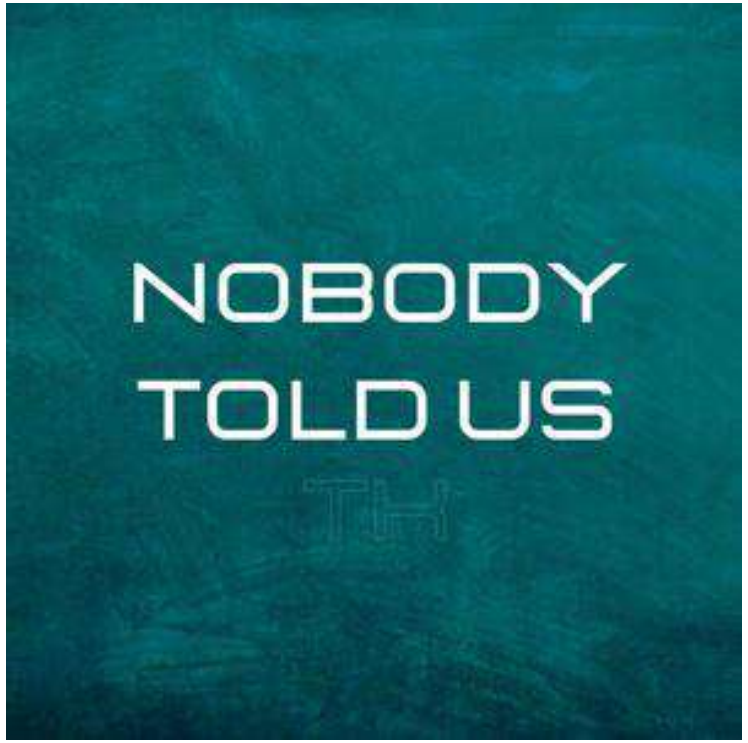
Forest Research

How we got here

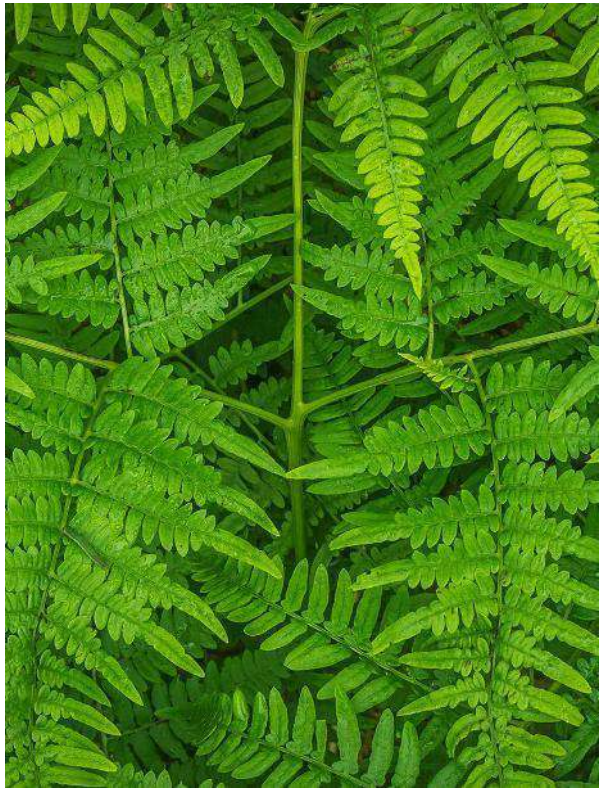


How we got here

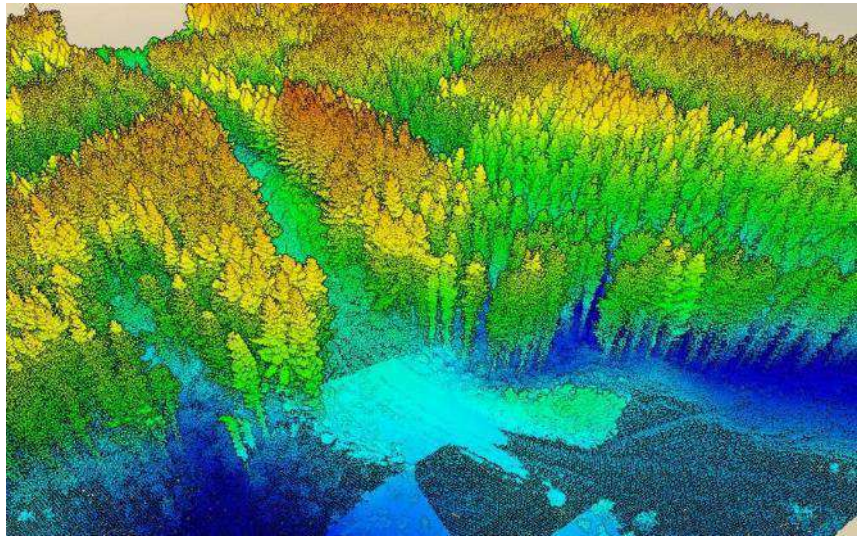


How we got here

What we learned – ecological

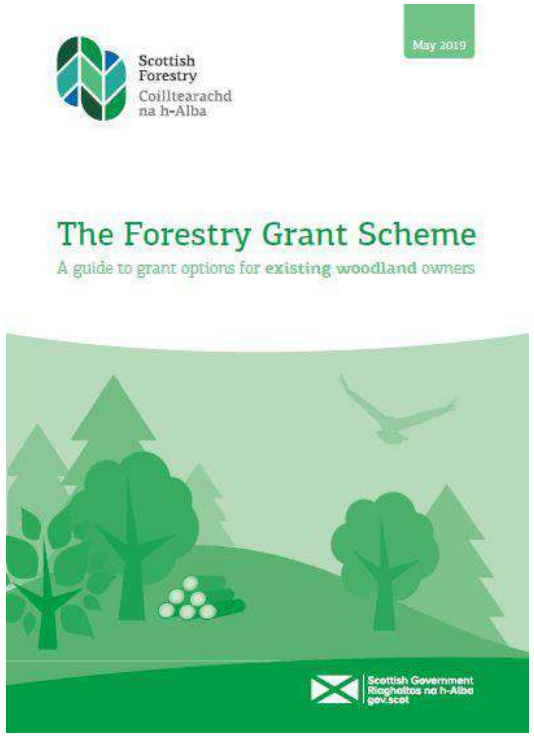


What we learned – technical



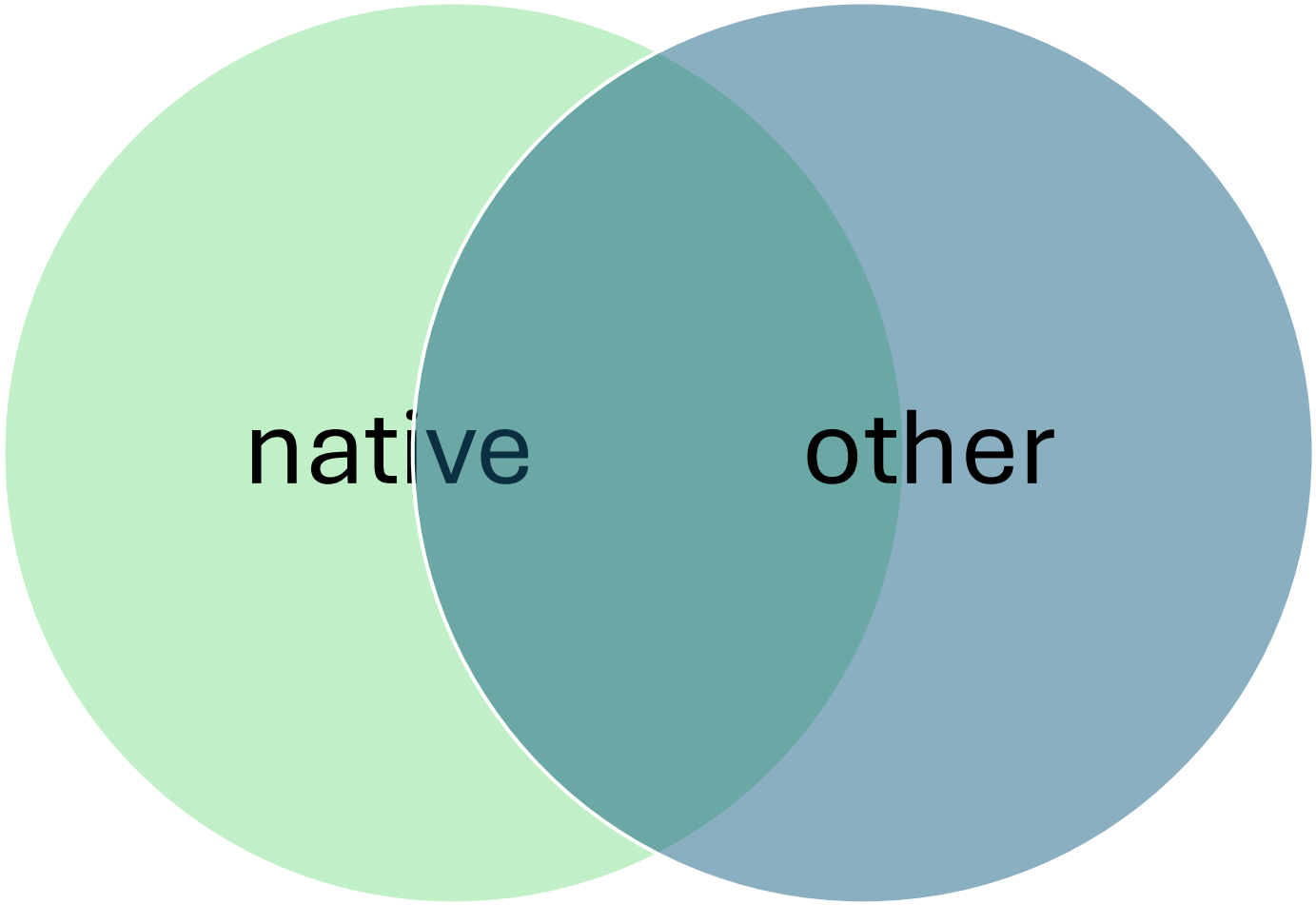
What we learned – social

What we learned – financial



Woodland Carbon CO_2de®

What we learned – overlap



Funding practitioner research

Specialist funders:

The Scottish Forestry Trust

Future Woodlands Scotland

The Scottish Forestry Trust

‘Forestry’ in the broadest sense

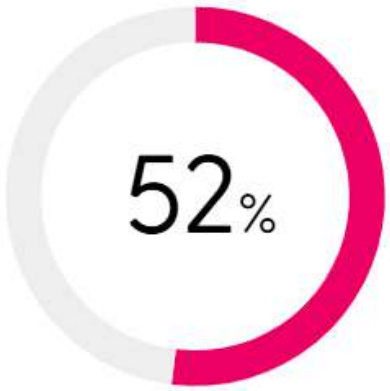
Last year, awarded £175,000 in funding across:

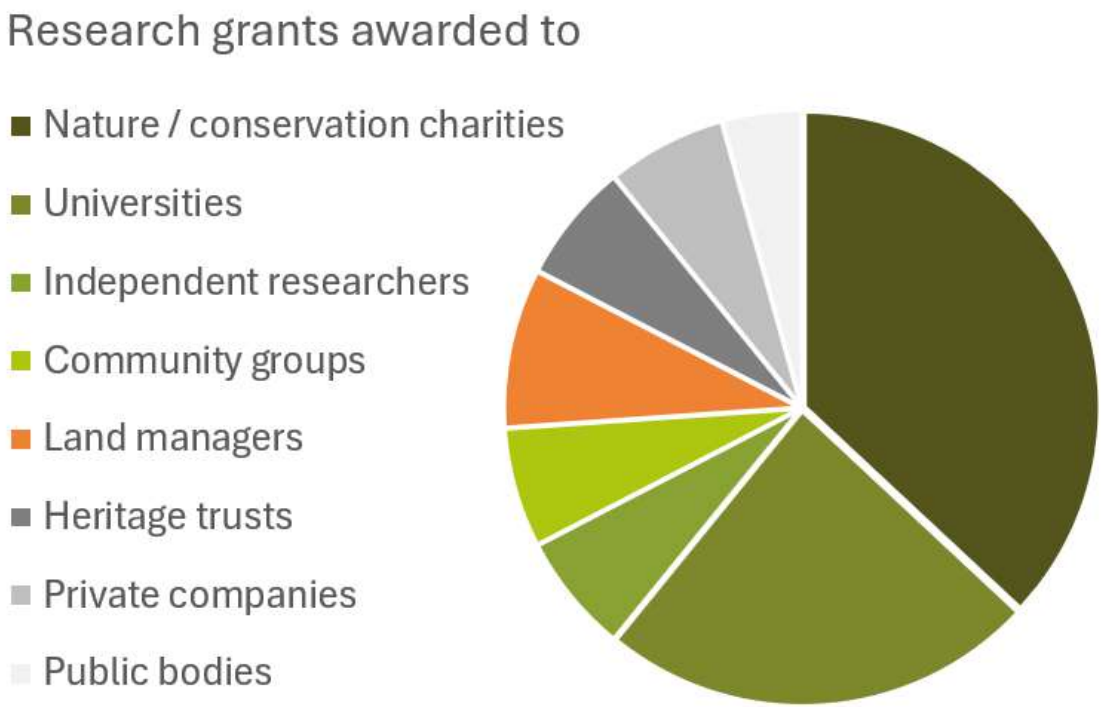
- Research – 65-75%
- Education – 25-30%
- Training – 5% or less

Future Woodlands Scotland

Grants for native woodland research (and regenerative silviculture)

Annual budget c. £80k



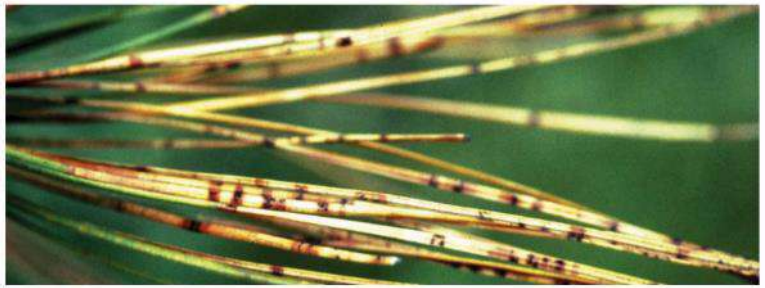


Future Woodlands Scotland

Improving riparian buffer zones to encourage distribution of beavers

Assessing 20 years of montane scrub restoration and the impact of reduced grazing on associated alpine flora

Case-study based resources to inform and educate deer management practitioners



Identifying a Control Agent for Dothistroma Needle Blight

Civic Mediation for Sustainable Deer Management

Assessing RTK multispectral surveying to aid removal of INNS

Trialling Approaches to Establish Native Ground Flora

Ancient Slope Alder Wood Pasture Study

Potential steps to improve funding landscape

- Convene a woodland research funders group:
  - assess overlap
  - combine funds
  - reduce grant admin and reporting

- Researchers to input on grant panel:
  - advise on methodologies
  - link up projects, sites, collaborators, specialists
  - join up data

Practitioners are researchers

Researchers ask and answer questions

Practitioners use new knowledge to deliver change

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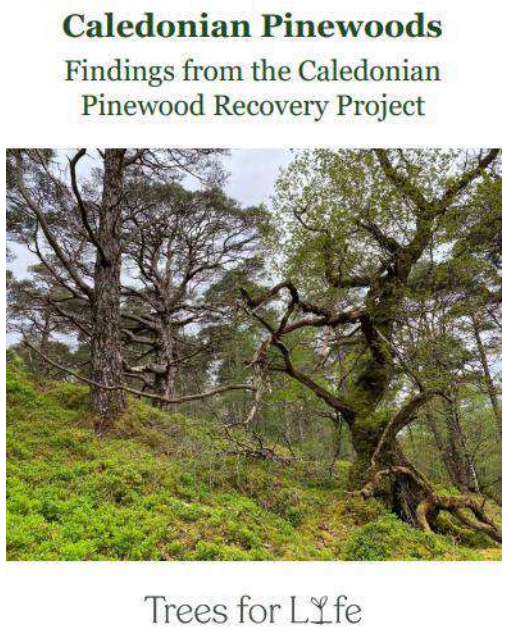

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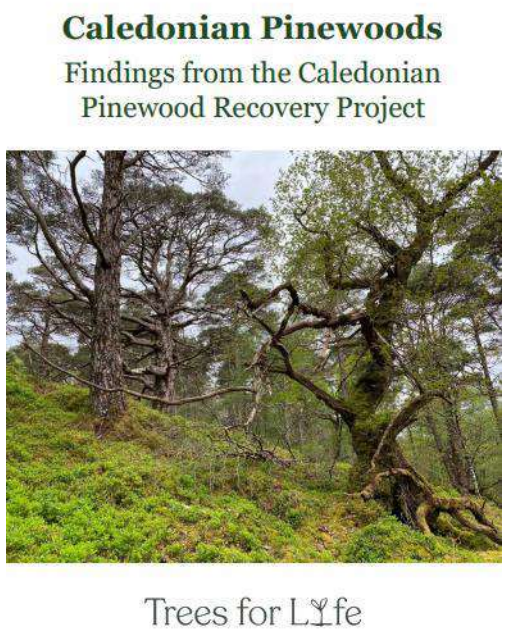

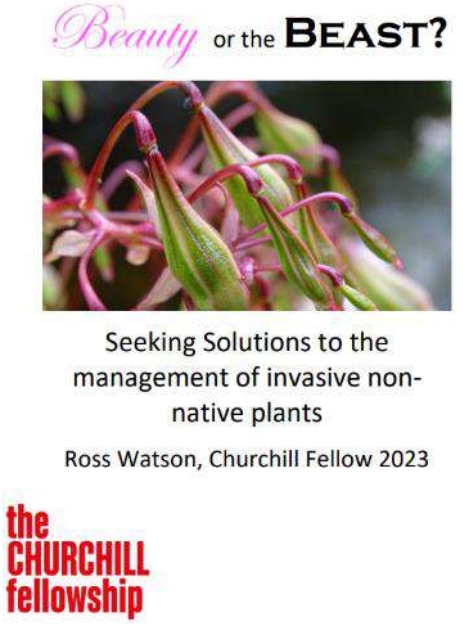

Practitioners + researchers develop & answer questions

Practitioners + researchers use new knowledge to deliver change

Close the enaction gap – practice ⟷ research

- Improved funding landscape
- How to conduct research over the very long-term?
- Communicate learning and insights
- Skills
- Closer working between researchers and practitioners
- NGOs and funders to feed into national research strategies

Any questions?

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Forest Research

Forest Research

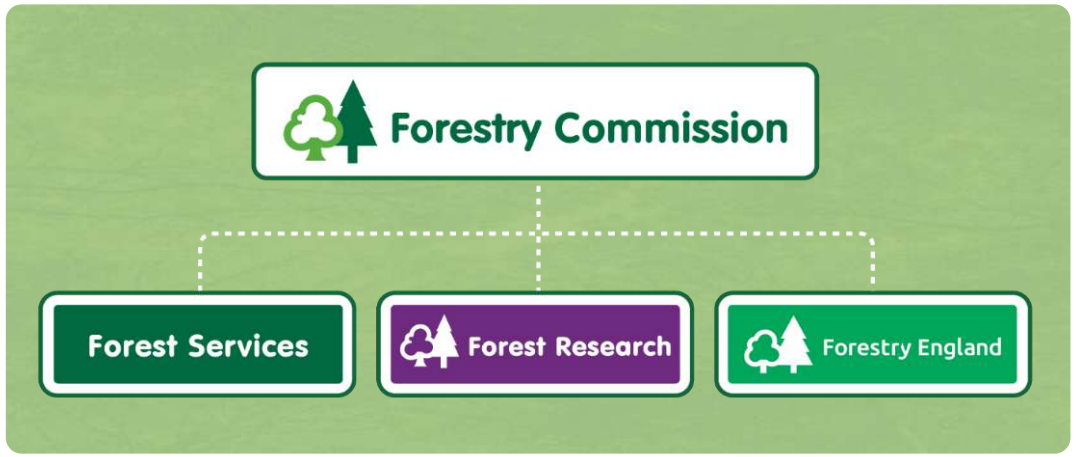
Overview of Forest Research

Prof Bianca Ambrose-Oji
Chief Scientist

Organisational responsibilities

Great Britain's primary research organisation for trees, woods and forests.

We deliver services and support across the UK for the English, Scottish, Welsh and Northern Irish governments.



We are an agency of the Forestry Commission but have a GB wide remit to deliver across all the devolved administrations.

We support tree and forestry strategies in England, Scotland and Wales, as well as Defra's EIP

Science and evidence functions and capability

425 FTE staff

58 labs,
1 Level 2 Containment

Network of long-term plots & experiments

Forest Management

- Climate Change Science
- Society & Environment Research
- Land Use & Ecosystem Services
- Silviculture and Wood Properties
- Mensuration, Growth and Yield
- Urban Forests

Forest Protection

- Pathology
- Diagnostic and Advisory Service
- Entomology
- Physical & Environmental Sciences
- Forest Genetics

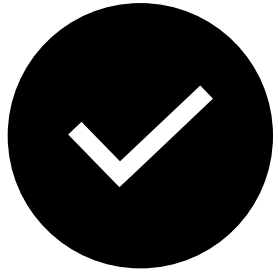
Inventory, Forecasting and Operational Support

- GIS and Data Services
- Natural Capital Ecosystem Assessment Programme (NCEA)
- Forest Information and Statistics
- Technical Development Contracts

