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TO PLANT OR NOT TO PLANT? DRIVERS OF NATIVE WOODLAND CREATION IN THE UNITED KINGDOM

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STATEMENT OF ORIGINALITY

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ABSTRACT

Ecosystem restoration, particularly forest restoration, has become a global priority given its potential benefits (carbon storage, biodiversity, etc.), but its successful delivery depends on people, especially landholders. Nevertheless, our theory-based understanding of what drives landholders to create woodland types important for ecosystem restoration—such as mixed native woodlands, which offer the highest environmental benefits—remains limited.

This thesis builds on Diffusion of Innovations Theory (DOIT) exploring what drives landholders to create diverse native forests in and around the Cairngorms National Park in Scotland through three analyses. The first explores how woodland creation intervention, landholder, and context characteristics influence landholders' decisions to create mixed native woodland. The second examines how the most important woodland creation intervention attributes according to DOIT affect decisions to create mixed native woodland, accounting for causal links between DOIT attributes to minimise estimate bias. The third is a choice experiment exploring landholders' preferences for attributes of a native woodland managed for biodiversity creation scheme.

This thesis' overarching findings suggest that landholders' sustainable land use goals, together with their views of ecosystem restoration's environmental benefits and compatibility with their land uses, precede deeper considerations of restoration adoption, where practical details (e.g. payment timings, profitability) gain prevalence. This indicates that the scalability and success of ecosystem restoration initiatives requires providing landholders with: (i) clear, evidence-based information on the environmental, practical, and economic aspects of restoration, helping them assess its compatibility with their land use goals and practices; (ii) adequate financial support; and (iii) restoration schemes that keep financial and non-financial aspects as simple and flexible as safeguards allow, making them easier to understand, use, and tailor. Overall, this thesis shows that to achieve ecosystem restoration and its multiple benefits at scale, programme designs should be more holistic, iterative, and sensitive to landholders' perspectives, while incorporating safeguards against negative outcomes.

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1. INTRODUCTION

All species impact their environment, but over time, human ingenuity has allowed us to amplify our influence over the planet. This is so much so, that we may now be in the Anthropocene, a new geological epoch marked by rapid and profound changes to earth's systems driven by human activities (Zalasiewicz et al., 2017).

Today, much of Earth's air, land, and water experience some level of human related impacts (Halpern et al., 2008; Venter et al., 2016). Human caused greenhouse gas emissions to the atmosphere have warmed the earth and acidified its oceans (IPCC, 2021). This together with land and sea use change, direct exploitation, pollution, and invasive alien species are threatening biodiversity and ecosystems services (IPBES, 2019), and causing the sixth mass extinction of life on earth (Ceballos et al., 2015). Nonetheless, despite growing awareness and action against these issues, their underlying drivers keep accelerating (IPBES, 2019). Thus, pushing Earth's systems beyond safe boundaries on a planetary scale, causing a global environmental crisis (Steffen et al., 2015) that threatens not only the survival and well-being of the species we share this planet with, but our own (IPBES, 2019).

Addressing these issues will ultimately require deep and transformative changes to our behaviours, particularly in the way we use land and sea (IPBES, 2018, 2019; Leclère et al., 2020; Mace et al., 2018). One such change is ecosystem restoration, which has emerged as a global priority for mitigating the climate and biodiversity crises (Aronson & Alexander, 2013; Cook-Patton et al., 2021; Griscom et al., 2017). The Kunming-Montreal Global Biodiversity Framework, recently adopted by the Convention on Biological Diversity (CBD), sets the biodiversity goals and targets for the world by 2050. One of the goals in this framework is to maintain, enhance, or restore the integrity, connectivity, and resilience of all ecosystems by 2050; setting targets to restore 30% of degraded terrestrial, inland waters, and marine and coastal ecosystems by 2030, as well as to effectively protect and manage 30% of terrestrial and inland water areas, and marine and coastal areas by 2030, especially those important for biodiversity and ecosystems services (CBD, 2022). This together with the United Nations

decade on ecosystem restoration (2021-2030) which aims to “prevent, halt, and reverse the degradation of ecosystems worldwide” (UNEP & FAO, 2021), the recent Glasgow Leader’s Declaration on Forests and Land Use (UNFCCC, 2021), and many other international initiatives such as the Bonn Challenge (IUCN & Government of Germany, 2011), has increased the push for large scale restoration efforts worldwide.

At a terrestrial scale, land degradation is one of the main drivers of biodiversity and ecosystem services loss, as well as climate change (IPBES, 2018). Biodiversity assemblages form natural ecosystems that store vast amounts of carbon in their biomass and provide a wealth of other ecosystem services, but they are threatened by processes such as destruction, fragmentation, and degradation (Banks-Leite et al., 2020). This erosion of biodiversity and its services on land—but also at sea—has profound consequences for humanity, already impacting the lives of billions of people and the global economy (IPBES, 2018). Thus, better land management is one of the main strategies to tackle the current environmental crises, by reducing, halting, and reversing land degradation (IPBES, 2018).

Ecosystem protection and restoration are key tools in achieving these goals (Cook-Patton et al., 2021). When deciding between protection and restoration, the priority is usually to protect diverse native ecosystems that are considered “undisturbed or intact”. This is so because, while restoration can promote the recovery of degraded ecosystems, it generally fails to replicate the ecological complexity and balance found in “undisturbed” or “intact” ecosystems (Crouzeilles et al., 2016; Jones et al., 2018; Moreno-Mateos et al., 2012, 2017; Rey Benayas et al., 2009).

Nonetheless, the concept of “undisturbed” or “intact” ecosystems is highly contentious. Many ecosystems considered pristine today—defined as largely free from significant human influence—have, in fact, experienced long histories of human habitation and use that have notably altered their ecological composition (e.g. Boivin et al., 2016; Fletcher et al., 2021; Levis et al., 2018). For example, in parts of the Amazon’s Forest—often perceived as pristine wilderness—millennia of human activity, including fire management and the promotion of

useful plant species, have significantly shaped what are now seen as “pristine” areas (Levis et al., 2018). Moreover, most ecosystems considered “undisturbed” or “intact” today are likely degraded (Beyer et al., 2020; Newbold et al., 2016) and not ecologically complete and/or functional (Plumptre et al., 2021). An ecologically incomplete ecosystem has lost some of its original species, while in ecologically non-functional ecosystems some species’ abundances have dropped to levels that prevent them from fulfilling their ecological roles (Plumptre et al., 2021). When these changes in ecosystem completeness and functionality affect key species, they can lead to shifts in an ecosystem’s estate through a process of trophic downgrading, with effects up and down the food chain (Estes et al., 2011).

Given these complexities, ecosystem restoration is seen as essential not only to expand and connect habitat remnants, recover degraded ecosystems, and combat climate change, but to sustain and enhance ecosystem services such as water purification, pollination, or flood control (Cook-Patton et al., 2021; Griscom et al., 2017). Nevertheless, ecosystem restoration is not a panacea to fix all environmental problems, nor a substitute to nature conservation (Crouzeilles et al., 2016; FAO et al., 2021; Jones et al., 2018; Moreno-Mateos et al., 2012; Rey Benayas et al., 2009). Its long-term success ultimately depending on a transition toward sustainable natural resource use by human societies, and a quick decarbonization and detoxification of human activities (FAO et al., 2021).

The practice of ecosystem restoration encompasses a range of activities—in terms of their target ecosystems, restoration approaches (active vs. passive), objectives, and scales—that ultimately aim to halt ecosystem degradation and promote recovery (Gann et al., 2019; Nelson et al., 2024). Despite that, forest restoration has captured the imagination of the public, politicians, and scientists (Temperton et al., 2019). This is highlighted by a flurry of high-level international restoration campaigns focused on forests such as the Bonn Challenge (IUCN & Government of Germany, 2011) or the One Trillion Trees Initiative (World Economic Forum, 2020). The right types of forests growing in the right places can have many benefits (e.g. Adams et al., 2016; Bonan, 2008; Di Sacco et al., 2021; Elias et al., 2021; Wang et al., 2021).

These combined with the fact that forest restoration can be conveyed via the action of planting a tree, which is both 'simple' and full of agency, perhaps explains the popularity of forest restoration. Nonetheless, viewing forest restoration purely in terms of trees planted can be problematic, as it fosters a short-term approach to forest establishment. In reality, restoring forests is a long and complex process, relying on tree survival and growth, which are currently low, probably due to a focus on tree planting instead of tree growing (Duguma et al., 2020). Additionally, in many cases natural regeneration, also known as passive restoration, is a cheaper and superior alternative to active restoration. This is generally so when restoration sites are close to forest remnants or have experienced low levels of degradation (Di Sacco et al., 2021).

Forest restoration is a process occurring in complex social-ecological systems, with short and long-term, biophysical, social, economic, and political implications, particularly at a local scale and for different groups of local people (Elias et al., 2021; Löfqvist et al., 2023; Tedesco et al., 2023). The restoration of forests can provide a host of environmental (climate change mitigation, biodiversity, water quality, etc.) and social (health, recreation, etc.) benefits (Sing et al., 2017). However, forest restoration outcomes can be varied and involve trade-offs (e.g. Löfqvist et al., 2023).

The environmental outcomes of forest restoration depend on factors such as the type, location, and size of forests restored; the time elapsed since restoration; or how restored forests are managed or their products used (Di Sacco et al., 2021; Fleischman et al., 2020; Oliver et al., 2014). Trade-offs resulting from this include less timber production in more biodiverse forests (Hua et al., 2022), or reduced carbon sequestration from forests created on carbon rich soils (Friggens et al., 2020).

Presently, one of the main incentives for restoring forest is their huge potential for climate change mitigation through carbon storage in their biomass and soils (Bastin et al., 2019; Brancalion, Niamir, et al., 2019; Cook-Patton et al., 2021; Griscom et al., 2017; Strassburg et al., 2020). Overall, at a global scale forests act as a carbon sink (Harris et al., 2021).

Maintaining and increasing this sink requires addressing anthropogenic sources of forest degradation (e.g. human induced fires, deforestation), and restoring degraded forests (Law et al., 2001; Silva et al., 2020). From a carbon drawdown perspective, restoring forest in the right places and as quick as possible is key (Law et al., 2001; Silva et al., 2020), since forests can be carbon sources in early stages of their life (Law et al., 2001), when they are heavily degraded (Gatti et al., 2021) or when they are growing in carbon rich soils (Friggens et al., 2020; Matthews et al., 2020). Moreover, forests not only influence the climate via carbon sequestration, but through their effects on evapotranspiration, albedo, other greenhouse gases, or the generation of aerosols, with net climate effects depending on a combination of all these factors (Bonan, 2008).

Another driver for restoring forests are their benefits for biodiversity. Re-establishing and restoring forest can be great for biodiversity, but biodiversity benefits depend a lot on factors such as the type of forest restored, its location, and the time passed since restoration (Di Sacco et al., 2021; Poorter et al., 2021; Sutherland et al., 2021; Wang et al., 2021). Where forests are created is key in to enhance potential biodiversity benefits, since afforesting non-forest ecosystems (e.g. grasslands, peatlands) will result in a loss of their biodiversity and survival potential (Di Sacco et al., 2021; Sutherland et al., 2021). Overall, biodiversity is enhanced when areas are reforested instead of afforested, when a mix of species is used over monocultures, when native species are prioritised over non-natives, and when management focuses on restoring the original diversity and function of native ecosystems rather than maximising short-term timber yields (Wang et al., 2021). Other factors such as the time elapsed since restoration, the severity of the degradation in the restored area, or landscape factors such as the presence of existing forests, can also influence the success of forest restoration for biodiversity and other outcomes (Crouzeilles et al., 2016; Crouzeilles & Curran, 2016; Latawiec et al., 2016). There is conflicting evidence as to whether active restoration accelerates the forest recovery process when compared to natural regeneration (Jones et al., 2018; Wang et al., 2021). Nonetheless, regardless of the restoration method, biodiversity

recovery to old growth forest levels can take more than a century to achieve (Poorter et al., 2021; Wang et al., 2021).

The way forests are managed and how their products are used also affects their impact on climate and biodiversity. Longer forestry rotations (time from planting to harvesting), no or low intensity management that mimics natural processes, or a combination of productive and environmental objectives can enhance forests' contributions to climate change mitigation, biodiversity, and have other benefits like improved water supply (Law et al., 2018; Sing et al., 2017; Wang et al., 2021). Forest products can also contribute to reduce emissions, by storing carbon, replacing more carbon intensive materials such as concrete or steel, or by substituting fossil fuels in the production of energy (Oliver et al., 2014). Overall, replacing carbon intensive building materials with wood would be the most effective alternative when reducing carbon dioxide (CO₂) emissions and fossil fuel use (Oliver et al., 2014). This could also lower the warming caused by forest loss (Williams et al., 2021). Nonetheless, it is likely that the benefits of replacing more carbon-intensive materials with wood have been exaggerated (Harmon, 2019).

The social impacts of forest and ecosystem restoration are varied, affecting people's incomes, employment, livelihoods, land tenure, property and use rights, governance, and well-being, through effects on food security, equity, health, power, and poverty (Adams et al., 2016). Despite that, historically, ecosystem restoration narratives have been dominated by either a focus on returning ecosystems to a previous 'more natural' state or compensating for degradation in an area by restoring a different one. These narratives, which are still alive today, have resulted in shortcomings in terms of social inclusion, socio-economic benefits (Sigman & Elias, 2021), and in the evaluation of socio-economic outcomes within ecosystem restoration (Wortley et al., 2013). When forest restoration incentive mechanisms are considered, for example, most of the factors enabling or hindering their establishment and long-term success are social or economic in nature (Tedesco, Brancalion, et al., 2023). Thus, omitting socio-

economic concerns in the planning and implementation of ecosystem restoration is likely to have negative implications for its success and longevity.

Despite often being touted as a win-win solutions to both environmental and socioeconomic challenges, forest and ecosystem restoration efforts normally have mixed results, with inevitable trade-offs between social and environmental outcomes. Both the ecological and/or social outcomes of ecosystem restoration can be positive, negative, or mixed depending on how the restoration process unfolds (Löfqvist et al., 2023). A recent review on forest restoration incentive mechanisms (Tedesco, Brancalion, et al., 2023) is a good example of this. In it, only half of the studies included (73 in total) reported positive social and ecological outcomes. Perhaps more interestingly, when negative outcomes were reported they tended to be social instead of ecological (Tedesco, Brancalion, et al., 2023). But the examples do not stop there. On the positive end of the spectrum, we find examples from Madagascar (Mansourian et al., 2016), South Africa (Palmer et al., 2022), and Brazil (de Souza et al., 2016) where restoration resulted in positive ecological and social impacts, such as simultaneous improvements to forest cover, biodiversity, and local people's livelihoods (Löfqvist et al., 2023). Examples of forest restoration with mixed results come from Uganda, where the Trees for Global Benefit Program restoration improved livelihoods and the local environment, but accentuated inequalities (Fisher et al., 2018), or China where the Sloping Land Conversion Program had positive and negative impacts on incomes and caused conflict in some areas by ignoring local knowledge (Adams et al., 2016). Finally, on the negative end of the spectrum we find an example from northern India, where tree planting efforts not only had little effect on increasing canopy cover but reduced the cover of broadleaf species valued by local people (Coleman et al., 2021), increased the occurrence of invasive species, and changed access to land disrupting the migratory routes and livelihoods of pastoralists (Ramprasad et al., 2020). Other negative examples come from Malawi (Djenontin & Zulu, 2021) or Ecuador (Wiegant et al., 2020) where restoration interventions had both deleterious or insufficient social and environmental outcomes (Löfqvist et al., 2023).

Ultimately, the goal should be to minimise negative unintended consequences, as well as trade-offs between the environmental and social outcomes of forest and ecosystem restoration. For many authors, this requires a shift towards a concept of ecosystem restoration focused on socio-ecological resilience, that sees ecosystem restoration as a socio-ecological process and considers social and biophysical aspects inclusively adapting to their changes in time and space (Elias et al., 2021; Löfqvist et al., 2023; Osborne et al., 2021; Sigman & Elias, 2021; Tedesco, López-Cubillos, et al., 2023). Existing guidelines, such as the Society for Ecological Restoration's principles and standards for ecosystem restoration (Gann et al., 2019) or the ten golden rules for reforestation (Di Sacco et al., 2021), already emphasise the need to consider social and biophysical aspects and engage with local stakeholders to draw from their knowledge when designing and implementing restoration interventions (Di Sacco et al., 2021; Gann et al., 2019).

Despite that, according to several authors, current guidelines are not explicit nor exhaustive enough about the human and social aspects of ecosystem restoration (Elias et al., 2021; Osborne et al., 2021). To counteract this, they propose a set of rules (Elias et al., 2021), principles, and strategies (Osborne et al., 2021) to complement existing guidelines. These two proposals (Elias et al., 2021; Osborne et al., 2021) share core concepts. They recognise that the present is the result of a set of dynamic processes taking place now and in the past. These processes can be biophysical, social, economic, and political and occur at spatial scales ranging from local to global. The processes and the scales (temporal and spatial) at which they happen, do not exist in isolation, instead, they are interconnected and can influence each other. The result is the present status quo, with its power structures, power dynamics, social tensions, and inequalities. According to the authors, restoration interventions ought to be designed to fit the complex geographic and historical contexts in which they operate. Acknowledging the existence and interactions of diverse stakeholders and incorporating their knowledge, priorities, views, and interests into their plans. The main aim of considering all these facets is to generate ecological and social benefits in parallel, in a way that fosters

equity. Empowering local communities and marginalised groups, instead of creating conflicts by exacerbating tensions and inequalities (Elias et al., 2021; Osborne et al., 2021).

The delivery (passive or active) and success of forest restoration, ultimately depends on a range of stakeholders, notably landholders and the entities promoting forest restoration (Piñeiro et al., 2020; Tedesco, Brancalion, et al., 2023; Tedesco, López-Cubillos, et al., 2023). Landholders, ultimately decide whether restoration happens or not. Whilst the public and private organizations advocating for restoration, design and implement schemes to persuade landholders to adopt restoration practices. Landholders' motivations to participate in restoration and other environmentally minded behaviours are always diverse and their relative importance changes over time with, for example, changes to demographics, knowledge, or politics (Aradóttir et al., 2013; Hagger et al., 2017). One of the strategies entities promoting restoration use to tap into those motivations is reducing or eliminating the financial and non-financial barriers experienced by their target populations. For example, they might cover the initial costs of restoration or provide technical support. Often several of these financial and non-financial incentives, are bundled into voluntary incentive schemes (Tedesco, Brancalion, et al., 2023). Understanding how these voluntary schemes and restoration itself are perceived by individuals and groups, particularly those owning or managing land, and the factors driving their uptake, spread, and abandonment will be crucial to design restoration initiatives that scale successfully (Ambrose-Oji et al., 2018; Lawrence & Dandy, 2014; Mills et al., 2019). Several studies show that landholders' perceptions of the financial and non-financial aspects of an initiative, together with their objectives and intentions are, amongst others, key determinants for the adoption and scaling of environmentally focused initiatives such as sustainable agricultural practices (Swart et al., 2023) or different conservation and resource management initiatives (Jagadish et al., 2024; Mascia & Mills, 2018; Mills et al., 2019; Romero-de-Diego et al., 2021; Sorice et al., 2011). Overall, this suggests that programmes focused only on economic incentives to promote the uptake of initiatives may be insufficient

(Sorice & Donlan, 2015; Swart et al., 2023), requiring a shift towards more holistic programmes that gather and incorporate stakeholders' inputs throughout (Sorice & Donlan, 2015).

Landholders' decisions to engage in woodland creation, which includes forest restoration, are influenced by an array of factors including: the availability of land, support, or funding for woodland creation; bureaucratic burdens; or landholder's motivations, perceptions, and attitudes towards woodland creation (e.g. Hemery et al., 2018, 2020; Kaine et al., 2023; Lawrence & Dandy, 2014; Powlen & Jones, 2019; Ross-Davis et al., 2005; Tran et al., 2019). The role of these factors as drivers or barriers to woodland creation is circumstantial, depending on individual landholders and their contexts at a particular point in time. For example, a landholder's ability to create woodland will change according to their economic situation or knowledge, and the political forces influencing them. Additionally, the preferences of landholders for specific aspects of woodland creation schemes, such as the amount of funding or types of non-financial support they provide, might also dictate their participation in them (e.g. Baker et al., 2019; Broch & Vedel, 2012; Haile et al., 2019; Kefale et al., 2021; Lienhoop & Brouwer, 2015; Polyakov et al., 2024; Vedel et al., 2015). Some of these preferences are likely to be more stable in time than landholders' ability to create woodland, such as preferences for schemes offering higher payments or less paperwork. In contrast, other preferences may vary with time; for example, preferences for support might change as landholders become more knowledgeable about woodland creation.

In terms of forest restoration, mixed native woodlands—woodlands formed by a combination of different native tree species—have superior environmental benefits when compared to other woodland types (e.g. Allek et al., 2022; Hua et al., 2022; Wang et al., 2021; Waring et al., 2020). As such, they are widely considered as the woodlands with the highest potential for ecosystem restoration when created in the right places (Di Sacco et al., 2021; Gann et al., 2019). Nonetheless, the literature on landholders' decisions and preferences to create woodland rarely focuses on mixed native woodlands specifically (Hemery et al., 2018, 2020; Kaine et al., 2023; Lawrence & Dandy, 2014; Tran et al., 2019). Moreover, much of the existing

research on woodland creation is either atheoretical (e.g. Hemery et al., 2018, 2020; Hopkins et al., 2017; Jellinek et al., 2013; Ross-Davis et al., 2005; Tran et al., 2019), or based on theories focused on individual decision-making (e.g. Bosshard et al., 2025; Chung et al., 2020; Kaine et al., 2023; Karppinen, 2005; Swart et al., 2023). Studies without a theoretical framework are more vulnerable to spurious conclusions (Smaldino & McElreath, 2016), while those focused on individual decision-making theories may overlook the dynamics of decisions made by groups (e.g. organisations, families), which constitute a significant portion of decision makers in many land use and other contexts (e.g. Pannell et al., 2006; Wightman, 2024). These gaps in our understanding of landholders' decisions to create woodland have potential negative implications for global ecosystem restoration efforts, particularly considering the current emphasis on scaling up forest restoration (IUCN & Government of Germany, 2011; Temperton et al., 2019; World Economic Forum, 2020) .

1.1. Aims and objectives

Through this thesis I **aim** to improve our theory-based understanding of what drives landholders' decisions to engage in ecosystem restoration on the land they manage.

I do so by studying the decisions of landholders—both individuals and groups—to create mixed native woodlands in and around the Cairngorms National Park in Scotland.

Given the diverse, context-specific, and ever-changing nature of both the potential outcomes of creating woodland, and landholders' motivations and preferences to do so, broader theories of human decision-making able to capture its dynamism and two-way interplay with its context, may help us better understand woodland creation decisions (Schill et al., 2019). One such theory is Diffusion of Innovations Theory (DOIT; Rogers, 2003), which suggests that decisions to engage in new behaviours are driven by characteristics of the new behaviour itself, the individual or group adopting it, and the context where they interact. DOIT acts as the main theoretical framework for this thesis (**Section 2.1**). I selected DOIT given its broad scope,

established history, versatility across adopter types (e.g. individuals, organisations), and its relevance to various fields (Jagadish et al., 2021; Montes de Oca Munguia et al., 2021; Rogers, 2003; Wejnert, 2002), including biodiversity conservation (e.g. Jagadish et al., 2021, 2024; Lewis-Brown et al., 2021; Mahajan et al., 2021; Mascia & Mills, 2018; Mills et al., 2019; Romero-de-Diego et al., 2021) and ecosystem restoration (Garbach & Long, 2017; Kernecker et al., 2021; Pienkowski et al., 2024).

In **Chapter 7** of this thesis, I also use elements of the Comprehensive Action Determination Model (CADM) (Klöckner, 2013) as a secondary theoretical framework (**Section 2.2**). This theory suggests an individual's behaviour depends on psychosocial factors such as social norms, attitudes, and intentions (Klöckner, 2013). Within **Chapter 7**, I present a choice experiment exploring landholders' individual preferences for native woodland creation scheme attributes and their heterogeneity. Given the CADM's focus on individual decision-making, its comprehensive approach, and its emphasis on environmental behaviours (Klöckner, 2013), it serves as an ideal complement to DOIT in this context.

My **research objectives** in this thesis are:

1. To explore how characteristics of landholders, ecosystem restoration initiatives, and the context in which they interact, influence landholders' decisions to engage in ecosystem restoration on their land.
2. To assess landholders' preferences for ecosystem restoration incentive scheme attributes and how these preferences vary.
3. To propose policy, practice, and research recommendations based on my findings.

This thesis includes material from the following peer-reviewed journal papers:

- Roel Bellot, A., Clark, M., Jagadish, A., Potter, C., and Mills, M. (In review). Drivers of mixed native woodland creation in Scotland: Compatibility with land use practices and environmental benefits influence decision-making (**Chapter 6**).
- Roel Bellot, A., Kountouris, Y., Jagadish, A., and Mills, M. (In writing) Scottish landholders' preferences for native woodland creation scheme attributes (**Chapter 7**).

I wrote both papers with support and supervision from the co-authors.

The rest of this thesis is structured as follows. In **Chapter 2**, I describe the DOIT and CADM theoretical frameworks used throughout this thesis, my study area and its woodland creation context, as well as my research ethics. Analytical chapters are divided into two parts. The first part addresses **Objectives 1 and 3** and comprises **Chapters 3, 4, 5, and 6**. In **Chapter 3**, I provide a general introduction to this first part of the thesis. In **Chapter 4**, I describe the survey and sampling design used to collect the data analysed in **Chapters 5 and 6**. In this chapter, I also outline the methods and results of a small qualitative analysis informing my discussion of those chapters' findings and provide sample descriptive statistics. In **Chapter 5**, I describe a general exploration of which DOIT characteristics of landholders, woodland creation interventions, and the context where they both interact influence decisions to create mixed native woodland and how. In **Chapter 6**, I focus on the woodland creation intervention attributes DOIT suggest are most important to explain adoption (i.e. relative advantage, compatibility, complexity, observability, and trialability), and estimate their association with decisions to adopt mixed native woodland creation. I achieve this through a causal model that maps how DOIT attributes influence each other, based on DOIT and my knowledge of woodland creation in the study area. This approach enables me to identify and account for the potential bias introduced by other variables when estimating the effects of my focus variables. In the second analytical part of this thesis (**Chapter 7**), I present a choice experiment exploring landholders' preferences for the attributes of a hypothetical scheme designed to incentivise

the creation of native woodland managed for biodiversity (**Objective 2**). I also examine how those preferences vary based on landholders' intentions, and their perceived ability and opportunity to create such woodland (**Objective 2**). I end the chapter with a set of recommendations based on its findings (**Objective 3**). The third and final part of the thesis consists of two chapters. In **Chapter 8**, I discuss the overall relevance of my findings and their overarching implications for policy, practice, and research, addressing **Objective 3**. Finally, in **Chapter 9** I close the thesis by presenting the general conclusions drawn from my overall findings.

2. THEORETICAL FRAMEWORKS AND STUDY AREA

2.1. Diffusion of Innovations Theory

I conceptualised the behaviour change process leading to the adoption or rejection of mixed native woodland creation using DOIT (Rogers, 2003). DOIT describes a general process through which innovations—novel ideas, practices, or technologies—can diffuse over time through the communication channels of a social system leading to their adoption or rejection by system members.

According to DOIT, there are three main components that influence the adoption of innovations: (i) the innovation itself, (ii) the potential adopter, and (iii) the context where the innovation and its potential adopters interact (Rogers, 2003; Wejnert, 2002). Each of the three components have a set of attributes that influence the adoption process. I adapt a framework (Jagadish et al., 2021; Mahajan et al., 2021) that builds on previous studies of DOIT (e.g. Rogers, 2003; Wejnert, 2002). This framework outlines the important attributes that influence adoption in the context of nature/biodiversity conservation across the theory's three main components (Table 2.1; **Appendix D**).

TABLE 2.1. Components of the Diffusion of Innovations Theory (DOIT) and their attributes.

Adapted from Jagadish et al., 2021 and Mahajan et al., 2021.

Component	Attribute	Definition
Innovation	Relative advantage	The expected net benefits (financial, social, environmental, or other) of adopting an innovation compared to the status quo.
	Compatibility	The degree to which an innovation is perceived as consistent with the existing values, existing actions, past experiences, and needs of potential adopters.
	Complexity	The degree to which the innovation is perceived as relatively difficult to understand and use.
	Trialability	The degree to which the innovation may be experimented with on a limited basis.
	Observability	The degree to which the innovation and its results are visible or communicable to others.
	Flexibility	The ability to transform the innovation to something that aligns with the adopter's desires and constraints.
Adopter	Social-economics	The social and economic characteristics of an individual that influence its ability to implement or learn about an innovation. These include education, skills, relative wealth, organisational size, and financial resources.
	Personality	Personality traits that influence an adopter's willingness to learn and implement new practices, such as risk orientation and competitiveness.
	Knowledge	The degree to which the adopter is familiar with the innovation and its potential consequences through its existing or newly acquired knowledge and skills.
	Decision-making	Decision-making arrangements specify the rights of individuals or groups to make choices regarding various aspects of the innovation design and management.
Context	Geographical setting	Physical features of the landscape/seascape, as well as spatial proximities to other adopters, markets, etc. that affect adoption by influencing the applicability of the innovation.
	Culture	Shared behaviours and ideas—belief systems, traditionalism, and socialization of adopters—that influence the adoption of innovations.
	Political conditions	Character of political systems, along with the regulations and norms inherent in the legal systems that influence the potential adopters' behaviours.
	Extension support	Organisations' and individuals' (public or private) activities relating to technology transfer, education, human resource development, and information sharing that influence the adoption and implementation of the innovation.
	Global discourse	The extent to which the adopters' context influences and is influenced by globally circulating ideas, norms, and practices related to the innovation.

2.2. Comprehensive Action Determination Model

The CADM (Klöckner, 2013) is perhaps one of the most exhaustive theories of behaviour change. This model focuses on environmental behaviour and integrates three of the most commonly used theories to study behaviour: the Theory of Planned Behaviour (Ajzen, 1991), the Norm Activation Theory (Schwartz, 1977), and the Value Belief Norm theory (Stern, 2000). Additionally, it also considers the influence of habits on behaviour. According to the CADM an individual's behaviour can be determined by an awareness of the consequences of its actions; their perception of needing to do something about it or ascription of responsibility; their self-transcendence and self-enhancement values; as well as the individual's ecological worldview as portrayed by the New Environmental Paradigm (Dunlap & Van Liere, 2008). All these areas in combination with an individual's attitudes, habits, and perception that they can perform the new behaviour successfully or perceived behavioural control, as well as the expectations of other individuals or social norms; inform the personal norms and intentions of an individual and ultimately its behaviour (Fig. 2.1).

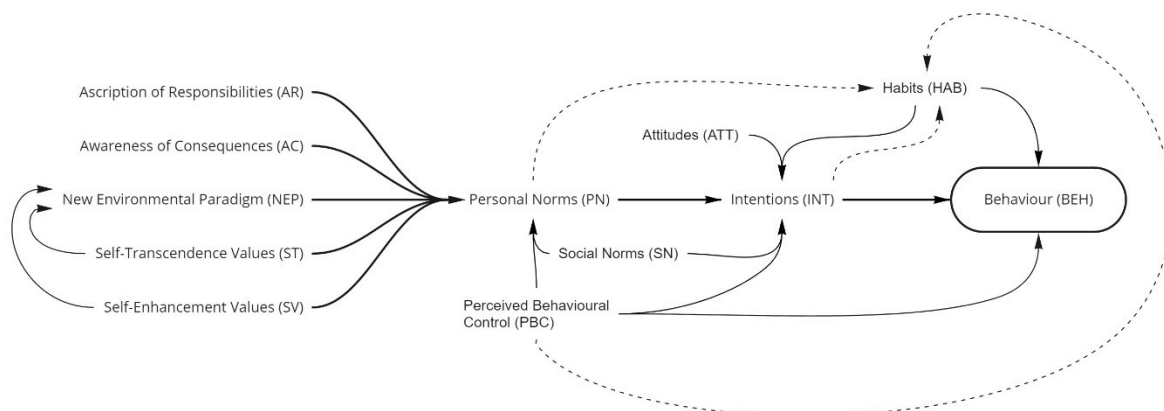


FIGURE 2.1.

Comprehensive Action Determination Model (CADM). Dotted lines show that habits are dynamic; intentions, personal norms, and perceived behavioural control dominate the first few times a behaviour is performed; habits take control once established. Adapted from Klöckner, 2013.

The CADM conceptualises personal norms as feelings of moral obligation to act in a specific way in a given situation (Schwartz, 1977), which are determined by an individual's ascription of responsibility, awareness of consequences, ecological worldview as measured by the New Environmental Paradigm, and their self-enhancement and transcendence values (Fig. 2.1; Klöckner, 2013). Ascription of responsibility is defined as an individual's willingness to accept responsibility for the consequences of his or her actions (Klöckner, 2013; Schwartz, 1977; Stern, 2000). This concept has also been labelled "responsibility denial", to emphasise that individuals tend to deny instead of accept responsibility, taking a defensive stance and accepting rationales that deny responsibility for the consequences of their action or inaction (Schwartz, 1977). Awareness of consequences is a concept that captures to what degree an individual knows the repercussions of a particular action on someone or something (Klöckner, 2013; Schwartz, 1977; Stern, 2000). The New Environmental Paradigm is a measure of how much someone's worldview concurs with new general beliefs about the environment and how humans relate to it, for example: that natural resources are limited, that human activities are a threat to the natural equilibrium, and that humans shouldn't dominate nature (Dunlap & Van Liere, 2008; Klöckner, 2013). Within the CADM the New Environmental Paradigm acts as a connector between someone's value orientations and their personal norms, although in other contexts it is often used as a measure of general environmental attitudes (Klöckner, 2013). When it comes to values the CADM incorporates self-transcendence and self-enhancement values. Self-transcendence values are those that go beyond ("transcend") an individual and their immediate social circle, meaning that an individual sees others as equals and cares for their wellbeing (Klöckner, 2013; Stern, 2000). Self-transcendence values can be conceptualised as having two dimensions: altruistic values which relate to being concerned about other human beings, and biospheric values which relate to concerns about nature and the biosphere (Stern & Dietz, 1994). Self-enhancement or egoistic values are those through which individuals focus more on themselves than others emphasising power, achievement, and hedonism (Klöckner, 2013; Stern, 2000). In general, self-transcendence values lead to

more environmentally focused behaviours, while self-enhancement values don't (Klöckner, 2013).

According to the CADM, personal norms are also influenced by an individual's perceived behavioural control and social norms (Fig. 2.1; Klöckner, 2013). Perceived behavioural control is someone's perceived ability and opportunity to carry out a particular behaviour (Ajzen, 1991; Klöckner, 2013). Social or subjective norms refer to the social pressure an individual perceives to perform or not a behaviour (Ajzen, 1991; Schwartz, 1977) and can be divided into injunctive and descriptive norms (Keizer & Schultz, 2018). Injunctive social norms define the behaviours commonly approved or disapproved within a social group, while descriptive social norms refer to the most common behaviour displayed by the members of a social group (Keizer & Schultz, 2018).

In turn, personal norms, social norms, and perceived behavioural control influence intentions, together with attitudes (Fig. 2.1; Klöckner, 2013). Attitudes are an individual's measure of how favourable would be for them to display a particular behaviour in a given situation. This evaluation is based on the individual's beliefs regarding the outcomes of displaying the behaviour, the likelihood of those outcomes materialising, and their favourability for the individual (Ajzen, 1991; Klöckner, 2013).

Finally, habits which are behaviours that are performed automatically under specific circumstances, are also included in the CADM (Klöckner, 2013). This is done to make the model more robust to describe behaviours that are repeated often, since frequent repetition erodes the influence of intentions while strengthening that of habits (Klöckner, 2013).

2.3. Background to the UK's woodland expansion efforts

2.3.1. The state of the UK's environment

The UK is one of the countries with the most degraded natural environments in the world. Its Biodiversity Intactness Index, which measures the number and abundance of native species

relative to their inferred original state in a particular area (Scholes & Biggs, 2005), has an estimated average value of 53% (McKie, 2021). This is well below the global average of 75% and much lower than the safe planetary boundary of 90% average biodiversity intactness (McKie, 2021; Natural History Museum London, 2021).

The latest UK's state of nature report (Burns et al., 2023) shows the abundances or distributions of monitored species on average shrank since monitoring started in the 1970s and 80s. Extinction threatens 16.1% of the 10,008 species with an IUCN extinction risk assessment in Great Britain, with 2% of them being already extinct (Burns et al., 2023). Moreover, in 2019 only 8% of UK habitats of European importance were in a favourable status with the remaining showing different levels of an unfavourable status (19% improving, 40% stable, 23% declining; JNCC, 2024).

The UK government is focused on improving the union of nations' environment. One of their main strategies to do so is increasing nature's protection and promoting nature recovery inside and outside protected areas (UK Government, 2018). Additionally, the government also plans to reduce emissions by roughly 78% by 2035 compared to 1990 levels and to be net zero by 2050 (UK Government, 2021a). Their climate change strategy includes ecosystem restoration and focuses on two of the most carbon dense ecosystems in the UK: peatlands and woodland.

2.3.2. UK woodlands and woodland expansion efforts

Woodlands have been a large feature of the British landscape since the last glaciation ended (Rackham, 1986; Raum, 2020). An increase in the human population of the British Isles coupled with a rise in the use of timber for different purposes, led to a huge reduction in woodland area over time (Raum, 2020). By the beginning of the 20th century, less than 5% of the UK's land area was woodland (Forest Research, 2024). This coupled with the fact that World War I cut the UK's timber import lines causing a timber crisis, pushed forestry and homegrown timber production up the national strategic agenda, culminating in the Forestry

Act of 1919 and the creation of the Forestry Commission (FC) to promote afforestation (Raum, 2020; Raum & Potter, 2015). Until then woodland creation had been mainly the remit of private landholders (Raum, 2020), with the establishment of the FC arguably representing a change in paradigm toward an industrialised forestry sector managed by the state (Raum & Potter, 2015).

Since then, woodland area has been increasing steadily resulting in today's approximate 13.5% woodland area, which is still relatively low when compared to Europe or the World, both with a 46% and 31% forest cover respectively (Forest Research, 2024). Today, the UK's wooded land is almost evenly split between native and non-native woodland. Only 2.5% of the UK's land is considered Ancient Woodland, meaning that it has been forested since 1600 in England, Wales, and Northern Ireland, and 1750 in Scotland. Woodlands can be ancient but not native. Many ancient woodlands were felled and replanted with conifer plantations during World War II (WWII). These are known as Plantations in Ancient Woodland Sites. They comprise about 39% of the total Ancient Woodland area. The remaining 61% is occupied by Ancient Semi Natural Woodlands which are predominantly native (Reid et al., 2021). Native UK woodlands are highly degraded, with only 7% considered to be in favourable ecological condition (Ditchburn et al., 2020).

The current UK overall goal is to increase woodland creation rates to 30,000 hectares a year by 2025 (UK Government, 2021a). This goal aligns with the Climate Change Committee's recommendation to raise yearly afforestation rates to 30,000ha by 2025 and 50,000ha by 2035, with the ultimate goal of expanding woodland area to 18% of the UK by 2050 (Climate Change Committee, 2020). As the issues of environment and forestry are devolved, each of the four UK nations—England, Scotland, Wales, and Northern Ireland—manages them independently (The Parliamentary Office of Science and Technology, 2021). After decades of decline, UK wide planting rates hit a minimum in 2016. Since then, however, planting rates have improved, driven in part by the current UK wide target and subsequent national targets and schemes. In 2024 planting rates reached 20,660 hectares, a great increase, but still far

from what is needed to meet the UK wide 30,000 hectare target for this year (Forest Research, 2024).

Although, non-governmental entities support woodland creation through schemes such as the Woodland Trust's MOREwoods which provides funding and advice to create new woodlands (Woodland Trust, 2021). The main source of woodland creation support in the UK are national governments.

The history of woodland grants and loans dates back to the creation of the FC in 1919, starting with the "Planting Grants" of 1919. The FC was established as a semi-autonomous agency of the government, with ability to buy and plant land, as well as to supply funding, advice, and assistance for woodland creation. During its first fifty years, the organisation centred on industrial forestry focused on timber production and supply, and on boosting national standing timber reserves by planting non-native even-aged woodlands. Throughout that period, FC increased the amount of land under its control, opening some of its less productive forest to the public as interest in the recreational aspects of woodland grew during the 1930s. WWII decimated timber reserves causing another timber crisis. Private landholders suffered massive woodland asset losses, increasing the focus of government and the FC on private woodlands, and spurring the enactment of a series of Forestry Acts, including the Forestry Act of 1947, which supported the restocking of private woodlands via the 'Dedicated Woodland Scheme', and the Forestry Act of 1951, which further supported the re-establishment of private woodlands via the 'Small Woods Grant Scheme' of 1951 and the 'Approved Woodland Grant Scheme' of 1952. This period also coincided with the transformation of ancient broadleaved woodlands into conifer Plantations in Ancient Woodland Sites with the associated loss of biodiversity (Raum & Potter, 2015).

