Setting the agenda:

Rooting future woodland restoration research in practitioner needs

Full report

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Project overview

This report examines what knowledge woodland restoration practitioners say they need, with the goal of co-developing a shared plan for future research with researchers. We used a mixed-methods approach: an online survey, in-depth interviews, and a collaborative workshop. We bring together findings from all three to identify priority knowledge gaps; show how shortages in evidence, knowledge sharing, or practical implementation contribute to those gaps; and propose actions that practitioners and researchers can take to address them. We also consider how external factors — such as policy, funding, and organisational capacity — shape what is possible. The report concludes with a shared vision for future research in woodland restoration.

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Contents

List of figures and tables

Summary

Understanding knowledge needs and developing a shared vision for future research

In Scotland, woodland restoration research is vast, varied, and well-developed in many ways, but this research is not always aligned with practitioner knowledge needs. To better understand woodland restoration practitioners' perspectives, we conducted a survey, nine in-depth follow-up interviews, and a workshop to facilitate practitioner-research discussion and develop a shared vision for future research.

Knowledge needs are diverse and may not stem from a lack of evidence

We identified multiple knowledge needs which exist at all scales from the molecular to the national. Knowledge needs do not always result from a lack of evidence or academic understanding. Often, the issue lies in limited knowledge exchange or the absence of mechanisms to implement required action. Addressing knowledge needs requires an understanding of the specific context and the mix of evidence, exchange, and/or enaction gaps that may be at play.

Ecological needs highlighted by practitioners covered understanding best practices for establishing trees in different contexts and managing herbivores, and the wider environmental impacts on and of different afforestation approaches in relation to carbon, climate change and biodiversity.

Social needs emphasised by practitioners ranged from understanding and managing perceptions, conflicts and social impacts of woodland restoration efforts, to knowing how to increase community involvement and connections with land.

Financial needs pinpointed by practitioners included understanding nature markets better and how to engage with funding mechanisms more effectively, as well as the need for more evidence on the cost-effectiveness of various approaches.

Better researcher-practitioner collaboration is needed

Research is not automatically relevant to, or adopted in, practice; this is the basis for a knowing-doing gap. Closing this gap requires proactive efforts to align priorities, improve communication, and strengthen knowledge translation. Practitioners and researchers offer distinct yet complementary contributions to supporting progress towards this goal. Practitioners are uniquely placed to identify research questions that could have a transformational impact on practice while researchers can catalogue, signpost and translate existing research; both can engage in knowledge exchange practices to help lessen the gap between generating evidence and implementing practice.

Economic, political, and societal factors constrain effective collaboration

Closing the knowing–doing gap is not the sole responsibility of practitioners and researchers. Research agendas and practitioner priorities are shaped by economic pressures, political priorities, established priority-setting, and funding practices. The conversation therefore needs to extend beyond researchers and practitioners to include policymakers, funders, and other stakeholders.

A solution-focused woodland restoration research vision

Meeting practitioners' knowledge needs is a continuous process that requires regular, transparent channels for practitioners to identify and share what they need. At present, there are few opportunities for building strong practitioner–researcher relationships, setting research priorities together, and supporting broader socio-political changes that enable progress in woodland restoration research. Workshop participants helped inform a solution-focused vision.

A vision for future woodland restoration research

Woodland restoration research should be solutions-focused, outcome-driven and capable of supporting long-term, practical goals. Success will be defined by research that actively supports the ongoing delivery of sustainable, healthy and resilient woodlands – for the benefit of both nature and people.

Achieving this requires a collaborative system underpinned by social, political, and economic mechanisms that enable practitioners and researchers to co-design and co-produce research that is innovative, iterative, and responsive to real-world challenges.

Central to this vision is a commitment to 'translating' and exchanging knowledge, cultivating a culture of mutual trust and respect. Practitioners and researchers should not always be seen as distinct entities, but as a community with a shared identity and ambitions.

Definitions

For clarity throughout this report, the following definitions are used. These have been iteratively refined in response to participant input at each stage of the research.

Woodland restoration: efforts to achieve functional, resilient, and quality woodland habitats that deliver for both nature and people. This includes but is not limited to woodland creation, recovery, and regeneration activities (*see Appendix A for fuller discussion on this definition*).

Practitioner: Someone whose primary role is doing or organising woodland restoration activities, furthering on-the-ground efforts in this field.

Researcher: Someone whose primary role is understanding, investigating and studying aspects of woodland restoration, to produce evidence about restoration activities and relevant ecosystems.

Knowledge need: an area, or topic, where there is a perceived gap in understanding that must be addressed to achieve a desired goal.

Evidence gap: a knowledge need which is due to a lack of scientific understanding.

Knowledge exchange gap: a knowledge need which is due to ineffective, or insufficient, sharing of scientific or practical understanding.

Enaction gap: a knowledge need which is due to wider contextual factors that limit required action/s.

1. Introduction

Woodland ecosystems are ecologically important and key to supporting society[1]. In Scotland, where forestry is a devolved issue, the environmental and social benefits of woodlands are recognised in policy such as Scotland's Forestry Strategy 2019-2029[2], which states a goal to increase woodland cover from 18.5% in 2019 to 25% by 2050. As for all aspects of conservation, research offers a vital underpinning for understanding woodland restoration efforts, ensuring it is evidence-based and cohesive with wider societal priorities. However, a challenge lies in the potential for disconnects to manifest between those conducting research and those implementing on-the-ground efforts: a so-called 'knowing-doing' gap[3]. While restoration researchers and practitioners often share broadly similar environmental goals, they operate within different institutional frameworks that involve distinct constraints, practices, and measures of success, which may lead to varied perceptions of what future research is needed to achieve these shared goals.

Developing credible, relevant solutions to issues encountered in restoration requires thoughtful management of the boundaries between different knowledges and actions[4]; in other words, realising woodland restoration ambitions requires an ongoing examination of how the practitioner-researcher dynamic is functioning. To understand the extent and consequences of a potential knowing-doing gap for woodland restoration in Scotland, and work towards addressing this, it is important to understand the various views held by practitioners in the field. The value of practitioners' experiential knowledge is often neglected in conservation science[5]; as such, this project aimed to centre practitioners' perspectives and investigate the opportunities and challenges presented by the current state of the knowing-doing gap in Scottish woodland restoration.

The following questions guided this project:

- What knowledge needs do woodland restoration practitioners currently have?
- Why do these knowledge needs exist?
- What could a shared vision, co-created by practitioners and researchers, look like for the future of woodland restoration research?

[1]Sing *et al.* 2017; Burton *et al.* 2019
[2]Scottish Government, 2019
[3]Knight *et al.* 2008; Hulme 2014; Sabo *et al.* 2024
[4]Burton *et al.* 2019
[5]Adams and Sandbrook 2013

2. Approach

This research consisted of three main stages: an **online survey** of practitioners working in woodland restoration across Scotland to scope out a wide range of knowledge needs; **nine online semi-structured interviews** with practitioners to contextualise and deepen the understanding of these needs and why they might exist; and an **in-person workshop** with both practitioners and researchers to consider what collaborative work may be desirable and possible in addressing some of the knowledge needs raised throughout the project. This report reflects on findings from all three stages of the project.

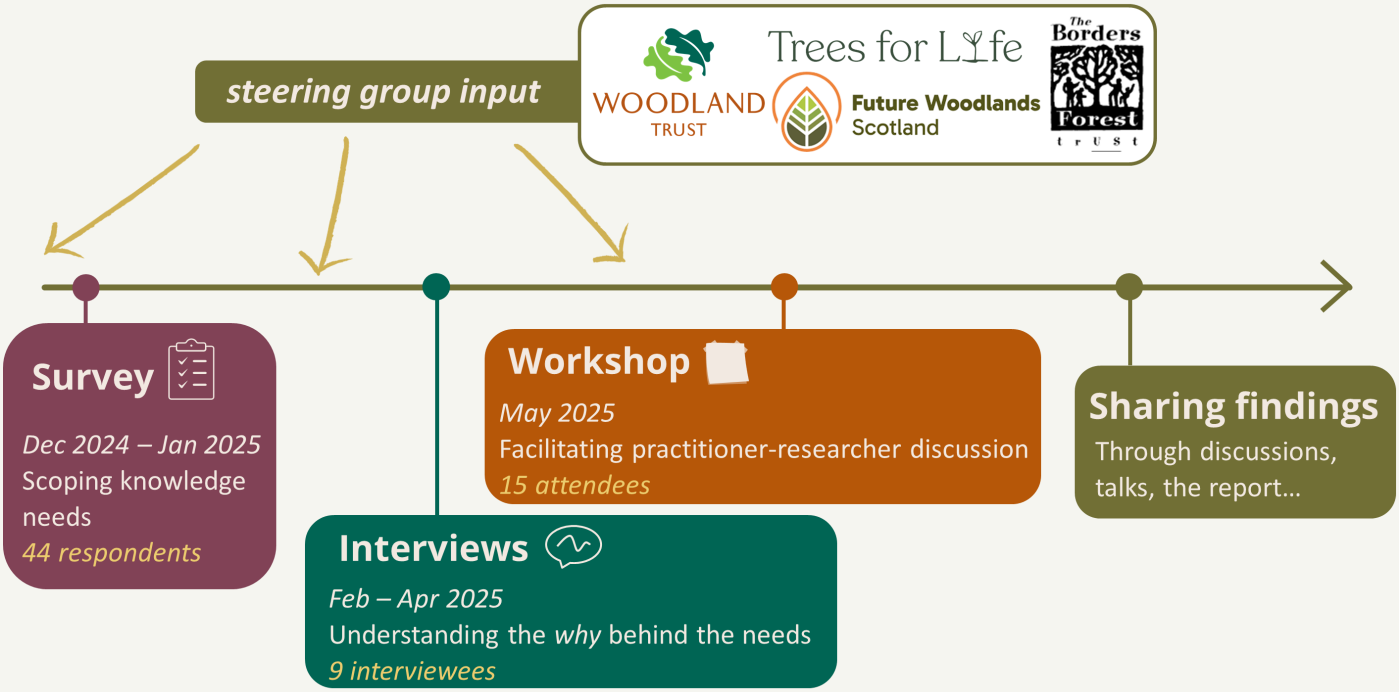

Figure 1: timeline of the project

2.1 Survey: scoping out practitioner knowledge needs

The online survey aimed to understand the breadth of practitioners' knowledge needs in the field of woodland restoration. Open-ended questions sought to identify what ecological, social, and financial knowledge needs exist amongst practitioners working across Scotland and gauge how practitioners broadly view the relevance of research to their practice (*see Appendix B for survey questions*). The survey was open from 2nd December 2024 to 16th January 2025, hosted on Jisc and disseminated via mailing lists of relevant organisations and shared online via LinkedIn. Survey responses were coded thematically.

The survey received 44 responses, of which 14 respondents worked for a conservation non-governmental organisation (NGO) or charity, nine worked in consultancy, seven worked for a government agency, six either were or worked for a private landowner, three worked in higher education, two worked in the private sector (not including consultancy), one worked for a co-operative, one was a crofter, and one held multiple roles spanning several of the aforementioned categories.