Main areas of work

APPLIED RESEARCH

DIAGNOSTICS AND OUTBREAK RESPONSE



MODELS AND DSS FOR GOV AND SECTOR

NATIONAL AND INTERNATIONAL STATISTICS – M&E

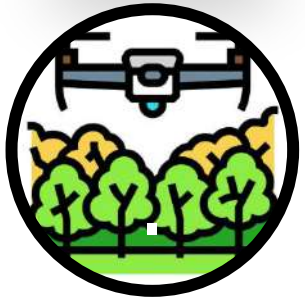
Key Thematic areas

Ecosystem Resilience

Forest, Woodland, Tree Cover Expansion and Establishment

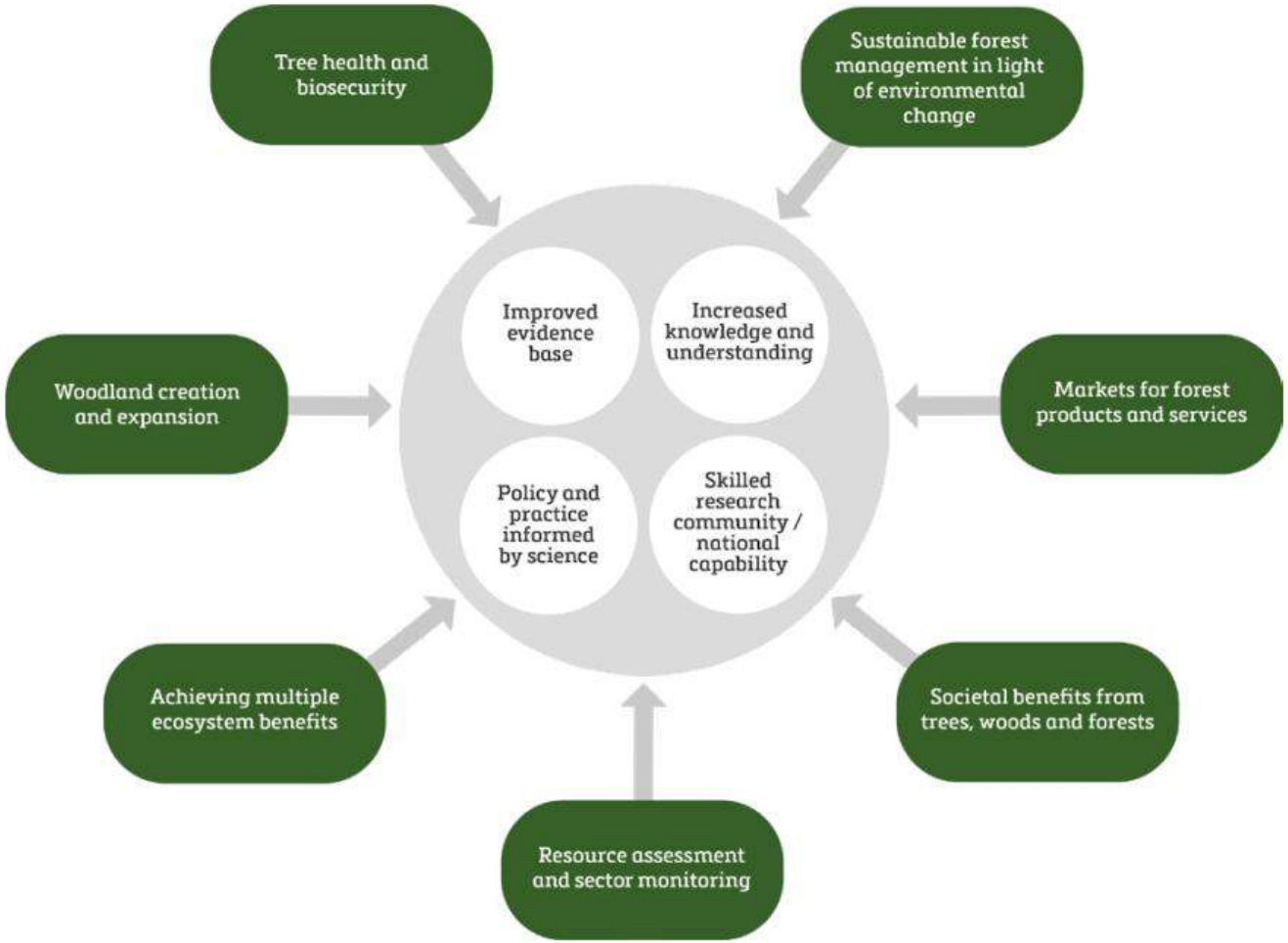
Forest Protection

Sustainable Forest Management



Understanding Change

Core capability & outcomes



Example projects: Trees outside of woodlands

Trees Outside Woodland Public Map

Legend
Details
Layers
Collapse

Details

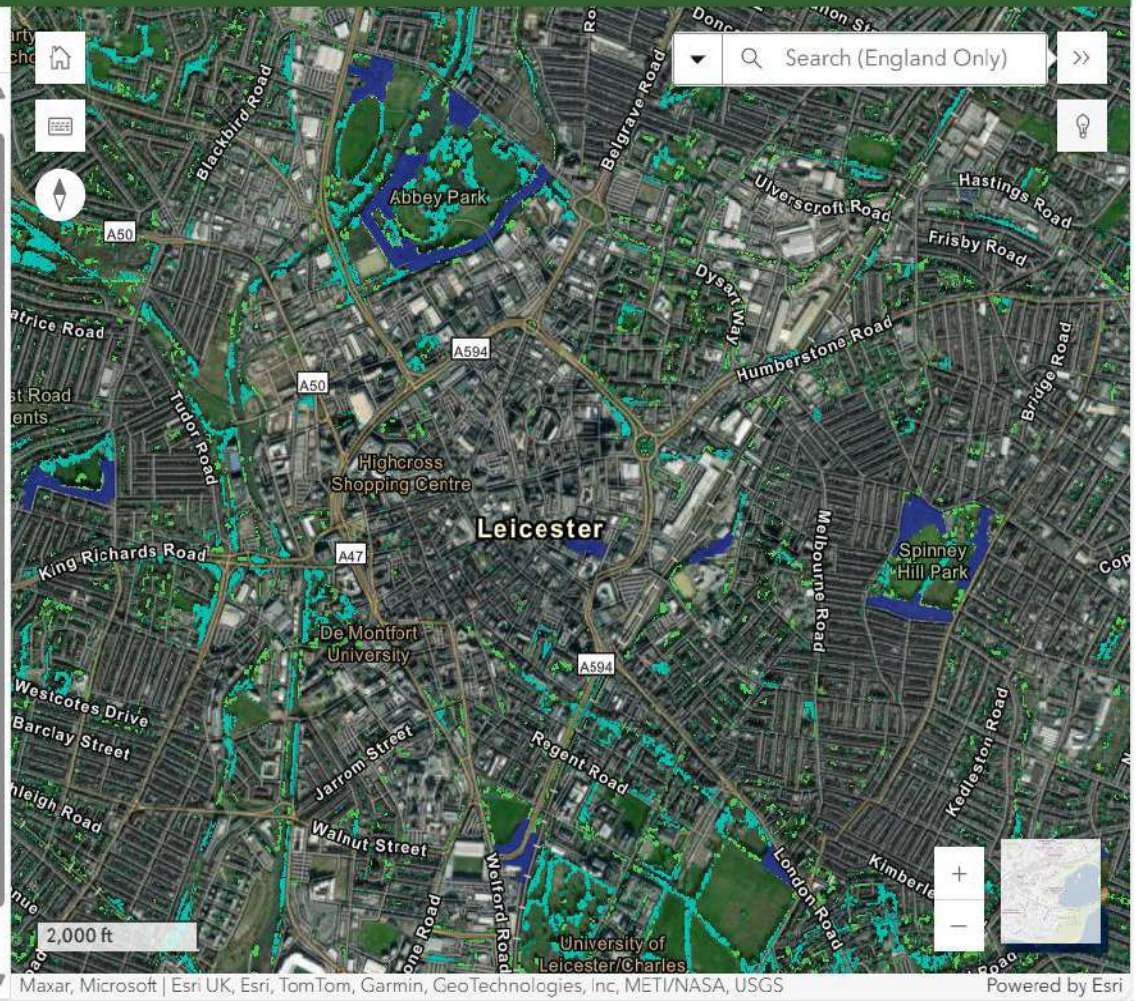
This app displays the Trees Outside Woodland (TOW) woodland types grouped by regions in England.

The mapping method delineates features identified in TOW to the drip-line of the canopy, also referred to as Over Hanging Canopy (OHC). When used in conjunction with the National Forest Inventory it provides complete information on tree canopy cover in England. The National Forest Inventory England 2023 map is also displayed (dark blue polygons) to allow for side-by-side comparison with TOW.

TOWs are categorised into woodland types according to a set of size criteria (Table 1).

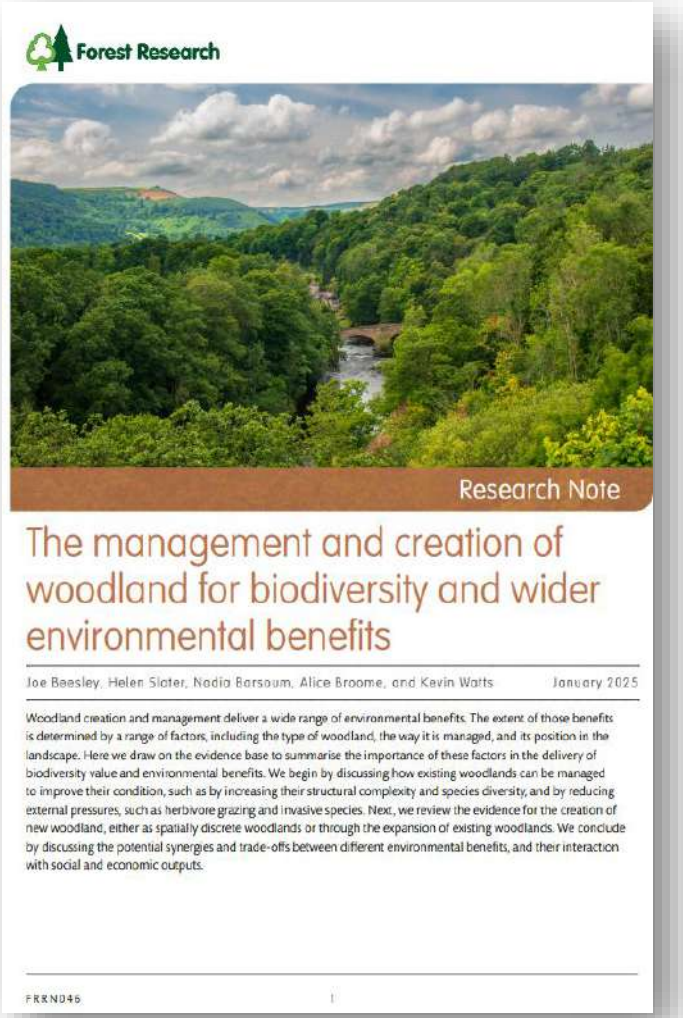
TOW Feature	Min Height	Min Area	Max Area
Lone Tree	3m	5m²	350m²
Group of Trees	3m	5m²	1000m²
Small Woodland	3m	1000m²	NA

Table 1: TOW feature classification criteria by size only.



Source: https://www.forestresearch.gov.uk/tools-and-resources/fthr/trees-outside-woodland-map/

Example projects: Forestry and biodiversity



The FOrest Biodiversity Index (FOBI) tool

"Providing these two headline numbers is useful for high-level decision makers, such as policymakers reporting on progress towards biodiversity goals, whilst forest managers and other users can make use of the underlying detail"

Example projects: Resilience for timber production

Selecting a shortlist of tree species for diversification and resilience

Forest Research is collaborating with stakeholders across the forestry sector to assemble the evidence required to select a shortlist of product conditions. This will guide actions to diversify our forests and increase their resilience to pests and diseases and climate change.

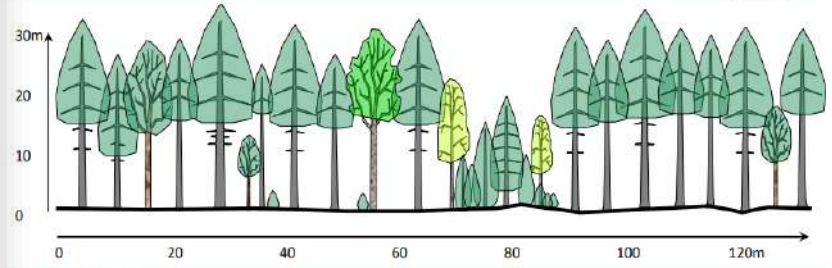
Author(s): David Edwards

Research Status: Current

Forest management

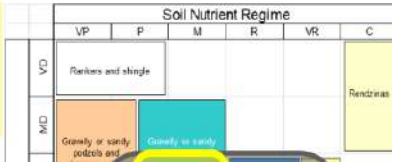
Forest Development Types:

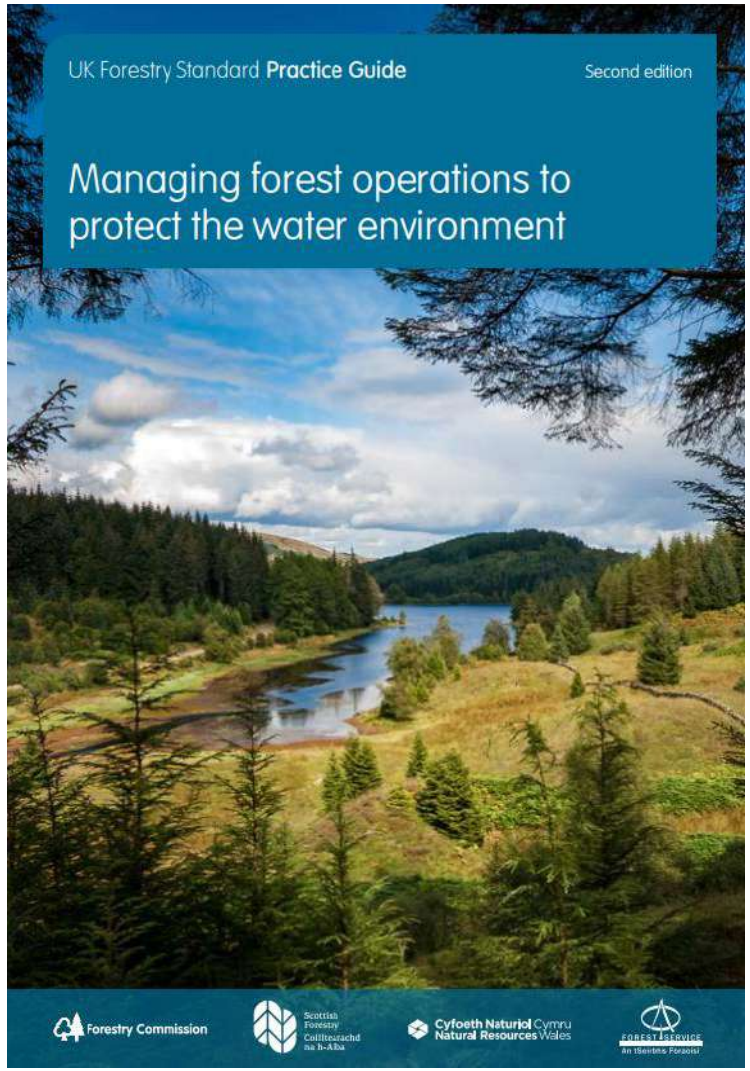
FDT 1.1.2 SS



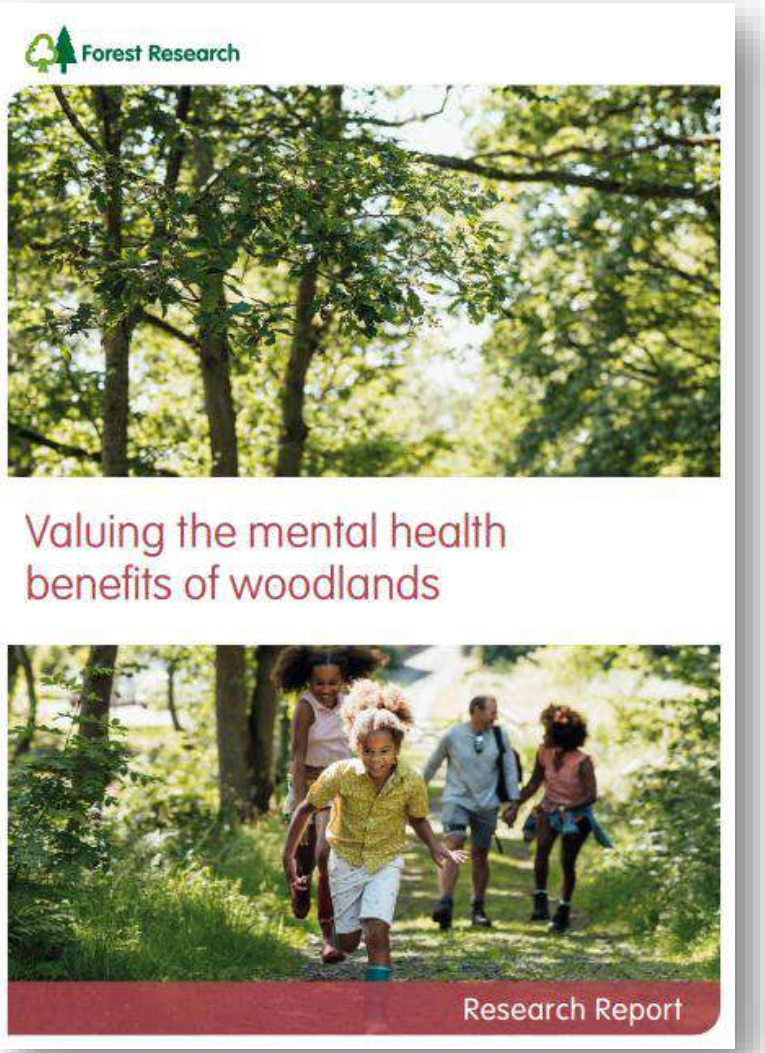
1. Structure and dynamics:
Single to multiple-storeyed SS stands with category A minor species which are mixed in individually or in groups and mostly occupy suitable microsites and areas of difficult access.
Species distribution: SS 80 – 90% minor species: 10 – 20%
Stands are managed under LIMA / CCF regimes, with management aiming to create a diverse structure and using natural regeneration wherever practical.

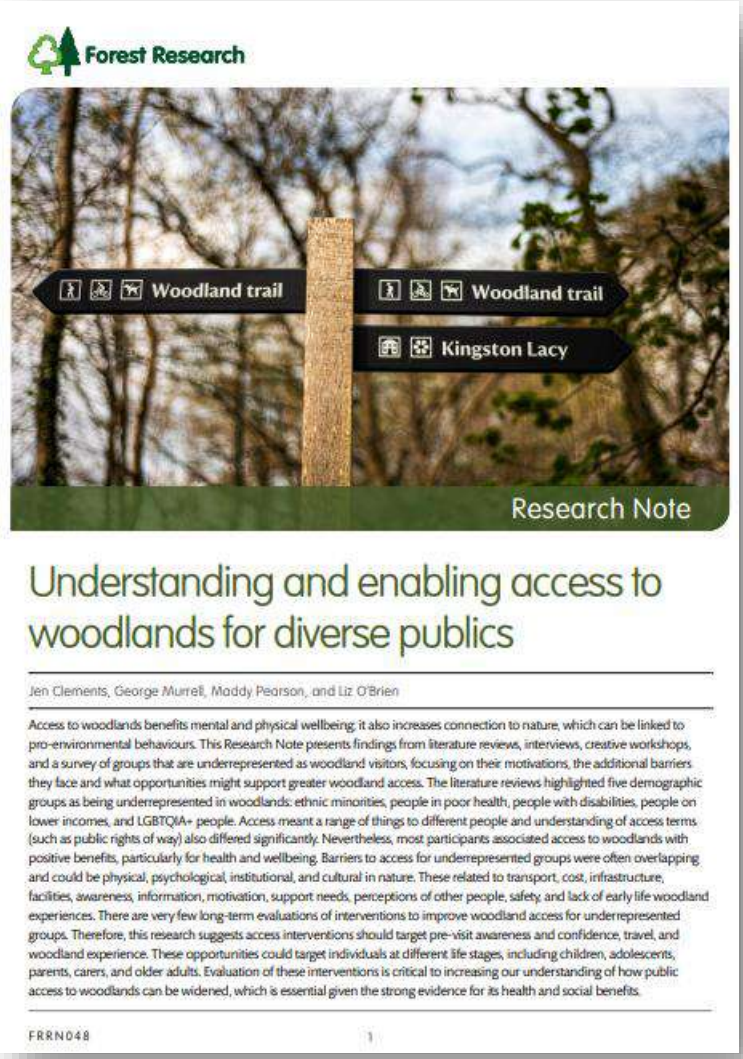
2. Ecological suitability:
Represents no NVC type but provides niches for elements of W4, W7, W11 and W17. Suitable for more fertile soils (GYC > 14) where admixed species add to diversity and site productivity.

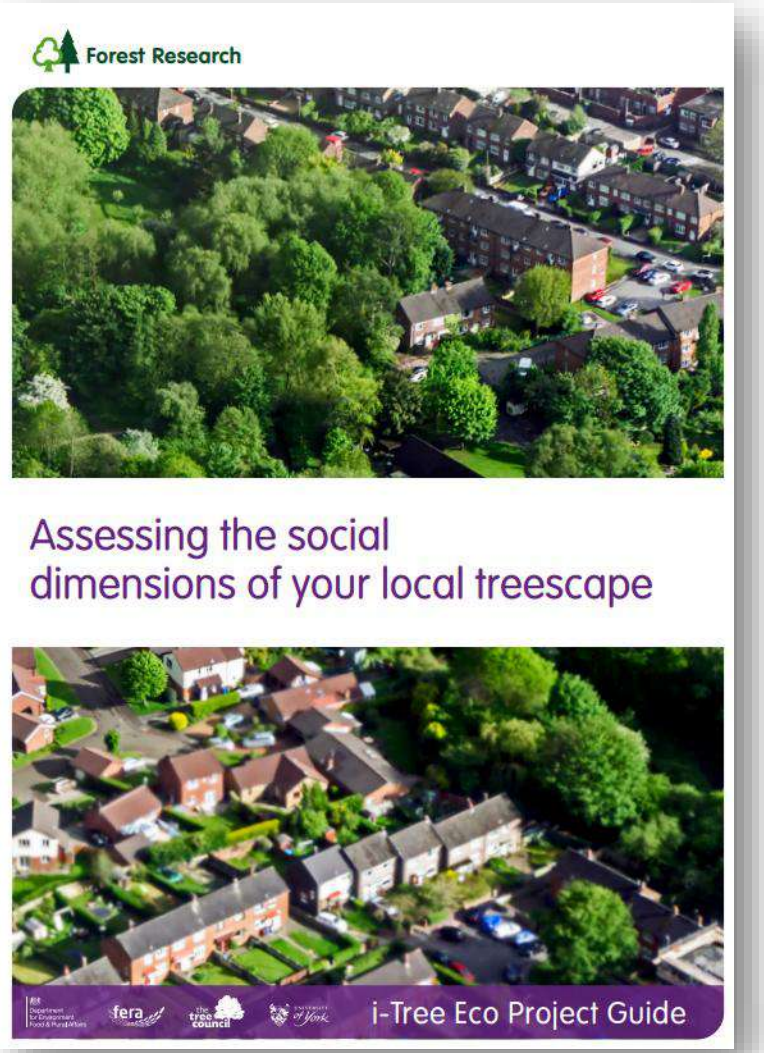




Example projects: Wellbeing and cultural values







Funding Sources

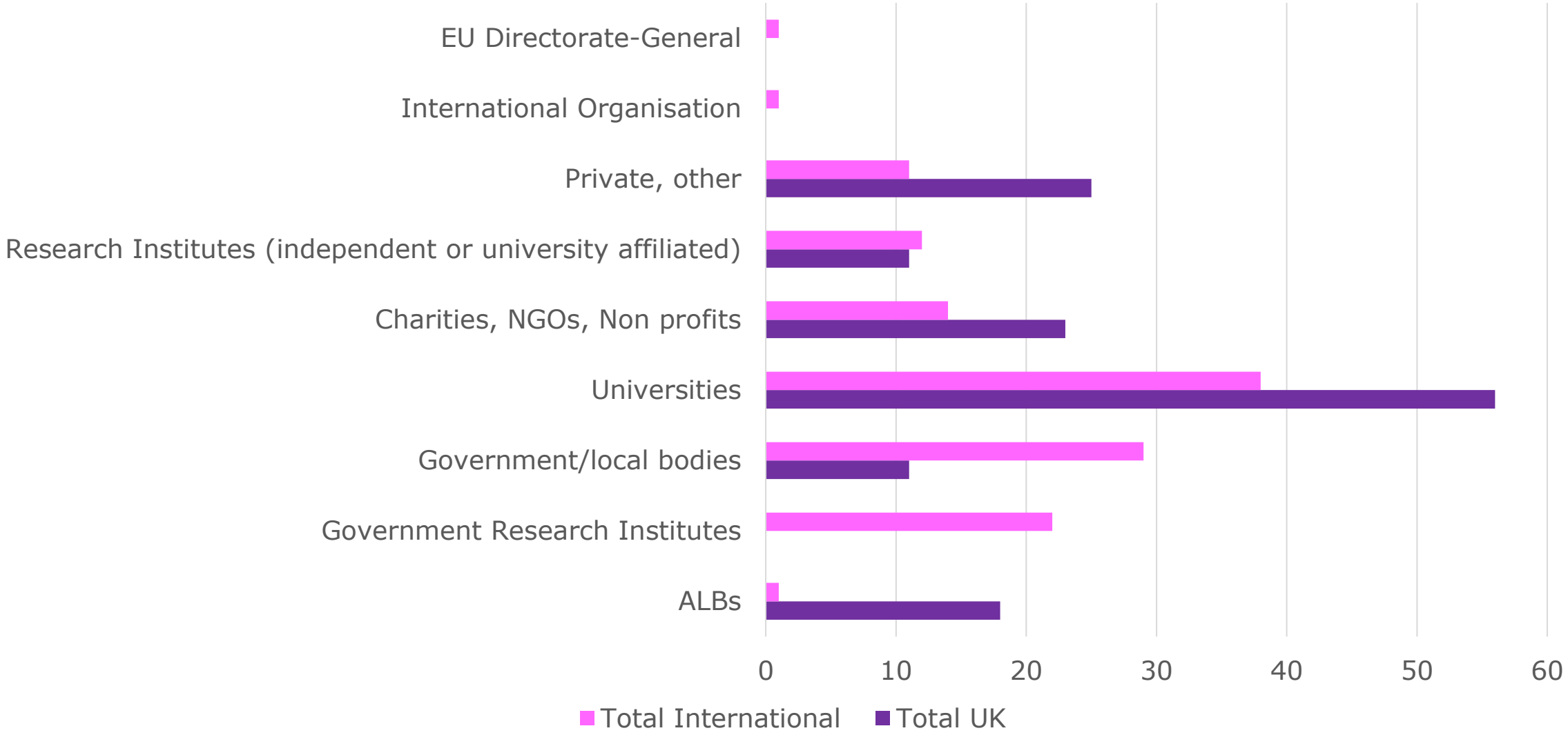
MOU Funding

Spending Review Allocations

SLA's – testing and surveys

Bid won funding (inc Defra)