Over the years following WWII, perceptions of forestry in the UK slowly changed towards a more multifunctional paradigm, under which woodlands should produce timber, but also provide recreational opportunities, enhance natural beauty, and contribute to wildlife conservation. This change in paradigm solidified in the late 1960s and prevailed throughout

the 1970s and 80s. During that time international influences and obligations grew in importance in the forestry policy space, as did the weight of the amenity and wildlife conservation values of woodland. The 1985 Wildlife and Countryside Act formally established the need for a multi-functional forestry sector with a reasonable balance between timber production, enhancement of natural beauty, and wildlife conservation. Also in that year, the FC published its Broadleaves Policy aiming to stop the conversion of broadleaved woodlands into conifer plantations and set up the “Broadleaved Woodland Grant Scheme” to assist in the rehabilitation and creation of multifunctional broadleaved woodlands (Raum & Potter, 2015). Shortly after, in 1988, the FC introduced the Woodland Grant Scheme 1 (WGS1) (Forestry Commission, 2016a; Natural Resources Wales, 2018; Raum & Potter, 2015; Scottish Forestry, 2019a) in response to changes to the UK’s fiscal policy that removed forestry’s exemption from income tax in place since 1909 (Raum & Potter, 2015). The Farm Woodland Scheme accompanied WGS1 to incentivise woodland creation on agricultural land. The WGS1 and those following it, widened the scope of their predecessor, the Forestry Grant Scheme (1981-1988), to a broader set of objectives beyond timber production, including landscape, wildlife, and recreation aspects. Overall, during this period the amount of conifer plantations created reduced significantly (Raum & Potter, 2015).

The dawn of the 1990s marks another change in the forestry paradigm of the UK towards sustainable forestry. This was heavily influenced by a growing international focus on sustainable development, epitomised by the United Nations (UN) Earth Summit of 1992 in Rio de Janeiro (Brazil) and some of the international agreements stemming from it: UN Convention on Biological Diversity, UN Convention on Climate Change, UN Forest Principles, or EU Habitats Directive. Around this time the concept of sustainable forest management emerged and was endorsed by the UK government, leading to the publication of the first “UK Forestry Standard: The Government’s Approach to Sustainable Forestry” in 1998, which outlines best practice in UK forestry (Raum & Potter, 2015). The standard was preceded by the Forestry Policy for Great Britain of 1991, which replaced WGS1 with the Woodland Grant Scheme 2

(WGS2) in 1991 (Forestry Commission, 2016b; Natural Resources Wales, 2018; Raum & Potter, 2015; Scottish Forestry, 2019b). The Farm Woodland Scheme was replaced by the Farm Woodland Premium Scheme in 1992 (Raum & Potter, 2015). The WGS2 ended in 1994 when the Woodland Grant Scheme 3 (WGS3) started (Forestry Commission, 2016c; Natural Resources Wales, 2018; Scottish Forestry, 2019c). The process of devolution—transfer of powers from the UK’s central government to its constituent nations—has been ongoing since the 18th century (Torrance, 2022), but 1998 marked a milestone, since that year Scotland, Wales, and Northern Ireland set up their own governments with legislative and executive power in devolved matters (Civil Service, n.d.; Torrance, 2022). Scotland and Wales achieved this through separate referendums in 1997, whilst Northern Ireland achieved devolution in 1998 through the Good Friday Agreement, returned to direct rule in 2002, and restored devolution in 2007 (Civil Service, n.d.). As mentioned earlier, forestry is one of the devolved issues (Lawrence et al., 2009; Raum & Potter, 2015; Wong et al., 2015), therefore WGS3 marked the end of UK wide funding. The program ended in England, Wales, and Scotland in 2004 (Forestry Commission, 2016c), 2006 (Natural Resources Wales, 2018) and 2003 (Scottish Forestry, 2019c) respectively. In Northern Ireland, the funding seems to have continued until at least 2007, when it was incorporated into the Northern Ireland Rural Development Programme from 2007 to 2013 as Woodland Grant Scheme (DAERA, 2015; Forest Service, 2010).

The 2000s have been characterised by an increasing focus on the CBD’s Ecosystem Approach—a *strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way* (CBD, 2023)—and the provision of ecosystem services within forestry due a growing conscience of environmental crises, particularly the climate and biodiversity crises (Raum & Potter, 2015). This is patent not only in governmental documents (e.g. Forestry Commission Scotland, 2009; Welsh Government, 2018; UK Government, 2021c, 2018a, 2021b; Northern Ireland Executive, 2021), but also in the creation of woodland and peatland carbon markets (UK Woodland

Carbon Code, 2019; IUCN National Committee United Kingdom, 2023), as well as in higher woodland expansion targets and objectives. Current woodland expansions ambitions and objectives per UK nation, and their supporting funding schemes are outlined below.

2.3.3. Northern Ireland woodland creation

In 2006, Northern Ireland pledged to increase its forest cover to 12% by about 2056 (Forest Service, 2006), which has contributed to increase woodland cover from 6% to 9% over the last 18 years (Forest Research, 2024). In its latest draft of its Environment Strategy the nation pledged to increase its woodland area to 8.8% by 2030 (Northern Ireland Executive, 2021), a goal it has already achieved (Forest Research, 2024). From 2007, funding to create woodlands has been granted through the Northern Ireland Rural Development Programme, first in the form of Northern Ireland's own Woodland Grant Scheme and the Farm Woodland Grant Scheme (DAERA, 2015), which were later replaced by the Small Woodland Grant Scheme and the Forest Expansion Scheme in 2014 (DAERA, 2019). These have been recently boosted via the Forest for Our Future Programme (2020) which aims to plant 18 million trees in 10 years (Ares et al., 2021).

2.3.4. Wales woodland creation

Wales, currently 15% of it wooded (Forest Research, 2024), also wants to increase the extent of its woodlands, committing to raise woodland expansion rates to 2000ha a year by 2020 and sustaining them past 2030, with a priority for native and mixed woodlands (Welsh Government, 2018). However, planting rates remain low (700ha in 2024), being some of the lowest (80ha in 2020) in recent years (Forest Research, 2024).

In Wales, WGS3 was replaced in 2006 by Better Woodlands for Wales until 2011 when the Glastir Woodland Creation Scheme started (Forest Research, 2022; Rose, 2011). Glastir Woodland Creation was replaced by the Woodland Creation Offer in 2022, which comprises

the Small Grants - Woodland Creation scheme for the creation of woodlands below 2 hectares; the Woodland Creation Planning scheme to finance woodland creation plans; and the Woodland Creation Grant for woodlands over 2 hectares (Welsh Government, 2022b). Additionally, the National Forest for Wales programme aims to create new woodlands and restore ancient ones (Welsh Government, 2021) and provides funding through two grants: The Woodland Investment Grant (TWIG) introduced in 2021 to enhance and expand woodlands, and the Coetiroedd Bach 'Tiny Forest' Grant which aims to create 100 'Tiny Forests' (well managed accessible woodlands that allow local communities to be involved in woodlands and nature) between April 2023 and the end of March 2025 (Welsh Government, 2021).

The Woodland Restoration Scheme (2022) offers grants to replant larch (*Larix decidua*) stands affected by the fungal pathogen *Phytophthora ramorum* and encourages the use of a diversity of species when replanting (Welsh Government, 2023).

Finally, the Welsh Government has proposed introducing a set of universal actions that farmers will need to do to receive payments from the future Sustainable Farming Scheme. Notably, from an ecosystem restoration and woodland creation perspective, farms accessing this future subsidy might be required to have 10% woodland cover and manage 10% of the land to maintain and enhance semi-natural habitats, as well as a host of other environmentally beneficial actions (Welsh Government, 2022a). It remains to be seen whether this proposal will be accepted, but it is clear that currently the Welsh government wants to incentivise woodland expansion and more environmentally responsible land management.

2.3.5. Scotland woodland creation

Scotland is the UK's most forested nation (Forest Research, 2024) and aims to increase its woodland area to 21% by 2032 (Scottish Government, 2019). To do this, they propose raising the current rate of woodland creation from 11,050ha to 15,000ha a year by 2025, of which

3000 to 5000ha should be native woodlands (Scottish Government, 2019). This target has been revised upwards to 18,000ha a year by 2024/25 in the latest update to the Scottish Government Climate Change Plan (The Scottish Government, 2020). They also aim to raise the amount of native woodland in good condition and to restore 10,000ha of native woodland, as well as making sure that protected sites are under good conservation management (Scottish Government, 2019).

In Scotland, the WGS3 was first replaced by the Scottish Forestry Grant Scheme (2003-2006). When this program ended the government introduced the Scottish Rural Development Programme (2007-2013), which was later replaced by Forestry Grant Scheme in 2015 after a two-year gap in funding (Forest Research, 2022; Scottish Government, 2021). Parallel to the Forestry Grant Scheme, the Scottish Government has also introduced the Small Woodlands Loan Scheme (2021), which provides 50% of the funding needed to create a woodland before it is created, and the rest of the Forestry Grant Scheme grant payment afterwards. The loan only applies to projects smaller than 50 hectares and has an upper limit of £40,000 per applicant (Scottish Forestry, 2021, 2022).

2.3.6. England woodland creation

England with 10% of its area wooded (Forest Research, 2024) aims to triple its planting rates by 2025, which were circa 2000ha a year in 2020/21 when the England Trees Action Plan was introduced (UK Government, 2021b) and have since increased to 4500ha a year in 2024 (Forest Research, 2024). The English government aims to do this creating mainly native broadleaf woodland and commits more than £500 million to the achievement of that goal through the Nature for Climate fund (UK Government, 2021b).

In England, the English Woodland Grant Scheme replaced WGS3 in 2005. This was later replaced by the Countryside Stewardship Woodland Creation Grant in 2015 (Forestry Commission, 2023b). The Countryside Stewardship still exists today, but from 2021 woodland

creation funding is granted through an independent scheme: the England Woodland Creation Offer (UK Government, 2021c). Nonetheless, there are still a few funding streams related to forestry within Countryside Stewardship: Woodland Management Plan, Woodland Tree Health, and Woodland Improvement grants (Forestry Commission, 2023a). These are mainly concerned with woodland management and health.

The new England Woodland Creation Offer has been and is complemented by a series of ancillary grants. The HS2 Woodland Fund (February 2018) finances native woodland creation and restoration of Plantations in Ancient Woodland Sites projects within a 25-mile radius of the first phase of the HS2 rail line joining London and the West Midlands. The fund is administered within the England Woodland Creation Offer since May 2023 (Forestry Commission, 2018, 2023a). The Woodland Creation Planning Grant which started either in 2015 (UK Government, 2015) or 2018 (UK Government, 2018b), and was reviewed in 2020 (UK Government, 2015), provides funding to produce UK Forestry Standard compliant woodland creation plans (UK Government, 2018d). The UK government also incentivises woodland creation in England via the Woodland Carbon Guarantee (2018), where they sign agreements with landholders to buy their woodland carbon credits at a guaranteed price (UK Government, 2019). Another carbon focused scheme was the Woodland Carbon Fund (2018 - 2021), which offered funding to create productive woodlands for carbon sequestration (UK Government, 2018c).

England is also implementing other initiatives such as the Forestry England Woodland Partnership (2021), through which Forestry England offers to lease land from different landowners to create woodlands (Forestry England, 2021). Other notable woodland creation initiatives in England are: the Urban Tree Challenge Fund which finances tree planting in urban and peri-urban areas; Trees for Climate which invests in tree planting on community forests across England; or The Northern Forest which is a partnership between the Woodland Trust, The Mersey Forest, City of Trees, White Rose Forest, and Humber Forest, aiming to increase the amount of woodland cover in Northern England (Community Forest Trust, 2023).

2.4. Study area

I focused my study on the area in and around the Cairngorms National Park as it has high levels of both woodland creation and management funding uptake relative to surrounding areas (Scottish Forestry, 2019a, 2019b, 2019e, 2019d, 2019c)

The Cairngorms National Park was designated in 2003 and is the largest in the United Kingdom (UK). Located in Northeast Scotland, it straddles the Perth and Kinross, Angus, Aberdeenshire, Moray, and Highland councils. The national park is home to over 18,000 people and encompasses more than 150 independently managed landholdings owned mainly by private individuals and organisations. The remainder of the land is owned by non-governmental organisations, the Crown, and public bodies (Cairngorms National Park Authority, 2015, 2023).

Woodland covers over 16% of the national park (Cairngorms National Park Authority, 2022). Most of this woodland is native, with Scots pine as the dominant species, both in commercial and non-commercial forests (Cairngorms National Park Authority, 2018). The extent of woodland within the park is expected to increase as part of efforts to manage 50% its area mainly for ecosystem restoration by 2045. These efforts rely on better moorland management, woodland expansion, and the restoration of peatlands and rivers amongst other initiatives (Cairngorms National Park Authority, 2022).

Land uses within the national park are dominated first by moorland managed for field sports (mainly deer stalking and grouse shooting) and second by farming (mainly rough grazing), with a smaller extent managed for conservation and forestry (Cairngorms National Park Authority, 2015). The areas surrounding the national park also supports a mix of land uses. Nonetheless, farming is even more prevalent there, particularly in areas immediately to the east and south of the national park, which have better soils suited for arable farming (Space Intelligence, 2023; Space Intelligence & NatureScot, 2023).

The current patterns of land ownership and use within the national park and other areas of the Scottish Highlands have their roots in a historic process known as the Highland Clearances. This process took place between the 1700s and 1800s. It led to the concentration of land ownership in a few hands, with land use changing to reflect the profit-driven priorities of new landholders. This change in land use happened in two waves: a first shift from intensive cattle raising on small farms to extensive sheep grazing in large landholdings; and later, as wool prices fell and imported lamb outcompeted domestic production, a second shift to recreation for wealthy visitors, primarily deer stalking, along with other hunting and fishing. These new land uses required less labour, which combined with events like the mid-1800s potato famine, resulted in the progressive depopulation of the Scottish Highlands. The forest area of the Highlands also decreased during this time, as forest were cleared for profit and struggled to regenerate due to increased grazing pressure from deer and sheep, along with regular burning of open areas to maintain habitats important for game species, especially moorland for red grouse. The impacts of the Highland Clearances are evident to this day. Nonetheless, NGOs and local communities have acquired some Highland estates in recent years (Hobbs, 2009) and there seems to be growing interest in ecosystem restoration and natural capital amongst old and new landholders (Burton et al., 2019; Glendinning & Merrell, 2023; Hobbs, 2009).

2.5. Research ethics

This study was granted ethics approval by Imperial College London's Science Engineering Technology Research Ethics Committee (SETREC reference number 22IC7888; **Appendix A**).

PART 1

DRIVERS OF MIXED NATIVE WOODLAND CREATION

3. GENERAL INTRODUCTION TO PART ONE

Ecosystem restoration at scale depends on people's decisions, particularly those of landholders. Therefore, understanding what drives landholders' decisions to engage in ecosystem restoration is crucial.

In the introduction to this thesis (**Chapter 1**), I present ecosystem restoration and its adoption by people, noting that forests have especially captured public interest among other restorable ecosystems (Temperton et al., 2019). I then describe how, while other woodland types can contribute to restoration, mixed native woodlands—when created in the right places—are considered to have the highest potential for ecosystem restoration (Di Sacco et al., 2021; Gann et al., 2019) due to their superior environmental benefits (e.g. Allek et al., 2022; Hua et al., 2022; Wang et al., 2021; Waring et al., 2020). Concluding that as such, understanding what drives landholders to create mixed native woodlands can offer valuable insights for broader forest restoration efforts.

As shown in **Chapter 1**, basing our understanding of landholders' decisions regarding mixed native woodland creation on established scientific theories has several benefits. First, it contributes to build a robust understanding of the factors driving landholders to adopt ecosystem restoration initiatives through the accumulation of comparable studies (Muthukrishna & Henrich, 2019). And second, it minimises the risk of spurious conclusions (Smaldino & McElreath, 2016). Despite that, existing woodland creation research seldomly focuses on decision to create mixed native woodlands specifically (Hemery et al., 2018, 2020; Kaine et al., 2023; Lawrence & Dandy, 2014; Tran et al., 2019), and is either atheoretical (e.g. Hemery et al., 2018, 2020; Hopkins et al., 2017; Jellinek et al., 2013; Ross-Davis et al., 2005; Tran et al., 2019), or based on theories of individual decision-making (e.g. Bosshard et al., 2025; Chung et al., 2020; Kaine et al., 2023; Karppinen, 2005; Swart et al., 2023).

In this first part of the thesis, I present two separate analyses aimed at deepening our theory-based understanding of what drives landholders' (both groups and individuals) decisions to

create mixed native woodland (**Objective 1**), to then discuss the potential mechanisms underlying my findings, and their implications for policy and practice (**Objective 3**). In both analyses, I focus on landholders' decisions to create mixed native woodlands in my study area (**Section 2.4**), analysing data collected through the Drivers of Native Woodland Creation Survey (**Section 4.1.1 and 4.1.2**), which is based on DOIT.

In the first analysis (**Chapter 5**) of this first part of the thesis, I explore what characteristics of landholders, ecosystem restoration initiatives, and the context in which they interact, influence landholders' decisions to create mixed native woodland on their land and how (**Objective 1**). In this analysis, I test theory in the sense that the variables considered by the model are all important for adoption decisions according to DOIT. Nonetheless, my variable selection process is data-driven (Berk et al., 2013; Heinze et al., 2018; Staerk et al., 2024; Ullmann et al., 2024), thus completely atheoretical, resulting in a generic exploration of what DOIT variables drive my landholders' decisions to create mixed native woodland in my study area (**Section 2.4**).

Data-driven variable selection approaches are common practice. Nonetheless, their dependency on the specific data and method used to select variables makes them stochastic, meaning they involve an element of randomness. This can result in additional uncertainty and bias in model estimates, leading to model instability and unreliable results in calculations done after running the model, such as standard errors, confidence intervals, or p-values. The alternative is a priori variable selection, where variables are selected based on prior knowledge of the subject or phenomena studied, such as that gained through experience, or captured in previous scientific studies and theories (Berk et al., 2013; Heinze et al., 2018; Staerk et al., 2024; Ullmann et al., 2024). These methods have their caveats too, particularly if they omit key variables or include biasing ones in models, as both issues can affect the validity of model estimates (Byrnes & Dee, 2025; McElreath, 2020; Pearl, 2009; Siegel & Dee, 2025; Staerk et al., 2024). The suitability of a variable selection approach (data-driven vs. a priori) depends on the ultimate goals of a research project (Staerk et al., 2024). With a priori

variable selection being particularly well suited for hypothesis-based research (Staerk et al., 2024), such as that presented in this first part of the thesis, where I essentially test whether DOIT's hypothesized relationships between key variables and adoption hold true in an ecosystem restoration context.

Accordingly, in the second analysis (**Chapter 6**) of **Part 1**, I use an a priori variable selection method informed by my theoretical framework (Table 2.1; **Appendix D**), placing even greater emphasis on my theory-based approach. I achieve this further emphasis on theory in two ways. First, by focusing my statistical analysis on attributes of my theoretical framework (Table 2.1; **Appendix D**) that according to DOIT explain most of the variability in adoption decisions (i.e. relative advantage, compatibility, complexity, observability and trialability; Rogers, 2003). And second, by explicitly considering how my outcome of interest (decisions to create mixed native woodland creation) is influenced by its predictors (my DOIT framework attributes and the variables within them), as well as how predictors interact amongst themselves, using a causal model (Fig. 5.1) based on DOIT and the knowledge of Scottish woodland creation I gained through research and fieldwork. The causal model's purpose is to help me pinpoint the variables I need to control for in my statistical model to reduce bias when estimating the influence of my focus variables on decisions to create mixed native woodland (Byrnes & Dee, 2025; Heinze et al., 2018; McElreath, 2020; Pearl, 2009; Siegel & Dee, 2025; Staerk et al., 2024).

Beyond employing a theory-based a priori variable selection approach, I further distinguish my second analysis (**Chapter 6**) from its predecessor (**Chapter 5**) by using a Bayesian framework, which enhances the interpretability of its results (Albers et al., 2018; Fornacon-Wood et al., 2022; Hespanhol et al., 2019; McElreath, 2020). A classic example of how Bayesian statistics can be easier to interpret is the difference between frequentist and Bayesian confidence intervals—the latter are more commonly known as credible intervals. For example, a frequentist 95% confidence interval represents the range of values around a sample's statistic (e.g. the mean) that would contain the true population statistic value in 95%

of hypothetical repetitions of the study with other samples. In contrast, a Bayesian 95% credible interval represents the range of values within which the true population statistic lies with a 95% probability, based on a given model and dataset (Fornacon-Wood et al., 2022; Hespanhol et al., 2019). Thus, although frequentist and Bayesian confidence intervals can be numerically very similar—especially when Bayesian methods use uninformative priors (Albers et al., 2018)—only Bayesian methods allow interpretations about how likely estimates are to reflect the true population values. This facilitates interpretation, since most people—including researchers using frequentist methods—tend to intuitively interpret statistical results this way (Albers et al., 2018; Fornacon-Wood et al., 2022; Hespanhol et al., 2019; McElreath, 2020).

Additionally, the R packages I used in my second analysis (i.e. Bürkner, 2017; Stan Development Team, 2024) are more flexible than those I used in **Chapter 5** (i.e. Friedman et al., 2010; R Core Team, 2024; Simon et al., 2011; Tay et al., 2023), enabling me to achieve a more accurate representation of my data. For instance, in my second analysis I model Likert item data as ordinal variables with a monotonic effect—consistent positive or negative effect that varies in size across adjacent variable levels—on the outcome (Bürkner & Charpentier, 2020), something my previous approach did not accommodate.

Overall, this yields more robust and interpretable results, that allow me to interrogate the influence of the factors DOIT suggests are most important for adoption decisions in a restoration context, while controlling the biasing effects of other factors on those estimates.

4. METHODOLOGY, RESULTS AND LIMITATIONS SHARED BY BOTH ANALYTICAL CHAPTERS WITHIN PART ONE

4.1. Methods

4.1.1. Survey design

In both analyses in this first part of the thesis I aim to further our theory-based understanding of what drives landholders (both individuals and groups) to create mixed native woodlands specifically. I do so by exploring how different characteristics of woodland creation interventions (innovations), landholders (potential adopters) and their physical, environmental, and social context (context) influence landholders' decisions to create mixed native woodland in my study area (**Objective 1**), to then investigate the potential mechanisms underlying my findings, and their implications for policy and practice (**Objective 3**). To achieve this, I designed the Drivers of Native Woodland Creation Survey.

The survey was divided into three sets of questions relevant to the analyses outlined in this part of the thesis: (i) participant screening questions, (ii) background questions, and (iii) questions targeting DOIT constructs.

Through the participant screening questions I ensured that respondents were involved in both the management of the land they referred to in their response, and decision-making processes that lead to changes in the use of that land, such as the decisions to create a new woodland on it or not. If respondents did not meet both criteria, their responses were not recorded.

Background questions focused on the landholding, their woodland creation activity, and the respondent's organisation and personal data.

For the set of questions targeting DOIT constructs I used the framework outlined in Table 2.1 as a guide. Overall, I considered 44 sub-attributes stemming from the 15 attributes and three main components in my DOIT framework (Table 2.1; **Appendix D**). I operationalised the

framework to suit the UK woodland creation context, deeming seven context and two woodland creation initiative sub-attributes irrelevant and excluding them from my survey.

I designed questions (n=61) targeting the remaining 35 DOIT sub-attributes to explore their influence on decisions to create woodland. Most of these questions (n=45) were Likert items with five response levels (e.g. Strongly disagree to Strongly agree). The remaining questions (n=16) were categorical (n=15) and binary (n=1).

The survey had two versions, one targeted at landholders who had created woodland and another at those who had not.

The main difference between survey versions was the time frame they asked respondents to consider when answering questions targeting DOIT constructs, as well as some background questions. The phrasing of these questions was the same in both surveys. However, the survey version for landholders that had created woodland asked respondents to think back to the time when they were still deciding to create new woodland on the landholding they represent, while the survey version for those that hadn't created woodland asked them to respond in the present.

My surveys and full DOIT framework are available in **Appendixes B, C, and D**.

4.1.2. Sampling and data collection

I collected data through both in-person (n=59) and online (n=25) surveys. I targeted landowners or managers within the study area involved in land use decisions. As no unified registry of this population exists, I used a combination of non-probability methods to obtain a sample of respondents, namely convenience and snowball sampling (Stratton, 2021). My final sample included 84 landholders. Only 77 responses (59 in-person, 18 online) were within my study area, thus included in the analysis.

I chose to split my data collection across in-person and online surveys to provide flexibility to my respondents and maximise my sampling reach given my limited field team. For my in-person survey, I drove around the study area visiting landholdings, inviting them to take part in the study (convenience sampling (Stratton, 2021)) and asking them for references of other local landholders that might be interested in participating (snowball sampling (Stratton, 2021)). I distributed the survey online via organisation newsletters, and mailouts to publicly listed emails for estates, farms, and other rural businesses. If landholders were unavailable during/for in-person visits, I invited them to complete the survey online. I used convenience sampling when collecting data online, advertising the survey and inviting recipients to participate. I ensured that my sample for in-person and online interviews did not overlap by collecting and screening, respondents' personal data and landholdings' locations.

I piloted the survey in my study area in April 2023 and collected data between July and September 2023. Pilot responses were included in analysis since the survey only needed minor changes post-pilot. I obtained informed written consent from all respondents before starting the survey.

4.1.3. Qualitative analysis

My survey includes an open-ended question designed to examine why adopters decided to create new woodland on their land. I analysed responses to this question using inductive coding (Thomas, 2006), developing codes for the justifications given by respondents to create woodlands as I read their responses. For example, I developed the codes "Grant income" and "Using poor land" after reading a response listing grant aid and using poor pasture as the main reasons to create woodland. I reused these codes whenever similar reasons were mentioned in other responses.

4.2. Results

4.2.1. Sample descriptive statistics

4.2.1.1. *Landholding types, tenure, sizes, and uses*

My sample is dominated by landholdings of less than 1,250 acres (~505 hectares) (70%), managed for profit (83%), for ten years or more (in some case much longer) (88%), by family organisations (83%) of less than five members (70%).

Most respondents (92%) were landowners directly managing the landholding they referred to in their responses. Some landowners (24%) also acted as landlords (21%) and/or licensors (3%) to others, whilst some tenanted (13%) or crofted (1%)—agricultural land tenure specific to the Scottish Highlands (Crofting Commission, 2025)—other land. Only 7% of all respondents were tenants (3%) and/or crofters (4%) with no ownership, but powers to decide how land was used.

Generally, decisions to create woodland had been or would be made as a group (62%), either collectively by all member of the organisation (45%) or by a select group of individuals (17%). For a third of respondents (33%) these decisions depended on a single individual.

Most of the 77 landholdings within my sample are farms (47%) or estates (30%), accompanied by crofts (11%), nature reserves (2%), or other landholding types (9%) such as private homes, and mixed farms and crofts.

The land use most often reported by respondents was farming (86%), followed by forestry (40%) and private enjoyment (38%). Nonetheless, the land uses reported were varied including wildlife conservation (32%), public recreation (27%), game/hunting (26%), horse grazing (3%), holiday lets (3%), fishing (1%), wind farms (1%), land-based crafts (1%), or therapy and meditation (1%). Most landholdings (56%) reported a mix of land uses, with some respondents (13%) reporting six or more distinct uses.

In terms of holding size or extent, although most landholdings (70%) were under 1,250 acres, some were much larger with one even surpassing 50,000 acres. Likewise, although small organisations (9 or less members) dominated my sample (84%), some respondents (4%) represented large organisations with more than 50 members.

4.2.1.2. New woodland creation

For the analysis, I differentiated between landholders who declared that they or their organisations had (adopters (n=31)) or had not (non-adopters (n=46)) created at least one mixed native woodland on the landholding they represented since their management started.

A total of 48 respondents had created new woodland, in many cases repeatedly, but 17 (35%) were non-adopters since they had created woodland but not mixed native one yet.

The extent of new woodland created was usually under 125 acres (73%), but most commonly under 12 acres (39%). Generally new woodlands were planted (87%), with only a few created through natural regeneration (35%). In some cases, the same landholding used both planting and natural regeneration (33%).

Only six landholders (13%) created woodland without using external funding. The rest funded their woodland creation projects using government funds (73%), non-governmental funds (6%), bank loans (2%), or other sources (4%). Two landholdings (4%) used a mix of funding sources.

4.2.1.3. Existing woodland

Seventy percent (n=54) of the 77 landholdings in my sample contained existing woodland, either before new woodland (mixed native and others) was created (61%) or at present if no new woodlands had been created (39%). Most of those landholdings (59%) had less than 125 acres of existing woodland.

Mixed native and predominantly native woodland were the most common types of existing woodland, being present in 50% and 37% of landholdings with existing woodland respectively. Thirty-one percent (n=17) of landholdings with existing woodland contained more than one type of existing woodland (e.g. native and non-native).

Most landholdings with existing woodland (mixed native and others) managed it for timber production, mainly through even aged clear-fells (41%), but also through uneven aged regular or irregular fells (28%), and coppicing (4%). Hunting (11%), as well as wildlife conservation through either active (26%) or passive (26%) management, were also common existing woodland management objectives. Thirty-three percent of landholdings with existing woodland did not manage it at all, whilst 4% managed some patches but not others. Thirty-nine percent of landholdings with existing woodland had a mix of management objectives.

Full sample descriptive statistics are available in **Appendix E**.

4.2.2. Qualitative results

My qualitative analysis revealed that the main reasons for woodland creation reported by adopters and non-adopters who had created woodland of any type were similar. Wildlife, using poor land, shelter, and amenity were amongst the top five reasons to create woodland for both groups. A higher proportion of adopters (A) than non-adopters (NA) mentioned: wildlife (A 39%, NA 24%); shelter (A 26%, NA 18%); diversifying habitats (A 16%, NA 12%); and finances (A 13%, NA 6%) as reasons to create woodland. Whilst the opposite was true for: amenity (A 13%, NA 29%); using poor land (A 26%, NA 29%); business diversification (A 3%, NA 18%); aesthetics (A 13%, NA 18%); grant income (A 13%, NA 18%); environment (A 13%, NA 18%); firewood (A 3%, NA 6%); and legacy (A 3%, NA 6%).

4.3. Limitations

The main limitation of both studies within **Part 1** is that I used non-probabilistic sampling methods, hence my results only apply to my sample and have limited generalisability to broader populations (Stratton, 2021). This is mainly due to selection bias (Catalogue of Bias Collaboration, Nunan, et al., 2017), since my respondent were self-selected. Future studies could avoid this by using probabilistic sampling if robust unified registries of land ownership for their focus area exist and are accessible.

Survey studies—like those in **Part 1**—can incur in a broad range of biases because of poor question and/or questionnaire design, and/or administration of the survey (Choi et al., 2005). I mitigated design flaws through careful crafting of my questions and questionnaire, and by piloting them. Biases linked to the administration of my survey were harder to mitigate.

Recall bias (Catalogue of Bias Collaboration, Spencer, et al., 2017) is a particular risk for both studies in **Part 1**, since when respondents had created woodland, I relied on their memories—which may be inaccurate—for some questions. To minimize recall bias, I piloted my surveys to ensure their layout and phrasing was effective and used mainly close ended questions (Bernard et al., 1984).

Respondents answering questions in a way they perceived as socially desirable, taking shortcuts (i.e. satisficing), and tending to select the ends (e.g. “Strongly disagree” or “Strongly agree”) or centres (e.g. “Neither agree nor disagree”) of my Likert items (Choi et al., 2005) are also risks for both studies in **Part 1**. I mitigated these risks through piloting, ensuring anonymity, and the use of simple neutral questions and a short questionnaire to avoid respondents’ fatigue.

5. LANDHOLDERS, WOODLAND CREATION INTERVENTIONS, AND THEIR SHARED CONTEXT: A GENERAL EXPLORATION OF THEIR CHARACTERISTICS' INFLUENCE ON DECISIONS TO CREATE MIXED NATIVE WOODLAND

5.1. Overview

In this chapter I describe the first analysis of my Drivers of Native Woodland Creation Survey (**Section 4.1.1 and 4.1.2**) data. As previously described in **Chapters 1 and 3**, in this initial analysis I examine decisions to create mixed native woodland as a proxy for the adoption of forest restoration initiatives. Through this chapter I aim to expand our theory-based understanding of what drives landholders' (both individuals and groups) to create mixed native woodland on the land they manage by investigating what traits of woodland creation interventions, landholders, and the context where they interact influence these decisions, and how (**Objective 1**). I achieve this through a modelling approach that is theoretical in its consideration of DOIT variables, but atheoretical in its variable selection, since it relies on a data-driven approach to determine what variables enter the model. As such, it represents a general exploration of which DOIT variables govern landholders' mixed native woodland creation decisions in my study area (**Section 2.4**). Finally, the implications for policy and practice are explored (**Objective 3**).

5.2. Methods

5.2.1. Variable selection

I use an elastic net regression based variable selection approach, implemented with the glmnet R package (Friedman et al., 2010; Simon et al., 2011; Tay et al., 2023). I chose this

approach due to the high correlation among my variables (collinearity and multicollinearity). Elastic net and lasso regressions have been shown to outperform other variable selection methods in identifying the direct predictors of an outcome—at least in a linear regression setting—particularly when there are lots of variables and correlations (Hanke et al., 2024).

Elastic net regression is a regularisation—reducing model complexity by penalising variable coefficients—and variable selection methodology, that combines the strengths of two existing regularisation techniques: lasso regression, which can regularise variable coefficients down to zero, thus performing variable selection; and ridge regression, which cannot perform variable selection, but regularises variable coefficients equally, dealing with correlated (collinear and multicollinear) variables effectively. Elastic net regression modulates the strength of the lasso and ridge penalties through the elastic net penalty parameter (α), which ranges from 0 (ridge regression) to 1 (lasso regression). The strength of the applied penalization is further controlled by a tuning parameter (λ) (Zou & Hastie, 2005).

I test a set of α s ranging between 0 and 1 in 0.1 increments, to determine my optimal model. I use cross-validation to find the λ that minimises binomial deviance—a measure of model fit for logistic regressions—for each α . I then compare the results for each α , considering the model with the smallest overall binomial deviance as the “best”, and extracting its variables. I repeat this process five times, each with a different starting point for the glmnet algorithm, comparing the recommended models in terms of their AIC and BIC scores. I use the 11 variables producing the model with the lowest AIC and BIC to run my statistical model (Table 5.1).

TABLE 5.1. Summary information for the “best” models resulting from each of the five runs of **Chapter 5’s** Elastic Net Regression variable selection process.

Seed	“Best” model information				
	Alpha	Number of variables	AIC	BIC	Variable names
12345	1	11	56.35	82.98	1 Initial costs - Money
					2 Expected changes to habitat for wildlife
					3 Expected changes to soil quality
					4 Compatibility with land use practices
					5 Economic wellbeing
					6 Landholding size
					7 Risk aversion
					8 Perceived competition for woodland creation resources
					9 Perceived knowledge and skills to create woodland
					10 Windiness in the landholding
					11 Decisions made by a single individual
56789	0.9	12	58.13	86.98	1 Initial costs - Money
					2 Expected changes to habitat for wildlife
					3 Expected changes to soil quality
					4 Compatibility with land use practices
					5 Economic wellbeing
					6 Landholding size
					7 Risk aversion
					8 Perceived competition for woodland creation resources
					9 Perceived knowledge and skills to create woodland
					10 Windiness in the landholding
					11 Decisions made by a single individual
					12 Resource slack - Time
101112	1	11	56.35	82.98	Idem to variables selected with seed 12345.
131415	0.6*	12	58.12	86.98	Idem to variables selected with seed 56789.
161718	0.5	13	59.92	90.99	1 Initial costs - Money
					2 Expected changes to habitat for wildlife
					3 Expected changes to soil quality
					4 Compatibility with land use practices
					5 Economic wellbeing
					6 Landholding size
					7 Risk aversion
					8 Perceived competition for woodland creation resources
					9 Perceived knowledge and skills to create woodland
					10 Windiness in the landholding
					11 Decisions made by a single individual
					12 Resource slack - Time
					13 Familiarity with woodland creation

*Alpha 0.2 produces the “best” model with this seed, but that model does not converge. Alpha 0.6 produces the second “best” model, this model converged, thus is reported here.

5.2.2. Statistical model

Since my outcome of interest, mixed native woodland creation, is binary, I developed a binomially distributed logistic regression implemented within a frequentist framework (Equation 5.1).

$$Y_i \sim \text{Binomial}(\pi_i)$$
$$\text{logit}(\pi_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_n X_{ni}$$

EQUATION 5.1.

Binomial logistic regression equation describing **Chapter 5's** model, where: " Y_i " is the binary outcome of mixed native woodland creation decisions for observation " i "; " π_i " is the estimated probability of mixed native woodland creation for observation " i "; " β_0 " is the intercept; " β_n " is the slope coefficient for predictor " n "; and " X_{ni} " is the observed values for predictor " n " and observation " i ". Model variables (1...n) are outlined in Table 5.2.

Most of my statistical model variables were measured using Likert items so are effectively ordered factors. Despite that and given software limitations, I model them as numerical variables (Robitzsch, 2020). The "Decisions made by a single individual" variable is binary and modelled as such (Table 5.2).

I run my model in R using the glm function of the stats package (R Core Team, 2024).

My data, variable selection, and model code are available in **Appendix J**.

TABLE 5.2. List of variables entering **Chapter 5's** statistical model (frequentist binomial logistic regression) and their a priori effects.

Variable (DOIT Element)	DOIT Component	DOIT Attribute	Data type	A priori effect direction*
Outcome				
Adoption of mixed native woodland creation	NA	NA	Binary	NA
Predictors				
Initial costs - Money	Innovation	Relative advantage	Numerical	Negative
Expected changes to habitat for wildlife	Innovation	Relative advantage	Numerical	Positive
Expected changes to soil quality	Innovation	Relative advantage	Numerical	Positive
Compatibility with land use practices	Innovation	Compatibility	Numerical	Positive
Economic wellbeing	Adopter	Social-economics	Numerical	Positive
Landholding size	Adopter	Size	Numerical	Positive
Risk aversion	Adopter	Risk orientation	Numerical	Negative
Perceived competition for woodland creation resources	Adopter	Competition	Numerical	Negative
Perceived knowledge and skills to create woodland	Adopter	Knowledge	Numerical	Positive
Decisions made by a single individual	Adopter	Innovation decision	Binary	NA
Windiness in the landholding	Context	Geographical setting	Numerical	Negative

5.2.3. Auxiliary analyses

I carried a set of auxiliary analyses to complement this chapter's statistical models' findings.

I used the 'correlation' function of the 'rcompanion' R package (Mangiafico, 2025) to test the correlations among all my DOIT variables to assess potential links between them (**Appendix J**). I chose this R package because it accounts for the data types (e.g. numeric, binary, ordinal) of the variables entering the correlation calculation and automatically selects the most appropriate type of correlation measure (e.g. Spearman, Pearson).

I counted the number of woodlands within different size brackets in publicly accessible Forestry Grant Scheme options (Scottish Forestry, 2019a) and claims (Scottish Forestry,

2019b) data, which identifies locations with approved and claimed Forestry Grant Scheme funding respectively. I did this to see whether the sizes of woodlands created using public funding hinted to a bias towards larger landholdings in woodland creation schemes. The publicly available data (Scottish Forestry, 2019a, 2019b) includes case references for each woodland creation project. When a project involved the use of multiple tree species or species mixes, its case reference is linked to multiple records in the database—each representing a specific tree species or mix. These individual records specify the area of woodland created with a particular tree species or mix. In such cases, I calculated the total woodland area for each project by summing all the areas associated to the same case reference.

5.3. Results

5.3.1. Statistical model results

My model results suggest that landholding size, landholder's expectations that woodland will increase habitat for wildlife, and perceptions that woodland creation is compatible with their current land use practices have a positive association with my landholders' decisions to create mixed native woodland. This is indicated by the positive and non-overlapping with zero 95% confidence intervals for those three predictors (Fig. 5.1, Table 5.3), which indicate I can be at least 97.5% confident their true (unknown) association with the outcome would be positive, based on hypothesized repeats of this study.

In contrast, my landholders' risk aversion and perceived windiness of their landholdings, as well as land use decisions depending on a single individual, have a negative association with mixed native woodland creation decisions. This is suggested by the negative and non-overlapping with zero 95% confidence intervals for those three predictors (Fig. 5.1, Table 5.3), which indicate I can be at least 97.5% confident their true (unknown) association with the outcome would be negative, based on hypothesized repeats of this study.

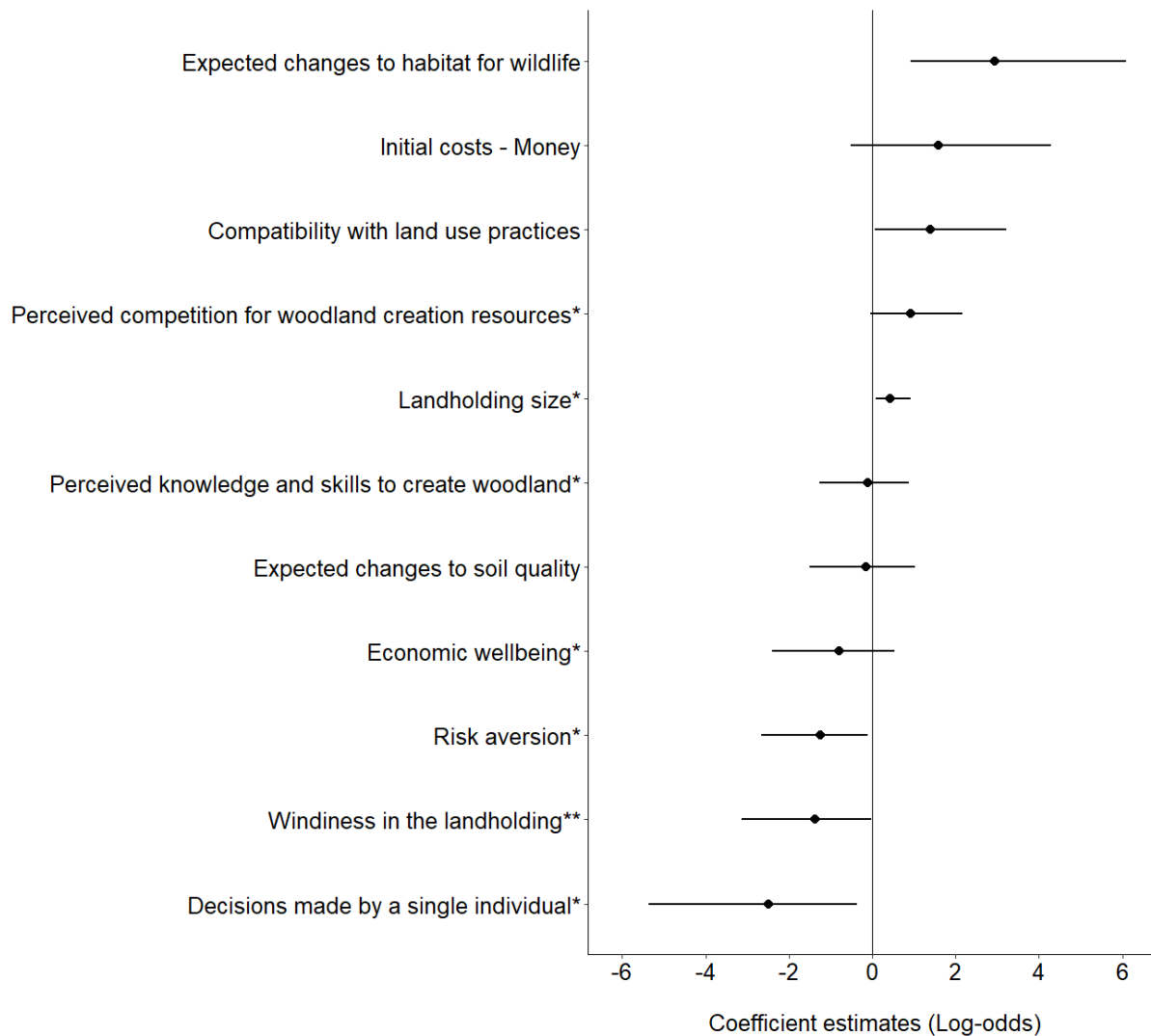


FIGURE 5.1.