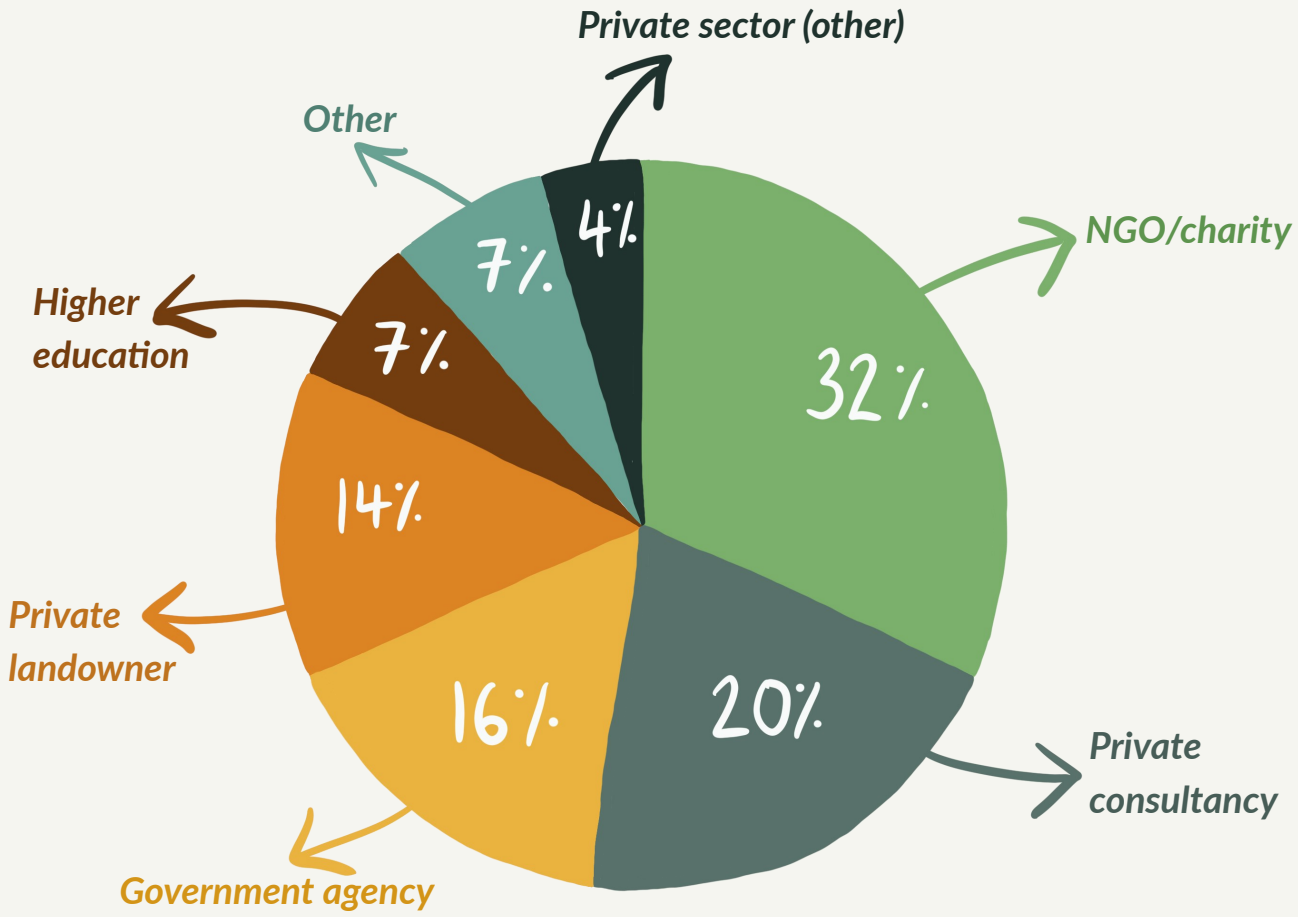

Figure 2: breakdown of the 44 survey respondents by sector

Across sectors, the roles of respondents varied, including six (executive/associate) directors, four habitat restoration/woodland managers, four ecologists, four estate/site managers (one of whom also acted as a volunteer leader), four consultants (one of whom was also a trustee; one of whom also owned woodland and was the chair of an NGO), four foresters (two of whom were retired), two operation managers (one of whom was retired), two academic/science managers, and one of each of the following: natural environment planner, forest operations technical trainer, head of finance, rainforest advisor, project manager, landowner, farmer, nature network officer, forest management educator and silviculturist, crofter, and archaeologist. It is important to note that by choosing to complete the survey, respondents were self-identifying as practitioners—all responses were included in this project to avoid the research team dictating what roles do or do not constitute 'being a practitioner'.

2.2 Interviews: contextualising knowledge needs

Following the survey, nine semi-structured interviews were conducted to further investigate practitioners' perceptions of why these knowledge needs exist and why certain needs are key to address (*see Appendix C for interview schedule*). The nine interviews were conducted online between February and April 2025 on Teams, with eight of these recorded and transcribed, and detailed notes taken for the remaining one. A list of potential interviewees was identified from survey respondents who indicated interest in participating in an interview and supplemented by further suggestions from the Steering Group. The final selection of interviewees was chosen to reflect a balance of sectors and roles. Interview transcripts and notes were coded thematically.

Of interviewees, three worked for a public body (one manager, one ecologist, one forester), three worked for a conservation charity (one manager, one ecologist, one director), and three worked in the private sector (one manager, one forester, one private landowner).

Table 1: breakdown of interviewees' roles and organisation types in order of date interviewed. Quotes throughout the report are attributable to each individual by allocated 'code' in final column.

Number	Role	Organisation type	Code
1	Senior land use manager	Public body	PB1
2	Senior ecologist	Conservation charity	CC1
3	Forest programme manager	Conservation charity	CC2
4	Forester	Private consultancy & management	PC1
5	Woodland owner & consultant	As a private landowner	PL1
6	Director	Conservation charity	CC3
7	Woodland ecologist	Public body	PB2
8	Conservation manager	For a private estate	PL2
9	Planning forester	Public body	PB3

2.3 Workshop: collaborating on future thinking

A workshop with 15 practitioners and researchers was held on 1st May 2025, with the aim to facilitate solutions-focused discussions around some of the issues that arose throughout prior stages of the project. Several activities were designed to lead participants through conversations of why certain knowledge needs exist, resources that are needed to overcome the challenges presented by trying to address these, and what a successful future woodland restoration research strategy might look like (*see Appendices D and E for workshop schedule and example materials*). A workshop plan was presented in a meeting with the Steering Group plus several additional researchers prior to the workshop, resulting in feedback which helped to refine the aims and ensure they remained aligned with practitioner needs.

Figure 3: photo of workshop participants doing group work on mixed tables of practitioners and researchers.

Among the 15 participants present, there was considerable diversity in practical and research experience, career trajectories, and types of organisations represented (*see Table 2 for a detailed breakdown*). Participants were evenly distributed across three tables, with deliberate efforts to ensure a balanced mix of backgrounds at each table.

*Table 2: breakdown of workshop participants' roles and organisation types, grouped by table sat at. The three columns on the right indicate whether the participant was a woodland restoration practitioner or researcher. The one participant marked with a * worked for a funding body rather than as a practitioner/researcher.*

Table	Role	Organisation type	Prac.	Res.
1	Academic	University		X
	Plant ecologist	Research institute		X
	Department head	Public body	X	
	Director	Partnership (at a university)	X	
	Department head & academic	Private sector (land) & university	X	X
2	Director	Environmental NGO/charity	X	
	Manager	Environmental NGO/charity	X	
	Manager	University		X
	Team leader	Environmental NGO/charity	X	
	Department head	Public body		X
3	Chief executive	Environmental NGO/charity	X	
	Statistical ecologist	Research institute		X
	Academic	University		X
	Director*	Grant-giving NGO/charity	-	-
	Forester	Private consultancy	X	

3. Practitioner knowledge needs

Through the survey and interviews, practitioners identified various knowledge needs concerning the ecology of woodland restoration, the social impacts of such efforts, and the financial aspects related to conducting this work. This section outlines some of the knowledge needs raised, providing examples of the sorts of topics practitioners are interested in seeing addressed. Illustrative quotes are from the interviewees listed in Table 1 and include the 'code' number to attribute them.

3.1 Ecology needs

Unsurprisingly, to support their work, practitioners primarily noted a range of ecological knowledge needs that require attention. These covered a vast array of concerns, from questions regarding the best practices for establishing trees and managing herbivores, to queries surrounding the wider environmental impacts on and of different afforestation approaches in relation to carbon, biodiversity, and climate change.

Tree establishment and species

In terms of tree establishment, respondents wanted to know what best practice for this may be beyond the conventional approaches. Research is needed to better understand new and experimental approaches, including those that mimic or use natural processes, and how to support trees to establish in response to new challenges linked to climate change and disease spread. Practitioners provided various examples of specific conditions in which tree establishment remains less understood, from creating woodlands in montane, pasture, and riparian habitats to planting on impoverished upland soils or in areas with a lot of bracken. There were several questions regarding the best ways for woodlands to be multifunctional, such as how to create mixed woodlands that fulfil both nature commitments and timber production, what the silviculture opportunities of productive broadleaves might be, how many seed trees to leave when harvesting in pinewoods, and how to manage the interface of native and commercial woodlands. Participants also shared particular concerns related to ancient woodland sites, with some wondering what the window of opportunity might be for saving ghost woodlands.

Many knowledge needs related to continuous cover forestry (CCF), in terms of attitudes, methods and potential benefits. One interviewee contextualised this: '*when I look at the rest of Europe, it seems that kind of low-impact silviculture, continuous cover stuff is really rooted within forest restoration, whereas I don't think that's so much the case within the culture*

here in the UK' (CC2). Method-wise, some wanted to understand which CCF approach is best for specific woodland types, particularly beyond timber production objectives, whilst others wanted to know the prevalence of different thinning regimes. In terms of the benefits that CCF could bring, there are '*many unanswered questions…what is the resilience or biodiversity benefit of doing that?'* (CC2).

> *'One of the things that we are discovering is that where you manage deer populations such that these natural processes can unfold and the native woodland can expand by itself, surprise surprise, it expands – and it will often expand onto adjacent habitats, which interestingly some of them have been designated as important nature conservation habitats in their own right, particularly upland heath. And so you've then got upland heath experts saying, 'oh, wait a minute, what's happening here in my upland heath is deteriorating its condition because it's got all these birch trees in it' and the tree people are saying, 'well, this is fantastic'…We could find a way through that much more clearly with more robust research and evidence' (CC3)*

Further, respondents had questions regarding natural regeneration in relation to predicting patterns, composition, spread, growth rate, density, and optimal location of seed sources in different contexts. Similarly to CCF, natural regeneration is perceived to be a promising prospect for resolving current concerns: '*fragmentation is quite a big issue and that takes us into the woodlands creation/expansion space – historically, we've done that through tree planting, and that's fine and has its role, but…we're recognising that natural processes and natural regeneration can do that very well in a way that potentially gives better outcomes for nature… there's a number of areas that we would like to see research on [regarding] improving native woodland establishment'* (CC3).

> *'There's a gap around predicting natural regen responses, that's something that's pretty major, because a lot of the funding for woodland expansion or creation is very much focused on 'this many stems per hectare'. I think we should change the funding; it needs to be looked at so there's a bit more flexibility around densities of trees and stuff like that, but being able to predict more in advance based on your kind of tree and vegetation and your seed trees, how much regeneration you might actually get would be a really, really helpful thing' (CC1)*

Alongside tree establishment methods, respondents were also interested to know more in terms of tree species. Particularly, which species may be best for different site types and objectives, how to source appropriate native stock for planting, how to best manage mixtures of species, how native species can undergo genetic improvements to make them useful for timber production, and what the engineering

characteristics of softwood roundwood are to enable greater use of this in construction.

Managing herbivores and their impacts

Among respondents, knowledge needs related to the management of herbivores and the impacts they have on the wider environment were not only widespread but urgent to address: '*ensuring success from deer is major*' (PB3). One interviewee expanded, '*they're the thing that if we fixed, so much would change, such a big advance would happen so quickly*' (PB1). Much of the discussion surrounding herbivores focused on the best way to manage deer to support desired landscapes to flourish. The mobility, agility and adaptability of deer were depicted as huge threats to restoration efforts, as one interviewee succinctly put it: '*deer have legs and trees don't*' (PB1).

Participants spoke about the knowledge needed to either improve containment techniques through having better fencing, or to manage deer at a landscape scale through culling. On fencing, participants were quick to note that '*it takes a huge investment to maintain a woodland deer-free using fences…in a landscape so heavily laden with deer everywhere you can't put up fences and expect that to work*' (PB1). Alternatively, '*the landscape-scale thing works really well*' (CC1). One interviewee illustrated this shift: '*we've been working with landowners to restore [ghost woodlands], which has mostly been through providing funding for fencing, but we've actually changed our approach quite substantially, and we're really trying to work with landowners who are willing to work at a landscape scale with their neighbours and reduce their numbers*' (CC2). Despite the widespread enthusiasm for this approach, it is '*really challenging and there's still not that many places that are able to show that they're doing it successfully*' (PL2).