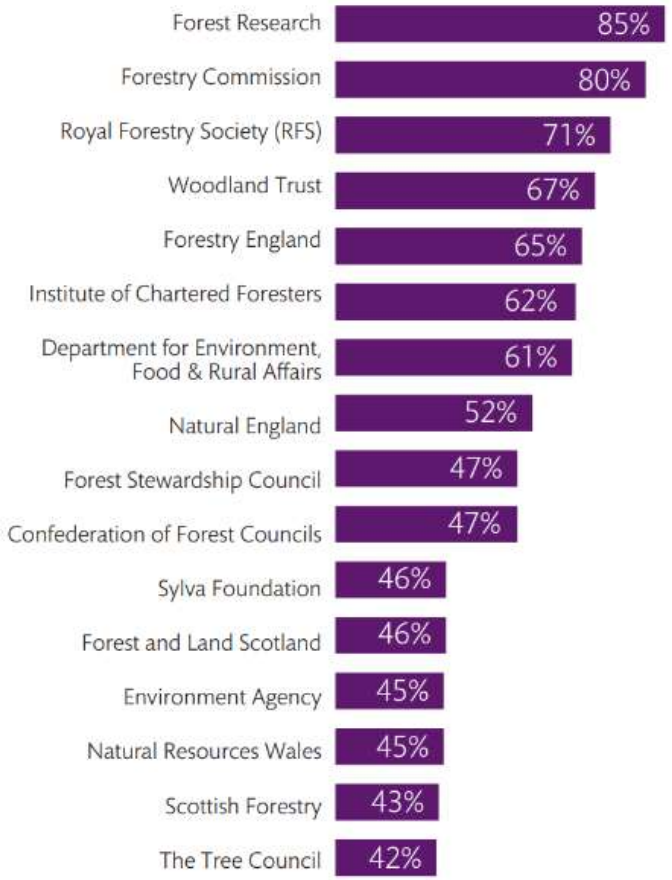
Indicative* Collaborations FY25/26



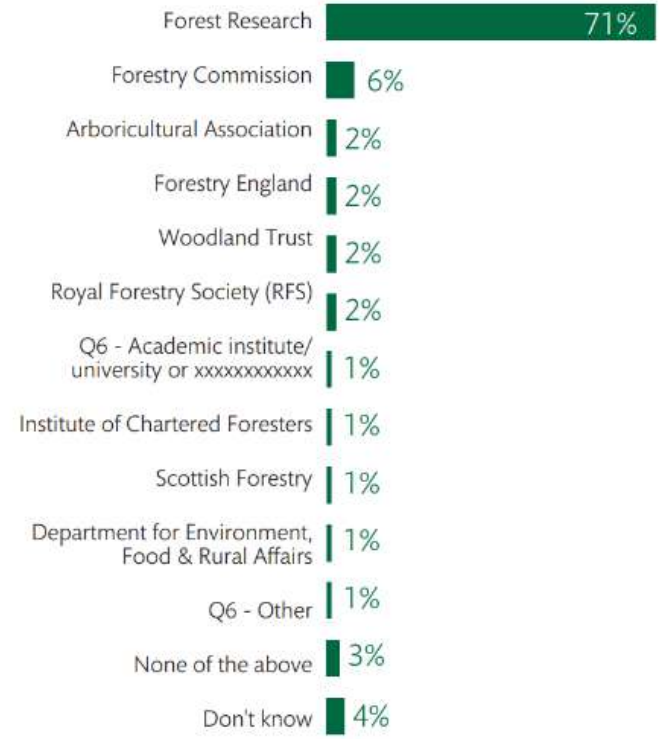
Source: FR Research Office data.
*Count of all collaborations by project (not unique organisations) excludes Science and Innovation Strategy for Forestry (MoU funding) , IFOS, and projects not managed by RO.

What our audience thinks

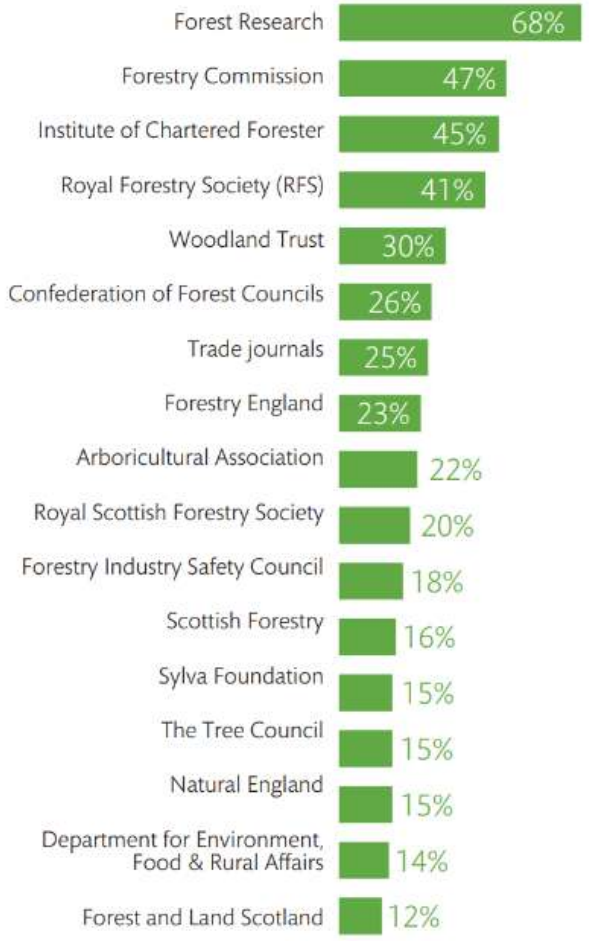
Awareness of tree and forest science organisation



Who do you most trust for news on trees and forests?



Who is the leading voice in tree and forest-based science?



Nº1

85%
OF SURVEY RESPONDENTS ARE AWARE OF FOREST RESEARCH

Our unique attributes

Value to governments

As a GB body, Forest Research provides impartial advice to the government and devolved administrations, supported by data and skills that enable both the UK Government and the devolved administrations to fulfil their statutory obligations. We also provide emergency response capability to all three countries, and evidence and support to policymakers. We provide expert advice to manage pest and disease outbreaks and contribute extensively to the UK Forestry Standard – the reference standard for sustainable forest management in the UK.

Recognised experts

We are the largest single employer of forest scientists across all parts of the UK. We are internationally recognised with an established reputation for the quality, relevance, utility, uptake, and impact of our work. We have a strong track record of securing and delivering on complex and interdisciplinary projects. We have experts who advise across the breadth of forest topics from policy to practice and, as an organisation, we combine expertise to ensure all aspects of complex forestry-related issues are fully addressed. Our staff are passionate about what they do and the difference they make.

Value to the sector

We are highly valued by the forestry sector, from forest owners and processors to nurseries, conservation organisations, and urban-forest managers.

Interdisciplinary

We are the only provider of interdisciplinary research across the whole forest-wood supply chain, from tree breeding and ground preparation to forest management, harvesting, wood processing, forest inventory, and resource evaluation. We also work in all the diverse settings in which trees are valued.

Collaboration and leverage

We have a long history of effective collaboration and partnership, working across disciplines within our own research programmes as well as with other institutes and universities across the world. We keep up to date with the latest scientific developments and attract additional funding for research activities.

Information assets

We have an unparalleled range and longevity of experimental and forest-survey datasets and models. These underpin the evidence and policy needs of government as well as sector initiatives such as the Woodland Carbon Code, UK Forestry Standard, and tree-health strategies. Data and models are accessible through our website, as are software and decision-support tools, including Ecological Site Classification (ESC), ForestGALES, Forester, and Forest Yield.

Skills development

We support PhDs and post-doctoral research, along with both graduate and technical apprenticeships, and provide an essential training ground for specialist expertise in trees, woods, and forests. Many sector leading specialists work or have worked at or with, Forest Research – benefiting them as well as us and the wider interests of the sector and society.

Forest trials and experimental plots

We have over 2,600 forest experiments located throughout Great Britain including, for example, the majority of forest genetic resources trials. We act as the long-term guardian of this asset which underpins much of our key science, such as yield and wind stability models. We hold our long-term data, supporting documentation, and experience of our Technical Services Unit in establishing, monitoring, and managing these sites, and we ensure maximum use and benefit from these. No other organisation has these skills or resources.

Brand value

As the UK's leading provider of applied forest science, we are valued for our independence, and the authority and impartiality of our research.

Biodiversity outcomes from active to passive woodland creation

Growing Together workshop

9th June 2026

Kevin Watts, Joe Beesley and many colleagues & collaborators
kevin.watts@forestresearch.gov.uk
joseph.beesley@forestresearch.gov.uk

Woodland creation as a Nature-based Solution (NbS)

RESTORATION ECOLOGY

The global tree restoration potential

Jean-Francois Bastin[1]*, Yelena Finegold[2], Claude Garcia[3,4], Danilo Mollicone[2], Marcelo Rezende[2], Devin Routh[1], Constantin M. Zohner[1], Thomas W. Crowther[1]

Nation to benefit from two new national forests backed by £1 billion investment in tree planting

SA

National Trust to plant 416,000 trees over next three months

Michael Ribbeck

Record high as 30 million trees planted in Scotland last year

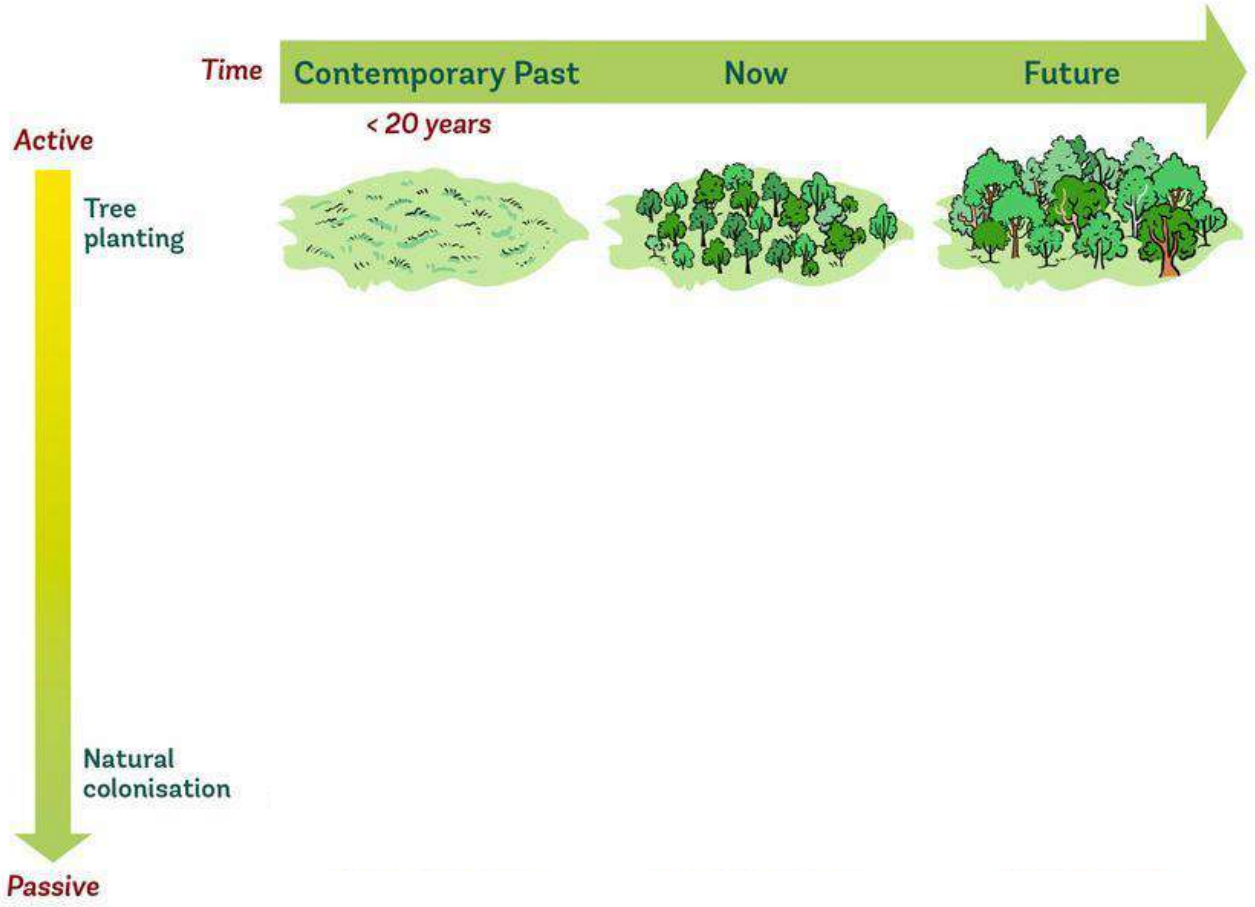
Between Apr
across Scotl
reated

England | Local News

Almost two million trees planted in North in 2023

A year of growth: tree planting rates hit their highest level in over 20 years

Active woodland creation



WrEN

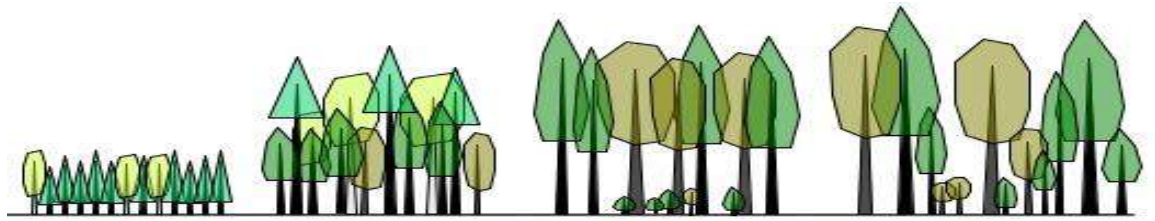
Woodland Creation & Ecological Networks

Using a ‘space-for-time’ approach to assess the effects of ***past*** woodland creation on ***current*** biodiversity to inform ***future*** actions


Prof Kirsty Park
Dr Elisa Fuentes-Montemayor

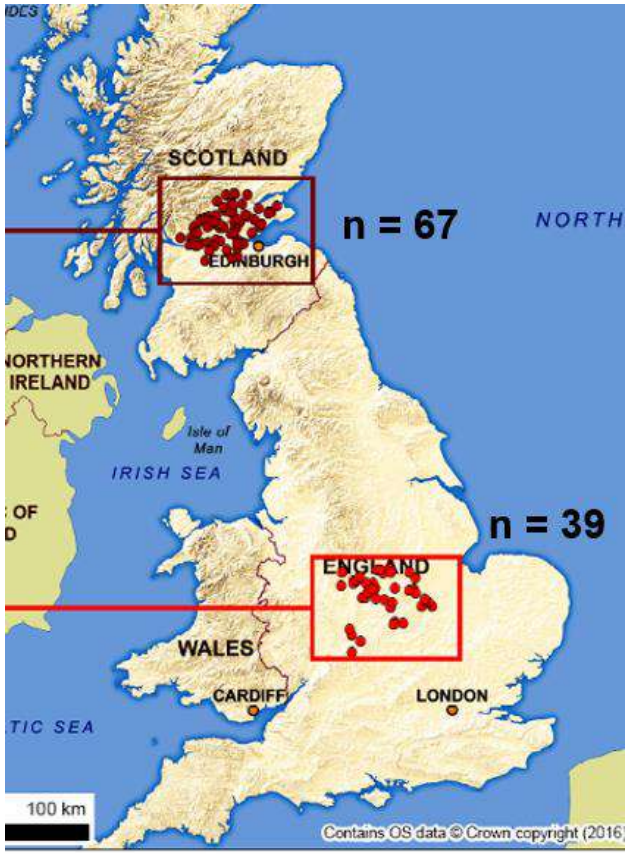
UNIVERSITY of STIRLING

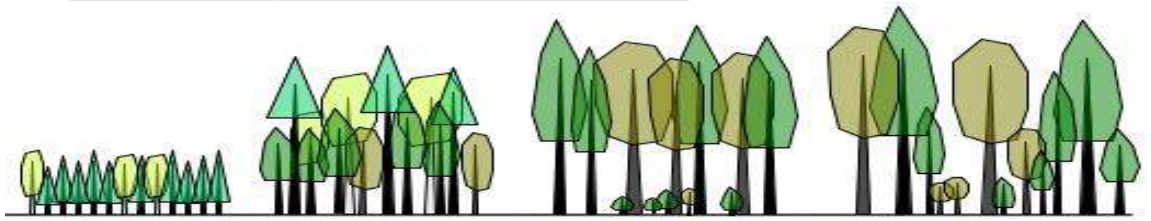
WrEN Project



WrEN

Woodland Creation & Ecological Networks





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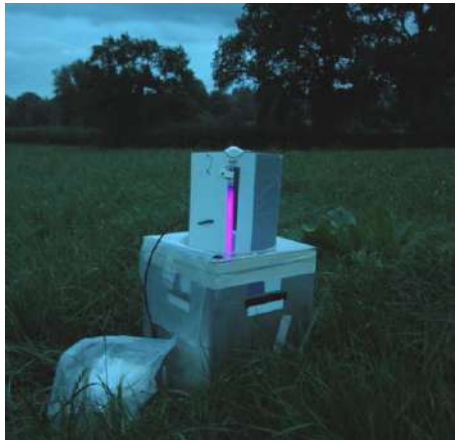
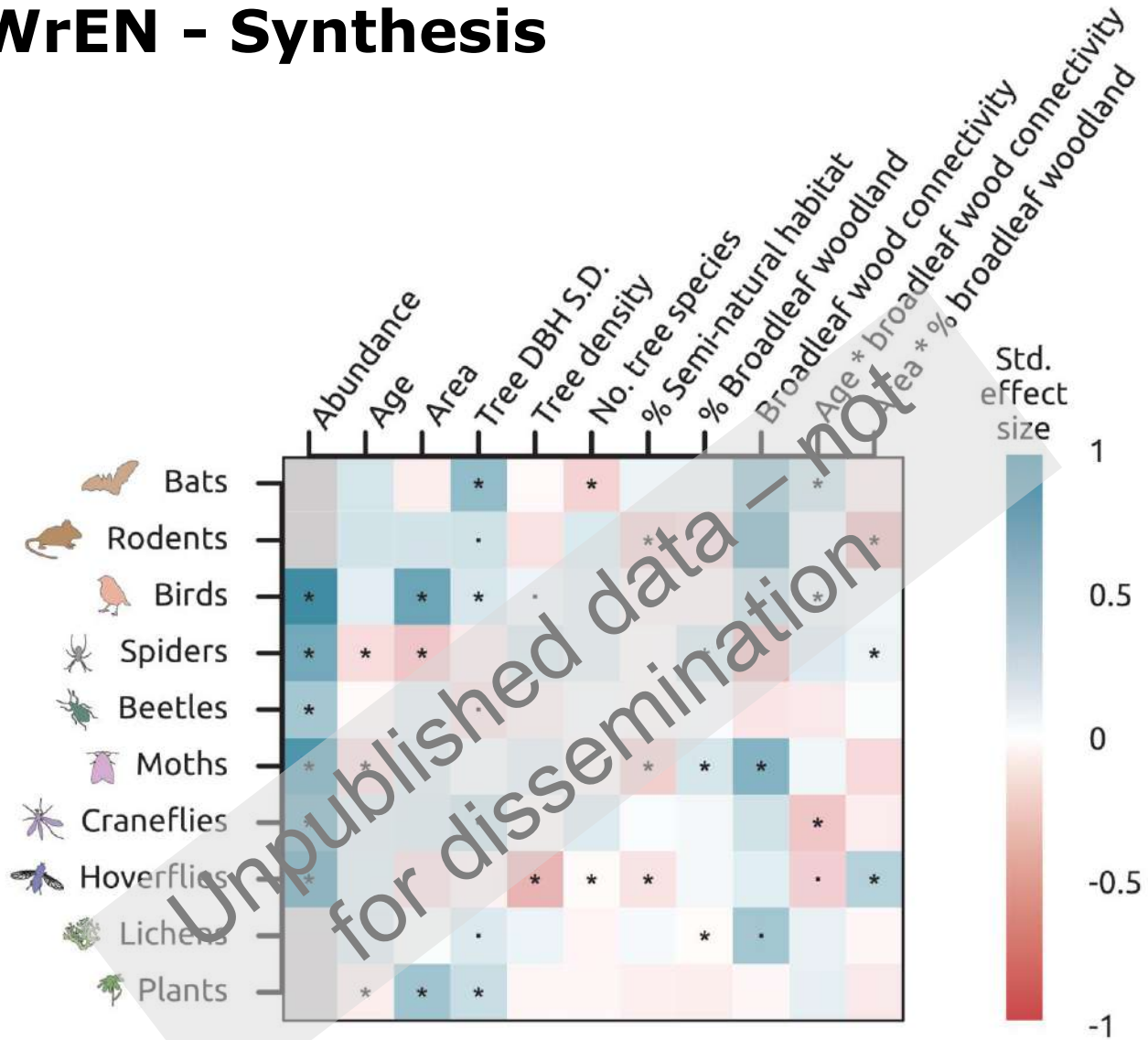
WrEN



Woodland Creation & Ecological Networks

WrEN - Synthesis



Park et al. in review

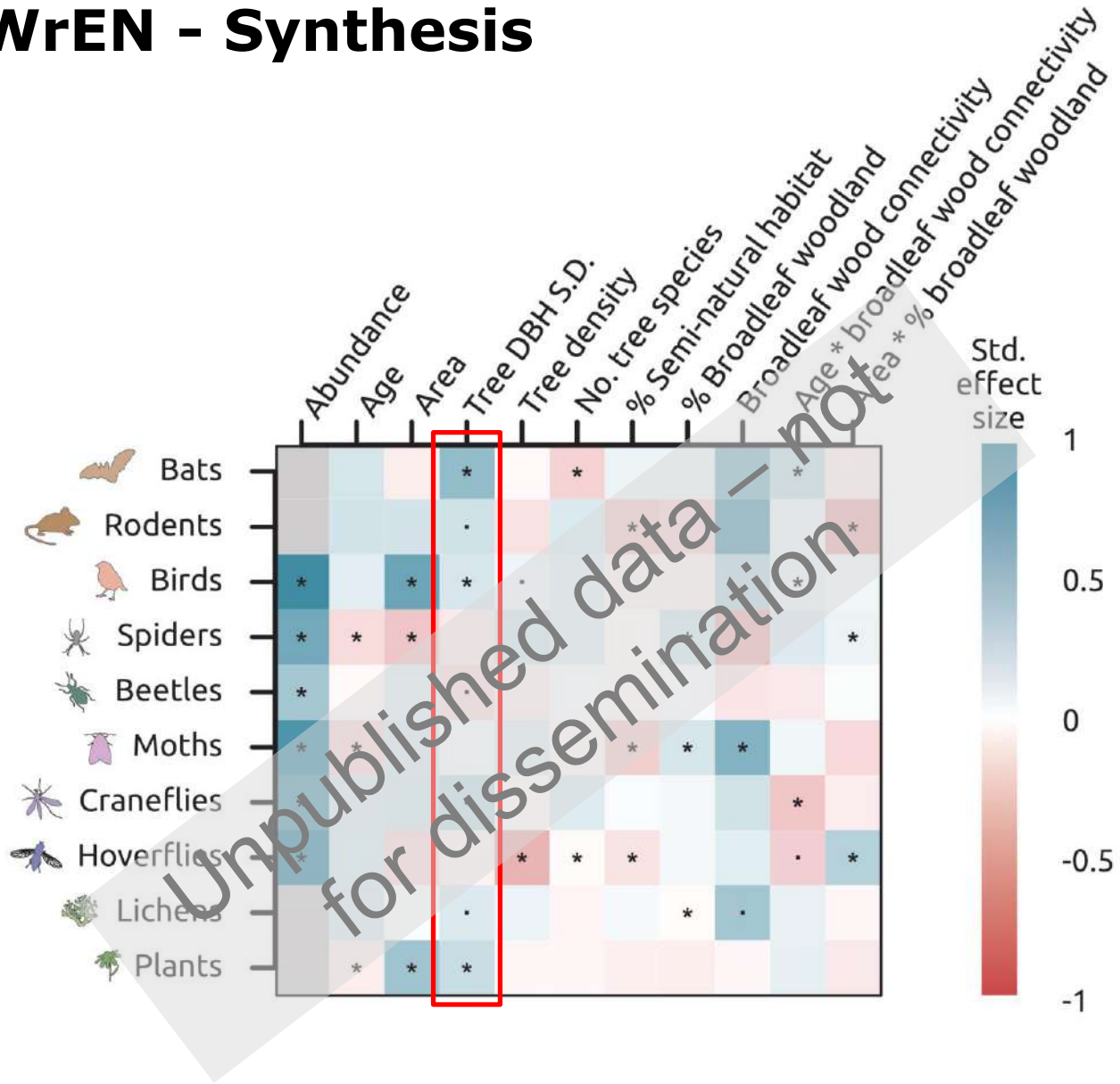
- Abundance always a strong predictor of richness
- Overall local >> landscape
- Structural heterogeneity most consistently +ve effects
- Mixed effects of landscape