Log-odds coefficients estimates for **Chapter 5's** model (frequentist binomial logistic regression) estimating drivers of decisions to adopt mixed native woodland creation initiatives. Black dots indicate mean coefficient estimates and black bars 95% confidence intervals. DOIT innovation, adopter, and context sub-attributes, are marked by zero, one, and two asterisks respectively.

TABLE 5.3. Results of the statistical model (frequentist binomial logistic regression) in
Chapter 5.

Variable	Mean [95% CI]	Standard error	p-value [95% CI] *	p-value replication interval *
Initial costs - Money	1.58 [-0.52, 4.29]	1.2095	0.1917 [0.001, 1]	[4.55x10 ⁻⁵ , 1]
Expected changes to habitat for wildlife	2.94 [0.91, 6.10]	1.2867	0.0221 [2.15 x10 ⁻⁵ , 0.74]	[4.18x10 ⁻⁷ , 1]
Expected changes to soil quality	-0.15 [-1.51, 1.04]	0.6251	0.8136 [0.028, 1]	[0.003, 1]
Compatibility with land use practices	1.39 [0.08, 3.23]	0.7697	0.0703 [1.63 x10 ⁻⁴ , 1]	[4.61x10 ⁻⁶ , 1]
Economic wellbeing	-0.79 [-2.41, 0.55]	0.7207	0.2751 [0.0023, 1]	[1.12x10 ⁻⁴ , 1]
Landholding size	0.43 [0.08, 0.91]	0.2044	0.0351 [4.76 x10 ⁻⁵ , 0.88]	[1.07 x10 ⁻⁶ , 1]
Risk aversion	-1.24 [-2.65, -0.1]	0.6321	0.0491 [8.58 x10 ⁻⁵ , 0.99]	[2.14 x10 ⁻⁶ , 1]
Perceived competition for woodland creation resources	0.93 [-0.04, 2.18]	0.5378	0.0850 [2.31x10 ⁻⁴ , 1]	[6.98 x10 ⁻⁵ , 1]
Perceived knowledge and skills to create woodland	-0.12 [-1.26, 0.89]	0.5392	0.8294 [0.03, 1]	[0.0028, 1]
Decisions made by a single individual	-2.48 [-5.37, -0.37]	1.2119	0.0408 [6.19x10 ⁻⁵ , 0.93]	[1.45 x10 ⁻⁶ , 1]
Windiness in the landholding	-1.38 [-3.13, -0.03]	0.7718	0.0737 [1.78x10 ⁻⁴ , 1]	[5.11 x10 ⁻⁶ , 1]

*p-value 95% confidence (or prediction) interval and p-value replication interval reported following Halsey, 2019, to state the uncertainty of the p-values of my study and future replicate studies respectively. Both intervals were estimated using the calculator provided by Lazzeroni et al., 2016.

5.3.2. Auxiliary analysis results

5.3.2.1. Correlations among DOIT variables

My data was composed by ordinal (e.g. Likert items) and binary (e.g. Yes or No) variables, as a result, the correlation measurements estimated were Kendall tau-c, Glass rank biserial, and Phi correlation coefficients for ordinal and ordinal, ordinal and binary, binary and binary variable pairs respectively (Mangiafico, 2025).

Following common practice (Schober & Schwarte, 2018), I interpret correlation scores of ± 0.7 or higher, between ± 0.4 and 0.69 , between ± 0.1 and 0.39 , and below ± 0.1 as an indication

of strong, moderate, weak, and negligible correlation among variables respectively. This allows me to assess potential relationships between variables that might clarify my statistical model results. For example, variables like income (Eves, 2015; cited in Ambrose-Oji et al., 2018), education, length of management, age, ownership, or labour availability (Hopkins et al., 2017), might interplay with landholding size influencing adoption decisions or intentions to create woodland. My DOIT variables included education, as well as proxies for labour availability (i.e. organisation size, resource slack in terms of time) and income (i.e. economic wellbeing and resource slack in terms of money). Nonetheless, only organisation size—number of people that are part of the organisation—is moderately correlated to landholding size (Kendall's tau-c = 0.49), while education (Kendall's tau-c = 0.197), economic well-being (Kendall's tau-c = -0.029), and resource slack in terms of money (Kendall's tau-c = -0.09) and time (Kendall's tau-c = -0.048), exhibited only weak or negligible correlations with landholding size. Similarly, resource slack in terms of time (Kendall's tau-c = 0.012) or money (Kendall's tau-c = -0.043), were negligibly correlated with organisation size, despite the intuitive assumption that larger organisations would have more time and financial resources available due to their scale.

Full results for correlation estimates among our DOIT variables are available in **Appendix J**.

5.3.2.2. Size of woodlands created using public funds

My analysis of publicly accessible data for areas with approved (Scottish Forestry, 2019a) and claimed (Scottish Forestry, 2019b) Forestry Grant Scheme funding, shows more than half of the projects are under 20 hectares (56% and 59% respectively) and that a majority of projects are under 50 hectares (78% and 82% respectively; Table 5.4).

TABLE 5.4. Size of projects with approved and claimed Forestry Grant Scheme funding listed in publicly available databases (Scottish Forestry, 2019a, 2019b).

Woodland size	Projects with approved funding		Projects with claimed funding	
	Count	%	Count	%
Less than 5ha	532	27%	497	29%
5 ha or more, but less than 10 ha	290	15%	263	15%
10 ha or more, but less than 20 ha	297	15%	271	16%
20 ha or more, but less than 50 ha	445	22%	385	22%
50 or more, but less than 100 ha	222	11%	178	10%
100 ha or more, but less than 200 ha	124	6%	92	5%
200 ha or more, but less than 300 ha	47	2%	29	2%
300 ha or more	37	2%	19	1%

5.4. Discussion

There is now wide agreement concerning the need to increase rates and extents of ecosystem restoration worldwide. Success in delivering restoration schemes depends heavily on the uptake of ecosystem restoration initiatives by landholders. In this chapter, I focused on forest restoration and undertook a DOIT based exploration of the factors driving the uptake of mixed native woodland creation in and around the Cairngorms National Park in Scotland. I found my landholders were more likely to have created mixed native woodland if they managed larger landholdings, or if they believed creating woodland was compatible with their land use practices or would increase habitat for wildlife on their landholding. In contrast, more risk averse landholders or those perceiving their landholding's windiness as unsuitable for woodland creation were less likely to have created mixed native woodland. Landholdings where land use decisions, such as woodland creation, depended on a single individual were also less likely to adopt mixed native woodland creation. These findings agree with the effects hypothesised by DOIT for these predictors of adoption. My results exemplify how DOIT could be used to understand forest restoration decisions and suggest UK mixed native woodland

creation could be boosted by modifying current woodland creation schemes to: (i) mainstream easy-to-understand evidence-based comparisons of the potential benefits of different woodland types so landholders can make better informed choices; (ii) emphasise woodland's compatibility with other land uses; (iii) foster flexibility within woodland creation actions, so landholders can more easily adapt them to their circumstances and needs; and (v) reduce landholders' risk perceptions by improving knowledge access and exchange, and improving information on wind damage risks, especially its evolution through a woodland's lifespan, its impacts on different woodland types, and mitigation effectiveness. Actions other than scheme changes could also contribute to raise mixed native woodland creation rates. These other actions could encompass updates to inheritance tax regulations to exempt non-commercial woodland and/or include woodland in Agricultural Property Relief; evaluations of whether schemes are inadvertently favouring larger landholdings; or allowing the removal of young woodland once grants are reimbursed or fines paid.

I found a landholding's size was positively associated to decisions to create mixed native woodland. This matches my DOIT-based a priori hypothesis (Table 5.2). Nonetheless, other DOIT-based studies of habitat restoration decisions amongst landholders have mixed findings regarding the effect of landholdings size, with larger landholdings being more likely to restore Brazil's Atlantic Forest (Pienkowski et al., 2024), but less likely to restore field edges in California's Sacramento Valley (Garbach & Long, 2017). Similarly, UK studies also report mixed findings for the effects of landholding size on woodland (mixed native and others) creation decisions (Staddon et al., 2021).

Larger landholdings can have more land-use flexibility, given their larger size, thus potential for more varied soils and terrains. Additionally, studies suggest other factors such as income (Eves, 2015; cited in Ambrose-Oji et al., 2018), education, length of management, age, ownership, or labour availability (Hopkins et al., 2017), might interplay with landholding size influencing adoption decisions or intentions to create woodland. I collected data for several of these factors (i.e. education) or their proxies (i.e. organisation size, resource slack in terms of

time and money, economic wellbeing). My tests assessing the correlation of those factors to landholding size (**Section 5.3.2.1; Appendix J**), suggest only the number of people that are part of an organisation (i.e. organisation size) is moderately correlated to landholding size. This suggests labour availability might be higher in larger landholdings within my sample. Paradoxically, a larger organisation size was not correlated to stronger perceptions of having enough time or money to create woodland.

Another explanation could be that current grant schemes are somehow favouring larger projects thus landholders. Whether this is the case is unclear and I am unaware of scheme evaluations exploring it. The Forestry Grant Scheme—the Scottish government's current woodland creation grant scheme—accounts for the scale of woodland creation projects in its scoring criteria. Nonetheless, it simultaneously does not impose a minimum size on projects, has supporting a range of project sizes as a budgetary aim, provides reduced funding to projects over 300 hectares to account for economies of scale, and recognises the 2024 budget available for large projects (50ha and above; and 20ha and above, for woodland creation and native woodland creation respectively) is insufficient to meet all applications (Scottish Forestry, 2024; Scottish Government, 2021). Furthermore, my analysis of publicly accessible data for areas with approved (Scottish Forestry, 2019a) and claimed (Scottish Forestry, 2019b) Forestry Grant Scheme funding, shows projects under 20 and 50 hectares predominate (Table 5.4). This shows smaller woodlands are created more often, suggesting smaller landholdings could be playing a significant role in woodland creation. I speculate here given the lack of publicly available data on the size of adopting landholdings.

I found compatibility with landholders' land use practices was positively associated to decisions to create mixed native woodland. This is congruent with DOIT (Table 5.2), previous woodland creation studies in the UK (Crabtree et al., 1998; Wynne-Jones, 2013), and studies on the diffusion of biodiversity conservation initiatives around the world (e.g. Jagadish et al., 2024; Romero-de-Diego et al., 2021).

Specific land use types are likely to influence whether mixed native woodland matches them or not. For instance, the dominance of silvopastoral systems—integrating trees and livestock—in UK agroforestry (~88% of UK agroforestry (Chanarin et al., 2022)), suggests woodland is more compatible with livestock rather than arable farming.

Similarly, landholdings with a game management and/or hunting interest might find woodland more or less compatible with their current land use based on their focal species (e.g. Duckworth et al., 2003; Ewald & Gibbs, 2019; Oldfield et al., 2003). For example, pheasant shoots when compared to grouse moors should perceive mixed native woodland as more compatible, since pheasants mainly live on woodland edges (Sage et al., 2020), whilst red grouse is a heathland and moorland specialist (Tharme et al., 2001).

Specific characteristics of landholdings (e.g. higher prevalence of poorer soils) might also influence landholders' perceptions of the compatibility of mixed native woodland with their land use practices. For example, in the UK, cereal, general cropping, cattle, and sheep farms in Less Favoured Areas—areas of poorer land where agricultural production is more challenging (Scottish Government, 1997)—were the most likely to participate in the Farm Premium Woodland Creation Scheme (Crabtree et al., 1998). This suggests that perceptions of compatibility might be driven by the lower opportunity costs of woodland creation on less productive land.

Specific practices within specific land use types, might also determine the compatibility of mixed native woodland with land use practices. For instance, current trends towards the use of larger farm machinery in arable settings (Keller et al., 2022) might result in more “*idle*” or “*odd bits*” (e.g. corners where harvesters turn) open for woodland or other land uses.

Expectations that woodland will increase habitat for wildlife, were also positively associated with decisions to create mixed native woodland as hypothesised by DOIT (Table 5.2). Intuitively, the chance to promote wildlife conservation was one of the main reasons for woodland creation reported by my respondents based on my qualitative questions. A majority

of these responses (62%) came from landholders who had created mixed native woodland. These results agree with past reviews of woodland creation in the UK, which found prevailing motives for woodland creation and management to be consistently related to natural and environmental enhancement, as well as personal enjoyment, whilst productive and economic motivations tended to be lower (Hemery et al., 2018, 2020; Lawrence et al., 2010; Lawrence & Dandy, 2014). Overall, these results suggest that landholders have clear woodland creation objectives and create the type of woodland they think is best to meet them.

I found more risk averse landholders were less likely to have created mixed native woodland. This again matches my DOIT-based hypothesis (Table 5.2). Likewise, another DOIT-based study looking at (amongst other things) the impact of landholders' risks perceptions on decisions to restore field edge habitats, found non-adopters were generally more concerned about restoration's potential negative impacts than adopters (Garbach & Long, 2017), thus maybe more risk averse. Other non-DOIT based studies of, for example, the adoption of agricultural practices to prevent land and water degradation (Pannell et al., 2006), also highlight risk aversion's importance on landholders' decisions, suggesting more risk averse landholders are less likely to adopt innovations that increase risk.

Woodland creation is inherently uncertain and risky given its long-term nature—which restricts trialability, flexibility, and reversibility—and the range of physical (e.g. wind, frost, drought, fire) and biological (e.g. herbivory, pests, diseases) factors affecting woodland establishment and survival. The risks of woodland creation are further amplified by financial, legal, and social considerations (Staddon et al., 2021). The significant upfront costs of woodland creation often require landholders to borrow funds or apply for grants. Additionally, the UK's tax and land use policies have further implications for woodland creation. For example, establishing woodlands on farmland may result in the loss of tax breaks (Johnston Carmichael, 2024; Staddon et al., 2021). Whilst strong legal presumptions against woodland conversion to other land uses, typically prohibit felling trees without a felling licence and require re-creating the woodland once felled (Forestry Commission, 2017). Socially, landholders considering woodland creation

might take into account aspects such as whether adoption will be supported by their family and peers (Pannell et al., 2006), or how it will affect their reputation (Lawrence & Dandy, 2014; Staddon et al., 2021). Together, these financial, legal, and social factors are likely to increase landholders' overall risk perceptions by introducing extra risks (e.g. interest payments, grant payment delays, disapproval by others), and limiting tax benefits and control over the land (i.e. felling licences) for current and/or future landholders (Staddon et al., 2021).

I found my landholders were less likely to have created mixed native woodland if they perceived wind levels on their landholding were unsuitable to do so. This highlights certain risks might be more prevalent in some landholdings. Windiness is certainly a challenge for woodland creation across the UK (Forest Research, 2025). Moreover, in recent years my study area has suffered severe windstorms, with storm Arwen in particular causing extreme damage to woodlands in 2021 (Scottish Government, 2022). Arwen and its destructive effect on woodlands were definitively fresh in people's mind, and repeatedly mentioned anecdotally by respondents and others during our conversations. Hence, I believe both the prevalence of windstorms in my study area, coupled with the recency of storm Arwen and its severe impacts on woodlands, might explain my results.

I found my landholders were less likely to have created mixed native woodland when land use change decisions rested on a single individual. DOIT distinguishes between three types of innovation decisions: those made by an individual independently (optional innovation decisions), those made by consensus amongst all members of a group (collective innovation decisions), and those made by a select group of individuals with power, status, or technical expertise (authority decisions; Rogers, 2003). In the case of woodland creation, all these kinds of decisions are possible depending on the landholder type (i.e. individual vs. group), and its decision-making arrangements (e.g. deciding by consensus). I am unaware of any studies comparing the effect of different decision-making arrangements on adoption. Nonetheless, I speculated landholdings where decisions rest on a single individual might be less likely to adopt mixed native woodland creation because they are smaller, employ less people, are less

educated, more risk averse, or have less money and time to devote to woodland creation. However, according to my correlation tests, none of those factors correlated to decisions being made by a single individual (**Section 5.3.2.1; Appendix J**). This suggests these variables might not accurately describe landholdings in our sample where decisions are made by one individual. Future studies could compare landholdings that are similar but make decisions differently, to unpack the potential mechanisms behind my results.

Generally, the mixed native woodlands created by my landholders were small (<12 acres), created using government grant schemes, and planted rather than naturally regenerated. This highlights the key role of government woodland creation grant funding in the UK (Raum, 2020; Raum & Potter, 2015), and my landholders' preference for active instead of passive woodland creation methods. While the small size of newly created woodlands hints to prevalent barriers to woodland creation such as: lack of land, insufficient funding (Hemery et al., 2018, 2020), or perceptions of woodland as an inferior, aesthetically untidy, and irreversible land use that contravenes traditional practices and takes too long to yield benefits (Lawrence et al., 2010; Lawrence & Dandy, 2014).

5.4.1 Limitations

Apart from limitations common to both studies in **Part 1** of this thesis (**Section 4.3**), the data-driven variable selection approach described in this chapter has a set of limitations of its own, which are described in **Chapter 3**.

5.4.2. Implications for policy and practice

My results reaffirm the importance of considering landholders perspectives when designing scalable ecosystem restoration programs (Ambrose-Oji et al., 2018; Lawrence & Dandy, 2014; Mascia & Mills, 2018; Mills et al., 2019; Tedesco, Brancalion, et al., 2023).

Through my theory-based approach, I aim for my findings to be easily scrutinised by future studies and to contribute to a DOIT based understanding of forest and ecosystem restoration adoption through the accumulation of comparable studies (Muthukrishna & Henrich, 2019). Pending said scrutiny to confirm their generalisability to other areas and samples, my findings already hint to a series of improvements to the design and rollout of current and future woodland creation schemes.

First, my findings suggest governments should improve access to easy-to-understand evidence-based comparisons of the environmental, social, and economic benefits of different woodland types (i.e. single and multi-species native, single and multi-species non-native, or mixed non-native and native woodland). Some frameworks that do this have already been proposed (e.g. Baral et al., 2016). Nonetheless, UK focused research on woodland expansion benefits seems to be skewed towards biodiversity and regulating ecosystem services (carbon sequestration, flood control, etc.) and limited for other services (Burton et al., 2018). Expanding this evidence-base seems essential for better policy design and to facilitate more robust decision-making by landholders, who according to my findings have clear woodland creation motivations that directly inform the type of woodland they create.

I stress that comparisons of benefits of different woodlands should always be caveated by at least the woodland's location, extent, and the habitat/land use it replaces (e.g. Bradfer-Lawrence et al., 2021; Friggens et al., 2020; Matthews et al., 2020; Monger et al., 2024; Stephens & Wagner, 2007). Ultimately those and the woodland type created are the main factors that can be controlled at a woodland's creation stage, with woodland benefits contingent on them and on how the woodland is managed after its creation. This is particularly important given my landholder's apparent focus on using poor land to create woodland. Poor land might be less productive (e.g. lower soil quality) or harder to work/access (field corners, stony soils, steep slopes, etc.) for agriculture, but can host important ecosystems like grasslands or peatlands. Conversion of these ecosystems to woodland will negatively affect

biodiversity and climate change mitigation (e.g. Bradfer-Lawrence et al., 2021; Di Sacco et al., 2021; Friggens et al., 2020; Matthews et al., 2020).

Second, woodland expansion schemes should increase their emphasis on the compatibility of woodlands (mixed native and others) with other land uses such as agriculture, hunting or recreation. Such efforts have been ongoing and continue in all UK nations, with a vast array of online and in-person support from governmental and non-governmental sources highlighting the compatibility of trees with other land uses, particularly farming (e.g. Forestry Commission, n.d.; Forestry Commission Wales, 2012; Scottish Forestry, n.d.; Woodland Trust, 2022). However, official sources showing persistently low rates of woodland creation (Forest Research, 2024), together with my findings, suggest that better targeting of these efforts could improve rates of adoption.

Third, based on my findings the flexibility of a scheme's woodland creation options is also key for two reasons, first to enhance the compatibility of woodland with other land uses, and second to ensure woodland creation is attractive to a range of landholders. Currently, although bound by the UK Forestry Standard (Forestry Commission, 2017), landholders have considerable leeway in matters such as the size, content, or method of creating their woodland (DAERA, 2024; Scottish Government, 2021; UK Government, 2021c; Welsh government, 2024). This level of flexibility should be maintained, subject to appropriate benchmarks, since it most likely helps landholders adapt woodland to their circumstances and needs increasing its compatibility, while also making it more attractive to a range of landholding sizes.

Fourth, an evaluation of whether current woodland creation schemes are inadvertently favouring larger landholders might be pertinent given my results. As mentioned earlier, larger landholdings have more land use flexibility by virtue of their size, and none of the publicly available evidence seems to indicate they are being favoured by current schemes. Nonetheless, reviewing past grant funding allocations accounting for landholdings sizes could contribute to a better understanding of what type of landholdings are applying to the schemes, allowing their implementers to identify gaps in adoption to address.

Fifth, there are several actions schemes could take to lower landholders' risk perceptions, easing risk averse landholders' concerns and facilitating adoption.

Given the lack of trialability inherent to woodland creation, schemes could draw on the experiences of landholders who have already created woodland as a proxy for what new adopters might encounter. Demonstration sites, landholder networks, and case studies offer an effective way to achieve this (Hopkins et al., 2017; Khanal et al., 2019; Lyon et al., 2020; Staddon et al., 2021; Valatin et al., 2016), with several already in place (Farm Advisory Service, 2025; Forestry Commission Scotland, 2018; LEAF, 2025; Scottish Forestry, 2025). The insights prospective landholders gain through these approaches are likely to reduce perceptions of risk and uncertainty (Montes de Oca Munguia et al., 2021; Pannell et al., 2006; Rogers, 2003). Furthermore, emphasising peer-to-peer learning has the added benefit of appealing to more reticent landholders, who often place greater trust in peers than in external sources (Khanal et al., 2019; Rogers, 2003). Considering landholder diversity is therefore essential, ensuring prospective landholders can easily find examples relevant to their circumstances (Dunn et al., 2020; Lyon et al., 2020).

In terms of reversibility, some authors have suggested removing the need for felling licences for some landholder types (i.e. farmers) might contribute to the adoption of woodland creation (Lloyd et al., 1995). Notwithstanding the fact that this could be an easy fix to the prevalent and justified perceptions of irreversibility surrounding woodland creation (Lawrence & Dandy, 2014), without proper safeguards the negative ramifications of such an approach could be immense. For example, it could easily lead to the removal of older woodlands of higher ecological value, or result in a waste of public funds, when the removed woodland was created using public grants. Instead, a safer approach could be to offer landholders a cooling off period within which they would be allowed to remove new woodlands created with public funds. To regulate and monitor these removals and avoid wasting public funds, interested landholders should submit removal licenses, cover removal costs, and reimburse the grant or pay a proportionate fine. The overall principle here, should be allowing the removal of new

woodlands during their first few years, whilst making it unprofitable for interested landholders. The length of the cooling off period should be specific to different woodlands and contexts. Whilst reimbursements and fines should be decided on a case-by-case basis.

Another initiative that could help reduce some landholders' risk perceptions regarding mixed native woodland creation, would be updating inheritance tax regulations. Currently, inheritance tax relief only applies to woodland "ancillary" to agricultural land or pasture, commercial woodland, or woodland with national heritage value. Otherwise, landholders can only claim Woodlands Relief, a type of inheritance relief that applies to the value of the timber but not the land, and only until the timber is sold (His Majesty's Revenue and Customs, 2016; Johnston Carmichael, 2024). This can be detrimental, especially for farmers creating non-commercial woodland that is not "ancillary" to their farm, since they could lose part of their Agricultural Property Relief, meaning their heirs would have to pay inheritance tax for the land where the woodland is created (Rewilding Britain, 2024; Rewilding Britain & The Lifescape Project, 2023). Creating non-commercial woodland outside of farmland in principle does not have negative tax connotations, since heirs would have to pay inheritance tax for the land anyway (His Majesty's Revenue and Customs, 2016; Johnston Carmichael, 2024). Thus, changing taxation so either woodland created on farmland is included in Agricultural Property Relief or all non-commercial woodland is exempt from inheritance tax, could relax the risk perceptions of landholders concerned about woodland creation's impacts on inheritance. Changes akin to this are already taking place, with the new UK government pledging to reform Agricultural Property Relief so it includes land under environmental management funded by a set of national and sub-national entities (His Majesty's Treasury, 2024)

Sixth, to address landholders' concerns about wind damage risk and encourage woodland creation, schemes could provide more targeted information on how wind risk evolves throughout the lifespan of woodlands, its impacts on different woodland types, and the effectiveness of various mitigation strategies. The risk of wind damage (e.g. windthrow, windsnap) to woodlands is influenced mainly by their location, soil type, structure, age, and

tree species. Moreover, wind damage is expected to grow in the future due to increases in storms, wind speeds, and winter rainfall driven by climate change (Forest Research, 2025). The likelihood and severity of wind damage can be mitigated by carefully considering it during woodland planning and design. Current woodland creation schemes and the UK forestry standard, emphasise this and suggest preventive actions, such as diversifying woodland structure, age and composition, along with contingency planning. Additionally, they provide annual maintenance payments to help landholders mitigate risks and respond to damage from wind and other sources (DAERA Forest Service, 2024; Forest Research, 2023, 2025; Scottish Government, 2021; UK Government, 2021c; Welsh Government, 2022b). Despite these efforts, my findings suggest landholders' perceptions of wind damage risk remain high, even when considering the creation of mixed native woodlands, which are generally less vulnerable to wind damage (Forest Research, 2025). As mentioned earlier this might be due to recent severe windstorms hitting my study area (Scottish Government, 2022). Nonetheless, improving wind damage information and mitigation advice—which is currently somewhat broad (e.g. Forest Research, 2025)—to give landholders a better sense of how wind risk changes as woodlands mature, how different types of woodlands are affected, and which mitigation actions are most effective, could reduce risk perceptions encouraging more landholders to create woodland.

Finally, if future studies comparing landholdings that are similar but make decisions differently (i.e. optional, collective, authority), find potential mechanisms to incentivise woodland creation amongst these different landholders, schemes should consider incorporating them.

6. THE IMPACT OF KEY WOODLAND CREATION INTERVENTION ATTRIBUTES ON MIXED NATIVE WOODLAND CREATION DECISIONS: A CAUSAL INVESTIGATION

6.1. Overview

In this chapter, I describe the second analysis of my Drivers of Native Woodland Creation Survey (**Section 4.1.1 and 4.1.2**) data. As outlined in more detail in **Chapters 1 and 3**, in this second analysis I focus again on decisions to create mixed native woodland as a proxy for the adoption of forest restoration initiatives. Nonetheless, in contrast to **Chapter 5**, here I use an a priori variable selection approach guided by my theoretical framework and a causal model to choose variables for my statistical model. In my causal model, I explicitly outline my assumptions regarding how DOIT attributes influence each other and decisions to create mixed native woodland, which allows me to identify the smallest set of variables I should include in my statistical model to control for bias in my estimates (Byrnes & Dee, 2025; Heinze et al., 2018; McElreath, 2020; Pearl, 2009; Siegel & Dee, 2025; Staerk et al., 2024). Additionally—and again in contrast to the previous chapter—in this chapter I use a Bayesian framework and a more flexible R package (Bürkner, 2017; Stan Development Team, 2024), which—as discussed in **Chapter 3**—facilitate the interpretation of my findings (Albers et al., 2018; Fornacon-Wood et al., 2022; Hespanhol et al., 2019; McElreath, 2020) and enable me to more accurately represent my data when modelling respectively.

Overall, in this chapter I showcase how DOIT could be used to better understand forest restoration decisions and support robust a priori variable selection that minimises estimate bias. I also illustrate how combining this approach with a Bayesian framework can produce more robust and interpretable results. My findings further expand our understanding of how characteristics of woodland creation interventions, the landholders adopting them, and their shared context shape decisions to create mixed native woodland (**Objective 1**). Finally, I also

discuss the potential mechanisms behind these findings, as well as their implications for policy and practice (**Objective 3**).

6.2. Methods

In this analysis, I use an a priori variable selection approach (Berk et al., 2013; Heinze et al., 2018; Staerk et al., 2024; Ullmann et al., 2024), based on my theoretical framework (Table 2.1; **Appendix D**) and DOIT (Rogers, 2003). As a result, I focus on the relative advantage, compatibility, complexity, observability and trialability attributes of my theoretical framework and their associated variables (focus variables), since these explain most of the variability of adoption decisions according to DOIT (Rogers, 2003).

My aim with this analysis is inference (Tredennick et al., 2021), meaning I aim to find focus variables with credible, non-zero coefficients, and thus a meaningful association with the adoption of mixed native woodland creation initiatives, given the data. I also aim to determine the direction (positive or negative) of credible associations and assess whether they align with my DOIT based a priori hypotheses (Table 6.2).

I developed two models, one causal and another statistical to answer these questions.

6.2.1. Causal model

Following best practice guidance for causal inference (McElreath, 2020), I outlined my causal model using a Directed Acyclic Graph (DAG)—also known as a Causal Diagram or Causal Bayesian Network—using the ‘dagitty’ R package (Textor et al., 2017).

My causal model’s DAG describes the hypothesised causal pathways between my outcome of interest (adoption of mixed native woodland creation interventions) and its predictors (DOIT framework attributes and the variables within them), as well as causal links between the predictors themselves (Fig. 6.1). I based my DAG on DOIT and the knowledge of Scottish

woodland creation I gained through research and fieldwork. For example, I link extension support to knowledge in my DAG, since DOIT suggests extension support efforts influence the discovery and understanding of innovations among potential adopters (Rogers, 2003).

Full justifications for my causal pathways are available in **Appendix F**.

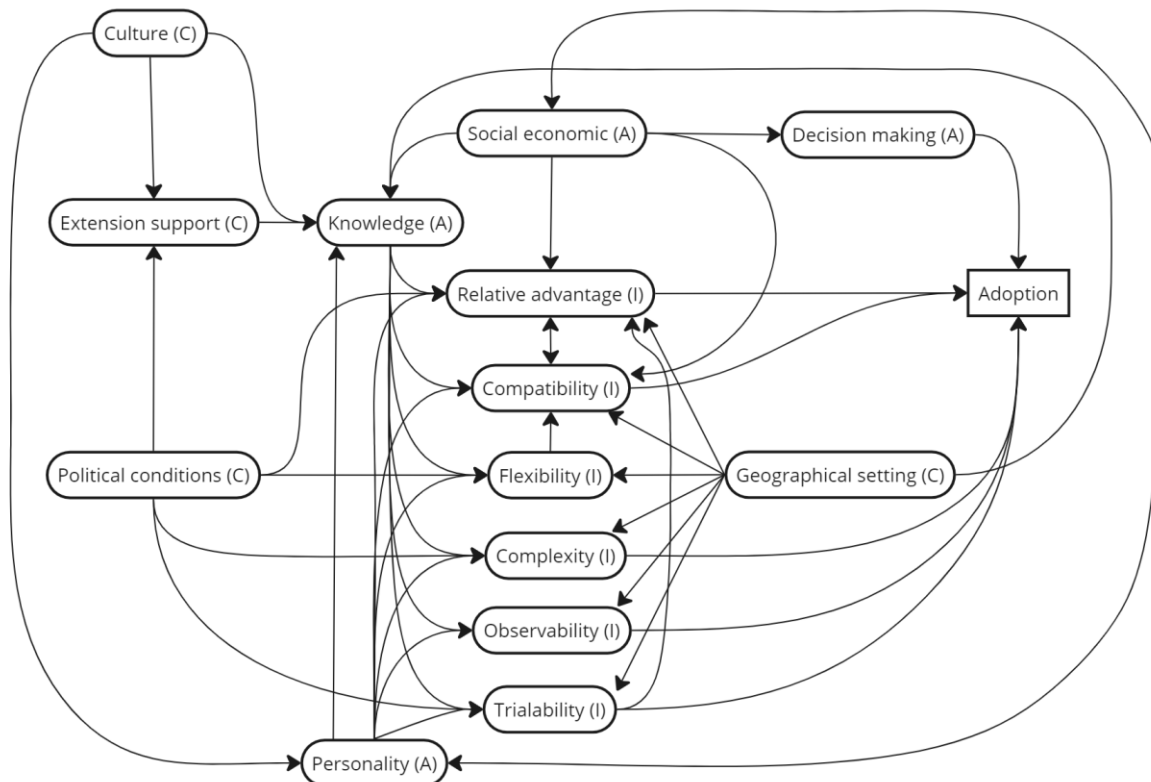


FIGURE 6.1.

Directed Acyclic Graph (DAG) displaying the hypothesised causal connections underpinning **Chapter 6's** statistical model (Bayesian Bernoulli logistic regression). Arrows signal the direction of causal effect. I, A, or C in brackets indicate innovation, adopter, and context attributes respectively. Attributes assumed irrelevant for the UK woodland creation context were not included in my DAG.

By analysing the causal links within my causal model, I can identify the smallest set of variables that must be included in my statistical model to minimise bias when estimating the causal effects of my focus variables (Byrnes & Dee, 2025; Heinze et al., 2018; McElreath, 2020; Pearl, 2009; Siegel & Dee, 2025; Staerk et al., 2024). Given my DAG and my focus variables, I found the variables associated to the 'Decision-making' attribute form the minimum set of variables needed to control bias when estimating how my focus variables influence decisions to create mixed native woodland. Thus, I included them in my statistical model. Moreover, by using a theory-based causal model and a priori variable selection, I aimed to limit the likelihood of spurious findings and enhance the replicability of my study (Muthukrishna & Henrich, 2019; Smaldino & McElreath, 2016).

6.2.2. Statistical model

Given that my outcome of interest, mixed native woodland creation, is binary, I developed a Bernoulli distributed logistic regression implemented within a Bayesian framework (Equation 6.1).

My focus variables (i.e. those associated to the relative advantage, compatibility, complexity, observability and trialability attributes of my DOIT theoretical framework) enter the model as predictors. Whilst variables associated to the “Decision-making” attribute enter the model as controls to account for their biasing impact on my focus variable effect estimates according to my causal model (Table 6.1).

I measured most statistical model variables using Likert items. I modelled these as ordered factors with a monotonic effect on the outcome (Bürkner & Charpentier, 2020). Only the “Innovation decision” variable enters the model as a non-ordered factor with three independent levels: "By a single individual"; "Collectively, by all members of the organisation"; and "By a select group of individuals within the organisation".

$$Y_i \sim \text{Bernoulli}(\pi_i)$$

$$\text{logit}(\pi_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 \text{mo}(X_{2i}, \zeta_2) \dots \beta_n \text{mo}(X_{ni}, \zeta_n)$$

$$\beta_n \sim \text{Normal}(0,1)$$

EQUATION 6.1.

Bernoulli logistic regression equation describing **Chapter 6's** statistical model, where: " Y_i " is the binary outcome of mixed native woodland creation decisions for observation " i "; " π_i " is the logistic transformed linear estimated outcome for observation " i "; " β_0 " is the intercept; " β_n " is the slope coefficient for predictor " n "; " X_{ni} " is the observed values for predictor " n " and observation " i "; and " ζ_n " is the simplex parameter for monotonic predictor " n ". " mo " indicates predictors modelled as having a monotonic effect on the outcome. All predictors are modelled as having a monotonic effect apart from "Innovation decision" represented by " $\beta_1 X_{1i}$ ". I use a normal regularizing prior for all " β " parameters " $\beta_n \sim \text{Normal}(0,1)$ ". Model variables (1... n) are outlined in Table 6.1.

I implemented this statistical model in the probabilistic programming language Stan (Stan Development Team, 2024) accessed through the brms R package (Bürkner, 2017). I used a normal (N (0,1)) regularizing prior for all slope coefficients (β_n ; McElreath, 2020). I fitted my model using four Markov chains, each run for 10,000 iterations at a maximum tree depth of 15. I evaluated model convergence through the adequate mixing of Markov chains, $\hat{R}$ values equal to one, and effective sample sizes over 10,000 (Bürkner, 2017; Kruschke, 2021).

I estimated the Highest Density Interval (HDI) for each estimand. The HDI encompasses all values in the posterior distribution with the highest probability density (i.e. credibility). In other words, values inside the HDI are more credible than those outside it (Kruschke, 2014). When interpreting model outputs, I considered any parameter estimate whose 90% HDI did not overlap with zero to have a credible effect on the outcome. This equates to at least a 0.95 probability of a true effect given my model and data (McElreath, 2020).

My model's data, code, and diagnostic tests are available in **Appendixes G and J**.

TABLE 6.1. List of variables entering **Chapter 6's** statistical model (Bayesian Bernoulli logistic regression) and their a priori effects.

Variable (DOIT Element)	DOIT Component	DOIT Attribute	Data type	Effect type	A priori effect direction*
Outcome					
Adoption of mixed native woodland creation	NA	NA	Binary	NA	NA
Predictors - Estimands					
Initial cost - Money	Innovation	Relative advantage	Ordinal	Monotonic	Negative
Initial cost - Time	Innovation	Relative advantage	Ordinal	Monotonic	Negative
Perceived risk	Innovation	Relative advantage	Ordinal	Monotonic	Negative
Environmental benefit - Carbon	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Environmental benefit – Habitat for wildlife	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Environmental benefit – Diversity of species	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Environmental benefit – Water quality	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Environmental benefit – Flooding prevention	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Environmental benefit – Soil quality	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Economic benefit	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Social benefit – Community well-being	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Social benefit – Jobs created by landholding	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Social prestige	Innovation	Relative advantage	Ordinal	Monotonic	Positive
Compatibility with values and beliefs	Innovation	Compatibility	Ordinal	Monotonic	Positive
Compatibility with needs	Innovation	Compatibility	Ordinal	Monotonic	Positive
Compatibility with current practices	Innovation	Compatibility	Ordinal	Monotonic	Positive
Ease of understanding - Ground preparations	Innovation	Complexity	Ordinal	Monotonic	Positive
Ease of understanding - Control herbivore damage	Innovation	Complexity	Ordinal	Monotonic	Positive
Ease of understanding - Planting	Innovation	Complexity	Ordinal	Monotonic	Positive
Ease of doing - Ground preparations	Innovation	Complexity	Ordinal	Monotonic	Positive
Ease of doing - Control herbivore damage	Innovation	Complexity	Ordinal	Monotonic	Positive
Ease of doing - Planting	Innovation	Complexity	Ordinal	Monotonic	Positive
Visibility of results	Innovation	Observability	Ordinal	Monotonic	Positive
Visibility of practice	Innovation	Observability	Ordinal	Monotonic	Positive
Reversibility	Innovation	Trialability	Ordinal	Monotonic	Positive
Predictors - Controls					
Innovation decision	Adopter	Decision-making	Nominal	Non-monotonic	NA
Formalization	Adopter	Decision-making	Ordinal	Monotonic	Negative

*A priori effect direction hypotheses based on Diffusion of Innovations Theory (Rogers, 2003)

6.2.3. Conditional effects estimation

For each predictor with a credible effect on the outcome, I calculated the conditional effect of a single unit increase in that predictor on the probability of having adopted mixed native woodland creation initiatives. Conditional effects quantify these probabilities maintaining the parameter of focus' full range of values, whilst holding all other predictors constant. For example, when estimating the conditional effect of "compatibility with current land use practices" (Fig. 6.3 A), said predictor could take any value in its range ("Strongly disagree" to "Strongly agree"), whilst all other predictors remained constant. I held predictors measured with Likert items constant at their neutral value (e.g. Neither agree nor disagree) and "Innovation decision" constant at "Collectively, by all members of the organisation" the most common response.

6.3. Results

6.3.1. Statistical model results

My analysis provides strong evidence that decisions to adopt mixed native woodland creation initiatives are positively influenced by landholder's expectations of changes to soil quality and habitat for wildlife, and perceived compatibility with current land use practices. Conversely, landholders' perceived ease of understanding interventions to protect new woodland from herbivore damage (herbivore controls) is negatively associated with decisions to adopt mixed native woodland creation initiatives (Fig. 6.2). Ten thousand draws from the posterior distribution indicate a greater than 0.95 probability of those four associations, as highlighted by the lack of overlap between their 90% HDIs and the zero line in Figure 6.2.