> *'Our primary tool for managing deer is humans becoming the predator effectively… we've used deer culling, we've used fencing and we've used plastic protection…there has been pretty much no development of those really at all…we were interested to see more innovation around using deer scaring techniques…[and another] area of innovation is using thermal imaging and drones to survey deer' (CC3)*

It is not just herbivores that need managing; the impacts they have on the landscape also require management. To do this successfully, certain issues require new knowledge. Some examples mentioned by participants include: understanding the impacts of selective overbrowsing on tree and ground vegetation diversity and the reasons for this selectivity varying spatially, investigating the knock-on impacts of overbrowsing on other species, establishing recovery times for different woodland species once herbivore impacts are reduced, researching the interaction between cattle and deer in woodland grazing,

determining which grazing species should have a role in the future landscape, and understanding how natural regeneration responds cattle browsing. The consensus seemed to be that '*reducing deer pressure to enable woodland expansion is probably the most valuable way to restore woodland from a biodiversity point of view'* (PB2). Therefore, efforts to address knowledge needs in this area would likely be enthusiastically received.

A key need raised was to better understand the success of different strategies for controlling and eradicating invasive non-native species (INNS) such as sitka spruce, grey squirrels, western hemlock, and rhododendron, which is specifically '*a really key threat to the rainforest'* (CC3). Practitioners wanted to not only know how to control such species, but how to do so without pesticides, for example in relation to pine weevils.

Other species and biodiversity

Respondents also held knowledge needs related to species other than trees concerning biodiversity more generally. This included understanding the 'winners' and 'losers' in native woodland creation projects at landscape scale as well as conflicting habitat and species priorities to inform trade-offs. Further, practitioners wanted to understand the impact of afforestation in the uplands on ground nesting birds like curlew, which tree species are most appropriate for biodiversity conservation and resilience, how to improve the diversity of new woodland ground flora, how to monitor biodiversity throughout the regeneration process, and what the role of soil is in supporting woodland restoration.

> *'The importance of mycorrhizal associations under the soil– we're only just beginning to understand those…we still have so much to learn about the biology of what's going on in our soil ecosystems' (CC3)*

Another key topic of conversation related to spruce plantations. Respondents wondered what the effects are of commercial conifers on upland soils, drought resilience, carbon sequestration and biodiversity, what the impact on these factors might be of thinning plantations, and how to produce quantitative evidence of the biodiversity and carbon benefits of transforming failing and commercial spruce plantations into CCF or native woodlands.

Carbon

Several questions arose in relation to carbon. The majority of these queries related to a need to better understand carbon flows and the impact of different strategies of tree establishment on carbon. For example, what the emissions from tree planting are (with a few specific queries regarding trees on peaty soils and comparisons to existing land uses such as grazing on organic rich soils), what the carbon lifecycle of products harvested from forests are,

what the absorption potential for different tree species might be, and how uncertainties surrounding soil carbon loss can be better understood. Respondents also wanted greater knowledge surrounding how carbon is measured, including how they might be able to compare changes in carbon sinks within a forest as a result of shifting management strategies. Some participants linked these knowledge needs to wider societal shifts towards focusing on the opportunities that carbon may present for politics and markets, expressing concerns that this fixation may steer action in ways that do not necessarily support nature restoration.

> *'The extent to which forestry and woodlands are being promoted as crucial to net zero...there are a lot of gaps in that. We have the Woodland Carbon Code, which makes predictions about how much carbon will be sequestered...but there's also a lot of evidence that the soil carbon has been massively underestimated...a lot of what's being planted isn't going to be a carbon sink in the time we're looking at...a lot of our policy is based on the assumption that tree planting sequesters carbon and I don't know if it always does...there are better reasons to be expanding woodland which are getting eclipsed' (PB2)*

Changing environments

Concerns regarding the ways in which the environment is going to change in the future, due to climate change and extreme weather, informed a widespread focus on knowledge needs addressing woodland restoration in a changing environment. Questions raised included how to shift the focus of 'restoration' from 'what is supposed to be' to 'what should be', including how to appropriately select tree species and seeds for the future. Some of this discussion revolved around perceptions of nativeness, asking '*what is the role of potentially non-native trees replacing some of these [lost native species] and maintaining a degree of diversity and resilience to those things coming down the line?*' (CC3) and '*should we be looking at planting more southern provenances from a climate change perspective?*' (PB3).

> *When I started [in the 1990s] it was all about native woodland species...what were native tree species was essentially a complete overlap of natural and good and desirable...that was a reasonable position at the time. The trouble is...it's made up of the historical and the future...so you have a native location but you also have a native climate for a certain location. The historical nativeness may still be valid but the climate's moved, so you have this increasing, uncomfortable stretch between those two things – this is native here, except the native climate is now somewhere else...a stretch between historical-authenticity nativeness and viable climate' (PB1)*

Other queries included how to predict and prepare for future threats, how to identify areas

where the microclimate is least likely to change or where the future microclimate will be suitable for climate-threatened species, and how to recognise which sites may be unsuitable for certain interventions due to future changes. One interviewee explained, *'if you're doing a restoration project which needs to involve planting, you're having to think: what's this going to be like in 100 years [and] is it going to be resilient for that?*' (PL2).

Environmental impacts

Several participants noted knowledge needs relating to wider environmental impacts, from fire risk to disease spread. Most commonly, concerns were in reference to water, as respondents were keen to know more about the impacts of both habitat restoration and different types of woodland on water quality, flood risk, and drinking water supplies, how best to restore damaged hydrologies as part of woodland restoration, and the best way to manage operations around water sensitivities.

Additionally, respondents noted knowledge needs in relation to the ecosystem impact of chemical use in restoration, the environmental impact of clear felling, how to manage fire risk when creating woodlands, how to reduce the environmental impacts of short-rotation conifers, and how best to restore deep peat areas. One interviewee described the importance of '*understanding the disbenefits, perhaps, of some restoration projects—if you're adding woodland into landscapes, that might be problematic, for instance, through a disease transfer or bringing species corridors that may be undesirable'* (PB3).

Data and tools

A lesser noted, but crucial, knowledge need discussed by participants related to ecological data. This appeared in questions regarding LiDAR and tree cover data not always being very readily available, how to best assess soil and plants for forest management decision making, how to best measure and evidence restoration via natural regeneration, the lack of relevant baseline data for many woodland restoration tasks, and how to assess whether management objectives are being met.

Some also pointed out the influential role of classification systems, for example, '*there's no real good National Vegetation Classifications for mountain woodlands like mountain birch or things like dwarf birch mosaics. They just don't exist; so you can't get them into policy…I think trying to move outside the box and these restricted classifications of what we have as reference systems [is key]*' (PL2). This indicates how mechanisms for measuring and categorising habitats play a vital part in what is seen to be a problem, or not, in restoration and what decisions may subsequently get made.

3.2 Social needs

Turning the spotlight away from ecological knowledge needs, respondents highlighted a variety of social concerns which they see as key to address in order to achieve successful restoration. These issues ranged from understanding and managing perceptions, conflicts and social impacts of woodland restoration efforts to increasing community involvement and connections with land and place through various mechanisms such as community ownership.

Understanding and managing perceptions

Many of the social knowledge needs reported by respondents related to the desire to understand and, as a result, be able to better engage with public perceptions of woodland restoration. One interviewee summarised, '*a lot of them [issues in woodland restoration] have more to do with the social side of science. We do know practically how to reduce deer impact…if there is additional work needed there it is probably more on working with people about their objectives and barriers, what would encourage them to do it'* (PB2). Such social needs ranged from understanding perceptions of natural regeneration versus tree planting, knowing how to best communicate scientific evidence to the public and what would best convince people to support restoration and conservation activities more widely, to knowing how to effectively change public perception, best communicate the economic benefits of conservation activities like job creation, and build resilience to societal and economic change to ensure the long-term survival of woodlands.

Unsurprisingly, in terms of understanding and managing perceptions, deer management was a key area of interest for many participants. From landowners and the general public, to '*those people who come [to shoot deer], what are their opinions and why do they care about forest restoration?'* (CC2). Respondents felt that one of the challenges is '*breaking down some of the social perceptions of how things should be – there's still people out there saying that 'oh, Scotland's wild deer population is the most natural in Europe and it's supposed to be really high''* (PL2). Participants expressed their frustration at such misconceptions and their uncertainty regarding the best approach to tackle this.

> *'If we're really successful [at controlling deer], are we going to face a degree of public revulsion when we rock up and say, 'hey, look at these wonderful animals, they're part of our culture, they're part of our wildlife, and we've killed 95% of them'?' (PB1)*

Interviewees offered various visceral examples of this frustration beyond deer: '*politically, predators are very, very difficult [to talk about] because, as we know, introduce a predator into*

Scotland and it'll be dressing up in Granny's clothes and climbing into our bedrooms and killing our children and destroying agriculture' (PB1).

Societal narratives and symbols can be entrenched and tricky to change. They can also have a huge impact on what activities are carried out, or favoured, regardless of where the ecological science stands. For instance, perceptions of what 'good' tree planting looks like can influence the widespread practice.

> *'There are perceptions of what woodland creation looks like, and a lot of the work which is done to create woodland is done because of those perceptions – soil preparation, for example…hinge mounding is still very much the default across Scotland…is it because people expect that and don't believe you're doing a good job if you don't?' (PB2)*

Additionally, several respondents mentioned the need to understand, and have the tools to be able to reconcile, various conflicts between different groups of people and different land-use priorities. For example, between those carrying out restoration work and farmers, or between aims to increase public access and conservation goals. The need to understand how incentives and compensation may work in such situations was also raised, through questions related to the form and scale of compensation, incentivisation, or mitigation that may be needed to resolve certain issues, such as the reintroduction of large carnivores.

Having a better grasp of people's perceptions and any potential tensions was often discussed in connection with consultation and planning knowledge needs. By having better information about how best to listen to local communities to understand what they want, and the trade-offs they are prepared to accept, respondents hoped this would support decision-making. Some noted uncertainties around who counts as a community to be consulted, and recognised that some communities feel let down by previous experiences of inadequate consultation; some felt these points could be reconciled in part through better community engagement guidance and early engagement mechanisms.

Understanding social impacts

Respondents also wanted to better understand the various social impacts of woodland restoration, for example, on recreation, access, visual amenity, tourism, or local infrastructure. This was noted in terms of understanding both the benefits and burdens local communities may face, knowing what communities and wider society wish to prioritise and then having the ability to deliver these desires where feasible – plus being able to measure and monitor those benefits over time to have a strong evidence base for positive social impact. Further, respondents wanted to know how economic outputs from native woodlands can continue to

be produced whilst also preserving fundamental ecological processes. When speaking to these various topics of social impact, participants highlighted the importance of considering the multiple functions of woodlands, and the need for greater discussion around this and evidence to support prioritisation decisions: '*the biodiversity outcomes are important, but also balancing that with timber production objectives… [we need] a more overall landscape-level of focusing on how this is all going to play out'* (CC2).

Community involvement and connection

Many respondents demonstrated enthusiasm for greater community involvement in restoration efforts and wished to be able to facilitate better community connection with woodlands but felt they were sometimes limited in doing so. This was raised in terms of wanting to better understand practical ways to get local communities working in woods, how to build capacity and support citizen science projects, how to support a 'woodland culture' within local communities, where to access resources about forestry for 'non-foresters' to share with local people, how to develop the local bio-economy, and questions of ecotourism.