* P < 0.05

. P < 0.1

Woodland Creation & Ecological Networks

WrEN - Synthesis



Park et al. in review

- Abundance always a strong predictor of richness
- Overall local >> landscape
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- Mixed effects of landscape

* P < 0.05
. P < 0.1

Woodland Creation & Ecological Networks

WrEN

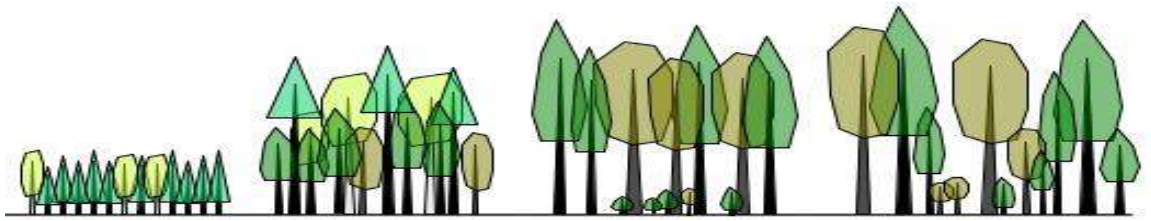
Woodland Creation & Ecological Networks

… but how and where we create new woodland matters

1. Spatial targeting of woodland
   - *Enhances connectivity & aids colonisation by poor dispersers*

2. Increase woodland area
   - *Plants & birds; spatial targeting to increase size of existing woodlands*

3. Manage to enhance structural heterogeneity
   - *Tree recruitment low in many sites, leading to low heterogeneity + threatens their future*
   - *Management, grazing reduction*
   - *Incorporation of 'natural processes'?*



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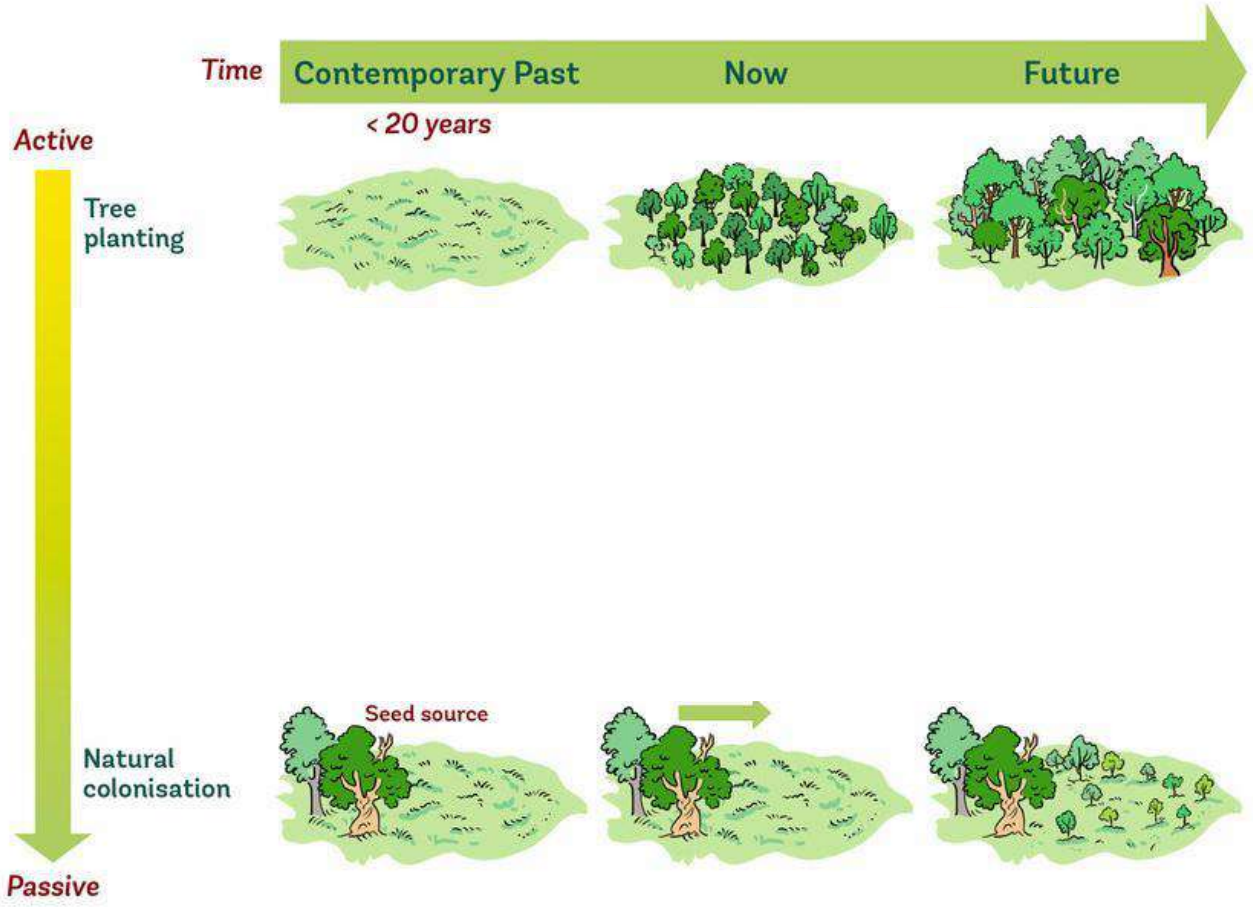
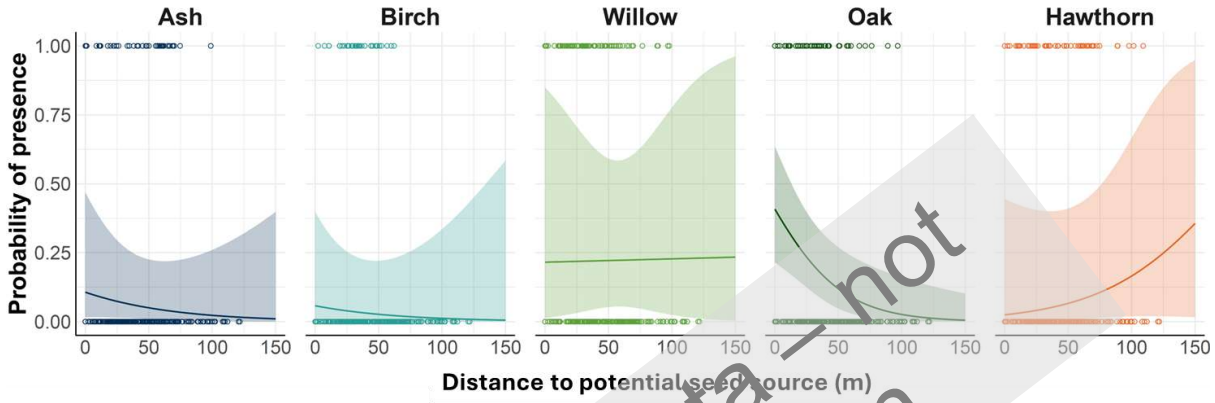
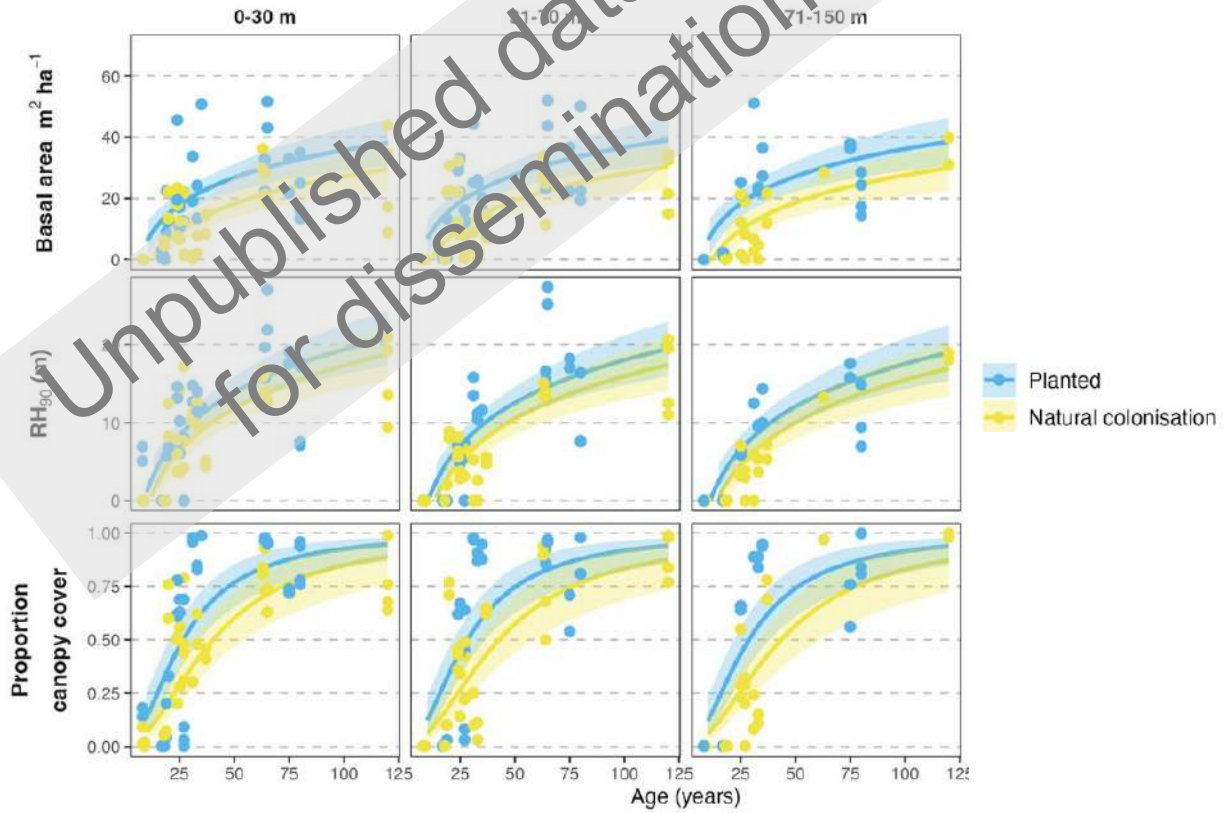
Passive woodland creation



Natural Colonisation projects

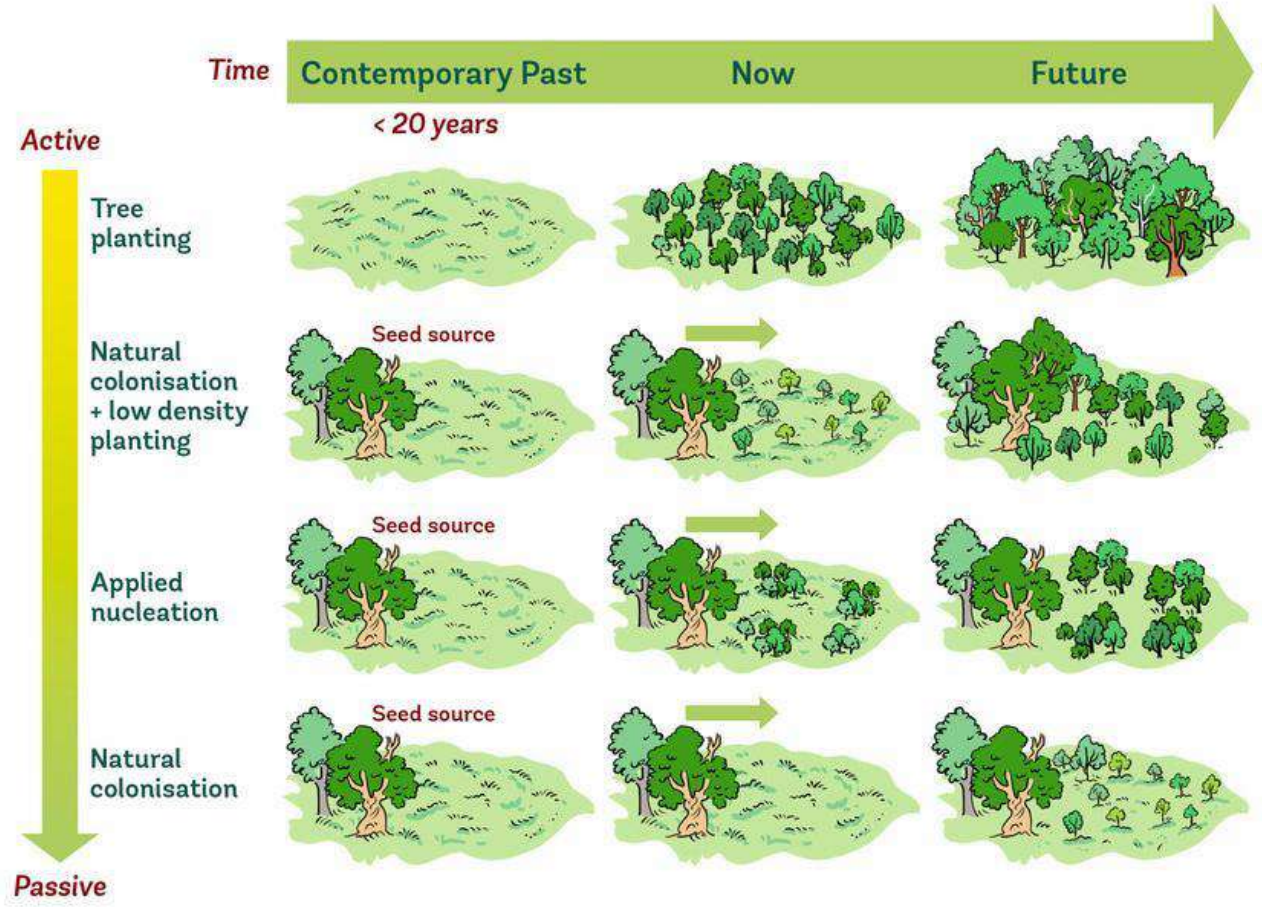


- Space-for-time study at lowland field sites
- Colonisation distance is species dependent
- Planted stands have higher basal area and canopy cover
- **Highly variable**



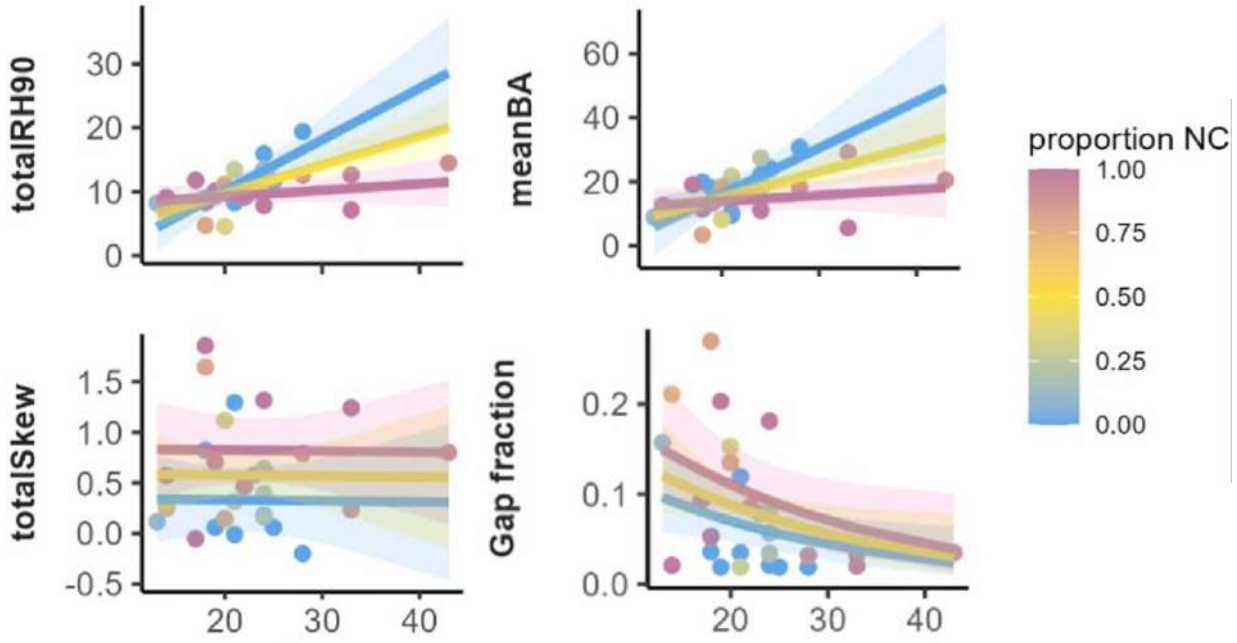
Guy *et al.* (in review)
Hughes *et al.* (in review)

Hybrid approaches to woodland creation



TreE PlaNat

- Space-for-time study
- Supports Natural Colonisation findings
- **Hybrid approaches deliver intermediate vegetation structure**



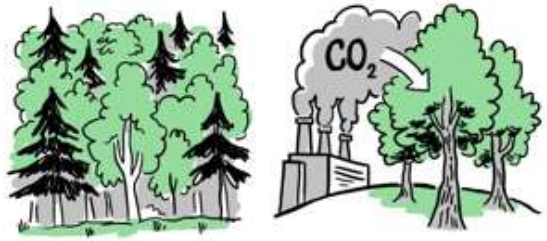

Prof Kirsty Park
Dr Elisa Fuentes-Montemayor

UNIVERSITY of STIRLING

FUTURE OF UK Treescapes

Hughes *et al.* (2026) *Forest Ecology and Management*, *605*, 123490 link

TreE PlaNat webpage

Approach	Outcome	Objective
 Tree planting	• Faster tree growth • Vertical complexity 	 Biomass accumulation (carbon / timber)
 Hybrid approaches	• Intermediate outcomes • ⇩ uncertainty ⇧ control • Biodiversity benefits	⇧ Diverse goals / can balance priorities  ⇩
 Natural processes	• Horizontal complexity 	 Structural heterogeneity & biodiversity

Large-scale Ecosystem Recovery Network (LERN)

30-year woodland creation experiments

[LERN webpage]

Testing impact of:

- Distance from seed source
- Herbivory
- Applied nucleation (hybrid approach)
- Individual site factors (climate, soil)

Forest Research

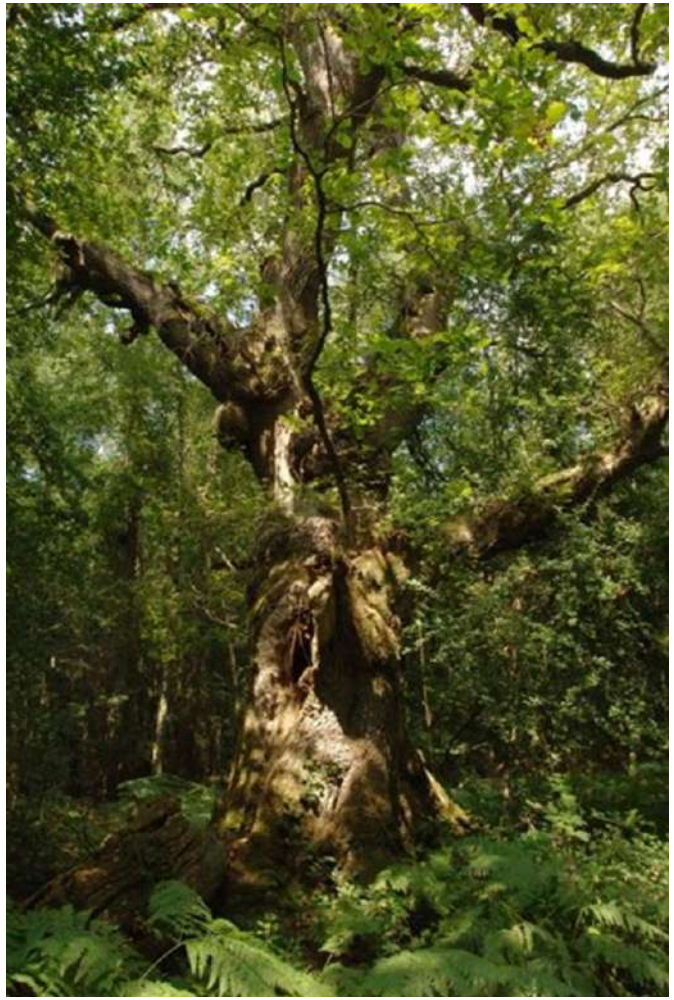
Management of woodlands for nature recovery

Katty Baird & Alice Broome
Katty.baird@forestresearch.gov.uk
Alice.broome@forestresearch.gov.uk

Growing together: research-practice partnership for woodland restoration
Edinburgh CCI, 09/06/2026

BACKGROUND

- Research on priority and protected species and habitats
- Outputs inform forestry and woodland policy and practice



Ecological characteristics of Long-established woodland

APPROACH:

1) Workshops with expert woodland ecologists

What are the important ecological features?

2) Surveys and focus groups with woodland stakeholders

Does terminology matter?

RELEVANCE:

- What features should we be encouraging / enhancing in restoration?
- How can we assess when they are present in sufficient quality/quantity?
- What are the timescales involved?
- How important is the language/terminology that we use?

Ecological value of older woodlands

Ecological Feature	Time to develop	Example species benefitted	Influence of management
Ancient & Veteran Trees	Long	Roosting bats	Tree management Veteranisation
Undisturbed Soils	Medium-long	Mycorrhizal fungi	Compaction Non-woodland land use
Ancient Woodland Indicators	Medium-long	Sanicle	Proximity to Ancient Woodland
Deadwood	Medium	*Tanyptera nigricornis*	Harvesting methods
Structural diversity	Short-medium	*Osmia uncinata*	Ride / wayleave clearance Thinning
Scrub mosaic	Short	Spotted Flycatcher	Browsing pressure Felling cycles

Do floral introductions fast-track nature recovery?

- Part of Defra-funded Pathways project
- Collaboration with Woodland Trust

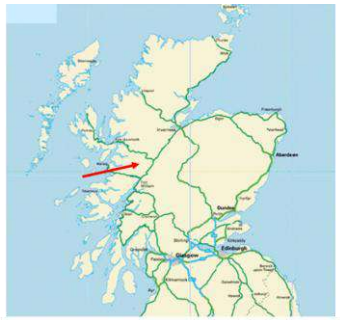
- Long term experiment in woodlands planted on former agricultural sites ~30 years ago.
- Sites ready for thinning interventions.
- Compare biodiversity changes over time in plots with / without addition of woodland ground flora.