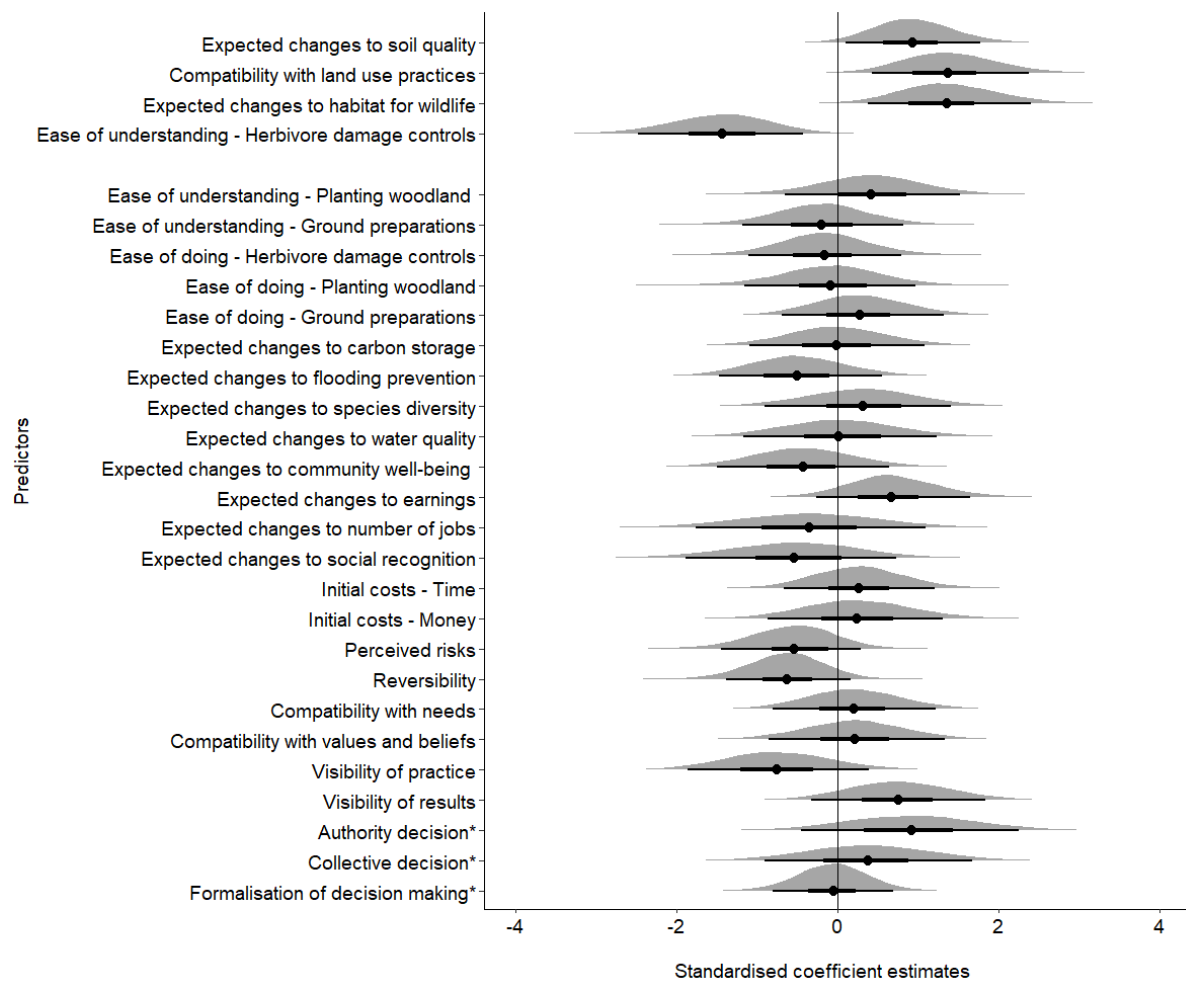


FIGURE 6.2.

Standardized posterior coefficient estimates for **Chapter 6's** statistical model (Bayesian Bernoulli logistic regression) to estimate drivers of decisions to adopt mixed native woodland creation initiatives. Black dots indicate the median posterior coefficient estimates. The thick and thin black bars show the 50% and 90% Highest Density Interval (HDI) of the posterior distribution respectively. Grey density curves show the full posterior distribution. No overlap between the 90% HDI and the zero line indicates a higher than 0.95 probability of a true effect on the outcome given my model and data. Asterisks mark DOIT adopter sub-attributes, the rest are innovation sub-attributes. To enhance figure readability, predictors with a credible effect on the outcome are listed at the top separated by a space from predictors with non-credible effects.

The probability of having adopted mixed native woodland creation initiatives increases with the perceived compatibility with land use practices. All else held constant, respondents who agreed or strongly agreed with the statement “Creating woodland matches my land use practices” have a 12% (90% HDI 0-40%) and a 23% (90% HDI 0-73%) mean probability of having adopted respectively (Fig. 6.3 A, Table 6.2).

The likelihood of adopting mixed native woodland creation initiatives also rises with expectations of changes in wildlife habitat. Holding all other factors constant, the mean probability of having adopted mixed native woodland creation initiatives increases by 34%, from 2% (90% HDI 0-4%) for landholders expecting great declines in wildlife habitat due to woodland creation, to 36% (90% HDI 0-90%) for those expecting great increases (Fig. 6.3 C, Table 6.2).

Respondents expecting larger improvements in soil quality were also more likely to have adopted, with the mean probability of having adopted mixed native woodland creation initiatives increasing from 2% (90% HDI 0-4%) for landholders expecting great declines, to 18% (90% HDI 0-62%) for those expecting great increases in soil quality (Fig. 6.3 D, Table 6.2).

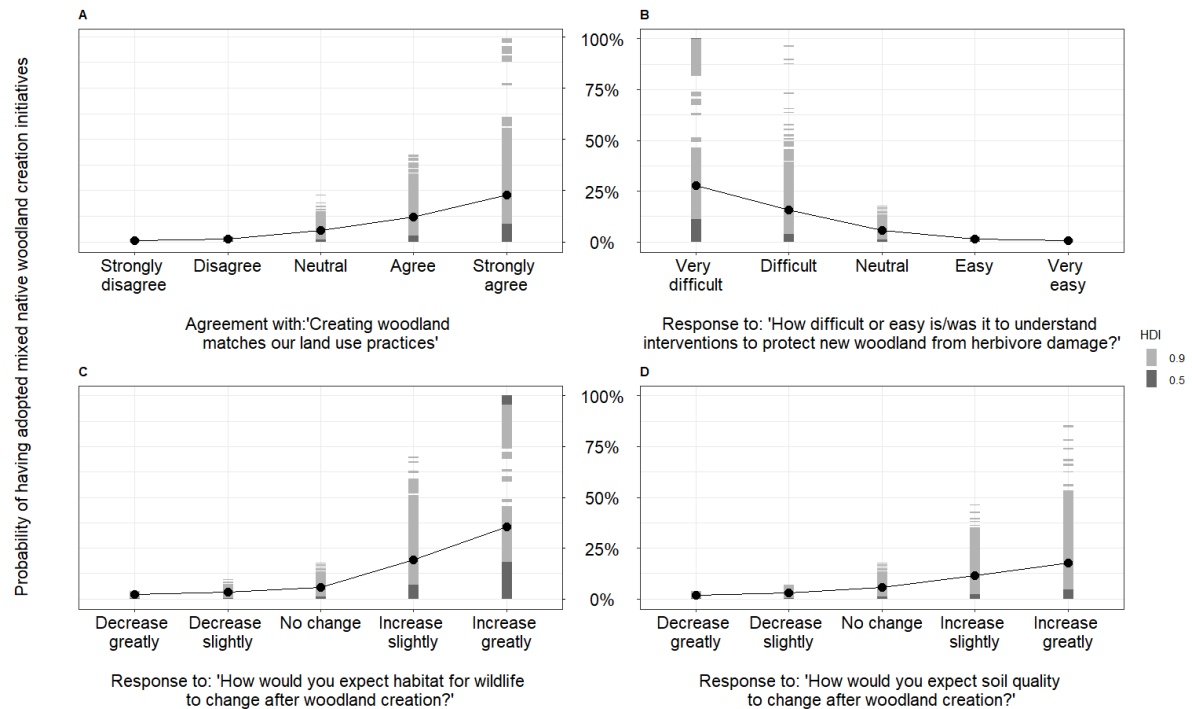


FIGURE 6.3.

Conditional effect of the participants': (A) perceptions that creating woodland matches their land use practices; (B) perceptions of how difficult or easy it is/was to understand interventions to protect new woodland from herbivore damage; and expectations of change to (C) habitat for wildlife and (D) soil quality after woodland creation; on the probability of having adopted mixed native woodland creation initiatives, given that all other predictors are held constant. Likert item predictors are held constant at their neutral response level, whilst innovation decision is held constant at "Collectively, by all members of the organisation". Black dots and line show mean conditional effect estimates and their trend. Shading shows the 50% and 90% Highest Density Interval (HDI).

Finally, the probability of having adopted mixed native woodland creation interventions decreases as the perceived ease of understanding herbivore controls increases. In this case, and perhaps counterintuitively, respondents who saw herbivore controls as "Very difficult" or "Difficult" to understand were the most likely to have adopted, with a 28% (90% HDI 0-87%) and a 15% (90% HDI 0-57%) probability of having adopted respectively. Whilst those who

thought controlling herbivores would be easy or very easy have a 1.2% (90% HDI 0-3%) and 0.6% (90% HDI 0-1%) mean probability of having adopted (Fig. 6.3 B, Table 6.2).

Model and conditional effect estimates are available in **Appendix G**.

TABLE 6.2. Conditional effect estimates for credible predictors according to **Chapter 6's** statistical model (Bayesian Bernoulli logistic regression) and data.

Likert response level	Probability of having adopted mixed native creation initiatives			
	Mean	Median	50% HDI [Lower, Upper]	90% HDI [Lower, Upper]
Compatibility with land use practices				
Strongly disagree	0.00793	0.000393	[0.00, 0.00]	[0.00, 0.01]
Disagree	0.0137	0.001	[0.00, 0.00]	[0.00, 0.03]
Neutral	0.0572	0.00888	[0.00, 0.01]	[0.00, 0.17]
Agree	0.121	0.0297	[0.00, 0.03]	[0.00, 0.40]
Strongly agree	0.227	0.0883	[0.00, 0.09]	[0.00, 0.73]
Expected changes to habitat for wildlife				
Decrease greatly	0.0204	0.00139	[0.00, 0.00]	[0.00, 0.04]
Decrease slightly	0.032	0.00332	[0.00, 0.00]	[0.00, 0.08]
No change	0.0572	0.00888	[0.00, 0.01]	[0.00, 0.17]
Increase slightly	0.191	0.0667	[0.00, 0.07]	[0.00, 0.62]
Increase greatly	0.356	0.239	[0.00, 0.24]	[0.00, 0.90]
Expected changes to soil quality				
Decrease greatly	0.0183	0.00121	[0.00, 0.00]	[0.00, 0.04]
Decrease slightly	0.028	0.00282	[0.00, 0.00]	[0.00, 0.07]
No change	0.0572	0.00888	[0.00, 0.01]	[0.00, 0.17]
Increase slightly	0.113	0.0231	[0.00, 0.02]	[0.00, 0.38]
Increase greatly	0.176	0.0467	[0.00, 0.05]	[0.00, 0.62]
Ease of understanding intervention to protect new woodland from herbivore damage				
Very difficult	0.277	0.112	[0.00, 0.11]	[0.00, 0.87]
Difficult	0.159	0.0363	[0.00, 0.04]	[0.00, 0.57]
Neutral	0.0572	0.00888	[0.00, 0.01]	[0.00, 0.17]
Easy	0.0123	0.00117	[0.00, 0.00]	[0.00, 0.03]
Very easy	0.00603	0.000401	[0.00, 0.00]	[0.00, 0.01]

6.4. Discussion

This chapter involves a second analysis of my Drivers of Native Woodland Creation Survey (**Section 4.1.1 and 4.1.2**) data and my exploration of what drives landholders' decisions to engage in ecosystem restoration. In it I focused again on forest restoration, but this time undertaking an analysis of the attributes within my theoretical framework that according to DOIT should explain most of the variability in mixed native woodland creation decisions, while controlling for variables that could introduce bias in my estimates. The variable selection methods in this analysis and its predecessor (**Chapter 5**) led to some differences in the variables chosen for inclusion in each statistical model. Nonetheless, here, I again found that landholders were more likely to have created mixed native woodland if they believed doing so was compatible with their land use practices or would increase habitat for wildlife. I already discuss the potential mechanisms, as well as the policy and practice implications, of these shared findings in **Chapter 5**. I discuss the rest of this chapter's findings and their implications below.

In this second analysis and in contrast to **Chapter 5**—whose statistical model also included this variable—I found that expectations that woodland will increase soil quality were positively associated with decisions to create mixed native woodland as hypothesised by DOIT (Table 6.1). This is corroborated by my qualitative data, which shows 75% of my landholders who had created mixed native woodland, mentioned using poor land as one of the main reasons to do so. Similarly to my result on the positive association of expected improvements to wildlife habitat and decisions to create mixed native woodland, this aligns with past reviews of woodland creation in the UK, which found that motivations for creating and managing woodland were more commonly driven by environmental benefits and personal enjoyment, rather than by productive or economic considerations (Hemery et al., 2018, 2020; Lawrence et al., 2010; Lawrence & Dandy, 2014). This again suggest that landholders have clear woodland creation objectives and create the type of woodland they believe best achieves those goals.

Counter to DOIT, which suggests easier to understand innovations are more likely to be adopted (Rogers, 2003), landholders who had created mixed native woodland were more likely to find herbivore controls difficult to understand. Further research is needed to detail the mechanisms leading to this result, but my data suggest my landholders' previous woodland creation experiences (71% of adopters had created other woodland/s), may have demonstrated the complexity of herbivore controls to them. High levels of browsing by herbivores can slow or stop the natural or assisted regeneration and expansion of woodlands and reduce the survival rates of new plantings (Côté et al., 2004). This is a major constraint to woodland creation in the UK (Hemery et al., 2018, 2020), with sheep and deer impacts being particularly significant in my study area (Gullett et al., 2023; Hare et al., 2021; Hobbs, 2009; Newton et al., 2001). Herbivore controls such as culling, fencing, tree-guards, or repellent chemicals are diverse, and their success depends on several aspects (Hodge & Pepper, 1998). For example, effective fencing requires considering factors such as a site's topography, climate, and herbivore species, as well as potential impacts on other wildlife (e.g. capercaillie, or black grouse collisions), and adapting the fence's design (layout, type, height, etc.) to them (Trout & Pepper, 2006). My results suggest, landholders often misjudge the difficulty of understanding such nuances of herbivore control until they experience them first-hand. However, learning about these challenges does not stop them from creating woodland again, supporting DOIT's notion that knowledge lessens uncertainty facilitating adoption (Rogers, 2003).

6.4.1. Limitations

In addition to limitations common to both studies in **Part 1** of this thesis (**Section 4.3**), the a priori variable selection approach used in this chapter may have affected the validity of model estimates by omitting key variables or including biasing ones in the statistical model (Byrnes & Dee, 2025; McElreath, 2020; Pearl, 2009; Siegel & Dee, 2025; Staerk et al., 2024). To mitigate this risk, I followed best practices in causal inference (McElreath, 2020), using a

theory-based causal model and variable selection approach (Fig. 6.1, **Section 6.2**). This not only reduces the potential for spurious findings (Smaldino & McElreath, 2016), but also enhances the transparency of my variable selection approach and the assumptions underlying it, thereby facilitating both critical scrutiny and replicability.

6.4.2. Implications for policy and practice

This second set of results further reaffirms the importance of considering landholders perspectives when designing scalable ecosystem restoration programs (Ambrose-Oji et al., 2018; Lawrence & Dandy, 2014; Mascia & Mills, 2018; Mills et al., 2019; Tedesco, Brancalion, et al., 2023). Similarly to my previous analysis (**Chapter 5**), these results still require replication to ensure their generalisability, something facilitated by my theory-based approach. Nonetheless, they also suggest a set of recommendations to boost UK mixed native woodland creation.

Some of the recommendations stemming from this second analysis are similar to those in **Chapter 5**: (i) emphasise woodland's compatibility with other land uses; (ii) foster flexibility within woodland creation actions, so landholders can more easily adapt them to their circumstances and needs; and (iii) mainstream easy-to-understand evidence-based comparisons of the potential benefits of different woodland types so landholders can make better informed choices.

While those three recommendations are supported by findings in both this chapter and the previous one, recommendation (iii) is further reinforced by a finding unique to this chapter: landholders might be more likely to create mixed native woodland when they expect woodlands to improve soil quality. Combined with the importance of expected benefits to wildlife habitat for mixed native woodland creation, this finding emphasises even more the importance of clear evidence-based comparisons of different woodland types to support both better policy design and more informed decision-making by landholders, who seem to create

specific woodland types based on their land use goals. At this point, I must reiterate that comparisons of different woodland types should always be caveated by at least the woodland's location, extent, and the habitat/land use it replaces (e.g. Bradfer-Lawrence et al., 2021; Friggens et al., 2020; Matthews et al., 2020; Monger et al., 2024; Stephens & Wagner, 2007), to maximise benefits and minimise unintended negative consequences.

In addition to the three recommendations shared across both chapters, based on this chapters' findings, I suggest that woodland creation schemes should better support landholders' knowledge needs, particularly regarding herbivore control tasks. In Scotland, most woodland creation projects require some herbivore control measures, such as fencing or culling (Gullett et al., 2023; Hobbs, 2009). However, my results imply landholders struggle to understand how to implement these controls effectively, suggesting that woodland creation rates could improve if better support for herbivore control tasks was available.

PART 2

NATIVE WOODLAND CREATION

PREFERENCES

7. LANDHOLDERS' PREFERENCES FOR NATIVE WOODLAND CREATION SCHEME ATTRIBUTES: A CHOICE EXPERIMENT

7.1. Introduction

The successful implementation of restoration at scale depends on engagement by a range of stakeholders. Among them, landholders and the entities promoting the uptake of ecosystem restoration are especially important (Piñeiro et al., 2020; Tedesco, Brancalion, et al., 2023; Tedesco, López-Cubillos, et al., 2023). Landholders, as the final land use decision-makers, determine whether restoration takes place. Whilst, the public and private entities promoting restoration, design and implement the instruments to encourage landholders to adopt restoration practices.

One of the main approaches used to promote restoration among landholders are voluntary incentive schemes (Tedesco, Brancalion, et al., 2023). The attributes of these incentive schemes can be financial and non-financial (Piñeiro et al., 2020; Tedesco, Brancalion, et al., 2023). These attributes change according to their implementers' priorities and constraints, such as their target populations, resource limitations, and policy goals (Raum & Potter, 2015; Tedesco, Brancalion, et al., 2023). Financial attributes include the type of incentive (e.g. compensation, tax reduction), amount and timing of payments (e.g. upfront vs. in arrears, annual vs. monthly), or purpose of rewards (e.g. cover costs, recompensate outcomes). Non-financial attributes, on the other hand, cover aspects like contract duration, bureaucratic complexity, availability of technical support, monitoring requirements, award process (i.e. competitive [e.g. reverse auctions] vs. non-competitive), target ecosystems, or withdrawal options (Hanley et al., 2012; Mitani & Lindhjem, 2022; Piñeiro et al., 2020; Raina et al., 2021; Sorice & Donlan, 2015; Tedesco, Brancalion, et al., 2023).

Landholders' preferences for these attributes are diverse and dynamic. When deliberating whether to participate in incentive schemes, landholders consider some or all their attributes

simultaneously (Sorice & Donlan, 2015). Their individual attribute preferences depend on their circumstances, and their attitudes towards what schemes promote (Broch & Vedel, 2012b; Lawrence & Dandy, 2014; Sorice et al., 2011; Tedesco, Brancalion, et al., 2023; Trenholm et al., 2017). Those circumstances and attitudes in turn are influenced by the socio-ecological context landholders operate in, as well as their motivations to participate in ecosystem restoration. For example, in agricultural contexts where legal restoration or certification mandates are absent, financial compensation or market access incentives may be particularly attractive. Conversely, when landholders have informal land tenure, incentives that secure land use management rights might be more appealing (Tedesco, Brancalion, et al., 2023).

Psychosocial factors are also likely to play a role on landholders' preferences. Studies on conservation (Sorice et al., 2011) or agri-environmental (Schaub et al., 2023) schemes suggest psychosocial factors such as social norms, intentions, or attitudes significantly shape landholders' preferences. Moreover, these psychosocial influences evolve as landholders progress in their decision-making journey. For example, research on reforestation advice suggests landholders starting to consider reforestation prefer narrative advice (i.e. advice sharing the experiences of others), whilst those closer to making a decision prefer efficacy (i.e. advice to plan and do reforestation) and informational (i.e. advice on the benefits and opportunities of reforestation) advice (Chung et al., 2020).

Overall, the existing literature suggests that the design of effective and scalable forest restoration incentive schemes requires a comprehensive understanding of: (i) incentive's attributes; (ii) their target population's preferences for them; (iii) the socio-ecological context for implementation, particularly existing motivations and attitudes towards forest restoration; and (iv) the likely negative environmental and social impacts of incentivised actions (Tedesco, Brancalion, et al., 2023). This should not only increase the chances of implementing attractive incentives but minimise the risk of unintended consequences, such as negative environmental or social outcomes (Tedesco, Brancalion, et al., 2023), or neutralising landholders' intrinsic motivations to restore (Sorice & Donlan, 2015).

Choice experiments offer an effective way to study landholders' preferences for specific incentive scheme attributes and their heterogeneity (Hensher et al., 2015). These methods have been widely used to study farmers' preferences for attributes and benefits of agri-environmental schemes (e.g. Mamine et al., 2020; Piñeiro et al., 2020; Raina et al., 2021)—including general woodland creation (Baker et al., 2019; Broch & Vedel, 2012a; Haile et al., 2019; Kefale et al., 2021; Lienhoop & Brouwer, 2015; Polyakov et al., 2024; Vedel et al., 2015)—and native ecosystem restoration schemes (Ben-Othmen & Ostapchuk, 2023; Pérez-Rubio et al., 2021; Polyakov et al., 2024). However, choice experiment research focusing on landholders' preferences for native woodland creation scheme attributes remains limited (Polyakov et al., 2024).

In this chapter, I investigate what attributes of a scheme to incentivise the creation of native woodland managed for biodiversity are important to landholders (both farmers and non-farmers) using a choice experiment (**Objective 2**). I use the creation of native woodland managed for biodiversity as a proxy for forest restoration, since this represents a common goal in projects aiming to attain the highest levels of restoration (Gann et al., 2019). Moreover, I explore the heterogeneity of my landholders' preferences based on their intentions, as well as their perceived ability and opportunity to create native woodland managed for biodiversity. I focus on Scottish landholders given the Scottish and UK governments' ambitious plans to expand woodlands (Northern Ireland Executive, 2021; Scottish Government, 2019; UK Government, 2021; Welsh Government, 2018), which aim to increase woodland cover to 18% of the UK's land by 2050, with native woodland as a priority (DEFRA, 2023a; UK Government, 2018a). Despite woodland creation rates increasing over the last few years, they are still far from the UK wide 30,000 hectare yearly target needed to achieve that goal by 2050 (Forest Research, 2024). Recent surveys suggest that, in general, landholders do not plan to create new woodland in the near future (Hemery et al., 2018, 2020), despite promising potential for huge areas to be converted to woodland under the right incentives (Hemery et al., 2018).

Thus, another key objective of this study is to provide nuanced insights into how to design attractive forest restoration schemes (**Objective 3**).

7.2. Methods

7.2.1. Survey design

The survey was divided into four sets of questions relevant to this study: (i) participant screening questions, (ii) background questions, (iii) questions targeting CADM constructs, and (iv) choice experiment choice sets based on DOIT attributes.

Through the participant screening questions I ensured that respondents were involved in both the management of the land they referred to in their response, and decision-making processes that lead to changes in the use of that land, such as the decisions to create a new woodland on it or not. If respondents did not meet both criteria, their responses were not recorded.

Background questions focused on the landholding, their woodland creation activity, and the respondent's organisation and personal data.

I measured my landholders' personal and social norms, intentions, and perceived behavioural control, through my CADM questions. I focus on those four CADM constructs, since according to the CADM an individual's self-transcendence and self-enhancement values, awareness of the consequences of its actions, ascription of responsibility, and ecological worldview act on other variables indirectly through their influence on personal norms (Fig. 2.1). Attitudes have also been found to be important (Klöckner, 2013), but they are already captured by my landholders' choices. I did not consider habits as important in the context of woodland creation, since this is not a behaviour that is repeated often or at all, hindering habits from forming and gaining influence over other psychosocial factors like intentions (Klöckner, 2013), which have a stronger influence on seldomly repeated behaviours (Ouellette & Wood, 1998).

Finally, the main element of my survey was an unlabelled stated choice experiment (Bliemer & Rose, 2014). In it, I asked respondents to choose between two hypothetical alternatives describing different native woodland creation interventions. I also gave respondents the chance to choose neither of the two alternatives. Choosing an alternative entailed its fictional implementation on the respondent's land. I asked respondents to imagine that the woodland would be managed for biodiversity, generating amenity value and a small timber income derived from thinning. The woodland would also be enrolled into the Woodland Carbon Code, yielding revenue for each tonne of carbon captured, with the relevant land remaining wooded for at least 100 years. Respondents could imagine creating any size of woodland realistic to their circumstances. I requested them to state this size before completing the choice experiment.

7.2.2. Choice Experiment Design

7.2.2.1. Attribute and attribute levels selection

At the heart of choice experiments is the assumption that individuals try to maximise their personal satisfaction when choosing amongst alternatives, based on the alternatives' attributes and the utility they assign to them (Böckenholt, 2006; Sorice et al., 2011; Thurstone, 1927, 1931). Hence, a first and essential step in the design of choice experiments is defining alternative attributes and the levels that will conform them.

Using a literature review, my DOIT framework (Table 2.1; **Appendix D**), and a pilot study, I explored the attributes that may be important to landholders adopting native woodland creation interventions in Scotland. I discovered several potential attributes through this process and settled on four of them (Table 7.1): (i) expected average net income; (ii) minimum time to complete woodland creation administrative requirements; (iii) availability of free advice on native woodland creation; and (iv) percentage of all initial costs received as an interest free loan. Throughout the thesis, I sometimes refer to these attributes as: (i) profitability; (ii)

bureaucracy/administrative or bureaucratic burdens; (iii) free advice; and (iv) timing of initial payments respectively. My main aim when selecting attributes was to gather useful information, but also to minimise the cognitive burden on respondents by maintaining the number of attributes low and ensuring they were easy to understand.

The final selection of attributes for the choice experiment focuses on innovation and context attributes of DOIT (Table 7.1). The “Expected average net income” and “Percentage of all initial planting costs received as an interest free loan” attributes, target different DOIT sub-attributes of the relative advantage associated to the innovation and their influence on adoption. The “Minimum time to complete woodland creation administrative requirements” attribute, targets the effect of the bureaucratic burden imposed by the political conditions of the context on adoption, while the “Availability of free advice on native woodland creation” attribute controls for the influence of the presence of support and facilitation within the context on adoption.

After choosing my attributes, I defined their levels (Table 7.1).

The “Expected average net income” attribute has four levels. I set a base expected net income level of £120 per hectare and year for native woodland. This is based on a UK government financial case study for the creation of a 10ha of native woodland in England, which estimates an £85,100 (£6200 per ha) overall net income over a 50-year period (Forestry Commission, 2023b). I divide the per hectare net income by the 50-year period to obtain a £124 per hectare a year base value, which I round to £120 per hectare and year. I derive the rest of levels from this base level. One level is 50% lower (£60 per hectare and year), while the other two are 50% and 100% higher than the base respectively (£180 and £240 per hectare and year).

The “Minimum time to complete woodland creation administrative requirements” attribute has four levels: 6 months, 1 year, 2 years, and 4 years. These are based on forestry consultants’ estimates for how long it takes for a simple woodland creation project to secure permission to create woodland and gain access to the Woodland Carbon Code in Scotland. I start at 6 months, doubling the previous level until reaching 4 years.

The “Availability of free advice on native woodland creation” attribute has two levels: “Available” and “Unavailable”.

Finally, the “Percentage of all initial costs received as an interest free loan” has four levels: 0%, 30%, 70%, and 100%.

TABLE 7.1. Attributes, attribute descriptions, and levels of the choice experiment in **Chapter 7**.

Attribute	Attribute description	Levels
Expected average net income	Average net income that could be expected from the woodland on a yearly basis. The average net income is the result of subtracting all costs (i.e. planting, fencing, maintenance, insurance...), from all revenue streams generated by the woodland (i.e. grants, timber, carbon...). Income will vary between years, but evens out to the yearly average over the lifetime of the project.	1. £60 per ha a year 2. £120 per ha a year 3. £180 per ha a year 4. £240 per ha a year
Minimum time to complete the woodland creation administrative requirements	Minimum time a simple project needs to complete the administrative burden required to gain approval and secure funding for native woodland creation. This includes time spent completing the paperwork and waiting for the relevant authorities' responses, as well as the time to amend and resubmit applications if requested. Smaller, less remote woodland creation projects tend to be simpler than larger and/or more remote ones.	1. 6 months 2. 1 year 3. 2 years 4. 4 years
Availability of free advice on native woodland creation	Whether or not free advice is available on how to access woodland creation funding, and how to create and maintain native woodland. This advice, if available, includes a website containing downloadable guidance; an on-demand phone call and email support service with forestry experts; and a single in person visit to the site where the woodland will be created by a forestry expert before planting occurs.	1. Unavailable 2. Available
Percentage of all initial costs received as an interest free loan	What percentage of the initial woodland creation costs are received as an upfront interest free loan. The rest is received as a grant once works are completed. Almost all initial woodland creation costs are covered by this subsidy. Costs include tree planting, deer or stock fencing, tree guards, ground preparations, gorse and bracken removal, and others. They also include a small maintenance payment for the first 5 years of the project. Woodlands can be created through planting or natural regeneration. To access the subsidy, a woodland creation proposal outlining where, how, and which native woodland creation activities would be carried must be submitted. This would require engagement with Scottish Forestry and other stakeholders (e.g. neighbours). In some cases, an Environmental Impact Assessment might be needed. Works can commence once the proposal is approved by Scottish Forestry and the relevant contracts are signed. The loan payment will be made shortly after the woodland creation proposal is approved and contracts are signed. Awardees would need to fill a claim once works are completed and submit this to Scottish Forestry for approval. The portion of the payment received as a grant, would be paid shortly after claims are approved. Inspections might be carried. Awardees are liable to return part or the totality of the loan, or not receive part or all of the portion paid as a grant in case of contract breaches.	1. 0% 2. 30% 3. 70% 4. 100%

7.2.2.2. Choice sets design

A combination of all attributes, each with a unique level value, creates an alternative. I formed “choice sets” by combining two alternatives with a “no choice” option that respondents can use to indicate that they wouldn’t adopt any of the alternatives in the choice set (Fig. 7.1). Choice sets are then presented to respondents who are asked to choose their preferred alternative within them.

When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	Expected average net income: £240 per ha a year	Expected average net income: £60 per ha a year	
	Minimum time to complete woodland creation admin: 6 months	Minimum time to complete woodland creation admin: 4 years	
	Availability of free advice on native woodland creation: Available	Availability of free advice on native woodland creation: Unavailable	
	% of all initial planting costs paid as interest free loan: 0%	% of all initial planting costs paid as interest free loan: 100%	I would not create native woodland managed for biodiversity under any of these two scenarios.
Your choice (tick your preferred scenario)	☐	☐	☐

FIGURE 7.1.

Choice set example.

My selection of attributes results on 128 possible alternatives ($4 \times 4 \times 2 \times 4$). This produces a total of 8,128 possible alternative combinations ($((128 \times 127)/2)$) or choice sets. The use of a full factorial design would see every respondent answer all choice sets which, in my case, is impractical if not impossible. I use a D-efficient design to reduce the number of alternative combinations shown to respondents. D-efficient designs consider a particular model and optimise the set of alternative pairings, so the data collected results in sounder estimates for that model (Bliemer & Rose, 2010). Alternatives are paired in a way that forces respondents to make trade-offs between them, thus increasing the amount of information gained from every choice (Traets et al., 2020). I coded all attributes as continuous variables, apart from “Availability of advice on native woodland creation” which was coded as a dummy variable, and used Ngene (ChoiceMetrics, 2018) to generate all my designs. I settled on a design with 12 choice sets, after testing different design sizes.

A key step in generating a D-efficient design is defining the prior values for each attribute. These are known as coefficient prior values for multinomial logit models (MNL) and parameter prior values (mean and standard deviation) for mixed multinomial logit models (MMNL; Train, 2009). I optimised my D-efficient design for a panel MMNL.

Contrary to the MNL which estimates a single utility coefficient for each attribute assuming that is shared by all individuals within the population, the MMNL assumes utility coefficients vary from one individual to another according to a specific density function ((e.g. normal, triangular; Train, 2009). Therefore, a key step in generating a D-efficient design optimised for an MMNL is defining the coefficients’ distributions and the prior values for those distributions’ parameters (i.e. mean and standard deviation). Following standard procedures in choice experiment design, I assumed all attribute coefficients had a normal density function, assigned them prior parameter values as close to zero as possible, and gave priors a positive or negative sign if I expected utility to increase or decrease as attribute levels grow larger (Bliemer & Collins, 2016; Bliemer & Rose, 2010; ChoiceMetrics, 2018; Train, 2009). I anticipated the “Expected average net income”, “Availability of free advice on native woodland creation”, and “Percentage of all

initial costs received as an interest free loan” attributes to have higher utility as levels grew, hence I assigned them positive mean prior values of 0.3 with standard deviations of 0.01 each. I expected the “Minimum time to complete woodland creation administrative requirements” attribute to decrease in utility as levels grew, thus I assigned it a negative mean prior value of -0.3, with a standard deviation of 0.01.

Simulations are needed when generating MMNL designs, these are used to evaluate the design over the parameter distributions (ChoiceMetrics, 2018). I do my simulations by taking 500 Halton draws from the parameter distributions. I use a panel instead of a cross-sectional MMNL, since the choice tasks will be faced by the same individual, thus the data derived from them won’t be independent as required by the cross-sectional MMNL (Bliemer & Rose, 2010; ChoiceMetrics, 2018). Generating a panel MMNL requires simulating a certain number of respondents, I used 500 simulated respondents when producing my designs (ChoiceMetrics, 2018).

I generated several designs using my parameter priors and simulations, comparing them in terms of their efficiency measures and level balance. I also checked all designs for strictly dominant alternatives. A strictly dominant alternative would be one where all attributes are more advantageous when compared to the other alternatives within the choice set (Crabbe & Vandebroek, 2012). This should be avoided since rational respondents will always choose the strictly dominant alternative and no information will be gained from their choices (Crabbe & Vandebroek, 2012). Originally all my designs contained strictly dominant scenarios. I solved this issue by introducing a constraint into my design which ensured that when the “Percentage of all initial costs received as an interest free loan” attribute was better for one alternative or equal amongst alternatives, at least one of the other attributes would be better in the other alternative or in one alternative respectively (Table 7.2).

The final design is detailed in Table 7.2, both for its MMNL and MNL optimisation.

My survey is available in **Appendix H**.

TABLE 7.2. Choice sets design of the choice experiment in **Chapter 7**.

		MNL	MMNL (Panel data)		
Efficiency measures					
D-error		0.312083	0.783764		
A-error		0.54903	1.579459		
B-error		89.916524	89.844278		
S-error		56.368572	195756.7025		
Attributes	Coefficient priors	Parameter priors			
		Mean	SD		
Expected average net income	0.3	0.3	0.01		
Minimum time to complete the woodland creation administrative requirements	-0.3	-0.3	0.01		
Availability of free advice on native woodland creation	0.3	0.3	0.01		
Percentage of all initial costs received as an interest free loan	0.3	0.3	0.01		
Constraint*					
;cond: if(alt1.lg>=alt2.lg, alt1.avi<alt2.avi or alt1.tc>alt2.tc or alt1.help<alt2.help), if(alt2.lg>=alt1.lg, alt2.avi<alt1.avi or alt2.tc>alt1.tc or alt2.help<alt1.help)					
Design					
Choice Set	Alternative	Expected net income	Minimum time to complete admin	Availability of free advice	% all initial costs received as loan
1	1	£60 per ha a yr	4 yrs	Unavailable	30%
	2	£240 per ha a yr	6 months	Available	0%
2	1	£180 per ha a yr	6 months	Available	70%
	2	£60 per ha a yr	1 yr	Unavailable	100%
3	1	£120 per ha a yr	1 yr	Available	100%
	2	£240 per ha a yr	4 yrs	Unavailable	100%
4	1	£120 per ha a yr	2 yrs	Available	0%
	2	£60 per ha a yr	1 yr	Unavailable	30%
5	1	£180 per ha a yr	6 months	Unavailable	70%
	2	£120 per ha a yr	6 months	Unavailable	100%
6	1	£180 per ha a yr	2 yrs	Available	100%
	2	£60 per ha a yr	6 months	Unavailable	0%
7	1	£240 per ha a yr	1 yr	Unavailable	0%
	2	£240 per ha a yr	2 yrs	Available	70%
8	1	£120 per ha a yr	2 yrs	Unavailable	30%
	2	£240 per ha a yr	4 yrs	Available	30%
9	1	£60 per ha a yr	1 yr	Unavailable	30%
	2	£180 per ha a yr	4 yrs	Available	70%
10	1	£240 per ha a yr	6 months	Available	70%
	2	£180 per ha a yr	2 yrs	Available	100%
11	1	£180 per ha a yr	4 yrs	Unavailable	0%
	2	£120 per ha a yr	2 yrs	Available	30%
12	1	£120 per ha a yr	2 yrs	Available	100%
	2	£60 per ha a yr	1 yr	Unavailable	0%

*I used attribute abbreviations in my Ngene coding: Expected average net income (avi), Minimum time to complete the woodland creation administrative requirements (tc), Availability of free advice on native woodland creation (help), and Percentage of all initial costs received as an interest free loan (lg).

7.2.3. Sampling and data collection

I gathered my choice experiment data simultaneously to my other survey. I used the sampling and data collection design previously described in **Section 4.1.2** of this thesis, using both an in-person and online version of my survey, and convenience and snowball sampling (Stratton, 2021). The final choice experiment sample consisted of 87 responses, of which, 71 (57 in-person, 14 online) were complete and within my study area, thus included in the analysis.

7.2.4. Analysis

Through the generic utility function for my Random Utility Model (Equation 7.1), I define the overall utility or benefit my landholders perceive for an alternative given the utility they assign to the status quo, factors I observe (i.e. my choice experiment attributes) and factors I do not observe (Train, 2009).

$$U_{nj} = \alpha + \beta_1 income_{nj} + \beta_2 admin_{nj} + \beta_3 help_{nj} + \beta_4 loangrant_{nj} + \varepsilon_{nj}$$

EQUATION 7.1.

Equation describing the utility function for **Chapter 7's** general random utility model where: " U " is the utility landholder " n " gets from alternative " j "; " α " is the alternative specific constant or the status quo's utility; " β_x " are the utility coefficients for the observed attributes " x " which in my case are: 1 = " $income$ " (i.e. expected net average income), 2 = " $admin$ " (i.e. minimum time to complete the woodland creation administrative requirements), 3 = " $help$ " (i.e. availability of free advice), and 4 = " $loangrant$ " (i.e. percentage of all initial cost covered by an interest free loan); and " ε_{nj} " is the part of utility explained by factors I do not observe.

By optimising my D-Efficient design for a MMNL, I kept the door open to data analysis that use either MNL or MMNL specifications. These different choice models specifications can be

derived from my generic random utility model (Equation 7.1), by changing model assumptions and the density distribution of “ ε_{nj} ”, the unobserved part of utility (Train, 2009).

I first estimate the probability of alternative choices using a MNL model (Equation 7.2). These models assume preferences are homogeneous amongst respondents and that “ ε_{nj} ” is an independent, identically distributed (i.i.d) extreme value (i.e. Gumbel or type 1 extreme value distribution), which results in their Independence from Irrelevant Alternatives (IIA) property. This makes them the simplest, thus most widely used discrete choice model, but has drawbacks since their assumptions are hardly realistic in most cases (Train, 2009).

$$P_{ni} = \frac{e^{\beta_1 income_{ni} + \beta_2 admin_{ni} + \beta_3 help_{ni} + \beta_4 loangrant_{ni}}}{\sum_j e^{\beta_1 income_{nj} + \beta_2 admin_{nj} + \beta_3 help_{nj} + \beta_4 loangrant_{nj}}}$$

EQUATION 7.2.

Probability function for **Chapter 7’s** Multinomial Logit (MNL) model where: “ P ” is the probability of individual “ n ” choosing alternative “ i ” amongst a set of alternatives “ j ”; and “ β_x ” are the utility coefficients for the observed attributes “ x ” which in my case are: 1 = “*income*” (i.e. expected net average income), 2 = “*admin*” (i.e. minimum time to complete the woodland creation administrative requirements), 3 = “*help*” (i.e. availability of free advice), and 4 = “*loangrant*” (i.e. percentage of all initial cost covered by an interest free loan).

To expand my MNL and start exploring the heterogeneity within my data, I also estimate a Latent Class Model (Equation 7.3). Standard LCMs, segment the population into a discrete number of classes, estimating an MNL for each class. Thus, they still treat “ ε_{nj} ” as an i.i.d extreme value and assume all individuals within a class have the same preferences (Hensher et al., 2015).