One interviewee highlighted the potential role that studying the histories of woodlands could play in galvanising community involvement and connection with specific sites, explaining that historical studies are '*under-served in [woodland restoration] academia…it's harder to fund and there's just less of an understanding that it's valuable in the first place'* (CC1). Yet, '*being able to talk about woodlands through these different frames'* (CC1) is a vital part of deepening the relational values fostered between people and places; supporting this requires a greater recognition of what a focus on 'less-obvious' disciplines can contribute to the collective knowledge held about woodlands.

> *'Historical information can help with being able to tell the story of the place and connect people with the place, and broaden the appeal of it and build support for restoring some of these woodland sites' (CC1)*

Another significant aspect of community involvement with, and connection to, woodlands that respondents reported wanting to learn more about is community ownership. They wished to understand how to best support this, what the costs and benefits of community woodland management might be (relative to more conventional management), what potential pathways for local ownership and stewardship may exist, and how to develop and promote woodland crofts throughout Scotland.

3.3 Financial needs

Respondents depicted a financial context for Scottish woodland restoration marked by concerns regarding the ongoing costs of certain aspects of land management practice (such as herbivore control and thinning operations) and new costs related to contemporary modes of data production (like utilising LiDAR), budgetary cuts, conflicting subsidies, an unrewarding timber market, problems of short-term funding mechanisms for long-term projects, lack of support for natural regeneration in the grant system, and fast-evolving (market) mechanisms for funding nature restoration. Against this backdrop, respondents described several financial knowledge needs apparent to practitioners, from understanding nature markets better and how to engage with funding mechanisms more effectively, to the need for more evidence on the comparative cost-effectiveness of various approaches.

Understanding nature markets

The most commonly raised financial knowledge need related to the wish to better understand nature markets. This came up through respondents wanting more familiarity with carbon markets and how natural capital payments might work, an understanding of the risks and long-term liabilities of these new funding streams, and guidance on the likely direction of travel for natural capital markets in Scotland. Whilst some wished to understand these better, others expressed their intention to steer clear from this way of financing woodland restoration. This suggests that for some, it is not that a knowledge gap exists per se, but that they disagree with such an approach, citing concerns in relation to the existing mechanisms for carbon credits and offsets, the focus on carbon at the expense of ecosystem function, challenges of a still-emerging market, a lack of buyers and standards, and a lack of consideration for natural regeneration.

> *'There's a lot of stuff around natural capital, but it's really not about the capital itself, it's about monitoring ecosystem change and that's what people are trying to build credits and stuff around, I don't know if it's the best model for actually doing stuff generally; I think things should just be regulated better. But while it is a thing, it's really a monitoring thing…there's still some gaps in that' (CC1)*

Funding and grant schemes

Knowledge needs related to funding and grant schemes illustrated that current mechanisms are not always easy to navigate and sometimes constrain what restoration activities are possible. Practitioners wished to know how to secure money for activities that fall outside the bounds of what is usually funded, for example agro-forestry projects, experimental approaches on public land, better community engagement, the restoration of plantations on ancient woodland sites (PAWS), pollen analysis in peaty

areas, insurance and training costs related to facilitating volunteers, crofting woodland schemes, and landscape archaeology studies. Expressing this frustration, one interviewee explained, '*as practitioners, we think a lot about the grant schemes and it's like, well, how would you ever put a direct seeding project through the grant scheme?*' (PC1). While some respondents indicated that these knowledge needs could be addressed through clearer direction and support around existing funding opportunities, others imparted that '*we need to convince changes in grant schemes'* (PC1) to better align these with practitioners' priorities. Research could encourage a shift in funding mechanisms by underscoring the importance of funding for sector innovation.

Cost-effective evidence

Another aspect of financial knowledge required by practitioners is the cost effectiveness of various interventions and strategies to support decision-making processes: '*the economics is really important because that's what will sell it to people in the end or not'* (CC2). Respondents mentioned various aspects of woodland restoration efforts which could benefit from stronger supporting evidence, from the most cost-effective measure for controlling deer grazing of new planting and financial evidence of the long-term benefits of using CCF as a management strategy, to a coherent case being made to enable a shift away from perceived preferential funding support for the creation of new woodlands over the restoration of existing threatened woodlands.

> *'One of the big things is the economics of [CCF], comparing a continuous cover silvicultural model with a traditional clear fell rotation and trying to work out which one of those is most economically beneficial…some people say, 'oh, we can't go to continuous cover because it doesn't pay the bills'…and then there's other people, other types of landowners, who are saying, 'oh, we really want to go down to continuous cover route so we can save money'…what is the truth there?' (CC2)*

Commercial interests

A few respondents felt knowledge was lacking in the realm of commercial interest. They wanted to know which trees species are most likely to provide the opportunity for commercial value, what techniques for producing and marketing timber from small woodlands may be most financially viable, and how supply chains for hardwood timber and alternative conifers that can be managed on a smaller scale could be improved. Further, advice on how to develop and effectively manage large-scale joint ventures with multiple funding sources and landowning partners would be welcomed.

4. Unpacking knowledge needs

From the practitioner perspective, there is a wide range of ecological, social, and financial knowledge needs related to woodland restoration that they hope to see addressed. Although this project began with the aim of identifying research gaps that, if addressed, could benefit practitioners, closer examination demonstrated that not all needs stem from a lack of existing research. Therefore, it is important to understand the various underlying reasons behind each issue, as this may impact what is required for resolution. Considering this context, some of the knowledge needs identified throughout the project are examined here using a triangular framework designed to unpack and explore their origins.

4.1 The Evidence-Exchange-Enaction Gap Framework

We identified three distinct aspects underpinning the practitioner knowledge needs outlined in Section 3, which can be represented in a triangular framework (*see Figure 4*).

Evidence gap: a knowledge need which is due to a lack of scientific understanding.

Knowledge exchange gap: a knowledge need which is due to ineffective or insufficient sharing of scientific or practical understanding.

Enaction gap: a knowledge need which is due to wider contextual factors that limit required action/s.

Figure 4: The Evidence-Exchange-Enaction Gap Framework

In the workshop, the 15 attendees split equally across three tables were asked to map five separate knowledge needs onto this framework. The exercise involved the group selecting a knowledge need and then each of the five participants at the table placed a cross within the framework based on whether they felt the chosen issue was the result of a gap in evidence, exchange, or enaction. Next, the group discussed the reasons for their placement and the context for why they held differences and convergences in opinion. Some of these examples will be elucidated further below.

4.2 Evidence gaps in woodland restoration

When practitioners identify missing knowledge needed to carry out specific restoration activities, this is often assumed to reflect an evidence gap; this is something that researchers can fill through producing new, or better, evidence. In one workshop group, nature markets were primarily seen as this type of gap, with practitioners citing a lack of both ecological and economic evidence to underpin credible mechanisms.

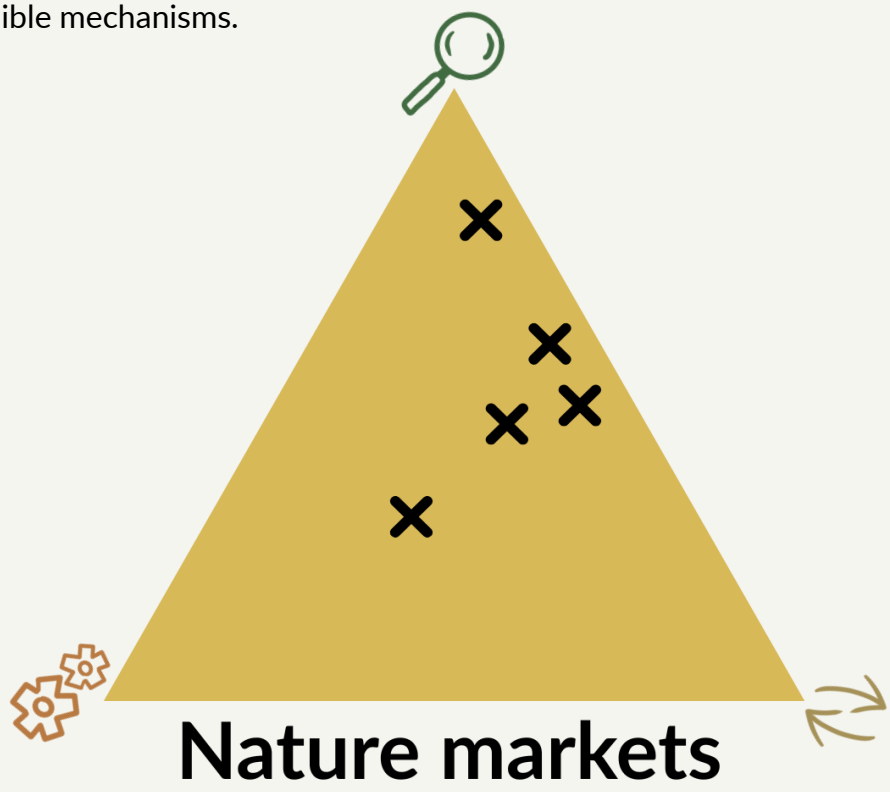

Figure 5: Nature markets mapped onto the E-E-E gap framework by workshop participants

Although carbon markets have been established for a relatively long time, uncertainties remain around accurate measurement, and even greater uncertainties surround newer instruments focused on creating markets out of biodiversity or water, for instance. Practitioners raised questions around which ecological metrics should be targeted, how England's Biodiversity Net Gain (BNG) approach translates, or not, to the Scottish context, and how to design implementable approaches that are both scientifically robust and accessible to non-specialists. Uncertainty also surrounds payment models and the integration of emerging technologies like eDNA or remote sensing for credible monitoring.

As such, participants placed nature markets towards the 'evidence' corner of the framework, while noting that these issues are entangled with challenges in communicating cross-disciplinary evidence and implementing complex mechanisms involving multiple stakeholders.

4.3 Knowledge exchange gaps in woodland restoration

In cases where relevant scientific research already exists but practitioners still feel uncertain, limited knowledge exchange rather than limited evidence may be the issue. One knowledge need identified in the survey, and developed in the workshop, focused on the effective communication of woodland restoration to the public. Practitioners recognise the importance of clear messaging and compelling storytelling to connect with disengaged audiences, many of whom may not prioritise woodland restoration in their everyday lives. However, some practitioners can feel unsure about how to do this well. Seen less as a need for knowledge and more as a need for certain skills, this points to a desire for greater collaboration between those skilled in public engagement and those working in ecological restoration. This would support practitioners to be able to convey complex ecological messages in accessible, meaningful ways.

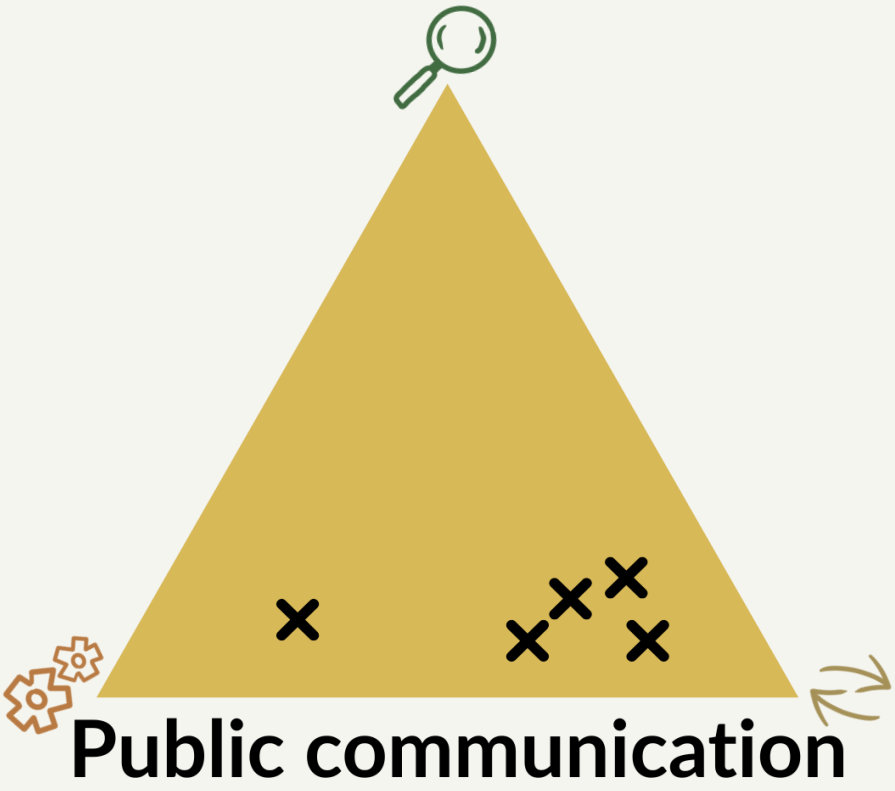

Figure 6: Public communication mapped onto the E-E-E gap framework by workshop participants

Addressing this knowledge exchange gap means ensuring that practitioners have the tools and information needed to tell convincing stories about the landscapes they are restoring. This is not solely a matter of exchange, of course; as discussed previously, one interviewee noted a lack of research into woodland histories, which could enrich storytelling and deepen public connection. Further, improving exchange also depends on creating more opportunities for interaction, such as public events, highlighting a need for some focus on enaction alongside evidence and exchange.