Conservation grazing on wood pasture nature reserve

Site and Treatments

Sheep and deer browsed

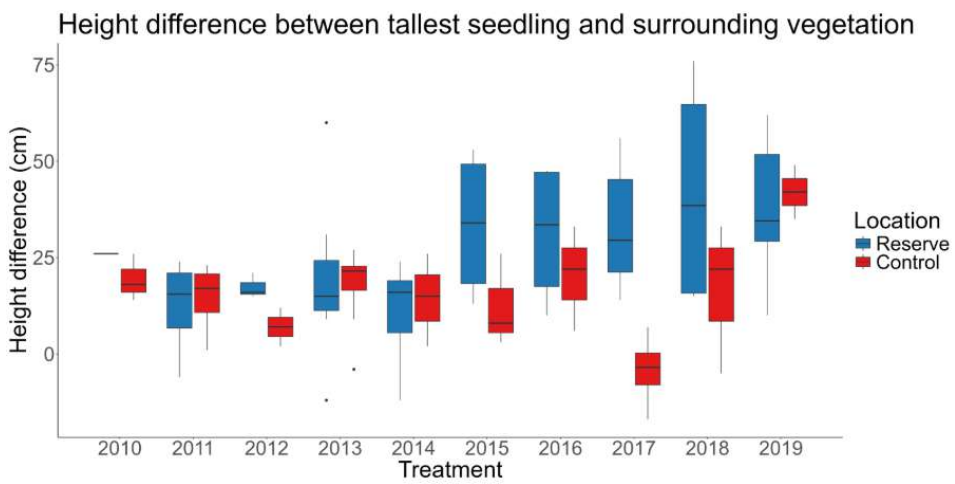
Winter cattle grazing (October-May) Highland cattle
0.25 livestock units ha^{-1} $year^{-1}$.
30 ha Lower Reserve

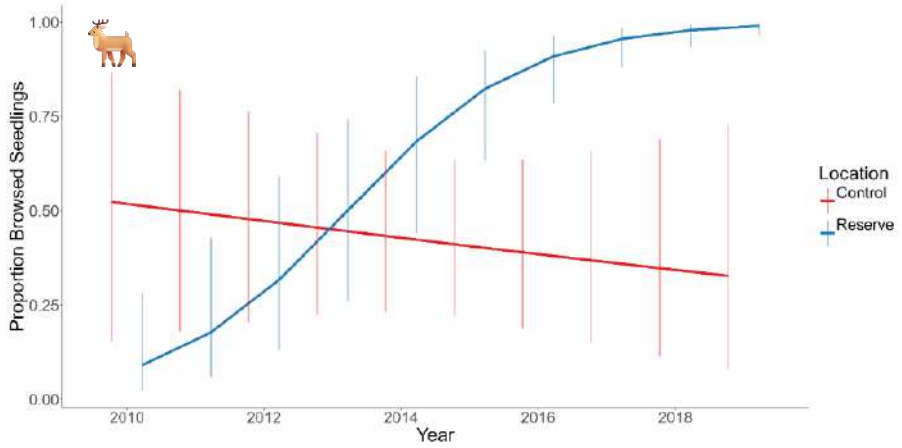


Monitoring: vegetation responses & butterfly numbers, annually; 2010-2019 data presented.

➢ Wood pasture expanded & maintained?

Seedlings above sward (tree regen)	Height advantage increased over time in Reserve (significant interaction, p = 0.006)
Tree Browsing (regen control)	More browsing in Reserve in later years (year by site interaction, p = 0.001)

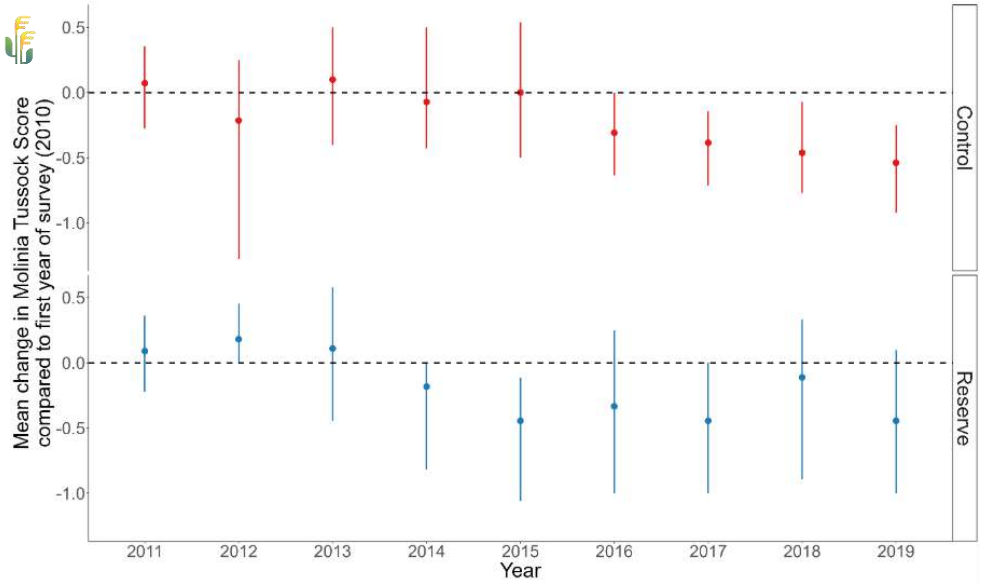


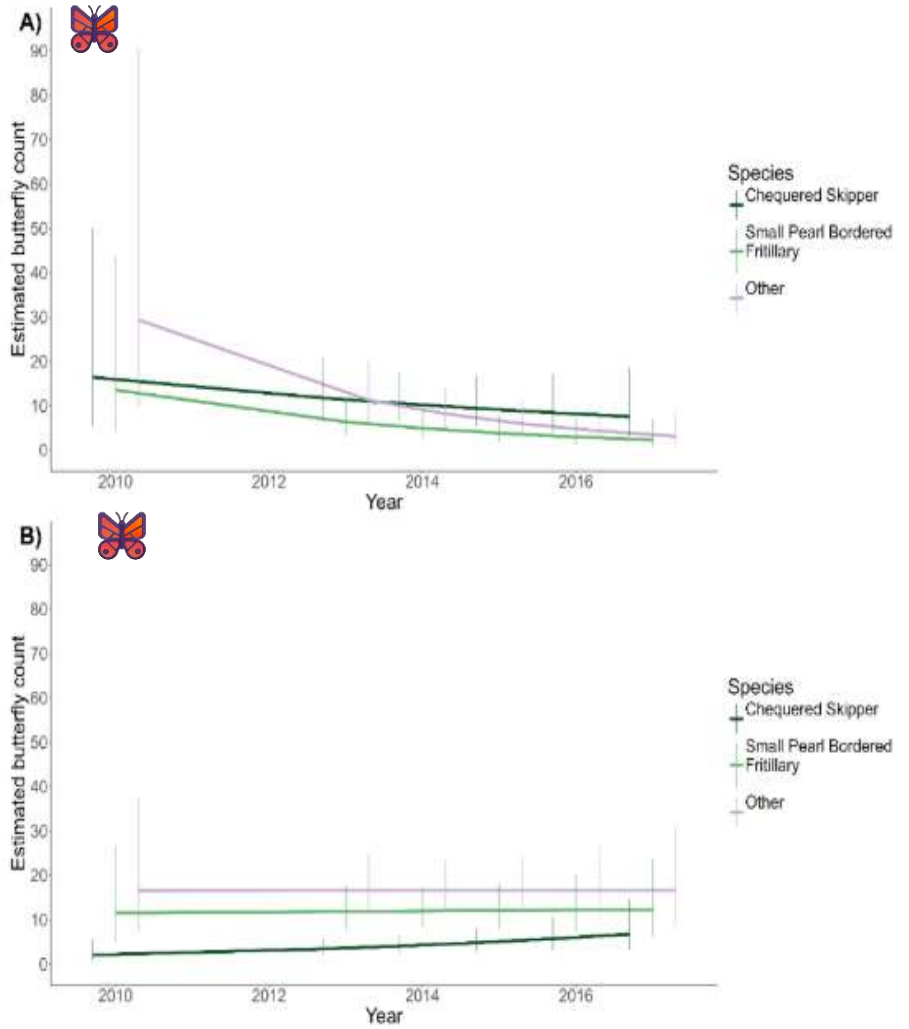


Conservation grazing on wood pasture nature reserve

➢ Chequered Skipper conserved?

Nectar Sources	Variation over time between sites (p = 0.001) but no trend
Chequered skipper larval habitat quality	Reserve remained stable but consistently low, declined on Control
Butterfly Abundance	Decline overtime on Control (p = 0.019) no change on Reserve





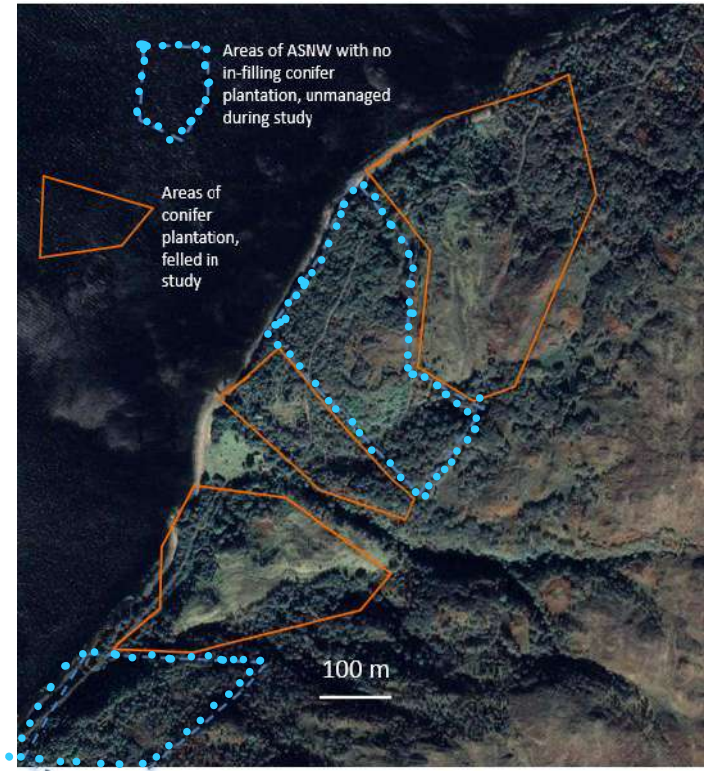
➢ Benefits of winter cattle grazing compared to extensive year-round deer and sheep grazing for maintaining the habitat for Chequered Skipper and potentially promoting long-term continuity of tree cover.

TRF lichens and PAWS restoration

Pre-survey - 18 lichen species on remnant trees

Glencripisdale NNR

- Fragmented ASNW oakwood TRF historically infilled with conifers
- Lichen community -native trees within ASNW patches & remnant trees within conifer matrix
- PAWS restoration – conifer matrix removed.



➢ **unintended consequence of habitat restoration for epiphyte populations on remnant trees?**

Assessed:

1. Change in abundance of lichen species
Pre-conifer removal and 9 years later

2. Vitality of 'leafy' lichen species
Pre- and post- conifer removal, and 9 years later

Lichens on remnant trees (Treatment) versus lichens on ASNW 'Control' trees

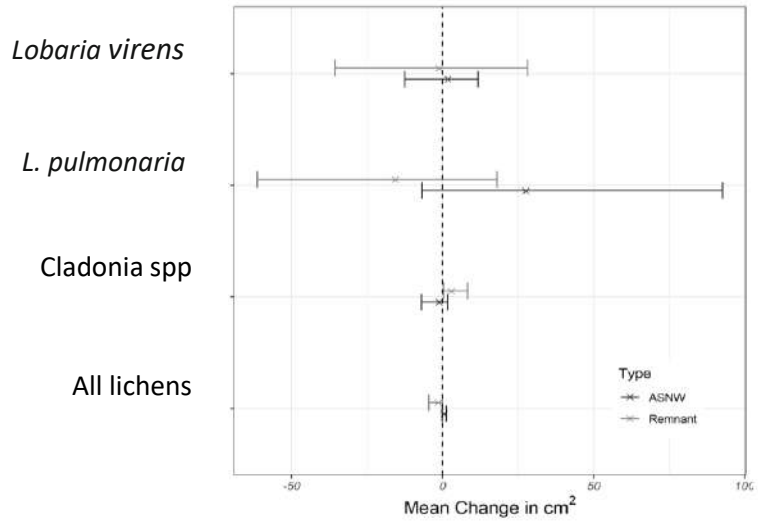
TRF lichens and PAWS restoration

➢ Change in lichen abundance

Pre-conifer removal

+9 years

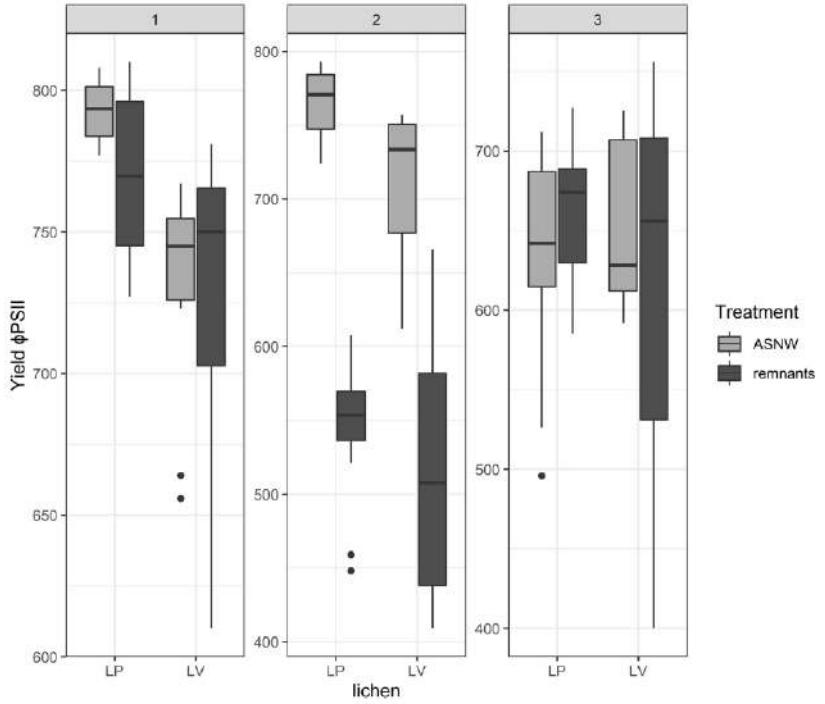
ASNW n = 8
Remnants n = 14



➢ Change in lichen vitality

Chlorophyl fluorescence measurements

Remnant n = 32
ASNW n = 20



- Abundance of key lichen species not significantly affected
- Lichen vitality initially reduced but recovers
- Re-vegetation is by ASNW ground flora
- Species richness and occurrence of native woodland indicator species increased.

Broome et al., 2021 https://doi.org/10.1007/s13595-021-01069-w

➢ Forest Lab - Stewardship Science* delivered by woodland managers

myForest app → Join Forest Lab → Core Settings → Join Additional Projects → Collect Data → Share Data

Core Settings: Engagement Agreement; Inventory Data

Join Additional Projects: Growth; Oak health

Collect Data ← Exchange knowledge → Share Data

About myForest

Free GIS for private woodland owners & agents

- map site, store data securely, supports applications for grant and felling licences.

Forest Lab

stewardship science promoting forest resilience

Forest Research

SYLVA FOUNDATION

Engagement Agreement

Version: 10th March 2023

Purpose

This **Engagement Agreement** sets out the joint commitments of Sylva Foundation and Forest Research working together with volunteer 'stewardship scientists' participating in Forest Lab. It outlines the general expectations of all parties, and provides examples of commitments which may exist within specific Forest Lab projects. This agreement is an important step in the volunteer sign-up process.

This Engagement Agreement covers the pilot phase of Forest Lab and includes the research project activity which runs until April 2025 and use of data arising from the research projects, occurring thereafter.

About Forest Lab

Forest Lab is a web-application, embedded within the myForest platform. Landowners and managers who use myForest to support woodland management and creation planning are offered an opportunity to voluntarily collect and share data from their woodlands to engage in environmental research, and thereby support scientific

phase of Forest Lab, which will run until April 2025. Financial support for its development is provided by the Department of Food, Environment and Rural Affairs (Defra). Sylva Foundation and /or Forest Research shall not be held liable for the result of any actions taken by the user based on guidance provided during the course of the pilot phase of Forest Lab.

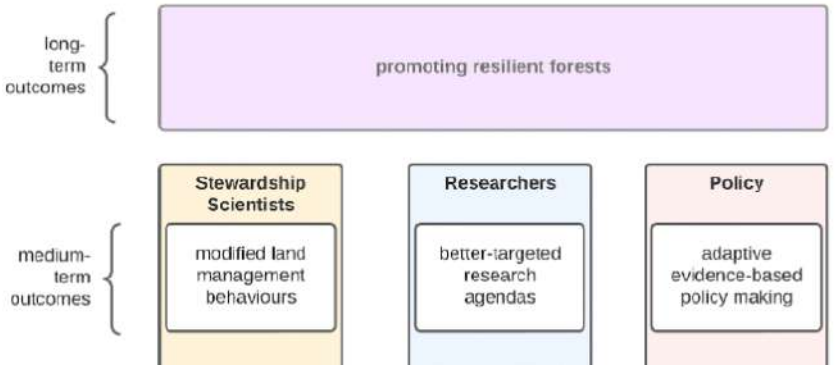
'**Stewardship Scientists**' are those landowners and managers using myForest to assist with woodland management and creation who subsequently volunteer to participate in Forest Lab.

Engagement Agreement - ethics, roles and responsibilities, data sharing and data use.

* *Stewardship Science*

Collaborative. Links scientists with land stewards, enables shared data, co-created evidence, and informed action. Engages decision makers (unlike citizen science).

Theory of Change



myForest

OS Grid: ST 43885 36965 Lat/Lng: 51.1292° N, 002.8033° W Postcode/Address postcode / addr

powerline 362 m
Car Park (east) 0.13 ha
Car Park (west) 0.04 ha
Tree Charter pole

Maps
map1

Creation
Downloads
Creation EIA Quiz

Management
Downloads

Lab
About
All Projects
Joined Projects
Resilience Project
Ips Project
Oak Health Project
Chat
Settings

Archive

Tools
Assessor
Assessment - Dated 21st February 2023
Submitted Assessments
Assessment - Dated 12th December 2022
RPA Land Parcels
Import Land Parcels
Export Mapping
Import Mapping
Measure

Close Lab | All Projects

Joined Projects

Living Layers

The aims of the Living Layers project is to investigate how woodland structure influences biodiversity and the implications for management.

You have joined this project.

View Project Details | Submit Data

Ips Project

The aims of the Ips Project are to help monitor the movement of the invasive tree pest the *eight-tooth spruce bark beetle (Ips typographus)* which affects spruce trees. If selected to take part, your woodland will be part of a pheromone trapping network being developed across Britain.

Your application to this project was successful.

View Project Details | Submit Data

Oak Health Project

This project will monitor the changing health of oak trees and woodland across Britain with volunteers helping test and deploy a new assessment method.

You have joined this project.

View Project Details | Submit Data

Available Projects

Wildfire Project

[Helping land managers rate the biodiversity value of woodland – Sylva Foundation]
[myForest - Forest Lab]

Forest Research

Does genetic diversity hold the key to whether our tree populations can adapt to climate change?

June 2026

Joan Cottrell
Head of Forest Genetics
Forest Research

Their phenotypic plasticity (ability to grow under a wide range of conditions) may allow them to cope.

The adult trees that are least able to cope may die and create gaps for seedling establishment.

Fecundity of reproducing trees may be negatively impacted so that fewer seedlings are produced.

Epigenetics may play a role in survival of populations. Changes in gene expression that do not affect the DNA code but can be passed on to the next generation.

Populations may migrate or if they remain in place, they may evolve to become better adapted to novel conditions in the next generation.

What questions should we be asking?

From a population genetics point of view

Do trees have the raw material to adapt genetically?

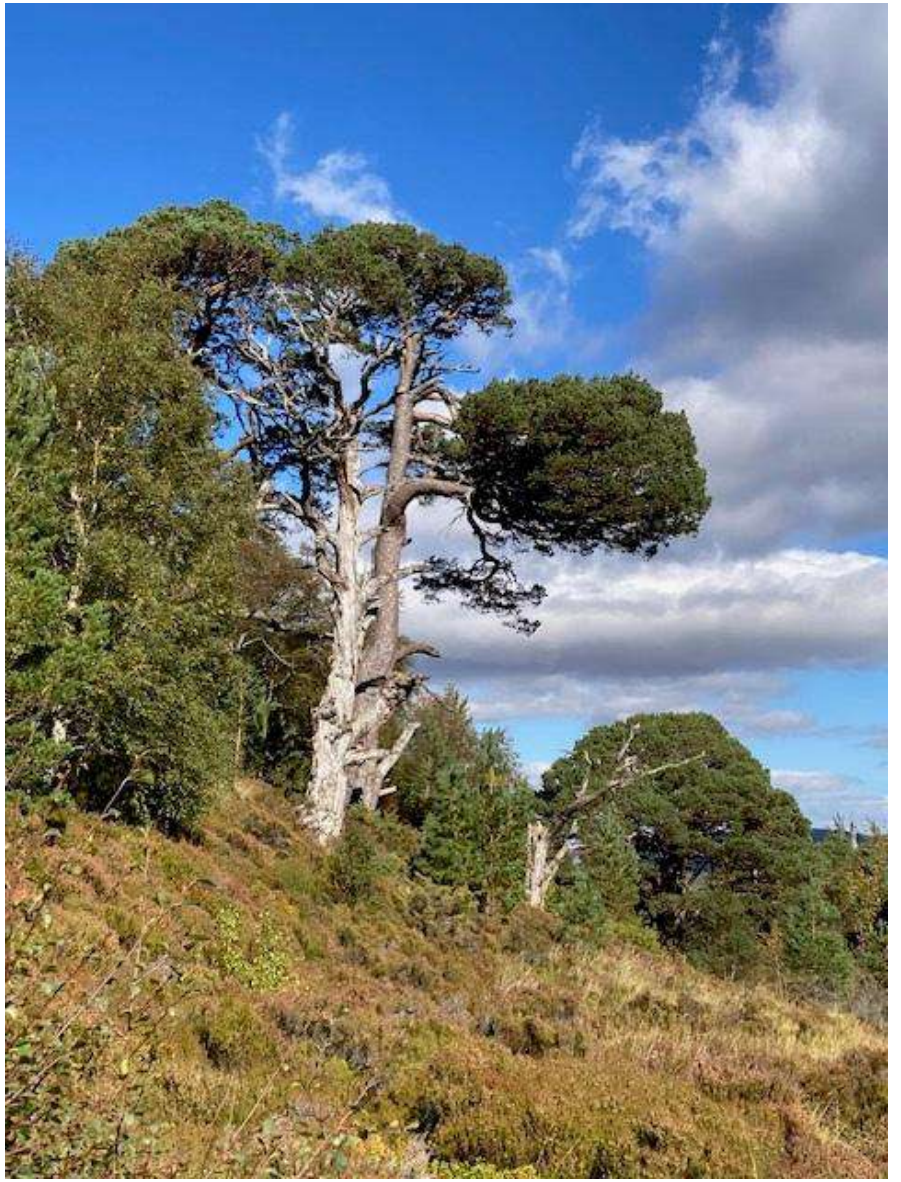
Do they have other qualities that help them to adapt?

Can they adapt quickly?

Are they likely to be able to adapt quickly enough to track climate change?

3

What should we do to encourage adaptation?

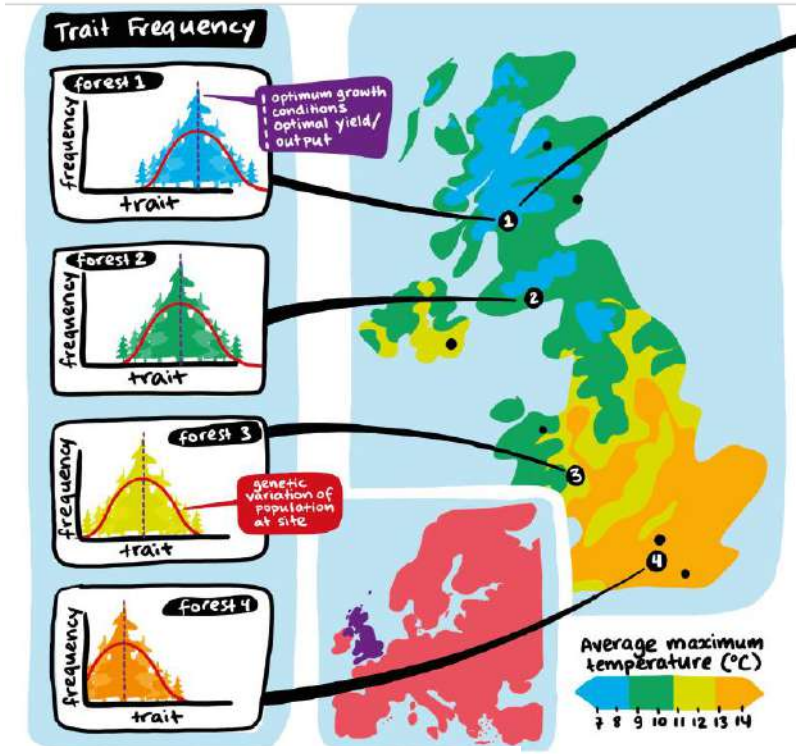


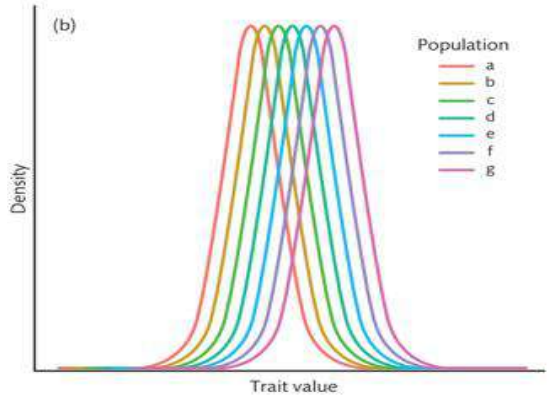
Do trees have the raw material to adapt?