The differences between classes result from observed and unobserved variables. Individuals within a class will be similar to each other, but different to those in other classes (Hensher et

al., 2015). In my LCM, I explore the effect of individuals' intentions and perceived behavioural control on class allocation. I focus on these two elements of the CADM since together with habits, which I consider irrelevant in a woodland creation context, they are considered direct predictors of behaviour (Klößner, 2013). Given software limitations, I model these variables as continuous (Robitzsch, 2020), despite measuring them using Likert items. In my survey, I targeted both the opportunity and ability to perform a behaviour aspect of perceived behavioural control with a statement each. The statement targeting the opportunity aspect was framed negatively (*"I feel that circumstances complicate the creation of woodland in the landholding I represent"*), thus more negative answers to this question show stronger perceived behavioural control. I inverted this variable's Likert item (e.g. Strongly disagree was coded as 5 instead of 1) to account for this in analysis.

$$P_{ni} = \sum_m^{M=2} sm \left(\frac{e^{b_{1m}income_{ni} + b_{2m}admin_{ni} + b_{3m}help_{ni} + b_{4m}loangrant_{ni}}}{\sum_j e^{b_{1m}income_{nj} + b_{2m}admin_{nj} + b_{3m}help_{nj} + b_{4m}loangrant_{nj}}} \right)$$

EQUATION 7.3.

Probability function for **Chapter 7's** Latent Class Model (LCM) where: " P " is the probability of individual " n " choosing alternative " i " amongst a set of alternatives " j "; " M " is the number of classes, two in my model; " m " is the class of interest; " sm " is the of the population within that class; and " b_{xm} " are the utility coefficients for the observed attributes " x " in class " m ". In my model, the observed attributes are: 1 = "*income*" (i.e. expected net average income), 2 = "*admin*" (i.e. minimum time to complete the woodland creation administrative requirements), 3 = "*help*" (i.e. availability of free advice), and 4 = "*loangrant*" (i.e. percentage of all initial cost covered by an interest free loan).

To fully relax the assumptions of the MNL and LCM, I run a MMNL. These models allow observed and unobserved (i.e. " ε_{nj} ") attributes to vary according to any distribution. The practical implications of this are that tastes are assumed to be heterogenous amongst

individuals, the IIA assumption is relaxed, and unobserved factors can be correlated (Train, 2009). In my MMNL specification (Equation 7.4), I assume all observed attributes have a normal distribution, apart from “expected average net income” which I model as log-normal distributed. I do the latter assuming my landholders always have positive preferences for interventions yielding higher expected average net incomes and to ensure my Willingness To Accept (WTA) estimates have finite moments (Daly et al., 2012).

$$P_{ni} = \int \frac{e^{\beta_1 income_{ni} + \beta_2 admin_{ni} + \beta_3 help_{ni} + \beta_4 loangrant_{ni}}}{\sum_j e^{\beta_1 income_{nj} + \beta_2 admin_{nj} + \beta_3 help_{nj} + \beta_4 loangrant_{nj}}} f(\beta) d\beta$$

$$\beta_1 \sim Lognormal(\mu, \sigma)$$

$$\beta_{2...4} \sim Normal(\mu, \sigma)$$

EQUATION 7.4.

Probability function for **Chapter 7’s** Mixed Multinomial Logit (MMNL) model where: “ P ” is the probability of individual “ n ” choosing alternative “ i ” amongst a set of alternatives “ j ”; “ α ” is the alternative specific constant or the utility of the status quo; “ β_x ” are the utility coefficients for the observed attributes “ x ” which in my case are: 1 = “*income*” (i.e. expected net average income), 2 = “*admin*” (i.e. minimum time to complete the woodland creation administrative requirements), 3 = “*help*” (i.e. availability of free advice), and 4 = “*loangrant*” (i.e. percentage of all initial cost covered by an interest free loan); “ $f(\beta)$ ” is the mixing distribution for the “ β ” coefficients with mean “ μ ” and standard deviation “ σ ”. All attribute coefficients’ are modelled as having a normal mixing distribution “ $\beta_{2...4} \sim Normal(\mu, \sigma)$ ”, except those for “expected average net income” which follow a log-normal “ $\beta_1 \sim Lognormal(\mu, \sigma)$ ” mixing distribution.

To evaluate trade-offs between attributes, I estimate WTA for all attributes in all my models according to equation 7.5 (Villamayor-Tomas et al., 2019). For my MMNL, I simulate the distribution of utility coefficients based on the distributions I specified for each attribute (i.e. normal or log-normal) and the means and standard deviations yielded by the model. I then

use these simulations to estimate the mean and standard deviation of my MMNL's WTA coefficients.

$$WTA = - \frac{\beta_x}{\beta_1}$$

EQUATION 7.5.

Willingness to Accept equation where: " β_x " is the utility coefficients for the observed attribute of interest " x "; and " β_1 " is the utility coefficient for the attribute I want to estimate trade-off against, in my case the average net income that could be expected from the native woodland created on a yearly basis.

I run my MNL and MMNL models using the mlogit R package (Croissant, 2020). I use the gmnI R package (Sarrias & Daziano, 2017) to run my LC-MNL model, since mlogit cannot run this type of models. When running my choice models, I code all observed attributes as continuous, apart from "Availability of free advice on native woodland creation" which is dummy coded.

My models' data and code are available in **Appendix J**.

7.3. Results

7.3.1. Sample

Most landholdings in my sample were under 1,250 acres (~505 hectares) (65%) and were managed for profit (80%) by family organisations (93%). Many managing organisations had less than five members (70%), and had been managing the land for ten years or more (92%),

Most respondents (97%) were landowners directly managing the landholding they referred to in their responses. Some landowners (18%) also acted as landlords (16%) and/or licensors (2%) to others, whilst others tenanted (12%) other land too. Only 4% of all respondents were tenants (1%) and/or crofters (3%) with no ownership, but powers to decide how land was used.

The 71 landholdings in my sample were farms (51%), estates (37%), crofts (7%), nature reserves (1%), and other landholding types (4%), such as a mixed farms and crofts. Farming was the predominant land use, accounting for 89% of the sample. Other land uses included forestry (46%), private enjoyment (37%), wildlife conservation (28%), game/hunting (28%), public recreation (24%), horse grazing (3%), holiday lets (3%), fishing (1%), wind farms (1%), land-based crafts (1%), hospitality (1%), or community involvement (1%). Most landholders (59%) practiced a mix of land uses, in some cases (12%) six or more distinct ones.

Landholdings' sizes ranged from less than 50 to more than 50,000 acres, but most landholdings were under 1,250 acres (65%). Organisation sizes also varied widely, but most organisations (87%) had fewer than 10 members.

Forty-four (62%) respondents had created new woodland since their organisation's management started, with 34% of them having done so multiple times. Most landholders (66%) relied solely on planting to create these woodlands. The remaining respondents either used a combination of planting and natural regeneration (32%), or only natural regeneration (2%). Most of the newly created woodlands were mixed native (77%), while others were predominantly non-native (23%) or predominantly native (14%).

Ninety-three percent of landholdings that had created new woodland relied on a single funding source. Of these, the majority (80%) used only government funding. The remainder used their own funds (17%), with one exception where compensation for trees lost to infrastructure construction was used. Only two landholdings (7%) combined funding sources: mixing government and personal funds, and government and non-government funds and a bank loan respectively.

Fifty-four (66%) of all landholdings in my sample had existing woodland, either prior to creating new woodlands (59%) or currently, in cases where no new woodlands had been established (41%). Most of these landholdings (63%) had less than 125 acres of existing woodland.

Mixed native and predominantly native woodland were the most common types of existing woodland, being present in 52% and 37% of landholdings with existing woodland respectively. Thirty percent (n=16) of landholdings with existing woodland contained more than one type of existing woodland (e.g. native and non-native).

Most landholdings with existing woodland managed it for timber production, mainly through even aged clear-fells (43%), but also through uneven aged regular or irregular fells (30%), and coppicing (6%). Hunting (15%), as well as wildlife conservation through either active (28%) or passive (31%) management, were also common existing woodland management objectives. Twenty-eight percent of landholdings with existing woodland did not manage their existing woodland at all, whilst 4% managed some patches but not others. Thirty-nine percent of landholdings with existing woodland had a mix of management objectives.

Timber production was the primary management goal for most landholders with existing woodland. These landholdings harvested timber through even-aged clear-felling (43%), regular or irregular uneven-aged felling (30%), and coppicing (6%). Additionally, 15% managed their existing woodlands for hunting, while 28% and 31% focused on wildlife conservation through active and passive management, respectively. However, 28% of landholders with existing woodland did not manage it at all, and 4% managed only certain

patches. Thirty-nine percent of landholdings with existing woodland had multiple management objectives.

Full sample descriptive statistics are available in **Appendix I**.

7.3.2. Landholder preferences

7.3.2.1. What are my landholders' preferences for scheme attributes?

My MNL model results (Table 7.3) suggest the landholders I sampled are generally reticent to adopt native woodland creation initiatives, preferring the status quo (1.48 ± 0.19 [SE]; $p \leq 0.001$)).

Nonetheless, when choosing between alternative native woodland creation schemes, my landholders are more likely to choose schemes expected to yield higher average net incomes (0.79 ± 0.10 [SE]; $p \leq 0.001$); providing free advice on woodland creation (0.79 ± 0.12 [SE]; $p.\text{value} \leq 0.001$), or paying a higher percentage of all initial costs upfront as an interest free loan (0.50 ± 0.17 [SE]; $p.\text{value} \leq 0.01$). This is supported by the positive and significant coefficients for these three attributes.

Conversely, my landholders are less likely to select native woodland creation schemes with longer minimum times to complete woodland creation administrative requirements, as implied by this attribute's negative (-0.21 ± 0.05 [SE]) and significant ($p \leq 0.001$) utility coefficient.

TABLE 7.3. Results of Multinomial Logit (MNL) model in **Chapter 7**.

Attribute	Coefficient (SE)
Expected average net income	0.79 (0.10)***
Minimum time to complete the woodland creation administrative requirements	-0.21 (0.05)***
Availability of free advice on native woodland creation	0.79 (0.12)***
Percentage of all initial costs received as an interest free loan	0.50 (0.17)**
Status quo	1.48 (0.19)***
Significance level: 0 '****' 0.001 '***' 0.01 '**' 0.05	
Model fit metrics: Log Likelihood = -815.47 Akaike Information Criterion (AIC) = 1640.93 Bayes Information Criterion (BIC) = 1664.67	

7.3.2.2. Are there groups of landholders with different preferences within my sample?

My LCM suggests there are two classes of landholders within my sample (Table 7.4).

The first class of landholders are not interested in native woodland creation, as indicated by their positive (8.14 ± 1.60 [SE]) and significant ($p \leq 0.001$) coefficient for the status quo option. Nonetheless, when making choices amongst different native woodland creation schemes, this group of landholders focus on their financial aspects. They prefer schemes expected to yield higher average net incomes (1.64 ± 0.54 [SE]; $p.\text{value} \leq 0.01$) and/or providing more of all initial costs upfront (3.01 ± 1.00 [SE]; $p.\text{value} \leq 0.01$), whilst the scheme's administrative burden and provision of free advice don't seem to play a significant role on their choices.

In contrast, landholders in the second class are not significantly attached to the status quo and have broader preferences. They prefer schemes expected to yield more income (1.32 ± 0.16 [SE]; $p.\text{value} \leq 0.001$), paying more of all initial costs upfront (0.89 ± 0.25 [SE]; $p.\text{value} \leq 0.001$), and offering free advice (0.60 ± 0.14 [SE]; $p.\text{value} \leq 0.001$). They also favour schemes that minimise administrative burdens (-0.45 ± 0.08 [SE]; $p.\text{value} \leq 0.01$).

Being part of class one or two is influenced by some of the CADM constructs included in my analysis. Landholders with weaker intentions to create woodland in the next five years (-0.48 ± 0.16 [SE]; $p.\text{value} \leq 0.01$) or weaker perceptions that their circumstances hinder woodland creation on the landholding they represent (-0.74 ± 0.17 [SE]; $p.\text{value} \leq 0.001$) are more likely to belong to the second class. Feelings that decisions to create woodland on the landholdings they represent depend more on them than others don't have a significant effect on class allocation.

Models with higher numbers of classes failed to converge.

TABLE 7.4. Results of Latent Class Model (LCM) in **Chapter 7.**

Attribute	Latent class model without observed heterogeneity		Latent class model with observed heterogeneity	
	Coefficient (SE)		Coefficient (SE)	
Class (Class share)	Class 1 (28%)	Class 2 (72%)	Class 1 (48%)	Class 2 (51%)
Expected average net income	1.64 (0.54)**	1.32 (0.16)***	1.64 (0.54)**	1.32 (0.16)***
Minimum time to complete the woodland creation administrative requirements	-0.25 (0.2)	-0.45 (0.08)***	-0.25 (0.20)	-0.45 (0.08)***
Availability of free advice on native woodland creation	0.90 (0.59)	0.60 (0.14)***	0.90 (0.59)	0.60 (0.14)***
Percentage of all initial costs received as an interest free loan	3.01 (1.00)**	0.89 (0.25)***	3.01 (1.00)**	0.89 (0.25)***
Status quo	8.14 (1.60)***	-0.04 (0.26)	8.13 (1.60)***	-0.05 (0.26)***
Effect on assignment to Class 2 of:	NA		Intentions = -0.22 (0.07)** Perceived Behavioural Control: - Opportunity = -0.20 (0.07)** - Ability = -0.05 (0.08)	
Model fit:	Log Likelihood = -531.12 Akaike Information Criterion (AIC) = 1084.24 Bayesian Information Criterion (BIC) = 1136.46		Log Likelihood = -530.31 Akaike Information Criterion (AIC) = 1088.629 Bayesian Information Criterion (BIC) = 1155.095	
Significance level: 0 '***' 0.001 '**' 0.01 '*' 0.05				

7.3.2.3. Are landholders' attribute preferences heterogeneous?

My mixed logit model (MMNL) suggests that the landholders in my sample hold significant preferences for all native woodland creation scheme attributes, but counter to my MNL results, without being significantly attached to their status quo (Table 7.5).

Similarly to my MNL, my MMNL suggests that on average my landholders prefer native woodland creation schemes that provide free advice, minimise administrative burdens, maximise expected average net incomes, and cover all initial costs paying a higher proportion of them upfront (i.e. through interest free loans). However, my MMNL adds nuance to my MNL results, suggesting that preferences for all attributes vary significantly amongst my landholders.

TABLE 7.5. Results of the Mixed Multinomial Logit (MMNL) model in **Chapter 7**.

Attribute	Coefficient (SE)	Coefficient's SD (SE)
Expected average net income	0.35 (0.06)***	1.45 (0.03)***
Minimum time to complete the woodland creation administrative requirements	-0.69 (0.08)***	0.21 (0.10)*
Availability of free advice on native woodland creation	0.82 (0.18)***	1.49 (0.23)***
Percentage of all initial costs received as an interest free loan	1.49 (0.27)***	2.86 (0.33)***
Status quo	0.41 (0.31)	3.21 (0.30)***
Significance level: 0 '***' 0.001 '**' 0.01 '*' 0.05		
Model fit metrics: Log Likelihood = -452.76 Akaike Information Criterion (AIC) = 925.53 Bayesian Information Criterion (BIC) = NA		

In my MMNL, preferences for schemes yielding higher expected average net incomes are assumed to be always positive, thus vary according to a log-normal distribution (Fig. 7.2 A) with mean 0.35 (0.06 [SE]; $p.value \leq 0.001$) and standard deviation 1.45 (0.03 [SE]; $p.value \leq 0.001$).

Conversely, according to my model, preferences for woodland creation schemes with longer minimum times to complete administrative requirements are (i.e. I don't assume this) always negative, following a normal distribution (Fig. 7.2 B) with mean -0.69 (0.08 [SE]; $p.value \leq 0.001$) and standard deviation 0.21 (0.10 [SE]; $p.value \leq 0.05$).

Preferences for interventions providing free advice on native woodland creation are very heterogenous, varying according to a normal distribution with mean 0.82 (0.18 [SE]; $p.value \leq 0.001$) and standard deviation of 1.49 (0.23 [SE]; $p.value \leq 0.001$). In this case, the heterogeneity is such that 72% of my landholders prefer free advice, whilst 28% don't (Fig. 7.2 C).

Similarly, preferences for the proportion of all initial costs covered upfront by an interest free loan are also very heterogeneous. They vary according to a normal distribution with mean 1.49 (0.27 [SE]; $p.value \leq 0.001$) and standard deviation 2.86 (0.33 [SE]; $p.value \leq 0.001$), with 70% of my landholders preferring to receive more of all initial funds upfront, and 30% preferring to receive more of those funds in arrears (Fig. 7.2 D).

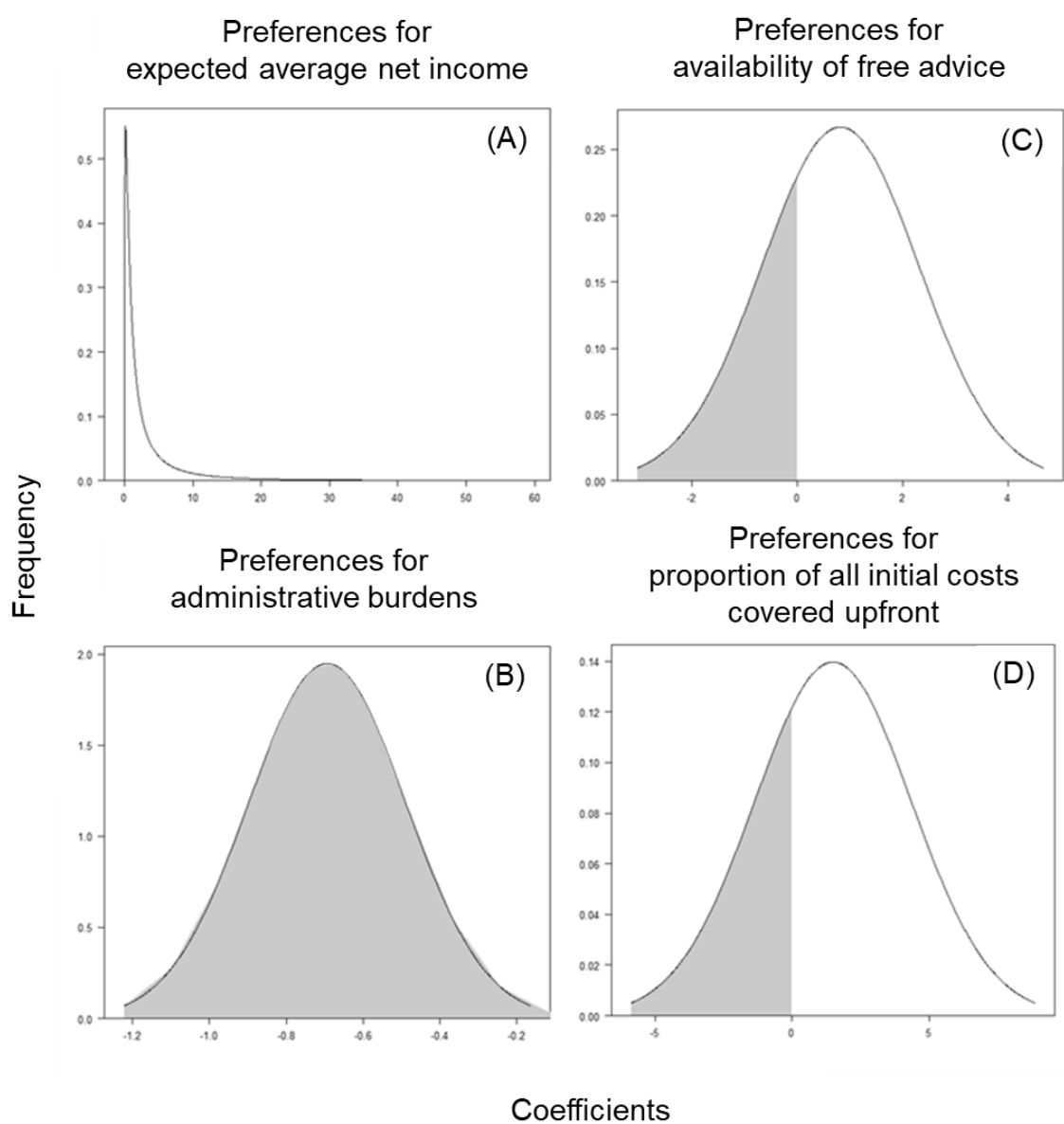


FIGURE 7.2.

Heterogeneity of landholders' preferences for (A) expected average net income; (B) administrative burdens; (C) availability of free advice on native woodland creation; and (D) proportion of all initial costs covered upfront, according to **Chapter 7's** Mixed Logit Model (MMNL). Grey shaded areas under curves signal negative preferences. Axis scales vary between plots to enhance readability.

7.3.2.4. Landholders' willingness to accept compensation: results across models

Willingness to accept estimates illustrate the trade-offs my landholders would be willing to make for specific attributes in native woodland creation managed for biodiversity schemes.

My willingness to accept estimates suggest that my landholders would need to be compensated to adopt native woodland creation schemes requiring at least an additional year to complete administrative burdens. The level of compensation needed for this ranged between £0.15 to £1.38 per hectare and year across models.

Landholders generally did not require compensation for increases in other attributes; instead, they were willing to pay for them. Their willingness to pay for schemes providing free advice varied between £0.46 and £1.63 per hectare and year across models. Additionally, and again depending on the model, they were willing to pay between £0.62 and £2.97 per hectare per year for each 1% increase in the proportion of initial funding covered upfront.

TABLE 7.6. Willingness To Accept (WTA) results across all models in **Chapter 7**.

Attribute	Multinomial Logit Model (MNL)	Latent Class Model (LCM)		Mixed Multinomial Logit Model (MMNL)
	WTA in £ per hectare and year (SE)			WTA in £ per hectare and year (Mean [SD])
		Class 1	Class 2	
Expected average net income				
Minimum time to complete the woodland creation administrative requirements	0.26 (0.06)	0.15 (0.12)	0.34 (0.04)	1.38 (3.87)
Availability of free advice on native woodland creation	-1.00 (0.23)	-0.55 (0.41)	-0.46 (0.14)	-1.63 (9.66)
Proportion of all initial costs covered upfront	-0.62 (0.21)	-1.84 (0.65)	-0.68 (0.18)	-2.97 (16.95)
Status quo	1.86 (0.20)	-4.96 (1.04)	0.03 (0.20)	-0.83 (18.87)

7.4. Discussion

In this chapter, I find that across all models, most of my landholders prefer native woodland creation schemes that maximise profit and cover all initial woodland creation costs, paying a higher proportion of them upfront (i.e. through interest free loans; Table 7.3, 7.4, and 7.5). This has profound implications for the UK, where woodland creation schemes that pay in arrears are and have been the norm, suggesting more flexible schemes that provide at least some funds upfront could boost woodland creation rates. My results also suggest that a subgroup of these landholders prefer schemes that also provide free advice and minimise administrative burdens. Landholders in this subgroup generally have weaker intentions to create woodland in the next five years, and weaker perceptions that circumstances complicate the creation of woodland on their land (Table 7.4). These findings suggest that further customising the free advice on offer and streamlining bureaucracy to the extent allowed by environmental and social safeguards, could broaden the appeal of existing UK woodland creation schemes. Given the heterogeneity of landholders' and their preferences, schemes should be broad in their scope and tailored to their end-users to achieve widespread adoption.

I consistently found that my landholders prefer native woodland creation schemes that maximise expected average net incomes across my models. Unsurprisingly, financial aid and the opportunity of making a viable income from woodlands are factors UK landholders repeatedly list as key to their woodland creation decisions (Hemery et al., 2018, 2020; Lawrence & Dandy, 2014). When studying preferences for the financial aspects of environmental schemes such as forest ecosystem services (Mitani & Lindhjem, 2022) or agri-environmental schemes (Mamine et al., 2020; Raina et al., 2021), choice experiments focus on attributes like compensation, tax relief, or cost-sharing. These attributes are routinely found to play a significant role on landholders' decisions, with landholders restoring/creating (e.g. Pérez-Rubio et al., 2021; Richards et al., 2020; Vedel et al., 2015) or conserving (e.g. Horne, 2006; Nunez Godoy et al., 2022) woodlands, preferring higher levels of compensation.

My landholders also generally prefer receiving a higher proportion of all initial woodland creation costs as upfront payments, with only a minority preferring to receive most funds in arrears (Fig. 7.2 D). Financing woodland creation through in arrears payments introduces a time lag between project completion and the receipt of funds. During this interim, landholders need to cover costs using their own funds or borrowing, with the latter adding the extra cost of interest payments. Providing partial or full upfront payments simplifies the process for landholders, by reducing or eliminating the need to raise or use their own funds. It also mitigates the perceived risk associated with receiving payment. My findings align with studies examining landholders' motivations to participate in incentive programs to provide forest ecosystem services (Mitani & Lindhjem, 2022) and conserve land for biodiversity (Putten et al., 2011). These studies highlight the importance of payment structures, showing that landholders favour upfront payments over annual payments or tax relief options respectively. Overall, this suggest that not only the amount of compensation, but how and when it is delivered plays a critical role on landholders' choices.

Free advice and minimising the administrative burdens in native woodland creation schemes were important to only a subgroup of my landholders, as hinted to by my models considering landholders' preferences heterogeneous (i.e. LCM and MMNL). Furthermore, my LCM results suggest landholders in this subgroup were more likely to have weaker intentions to create woodlands in the next five years and to not perceive significant barriers to doing so on their land. Overall, this may indicate that landholders who are not planning to create woodland in the near future have broader requirements for participating in such schemes, given the importance of all attributes for this particular subgroup of landholders.

The positive role of free advice is intuitive. UK landholders consistently mention free expert advice as one of the main ways to incentivise woodland creation (e.g. Hemery et al., 2018, 2020; Lawrence & Dandy, 2014). Choice experiments including this attribute tend to find it has a significant positive effect on choices for private-land protection/restoration (e.g. Cortés-Capano et al., 2021; Trenholm et al., 2017) or agri-environmental (e.g. Raina et al., 2021)

schemes for example. Nonetheless, it is easy to imagine circumstances where free advice might not be as relevant to landholders, such as when they have previous woodland creation experience, access to in-house technical expertise, or the ability to hire advice externally. Some studies have even found access to free technical advice is not relevant to choices for a private land conservation program (e.g. Putten et al., 2011).

The negative impact of excessive bureaucracy on decision-making is also intuitive. Lengthy paperwork and approval processes can make adopting any scheme more cumbersome. Additionally, much like in arrears funding, bureaucratic processes can create a time lag between the submission and approval of woodland creation projects. These delays can—in periods of economic instability—lead to increased labour and materials costs, forcing landholders to use their own funds if they failed to pre-empt these costs and funding authorities won't cover them retrospectively. Bureaucracy is consistently identified as a barrier to woodland creation by UK landholders (Hemery et al., 2020; Lawrence & Dandy, 2014), and in choice experiments investigating its impact in other environmental decision-making contexts (e.g. Ruto & Garrod, 2009). My findings corroborate this, but suggest that under the right circumstances, bureaucracy can be an insignificant concern for some landholders.

Finally, my results showing individuals' intentions and perceived ability to create woodland help explain the variability in their preferences, suggest that integrating DOIT with other behaviour change theories, such as the CADM, can improve our understanding of landholder preferences for restoration. This is especially important when decisions depend on a single individual. This is something my choice experiment simulates by capturing the response of a single person without consultation with others. However, in more realistic settings, landholdings' decisions would have been made by a group (see previous chapters) or can be fluid—sometimes made individually and others in common (e.g. Pannell et al., 2006) . For example, family farmers—who made up the majority of our sample (**Section 7.3.1**)—are known to make many decisions, especially major ones—like creating woodland—as a group. In such cases, final decisions typically reflect a consensus shaped by the diverse perceptions

and goals of each individual involved in the decision-making process (e.g. Pannell et al., 2006).

7.4.1. Limitations

The study described in this chapter has three main limitations.

The first one is linked to my sampling design (**Section 4.1.2**), which limits the generalisability of my findings, as described in detail in **Section 4.3**.

The second is this study's potential for hypothetical bias (Catalogue of Bias Collaboration et al., 2020). This bias is inherent to stated choice experiments (Haghani et al., 2021b, 2021a), where choices are made under hypothetical circumstances and might not match real behaviour. I aimed to mitigate this bias by giving respondents a "no choice" option, asking them to consider choices realistically, and piloting my survey to ensure choice tasks were easy to understand and answer (Haghani et al., 2021b).

The third and final limitation relates to the choice experiment's design, which may have affected my results through its number of alternatives, attributes, and attribute levels, as well as through the ranges of those attributes.

The number of alternatives in a choice experiment can make them harder to answer and increase bias in its estimates (Bliemer & Rose, 2014; Greiner et al., 2014). My choice experiment included only the minimum number of alternatives possible (i.e. two), plus a "no choice" option reflecting the voluntary nature of woodland creation schemes. Thus, was virtually risk-free in terms of its number of alternatives.

The number of attributes might have affected estimates and response consistency (Arentze et al., 2003; Bliemer & Rose, 2014). When attributes are numerous, respondents can struggle to process them all at once, resorting to random answers, rules of thumb, or ignoring some attributes (Bliemer & Rose, 2014; Green & Srinivasan, 1990). However, given the small

number of attributes (i.e. four) in my choice experiment, I consider this factor unlikely to have had a significant influence.

The number of levels per attribute can also affect estimates and response consistency (Bliemer & Rose, 2014). Nevertheless, I again believe this factor is unlikely to have had a negative impact on results, since I kept level numbers low (two to four) and consistent across attributes.

Lastly, the range of levels for each attribute (i.e. the gap between their lowest and highest values) may also affect model estimates (Bliemer & Rose, 2014; Greiner et al., 2014). This is especially important for financial attributes. For example, when including a cost attribute in choice experiments, it's crucial to not exceed respondents' highest acceptable costs, as this could make alternatives with such costs unacceptable regardless of other attributes (Glenk et al., 2019). In my choice experiment, where landholders considered profitability instead of costs, there is a risk of selecting levels that are either too low to cover respondents' opportunity costs, making most alternatives unattractive, or too high, causing respondents to focus only on economic benefits and overlook other attributes. To minimise this risk, I followed best practice guidelines for choice experiment design (Bliemer & Rose, 2014; Greiner et al., 2014) and set a realistic level range for my profitability attribute. This range had a core value based on a real case study (Forestry Commission, 2023b) and aligned with average profit values from farms in my study area (Farm Advisory Service, 2024).

7.4.2. Implications for policy and practice

My results suggest the profitability of woodland creation projects is a key concern for most landholders. In the context of native woodland creation managed for biodiversity, profitability depends on woodland creation and management costs, and the revenue streams generated by the woodland.

One of the main policy strategies to promote woodland creation in the UK is compensating landholders for their woodland creation and management costs (Raum & Potter, 2015). My results suggest that covering all costs, and crucially, paying a higher proportion of them upfront, could boost woodland creation rates. Shifting to upfront paying schemes would benefit landholders by reducing or eliminating their need to use personal funds or borrow. However, funding authorities have historically paid in arrears (Raum & Potter, 2015), and Scotland's Small Woodlands Loan Scheme (Scottish Forestry, 2021, 2022)—the only upfront-paying woodland creation scheme to my knowledge—is very cautious in its approach, only supporting projects under 50 hectares with a £40,000 cap per applicant. The existing funding designs indicate funding authorities may prefer in arrears payments, perhaps due to institutional inertia or perceptions that they are safer and simpler. As a result, if/when switching to upfront payment schemes, funding authorities may increase bureaucratic burdens or oversight to mitigate their risk exposure, something that could diminish the benefits of upfront payments for landholders if not carefully managed.

In terms of profitability, generating non-extractive revenue streams derived from native woodlands managed for biodiversity seems like a second area of policy action. Nascent carbon and biodiversity markets across the UK offer some promise on this front. The Woodland Carbon Code (UK Woodland Carbon Code, 2019) and its associated markets already allow landholders to generate revenue from the carbon captured by woodlands across the UK. Whilst England's new Biodiversity Net Gain regulation mandates that developers increase the size or quality of natural habitats affected by their projects by 10%, creating opportunities for landholders to monetise relevant native woodland creation projects through biodiversity credits (DEFRA, 2023b). Overall, these novel revenue streams combined with more traditional ones such as recreation or hunting, might enhance the profitability of native woodlands managed for biodiversity, making them more attractive for landholders.

Additionally, to appeal to a broader range of landholders, native woodland creation schemes should cover a diversity of financial and non-financial attributes, tailoring these to the needs

and motivations of their end-users (Sorice & Donlan, 2015; Tedesco, Brancalion, et al., 2023). This is highlighted by my landholders' heterogeneous preferences for free advice and administrative burdens, which were significant to some but not all landholders. This signals that, to appeal to a broader spectrum of landholders in my area, woodland creation schemes should provide free advice and minimise administrative burdens.

Free or low-cost woodland creation advice is and has been readily available across the UK from a range of governmental (e.g. DAERA Forest Service, 2024; Forest Research, 2023; Forestry Commission, 2021; Welsh Government, 2022) and non-governmental sources (e.g. Sylva Foundation, 2020; Woodland Trust, 2022). This support is consistently identified as a key incentive for those considering woodland creation in Britain (Hemery et al., 2018, 2020). Nonetheless, despite evidence suggesting that landholders often find support from advisors or experienced woodland owners more useful than online or printed resources (Hemery et al., 2018, 2020), there is a lack of research on how deliver this advice effectively (Lawrence & Dandy, 2014). A clearer understanding of how to design both the content and delivery of woodland creation advice so it is more effective (e.g. Chung et al., 2020; Ferranto et al., 2012; Lawrence & Dandy, 2014; Ma et al., 2012), could enhance the accessibility and impact of woodland creation schemes for landholders.

Minimising administrative burdens is always a balancing act. As hinted to earlier, the level of administration associated to a woodland creation project is likely influenced by its scale, as well as the revenue streams (e.g. carbon and biodiversity markets) and funding sources it aims to access. To encourage participation, regulatory bodies overseeing these markets or funding schemes could attempt to simplify and reduce bureaucracy. However, efforts to streamline administration should be cautious, ensuring environmental, economic, and social safeguards remain intact or are strengthened. The challenge, therefore, lies in making these programs both appealing to landholders and effective in preventing unintended negative consequences.

Incentivizing landholders to participate in environmental schemes is complex, as they simultaneously consider a range of financial and non-financial factors (Sorice & Donlan, 2015), such as payment levels, contract lengths, area enrolled, restrictions, advice availability, administrative burdens, and monitoring (Lawrence & Dandy, 2014; Mitani & Lindhjem, 2022; Piñeiro et al., 2020; Raina et al., 2021; Sorice et al., 2011; Tedesco, Brancalion, et al., 2023). Landholders' preferences for these attributes vary according to their circumstances and attitudes towards the actions schemes promote (Broch & Vedel, 2012b; Lawrence & Dandy, 2014; Sorice et al., 2011; Tedesco, Brancalion, et al., 2023; Trenholm et al., 2017). My findings and those of others, suggest the design and redesign of environmental incentive schemes should follow an adaptive approach, starting with a thorough exploration of scheme attributes and their target populations' preferences for them. This could be done through choice experiments for a limited numbers of attributes or using other methods for broader attribute sets. The knowledge gained should then inform the scheme's design, considering interconnections between attributes (e.g. the impact of riskier funding mechanisms on administrative complexity), as well as the implementer's limitations, and necessary environmental, economic, and social safeguards. Once the design or re-design is complete, the scheme could be released, with ongoing monitoring and adjustments as needed. I exemplify how the step of understanding a target audience's preferences could unfold in the context of ecosystem restoration, using native woodland creation in Scotland as a case study. Using a choice experiment limits the number of attributes I can investigate before choice tasks become too complex. Despite that, it allows me to observe how landholders' trade-off between attributes and the heterogeneity of their preferences. My findings, if generalisable, already indicate scheme aspects implementers could target to make UK native woodland creation schemes more attractive. Particularly, they suggest current schemes should adopt more flexible funding models that cover all initial costs and provide at least some funding upfront. When combined with better free advice and reduced bureaucracy, this approach could make native woodland creation more appealing to landholders, accelerating its adoption and increasing its area. This in turn could offer potential environmental and social benefits,

provided safeguards are observed. Applying similar approaches in other ecosystem restoration contexts could help scale up restoration efforts, expanding their potential to address the current environmental crises.

PART 3

GENERAL DISCUSSION AND

CONCLUSIONS

8. DISCUSSION

In this thesis, I set out to investigate what drives landholders to engage in ecosystem restoration on the land they manage. I had three main objectives: (i) to explore how characteristics of landholders, ecosystem restoration initiatives, and the context in which they interact, influence landholders' decisions to engage in ecosystem restoration on their land; (ii) to assess landholders' preferences for ecosystem restoration incentives attributes and how these preferences vary; and (iii) to propose policy, practice, and research recommendations based on my findings. I explored these objectives, through a case study of landholders' decisions to create native woodland in and around the Cairngorms National Park in Scotland. I used two surveys in my case study. The first was a primarily quantitative DOIT-based survey, which I employed to address **Objectives 1 and 3** via two distinct statistical analyses. In one analysis, I carried a general exploration of the influences of woodland creation initiative, landholder, and contextual characteristics on landholders' decisions to create mixed native woodland (**Chapter 5**). While in the other I explored the attributes that, according to DOIT, most influence adoption decisions, whilst explicitly considering how attributes interact and influence decisions to create mixed native woodland (**Chapter 6**). My second survey (**Chapter 7**) was a choice experiment, through which I explored landholders' preferences for a set of attributes of a scheme to create native woodland managed for biodiversity and examined how these preferences varied based on landholders' intentions, as well as their perceived ability and opportunity to create woodland on their land, contributing to **Objectives 2 and 3**. The overarching findings of this thesis, which replicate across multiple analyses, suggest that landholders who want their land to provide environmental benefits, especially wildlife habitat, and view restoration as the most effective way to achieve this—while still aligning with their current land uses—are more likely to engage in ecosystem restoration. Financial considerations, such as the profitability of restoration interventions, and the availability, type, and timing of compensatory payments, also influence adoption decisions, but only seem to become more relevant as the decision-making process unfolds. Additionally, other non-

overarching findings that don't replicate across chapters, indicate that landholders' knowledge and experiences are also likely to be important when targeting broader populations, as are the administrative burdens associated with restoration interventions. Overall, this suggests that providing landholders with clear, evidence-based information on the environmental, practical, and economic aspects of restoration is crucial, enabling them to assess its potential to support their sustainable land use goals and its compatibility with their land use practices. Restoration schemes should also offer adequate financial support and keep financial and non-financial aspects as simple and flexible as safeguards allow. Together, these measures could reduce both financial and non-financial barriers to participation by making restoration interventions easy to understand, implement, and tailor to landholders' specific goals and circumstances—while minimising unintended negative social, economic, and environmental outcomes. This combined with restoration programme designs that are more holistic, iterative, responsive to landholder perspectives, and robust against negative outcomes, will be essential for the scalability and long-term success of ecosystem restoration initiatives. In this general discussion, I explore these cross-sectional thesis findings and their policy, practice, and research implications.

8.1. Overarching findings: perceived environmental and financial benefits, and compatibility with land use are linked to forest restoration adoption.

The overarching findings of this thesis, indicate that landholders' decisions to adopt restoration interventions are driven by perceptions of environmental benefits and compatibility with current land uses, as well as financial considerations such as profitability and the timing of compensatory payments.

The positive association between decisions to restore, and perceptions of compatibility with land use practices and expected increases to wildlife habitat, are discussed at length in the context of forest restoration in **Chapters 5 and 6**.

Extending that discussion to ecosystem restoration in general, I find compatibility is consistently linked to landholders' decisions to engage in ecosystem restoration (e.g. Garbach & Long, 2017; Jellinek et al., 2013; Kernecker et al., 2021; Pienkowski et al., 2024; Zhu et al., 2016) and biodiversity conservation (e.g. Jagadish et al., 2024; Pannell et al., 2006; Romero-de-Diego et al., 2021). As posited in previous chapters, perceptions of ecosystem restoration's compatibility with other land uses are likely shaped by specific land use practices (e.g. livestock, cropping, or hunting) and their characteristics (e.g. size of machinery used), as well as by landholding attributes (e.g. size, prevalence of poor soils). Nonetheless, the role of compatibility on restoration decisions might not always be so clear-cut. For example, some studies find that landholders with income sources untied to their land—who might be expected to view restoration as more compatible—are more likely to adopt restorative interventions (Jellinek et al., 2013), while other studies find the opposite (Sorice et al., 2014). This could be due, in part and in certain contexts, to a lack of restoration knowledge and skills (Sorice et al., 2014), emphasising the need to consider how factors, such as knowledge and perceptions of compatibility, interact and change over time.

Taking the same broad ecosystem restoration perspective with landholders' expectations of restoration's environmental benefits—particularly wildlife habitat provision—I see they are also consistently found to be key drivers of landholders' engagement in ecosystem restoration (e.g. Garbach & Long, 2017; Hagger et al., 2017; Jellinek et al., 2013; Kernecker et al., 2021). This reinforces the idea that landholders' objectives strongly shape land use decisions introduced in **Chapters 5 and 6**, with the desire to generate environmental benefits—on site and/or beyond—often precluding the exploration and adoption of ecosystem restoration.

The significance of financial factors on restoration decisions, suggested by the importance of profitability and timing of payments across my choice experiment models, is discussed in the context of woodland creation and forest restoration in **Chapter 7**. That discussion mirrors debates within the broader ecosystem restoration literature. Ecosystem restoration can be financially burdensome (Bayraktarov et al., 2016; Brancalion, Meli, et al., 2019), primarily due

to its direct costs (Cortina-Segarra et al., 2021), which are typically divided into initial and maintenance costs. These costs are especially high when active interventions, such as planting or seeding, are needed or used (e.g. Brancalion et al., 2019; O'Neill et al., 2020). Indirect costs also play a role, affecting incomes through, for example, opportunity costs or foregone subsidies (Cortina-Segarra et al., 2021). Unsurprisingly, financial aspects, such as inadequate compensation—both in type and amount—are frequently cited as a major barrier to the adoption and scaling of ecosystem restoration (Cortina-Segarra et al., 2021; Tedesco, Brancalion, et al., 2023). However, context is crucial here. For example, in areas like my study site, where restoration is voluntary and private agricultural land ownership prevails, offering landholders direct compensation to cover their opportunity costs (i.e. the value of foregone land use) may be the most effective approach to encourage landholders to engage in restoration. In contrast, offering land use rights might be more effective in regions where informal land tenure dominates (Tedesco, Brancalion, et al., 2023).