4.4 Enaction gaps in woodland restoration

When both evidence and exchange needs are met and an issue still remains, this may signal an enaction gap. This refers to barriers in the broader context that prevent action, such as limitations in time, capacity, or resources. In this project, deer management provides a clear example. Practitioners repeatedly highlighted the critical impact of herbivore browsing on the success of woodland restoration and the persistent challenges in addressing this. All three workshop groups selected deer management to map onto the framework, with two groups identifying enaction as the main barrier (the third group placed the issue further towards 'evidence' as they focused specifically on deer management for ghost woodlands).

Figure 7: Deer management mapped onto the E-E-E gap framework by workshop participants

There is broad consensus that effective deer control requires coordinated, landscape-scale management with less reliance on fencing. However, implementation is hindered by insufficient resourcing and socio-political infrastructures to support this. There are signs this is changing. The Common Ground Forum, a network of individuals from across Scotland's upland deer management sector, was created to support stakeholders to develop a more collaborative and cohesive approach to deer management. Yet the sheer vastness and remoteness of affected areas present ongoing challenges to implementation. Evidence and exchange issues also persist: more research is needed on technologies to support deer control and the role of wild venison markets, for example, and participants raised questions about how to communicate the ecological benefits of deer culling to the public.

4.5 Mapping issues onto the framework

The following pages present all 15 topics chosen by the three groups within the workshop and how they chose to map these onto the E-E-E gap framework. This exercise illustrates that most knowledge needs involve a mix of evidence, exchange, and enaction gaps, potentially highlighting how a topic can be disentangled by identifying which areas require the most attention.

From the visualisation below, it is evident that individuals within a group (and between groups who discussed the same topics, marked with *) did not always agree on where an issue should be positioned. The aim of this exercise was not to definitively determine where each issue belongs, reducing issue X to simply a problem of Y. Rather, the framework is contextual and relational: in a different setting or with different stakeholders, the same topic may spark entirely different discussions, leading to its placement in another part of the framework. This demonstrates its use as a means rather than an end.

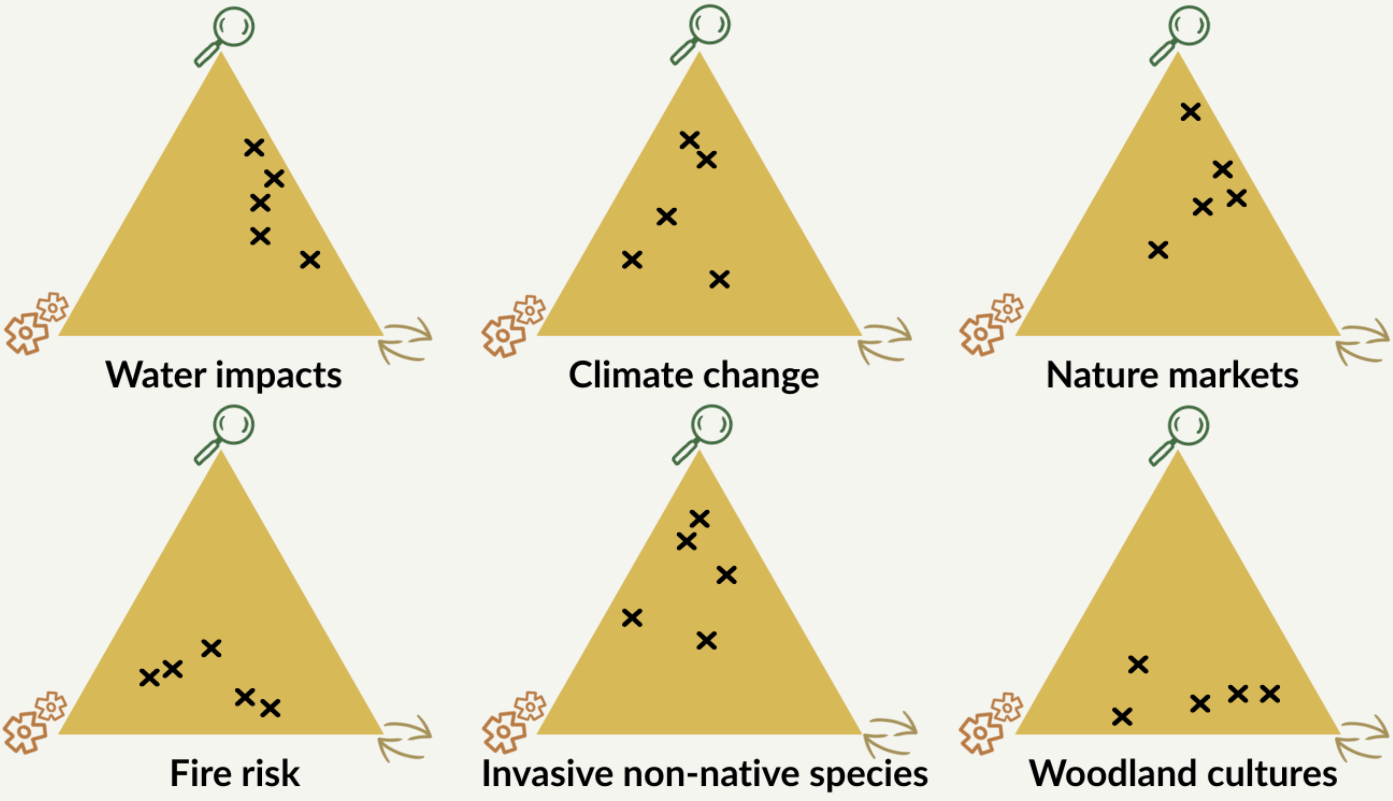

Figure 8a: Woodland restoration topics mapped onto the E-E-E gap framework

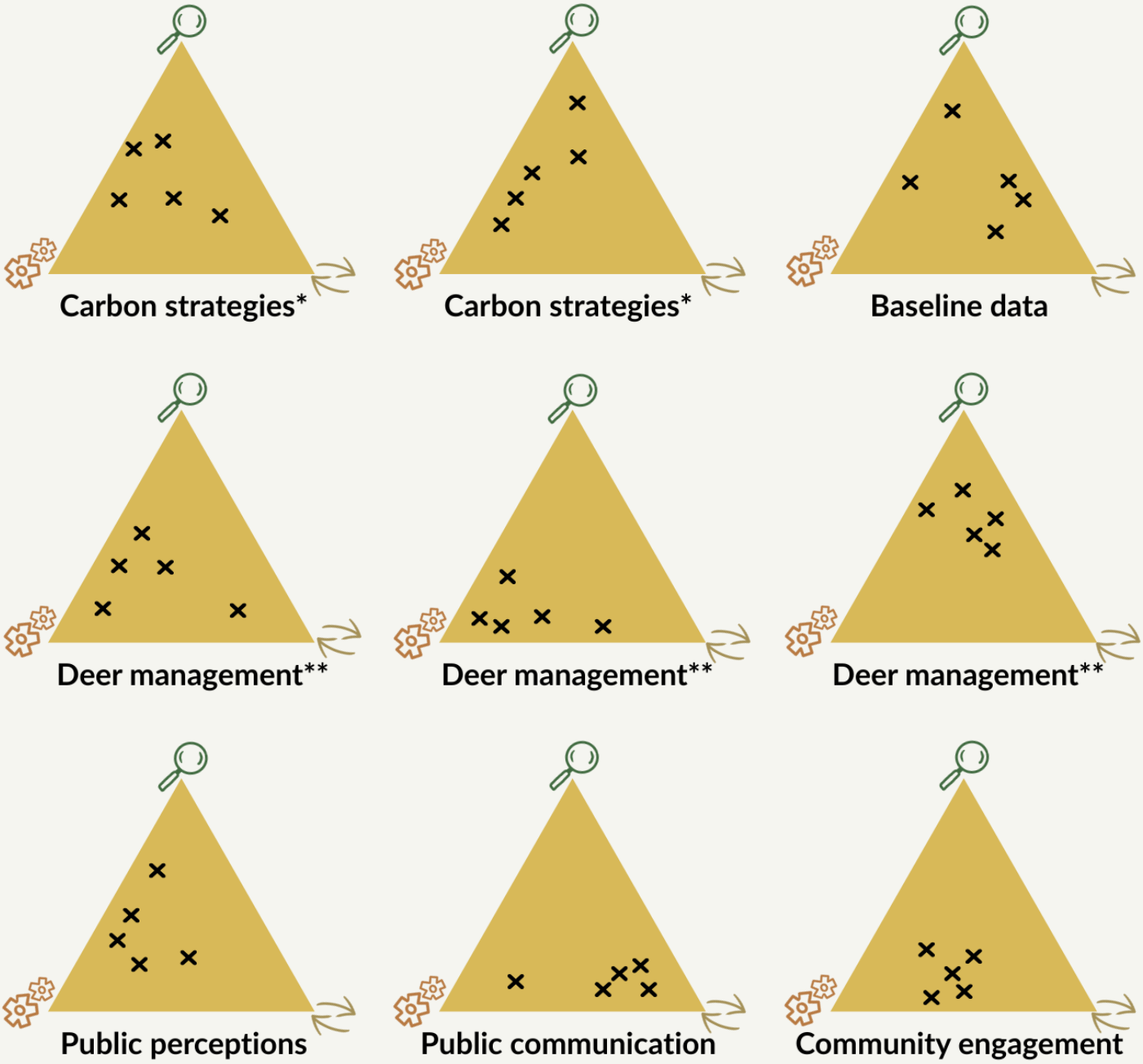

Figure 8b: Woodland restoration topics mapped onto the E-E-E gap framework
**Two groups discussed this*
***Three groups discussed this, left/centre groups focused on best management practices generally, right group on management for 'ghost woodlands' specifically*

4.6 Using the E-E-E gap framework

Attempting to pinpoint issues in a fixed location on the E-E-E gap framework is not only impossible, but unhelpful. What makes these conversations valuable is the opportunity they create to unpack needs and explore the specific frustrations and perceptions associated with them. Whilst the survey revealed a wide range of needs, it was often unclear whether these originated from a lack of research or, for instance, from dissatisfaction with the grant system. The E-E-E framework attempts to clarify these nuances, demonstrating that addressing a knowledge need is not always about generating new evidence. The approach will vary depending on who is involved, the scale and context of the issue, and the resources available.

How the E-E-E gap framework can support research design

1. **Framing the issue and its context:** developing a collective understanding of why X is the focus and the potential impact of resolving this
2. **Understanding the scale and scope of the discussion:** setting the parameters to ensure coherence amongst all actors
3. **Considering the existing knowledge:** investigating what scientific and practical knowledge already exists to address the issue to refine what remains unknown
4. **Unpacking the issue:** deliberating where the issue lies between gaps in evidence, exchange and enaction for a specific context and how improvements for each aspect could address the issue
5. **Initiating the co-design of research:** with a greater understanding of the evidence, exchange, and enaction gaps related to a knowledge need, research can be co-designed with actors having a better shared sense of the issue

5. Practitioner-researcher dynamics

Considering that the range of knowledge needs, and their possible reasons for existing, is vast and nuanced, addressing these needs is by no means a straightforward process. Within this context, the relationship between research and practice, and consequently researchers and practitioners, is vital to examine. One interviewee offered a provocation which acts as a helpful entry point for considering such dynamics: *'the whole point of research should be to inform practice, but if that's not working then there's something seriously wrong'* (PL2).