Yes!

Single populations contain large amounts of standing genetic variation which serves as the raw material for adaptation

Most of the variation is lodged within populations but some occurs between populations-so populations are differentiated from one another but retain plenty of diversity





Do they have other qualities that help them to maintain genetic diversity?

Yes! These include:

Many adaptive traits are controlled by multiple genes so a large range of phenotypes can be derived from existing standing variation via segregation alone. Every seedling is slightly different.

Adapted for long distance seed and pollen dispersal-so novel genetic diversity is continually being introduced to populations. May not be utilised unless conditions change and novel diversity is required.

Are largely outcrossing-so a single mother mates with many fathers.

Produce large amounts of seedlings throughout their lives for natural selection to operate on, though some evidence that fecundity is being negatively impacted.

5

Strongest selection generally occurs early in the lifetime of trees, so mean of a population can shift with each cohort of seedlings.

What characteristics of trees makes them ideally suited to adapt quickly?

Tree populations harbour large amounts of adaptive variation both as standing variation and inflowing geneflow from populations growing in different conditions.

In stable conditions, local material is better suited to conditions at a site than non-local material e.g. seeds and pollen from elsewhere.

Large size allows individuals to produce vast amounts of seed over a long lifetime. They are suited to capturing both local pollen and pollen flowing into the population from elsewhere i.e. they keep their options open.

Natural selection generally operates early in life at the seedling stage.
choose a different cohort of seedlings that are better suited to the novel conditions.

Regular production of seedlings allows the population to shift its mean towards the new conditions.

What we don't know is whether tree populations can react quickly enough.

What is the evidence?

Can tree populations adapt quickly?

Yes!

Even though they have long life cycles they can show significant evolution in a single generation if selection pressure is strong.

Evidence comes from two sources:

Introductions of exotic species into novel environments e.g. red oak from America shows evidence of adaptation to French conditions in a single generation.

Disease epidemics caused by introduced pests and pathogens-next generation shows signs of greater resistance than the previous one. E.g. individuals resistant to ash dieback are present in all populations so their offspring are the ones that survive.

The Guardian

Prof Richard Nichols, also at QMUL, said: "…We are watching evolution happen and what's remarkable is that it's happening so quickly, in a single generation." One ash tree can produce 10,000 genetically distinct seeds in one season, leading to scores of saplings.

Are they likely to be able to adapt quickly enough to track climate change?

Not sure!

Historic evidence-Trees have had to survive climate change in the past, though this has usually been to periods of cold rather than increasing temperatures.

Climate change differs from disease epidemics in that it is likely to occur gradually over many decades.

Adult trees exhibit a great deal of phenotypic plasticity and will withstand considerable change before reaching their tipping points into ultimate death.

8

Not sure if climate change will influence fecundity i.e. ability of trees to produce large quantities of offspring.

What steps can be taken to promote evolution and build resilience?

Need to:
Encourage regeneration of seedlings by regularly creating gaps in the canopy and supporting seedling establishment e.g. excluding herbivores. This will allow natural selection to operate on the abundant standing genetic variation present in populations. Suggests assisted migration is unlikely to be necessary.

Get a better understanding of effect of climate change on fecundity and whether epigenetics is likely to have an important role in adaptation.

Maintain genetic diversity-ensure a number of trees are flowering and contributing to the seedling generation.

Conserve genetic diversity by creating Gene Conservation Units in our best woodlands and listing them on the EUFGIS database. These are intending to allow dynamic conservation.

9
Quarterly Journal of Forestry July 2026

FEATURE ARTICLES

Growing Network Protects UK Tree Genetic Diversity

Tom Sim, Joan Cottrell and Stephen Cavers introduce Genetic Conservation Units (GCUs) and explain their importance in conserving genetic diversity.

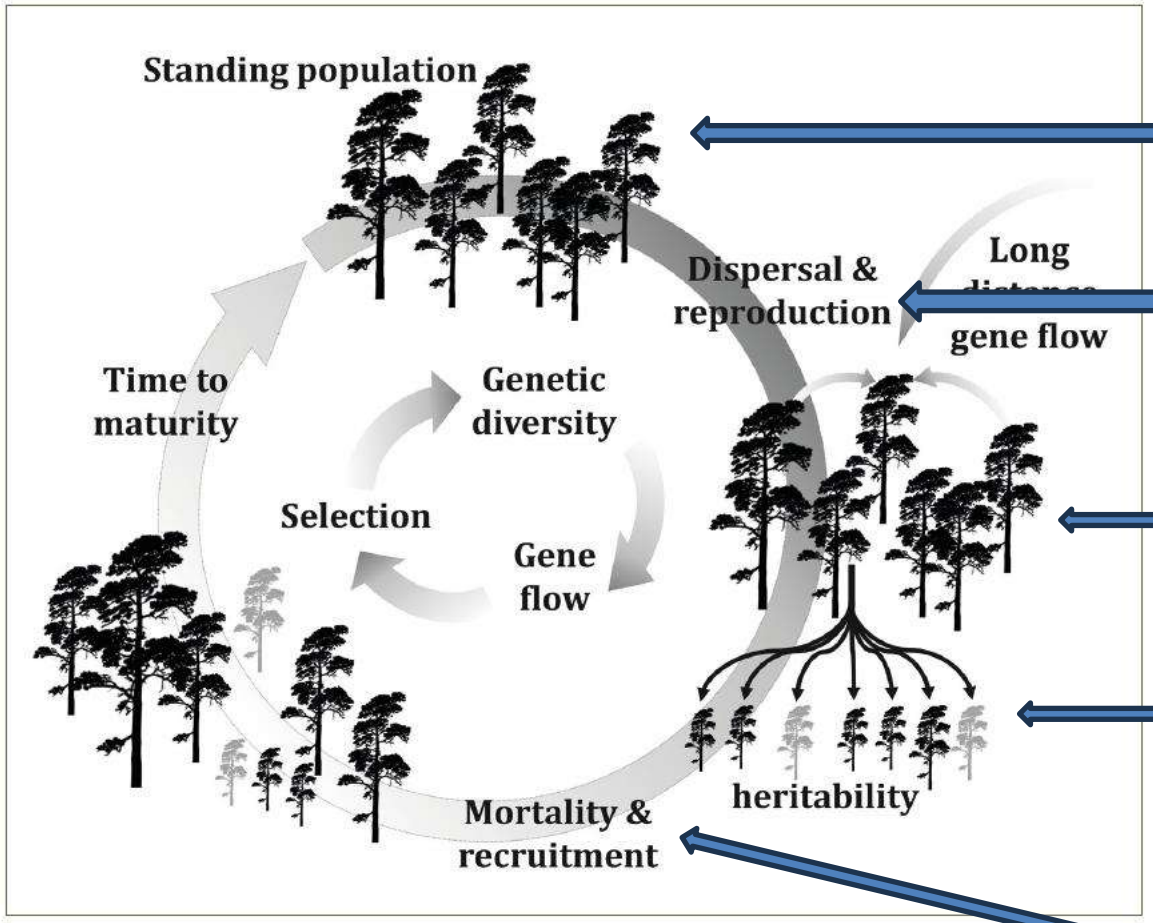


Figure 6. Processes conferring species resilience for forest trees. The capability to adapt to new pressures depends on genetic diversity, gene flow and the rate at which new genotypes can be recruited into the population.

High genetic variation in adult trees

Long distance geneflow introduces novel genetic variation

Adults produce large quantities of seedling over many years

Large numbers of seedling for natural selection to operate on

Seedlings best suited to current conditions survive and eventually contribute to next generation

Monitoring & Managing Mammal Impacts

Cally Ham, Nicola Rae, Ellie Scopes, Alice Broome

cally.ham@forestresearch.gov.uk

UAV Surveys – Ungulates

University of Southampton

Increasing Populations






Increasing Accessibility

DIGITAL FAUNA

BH Wildlife Consultancy

WILDSCAPE DEER MANAGEMENT

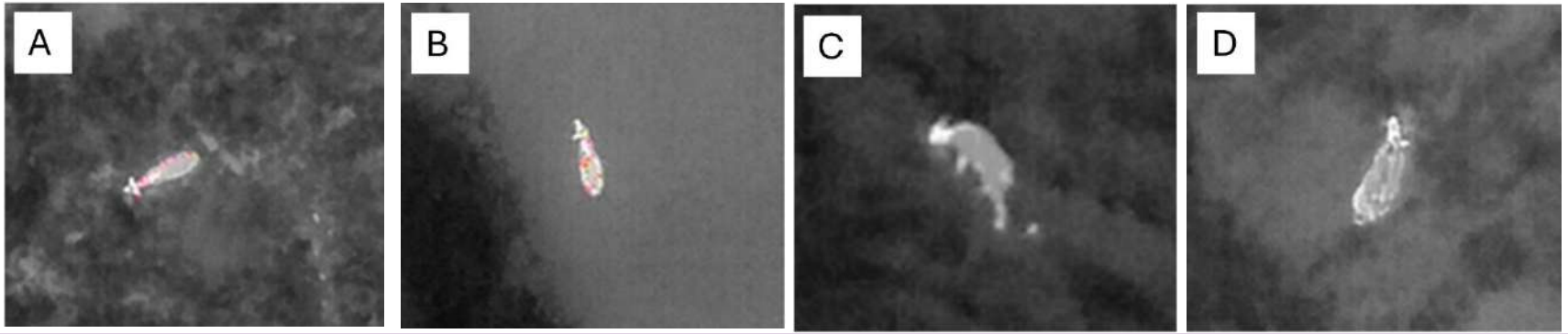
UAV Surveys – Census To Sample?

Existing Knowledge:

- Thermal and/or visual UAV sensors can detect & count ungulates
- Usually provide higher ungulate numbers than ground-based surveys

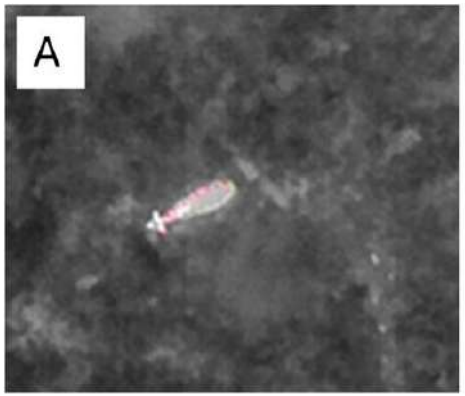
Less Clear:

- Impact of habitat (canopy) on detectability
- Impact of behaviour/biology on detectability
- How to quantify survey effort?
- How to survey expansive areas?
- Minimum count → density estimate



UAV Surveys – Census To Sample?

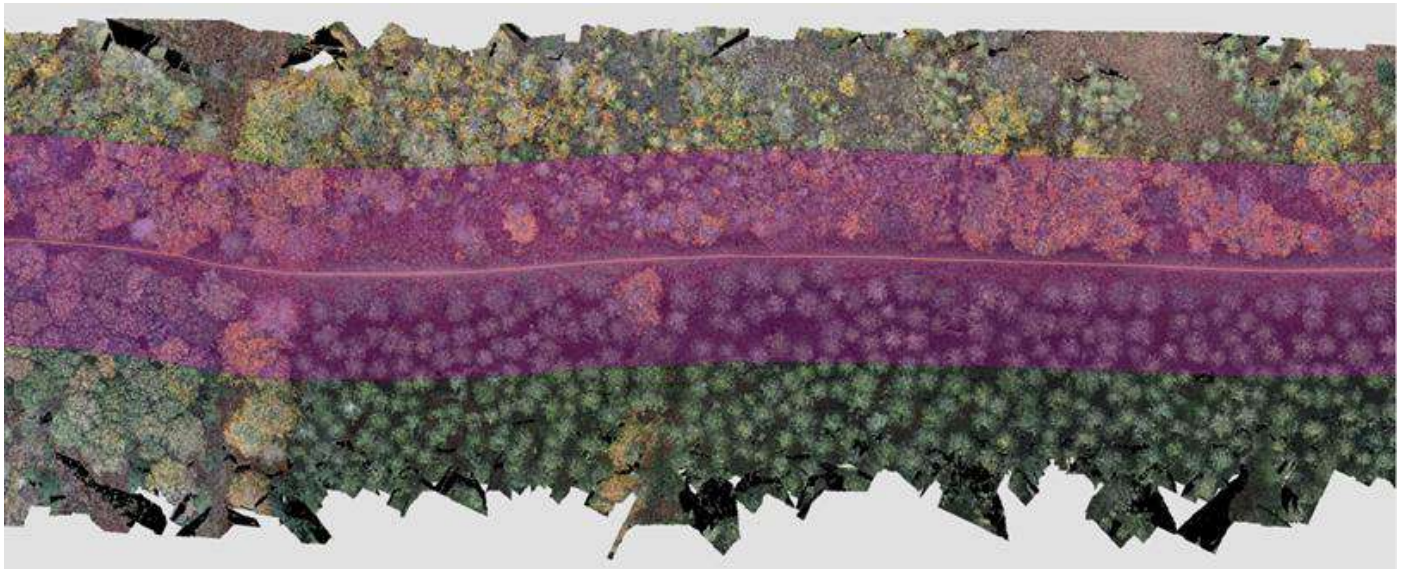
Quantify Effort



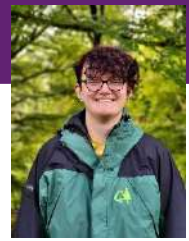
Pre-Determined Routes	Transect Based	Nadir (Vertical) View
Repeatable: • Years/seasons • Pilots	• Maintain VLOS • Bias to “edge” habitats	• Known footprint = known survey area • Reduced detections

UAV Surveys – Census To Sample?

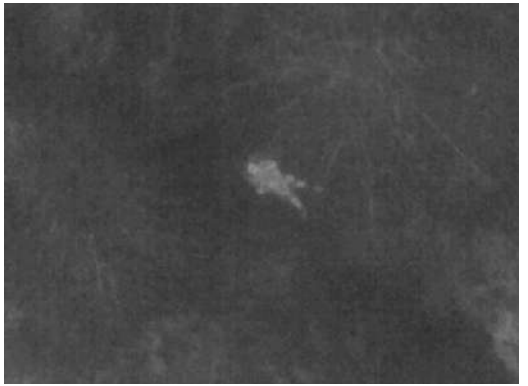
Detectability – Woodland Type



UAV Surveys – Census To Sample?



Detectability – Woodland Type

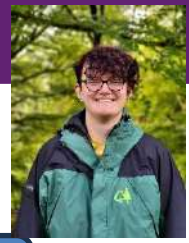


Small-scale trial of known “hot-objects”
Overall detection probability = 0.44
(0.32 – 0.58)

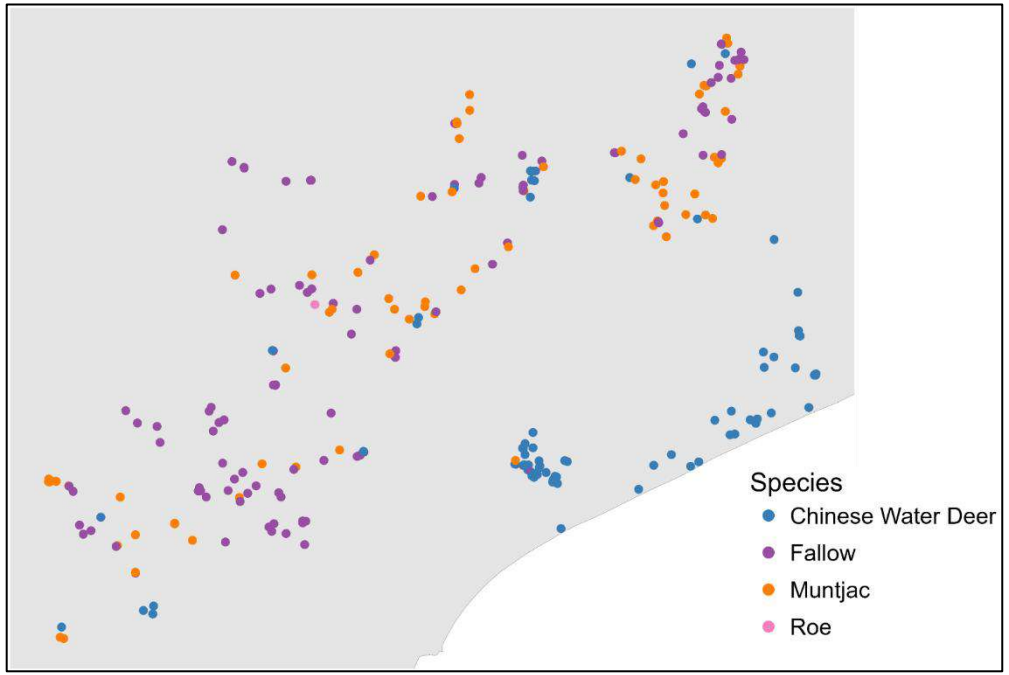
- Young Trees & Bracken = >0.7 detection probability
- Dense Conifer & Broadleaf = <0.25 detection probability

Habitat type should be considered when interpreting survey results

UAV Surveys – Census To Sample?



Minimum count → density estimate



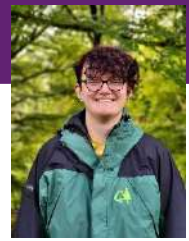
"Proof of concept"

Hierarchical Bayesian Model:
- Habitat Type
- Time of Day
- Pilot

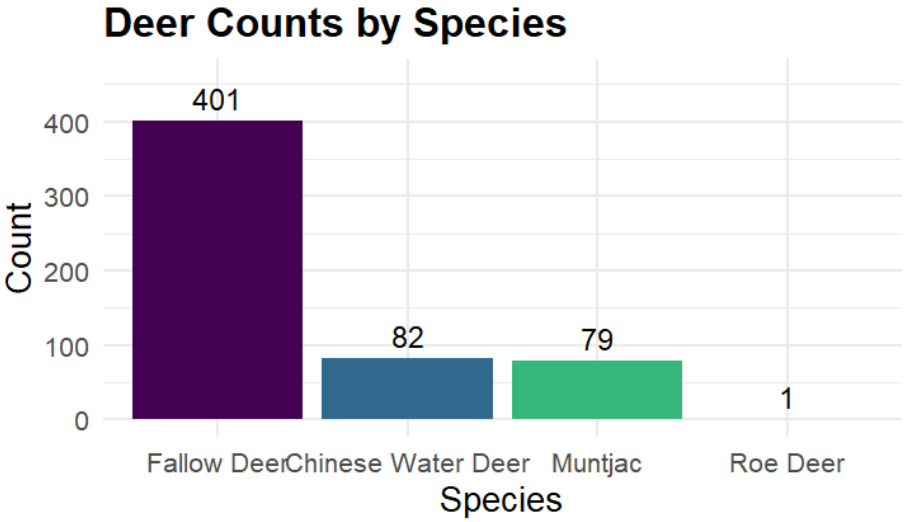
Further variables could be included….

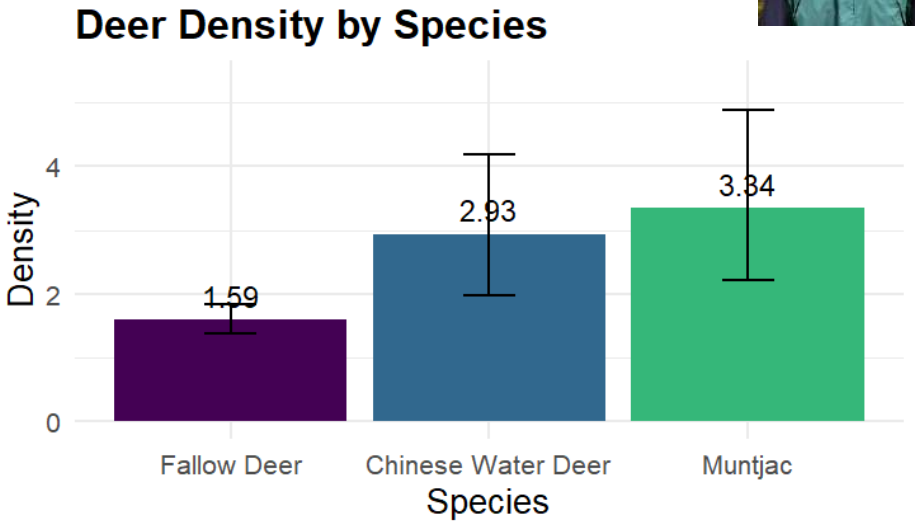
Data based on survey by BHWC

UAV Surveys – Census To Sample?