Discrepancies between the results of the models in **Chapters 5 and 6**, and the choice experiment in **Chapter 7**, however, suggest financial aspects only become more relevant in the later stages of restoration decisions. My choice experiment results indicate landholders prioritise the profitability of restoration interventions and the timing of compensatory payments for initial restoration costs when choosing amongst restoration initiatives. Despite that, these findings are not corroborated by the rest of analytical chapters. Landholders in my choice experiment were often willing to create native woodland managed for biodiversity, as indicated by the number of hectares they pledged to establish before completing choice tasks. The factors driving these intentions and their relative importance are clearly broader than the attributes considered in my choice sets. This was evident in **Chapters 5 and 6** which explored a larger range of financial and non-financial factors influencing landholders' restoration decisions. In those chapters, I found no association between the financial aspects studied—initial costs and economic wellbeing in **Chapter 5**; and initial costs and expected changes to earnings and number of jobs in **Chapter 6**—and decisions to create mixed native woodland.

Instead, I consistently found that landholders were more likely to have engaged in mixed native woodland creation if they believed it was compatible with their current land use practices or if they expected it to enhance wildlife habitat. Taken together, these findings—along with the fact that my choice experiment reflects a more advanced stage of landholders’ restoration decision-making, where selecting a scheme implied committing to create native woodland for biodiversity under that scheme’s conditions—suggest that financial considerations typically become relevant only after landholders decide their land should provide more environmental benefits, particularly wildlife habitat, and view restoration as both the best way to achieve this goal and compatible with their current land uses.

Another possible explanation for the discrepancies between the results in **Chapters 5, 6, and 7** is contextual. Woodland creation in my study area is and has been incentivised via various grant schemes (Raum & Potter, 2015; Scottish Government, 2021). This may have reduced the importance of financial factors on restoration decisions, as observed in **Chapters 5 and 6**, since most landholders are probably aware that funding is available should they choose to create woodland. However, it is unlikely that my results captured this, as my Likert items did not account for the availability of grants in my study area. For example, I measured landholders’ perceptions for initial costs of implementation through the statement “*The initial monetary investment required to create woodland is very high*”, which likely did not prompt respondents to consider the impact of grants in reducing these costs. Thus, I am more confident in my first interpretation of this result: that financial considerations gain prevalence only after landholders want their land to provide more environmental benefits and see restoration as both the best and most compatible way to achieve this goal.

A final potential explanation for the discrepancy in my findings regarding the importance of financial aspects is methodological and linked to my choice experiment’s framing, scope, and design.

The scope and framing of my choice experiment might have increased the influence of the variables considered, potentially leading to the discrepancies in my chapters’ results. In terms

of framing, my choice experiment' was very different to my survey, since in it I asked respondents to choose between two native woodland creation options, rather than expressing their views on various aspects of woodland creation. This difference in framing, coupled with the narrower scope of my choice experiment—which focused on just four variables (profitability, bureaucratic burden, availability of free advice, and timing of initial payments)—could explain why variables deemed unimportant to woodland restoration decisions by my survey results, influenced landholders' preferences for native woodland creation interventions according to my choice experiment.

The limitations linked to my choice experiment's design described in **Section 7.4.1** may have also resulted in the discrepancies across chapters' results discussed here. As a summary, the number of alternatives, attributes, and attribute levels, as well as the ranges of those attributes can affect choice experiment results. However, as described in **Section 7.4.1**, this is unlikely to have affected my results, since I designed my choice experiment minimising the number of alternatives, attributes, and attribute levels, and ensuring that level ranges were realistic, in line with best practice (Arentze et al., 2003; Bliemer & Rose, 2014; Glenk et al., 2019; Green & Srinivasan, 1990; Greiner et al., 2014).

8.2. On the use of frameworks and theory

My investigations in this thesis have mainly been guided by a DOIT based framework designed to be applied in biodiversity conservation contexts (Jagadish et al., 2021; Mahajan et al., 2021). The DOIT element of this framework (Mahajan 2021 adds elements of other theories) can be applied to the study of diffusion: *“process through which an innovation is communicated and spread among the members of a social system over time”*; and adoption: *“a decision to make full use of an innovation as the best course of action available”* (Rogers, 2003). Among the many available frameworks and theories (Darnton, 2008), I selected my DOIT-based framework, given DOIT's comprehensiveness, established history, flexibility to target different

adopter types (e.g. individuals, organisations), and applicability across various fields (Jagadish et al., 2021; Montes de Oca Munguia et al., 2021; Rogers, 2003; Wejnert, 2002), including biodiversity conservation (e.g. Jagadish et al., 2021, 2024; Lewis-Brown et al., 2021; Mahajan et al., 2021; Mascia & Mills, 2018; Mills et al., 2019; Romero-de-Diego et al., 2021) and ecosystem restoration (Garbach & Long, 2017; Kernecker et al., 2021; Pienkowski et al., 2024).

My theory-based approach has certain advantages and limitations.

One of its main advantages is that it enhances the otherwise limited generalisability of my case study. Taking a theory-based approach allows my study to be more easily compared to other DOIT-based studies in restoration or other fields. Thus, contributing to an extensive and growing body of comparable DOIT studies (Muthukrishna & Henrich, 2019). This however hinges on the similarity of the questions and scales used for measurement across studies (Partelow, 2023). I address this issue of measurement by basing my questions on those used by a previous study (Jagadish et al., 2024) and making my framework (including my questions) available (**Appendix B, C, D, and J**). A theory-based approach also minimises the risk of finding spurious associations between unrelated variables (Smaldino & McElreath, 2016).

My framework is a complexity framework, encompassing a long list of variables presumably linked to adoption decisions (Partelow, 2023). This presents both advantages and challenges. On the one hand, it is advantageous because it encourages researchers to adopt a broad approach when designing studies, helping prevent the omission of important variables. On the other hand, it can be challenging, as the inclusion of numerous variables may complicate decisions about what to prioritize at various stages of scientific inquiry, such as study design, analysis, and interpretation (Partelow, 2023).

The ambivalent nature of complexity frameworks highlights the importance of not using them or any other framework blindly. This is emphasized by one of the frameworks I use (Jagadish et al., 2021), which encourages its users to thoroughly understand the innovation, adopter, context, and adoption event when operationalising the framework. In my experience, this

approach is very valuable, even when a framework's broad scope can lead to understanding its key elements organically. In my case, building a deep understanding of Scottish woodland creation before operationalising the framework led, for example, to the omission of variables such as compatibility with previously introduced ideas or trialability from my survey. I excluded these variables based on my system's knowledge, assuming most UK landholders have prior experiences with woodlands and their creation, and that trialling woodland creation in the UK is virtually impossible due to the slow growth of trees and strong legal barriers against woodland conversion. In hindsight, I realize that this approach could have been extended to other variables, such as reversibility, which is particularly challenging in the UK's woodland creation context.

In inferential framework-based modelling studies, like those in **Chapters 5 and 6**, variable selection is another key consideration, alongside avoiding the blind use of frameworks. Variable selection is particularly important when using complexity frameworks. There are two main approaches to select variables, data-driven and a priori ones (Berk et al., 2013; Heinze et al., 2018; Staerk et al., 2024; Ullmann et al., 2024). **Chapter 5** applies a data-driven variable selection approach. This is the most common approach but can be problematic since the final model depends on the specific method and dataset used to select its variables (Berk et al., 2013; Heinze et al., 2018; Staerk et al., 2024; Ullmann et al., 2024). This is evident from how different pseudorandom starting points for the elastic net regression algorithm influenced its variable selection in **Chapter 5** (Table 5.1). Moreover, it can result in the omission of key variables, introducing additional uncertainty and bias in model estimates, undermining model stability and the reliability of post-modelling calculations, such as standard errors, confidence intervals, or p-values (Berk et al., 2013; Heinze et al., 2018; Staerk et al., 2024; Ullmann et al., 2024). Despite their shortcomings, using predictive methods to select variables for inference, as I have done in **Chapter 5**, can identify important variables that other methods might miss, especially in datasets with many variables (Breiman, 2001).

Given the caveats associated with my initial analysis, I decided to re-analyse my data using an a priori variable selection approach. A crucial consideration in a priori variable selection for inference is the potential interactions between variables (Byrnes & Dee, 2025; McElreath, 2020; Siegel & Dee, 2025; Staerk et al., 2024). Despite acknowledging that DOIT variables interact, the framework I used did not explicitly define these interactions, possibly as part of their effort to avoid being overly prescriptive about how the framework should be operationalised (Jagadish et al., 2021; Mahajan et al., 2021). Nonetheless, DOIT does suggest how its variables influence each other and, ultimately, adoption decisions (Rogers, 2003). Thus, following best practice guidance for causal inference (McElreath, 2020), I developed my causal model and its respective DAG (Fig. 6.1), which explicitly outlines the interactions between my framework's attributes. These are based on DOIT and the knowledge of Scottish woodland creation I gained through research and fieldwork. I then used my framework to select attributes whose variables, according to DOIT, best explain variability in adoption decisions: relative advantage, compatibility, complexity, observability, and trialability. After identifying my focus attributes, I used my DAG to pinpoint other variables to include in my model in order to minimise bias in my estimates. This approach addressed several limitations of my previous analysis. First, it limited the randomness of my model by selecting variables based on theory and variable interactions rather than on the data itself (Berk et al., 2013). And second, it reduced the risk of omitted variable bias by identifying relevant variables through the DAG (Siegel & Dee, 2025). Overall, I believe this improved the robustness and replicability of my methods by enhancing their interpretability and facilitating the critical evaluation of my assumptions.

8.3. Implications for theory, policy, and practice

To the best of my knowledge, this thesis represents one of the first applications of DOIT to the study of landholders' engagement in ecosystem restoration, more specifically, the restoration of diverse native ecosystems (see also: Garbach & Long, 2017; Kernecker et al., 2021;

Pienkowski et al., 2024). Overall, my findings, along with the methodological tools I have developed, make a significant contribution to DOIT.

The variables with a consistently significant effect across **Chapters 5 and 6**, as well as in my choice experiment models (e.g. compatibility with land use practices, expected changes to wildlife habitat, profitability, and timing of payments), all represent innovation characteristics linked to its relative advantage—*“the degree to which an innovation is perceived as better than the idea it supersedes”* (Rogers, 2003)—and compatibility—*“degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters”* (Rogers, 2003). This supports DOIT's assertion that adopters' perceptions of relative advantage and compatibility play a key role in adoption decisions (Rogers, 2003).

This is not to say other innovation, adopter, or context attributes don't play a role in adoption decisions. Some of my non-overarching findings support this idea. For example, my findings in **Chapter 5**, suggests that adopter characteristics, such as landholding size and decision-making arrangements, as well as perceived context characteristics like windiness, affect adoption decisions. Similarly, my findings in **Chapter 7** indicate that context characteristics like bureaucracy and availability of free advice, influence the adoption decisions of at least some landholders. Other factors are also likely to play a role in woodland creation restoration decisions, as highlighted by previous research on woodland creation. These include, for example, the low reversibility, low trialability, high costs, and slow rewards of woodland creation, or landholders' perceived knowledge and skills to implement it (Hemery et al., 2018, 2020; Lawrence et al., 2010; Lawrence & Dandy, 2014). However, when included in my models, these aspects were not reliably associated with restoration decisions, perhaps because of their low variability between landholders who had and hadn't created mixed native woodland, or the ineffectiveness of our measurements in capturing that variability.

My DOIT-based DAG (Fig. 6.1) provides a clear, visual framework for understanding these dynamics. It suggests only a few attributes are directly causally linked to adoption decisions, while others influence adoption indirectly through their impact on other attributes. All but one

of the innovation attributes (i.e. flexibility) are directly connected to adoption decisions. The other attribute directly connected to adoption decisions is the adopter's decision-making arrangements, including their formality, how decisions are made (e.g. individually or collectively), and the influence the individuals involved have on them. Altogether, this highlights the importance of innovation characteristics; the factors influencing adopters' perceptions of them, such as knowledge or political conditions; and the decision-making processes of individuals and groups.

In my view, the direct links of innovation characteristics and adopter's decision-making arrangements with decisions to adopt an innovation, as proposed by my DAG, have strong implications for practice. They suggest that assessing landholders' perceptions of key innovation characteristics (i.e. those directly linked to adoption decisions: relative advantage, compatibility, complexity, observability and trialability) and their decision-making arrangements, can help identify the direct drivers of adoption. Once these drivers are identified, scheme implementers could explore changes to indirect drivers of adoption (i.e. those shaping adopters' perceptions of innovations characteristics) to make schemes more attractive. Since some factors influencing adopters' perceptions, such as their personalities or geographical settings, will be difficult or impossible for implementers to influence, they should focus on levers within their control. These include, for example, simplifying interventions, making them as advantageous and flexible as possible, and providing potential adopters with clear and comprehensive information.

In addition to these implications, the overarching findings of this thesis—that landholders' sustainability goals and views of restoration's environmental benefits and compatibility with their land uses, often precede more serious considerations of adopting restoration where practical factors gain prevalence—suggest minimum requirements ecosystem restoration schemes should meet to improve their uptake and spread. First, providing clear, evidence-based information on the environmental, practical, and economic aspects of restoration seems key to allow landholders to assess how restoration aligns with their sustainable land use goals

and current practices, especially when compared to other land use options. Second, offering landholders financial support that compensates all or most of their expenses would be equally important. Finally, ensuring all possible aspects of restoration initiatives (e.g. timing of payments, size of restoration area, support) remain as simple and flexible as safeguards allow, should help landholders tailor restoration interventions to their specific circumstances and needs, increasing their overall compatibility, ease of understanding and use, and appeal.

8.4. Limitations and future research directions

My study has general limitations linked to my use of DOIT, which has four well known critiques: pro-innovation bias, individual blame bias, recall bias, and equality issues (Rogers, 2003).

Pro-innovation bias refers to the implicit insinuation within diffusion research that innovations will spread and be adopted by all members of a social system in an accelerating manner, with little reinvention or rejection. Something that does not hold true on all occasions (Rogers, 2003). I would argue that despite framing my question in a pro-innovation way—focusing on what drives adoption rather than rejection or abandonment—I understood that woodland restoration despite needing scaling, won't nor should be adopted by all UK landholders. Restoring woodlands in the wrong places can be harmful (Di Sacco et al., 2021; Elias et al., 2021; Fleischman et al., 2020; Sandbrook et al., 2023). Additionally, ecosystems like peatlands and grasslands also merit restoration, and we must accommodate for all other land-uses as well. Moreover, woodland restoration, with its irreversibility, long timelines, and lower profitability compared to other land uses, is likely to discourage a pro-innovation stance among potential adopters, who are generally more inclined to reject it than embrace it (e.g. Hemery et al., 2018, 2020). Although pro-innovation bias may have limited applicability to woodland restoration, its recognition in diffusion research has led to calls for examining not only adoption but also the ignorance, reinvention, rejection, and abandonment of innovations, as well as unsuccessful diffusion or efforts to prevent the uptake of 'bad' innovations—such as

environmentally harmful practices (Rogers, 2003). These are all crucial aspects of the adoption process that I encourage future studies to consider when exploring engagement with ecosystem restoration.

Individual blame bias highlights the tendency of diffusion researchers to link the success or failure of diffusion to adopters, overlooking the systemic factors at play (Rogers, 2003). This thesis has consistently highlighted the potential importance of systemic factors, primarily by suggesting changes to existing woodland creation schemes, such as ensuring simplicity and flexibility within safeguards, or providing adequate financial and informational support to landholders. In addition, I have highlighted how amendments to inheritance tax or woodland conversion regulations could reduce landholders' risk perceptions; explored how new revenue streams like carbon or biodiversity might make woodland ecological restoration more attractive; or suggested an evaluation of whether current schemes unintentionally favour larger landholdings. Nonetheless, potential systemic influences do not end there. For example, environmentally harmful subsidies can perpetuate damaging land uses acting as barriers to ecosystem restoration (e.g. Cortina-Segarra et al., 2021), whilst wars together with changes to forestry's policies and paradigms have defined the extent and type of forest cover on the UK through history (Raum & Potter, 2015). As suggested by DOIT, future research should be aware of this bias and broaden its scope accordingly. Otherwise, it risks missing key systemic influences on adoption and scaling, leading to a flawed understanding of their driving factors, and potentially ineffective diffusion strategies based on that incomplete knowledge. Thus, systemic influences on diffusion and adoption should only be ruled out after thorough explorations of both, with in-depth studies of systemic barriers or enablers conducted whenever relevant (Rogers, 2003).

Time is particularly challenging in diffusion studies. Most studies, including those in **Part 1**, represent a snapshot of adopters' perspectives at a particular point in time. Moreover, they tend to analyse adoption retrospectively, thus relying on adopters' potentially inaccurate memories and incurring the risk of recall bias (Catalogue of Bias Collaboration, Spencer, et

al., 2017; Rogers, 2003). As discussed in **Section 4.3**, I used piloting and close ended questions to mitigate recall bias in my surveys (Bernard et al., 1984). Nonetheless the only definitive way to overcome recall bias would be to collect data at the time of adoption. For centralised ecosystem restoration schemes, this could be accomplished through a survey administered to adopters when they first join the program. However, this should be carefully considered since it would increase paperwork levels and would exclude landholders restoring independently from the scheme.

Additionally, the snapshot nature of most diffusion studies makes it difficult to study changes over time. For example, individuals' or organizations' perspectives—and, by extension, their adoption or rejection decisions—are likely to evolve as their knowledge, context, and internal characteristics change (Rogers, 2003). These dynamic influences are often overlooked unless measurements are taken repeatedly over time, or before and after specific interventions.

Looking ahead, forecasting the spread of restoration initiatives in both time and space, in response to various factors, presents another exciting direction for future research. Within conservation, forecasting methods are considered essential for framing problems, shaping interventions, and guiding implementation and evaluation (Travers et al., 2019). These methods have been applied to study the adoption of conservation interventions, demonstrating, for instance, that adoption patterns over time (Clark et al., 2024), and the spatio-temporal adoption of community-based marine management initiatives (Jørgensen et al., 2024) can be accurately predicted. This approach has enhanced our understanding of the factors influencing adoption and supports more adaptive decision-making (Clark et al., 2024; Travers et al., 2019). Applying similar forecasting techniques to restoration could yield similarly valuable insights.

The final critique of DOIT—and subsequent area of future research—is the issue of equality. The adoption of innovations can widen socioeconomic gaps between the wealthiest and the poorest in society, undermining equality. Moreover, wealthier adopters are not only targeted more often by diffusion agencies, but also have the resources, time, and knowledge to engage

with innovations more easily (Rogers, 2003). Restoration projects are not immune to this (e.g. Fisher et al., 2018; Fleischman et al., 2020; Ramprasad et al., 2020), which has sparked calls to consider restoration's social impacts, involve local stakeholders, and empower local communities and marginalized groups to reduce tensions and inequality (Elias et al., 2021; Osborne et al., 2021).

My study area (**Section 2.4**) offers a stark example of how ecosystem restoration and the new financial mechanisms tied to it, may be perpetuating or worsening inequalities within already unequal socioecological systems. In Scotland, restoring woodlands and peatlands for natural capital gains has become a key objective for new landowners, driving up the prices of suitable landholdings (Glendinning & Merrell, 2023). Some say this is contributing to make land and housing unaffordable for local individuals and communities, while funnelling public funds into the pockets of wealthy landowners through restoration subsidies (e.g. Community Land Scotland, 2021; O'Grady, 2022). Thus, perpetuating Scotland's deeply unequal land ownership, where, due to historical processes, most land is controlled by a small group of wealthy landowners (Hobbs, 2009; Scottish Government, 2014; Wightman, 2024).

Although my study did not focus on how spatial features linked to a specific area affect restoration uptake, nor on how its adoption spreads through a region over time, these represent interesting directions for future research. Studies on the spatial factors influencing landholders' decisions to engage in forest restoration in Brazil's Atlantic Rainforest have identified various socio-ecological factors—such as altitude, terrain ruggedness, proximity to water bodies, distance from cities, population and cattle density, and forest cover—that can predict the likelihood of restoration in specific areas (Pienkowski et al., 2024). Extending this approach to other restoration contexts would be a valuable next step. Additionally, spatio-temporal analyses of how restoration spreads over time and space could provide further insights, particularly regarding the roles of landholder proximity and travel infrastructure density in the adoption and spread of restoration efforts. This would be especially relevant where restoration is found to occur in spatio-temporal clusters. Finally, as mentioned earlier,

spatial forecasting approaches would also be interesting. The UK, with its wealth of spatial data—including records of the type, location, and time of woodland creation using government funding (e.g. Forestry Commission, 2016c, 2016b, 2016a; Scottish Forestry, 2019c, 2019b, 2019a)—presents a promising case study for such research of the spatial dynamics of forest restoration adoption.

Another interesting avenue of scientific enquiry would be that of extending my research to other contexts, ecosystems, and adopter types. The main questions here would be about differences. For example, are landholders' motivations to restore mixed native woodlands different in other countries or regions? Are the factors driving landholders' decisions to restore other ecosystems significantly different? For instance, restoring grasslands might be more attractive to farmers due to its potential for easy conversion back to arable uses (reversibility) or suitability for grazing (compatibility). Additionally, questions regarding what motivates other adopter types—such as governments—to engage in restoration and the implications of this for ecosystems under their stewardship—such as coastal ecosystems in certain nations—could also be very interesting.

Finally, future studies could collect more nuanced data on the type of land use carried in landholdings. The data I collected on this was not detailed enough to allow me to assess, for example, whether livestock farmers find woodland more compatible than arable farmers, as suggested in **Chapter 5's** discussion (**Section 5.4**). This is akin to segmentation studies where samples are subdivided into different typologies based on a set of factors (Simmons et al., 2020; Urquhart & Courtney, 2011) and could contribute to more nuanced understandings of the heterogeneous perspectives of landholders towards restoration.

9. CONCLUSION

Ecosystem restoration is a process defined by change. Ultimately change to the use of a piece of land, but first and foremost to the perspectives and practices of those managing it and their contexts. Targets and economic incentives are common and essential strategies to foster that change and achieve ecosystem restoration at scale (Tedesco, López-Cubillos, et al., 2023). But my research and that of others (e.g. Tedesco et al., 2023) suggests a narrow focus on them will almost certainly lead to failure in scaling restoration effectively. Instead, a more holistic approach that considers landholders' goals, their context, and their perceptions of ecosystem restoration initiatives is needed. Grounding this holistic approach on suitably broad and dynamic scientific theories, such as DOIT, would not only deepen our understanding of restoration decisions (Schill et al., 2019), but also help us build a robust knowledge base through the accumulation of comparable studies (Muthukrishna & Henrich, 2019). The insights and restoration strategies resulting from this approach will be different for different theories and places. With the overall results of this thesis suggesting a key role for ecosystem and restoration initiative characteristics, as well as for landholders' perspectives on both. Specifically, landholders' objectives for more sustainable land use, along with their views of the environmental benefits of ecosystem restoration and its compatibility with their existing land uses, appear to be key factors driving the uptake of restoration. These elements seem to act as a trampoline to more serious deliberations of adoption, where more practical details—such as the timing of payments and profitability of available restoration initiatives—gain prevalence. The importance of these factors suggests that, to facilitate adoption, at a minimum, landholders should be provided with clear, evidence-based information on the environmental, practical, and economic aspects of restoration. Such information would enable them to compare the merits of restoration against those of other land uses in achieving their sustainability goals, as well as its compatibility with their current land use practices. Equally crucial would be to offer adequate financial support and keep financial and non-financial aspects of schemes as simple and flexible as safeguards allow—making those aspects as

easy to understand, use, and adapt to landholders' goals and contexts, while reducing the risk for unintended negative consequences. Overall, respecting these minimum requirements and taking an approach to designing and refining ecosystem restoration programs that is more holistic, iterative, and sensitive to landholders' perspectives, should increase their adoption. Provided safeguards against potential negative outcomes (environmental, social, and economic) are observed, this would contribute to the realization of ecosystem restoration's multiple benefits at scale.

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APPENDIXES

Appendix A – Ethics approval and amendments



Imperial College Research Ethics Committee
Imperial College London
Room 221
Medical School Building
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London
W2 1PG
Tel: +44 (0)207 594 1872

researchethicscommittee@imperial.ac.uk

09/08/2022

Dear Dr Mills

Study Title: To plant or not to plant? Drivers of native woodland creation in the United Kingdom

SETREC reference: 22IC7888

The above study was approved by your Head of Department on 09/08/22 and by the Joint Research Compliance Office on 18/07/22.

Under the Science Engineering Technology Research Ethics Committee process, a study that has been reviewed by the Joint Research Compliance Office and Head of Division/Department (or Principal), where no significant ethical issues have been identified in the protocol or ethics application, can be approved without requiring it to go to full committee.

Documents

The documents reviewed were:

- ICREC-SETREC Application form (v1.0 14/07/22)
- Protocol (v1.0 14/07/22)
- Participant Information Sheet Survey (v1.0 14/07/22)
- Participant Information Sheet Choice Expt (v1.0 14/07/22)
- Recruitment Materials Survey (v1.0 19/07/22)
- Recruitment Materials Choice Expt (v1.0 29/07/22)
- Survey Adopter (v1.0 18/07/22)
- Survey NonAdopter (v1.0 18/07/22)
- Choice Expt (v1.0 29/07/22)

Yours sincerely,

Ruth Nicholson,
Head of Research Governance and Integrity,
Imperial College London

04 April 2023

Dear Dr Morena Mills

Study Title: To plant or not to plant? Drivers of native woodland creation in the United Kingdom

SETREC Reference: 22IC7888

The above Notice of Amendment was reviewed by the Research Governance and Integrity Team on 04/04/23.

The Research Governance and Integrity Team (RGIT) have reviewed the revised documents you submitted and would like to grant RGIT approval to this study on the basis described in the Notice of Amendment 1.

Documents

The documents reviewed were:

- Notice of Amendment (v1.0, 03/03/2023)
- Protocol (v2.0, 03/03/2023)
- Participant Information Sheet – Survey (v2.0, 03/03/2023)
- Participant Information Sheet – Choice Experiment (v2.0, 03/03/2023)
- Recruitment Email - Choice Experiment (v2.0, 03/03/2023)
- Survey Adopter (v3.0, 03/03/2023)
- Survey Non-Adopter (v3.0, 03/03/2023)
- Choice Experiment ((v2.0, 03/03/2023)

Yours sincerely,

Keith Boland,
Head of Research Governance and Integrity,
Imperial College London

29/06/2023

Dear Dr Mills

Study Title: To plant or not to plant? Drivers of native woodland creation in the United Kingdom

SETREC Reference number: 22IC7888

The above Notice of Amendment was reviewed by the Research Governance and Integrity Team (RGIT) on 29/06/2023.

The Research Governance and Integrity Team have reviewed the revised documents you submitted and would like to grant RGIT approval to this study on the basis described in the Notice of Amendment.

Documents

The documents reviewed were:

- Notice of Amendment (No.2)
- Survey Adopter (v4.0 27/06/23)
- Survey Non-Adopter (v4.0 27/06/23)
- Choice Experiment (v3.0 27/06/23)

Yours sincerely,

Keith Boland,
Head of Research Governance and Integrity,
Imperial College London

Appendix B – Drivers of Native Woodland Creation Survey (Adopters version)

Drivers of Native Woodland Creation Survey

Welcome to the Drivers of Native Woodland Creation survey

This survey is part of the “To plant or not to plant? Drivers of native woodland creation in the United Kingdom” study which aims to examine the factors influencing landholders' decisions to either create new native woodlands or not in the UK.

This study is led by Dr. Morena Mills who is the principal investigator and her co-investigator Alvaro Roel Bellot. We are both affiliated to the Centre for Environmental Policy at Imperial College London (UK).

We want to understand the perspectives of people that have and have not created woodland on the land they manage, as well as those of people that plan and do not plan to engage in woodland creation in the future. All these perspectives are important to researchers and decision makers designing policies for new native woodlands in the UK.

In this survey we will ask you questions in reference to a piece of land. **Please answer the questions below to confirm that you are a suitable participant:**

- a) I am involved in the management of the land I will refer to in my response.

☐ Yes

☐ No

- b) I am involved in decision-making processes that lead to changes in the use of that land, including decisions on new woodland creation.

☐ Yes

☐ No

BLOCK 0

Do you consent to participate in this study?

Completing the survey takes about 30 minutes.

Participation is voluntary. If you decide to take part, you are still free to withdraw from the study at any time without giving a reason. You can leave questions unanswered if you do not feel confident or comfortable sharing your answer.

You can win a prize by participating! There are ten GiftPay online vouchers up for grabs: six £10 vouchers, two £20 vouchers, a £50 voucher and a top prize of £100.

We collect the following personal data via this survey: full name, email and postcode. We will keep your personal data separate from the rest of your response and will never share it with anyone outside the research team. We require personal data to contact raffle winners, send a copy of our results and/or share the details of a parallel research project we are running if you show interest in participating via the survey. Your personal data will be stored securely and will only be used for this project.

The rest of your response will be fully anonymous, meaning that we will ensure individual institutions and individuals themselves cannot be identified from it by anyone, not even ourselves. We will use this data in our analysis. When we publish our results, we will share a copy of the anonymised responses database via an online open access repository to ensure our results are fully transparent. If you withdraw from the study after we anonymise response data, we will be able to delete your personal data but not the rest of your response, since we won't be able to tell who submitted what after anonymisation. Unsubmitted responses will be fully deleted and won't be stored.

If this research leads to an invention and/or the development of a new product or service, you won't personally benefit financially from it. This study has been given approval by the Head of Department and the Research Governance and Integrity Team (RGIT) at Imperial College London.

You can read the full details of ethics and security on the study's Participant Information Sheet.

If you have any questions about ethics or the study in general, please contact Alvaro Roel Bellot (alvaro.roel-bellot@imperial.ac.uk) or Morena Mills (m.mills@imperial.ac.uk).

By clicking “Accept” on this page you are confirming that you have read and understood the information on this page and the study's Participant Information Sheet, and that you consent to take part in this study.

☐ Accept.

BLOCK 1

1. What type of landholding do you represent?

- ☐ Estate
- ☐ Farm
- ☐ Croft
- ☐ Nature Reserve
- ☐ *Do not know*
- ☐ *Other, please specify:*

2. What is your current land tenure? Please select all options that apply to you/your organisation.

- ☐ Landowner directly managing the landholding
- ☐ Tenant
- ☐ Landlord
- ☐ Licensor
- ☐ Licensee
- ☐ Crofter
- ☐ *Do not know*
- ☐ *Other, please specify:*

3. How big is the landholding you represent?

- ☐ Less than 50 acres
- ☐ 50 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 1,250 acres
- ☐ 1,250 acres or more, but less than 2,500 acres
- ☐ 2,500 acres or more, but less than 5,000 acres
- ☐ 5,000 acres or more, but less than 7,500 acres
- ☐ 7,500 acres or more, but less than 10,000 acres
- ☐ 10,000 acres or more, but less than 15,000 acres
- ☐ 15,000 acres or more, but less than 20,000 acres
- ☐ 20,000 acres or more, but less than 35,000 acres
- ☐ 35,000 acres or more, but less than 50,000 acres
- ☐ 50,000 acres or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

4. What type of organisation do you represent?

- ☐ Family organisation
- ☐ Non-family organisation
- ☐ *Other, please specify:*

5. What are the financial aims of your organisation?

- ☐ For profit
- ☐ Not for profit
- ☐ *Other, please specify:*

6. How many people are part of the organisation you represent?

- ☐ Less than 5 members
- ☐ 5 to 9 members
- ☐ 10 to 29 members
- ☐ 30 to 49 members
- ☐ 50 member or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

7. How long has the landholding been under your/your organisation's management?

- ☐ Under 1 year
- ☐ 1 to 4 years
- ☐ 5 to 9 years
- ☐ 10 years or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

8. What is the main use of the landholding you represent? Please select all that apply if you practice a mix of uses and one does not predominate over the rest.

- ☐ Farming
- ☐ Forestry
- ☐ Game/Hunting
- ☐ Wildlife conservation
- ☐ Public recreation
- ☐ Private enjoyment
- ☐ *Do not know*
- ☐ *Other, please specify:*

BLOCK 2

9. Have any new woodlands been created on the landholding you represent since you or your organisation manage it? Please don't consider restocking (replanting of woodland that has been felled) as woodland creation.

- ☐ Yes
- ☐ No

10. Has more than one new woodland been created on the landholding you represent since you or your organisation manage it?

- ☐ Yes
- ☐ No

11. How was the new woodland(s) created? Please select all options that apply to you/your organisation.

- ☐ Tree planting
- ☐ Natural regeneration
- ☐ *Do not know*
- ☐ *Other, please specify:*

12. Did you receive any external funding to create the woodland? Please select all options that apply to you/your organisation.

- ☐ Yes, government funding
- ☐ Yes, non-government funding
- ☐ Yes, a bank loan I need to repay
- ☐ No
- ☐ *Do not know*
- ☐ *Other, please specify:*

13. What type of tree species were used when creating the new woodland(s)? Please select all options that apply if more than one woodland has been created on the landholding you represent since you or your organisation manage it.

- ☐ Native – One species only
- ☐ Non-Native – One species only
- ☐ Native – Mix of species
- ☐ Non-Native – Mix of species
- ☐ Mixed (native and non-native) - Predominantly Native
- ☐ Mixed (native and non-native) - Predominantly Non-native
- ☐ Mixed (native and non-native) – Even split between natives and non-native trees.
- ☐ *Do not know*
- ☐ *Other, please specify:*

14. How many acres of new woodland have been created on the landholding you represent since you/your organisation manage it?

- ☐ Less than 12 acres
- ☐ 12 acres or more, but less than 25 acres
- ☐ 25 acres or more, but less than 125 acres
- ☐ 125 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 500 acres
- ☐ 500 acres or more, but less than 1,000 acres
- ☐ 1,000 acres or more, but less than 2,000 acres
- ☐ 2,000 acres or more, but less than 4,000 acres
- ☐ 4,000 acres or more, but less than 8,000 acres
- ☐ 8,000 acres or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

15. How was the decision to create a new woodland made?

- ☐ By a single individual
- ☐ Collectively, by all members of the organisation
- ☐ By a select group of individuals within the organisation
- ☐ *Do not know*
- ☐ *Other, please specify:*

16. How well would you say you/your organisation were managing financially while deciding to create the new woodland?

- ☐ Very well
- ☐ Well
- ☐ Just about getting by
- ☐ Finding it quite difficult
- ☐ Finding it very difficult
- ☐ *Do not know*
- ☐ *Other, please specify:*

17. Why did you decide to create new woodland?

BLOCK 3

18. Did the landholding you represent contain any existing woodland before the new woodland was created?

- ☐ Yes
- ☐ No

19. If yes, what type of woodland? Please select all options that apply to the landholding you represent if there was more than one type of woodland within it before new woodland was created.

- ☐ Native – One species only
- ☐ Non-Native – One species only
- ☐ Native – Mix of species
- ☐ Non-Native – Mix of species
- ☐ Mixed (native and non-native) - Predominantly Native
- ☐ Mixed (native and non-native) - Predominantly Non-native
- ☐ Mixed (native and non-native) - Even split between natives and non-native trees
- ☐ *Do not know*
- ☐ *Other, please specify:*

20. How many acres of woodland were there on the landholding you represent before new woodland was created?

- ☐ Less than 12 acres
- ☐ 12 acres or more, but less than 25 acres
- ☐ 25 acres or more, but less than 125 acres
- ☐ 125 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 500 acres
- ☐ 500 acres or more, but less than 1,000 acres
- ☐ 1,000 acres or more, but less than 2,000 acres
- ☐ 2,000 acres or more, but less than 4,000 acres
- ☐ 4,000 acres or more, but less than 8,000 acres
- ☐ 8,000 acres or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

21. Is the existing woodland managed? Please select all options that apply to the landholding you represent if it contained more than one existing woodland before new woodland was created, and you manage each differently.

- ☐ Yes, managed for wood production: coppice system.
- ☐ Yes, managed for wood production: even aged woodland harvested through clear felling.
- ☐ Yes, managed for wood production: unevenly aged woodland harvested through regular or irregular felling.
- ☐ Yes, managed for game/hunting: The woodland is managed to provide habitat for game species such as pheasants.
- ☐ Yes, actively managed for wildlife. The woodland is managed to improve its wildlife value through actions such as thinning to improve age structure, felling to create openings or ring barking trees to increase the amount of dead wood.
- ☐ Yes, passively managed for wildlife. The woodland is managed through a no intervention approach letting it develop on its own terms.
- ☐ Not managed at all.
- ☐ *Do not know*
- ☐ *Other, please specify:*

BLOCK 4

22. Think back to when you were still deciding whether to create woodland or not on the landholding you represent. To what degree would you have agreed or disagreed with the following statements back then:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am committed to creating woodland in the next 5 years.	☐	☐	☐	☐	☐
I feel a moral obligation to contribute to woodland expansion efforts.	☐	☐	☐	☐	☐
I feel a moral obligation to manage land in a way that contributes to the fight against climate change.	☐	☐	☐	☐	☐
I feel a personal responsibility to manage land in a way that allows wildlife to thrive.	☐	☐	☐	☐	☐
I feel it is my responsibility to manage land in a way that protects soil and water, preventing floods.	☐	☐	☐	☐	☐
I feel that circumstances complicate the creation of woodland on the landholding I represent.	☐	☐	☐	☐	☐
I feel that creating woodland on the landholding I represent depends more on me than others.	☐	☐	☐	☐	☐

BLOCK 5

23. Think back to when you were still deciding whether to create woodland or not on the landholding you represent. Back then, to what degree were the following aspects suitable for woodland creation in the landholding you represent:

Aspect	Very unsuitable	Unsuitable	Neither suitable nor unsuitable	Suitable	Very suitable	Do not know
Temperature	☐	☐	☐	☐	☐	☐
Soil quality	☐	☐	☐	☐	☐	☐
Windiness	☐	☐	☐	☐	☐	☐

24. Consider how browsing by deer, livestock, rabbits, hares, and/or voles might affect the survival of tree saplings. A high abundance of herbivores might be unsuitable to woodland creation hindering the establishment of most trees without protective measures (i.e. culling, fencing, tree guards...). Thinking back to when you were still deciding whether to create your woodland or not, please rate how suitable the herbivore abundance in the landholding you represent was for woodland creation back then:

Aspect	Very unsuitable	Unsuitable	Neither suitable nor unsuitable	Suitable	Very suitable	Do not know
Herbivore abundance	☐	☐	☐	☐	☐	☐

BLOCK 6

25. Think back to when you were still deciding whether to create woodland or not on the landholding you represent. To what degree would you have agreed or disagreed with the following statements back then:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
We are able to create woodland in a way that suits our objectives.	☐	☐	☐	☐	☐
If we create woodland, we can easily return the land to its previous use.	☐	☐	☐	☐	☐
The initial monetary investment required to create woodland is very high.	☐	☐	☐	☐	☐
The time required to first create woodland is very high.	☐	☐	☐	☐	☐
We have enough money to create woodland without external support (i.e. grant...)	☐	☐	☐	☐	☐
We have enough time to create woodland without external support (i.e. volunteers, more staff...).	☐	☐	☐	☐	☐
We have the knowledge and skills needed to create new woodlands.	☐	☐	☐	☐	☐
Creating woodland is risky.	☐	☐	☐	☐	☐
We will wait until we have enough information about woodland creation and its consequences before implementing it.	☐	☐	☐	☐	☐
We will wait until we are comfortable with the risks posed by woodland creation before implementing it.	☐	☐	☐	☐	☐
Government policies make it easier for us to create woodland.	☐	☐	☐	☐	☐

Our decision-making processes are very formal, when deciding to create woodland we have to consider our own rules and procedures.	☐	☐	☐	☐	☐
Making the decision to create woodland is easy.	☐	☐	☐	☐	☐

BLOCK 7

Think back to when you were still deciding whether to create woodland or not on the landholding you represent when answering the questions within this section.

26. How difficult or easy was it to **understand** the following aspects of woodland creation according to your experience

	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy	Do not know
The paperwork required to access funding for woodland creation (from government or others).	☐	☐	☐	☐	☐	☐
The paperwork needed to create woodland.	☐	☐	☐	☐	☐	☐
Ground preparations needed before planting new woodland (i.e. mounding, clearing scrub...).	☐	☐	☐	☐	☐	☐
Interventions to protect new woodland from herbivore damage (i.e. fencing, using tree guards...).	☐	☐	☐	☐	☐	☐
Creating/planting the woodland.	☐	☐	☐	☐	☐	☐

27. How difficult or easy was it to **actually do** the following aspects of woodland creation according to your experience.

	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy	Do not know
The paperwork required to access funding for woodland creation (from government or others).	☐	☐	☐	☐	☐	☐
The paperwork needed to create woodland.	☐	☐	☐	☐	☐	☐
Ground preparations needed before planting new woodland (i.e. mounding, clearing scrub...).	☐	☐	☐	☐	☐	☐
Interventions to protect new woodland from herbivore damage (i.e. fencing, using tree guards...).	☐	☐	☐	☐	☐	☐
Creating/planting the woodland	☐	☐	☐	☐	☐	☐

BLOCK 8

28. The following table shows aspects of the landholding you represent that may change after woodland creation. Please go through the table and indicate how much you expect these aspects to change and how long do you think it will take you to realise the changes.

Aspect	How would you expect this aspect to change after woodland creation?	When would you expect to realise this change after woodland creation?
Carbon storage (The land's capacity to capture and store CO ₂ from the air)	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Habitat for wildlife	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
The diversity of plant and animal species	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Water quality	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Flooding prevention	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Soil quality	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Money earned by the landholding	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Well-being of the people in your community	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly.	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Social recognition we receive from my community	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Number of jobs generated by the landholding	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised

29. Would there be any other environmental or social changes to you or your local area resulting from creating woodland on the landholding you represent?