Survey respondents were asked whether they think research is relevant to their practice and why, giving a broad oversight of opinions; this will be discussed first in this section. The ideas that emerged within survey responses were picked up and discussed in greater depth by interviewees. Here, this has been grouped into two themes for discussion: the priorities and design of research; and the sharing of knowledge between practitioners and researchers. Finally, workshop attendees considered the roles both practitioners and researchers can play in responding to the challenges of dynamics raised throughout the project.

5.1 Is research relevant to practice?

Whilst current research was noted by many respondents as an avenue for sourcing information, practitioner views on the relevance of such research to their operational efforts varied greatly. Some felt that research is very relevant and helpful, particularly as it can provide those new to their work with a good overview of the field, support practitioners to stay on top of current discussions, help substantiate claims and drive policy, be used to improve public perception of restoration efforts and therefore reduce potential backlash against their work, and underpin long-term monitoring. Through offering specific examples, respondents explained the importance of research to them and their work, from research showing that establishing woodland on peaty podzols can lead to carbon release for many years before rebuilding carbon in biomass, to work on mycorrhizal fungi in woodland creation.

However, more than a third of respondents suggested that research is often not very relevant to their work, suggesting it can lack real-life applicability, or be unnecessary, partial, or missing key detail. Whilst this percentage must be caveated by the fact that people self-selected to respond to the survey, meaning people who chose to do so may have had a stronger opinion (positive or negative) towards the topic than that of the general population of practitioners, it still identifies a sentiment amongst some practitioners which is important to examine.

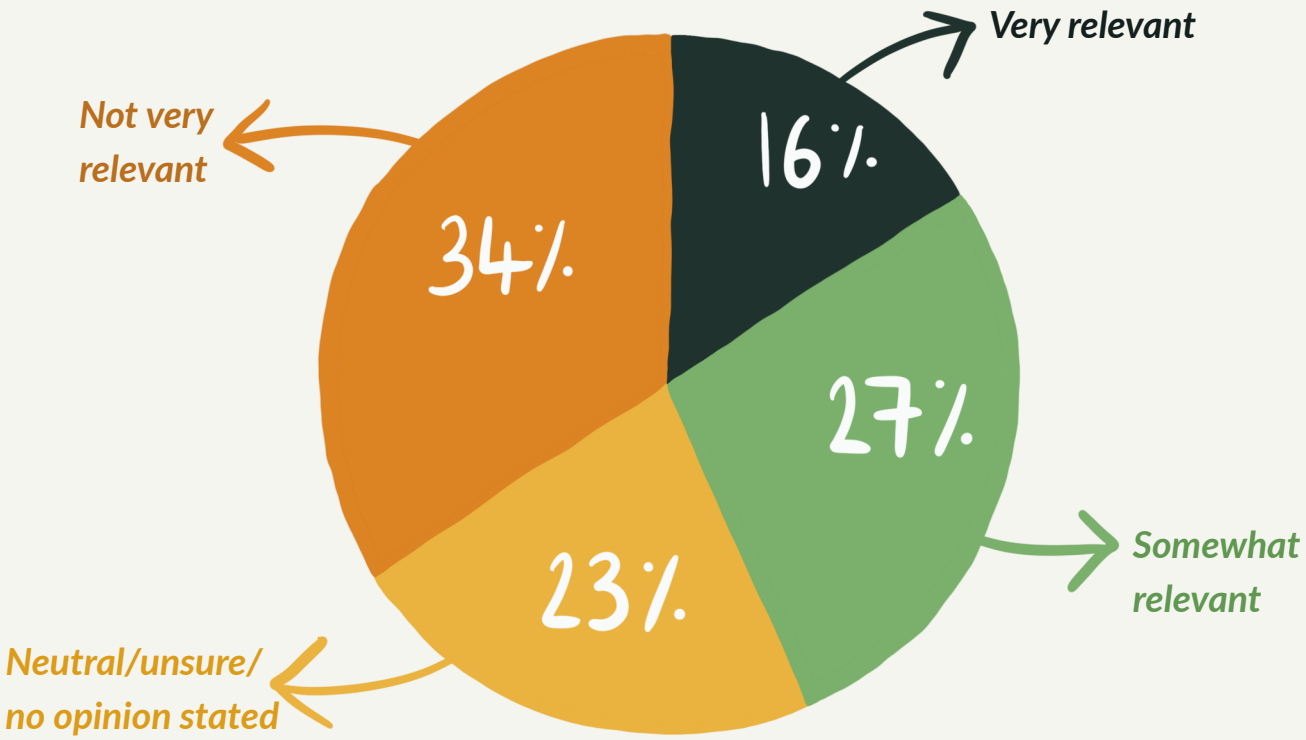

Figure 9: Survey respondents' opinions of the relevance of research to their practice

These respondents presented research as disconnected from both the practical needs and experience of their work. Research is sometimes perceived to be too academic, meaning it either approaches a topic from a single, narrow angle lacking any grounding in practice (and is therefore less relevant) or is formulated in an inaccessible way for those without statistical knowledge, an academic background, or indeed academic journal subscriptions. One respondent questioned the real-life relevance of certain PhD projects, assuming that these are sometimes designed more with a funder in mind, rather than to attend to problems that are key for practitioners. Others picked up on the tendency for research agendas to be grant focused or often heavily influenced by commercial forestry and carbon market objectives or thinking; this is not always helpful for producing relevant research. Further, some perceived there to be a lag between research happening and best practice trickling down into management spheres.

Whilst many of these concerns were widespread, some made it clear that the relevance and use of research heavily depends on the topic in question. For example, one respondent noted that, for

them, sufficient research is available on native tree species but is lacking in other flora such as understory plants. Further, in some instances, research is seen to be simply stating the obvious; it is not always developing the field sufficiently. Respondents felt that what is needed is often already known; what is more challenging is taking the necessary actions. As such, research on a more theoretical level requires translation and experimentation to make it actually deliverable.

Evidently, many respondents noted a dissonance between knowing and doing. In addition to best practice highlighted in research sometimes not being implemented due to lack of applicability, what is done in practice can sometimes contradict the evidence base. One respondent raised a point that, in their experience, sites are routinely clear-felled and replanted due to the lower costs associated with this approach; they felt this went against current evidence suggesting gradual change to be preferable. Such examples demonstrate that the existence of relevant evidence is not enough to trigger desirable action if the broader societal context makes this challenging. It is not just about knowing the right things, but having the right context to enact best practice.

5.2 Setting priorities and designing research

Interviewees echoed sentiments regarding the disconnect between research and practice, often in relation to identifying research priorities and the subsequent design of studies. These were depicted as being frequently misaligned with practitioner priorities. One interviewee conveyed that '*the processes by which [research bodies] define their priorities are quite opaque'* (CC3). Practitioners made a distinction between their own approach, tending to prioritise based on '*what's most achievable and what's most valuable on that particular set of circumstances'* (PC1), and how they perceived the approach of researchers to be, in that '*the questions that they're asking, they're not actually hitting to the nub of what the problem is'* (PC1). This is because '*the challenge with a lot of research that's done is that it's quite pure, it's not applied'* (CC3) and, from the practitioner perspective, '*the research providers are too far away from the highest priority things'* (PB1).

> *'I asked [a research organisation] what they were doing on deer and they said 'I'm not really doing much on deer because no one's really highlighted it as a priority'. And then I said, 'well, what are you doing on rhododendron' and they said, 'well, actually I'm not doing anything on rhododendron until it's a priority'. I thought well how am I hearing that these are the two single biggest things that are impacting native woodland in Scotland…there's clearly an issue in feeding through' (CC3)*

> *'You look at the research and you do come away thinking like, why would someone have researched that? That just doesn't make sense! Why would they think that we need an answer to this question? Sometimes it is the other way round as well, like particularly the soil carbon issue, I think, and carbon imbalances, where none of the practitioners in the charities, in private sector, in the government, have any vested interest in uncovering the truth there. And I really think it's being pushed by academics, that actually this whole carbon story that we're telling isn't what it's painted to be…academics are the only ones pushing that, the only ones really discussing that issue, and I think the rest of the sector is basically just ignoring it, really' (CC2)*

However, other participants offered a more nuanced perspective, suggesting that differences in priorities between researchers and practitioners are not necessarily problematic; in fact, such distinctions at times can contribute to greater integrity in the field. This is because certain differences can reflect the vested interests each group holds, for instance in the case of soil carbon.

This is perceived to be of great interest to researchers who are keen to better understand carbon sequestration to enable more accurate environmental accounting, yet such work may yield findings that could be counterproductive to specific current practices: '*there might be specific reasons why they don't want you to research something…what if the outcome is not as good as we think it is, and there's all these charities, suddenly, that all their work is undermined to some degree? I'm sure there are questions that are well-worth asking that might not be being driven by practitioners'* (CC2). Therefore, some heterogeneity in research priorities may contribute to the overall integrity of the production of woodland restoration knowledge and resulting actions.

Perceptions of what constitutes a priority directly influence how studies are designed. Several interviewees observed that, sometimes, research is '*designed in such a way that they don't actually pick up some of the most important bits, which is very frustrating for practitioners…[and] without [researchers] doing loads of fieldwork first'* (CC1). This highlights not only challenges around prioritisation but also a disconnect in how researchers and practitioners engage with practical, site-based knowledge. Practitioners in this project repeatedly emphasised the value of learning through hands-on experience, noting the benefits of being physically present on site; some expressed their concern that researchers often lack this direct and embodied connection to the woodlands they study.

5.3 Communicating and exchanging knowledge

Practitioners raised concerns not only about the initial stages of research but also about disconnects that can arise during the later stages of the research process. These concerns related to how research findings and data are organised, the limited two-way exchange of knowledge between researchers and practitioners, and the lack of systemic mechanisms for knowledge sharing. In terms of research organisation, one interviewee explained, '*there's probably loads of projects at different stages, and it would be really great to see those pull together…how can we learn stuff from those to help us on the ground?*' (PB3) whilst another expressed frustration that organisations have '*data that they've been sitting on and not sharing with anyone for a couple of years, which is a bit frustrating*' (CC3). This indicates that even when research priorities and design have potentially produced something relevant for practitioners, it is not always easy to find or, indeed, available for them to access.

Communication is '*the mechanism by which we get better research…[but] I don't think it happens enough*' (PB1). One interviewee explained, '*the ability for practitioners to bring their stories and their needs into this conversation doesn't seem to exist to me*' (CC3) whilst another suggested '*there's really interesting things happening [on specific sites], but nobody knows about them*' (PC1). This highlights the need for better communication between researchers and practitioners, with interviewees emphasising that '*it goes both ways*' (CC1). However, knowledge exchange is currently '*very dependent on individuals…I'm not aware of any particular structures*' (CC1); '*I don't really know how practitioners would be getting reached unless they've got relationships with universities from when they were students*' (PB3). Further, '*there's a pressure to get on and do the [restoration] thing…you don't necessarily have the time to link up with all the people who might be able to help and be interesting…you really need core points of contact in both spheres*' (CC1). This reveals both a lack of, and need for, systemic mechanisms that support exchange more widely and equitably.

> *'I do think there is something in that gap between what a researcher does and what the practitioner needs…I do think that is a very important thing, because it does feel like there's research happening that is probably useful, but we don't know about it; we don't see it and we don't have the tools and ability to translate that into action. So I don't know if it's possible to create a research agenda that cascades from 'this is what we need to know from a scientific point of view' down to 'this is what we need to know from a practical point of view', and whether you could design a research agenda that addresses both of those at the same time.' (PC1)*

Establishing effective mechanisms for knowledge exchange is challenging. Practitioners relayed experiences of trying to engage with existing processes: '*a major gripe of mine is you sometimes get these conferences advertised that's supposed to be researchers engaging with practitioners…but it's always in the middle of the fieldwork season and it's like, I can't go, I'm actually planting trees'* (PL2).