Minimum count → density estimate



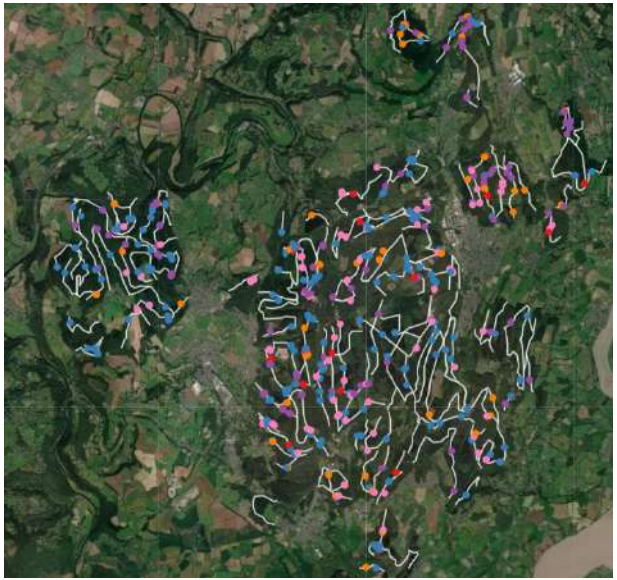


Estimate higher muntjac despite fewer detections…smaller, solitary & denser habitat

Implications for setting cull targets, influence stalker prioritisation, variability in species impacts on woodland

UAV Surveys

- UAV are powerful tools for ungulate surveys
- Survey aim needs to be determined
- Care needed to interpret results
- Beneficial to use standardised methods
- Density of surveys per area not known



Deer Mitigation

Ecological, Structural, Social & Economic Assessment of metal deer fencing
Long-term monitoring
Strathyre & South Uist

Trico Application Effectiveness

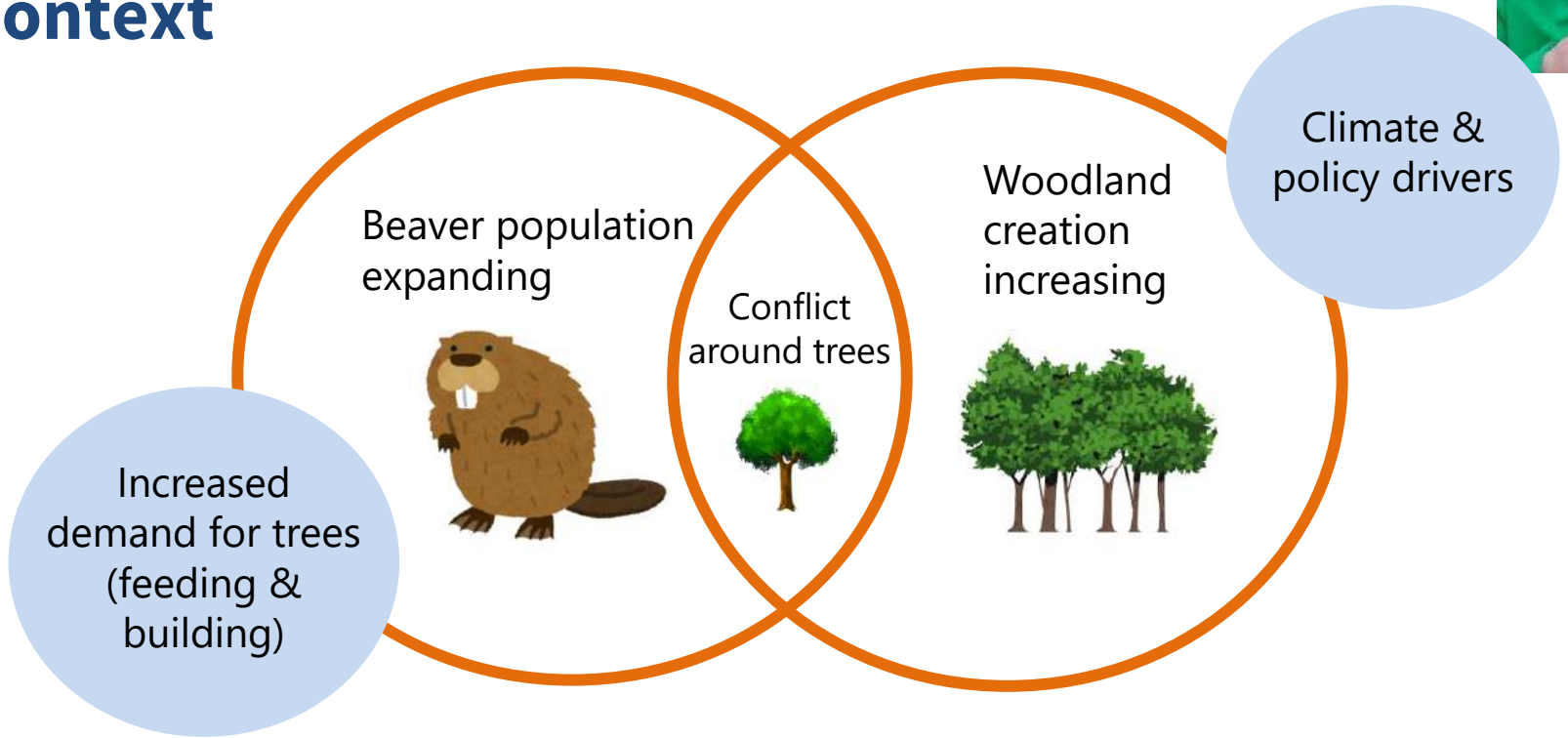
1. Control
2. 10ml per stem, October (product label)
3. 10ml per stem, April
4. 5ml per stem October & April
5. 5ml per stem October & April + Eco tac sticker adjuvant
6. Intimate mix treated & untreated

- Starting Autumn/Winter 2026
- Inform application guidance – broadleaf & conifer species

Beavers and Woodland Creation

Nicola Rae, Cally Ham, Alice Broome

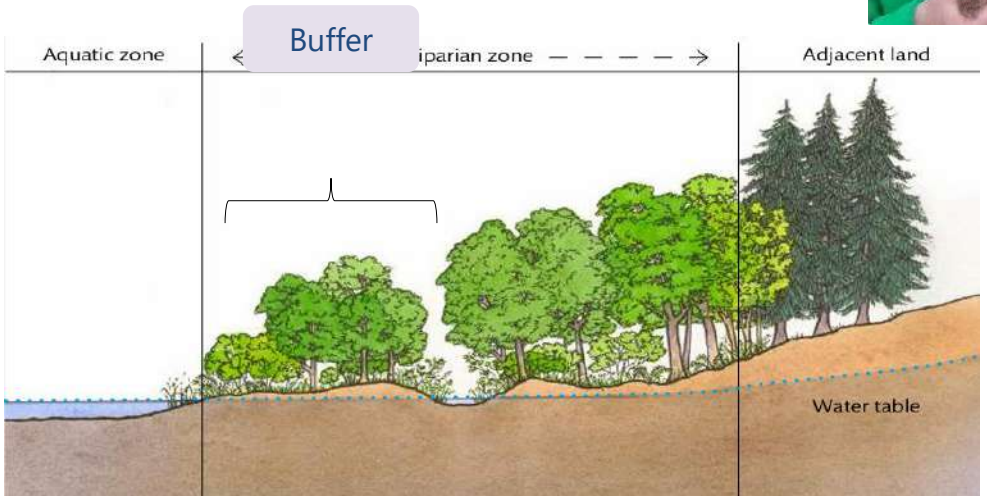
Context



Increasing overlap creates a new challenge for woodland establishment

Riparian buffers

Riparian buffer = planted strip along edge



Why might buffers work?

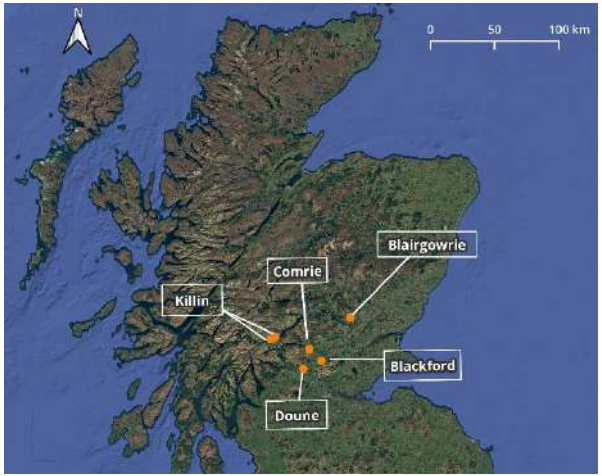
- Beavers mostly forage within ~10-30 m of water
- Buffers may divert feeding using palatable species (e.g. willow)

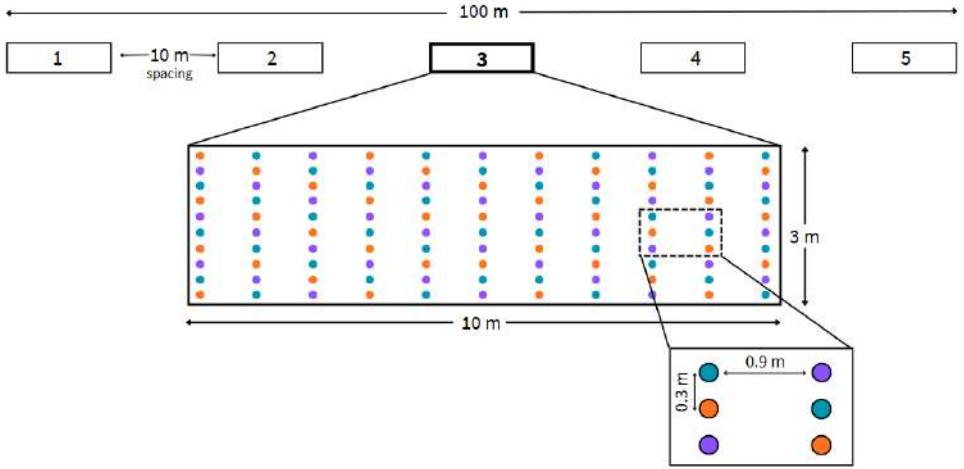
Current guidance:

- UK Forestry Standard recommends 20 m buffer as sacrificial planting

Pilot trial

6 pilot sites across Scotland





Buffer Area + Control Area Per Site

Examples of high-density buffer planting

Long term Monitoring

Build evidence

- Monitor long-term outcomes
  - Impact assessments
  - Camera trap beaver activity
- Share findings and guidance
  - Beaver Management Groups

Interested in getting involved?

We're looking for collaboration and suggestions for trial locations

nicola.rae@forestresearch.gov.uk

Special thanks to:

- Jenny Bryce, NatureScot
- Roisin Campbell-Palmer, Beaver Trust
- Ian Moss, Woodland Trust
- George, Cristin & Sam, Beaver Trust
- Forest Research staff volunteers

Thank you!

Any other woodland mammal related interests please get in touch!

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Forest Research

ainoa.pravia@forestresearch.gov.uk

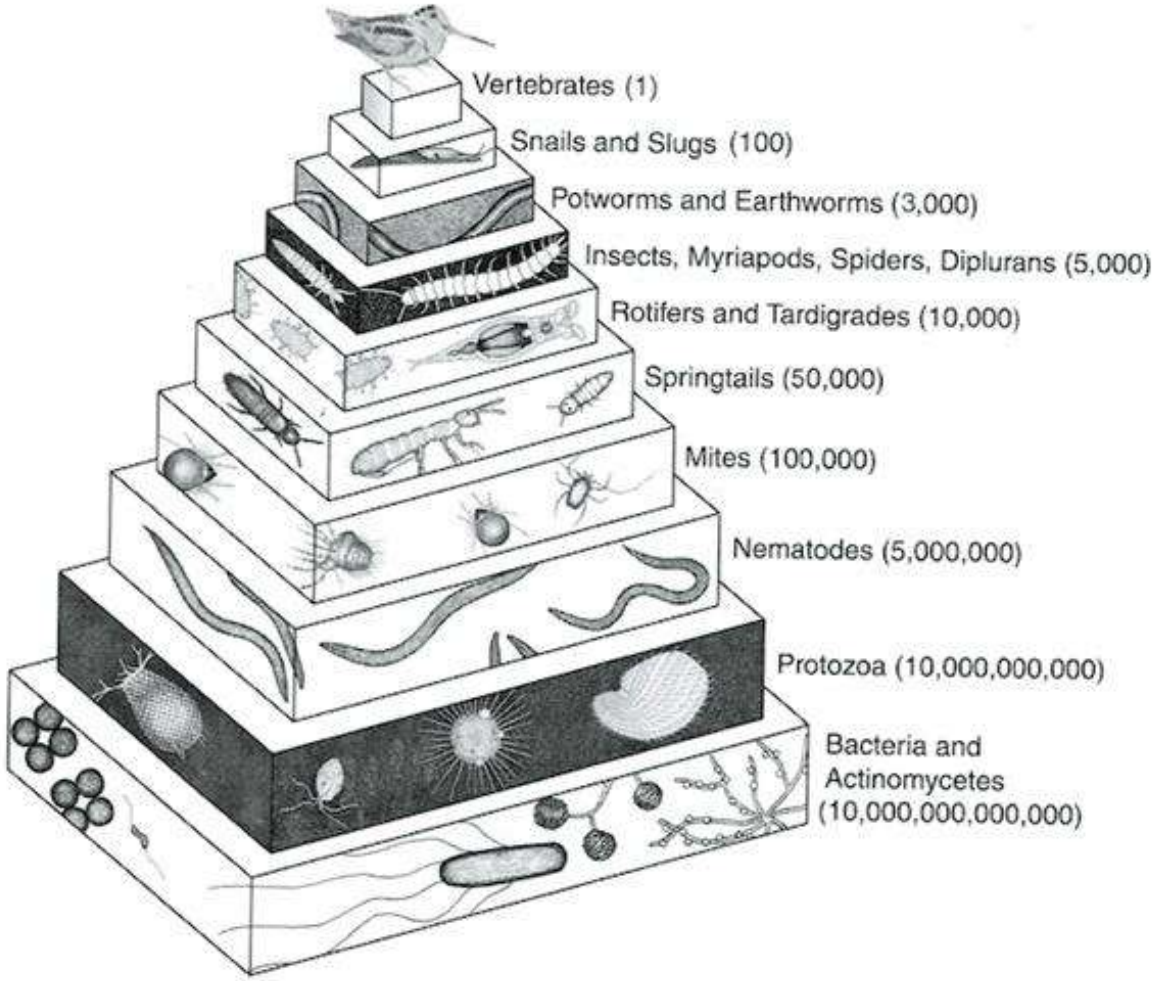
Soil Ecology Research

© Tom Ashton

Ainoa Pravia

(Tom Ashton, Olivia Azevedo, Nathan Brown, Luci Corbett, Kaisa Ilmari, Caitlin Lewis, Tim Lukins, Toby Robson & **Elena Vanguelova**)

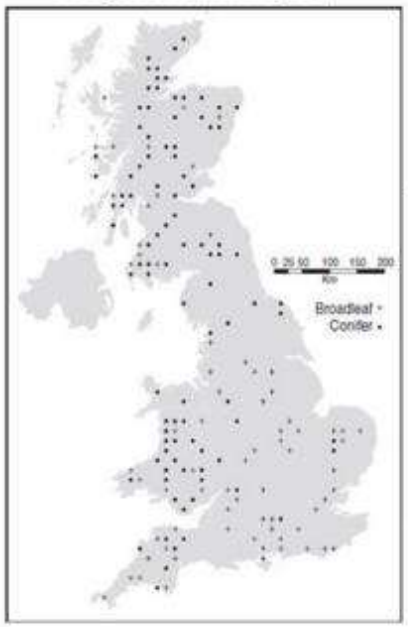
The Importance of Soils

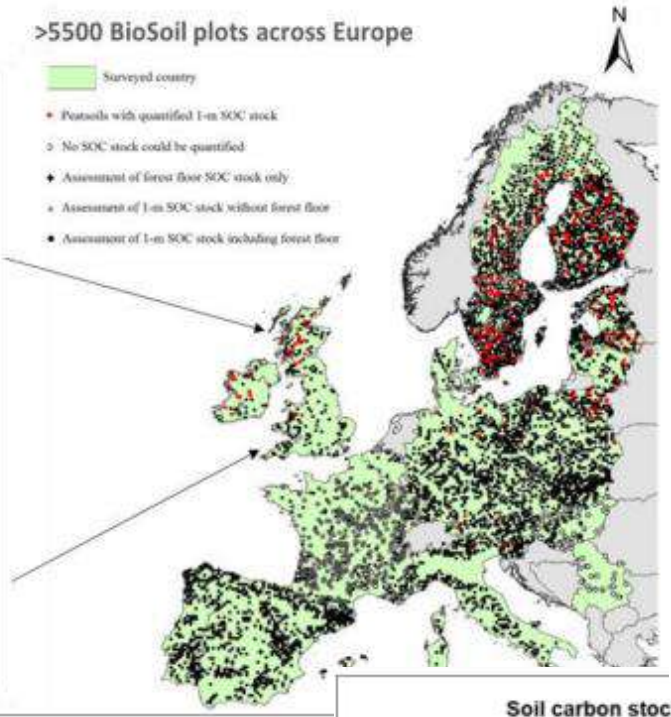


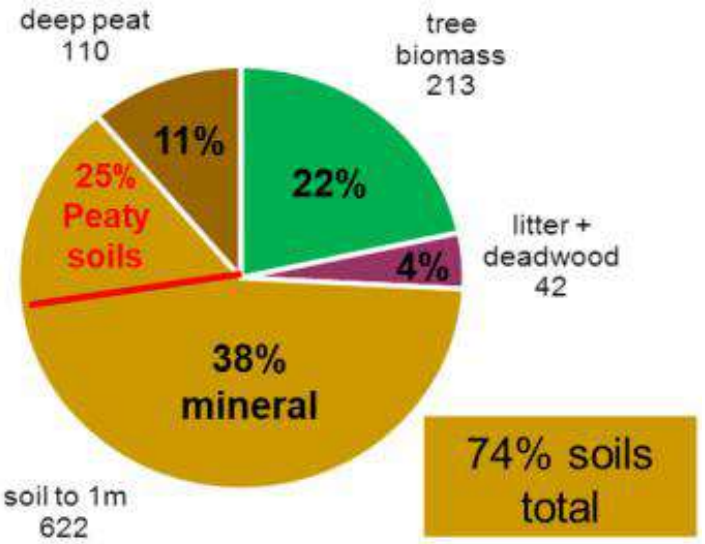
Nardi 2007

The Soil Team

UK Forest Soil Condition Baseline



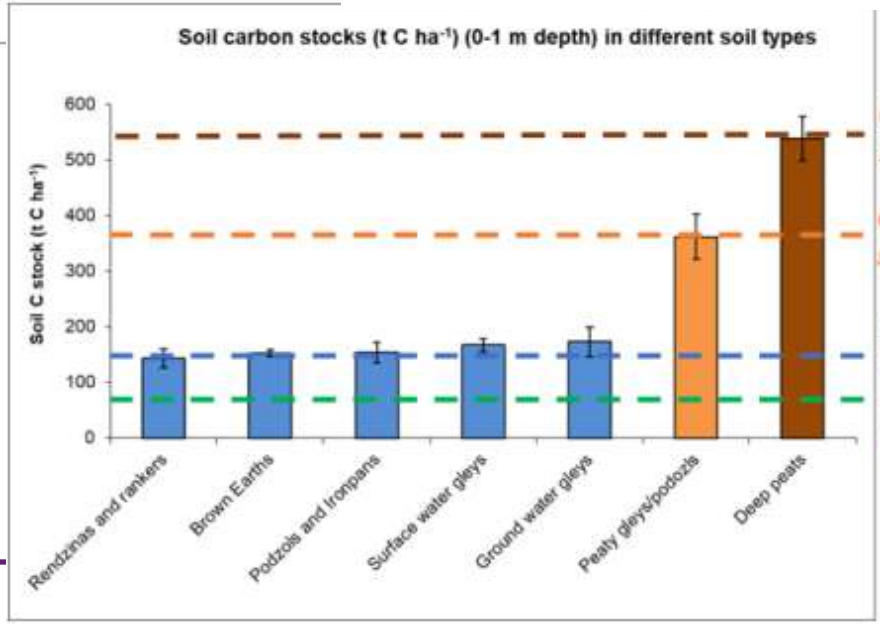




total UK C stock 'in forest' = 1095 Mt C

Carbon storage in forest soils depends heavily on forest and soil type (Vanguelova *et al.*, 2013**)**

Carbon estimates are only as reliable as the sampling and scaling methods used (Vanguelova *et al.*, 2016**)**



NCEA

(Biological) Forest Soil Condition

NCEA Natural Capital and Ecosystem Assessment

- Soil physico-chemical properties

AND

- Bacteria & Fungi (metabarcoding)
- Ectomycorrhiza (meta & taxonomic)
- Nematodes (taxonomic)
- Earthworms (taxonomic)
- Mesofauna (meta & taxonomic)

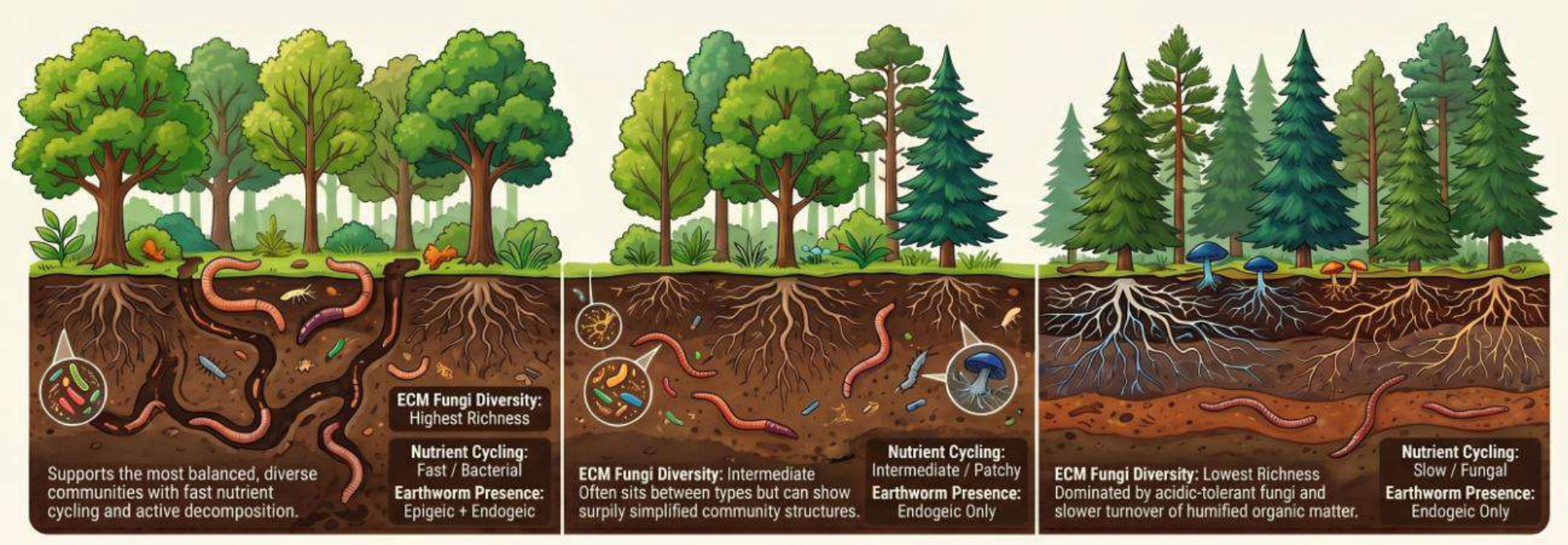
Natural Capital and Ecosystem Assessment (NCEA) programme - GOV.UK

Prelim Results – Forest Soils

DECIDUOUS FORESTS
Multitrophic soil systems

MIXED FORESTS
Intermediate (simplified!?) soil systems

EVERGREEN FORESTS
Fungal-driven soil systems



Higher diversity
Faster decomposition
(more surface activity)

More dependent on site history

Few dominant groups
Slower decomposition
(more soil activity)

NCEA MESOSCAN

Soil Mesofauna (Mites & Springtails) → Size: 2 µm – 2 mm

Sample Collection → Sample Extraction → Sample Identification → Sample Data

+ Onwards to Metabarcoding

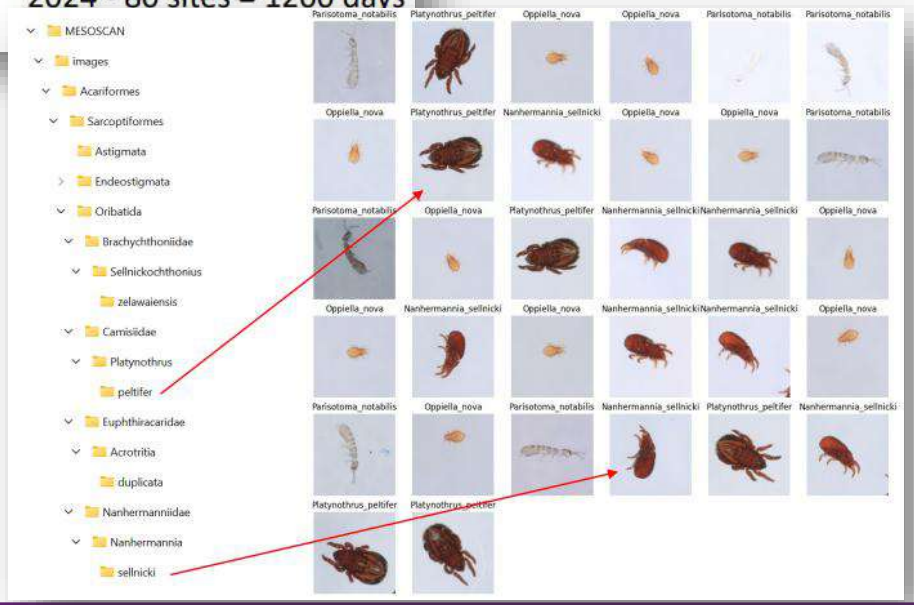
0.5 day per site 5 samples

5 days each sample x2 =10 samples per site

~1.5 days per sample **= 15 days per site**

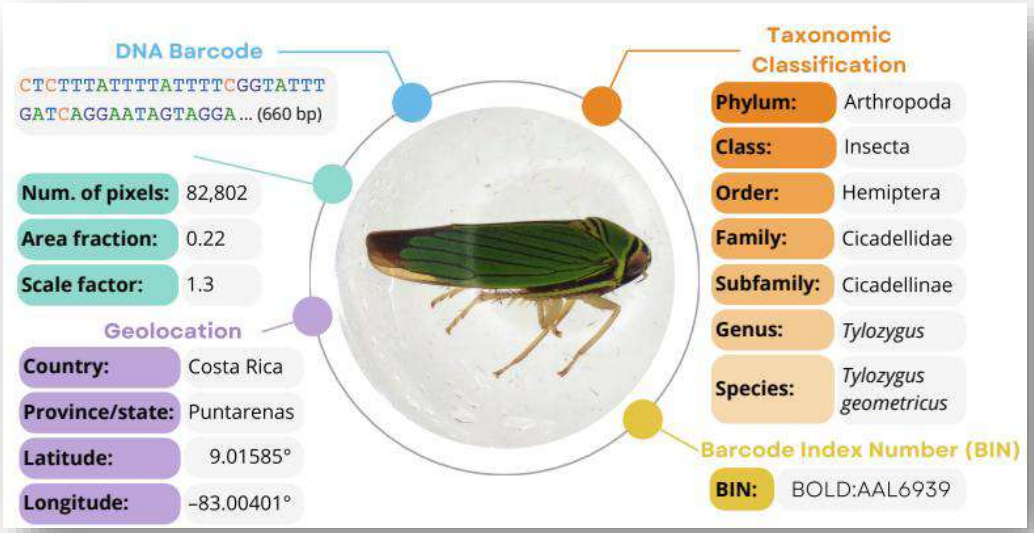
NCEA
2022 - 30 sites = 450 days
2023 - 40 sites = 600 days
2024 - 80 sites = 1200 days

thods for Soil
pringer.