- ☐ Yes
☐ No

30. If yes, which ones?

BLOCK 9

31. Think back to when you were still deciding whether to create woodland or not on the landholding you represent. To what degree would you have agreed or disagreed with the following statements back then:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
If we create woodland, the woodland will be visible to the rest of our community.	☐	☐	☐	☐	☐
The environmental and social consequences of woodland creation will be visible to the rest of our community.	☐	☐	☐	☐	☐
Creating new woodland matches our values and beliefs	☐	☐	☐	☐	☐
Creating woodland matches our needs.	☐	☐	☐	☐	☐
Creating woodland matches our land use practices.	☐	☐	☐	☐	☐

BLOCK 10

32. When your woodland was created, how often did the people in the landholding you represent (including you) interact with other landholders or land managers?

- ☐ Never
☐ Daily
☐ Weekly
☐ Monthly
☐ Once in six months
☐ Yearly
☐ *Do not know*
☐ *Other, please specify:*

33. When your woodland was created, were people in the landholding you represent (including you) part of any groups that discuss woodland management?

- ☐ Yes
☐ No

34. If, yes which?

BLOCK 11

35. Think back to when you were still deciding whether to create woodland or not on the landholding you represent. To what degree would you have agreed or disagreed with the following statements back then:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The people in the landholding you represent (including you) are open to new ideas and practices about land management.	☐	☐	☐	☐	☐
There are individuals within our community (i.e. neighbours...) that actively promote woodland creation.	☐	☐	☐	☐	☐
There are organisations in our area (governmental and non-governmental) that could offer us useful support in the woodland creation process.	☐	☐	☐	☐	☐
I sense that most people that are important to me are in favour of woodland creation.	☐	☐	☐	☐	☐
I sense that most of the landholders in my community have or are planning to create woodlands on their properties.	☐	☐	☐	☐	☐
I sense that there are many people creating woodlands in my area.	☐	☐	☐	☐	☐
There is a lot of competition to access woodland creation resources (i.e. grants, tree saplings...).	☐	☐	☐	☐	☐
I sense that those dearest to me think I shouldn't plant more woodland.	☐	☐	☐	☐	☐

BLOCK 12

36. Full name:
37. Email:
38. Year of Birth:
39. Postcode for the landholding subject of your response:
40. What is the highest level of formal education you have attained?
- ☐ Doctoral University Degree
 - ☐ Masters University Degree
 - ☐ Undergraduate University Degree
 - ☐ High (Secondary) School Graduate
 - ☐ Primary School Graduate
 - ☐ No formal education
 - ☐ *Refuse to answer*
 - ☐ *Other, please specify:*
41. Please indicate whether you would like to enter the study's raffle and/or receive a copy of its results when they are published.
- ☐ I would like to take part in the raffle to win a voucher for a value of up to £100.
 - ☐ I would like to receive a copy of the study's results when they are published.
42. We are running a parallel research project investigating the preferences of landholders towards different woodland creation interventions. It consists of a brief game where you will be asked to choose your favourite from a set of woodland creation interventions of varying characteristics. If you are interested in learning more about it and would consider participating, please tick the box below and we will send you more details.
- ☐ Yes, I am interested. Please send me more details about your parallel research project.

Appendix C – Drivers of Native Woodland Creation Survey (Non- adopter version)

Drivers of Native Woodland Creation Survey

Welcome to the Drivers of Native Woodland Creation survey

This survey is part of the “To plant or not to plant? Drivers of native woodland creation in the United Kingdom” study which aims to examine the factors influencing landholders' decisions to either create new native woodlands or not in the UK.

This study is led by Dr. Morena Mills who is the principal investigator and her co-investigator Alvaro Roel Bellot. We are both affiliated to the Centre for Environmental Policy at Imperial College London (UK).

We want to understand the perspectives of people that have and have not created woodland on the land they manage, as well as those of people that plan and do not plan to engage in woodland creation in the future. All these perspectives are important to researchers and decision makers designing policies for new native woodlands in the UK.

In this survey we will ask you questions in reference to a piece of land. **Please answer the questions below to confirm that you are a suitable participant:**

- c) I am involved in the management of the land I will refer to in my response.

☐ Yes

☐ No

- d) I am involved in decision-making processes that lead to changes in the use of that land, including decisions on new woodland creation.

☐ Yes

☐ No

BLOCK 0

Do you consent to participate in this study?

Completing the survey takes about 30 minutes.

Participation is voluntary. If you decide to take part, you are still free to withdraw from the study at any time without giving a reason. You can leave questions unanswered if you do not feel confident or comfortable sharing your answer.

You can win a prize by participating! There are ten GiftPay online vouchers up for grabs: six £10 vouchers, two £20 vouchers, a £50 voucher and a top prize of £100.

We collect the following personal data via this survey: full name, email and postcode. We will keep your personal data separate from the rest of your response and will never share it with anyone outside the research team. We require personal data to contact raffle winners, send a copy of our results and/or share the details of a parallel research project we are running if you show interest in participating via the survey. Your personal data will be stored securely and will only be used for this project.

The rest of your response will be fully anonymous, meaning that we will ensure individual institutions and individuals themselves cannot be identified from it by anyone, not even ourselves. We will use this data in our analysis. When we publish our results, we will share a copy of the anonymised responses database via an online open access repository to ensure our results are fully transparent. If you withdraw from the study after we anonymise response data, we will be able to delete your personal data but not the rest of your response, since we won't be able to tell who submitted what after anonymisation. Unsubmitted responses will be fully deleted and won't be stored.

If this research leads to an invention and/or the development of a new product or service, you won't personally benefit financially from it. This study has been given approval by the Head of Department and the Research Governance and Integrity Team (RGIT) at Imperial College London.

You can read the full details of ethics and security on the study's Participant Information Sheet.

If you have any questions about ethics or the study in general, please contact Alvaro Roel Bellot (alvaro.roel-bellot@imperial.ac.uk) or Morena Mills (m.mills@imperial.ac.uk).

By clicking "Accept" on this page you are confirming that you have read and understood the information on this page and the study's Participant Information Sheet, and that you consent to take part in this study.

☐ Accept.

BLOCK 1

1. What type of landholding do you represent?

- ☐ Estate
- ☐ Farm
- ☐ Croft
- ☐ Nature Reserve
- ☐ *Do not know*
- ☐ *Other, please specify:*

2. What is your current land tenure? Please select all options that apply to you/your organisation.

- ☐ Landowner directly managing the landholding
- ☐ Tenant
- ☐ Landlord
- ☐ Licensor
- ☐ Licensee
- ☐ Crofter
- ☐ *Do not know*
- ☐ *Other, please specify:*

3. How big is the landholding you represent?

- ☐ Less than 50 acres
- ☐ 50 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 1,250 acres
- ☐ 1,250 acres or more, but less than 2,500 acres
- ☐ 2,500 acres or more, but less than 5,000 acres
- ☐ 5,000 acres or more, but less than 7,500 acres
- ☐ 7,500 acres or more, but less than 10,000 acres
- ☐ 10,000 acres or more, but less than 15,000 acres
- ☐ 15,000 acres or more, but less than 20,000 acres
- ☐ 20,000 acres or more, but less than 35,000 acres
- ☐ 35,000 acres or more, but less than 50,000 acres
- ☐ 50,000 acres or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

4. What type of organisation do you represent?

- ☐ Family organisation
- ☐ Non-family organisation
- ☐ *Other, please specify:*

5. What are the financial aims of your organisation?

- ☐ For profit
- ☐ Not for profit
- ☐ *Other, please specify:*

6. How many people are part of the organisation you represent?

- ☐ Less than 5 members
- ☐ 5 to 9 members
- ☐ 10 to 29 members
- ☐ 30 to 49 members
- ☐ 50 member or more

- ☐ *Do not know*
- ☐ *Other, please specify:*

7. How long has the landholding been under your/your organisation's management?

- ☐ Under 1 year
- ☐ 1 to 4 years
- ☐ 5 to 9 years
- ☐ 10 years or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

8. What is the main use of the landholding you represent? Please select all that apply if you practice a mix of uses and one does not predominate over the rest.

- ☐ Farming
- ☐ Forestry
- ☐ Game/Hunting
- ☐ Wildlife conservation
- ☐ Public recreation
- ☐ Private enjoyment
- ☐ *Do not know*
- ☐ *Other, please specify:*

BLOCK 2

9. Have any new woodlands been created on the landholding you represent since you or your organisation manage it? Please don't consider restocking (replanting of woodland that has been felled) as woodland creation.

- ☐ Yes
- ☐ No

10. Has more than one new woodland been created on the landholding you represent since you or your organisation manage it?

- ☐ Yes
- ☐ No

11. How was the new woodland(s) created? Please select all options that apply to you/your organisation ☐ Tree planting

- ☐ Natural regeneration
- ☐ *Do not know*
- ☐ *Other, please specify:*

12. Did you receive any external funding to create the woodland? Please select all options that apply to you/your organisation.

- ☐ Yes, government funding
- ☐ Yes, non-government funding
- ☐ Yes, a bank loan I need to repay
- ☐ No
- ☐ *Do not know*
- ☐ *Other, please specify:*

**Greyed out questions were not asked to respondents who declared they had not created new woodland since they started managing their landholding.*

13. What type of tree species were used when creating the new woodland(s)? Please select all options that apply if more than one woodland has been created on the landholding you represent since you or your organisation manage it.

- ☐ Native — One species only
- ☐ Non-Native — One species only
- ☐ Native — Mix of species
- ☐ Non-Native — Mix of species
- ☐ Mixed (native and non-native) — Predominantly Native
- ☐ Mixed (native and non-native) — Predominantly Non-native
- ☐ Mixed (native and non-native) — Even split between natives and non-native trees.
- ☐ Do not know
- ☐ Other, please specify:

14. How many acres of new woodland have been created on the landholding you represent since you/your organisation manage it?

- ☐ Less than 12 acres
- ☐ 12 acres or more, but less than 25 acres
- ☐ 25 acres or more, but less than 125 acres
- ☐ 125 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 500 acres
- ☐ 500 acres or more, but less than 1,000 acres
- ☐ 1,000 acres or more, but less than 2,000 acres
- ☐ 2,000 acres or more, but less than 4,000 acres
- ☐ 4,000 acres or more, but less than 8,000 acres
- ☐ 8,000 acres or more
- ☐ Do not know
- ☐ Other, please specify: —

15. How would the decision to create a new woodland be made?

- ☐ By a single individual
- ☐ Collectively, by all members of the organisation
- ☐ By a select group of individuals within the organisation
- ☐ Do not know
- ☐ Other, please specify:

16. How well would you say you/your organisation are managing financially?

- ☐ Very well
- ☐ Well
- ☐ Just about getting by
- ☐ Finding it quite difficult
- ☐ Finding it very difficult
- ☐ Do not know
- ☐ Other, please specify:

17. Why did you decide to create new woodland?

BLOCK 3

18. Is there any existing woodland on the landholding you represent?

- ☐ Yes
- ☐ No

19. If yes, what type of woodland? Please select all options that apply to the landholding you represent if there was more than one type of woodland within it.

- ☐ Native — One species only
- ☐ Non-Native — One species only
- ☐ Native — Mix of species
- ☐ Non-Native — Mix of species
- ☐ Mixed (native and non-native) - Predominantly Native
- ☐ Mixed (native and non-native) - Predominantly Non-native
- ☐ Mixed (native and non-native) - Even split between natives and non-native trees
- ☐ Do not know
- ☐ Other, please specify:

20. How many acres of woodland are there on the landholding you represent?

- ☐ Less than 12 acres
- ☐ 12 acres or more, but less than 25 acres
- ☐ 25 acres or more, but less than 125 acres
- ☐ 125 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 500 acres
- ☐ 500 acres or more, but less than 1,000 acres
- ☐ 1,000 acres or more, but less than 2,000 acres
- ☐ 2,000 acres or more, but less than 4,000 acres
- ☐ 4,000 acres or more, but less than 8,000 acres
- ☐ 8,000 acres or more
- ☐ Do not know
- ☐ Other, please specify:

21. Is the existing woodland managed? Please select all options that apply to the landholding you represent if it contains more than one existing woodland, and you manage each differently.

- ☐ Yes, managed for wood production: coppice system.
- ☐ Yes, managed for wood production: even aged woodland harvested through clear felling.
- ☐ Yes, managed for wood production: unevenly aged woodland harvested through regular or irregular felling.
- ☐ Yes, managed for game/hunting: The woodland is managed to provide habitat for game species such as pheasants.
- ☐ Yes, actively managed for wildlife. The woodland is managed to improve its wildlife value through actions such as thinning to improve age structure, felling to create openings or ring barking trees to increase the amount of dead wood.
- ☐ Yes, passively managed for wildlife. The woodland is managed through a no intervention approach letting it develop on its own terms.
- ☐ Not managed at all.
- ☐ Do not know
- ☐ Other, please specify:

*Greyed out questions were not asked to respondents who declared they had not created new woodland since they started managing their landholding.

BLOCK 4

22. To what degree do you agree or disagree with the following statements:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am committed to creating woodland in the next 5 years.	☐	☐	☐	☐	☐
I feel a moral obligation to contribute to woodland expansion efforts.	☐	☐	☐	☐	☐
I feel a moral obligation to manage land in a way that contributes to the fight against climate change.	☐	☐	☐	☐	☐
I feel a personal responsibility to manage land in a way that allows wildlife to thrive.	☐	☐	☐	☐	☐
I feel it is my responsibility to manage land in a way that protects soil and water, preventing floods.	☐	☐	☐	☐	☐
I feel that circumstances complicate the creation of woodland on the landholding I represent.	☐	☐	☐	☐	☐
I feel that creating woodland on the landholding I represent depends more on me than others.	☐	☐	☐	☐	☐

BLOCK 5

23. To what degree are the following aspects suitable for woodland creation in the landholding you represent:

Aspect	Very unsuitable	Unsuitable	Neither suitable nor unsuitable	Suitable	Very suitable	Do not know
Temperature	☐	☐	☐	☐	☐	☐
Soil quality	☐	☐	☐	☐	☐	☐
Windiness	☐	☐	☐	☐	☐	☐

24. Consider how browsing by deer, livestock, rabbits, hares, and/or voles might affect the survival of tree saplings. A high abundance of herbivores might be unsuitable to woodland creation hindering the establishment of most trees without protective measures (i.e. culling, fencing, tree guards...). Please rate how suitable the herbivore abundance in the landholding you represent is for woodland creation:

Aspect	Very unsuitable	Unsuitable	Neither suitable nor unsuitable	Suitable	Very suitable	Do not know
Herbivore abundance	☐	☐	☐	☐	☐	☐

BLOCK 6

25. To what degree do you agree or disagree with the following statements:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
We are able to create woodland in a way that suits my objectives.	☐	☐	☐	☐	☐
If we create woodland, we can easily return the land to its previous use.	☐	☐	☐	☐	☐
The initial monetary investment required to create woodland is very high.	☐	☐	☐	☐	☐
The time required to first create woodland is very high.	☐	☐	☐	☐	☐
We have enough money to create woodland without external support (i.e. grant...)	☐	☐	☐	☐	☐
We have enough time to create woodland without external support (i.e. volunteers, more staff...).	☐	☐	☐	☐	☐
We have the knowledge and skills needed to create new woodlands.	☐	☐	☐	☐	☐
Creating woodland is risky.	☐	☐	☐	☐	☐
We will wait until we have enough information about woodland creation and its consequences before implementing it.	☐	☐	☐	☐	☐
We will wait until we are comfortable with the risks posed by woodland creation before implementing it.	☐	☐	☐	☐	☐
Government policies make it easier for us to create woodland.	☐	☐	☐	☐	☐
Our decision-making processes are very formal, when deciding to create woodland we have to consider our own rules and procedures.	☐	☐	☐	☐	☐
Making the decision to create woodland is easy.	☐	☐	☐	☐	☐

BLOCK 7

26. How difficult or easy is it to understand the following aspects of woodland creation according to your experience:

	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy	<i>Do not know</i>
The paperwork required to access funding for woodland creation (from government or others).	☐	☐	☐	☐	☐	☐
The paperwork needed to create woodland.	☐	☐	☐	☐	☐	☐
Ground preparations needed before planting new woodland (i.e. mounding, clearing scrub...).	☐	☐	☐	☐	☐	☐
Interventions to protect new woodland from herbivore damage (i.e. fencing, using tree guards...).	☐	☐	☐	☐	☐	☐
Creating/planting the woodland.	☐	☐	☐	☐	☐	☐

27. How difficult or easy is it to **actually do** the following aspects of woodland creation according to your experience:

	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy	<i>Do not know</i>
The paperwork required to access funding for woodland creation (from government or others).	☐	☐	☐	☐	☐	☐
The paperwork needed to create woodland.	☐	☐	☐	☐	☐	☐
Ground preparations needed before planting new woodland (i.e. mounding, clearing scrub...).	☐	☐	☐	☐	☐	☐
Interventions to protect new woodland from herbivore damage (i.e. fencing, using tree guards...).	☐	☐	☐	☐	☐	☐
Creating/planting the woodland	☐	☐	☐	☐	☐	☐

BLOCK 8

28. The following table shows aspects of the landholding you represent that may change after woodland creation. Please go through the table and indicate how much you expect these aspects to change and how long do you think it will take you to realise the changes.

Aspect	How would you expect this aspect to change after woodland creation?	When would you expect to realise this change after woodland creation?
Carbon storage (The land's capacity to capture and store CO2 from the air)	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Habitat for wildlife	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
The diversity of plant and animal species	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly.	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Water quality	☐ Decrease greatly ☒ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Flooding prevention	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Soil quality	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised

Aspect	How would you expect this aspect to change after woodland creation?	When would you expect to realise this change after woodland creation?
Money earned by the landholding	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly.	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Well-being of the people in your community	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Social recognition we receive from our community	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised
Number of jobs generated by the landholding	☐ Decrease greatly ☐ Decrease slightly ☐ No change ☐ Increase slightly ☐ Increase greatly	☐ Short term (0 to 5 years) ☐ Medium term (6 to 20 years) ☐ Long term (More than 20 years) ☐ Already realised

29. Would there be any other environmental or social changes to you or your local area resulting from creating woodland on the landholding you represent?

- ☐ Yes
☐ No

30. If yes, which ones?

BLOCK 9

31. To what degree do you agree or disagree with the following statements:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
If we create woodland, the woodland will be visible to the rest of our community.	☐	☐	☐	☐	☐
The environmental and social consequences of woodland creation will be visible to the rest of our community.	☐	☐	☐	☐	☐
Creating new woodland matches our values and beliefs	☐	☐	☐	☐	☐
Creating woodland matches our needs.	☐	☐	☐	☐	☐
Creating woodland matches our land use practices.	☐	☐	☐	☐	☐

BLOCK 10

32. How often do the people in the landholding you represent (including you) interact with other landholders or land managers?

- ☐ Never
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Once in six months
- ☐ Yearly
- ☐ *Do not know*
- ☐ *Other, please specify:*

33. Are people in the landholding you represent (including you) part of any groups that discuss woodland management?

- ☐ Yes
- ☐ No

34. If, yes which?

BLOCK 11

35. To what degree to you agree or disagree with the following statements:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The people in the landholding you represent (including you) are open to new ideas and practices about land management.	☐	☐	☐	☐	☐
There are individuals within our community (i.e. neighbours...) that actively promote woodland creation.	☐	☐	☐	☐	☐
There are organisations in our area (governmental and non-governmental) that could offer us useful support in the woodland creation process.	☐	☐	☐	☐	☐
I sense that most people that are important to me are in favour of woodland creation.	☐	☐	☐	☐	☐
I sense that most of the landholders in my community have or are planning to create woodlands on their properties.	☐	☐	☐	☐	☐
I sense that there are many people creating woodlands in my area.	☐	☐	☐	☐	☐
There is a lot of competition to access woodland creation resources (i.e. grants, tree saplings...).	☐	☐	☐	☐	☐
I sense that those dearest to me think I shouldn't plant more woodland.	☐	☐	☐	☐	☐

BLOCK 12

36. Full name:
37. Email:
38. Year of Birth:
39. Postcode for the landholding subject of your response:
40. What is the highest level of formal education you have attained?
- ☐ Doctoral University Degree
 - ☐ Masters University Degree
 - ☐ Undergraduate University Degree
 - ☐ High (Secondary) School Graduate
 - ☐ Primary School Graduate
 - ☐ No formal education
 - ☐ *Refuse to answer*
 - ☐ *Other, please specify:*
41. Please indicate whether you would like to enter the study's raffle and/or receive a copy of its results when they are published.
- ☐ I would like to take part in the raffle to win a voucher for a value of up to £100.
 - ☐ I would like to receive a copy of the study's results when they are published.
42. We are running a parallel research project investigating the preferences of landholders towards different woodland creation interventions. It consists of a brief game where you will be asked to choose your favourite from a set of woodland creation interventions of varying characteristics. If you are interested in learning more about it and would consider participating, please tick the box below and we will send you more details.
- ☐ Yes, I am interested. Please send me more details about your parallel research project.

Appendix D – Full Diffusion of Innovations Framework

This appendix is a table outlining the full theoretical framework used in my studies, its components, and the definitions for the attributes and the subattributes within them. The table includes:

1. The framework's three components (Column 1 = “Component”).
2. The attributes within each component (Column 2 = “Attribute”), which are defined in Table 2.1 of the thesis.
3. The subattributes stemming from each attribute (Column 3 = “Subattribute”).
4. The subattribute definitions (Column 4 = "Subattribute - Definition").
5. The subattribute definition clarifications (Column 5 = "Subattribute - Definition clarification"), wherever relevant.
6. The source/s for both subattribute definitions and, if relevant, clarifications (Column 6 = "Subattribute - Definition and clarification sources").
7. Information on whether subattributes were covered in my surveys or not (Column 7 = "Subattribute - Included in survey").
8. If a subattribute was not included, why (Column 8 = "Subattribute - Exclusion justification").

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Innovation	Relative Advantage	Economic benefit	Net economic benefits as perceived by the potential adopter.	For the purpose of this definition economic benefits are conceptualised in a broad sense and include amongst other things: considerations of costs and benefits over the long-term; risks; the cost of foregoing other opportunities; the value of keeping options open; resource degradation; resource-system issues; and non-financial benefits and costs.	Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. <i>Australian Journal of Experimental Agriculture</i> , 46(11), 1407. https://doi.org/10.1071/EA05037	Yes	
Innovation	Relative Advantage	Initial costs	The expected monetary and non-monetary direct or indirect costs and risks associated with the adoption of an innovation.	A direct monetary cost, for example, would be the money spent to acquire or implement an innovation, while an indirect monetary cost example would be the money spent in upgrading or acquiring equipment needed to implement the innovation. A direct non-monetary cost, for example, would be the time or members of staff needed to acquire or implement the innovation, while an indirect non-monetary cost example would be the time spent upgrading equipment or training staff.	Rogers, E. M. (2003). <i>Diffusion of innovations</i> (5th ed.). Free Press. Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In <i>Annual Review of Sociology</i> (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Innovation	Relative Advantage	Social benefits	The expected positive impacts of adoption in societal terms.	By societal terms I mean: food security; equality (gender, sexual, political, racial, economic, religious...); health; education; work; communication; safety; access to infrastructure; cultural survival and heritage; etc... This component does not include the social benefits of poverty reduction (covered by the economic benefits component) or environmental sustainability (covered by the environmental benefits component).	Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. <i>Australian Journal of Experimental Agriculture</i>, 46(11), 1407. https://doi.org/10.1071/EA05037 United Nations. (n.d.). United Nations Sustainable Development Goals. Retrieved March 9, 2023, from https://sdgs.un.org/goals	Yes	
Innovation	Relative Advantage	Social prestige	The expected social recognition or status gained through innovation adoption.		Rogers, E. M. (2003). <i>Diffusion of innovations</i> (5th ed.). Free Press.	Yes	
Innovation	Relative Advantage	Environmental benefits	The expected positive impacts of adoption on environmental sustainability terms	By "environmental sustainability terms" I mean: climate change mitigation or adaption; water security; biodiversity and ecosystem services; reduction of chemical, physical or biological pollution of water, air or soil; erosion control; flood regulation; habitat for wildlife; etc...	Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. <i>Australian Journal of Experimental Agriculture</i>, 46(11), 1407. https://doi.org/10.1071/EA05037 UNEP, U. E. P., & FAO, F. and A. O. of the U. N. (2021). <i>UN Decade on Restoration</i>. https://www.decadeonrestoration.org/	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Innovation	Relative Advantage	Perceived risks	The expected negative effects of adoption that may or may not materialise themselves in the future.		Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. <i>Australian Journal of Experimental Agriculture</i>, 46(11), 1407. https://doi.org/10.1071/EA05037 Rogers, E. M. (2003). <i>Diffusion of innovations</i> (5th ed.). Free Press. Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In <i>Annual Review of Sociology</i> (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	
Innovation	Relative Advantage	Immediacy of reward	The expected wait time until the benefits or beneficial consequences of adoption become evident.		Rogers, E. M. (2003). <i>Diffusion of innovations</i> (5th ed.). Free Press.	Yes	
Innovation	Compatibility	Values and beliefs	The perceived coherence of the innovation with the potential adopter's personal values (what one thinks is important) and beliefs (what one thinks is true).		Rogers, E. M. (2003). <i>Diffusion of innovations</i> (5th ed.). Free Press. Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In <i>Annual Review of Sociology</i> (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Innovation	Compatibility	With previously introduced ideas	The perceived coherence of the innovation with what the potential adopter already knows or has experience with.	Previous experience provides a standard against which an innovation can be interpreted, decreasing uncertainty and facilitating adoption.	Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	No	Excluded, based on the assumption that most UK landholders have some previous experience of woodland and its creation.
Innovation	Compatibility	With needs	The degree to which the potential adopter perceives the innovation to suit its requirements at a particular point in time.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Innovation	Compatibility	With current practices	The degree to which the potential adopter perceives the innovation to be compatible with its current practices.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Innovation	Complexity	Ease of understanding	The degree to which the innovation is perceived as relatively easy to understand.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Innovation	Complexity	Ease of use	The degree to which the innovation is perceived as relatively easy to use.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Innovation	Trialability	Experimenting on partial basis/ divisibility	The potential adopter's perceived ability to test the innovation before its full implementation or use.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	No	Excluded, based on the assumption that is impossible to realistically trial woodland creation in the UK, given the long time it takes woodland to establish and strong presumptions against woodland conversion in UK law.

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Innovation	Trialability	Reversible	The degree to which the potential adopter perceives the innovation can be abandoned and the status prior to adoption restored.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Innovation	Observability	Visibility of results	The degree to which the results of the innovation are observable by others.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Innovation	Observability	Visibility of practice	The degree to which the innovation itself is observable by others.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Innovation	Flexibility	Modification	The degree to which the potential adopter perceives they can change the innovation.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Adopter/ landing site	Social- economics	Economic well- being	The resources people use to meet basic consumption and material needs and access other sources of well-being.		Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Adopter/ landing site	Social- economics	Education	The level of formal education (school, high-school, undergraduate, postgraduate, other...) attained by an adopter or potential adopter.	Formal education is education that is institutionalised, intentional and planned through public organizations and recognised private bodies, and – in their totality – constitute the formal education system of a country.	Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press. UNESCO Institute for Statistics. (2012). International standard classification of education: ISCED 2011. UNESCO Institute for Statistics. Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	
Adopter/ landing site	Social- economics	Resource slack	The degree to which extra resources (time, money, staff etc. not key to maintain status quo) are available to the potential adopter while considering adoption, which could be invested on innovation adoption or in mitigating its risks.	Rogers only considers this when studying adoption by organisations, I extend this to individuals.	Page 412 - Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Adopter/ landing site	Social-economics	Size	According to literature this could be divided in two:- Size of the area (i.e. landholding, fishing grounds): This refers to the area within which the innovation is implemented, not just the space taken by the innovation.- Size of the organisation (applies to innovations adopted by organisations): Dimensions of the organisation adopting an innovation, in terms of its number of employees, the size of its budget, number and size of customers, number of branches and subsidiaries, etc.	Organisation size is probably a surrogate of total resources, resource slack, employee's technical expertise, formalisation, etc. Generally bigger organisations are more innovative.	Size of area: Page 1413 - Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture, 46(11), 1407. https://doi.org/10.1071/EA05037 Size of organization: Page 409 to 411 - Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Adopter/ landing site	Personality	Risk orientation	The level of risk proclivity or risk aversion of a potential adopter.		Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture, 46(11), 1407. https://doi.org/10.1071/EA05037 Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press. Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute - Definition clarification	Subattribute - Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Adopter/ landing site	Personality	Competition	The degree to which units within a system compete for resources, funds, ties to external agents, status, etc.		Burt, Ronald S. (1992) Structural Holes: The Social Structure of Competition. Harvard University Press. JSTOR, http://www.jstor.org/stable/j.ctv1kz4h78. Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	
Adopter/ landing site	Knowledge	Familiarity with the innovation	Degree to which the adopter knows about the innovation and its consequences.	Another aspect of this definition is the degree to which potential adopters perceive the innovation as radical or novel. Innovations perceived as radical, or novel are less likely to be adopted. Familiarity is increased by acquiring more information about the innovation and its consequences.	Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	
Adopter/ landing site	Knowledge	Complexity	Degree to which potential adopters perceive they possess the knowledge, skills and experience needed to implement an innovation. This is usually measured by the range of occupational specialties and degree of professionalism expressed as formal training.	Rogers only considers this when studying adoption by organisations, I extend this to individuals.	Page 412 - Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Adopter/ landing site	Knowledge	Interconnectedness	Degree to which the individuals within a particular social system are linked to one another via interpersonal networks. A higher level of interconnectedness increases innovativeness.	Rogers only considers this when studying adoption by organisations, I extend this to individuals.	Page 412 - Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Adopter/ landing site	Decision-making	Innovation-decision	The role of the individual potential adopter in the adoption decision-making process. This will be based on the type of decision-making process: - Optional - decision made by an individual independent of other members of the system; - Collective - decision made by consensus among members of a system; - Authority - decision made by relatively few individuals in a system who possess power, status, or technical expertise.		Page 28 - Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Adopter/ landing site	Decision-making	Political empowerment	The degree to which potential adopters perceive they have the ability to participate in the decision-making processes that affect their lives.		World Resources Institute. (2003). World Resources 2002 - 2004: Decisions for the Earth: Balance, Voice and Power. https://www.wri.org/research/world-resources-2002-2004	Yes	
Adopter/ landing site	Decision-making	Formalization	The level of formality or protocol an individual or group needs to adhere to in order to make a decision associated with an innovation (i.e. formal process involving a protocol (rules and procedures), approvals by a hierarchy and signings, etc.).	Rogers only considers this when studying adoption by organisations, I extend this to individuals.	Page 412 - Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Context	Geographical setting	Ecological conditions	The degree to which the ecological infrastructures of a place such as its climate, weather, soil or landscape characteristics limit, allow or affect the adoption of an innovation.		Page 311 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051	Yes	
Context	Geographical setting	Proximity	The degree to which the physical distance between a potential adopter and other adopters affects adoption.	Proximity can and does interplay with social density (i.e. number of adopter in an area), socialization and homogeneity. Access to travel infrastructure such as roads or markets is likely to influence proximity.	Page 311 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141052	No	To be drawn from census if needed.

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute - Definition clarification	Subattribute - Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Context	Culture	Traditionalism	The degree to which the individuals interacting in the context where the innovation diffuses follow or support the mainstream cultural norms, values and beliefs of the area. This is associated to social inertia or aversion to social change which can reduce openness to new ideas and practices slowing innovation adoption rates.		Page 314 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141053	Yes	
Context	Culture	Homogeneity	The degree of cultural similarity of the individuals interacting in the context where the innovation diffuses.	My use of similarity relates to Wejnert's definitions of structural equivalence: "an actor's perception of concordance with other members in a social and/or organizational network" and with Rogers's definition of homophily: "The degree to which two or more individuals who interact are similar in certain attributes".	Page 314 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141054	No	To be drawn from census if needed.

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute - Definition clarification	Subattribute - Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Context	Culture	Socialization	The frequency of interaction between individuals within a particular social network, which may influence adoption by mobilizing the available societal talents of entrepreneurship, perseverance, determination, and marketing skills needed to consider the adoption of innovations.		Page 314 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141055	Yes	
Context	Political conditions	National policies	The degree to which national/ state policies support or prevent adoption of innovations. For example, by protecting national technologies from replacement by similar technologies from foreign countries.		Page 315 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141056	Yes	
Context	Political conditions	Structure of government	The way in which different national governmental entities are organised and connected, and how this affects the context where adoption is taking place.		Page 315 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141057	No	Excluded, based on the assumption that UK government structures (national and local) have been relatively stable now and in the recent past.

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute - Definition clarification	Subattribute - Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Context	Political conditions	Bureaucracies	The level of administrative effort (i.e. paperwork and other processes (i.e. approvals)) imposed on the adopter to be able to adopt the innovation.		Page 315 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141058	Yes	
Context	Political conditions	Political character	The degree to which the ideological doctrines predominant in a state (liberalism, socialism, anarchism...) and its level of political censorship influence the context where the innovation will be adopted.		Page 315 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141059	No	To be drawn from census if needed.
Context	Extension support	Support and facilitation	The degree to which adoption is enhanced by the access to support that facilitates innovation adoption through for example: the provision of technical advice, facilitation of processes, or through capacity building and training.		Page 6 - Romero-de-Diego, C., Dean, A., Jagadish, A., Witt, B., Mascia, M. B., & Mills, M. (2020). Drivers of adoption and spread of wildlife management initiatives in Mexico. Conservation Science and Practice, February, 1–12. https://doi.org/10.1111/csp2.438	Yes	

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute - Definition clarification	Subattribute - Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Context	Extension support	Presence of Champions	The degree to which adoption is influenced by the existence of charismatic individuals who promote an innovation within their particular context, helping others overcome the indifference or resistance the innovation may provoke. Champions are internal to the context they influence.		Page 473 - Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.	Yes	
Context	Global discourse	Institutionalization	The degree to which an innovation is perceived to be coherent with rules and processes considered the standard to achieve global societal objectives such as sustainability (i.e. adoption of renewable energy generation is understood as the standard process to make the energy sector sustainable).		Page 315 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141059	No	Excluded, based on the assumption that the global goal of increasing woodland area and restoring ecosystems is well embedded within the UK's national agenda
Context	Global discourse	Global technology	The degree to which the adoption of innovations is affected by the existence of technologies that diffuse globally thanks to the existence of multinational corporations and markets.		Page 315 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141060	No	Excluded, based on the assumption that the UK's context is currently well connected to global markets.

Component	Attribute	Subattribute	Subattribute - Definition	Subattribute – Definition clarification	Subattribute – Definition and clarification sources	Subattribute - Included in survey	Subattribute - Exclusion justification
Context	Global discourse	World connectedness	The degree to which an adoption context is connected to the rest of the world through modern communication technologies (i.e. phone, internet...) and access to global media.		Page 315 - Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In Annual Review of Sociology (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141061	No	Excluded, based on the assumption that the UK's context is currently well connected to the rest of the world through global communication technologies.

Appendix E – Sample descriptive statistics for the Drivers of Native Woodland Creation Survey

Full sample descriptive statistics

My final sample included 84 landholders. Only 77 responses (59 in-person, 18 online) were within my study area, thus included in analysis. For analysis I differentiated between landholders who declared that they or their organisations had (adopters (n=31)) or had not (non-adopters (n=46)) created at least one mixed native woodland on the landholding they represented since their management started.

	Non-adopter (n=46)	Adopter (n=31)	Total (n=77)
Landholding type			
Farm	22	14	36
Estate	10	13	23
Croft	6	3	9
Nature reserve	1	1	2
Other	- Adopters (n=0) - Non-adopters (n=7): “Private home”, “Grazing for horses”, “Small holding”, “Farm and croft”, “Mini Estate”, “Field”, and “Farm and croft”.		
Land ownership			
<i>*Respondents could choose several options, 24 did so. All landholdings saw this question.</i>			
Landowner directly managing the landholding	42	29	71
Tenant	6	4	10
Landlord	8	8	16
Licenser	3	0	3
Licensee	0	0	0
Crofter	4	0	4
Other	- Adopters (n=3): “Agent representing landowner”, “Seasonal grazing agreement”, and “Seasonal lets to others”. - Non-adopters (n=0)		
Organisation type			
Family organisation	42	26	68
Non-family organisation	1	0	1
Blank response	0	1	1
Other	- Adopters (n=4): “Public body”, “Limited company”, “Sole trader”, and “Charity”. - Non-adopters (n=3): “Family and non-family organisation”, “Sole trader”, and “Public body”.		
Financial aims			
For profit	40	24	64
Not for profit	5	5	10
Other	- Adopters (n=2): “Mix of profit and non-profit”, and “For profit and community”. - Non-adopters (n=1): “Both, profit but also charity”		

Length of management			
Under 1 year	2	0	2
1 to 4 years	1	1	2
5 to 9 years	2	2	4
10 years or more	41	27	68
Blank response	0	1	1
Land use			
<i>*Respondents could choose several options if land uses were mixed, 43 did so. All landholdings saw this question.</i>			
Farming	39	27	66
Forestry	14	17	31
Game/Hunting	6	14	20
Wildlife conservation	8	17	25
Public recreation	8	13	21
Private enjoyment	13	16	29
Other	- Adopter (n=5): "Holiday lets"; "Fishing"; "Land-based crafts"; "Wind farm"; and "Community involvement". - Non-adopter (n=6): "Animal therapy, gardening, meditation in the nature"; "Horse grazing"; "Grazing for horses"; "Creating small pockets of woodland"; "Holiday lets. Ponds for amenity"; and "Stables".		
Landholding size			
<50 acres	10	5	15
50 to <250 acres	12	6	18
250 to <1,250 acres	14	7	21
1,250 to <2,500 acres	3	1	4
2,500 to <5,000 acres	2	2	4
5,000 to <7,500 acres	0	2	2
7,500 to <10,000 acres	1	0	1
10,000 to <15,000 acres	0	2	2
15,000 to <20,000 acres	2	2	4
20,000 to <35,000 acres	1	1	2
35,000 to <50,000 acres	0	2	2
50,000 or more	0	1	1
Blank response	1	0	1
Organisation size			
<5 members	37	17	54
5 to 9 members	5	6	11
10 to 29 members	1	4	5
30 to 49 members	2	2	4
50 or more	1	2	3
Responsibility for woodland creation decision-making			
By a single individual	17	8	25
Collectively, by all members of the organisation	22	13	35
By a select group of individuals within the organisation	5	8	13
Do not know	0	1	1
Blanks	1	0	1
Other	Non-adopter (n=1): "Following a management plan agreed with public body". Adopter (n=1): "Family".		

New woodland descriptive statistics

A total of 48 (62%) of my 77 respondents had created new woodland since they started managing the landholding, in many cases repeatedly, but 17 (35%) of them were non-adopters since they had created woodland but not mixed native one yet.

	Non-adopter (n=17)	Adopter (n=31)	Total (n=48)
Created new woodland (mixed native or other)			
Yes	17	31	48
No	29	0	29
Created more than one new woodland (mixed native or other)			
Yes	7	22	29
No	7	7	14
Blank response	3	2	5
How was/were the new woodland(s) created?*			
<i>*Respondents could choose more than one option, 16 did so. Only landholdings that had created new woodland (mixed native or other) could answer this question.</i>			
Tree planting	13	29	42
Natural regeneration	2	15	17
Blank response	2	3	5
External sources of funding			
<i>*Respondents could choose more than one option, 2 did so. Only landholdings that had created new woodland (mixed native or other) could answer this question.</i>			
Government funding	10	25	35
Non-government funding	2	1	3
Bank loan	1	0	1
No external funding	4	2	6
Blank response	2	3	5
Other	- Adopter (n=2): “Local government funding” and “Compensated by power company for trees that were cut down”. - Non-adopter (n=0): A single non-adopter chose “Other” and answered, “Farm woodland grant”. The Farm Woodland Grant is a government scheme and has been counted as such.		
Type of trees			
<i>*Respondents could choose more than one option, 11 did so. Only landholdings that had created new woodland (mixed native or other) could answer this question.</i>			
Native – One species only	2	1	3
Non-native – One species only	1	0	1
Native – Mix of species	0	31	31
Non-native – Mix of species	1	3	4
Mixed – Predominantly native	6	4	10
Mixed – Predominantly non-native	6	3	9
Mixed – Even split native and non-native	2	1	3
Acreage of new woodland created			
<12 acres	7	12	19
12 to <25 acres	2	1	3
25 to <125 acres	5	8	13
125 to <250 acres	0	0	0
250 to <500 acres	1	4	5
500 to <1,000 acres	1	2	3

1,000 to <2,000 acres	1	1	2
2,000 to <4,000 acres	0	2	2
4,000 to <8,000 acres	0	0	0
8,000 or more	0	0	0
Do not know	0	1	1
Why did you decide to create new woodland?			
<i>*This question was open-ended. The categories listed here are the result of inductive coding of the responses.</i>			
Wildlife	12	4	16
Use poor land	8	5	13
Shelter	8	3	11
Amenity	4	5	9
Environment	4	3	7
Grant income	4	3	7
Aesthetics	4	3	7
Diversify habitats	5	2	7
Finances	4	1	5
Diversify business	1	3	4
Restoration	3	0	3
Carbon	3	0	3
Legacy	1	1	2
Firewood	1	1	2
Crafts materials	2	0	2
Game/hunting	2	0	2
Protect road from snow	0	1	1
Risk of losing land	0	1	1
No demand for food	0	1	1
Visual barrier	0	1	1
Flooding	0	1	1
Climate change	1	0	1
Health	1	0	1
Building materials	1	0	1
Food	1	0	1
Rewild	1	0	1
Furniture materials	1	0	1
Water quality	1	0	1
Compensation for woodland loss	1	0	1

Existing woodland descriptive statistics

Seventy percent (n=54) of the 77 landholdings in my sample contained existing woodland, either before new woodland (mixed native and others) was created (n=33 (61%)) or at present otherwise (n=21 (39%)). Thirty-nine percent (n=21) of the 54 landholdings with existing woodland were adopters (i.e. had created mixed native woodland). The rest were non-adopters (n=33 (69%)).