Publishing in scientific journals, one of the most common knowledge sharing mechanisms utilised by researchers, is frequently a cause for practitioner frustration, as '*they're [often] not open access…and they're too technical – obviously you need that top-quality research, but recognising that, actually, if you're wanting impact, practitioners need to understand what does this actually mean for me?*' (PL2). Furthering this sentiment, another interviewee noted, '*I'm quite happy to read a scientific paper, the easy ones, but there's certain ones…I don't even bother! I can't understand what they're talking about…it takes a bit of time to translate that into the practical; based on this [paper], what are we actually going to do?*' (PC1). These perspectives highlight various issues with academic publishing, from physically accessing an article to digesting its content and translating this into practical outcomes. This illustrates that simply having mechanisms in place for sharing is not enough; they need to be accessible and responsive to the diverse needs of other knowledge users, such as practitioners.

Whilst academic publications arose repeatedly as an example where research is often failing to translate into practice, networks came up as a positive example of a working exchange mechanism: '*the big one has been the Alliance for Scotland's Rainforests, and that kind of network and brand has created a forum for people to come together and talk about these things'* (CC2). This provides '*a number of possibilities [for improving things in the future]…growing clusters of expertise and interest in particular subsets…landowners, charities, government agencies, research organisations, community groups, all coming together under that'* (CC3). Clearly, there is work to be done to build upon existing good communication practices and find ways to enable practitioners and researchers alike to partake in further, more robust and systemic knowledge exchange.

5.4 Researcher and practitioner roles

For this desired, communicative relationship to exist, both parties have unique yet complementary roles to play. Workshop attendees considered these two roles and their overlaps (*amalgamated in Table 3*). It is important to note these suggestions assume actors have the necessary capacity and resources for implementation (see next section for a deeper discussion on this).

Table 3: possible actions for practitioners and researchers

Actor	Possible actions
Practitioners	• Clearly define research needs and highlight the practical benefits that addressing these needs would deliver • Actively seek existing evidence throughout the process, to avoid asking for unnecessary new research • Share best practices with researchers using case studies as examples and by making site-specific data available to be used by researchers • Engage researchers as collaborators when investigating a topic to maximise the complementary strengths of each party • Facilitate site visits for researchers to enable them to gain on-site, practical experience to inform their research design
Researchers	• Organise and clearly signpost existing research to help practitioners easily find relevant information • Evaluate the practical relevance and potential impact of research before initiating a project • Involve practitioners at all stages of the research process, including from design to production to dissemination • Factor in time to visit relevant research sites to gain first-hand practical insight • Develop varied research outputs to make findings accessible and engaging for practitioners and wider audiences (e.g. free lunchtime webinars)
Both actors	• Participate in knowledge exchange activities and, where possible, support the development of stronger, more effective exchange mechanisms • Pursue opportunities for collaboration across both research and implementation phases • Support studentships that connect academia and practice, ensuring input from both researcher and practitioner partners • Advocate for improved funding models, policies, and systemic mechanisms that can deliver the shared ambitions of practitioners and researchers

6. External barriers

Although it is important to consider the roles both practitioners and researchers play in forging stronger connections that lessen the knowing-doing gap and support collaborative action to address knowledge needs, it is perhaps of greater value to examine the external barriers that constrain such possibilities. Both parties are operating within a wider context that shapes what is possible, or not, to achieve; within this landscape, certain ambitions are extremely challenging for practitioners and researchers to realise without external shifts.

6.1 Economic barriers

Economic factors present significant barriers to addressing the knowing-doing gap in woodland restoration. These challenges arise from the broader economic context surrounding both the employment and research funding landscapes. One interviewee explained '*budgets are getting cut [and] job roles are not being replaced when people leave, people are having to do more with less, so how can practitioners feed into research? It probably doesn't seem like much of a priority*' (PB3). Another reported, '*academia is really challenging, you're always fighting for funding and fighting to have this unique idea that's really interesting; sometimes the things that look really unique and an interesting story aren't necessarily the most useful [for practice]*' (CC2).

These perspectives highlight how economic constraints can limit engagement between practitioners and researchers, either through lack of time or due to pressures to prioritise activities that reflect the distinct and often misaligned economic models of academia and practice.

As discussed in the section on practitioner knowledge needs, participants perceived current funding and grant schemes as often inadequate. Activities that both researchers and practitioners value are frequently difficult to fund, and barriers exist in accessing both rapid-response funding (e.g. for fire recovery research) and long-term support for studies requiring extended timelines. Therefore, addressing issues within the wider economic context – by supporting overstretched practitioners, realigning economic priorities in both sectors, and revising grant schemes – could help close the knowing-doing gap.

6.2 Political will

Politics and policies are major factors influencing both research and practical action in woodland restoration. Whether particular threads of research are explored often depends on if there is a wider societal appetite for investigating certain topics and a political landscape that facilitates this or not. As one

interviewee observed, '*there's what the hard scientific evidence suggests, there's why people do things the way they do, and there's what you can do about it, and [the latter] is the hardest because it happens at a political level…and I don't know how you influence that really*' (PB2). Another added, '*there are a lot of people who are quite happy with how things are at the moment and they don't want to do [certain] research…there is a strong political will for tree planting, and a lot of foresters are happy with that…there's not necessarily the appetite for research which says we shouldn't be doing it this way, and why aren't we doing it this way?*' (PB2). These reflections emphasise a key tension: research that is academically and practically valuable may not be politically palatable. In such instances, it is incredibly difficult for researchers and practitioners to challenge the status quo and influence change.

Specifically in woodland restoration, several participants commented on the enduring influence of commercial forestry on research agendas: '*forestry has been very dominant in a lot of research, so there's a mindset associated with commercial forestry, which is production focused and the kinds of questions that get asked are framed in a certain way without people necessarily even really appreciating the extent of framing that's going on, and how some of that stuff is not necessarily aligned with ecological stuff or historical stuff*' (CC1). This suggests that research has been primarily framed through a production-oriented lens, which may pose challenges for those seeking to approach woodland restoration via alternative perspectives. This may explain why certain topics such as CCF, despite being valued by practitioners, have historically received limited attention and continue to be more challenging to pursue.

6.3 Sector expectations

Specific expectations within academia and practice, and the tensions that arise when these conflict, significantly influence what researchers and practitioners can do to address the knowing-doing gap. Academic publishing offers an important example of this, as one interviewee explained, '*as researchers, there's a huge pressure to publish in peer-reviewed journals and practitioners aren't exactly reading [these]. It would be valuable to have more co-developed research…and consider the best way in which that research can influence practice, which isn't going to be by publishing*' (PB2). A key measure of success within academia is having published articles in prestigious, high-impact journals; yet, this is acknowledged as being among the least useful outputs for practitioners. This disconnect is further compounded by the numerous pressures facing those in practice: '*people are so busy in practice that even if the information's out there, how do you make time available [to digest information] in people's busy schedules?*' (PB3).

Without acknowledging that researchers and practitioners are often pulled in different directions by the expectations of their respective roles, it remains difficult to further efforts that foster meaningful collaboration on research.

There are numerous external factors which can influence the shaping of woodland restoration research agendas, for instance the role of the education sector. However, these lie beyond the scope of this project and are not explored in depth here. Nevertheless, it is important to emphasise that responsibility for addressing knowledge needs and improving the processes that support them should not rest solely with researchers and practitioners. A broader conversation is needed to encompass this wider context and engage other influential actors across sectors.

6.4 Which mechanisms are working or not?

Considering this context, workshop participants were invited to identify existing mechanisms that either support or constrain progress in woodland restoration, as well as to propose additional mechanisms they felt would be valuable but are not currently in place.

Table 4: what mechanisms are working?

What's working?
• Networks (e.g. Royal Forest Society, Scottish Rainforest Alliance) • Free webinars to disseminate research findings in an accessible and engaging format • Demonstration sites to provide practical insights and showcase best practice (although there could be more of these) • Bodies such as Forest Research and the Scottish Land Commission • Long-term, collaborative, landscape-scale projects on topics like herbivore management and fire control • Facility for Investment Ready Nature in Scotland (FIRNS) – although some noted some issues with this too • Deer management groups – opportunity for collaboration and communication across diverse opinions • Incorporating Gaelic language and culture into projects • Interest and innovation of some estates to take part in experimentation projects (e.g. for studying natural processes)

Table 5: what mechanisms are not working?

What's not working?
• Overwhelming number of different Scottish Government papers, policies, strategies, and plans • Inadequate quick emergency funding for monitoring extreme events (fire recovery) – current emergency funding mechanisms are too slow and competitive • Sites of Special Scientific Interest (SSSIs) are creating management inertia • Broken value chains for woodland products (e.g. venison, timber) • Polarisation between different land management styles – traditional vs environmental – which creates bias in the knowledge people access • Community engagement mechanisms are not sufficient – more tangible benefits needed • Lag between policy and regulation • Challenges balancing economic and ecological priorities • Forestry grant scheme and regulation that accounts for natural processes • Need for updated climate models (e.g. Ecological Site Classification tool to go

Table 6: what mechanisms are missing?

What's missing?
• More integrated land management practices (e.g. agro-silvicultural systems) • Space for landowners, policymakers, community members and other key actors to feed into this discussion about research agendas (as well as improved avenues for practitioner input) • Wider forums and in-person meetings for researchers, practitioners, industry and others • Forestry and woodland-related studies embedded in national curriculum • Utilising the skills and enthusiasm of forestry postgraduate students for action research • Funding for action research • Restoration platform to collate and share evidence, with quality assessment tool and topic-specific portals • Research funding advisory body to Scottish Government • More targeted grants • Structures that support long-term studies • Systems thinking • Buy-in from wider sector

7. A vision for a future research strategy

Although identifying current knowledge needs is valuable for guiding short-term research efforts, '*success would be to build a process where these kinds of key needs could be updated*' (CC3). Therefore, this project aimed not only to capture practitioners' current priority topics, but also to consider a vision for a future research strategy that consistently integrates their perspectives into the long-term planning of research. At the end of the workshop, attendees were asked, in pairs, to generate phrases that capture their ideal vision for future woodland restoration research. Here, based in the shared ideal that restoration efforts should be grounded in practice and underpinned by evidence, attendees' ideas have been formed into a guiding vision.

A vision for future woodland restoration research

Woodland restoration research should be solutions-focused, outcome-driven and capable of supporting long-term, practical goals. Success will be defined by research that actively supports the ongoing delivery of sustainable, healthy and resilient woodlands – for the benefit of both nature and people.

Achieving this requires a collaborative system underpinned by social, political, and economic mechanisms that enable practitioners and researchers to co-design and co-produce research that is innovative, iterative, and responsive to real-world challenges.

Central to this vision is a commitment to 'translating' and exchanging knowledge, cultivating a culture of mutual trust and respect. Practitioners and researchers should not always be seen as distinct entities, but as a community with a shared identity and ambitions.

While many additional elements could be included, the aspects highlighted in the vision reflect the priorities most strongly emphasised by the practitioners and researchers involved in this project. Any vision is, by nature, idealistic—partially detached from the complexities of real-world contexts and necessarily incomplete. However, its value lies not in providing a definitive answer, but in offering a provocation and a call to action. This raises important questions: how can this vision be developed within different contexts and translated into meaningful changes in research directions and processes? How might actors beyond researchers and practitioners, such as contractors, policymakers, and community members, be actively involved in advancing this agenda? And how can broader systemic pressures be applied to encourage the political and economic shifts necessary to support the vision in practice?

8. Top ten takeaways

1. In Scotland, woodland restoration research is vast, varied, and well-developed in many ways. However, practitioners identified multiple areas where knowledge needs exist, spanning ecological, social, and financial topics and existing at all scales, from the molecular to the national.