Mesofauna *METABARCODING*

Defra DNA Centre of Excellence



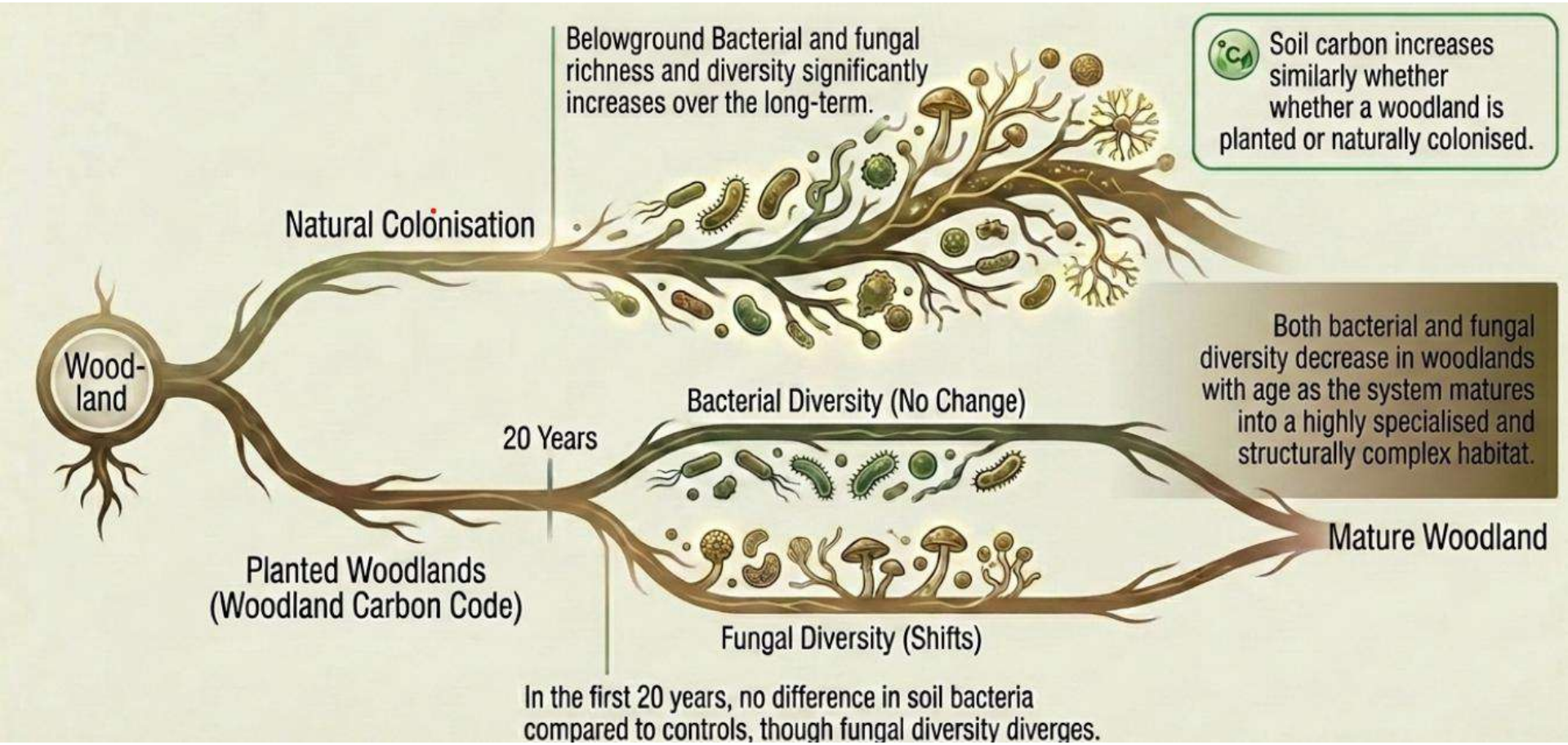
BIOSCAN 5M

https://arxiv.org/abs/2406.12723

1. **Standardisation of metabarcoding pipelines for mesofauna**
2. **Filling DNA barcoding gaps in reference libraries**
3. **Expand MESOSCAN dataset (adding barcoding sequences)**

Woodland Establishment

UKFS – requires that physical, chemical and biological properties of forest soils are protected or enhanced and that soil fertility is maintained during woodland creation and management (Forest Research, 2023a, 2023b).



Take Home Messages

1. **Put soil first**. Soils are the primary long-term carbon pool in woodlands and soil biota drives key functions (decomposition, nutrient cycling, structure and carbon stabilisation).

2. **Match tree species and management objectives**. Fast carbon gain and long-term biodiversity/resilience might not always be delivered by the same system. Short-term carbon gains are provided by conifers or N-fixing species; long-term biodiversity and resilience are provided by deciduous or mixed designs (including natural colonisation).

3. **Think in decades to centuries**. Woodland establishment changes in soil systems in predictable but time-dependent ways: carbon builds fairly early, but biodiversity requires more time.

4. **And think at landscape scales**. The benefits of woodland establishment can be maximised through landscape diversification via connectivity, buffers, agroforestry and existing woodland links rather than isolated sites.

5. **Natural colonisation and mixed approaches can deliver strong biodiversity benefits**. NC appears to deliver similar soil C gains to planting whilst building higher long-term belowground microbial diversity. Mixed stands often fall between deciduous and evergreen systems but can show simplified communities (depending on site history and management).

6. **Measure soil biodiversity explicitly**. Biodiversity is the cornerstone of soil health and resilience, and therefore of forest resilience. Diversity is shared across forest types, but each also hosts specialist groups. Because the interactions between biological communities drive function, monitoring should target several taxa. Here we see the potential indicator value of mesofauna, earthworms and ECMs, but it is the structure and interactions of these communities that best inform soil function.

Thank you

TOM ASHTON'S MESOFAUNA YOUTUBE CHANNEL

Who to Contact

Anything related to soils (carbon, management, pollution, land uses, biodiversity)

Elena Vanguelova elena.vanguelova@forestresearch.gov.uk

Ground preparation techniques for tree planting

Luci Corbett luci.corbett@forestresearch.gov.uk

Soil biodiversity in forests and peatlands (and peatland ecology)

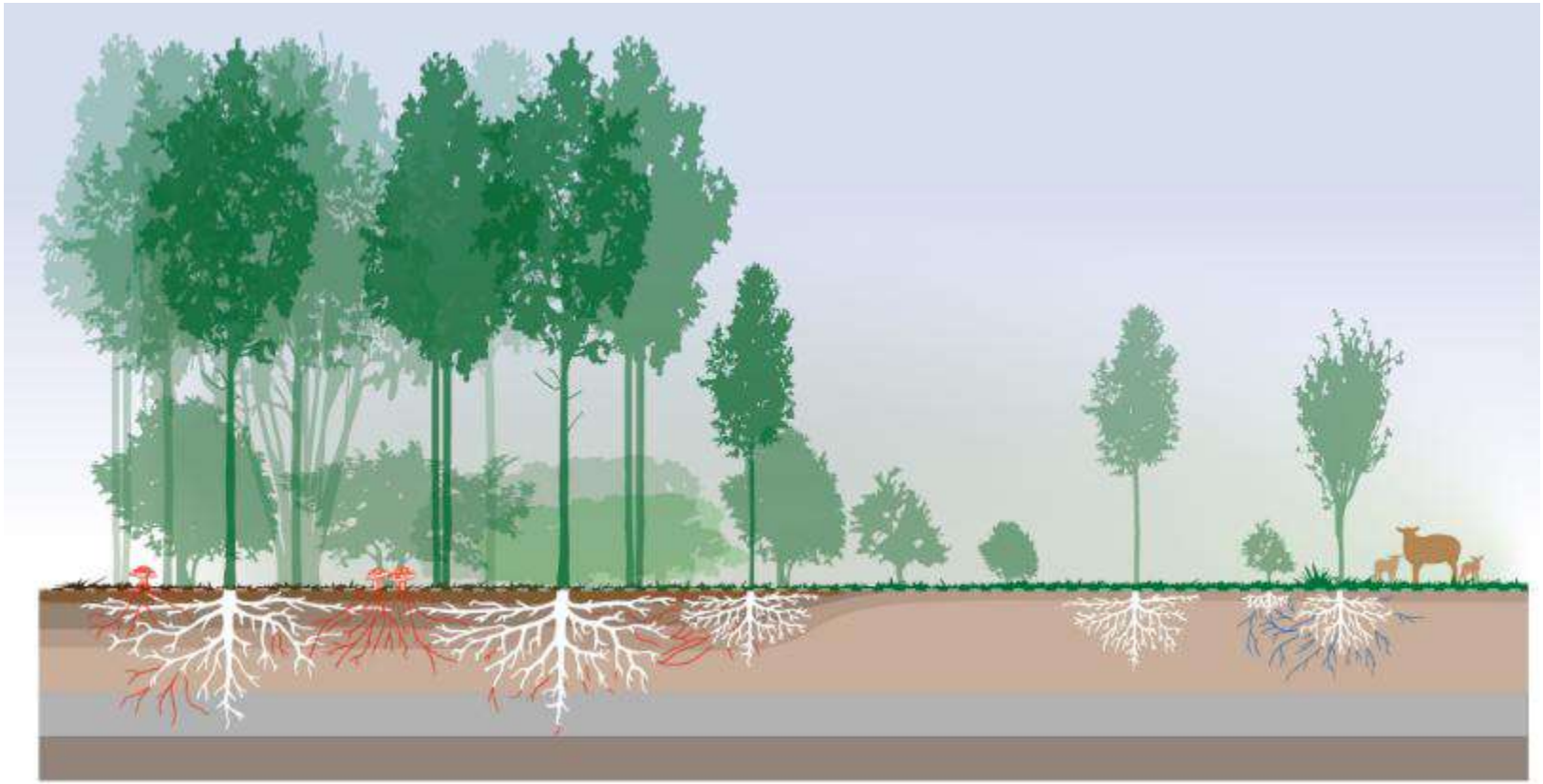
Ainoa Pravia ainoa.pravia@forestresearch.gov.uk

Air pollution effects on forests

Caitlin Lewis caitlin.lewis@forestresearch.gov.uk

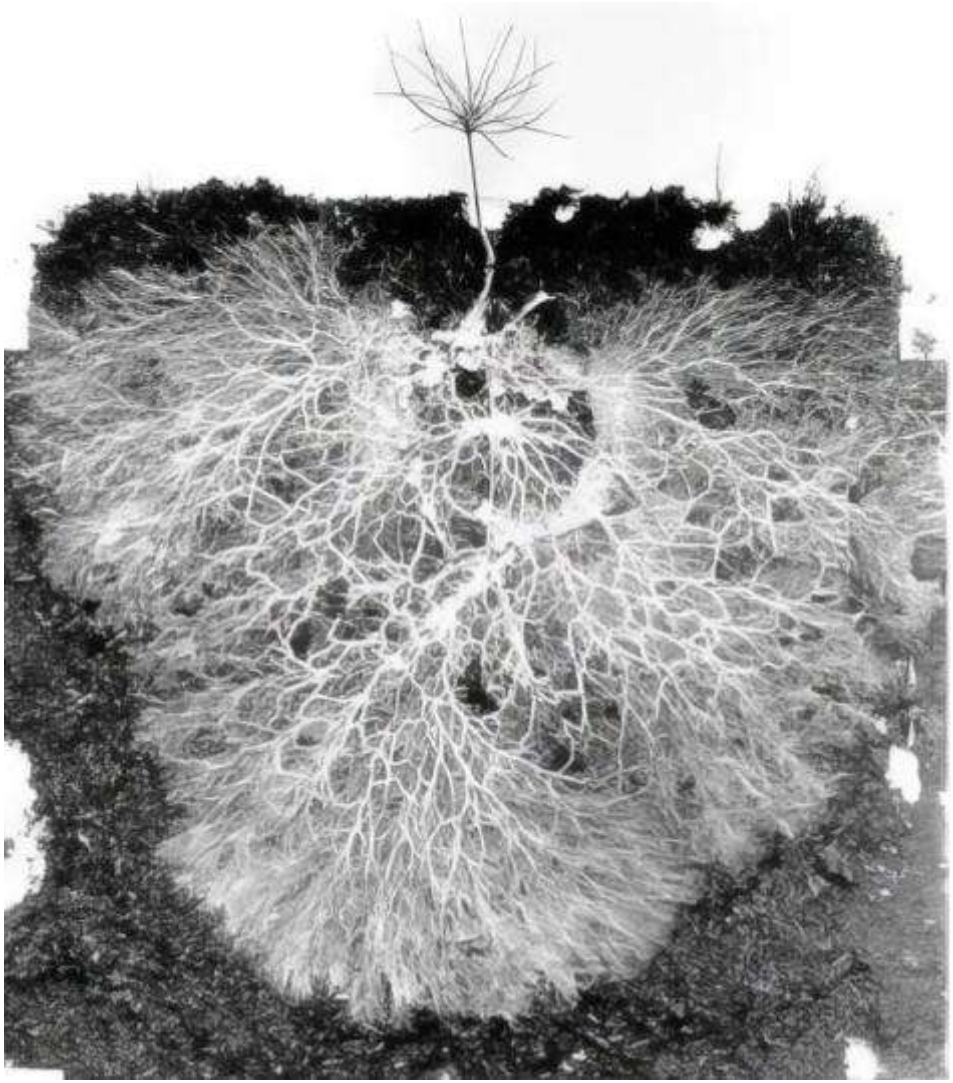
Mycorrhizal research and woodland creation

FOREST **FORMER ARABLE LAND**

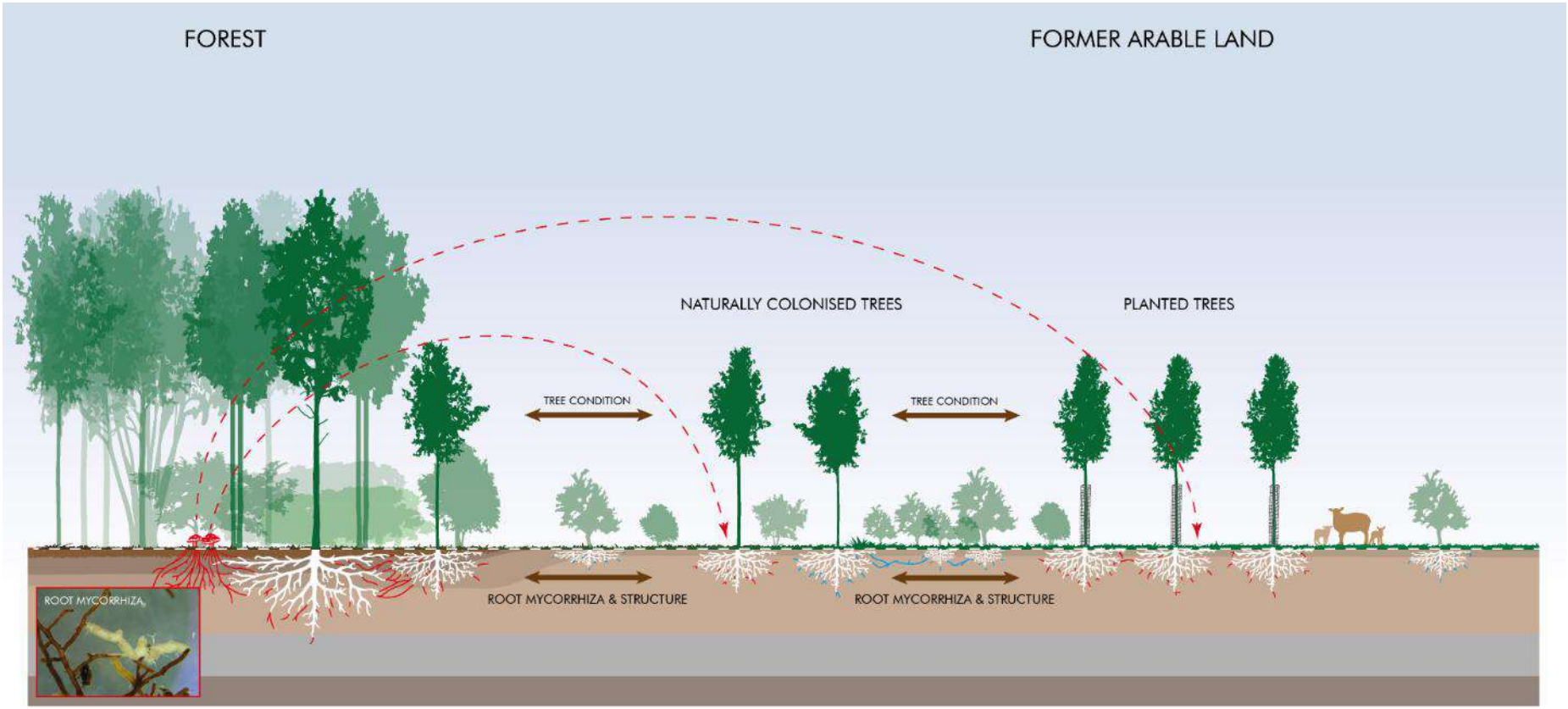


Soil	Brown Earth (Moder-Mull)	Mineral
Nitrogen source	NH4+ -NO3- (Mineralisation)	NH4+-NO3- (Nitrification)
←	Decreasing soil pH	→

Mycorrhizal research and woodland creation



Mycorrhizal research and woodland creation



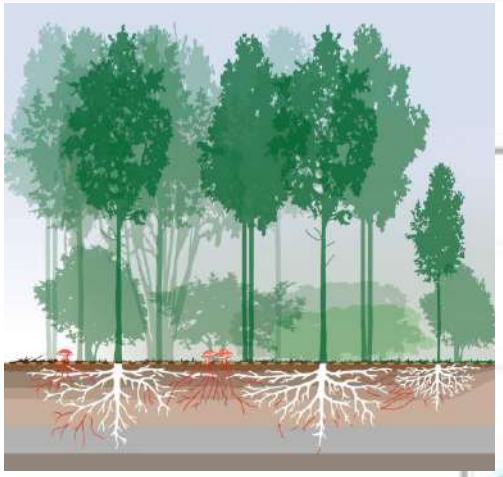
What are the colonisation routes?

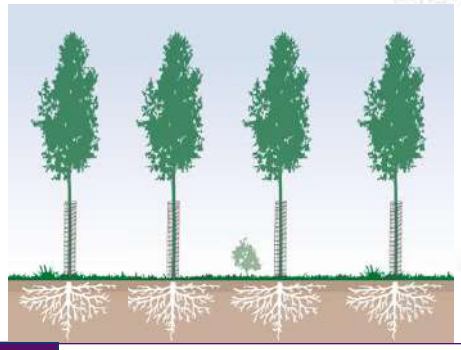
How long before woodland mycorrihizal communities become established?

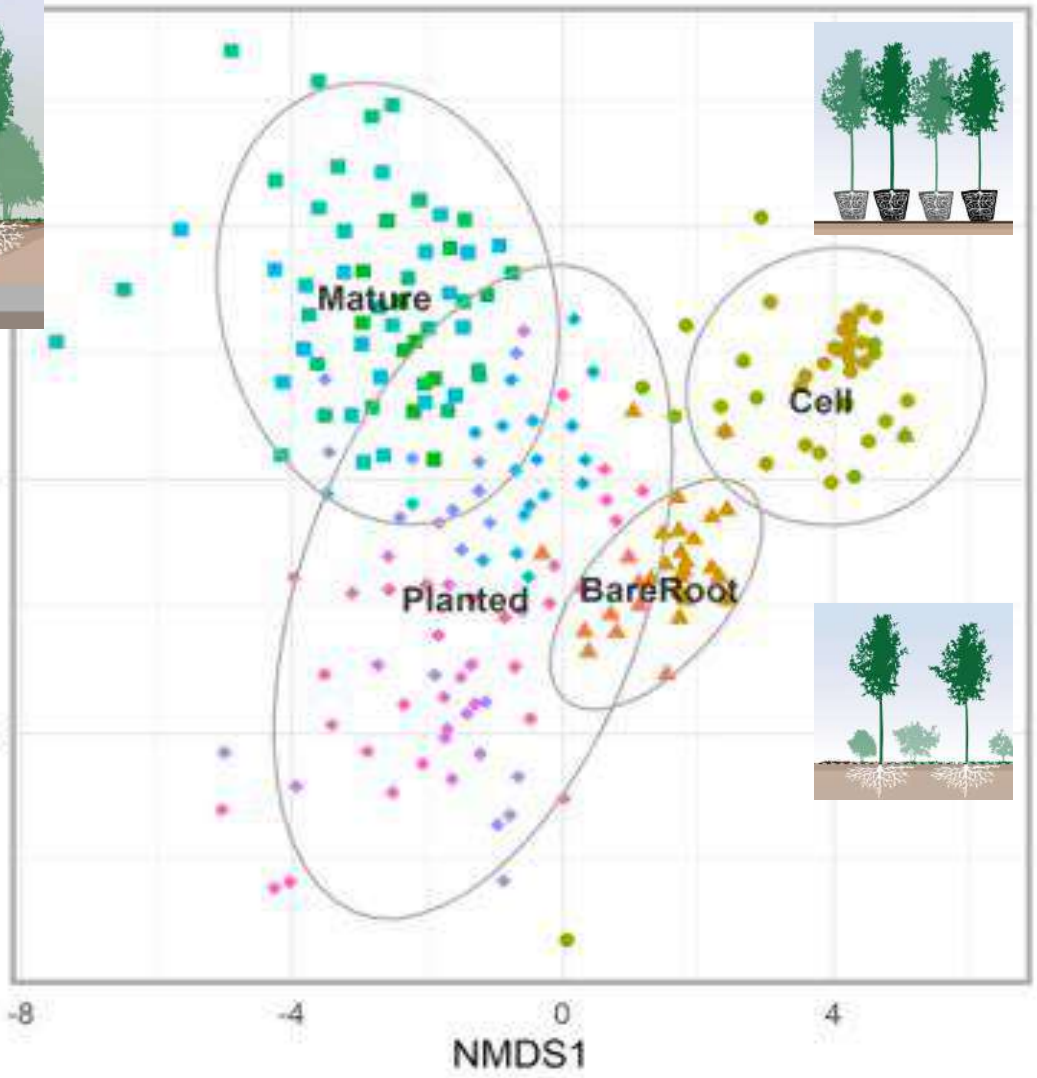
Is inoculation needed prior to planting or using companion plants?

Mycorrhizal research and woodland creation

Composition of EM-fungi on tree roots







Take home messages

- **Commercial nurseries** - Few 'weedy' EMF species on trees
- **Spore dispersal** – some spores of most genera; dominated by 'coloniser' EMF species,
- **EMF communities of former agricultural land** – Distinct from woodland EMF communities despite availability of inoculum via spores. Soil & microclimate conditions driving distinctiveness
- **Former agricultural land properties**– Long time lag before soil physico-chemical properties resemble woodland settings

- Fungi for Forest Restoration (Fungi4Restor)
- Contact Nadia Barsoum nadia.barsoum@forestresearch.gov.uk

Acknowledgments

Funded through the Government's Nature for Climate Fund

Forest Research

Lucia Manicom-Smith, Ben James, Daniel Sawyer, Nicola Rae, Nicola Cotterill,
Adenike Amoo, Padraig Hipple-Walsh, Thomas McNeil, Ian Keywood, Henry Marling,
Emily Parkinson, Joe Beesley, Ellen Wright, Benjamin Walshe, Joan Cottrell, Stuart A'Hara,
FR RO Office: Anna Dade, Tony Hutchings, Gaia Marini, Emma Lewis

John Crawford, Clive Steward, Sam Pettman, Aaron Philips,
Martin Allison, John Tucker, Peter Buckley,
Hucking Estate, Home Farm, Hainault, Barnetts and Comforts

WOODLAND TRUST

Tidgrove Estate
DenmarkField Rewilding Team (Rebecca Houston, Ellie Corsie)

National Trust

Slindon Estate

Sugley Wood, Arger Fen

THE wildlife TRUSTS

DEFRA: Chris McGurk
Natural England: Matt Wainhouse, Clare Pinches