2. Ecological needs identified by practitioners covered questions regarding the best practices for establishing trees and managing herbivores, to queries surrounding the wider environmental impacts on and of different afforestation approaches in relation to carbon, biodiversity, and climate change.

3. Social needs observed by practitioners ranged from understanding and managing perceptions, conflicts and social impacts of woodland restoration efforts, to increasing community involvement and connections with land.

4. Financial needs noted by practitioners included understanding nature markets better and how to engage with funding mechanisms more effectively, to the need for more evidence on the comparative cost-effectiveness of various approaches.

5. Not all knowledge needs originate from a lack of existing research – whilst sometimes a need is due to a lack of scientific evidence on a subject (requiring new, or better, knowledge production), often these needs stem instead from a lack of knowledge exchange (requiring improved networks and processes for sharing and discussing evidence), a lack of enaction (requiring shifts in wider contextual mechanisms such as funding or political structures), or some combination of these three dimensions.

6. Research is not automatically relevant and applicable to practice—proactive efforts are necessary to recognise differences between (and work to align) practitioner and researcher priorities, and improve channels of communication to translate research into actionable practice.

7. Practitioners and researchers hold unique yet complementary roles in supporting progress in woodland restoration research. Practitioners are uniquely placed to identify research questions that could have a transformational impact on practice while researchers can catalogue, signpost and translate existing research; both can engage in knowledge exchange practices to help lessen the gap between generating evidence and implementing practice.

8. The onus to address the knowing-doing gap in woodland restoration should not solely rest on the shoulders of practitioners and researchers; there are various economic, political, and societal factors that shape what is possible (from funding constraints to field-specific pressures), and numerous other actors (from policymakers to those working in industry) who have significant influence over shaping research agendas.

9. Addressing knowledge needs is an ongoing process; regular and transparent mechanisms for practitioners to identify and communicate their knowledge needs should be established and maintained. This requires long-term and reflective thinking to continually develop practitioner-researcher relations, collaborate on research priorities, and cultivate wider socio-political shifts that support positive developments in woodland restoration research.

10. Woodland restoration research should be solutions-focused, outcome-driven and capable of supporting long-term, practical goals; this must be underpinned by social, political, and economic mechanisms that enable practitioners and researchers to collaborate on innovative, iterative, and responsive research. Success will be defined by research that actively supports the ongoing delivery of sustainable, healthy and resilient woodlands for the benefit of both nature and people.

9. Practitioner reflections

This report is a culmination of contributions from many people. The Steering Group, made up of practitioners grappling with the questions raised in this report in their everyday work, played a key role in shaping the direction of the project throughout, offering valuable iterative feedback. Here, some of them reflect on the project and its outcomes, describing their hopes for what may come next.

> "This exercise has identified a clear need for practitioners to have a greater voice in identifying research priorities. Given Forest Research's role as a leading research institute in the field, I hope they will put in place a mechanism to enable this rich dialogue between practitioners and researchers to take place on a regular basis."
>
> ***Alastair Seaman, The Woodland Trust***

> "This study has been invaluable in highlighting the gap that exists between innovative practice and sound research underpinning that work. Better communication between researchers and practitioners is clearly needed to both inform research programmes and translate relevant research into good practice."
>
> ***Shireen Chambers, Future Woodlands Scotland***

> "Whether we recognise it or not, woodland restoration touches all of us deeply and on many layers. This report shows the variety of things there are to understand in order to make things happen, and especially the need for relationships between woodland researchers and woodland practitioners."
>
> ***Alan McDonnell, Trees for Life***

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Appendices

Appendix A: Defining woodland restoration

During the interviews, interviewees were asked for their opinion on using 'woodland restoration' as the catch-all term for activities discussed within this research. Interviewees held mixed opinions about the use and usefulness of 'woodland restoration'. Around half of interviewees were generally happy with the term as they felt it captures the key focus on conservation goals. Yet, several interviewees noted issues with 'restoration' being a catch-all term, meaning anything to anyone and rendering it somewhat meaningless at times (CC2) and, most discussed by participants, placing too much emphasis on an attempt to return to a past state (PB1, CC1, PB2, PL2), which is not necessarily the aim of their work. Three interviewees suggested woodland or nature 'recovery' described their aims better (PB1, CC1, PL2) whilst another felt 'regenerative forestry' is preferable (PC1). Most did not wish to dwell too much on terminology, though, and one described how restoration can indicate the move towards an ideal end point where we have achieved functional, resilient, quality habitats that deliver for both nature and people (CC3). This comment encapsulates the overall sentiment and goal of practitioners in this research, regardless of preferred terminology. As such, 'woodland restoration' is used throughout this report to encapsulate all activities related to conserving, restoring, creating, and recovering woodland ecosystems, with the caveat that this may not always be the most fitting or preferrable phrase.

Appendix B: Survey questions

Please provide your job title and describe what your role involves on a day-to-day basis. *[Open text]*

Which category best describes the type of organisation you work for? *[Government agency/ Conservation NGO/Private landowner/Private land advisor or consultancy/Other (describe)]*

What ecological and/or environmental knowledge needs do you have? (For example, in relation to soils, tree establishment, natural regeneration, herbivore management, carbon flows, invasive non-native species, species management, conflicting habitat/species priorities, harvesting, or any other ecological and environmental challenges) *[Open text]*

What social and/or community knowledge needs do you have? (For example, in relation to community benefits, social perceptions/attitudes, consultation and engagement, managing conflicting values/priorities, or any other social and community challenges) *[Open text]*

What financial and/or funding knowledge needs do you have? (For example, in relation to grants, carbon/biodiversity/other credits or offsets, natural capital approaches, sponsorship, nature finance, or any other financial and funding challenges) *[Open text]*

What other knowledge needs do you have? (For example, in relation to policy, climate and biodiversity targets, the wider context of land use/agriculture/forestry, or any other knowledge needs not covered by previous questions) *[Open text]*

Where do you go to find guidance, information, or knowledge about woodland restoration to support your work? *[Open text]*

How relevant is current research (that you are aware of) to the operational delivery of woodland restoration? *[Open text]*

Appendix C: Interview schedule

Opening

- Please outline your role/background in relation to woodland restoration
- In a sentence or two, what does 'woodland restoration' mean in the context of your work? (What's included/excluded?)
- In brief, what do you think are the key issues and challenges to woodland restoration in Scotland right now?

Priority needs

- What are three knowledge needs/research areas that you feel are a priority to address?
- For each of these priorities, why do you think the knowledge need exists?
- How do you think these priority areas should be addressed (and who by)?
- What practical impact would addressing these gaps have?

Future research agendas

- What would a successful programme of woodland restoration look like to you?
- In your opinion, is the on-the-ground experience of practitioners considered when new research is being planned? (How/why do you think that is? Are there mechanisms to support this?)
- How would you like to be able to feed into future research agendas? What could this look like?

Closing

- Is there anything you hoped to discuss here that we haven't covered?

Appendix D: Workshop schedule

Introduction
- Present aims of project, results so far, aim of workshop
- Introductions
- Interactive survey—how much scope

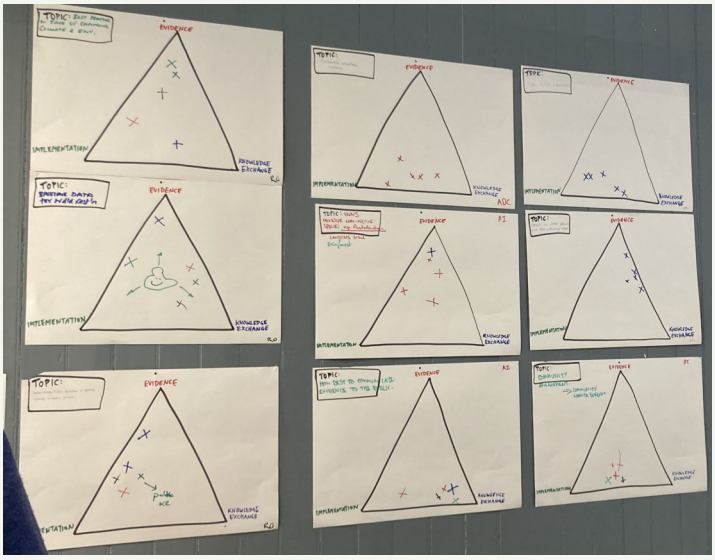
Gaps exercise
- Introduce the Evidence-Exchange-Enaction gap framework
- In their tables, attendees map 5 issues of their choosing on this framework and discuss the context

Context discussion
- In tables, consider resources and mechanisms needed to address gaps—what's missing?
- Consider the roles and capacities of practitioners/researchers
- What are the external constraints?

Plenary
- Recap and feedback to wider group
- Vision statement in pairs

Appendix E: Workshop materials

Examples of flipchart pages used in the workshop.



Appendix F: Illustrative research questions

This list illustrates some of the questions participants provided as examples of the knowledge needs they felt would be helpful for research to address. Please note, this is not a comprehensive list and it has limited utility taken out of context. However, it provides detail of the types of questions practitioners were interested in, beyond the thematic analysis contained within the report.

Example ecological questions

- What practices would best support successful tree establishment on impoverished upland soils (former grouse moor)?
- What are the best conservation grazing methods to support natural regeneration?
- What are the recovery times for different woodland species once herbivore pressure has been reduced?
- What are the growth rates of wild trees over time in different contexts?
- How to reduce fire risk on former grouse moors moving to woodland?
- Which tree species are most appropriate for both biodiversity and resilience?
- How to best remove invasive and non-native species, including sitka spruce?
- How to best restore damaged hydrologies as part of woodland restoration?
- What's the importance of mycorrhizal inoculum when planting in open ground habitats which have been treeless for centuries?
- How will climate change impact our species choices?
- What are the impacts of different types of forest practice on soil carbon?
- What impact does thinning Sitka spruce plantations have on the drought-resilience, carbon sequestration and biodiversity?
- What is the carbon lifecycle of products harvested from forests?
- What is the window of opportunity for saving ghost woodlands?
- What are the impacts of afforestation in the uplands on ground-nesting birds?
- How can we better control pine weevil without pesticides?
- What is the true environment impact of clearfelling in Scotland?
- What's the impact of chemical use in woodland restoration?
- How best to restore woodlands in order to protect drinking water supplies?

Example social questions

- How is natural regeneration/tree planting perceived by different stakeholders?
- How to best manage conflict around land-use change/species reintroductions?

- How to best engage communities in restoration and communicate forestry knowledge to a wider audience?
- What's the history of soils, trees, and archaeological landscapes of different sites, and how can this knowledge support restoration efforts?
- What's the evidence for community benefit of transforming commercial spruce plantations into native woodlands?
- How can we facilitate and support more communities to take on ownership of woodlands or land for restoration projects?
- How do we create a stronger voice within conservation/government organisations to steer change in a more positive direction?
- How do we better highlight the economic benefits of conservation, sustainable forestry?
- What would motivate people to undertake restoration?
- What trade-offs are stakeholders prepared to accept?
- What are the costs/benefits of community woodland management?
- What are the benefits and burdens of restoration for communities?

Example financial questions

- What are carbon markets and how can they help woodland restoration goals?
- What's a cost effective measure for controlling deer grazing of new planting?
- How can funding systems be changed to better align with practitioner priorities?
- How to fund innovative, alternative approaches?
- Is natural capital financing a realistic or desirable option?
- How can current subsidies be reformed to support desired futures?
- What are the risks and long-term prospects of new types of funding?
- How much does it cost to bring deer numbers down over landscape-scale areas, and to keep them low as woodland develops?
- How can we financially incentivise greater deer control as opposed to erecting more fencing?
- How can we improve supply chains for hardwood timber and alternative conifers that might be managed/harvested at a much smaller scale?
- How to build (and hold together) large-scale joint ventures with multiple funding and landowning partners?
- What are the costs and benefits of different methods (e.g. natural regeneration vs planting)?
- How to finance agro-forestry?