	Non-adopter (n=33)	Adopter (n=21)	Total (n=54)
Any existing woodland before new woodland was created or at present (if no new woodland had been created)?			
Yes	33	21	54
No	13	10	23
Type of trees in existing woodland*			
*Respondents could choose more than one option, 17 (31%) did so. Only landholdings with existing woodland could answer this question.			
Native – One species only	6	1	7
Non-native – One species only	7	5	12
Native – Mix of species	12	15	27
Non-native – Mix of species	5	3	8
Mixed – Predominantly native	12	8	20
Mixed – Predominantly non-native	5	9	14
Mixed – Even split native and non-native	0	0	0
Existing woodland management*			
*Respondents could choose more than one option, 21 (39%) of landholdings with existing woodland did so, meaning they had a mix of management objectives for different patches of existing woodland. Only 18 (33%) of landholdings with existing woodland did not manage it at all. Two (4%) managed some bits but not others.			
Coppice	1	1	2
Even-aged and clearfelling	8	14	22
Uneven-aged through regular or irregular felling	7	8	15
Managed for game/hunting	3	3	6
Actively managed for wildlife	6	8	14
Passively managed for wildlife	7	7	14
Not managed	14	6	20
Other	Adopter (n=0) Non-adopter (n=3): “Livestock shelter and firewood for own consumption”, “Natural woodland managed for enhancement by planting various native hardwood species”, and “Thinning occasionally for firewood. Shelter for livestock”.		
Acreage of existing woodland			
<12 acres	11	6	17
12 to <25 acres	6	1	7
25 to <125 acres	5	3	8
125 to <250 acres	2	1	3
250 to <500 acres	1	1	2
500 to <1,000 acres	2	2	4
1,000 to <2,000 acres	2	2	4
2,000 to <4,000 acres	0	2	2
4,000 to <8,000 acres	0	0	0
8,000 or more	2	2	4
Do not know	1	1	2

Appendix F – Causal model and Directed Acyclic Graph (DAG) justifications for the second analysis of the Drivers of Native Woodland Creation Survey

This appendix provides justification for the hypothesized causal pathways described in the Directed Acyclic Graph (DAG) introduced in **Chapter 6**'s methods (**Section 6.2.1**). My DAG outlines the links between my outcome of interest (adoption of mixed native woodland creation interventions) and its predictors (Diffusion of Innovations Theory (DOIT) framework attributes and the variables within them), as well as causal links between predictors themselves (Fig. F.1).

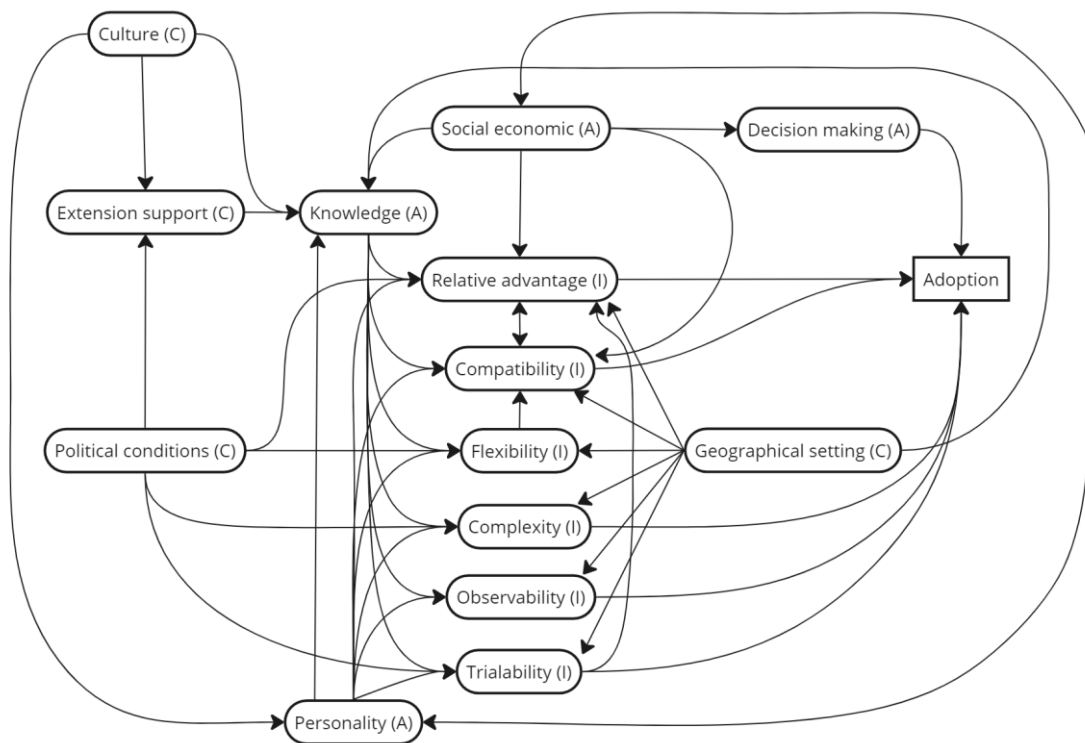


FIGURE F.1

Directed Acyclic Graph (DAG) displaying the hypothesized causal connections underpinning **Chapter 6**'s model. Arrows signal the direction of causal effect. I, A or C in brackets indicate innovation, adopter and context attributes respectively. Attributes assumed irrelevant for the UK woodland creation context were not included in my DAG.

The causal links between DOIT attributes in my DAG are defined based on the Innovation-Decision Process, which describes an individual's (or another unit of adoption) journey from first learning about an innovation, to its eventual adoption or rejection. According to DOIT, this process is divided into five stages: Knowledge, Persuasion, Decision, Implementation, and Confirmation (Rogers, 2003). The Knowledge stage encompasses the potential adopter's first awareness of the existence of the innovation, and its first understanding of its functioning. During the Persuasion stage the potential adopter builds a favourable or unfavourable attitude towards the innovation, mainly by gathering and evaluating more information about it. In the Decision stage the innovator acts on the information gathered and the attitudes built during the previous two stages adopting or rejecting the innovation. A Confirmation stage ensues where the adoption or rejection decision is questioned by the innovator, if sufficient justification is found the decision may be maintained, otherwise it may be reversed. For adopters, there is an intermediate stage between Decision and Confirmation, the Implementation stage. During this stage adopters use the innovation fully for the first time (some may have trialled it before), learning more about it and its use, and sometimes adapting it (re-invention). In some cases, the Implementation stage finishes when the innovation is fully incorporated into the adopter's established practices, losing its novelty in the process. In others it leads to the Confirmation stage (Rogers, 2003).

My survey and consequently my DAG (Fig. F.1) focuses on the first three stages of the innovation-decision process: Knowledge, Persuasion and Decision.

The potential adopter first learns about the innovation (Knowledge phase), either actively or passively. This can happen because of extension support efforts or because potential adopters are looking through information that matches their interests, needs and/or attitudes, and discover the innovation (Rogers, 2003). I capture the effect of extension support on knowledge in my DAG through a causal link between these two attributes. The presence of extension support not only influences adopters' chances of gaining awareness of the innovation

(knowledge stage), but also their access to more knowledge about the innovation afterwards (persuasion stage) (Rogers, 2003).

In my DAG, extension support is itself influenced by the culture and political conditions of the area. Culture has been shown to influence extension support provision by shaping preferences around the type of champions (Shane et al., 1995) and product launch strategies used (Dwyer et al., 2005; He & Lee, 2020). I also link culture directly to knowledge because cultural factors such as traditionalism or degree of socialisation (Wejnert, 2002) influence how open and/or exposed adopters within a particular culture are to new knowledge. Political conditions are linked to extension support in my DAG since forestry policy can undoubtedly affect the type, quality, and/or amount of support and facilitation available to landholders. For instance, within Europe, predominantly neo-liberal countries, tend to have forestry advisory services with less state involvement and a higher diversity of consultants and agents from the private and NGO sector, whilst post-socialist countries have a higher state involvement in forestry advice (Lawrence et al., 2020).

Political conditions can also affect the relative advantage, flexibility, complexity and trialability of an innovation. For example, insufficient grants can modulate the economic benefits and costs of adoption, affecting the perceived relative advantage of potential adopters of woodland creation initiatives (Hemery et al., 2018, 2020; Pannell et al., 2006; Rogers, 2003; Wejnert, 2002). Bureaucracy is another barrier to woodland creation as it adds complexity to the adoption process (Hemery et al., 2018, 2020; Rogers, 2003).

Finally, political conditions could also affect the flexibility of an innovation or the degree to which it can be changed. In the case of UK woodland creation, the UK Forestry Standard sets the approach of the four UK governments to sustainable forest management, outlining a set of requirements, such as the maximum area that can be planted with a single species (Forest Research, 2023). Changes to the UK Forestry Standard or forestry laws and regulations, could therefore increase or reduce the amount of flexibility adopters have when implementing woodland creation projects.

Similarly to extension support, the socio-economic characteristics of the adopter influence its ability to first learn about an innovation (knowledge stage) and continue learning about it afterwards (persuasion stage) (Rogers, 2003).

Knowledge about an innovation increases as adopters progress through their journey towards a final decision to adopt or not (Innovation-Decision Process). This is particularly true when potential adopters start to actively gather and evaluate information about the innovation (persuasion stage). The result of this process are changes in the way innovation attributes are perceived by adopters (Rogers, 2003). I capture this in my DAG by linking knowledge to relative advantage, compatibility, complexity, observability, and trialability; the innovation attributes DOIT classes as most important during this stage; as well as flexibility, an innovation attribute proposed by some authors (Mahajan et al., 2021), and rooted in the concept of re-invention proposed by DOIT (Rogers, 2003).

The innovation attributes in turn influence themselves, I capture this through causal links in my DAG. I link relative advantage and compatibility through a two-way link since they influence each other and, in some cases, have even been shown to not be empirically different (Rogers, 2003). Flexibility links with compatibility since it makes innovations more or less adaptable to potential adopters' circumstances affecting the innovations' compatibility with their practices, needs, values, and beliefs. The main effect of flexibility is that the innovation can be re-invented more easily, generally leading to faster adoption rates and sustainability, which is the continued use of an innovation after diffusion ends (Rogers, 2003). For my study I considered two aspects linked to the trialability of an innovation: experimenting on a partial basis and reversibility. I only measured reversibility, since experimenting on a partial basis is hardly applicable to woodland creation, which requires a very long time until woodland is fully established and therefore cannot be tested on a short-term basis. As a result, in my DAG, trialability only connects to relative advantage, since reversibility is likely to modulate the relative advantage perceived by potential adopters particularly in terms of risks. For innovations that can be tested on a partial basis, trialability can act indirectly on all innovation

characteristics through its influence on the adopters' knowledge, since they will be learning and updating their attitudes towards the innovation through their trials (Rogers, 2003).

All innovations attributes are influenced by the geographical setting of the potential adopter. This happens directly through the constraints put on adoption by the ecological conditions of a place, as well as through the adopters' proximity to the materials or providers needed to adopt. But also, indirectly through knowledge, which will be easier to access when potential adopters are closer to previous adopters or have easier access to communications and/or transport infrastructure (Wejnert, 2002). An example of this within a woodland creation context would be that of a landholding with low suitability for woodland creation (i.e. very cold, windy and with very poor soils) and remote. A potential adopter managing this landholding and living in it, would be less likely to access knowledge about woodland creation, and to see the undertaking as an advantageous, compatible, flexible, observable, triable, and easy to understand and do intervention.

The socioeconomic characteristics of an adopter also influence adoption decisions (Montes de Oca Munguia et al., 2021; Rogers, 2003; Wejnert, 2002). I incorporate this into my DAG through causal links that join socioeconomic attributes to knowledge, relative advantage, compatibility, personality and decision-making. The links between knowledge and socioeconomic characteristics of adopters are patent in several of the generalizations of DOIT, such as: "*Early knowers have more education (generalisation 5-1), and higher social status (generalisation 5-2), than later knowers*". DOIT also suggests that, generally, earlier adopting units are bigger, wealthier and have higher status than later ones. This probably happens through effects on the perceived relative advantage and compatibility of an innovation, since potential adopters that are larger and wealthier are likely to have more money and time to invest trying new ideas, seeing them as more compatible and less risky. Finally, the socioeconomic characteristics of an adopter, mainly its size, also affect decision-making. For example, larger organisations are more likely to follow collective or authority (small group of

individuals with power, status or expertise decide) decision-making processes, and to have more formal procedures for decision-making in place (Rogers, 2003).

DOIT outlines an adopters' personality as a key variable associated to their innovativeness or *"the degree to which an individual (or another unit of adoption) is relatively earlier in adopting new ideas than other members of a system"* (Rogers, 2003). In other words, personality traits modulate how fast or slow an adopter makes decisions regarding an innovation (i.e. moves through the Innovation-Decision Process). DOIT suggests personality filters the communications adopters pay attention to while learning about an innovation (*selective exposure*), and moderates their likely impact on them (*selective perception*) (Rogers, 2003). I connect personality to knowledge in my DAG to capture this. This link accounts, for example, for the possible effect personality traits such as intelligence or curiosity have on knowledge (Rogers, 2003). Personality also connects to all innovation attributes in my DAG (Fig. F.1), to account for the effect personality has on the process by which potential adopters evaluate an innovation by imagining its consequences. This process is fraught with uncertainty, particularly about the risk and benefits of adoption. Personality traits such as self-confidence, risk orientation, openness to change or ability to cope with uncertainty, modulate responses to uncertainty, consequently affecting the speed and outcome of final innovation adoption decisions (Rogers, 2003; Wejnert, 2002).

In my DAG, personality is influenced by the culture and socio-economic characteristics of the adopter. Culture modulates the personality of adopters within a national population or subgroups within that population (Wejnert, 2002). Herbig and Palumbo 1994, provide an example of this in their comparison of the adoption of industrial practices in an American and Japanese cultural context, showing innovations were adopted earlier by American actors due to their individualistic and risk-taking values, but spread faster amongst Japanese actors who value collectivism more than Americans (Herbig & Palumbo, 1994). The personality and socio-economic characteristics of adopters are linked by a two-way connection in my DAG. I do this to highlight that certain personality traits could lead to changes in the socio-economic status

of an adopter and vice versa. Research shows that socioeconomic status partially explains differences in individuals' personality traits (Luo et al., 2022), and that conversely, some personality traits can help individuals improve their socioeconomic status, generally compensating for background socioeconomic disadvantages only to a small extent, except for intelligence which can help an individual fully overcome background disadvantages (Damian et al., 2015).

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Appendix G – Model and conditional effect estimates and diagnostics for the second analysis of the Drivers of Native Woodland Creation Survey

This appendix provides the values for **Chapter 6**'s model and conditional effect estimates (**Section 6.3.1**), as well as the estimates' posterior distributions' 50% and 90% Highest Density Interval (HDI) and Equal Tailed Interval (ETI).

The conditional effect estimates are produced by varying the values of the predictor of interest's response levels while holding all other predictors constant. Likert item predictors were held constant at their neutral response level, whilst innovation decision was held constant at "Collectively, by all members of the organisation", the most common response.

The model's formula specification is as follows:

- Family: Bernoulli
- Link: mu=logit
- Formula:
$$\text{col160} \sim \text{mo}(\text{col92}) + \text{mo}(\text{col93}) + \text{mo}(\text{col97}) + \text{mo}(\text{col113}) + \text{mo}(\text{col114}) + \text{mo}(\text{col115}) + \text{mo}(\text{col116}) + \text{mo}(\text{col117}) + \text{mo}(\text{col118}) + \text{mo}(\text{col119}) + \text{mo}(\text{col120}) + \text{mo}(\text{col121}) + \text{mo}(\text{col122}) + \text{mo}(\text{col137}) + \text{mo}(\text{col138}) + \text{mo}(\text{col139}) + \text{mo}(\text{col105}) + \text{mo}(\text{col106}) + \text{mo}(\text{col107}) + \text{mo}(\text{col110}) + \text{mo}(\text{col111}) + \text{mo}(\text{col112}) + \text{mo}(\text{col135}) + \text{mo}(\text{col136}) + \text{mo}(\text{col91}) + \text{col53} + \text{mo}(\text{col101})$$
- Draws: 4 chains
- Iterations: 10,000 per chain
- Warm-up: 5,000 per chain
- Total post warm-up draws: 20,000
- Outcome: col160 = Adoption of mixed native woodland creation

Model estimates

Subattribute Column	Subattribute Name	Mean	Median	Mode	SD	MAD	HDI Lower 0.5	HDI Upper 0.5	HDI Lower 0.9	HDI Upper 0.9	ETI Lower 0.5	ETI Upper 0.5	ETI Lower 0.9	ETI Upper 0.9	Rhat	ESS Bulk	ESS Tail
b_col532	Collective decision-making	0.373	0.37	0.36	0.787	0.786	-0.174	0.885	-0.912	1.68	-0.155	0.906	-0.929	1.67	1	31050	15546
b_col533	Authority decision-making	0.908	0.914	0.948	0.829	0.828	0.313	1.43	-0.47	2.24	0.343	1.46	-0.436	2.27	1	37365	15922
bsp_mocol101	Formalisation of decision-making	-0.0633	-0.0578	0.0077	0.461	0.441	-0.371	0.222	-0.809	0.695	-0.36	0.234	-0.822	0.683	1	22774	16469
bsp_mocol105	Ease of understanding - Ground preparations	-0.208	-0.199	-0.106	0.614	0.576	-0.586	0.191	-1.18	0.818	-0.594	0.185	-1.22	0.782	1	23427	15372
bsp_mocol106	Ease of understanding - Herbivore damage controls	-1.46	-1.44	-1.35	0.629	0.621	-1.85	-1.02	-2.48	-0.428	-1.88	-1.04	-2.53	-0.468	1	24442	15445
bsp_mocol107	Ease of understanding - Planting woodland	0.397	0.407	0.457	0.662	0.635	-0.0022	0.852	-0.656	1.53	-0.0226	0.834	-0.718	1.47	1	21614	15545
bsp_mocol110	Ease of doing - Ground preparations	0.293	0.275	0.241	0.613	0.595	-0.146	0.653	-0.697	1.31	-0.115	0.686	-0.681	1.34	1	20777	16299
bsp_mocol111	Ease of doing- Herbivore damage controls	-0.16	-0.167	-0.191	0.578	0.548	-0.561	0.177	-1.11	0.792	-0.533	0.207	-1.1	0.8	1	19155	15927
bsp_mocol112	Ease of doing - Planting woodland	-0.101	-0.0853	0.00334	0.65	0.619	-0.476	0.359	-1.16	0.974	-0.512	0.325	-1.19	0.95	1	23692	16498
bsp_mocol113	Expected changes to carbon storage	-0.00288	-0.0179	-0.0905	0.663	0.636	-0.444	0.413	-1.1	1.09	-0.435	0.424	-1.08	1.11	1	22199	15925
bsp_mocol114	Expected changes to habitat for wildlife	1.38	1.36	1.25	0.623	0.609	0.883	1.7	0.394	2.42	0.964	1.79	0.404	2.44	1	21842	15752
bsp_mocol115	Expected changes to species diversity	0.309	0.311	0.357	0.704	0.693	-0.146	0.788	-0.907	1.41	-0.163	0.772	-0.862	1.46	1	25429	17186
bsp_mocol116	Expected changes to water quality	0.0236	0.0146	-0.0764	0.736	0.719	-0.422	0.54	-1.18	1.23	-0.465	0.502	-1.16	1.25	1	25525	16436
bsp_mocol117	Expected changes to flooding prevention	-0.49	-0.505	-0.561	0.62	0.607	-0.926	-0.108	-1.48	0.554	-0.906	-0.0867	-1.48	0.547	1	21298	16604
bsp_mocol118	Expected changes to soil quality	0.942	0.924	0.859	0.512	0.502	0.569	1.24	0.0967	1.77	0.595	1.27	0.127	1.81	1	23806	16350
bsp_mocol119	Expected changes to earnings	0.689	0.664	0.636	0.587	0.558	0.254	1.01	-0.27	1.65	0.304	1.06	-0.229	1.69	1	21613	15092
bsp_mocol120	Expected changes to community well-being	-0.426	-0.432	-0.431	0.656	0.637	-0.887	-0.0252	-1.5	0.638	-0.859	-0.000304	-1.49	0.659	1	23561	15987
bsp_mocol121	Expected changes to social recognition	-0.558	-0.539	-0.506	0.796	0.8	-1.02	0.0526	-1.89	0.725	-1.09	-0.00855	-1.9	0.715	1	24367	16628
bsp_mocol122	Expected changes to number of jobs	-0.366	-0.353	-0.333	0.869	0.873	-0.943	0.234	-1.77	1.09	-0.947	0.23	-1.81	1.06	1	23973	16875
bsp_mocol135	Visibility of results	0.759	0.752	0.747	0.661	0.653	0.312	1.19	-0.317	1.84	0.318	1.2	-0.304	1.86	1	21864	17140
bsp_mocol136	Visibility of practice	-0.735	-0.751	-0.856	0.684	0.676	-1.21	-0.305	-1.87	0.383	-1.19	-0.282	-1.84	0.413	1	17137	13855
bsp_mocol137	Compatibility with values and beliefs	0.202	0.208	0.226	0.669	0.641	-0.219	0.644	-0.863	1.33	-0.228	0.638	-0.905	1.3	1	21802	15586
bsp_mocol138	Compatibility with needs	0.203	0.197	0.178	0.619	0.602	-0.224	0.588	-0.805	1.22	-0.208	0.604	-0.794	1.23	1	21053	16638
bsp_mocol139	Compatibility with land use practices	1.4	1.37	1.33	0.6	0.587	0.928	1.72	0.422	2.38	0.989	1.78	0.451	2.42	1	21751	16548
bsp_mocol91	Reversibility	-0.643	-0.629	-0.566	0.472	0.457	-0.935	-0.318	-1.39	0.161	-0.948	-0.329	-1.44	0.115	1	21539	16073
bsp_mocol92	Initial costs - Money	0.247	0.233	0.166	0.663	0.666	-0.206	0.689	-0.866	1.31	-0.206	0.69	-0.83	1.36	1	18776	17290
bsp_mocol93	Initial costs - Time	0.268	0.266	0.302	0.569	0.561	-0.119	0.636	-0.663	1.2	-0.117	0.639	-0.654	1.21	1	22224	16423
bsp_mocol97	Perceived risks	-0.565	-0.541	-0.488	0.535	0.524	-0.818	-0.118	-1.45	0.288	-0.91	-0.201	-1.47	0.273	1	19360	15789

Conditional effects estimates

Estimand	Response_Level	Mean	Median	SD	MAD	HDI_Lower0.5	HDI_Upper0.5	HDI_Lower0.9	HDI_Upper0.9	ETI_Lower0.5	ETI_Upper0.5	ETI_Lower0.9	ETI_Upper0.9	Rhat	ESS_Bulk	ESS_Tail
Compatibility with land uses	Strongly disagree	0.00793	0.000393	0.0361	0.000574	0	0	0	0.01	0	0	0	0.03	1	18949	17201
Compatibility with land uses	Disagree	0.0137	0.001	0.0498	0.00146	0	0	0	0.03	0	0.01	0	0.06	1	18705	16807
Compatibility with land uses	Neither agree nor disagree	0.0572	0.00888	0.124	0.0128	0	0.01	0	0.17	0	0.05	0	0.32	1	18605	17793
Compatibility with land uses	Agree	0.121	0.0297	0.196	0.0426	0	0.03	0	0.4	0	0.14	0	0.6	1	19968	17457
Compatibility with land uses	Strongly agree	0.227	0.0883	0.282	0.127	0	0.09	0	0.73	0.01	0.36	0	0.87	1	20287	17581
Expected changes to habitat for wildlife	Decrease greatly	0.0204	0.00139	0.0683	0.00203	0	0	0	0.04	0	0.01	0	0.1	1	19798	17219
Expected changes to habitat for wildlife	Decrease slightly	0.032	0.00332	0.0875	0.00482	0	0	0	0.08	0	0.02	0	0.17	1	19553	17380
Expected changes to habitat for wildlife	No change	0.0572	0.00888	0.124	0.0128	0	0.01	0	0.17	0	0.05	0	0.32	1	18605	17793
Expected changes to habitat for wildlife	Increase slightly	0.191	0.0667	0.255	0.0943	0	0.07	0	0.62	0.01	0.28	0	0.8	1	19278	16975
Expected changes to habitat for wildlife	Increase greatly	0.356	0.239	0.334	0.327	0	0.24	0	0.9	0.05	0.65	0	0.96	1	19488	17496
Expected changes to soil quality	Decrease greatly	0.0183	0.00121	0.0628	0.00177	0	0	0	0.04	0	0.01	0	0.09	1	17933	17107
Expected changes to soil quality	Decrease slightly	0.028	0.00282	0.079	0.00409	0	0	0	0.07	0	0.02	0	0.15	1	18525	16977
Expected changes to soil quality	No change	0.0572	0.00888	0.124	0.0128	0	0.01	0	0.17	0	0.05	0	0.32	1	18605	17793
Expected changes to soil quality	Increase slightly	0.113	0.0231	0.194	0.0332	0	0.02	0	0.38	0	0.12	0	0.6	1	18578	17126
Expected changes to soil quality	Increase greatly	0.176	0.0467	0.255	0.0675	0	0.05	0	0.62	0.01	0.24	0	0.8	1	18976	17846
Ease of understanding herbivore damage	Very difficult	0.277	0.112	0.325	0.162	0	0.11	0	0.87	0.02	0.49	0	0.95	1	19279	17004
Ease of understanding herbivore damage	Difficult	0.159	0.0363	0.246	0.0525	0	0.04	0	0.57	0.01	0.19	0	0.78	1	18005	17551
Ease of understanding herbivore damage	Neither easy nor difficult	0.0572	0.00888	0.124	0.0128	0	0.01	0	0.17	0	0.05	0	0.32	1	18605	17793
Ease of understanding herbivore damage	Easy	0.0123	0.00117	0.0408	0.00169	0	0	0	0.03	0	0.01	0	0.06	1	18531	17935
Ease of understanding herbivore damage	Very easy	0.00603	0.000401	0.0247	0.000584	0	0	0	0.01	0	0	0	0.03	1	19703	18139

Appendix H – Native Woodland Creation Preferences Survey

Native Woodland Creation Preferences Survey

INTRO PAGE

Welcome to the Native Woodland Creation Preferences survey

This survey is part of the “To plant or not to plant? Drivers of native woodland creation in the United Kingdom” study which aims to examine the factors influencing landholders' decisions to either create new native woodlands or not in the UK.

This study is led by Dr. Morena Mills who is the principal investigator and her co-investigator Alvaro Roel Bellot. We are both affiliated to the Centre for Environmental Policy at Imperial College London (UK).

We want to understand the perspectives of people that have and that have not created woodland on the land they manage, as well as those of people that plan and do not plan to engage in woodland creation in the future. All these perspectives are important to researchers and decision makers designing policies for new native woodlands in the UK.

In this survey we will ask you questions in reference to a piece of land. **Please answer the following questions to confirm you are a suitable participant:**

e) I am involved in the management of the land I will refer to in my response.

☐ Yes

☐ No

f) I am involved in decision-making processes that lead to changes in the use of that land, including decisions on new woodland creation.

☐ Yes

☐ No

BLOCK 0

Do you consent to participate in this study?

Completing the survey takes about 15 minutes.

Participation is voluntary. If you decide to take part, you are still free to withdraw from the study at any time without giving a reason. You can leave questions unanswered if you do not feel confident or comfortable sharing your answer.

You can win a prize by participating! There are ten GiftPay online vouchers up for grabs: six £10 vouchers, two £20 vouchers, a £50 voucher and a top prize of £100.

We collect the following personal data via this survey: full name, email and postcode. We will keep your personal data separate from the rest of your response and will never share it with anyone outside the research team. We require personal data to contact raffle winners, send a copy of our results and/or share the details of a parallel research project we are running if you show interest in participating via the survey. Your personal data will be stored securely and will only be used for this project.

The rest of your response will be fully anonymous, meaning that we will ensure individual institutions and individuals themselves cannot be identified from it by anyone, not even ourselves. We will use this data in our analysis. When we publish our results, we will share a copy of the anonymised responses database via an online open access repository to ensure our results are fully transparent. If you withdraw from the study after we anonymise response data, we will be able to delete your personal data but not the rest of your response, since we won't be able to tell who submitted what after anonymisation. Unsubmitted responses will be fully deleted and won't be stored.

If this research leads to an invention and/or the development of a new product or service, you won't personally benefit financially from it. This study has been given approval by the Head of Department and the Research Governance and Integrity Team (RGIT) at Imperial College London.

You can read the full details of ethics and security on the study's Participant Information Sheet.

If you have any questions about ethics or the study in general, please contact Alvaro Roel Bellot (alvaro.roel-bellot@imperial.ac.uk) or Morena Mills (m.mills@imperial.ac.uk).

By clicking “Accept” on this page you are confirming that you have read and understood the information on this page and the study's Participant Information Sheet, and that you consent to take part in this study.

☐ Accept.

BLOCK 1

1. What type of landholding do you represent?

- ☐ Estate
- ☐ Farm
- ☐ Croft
- ☐ Nature Reserve
- ☐ *Do not know*
- ☐ *Other, please specify:*

2. What is your current land tenure? Please select all options that apply to you/your organisation.

- ☐ Landowner directly managing the landholding
- ☐ Tenant
- ☐ Landlord
- ☐ Licensor
- ☐ Licensee
- ☐ Crofter
- ☐ *Do not know*
- ☐ *Other, please specify:*

3. How big is the landholding you represent?

- ☐ Less than 50 acres
- ☐ 50 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 1,250 acres
- ☐ 1,250 acres or more, but less than 2,500 acres
- ☐ 2,500 acres or more, but less than 5,000 acres
- ☐ 5,000 acres or more, but less than 7,500 acres
- ☐ 7,500 acres or more, but less than 10,000 acres
- ☐ 10,000 acres or more, but less than 15,000 acres
- ☐ 15,000 acres or more, but less than 20,000 acres
- ☐ 20,000 acres or more, but less than 35,000 acres
- ☐ 35,000 acres or more, but less than 50,000 acres
- ☐ 50,000 acres or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

4. What type of organisation do you represent?

- ☐ Family organisation
- ☐ Non-family organisation
- ☐ *Other, please specify:*

5. What are the financial aims of your organisation?

- ☐ For profit
- ☐ Not for profit
- ☐ *Other, please specify:*

6. How many people are part of the organisation you represent?

- ☐ Less than 5 members
- ☐ 5 to 9 members
- ☐ 10 to 29 members
- ☐ 30 to 49 members
- ☐ 50 member or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

7. How long has the landholding been under your/your organisation's management?

- ☐ Under 1 year
- ☐ 1 to 4 years
- ☐ 5 to 9 years
- ☐ 10 years or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

8. What is the main use of the landholding you represent? Please select all options that apply, if you practice a mix of uses and one does not predominate over the rest.

- ☐ Farming
- ☐ Forestry
- ☐ Game/Hunting
- ☐ Wildlife conservation
- ☐ Public recreation
- ☐ Private enjoyment
- ☐ *Do not know*
- ☐ *Other, please specify:*

BLOCK 2

9. Have any new woodlands been created in the landholding you represent since you or your organisation manage it? Please don't consider restocking (replanting of woodland that has been felled) as woodland creation.

- ☐ Yes
- ☐ No

10. Has more than one new woodland been created on the landholding you represent since you or your organisation manage it?

- ☐ Yes
- ☐ No

11. How was the new woodland(s) created? Please select all options that apply to you/your organisation.

- ☐ Tree planting
- ☐ Natural regeneration
- ☐ *Do not know*
- ☐ *Other, please specify:*

12. Did you receive any external funding to create the woodland? Please select all options that apply to you/your organisation.

- ☐ Yes, government funding
- ☐ Yes, non-government funding
- ☐ Yes, bank loan I need to repay
- ☐ No
- ☐ *Do not know*
- ☐ *Other, please specify:*

13. What type of tree species were used when creating the new woodland(s)? Please select all options that apply if more than one woodland has been created on the landholding you represent since you or your organisation manage it.

- ☐ Native – One species only
- ☐ Non-Native – One species only
- ☐ Native – Mix of species
- ☐ Non-Native – Mix of species
- ☐ Mixed (native and non-native) - Predominantly Native
- ☐ Mixed (native and non-native) - Predominantly Non-native
- ☐ Mixed (native and non-native) - Even split between natives and non-native trees.
- ☐ *Do not know*
- ☐ *Other, please specify:*

14. How many acres of new woodland have been created on the landholding you represent since you/your organisation manage it?

- ☐ Less than 12 acres
- ☐ 12 acres or more, but less than 25 acres
- ☐ 25 acres or more, but less than 125 acres
- ☐ 125 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 500 acres
- ☐ 500 acres or more, but less than 1,000 acres
- ☐ 1,000 acres or more, but less than 2,000 acres
- ☐ 2,000 acres or more, but less than 4,000 acres
- ☐ 4,000 acres or more, but less than 8,000 acres
- ☐ 8,000 acres or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

BLOCK 3

15. Did the landholding you represent contain any existing woodland before the new woodland was created?

- ☐ Yes
- ☐ No

16. If yes, what type of woodland? Please select all options that apply if there is more than one type of woodland in the landholding you represent.

- ☐ Native – One species only
- ☐ Non-Native – One species only
- ☐ Native – Mix of species
- ☐ Non-Native – Mix of species
- ☐ Mixed (native and non-native) - Predominantly native
- ☐ Mixed (native and non-native) - Predominantly non-native
- ☐ Mixed (native and non-native) - Even split between natives and non-native trees.
- ☐ *Do not know*
- ☐ *Other, please specify:*

17. How many acres of woodland were there on the landholding you represent before the new woodland was created?

- ☐ Less than 12 acres
- ☐ 12 acres or more, but less than 25 acres
- ☐ 25 acres or more, but less than 125 acres
- ☐ 125 acres or more, but less than 250 acres
- ☐ 250 acres or more, but less than 500 acres
- ☐ 500 acres or more, but less than 1,000 acres
- ☐ 1,000 acres or more, but less than 2,000 acres
- ☐ 2,000 acres or more, but less than 4,000 acres
- ☐ 4,000 acres or more, but less than 8,000 acres
- ☐ 8,000 acres or more
- ☐ *Do not know*
- ☐ *Other, please specify:*

18. Is the existing woodland managed? Please select all options that apply to the landholding you represent if it contains more than one existing woodland, and you manage each differently.

- ☐ Yes, managed for wood production: coppice system.
- ☐ Yes, managed for wood production: even aged woodland harvested through clear felling.
- ☐ Yes, managed for wood production: unevenly aged woodland harvested through regular or irregular felling.
- ☐ Yes, managed for game/hunting: The woodland is managed to provide habitat for game species such as pheasants.
- ☐ Yes, actively managed for wildlife. The woodland is managed to improve its wildlife value through actions such as thinning to improve age structure, felling to create openings or ring barking trees to increase the amount of dead wood.
- ☐ Yes, passively managed for wildlife. The woodland is managed through a no intervention approach letting it develop on its own terms.
- ☐ Not managed at all.
- ☐ *Do not know*
- ☐ *Other, please specify:*

BLOCK 4

19. To what extent do you agree or disagree with the following statements:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I sense that most people that are important to me are in favour of woodland creation	☐	☐	☐	☐	☐
I feel it is my responsibility to manage land in a way that protects soil and water, preventing floods.	☐	☐	☐	☐	☐
I feel that circumstances complicate the creation of woodland on the landholding I represent.	☐	☐	☐	☐	☐
I feel a personal responsibility to manage land in a way that allows wildlife to thrive.	☐	☐	☐	☐	☐
I sense that most of the landholders in my community have or are planning to create woodlands on their property.	☐	☐	☐	☐	☐
I feel a moral obligation to contribute to woodland expansion efforts.	☐	☐	☐	☐	☐
I sense that those dearest to me think I shouldn't plant more woodland.	☐	☐	☐	☐	☐
I feel a moral obligation to manage land in a way that contributes to the fight against climate change.	☐	☐	☐	☐	☐
I am committed to creating woodland in the next 5 years.	☐	☐	☐	☐	☐
I feel that creating woodland on the landholding I represent depends more on me than others.	☐	☐	☐	☐	☐
I sense that there are many people creating woodlands in my area.	☐	☐	☐	☐	☐

BLOCK 5

This section explains how to answer the rest of questions in this survey. Please read this information carefully.

Decision makers and researchers are considering improvements to the structure of current incentives for woodland creation.

In the following questions you will be presented with two hypothetical scenarios. Each scenario will describe a woodland creation intervention, which would result in the fictional creation of a native woodland on your land. You can imagine creating a native woodland of any size that may be realistic to your circumstances.

If created, the woodland would be managed for biodiversity and generate amenity value for the landholding, as well as a small timber income derived from thinning. The woodland would be enrolled in the Woodland Carbon Code and you would be able to sell each tonne of carbon dioxide equivalent sequestered by the woodland as carbon units at any point after the project is validated. Validation happens soon after the trees are planted. The planted land must be kept as a woodland for at least 100 years.

We would like you to consider both scenarios as if you were choosing between them in the real world. We will then ask you which scenario you prefer. You will also be given the option to choose neither of the two scenarios.

In each question you will be presented with the two scenarios and the option to reject both side by side. You can see an example of a question in blue below:

When considering the creation of native woodland managed for biodiversity in your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £240 per ha a year	<i>Expected average net income:</i> £60 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 6 months	<i>Minimum time to complete woodland creation admin:</i> 4 years	
	<i>Availability of free advice on native woodland creation:</i> Available	<i>Availability of free advice on native woodland creation:</i> Unavailable	
	<i>% of all initial costs received as interest free loan:</i> 0%	<i>% of all initial costs received as interest free loan:</i> 100%	
Your choice (tick your preferred scenario)	☐	☐	☐

Once you understand how the scenario comparison questions work and are ready to start answering them, click next to see the actual questions. You will be shown 12 scenario comparison questions in the next section.

BLOCK 6

20. Please enter below the number of hectares of native woodland you will imagine creating when responding the scenario comparison questions you will see after this page:

BLOCK 7

21.

1/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £60 per ha a year	<i>Expected average net income:</i> £240 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 4 years	<i>Minimum time to complete woodland creation admin:</i> 6 months	
	<i>Availability of free advice on native woodland creation:</i> Unavailable	<i>Availability of free advice on native woodland creation:</i> Available	
	<i>% of all initial costs received as interest free loan:</i> 30%	<i>% of all initial costs received as interest free loan:</i> 0%	
Your choice (tick your preferred scenario)	☐	☐	☐

22.

2/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £180 per ha a year	<i>Expected average net income:</i> £60 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 6 months	<i>Minimum time to complete woodland creation admin:</i> 1 year	
	<i>Availability of free advice on native woodland creation:</i> Available	<i>Availability of free advice on native woodland creation:</i> Unavailable	
	<i>% of all initial costs received as interest free loan:</i> 70%	<i>% of all initial costs received as interest free loan:</i> 100%	
Your choice (tick your preferred scenario)	☐	☐	

23.

3/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £120 per ha a year	<i>Expected average net income:</i> £240 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 1 year	<i>Minimum time to complete woodland creation admin:</i> 4 years	
	<i>Availability of free advice on native woodland creation:</i> Available	<i>Availability of free advice on native woodland creation:</i> Unavailable	
	<i>% of all initial costs received as interest free loan:</i> 100%	<i>% of all initial costs received as interest free loan:</i> 100%	
Your choice (tick your preferred scenario)	☐	☐	

24.

4/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £120 per ha a year	<i>Expected average net income:</i> £60 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 2 years	<i>Minimum time to complete woodland creation admin:</i> 1 year	
	<i>Availability of free advice on native woodland creation:</i> Available	<i>Availability of free advice on native woodland creation:</i> Unavailable	
	<i>% of all initial costs received as interest free loan:</i> 0%	<i>% of all initial costs received as interest free loan:</i> 30%	
Your choice (tick your preferred scenario)	☐	☐	

25.

5/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £180 per ha a year	<i>Expected average net income:</i> £120 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 6 months	<i>Minimum time to complete woodland creation admin:</i> 6 months	
	<i>Availability of free advice on native woodland creation:</i> Unavailable	<i>Availability of free advice on native woodland creation:</i> Unavailable	
	<i>% of all initial costs received as interest free loan:</i> 70%	<i>% of all initial costs received as interest free loan:</i> 100%	
Your choice (tick your preferred scenario)	☐	☐	☐

26.

6/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £180 per ha a year	<i>Expected average net income:</i> £60 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 2 years	<i>Minimum time to complete woodland creation admin:</i> 6 months	
	<i>Availability of free advice on native woodland creation:</i> Available	<i>Availability of free advice on native woodland creation:</i> Unavailable	
	<i>% of all initial costs received as interest free loan:</i> 100%	<i>% of all initial costs received as interest free loan:</i> 0%	
Your choice (tick your preferred scenario)	☐	☐	

27.

7/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £240 per ha a year	<i>Expected average net income:</i> £240 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 1 year	<i>Minimum time to complete woodland creation admin:</i> 2 years	
	<i>Availability of free advice on native woodland creation:</i> Unavailable	<i>Availability of free advice on native woodland creation:</i> Available	
	<i>% of all initial costs received as interest free loan:</i> 0%	<i>% of all initial costs received as interest free loan:</i> 70%	
Your choice (tick your preferred scenario)	☐	☐	

28.

8/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £120 per ha a year	<i>Expected average net income:</i> £240 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 2 years	<i>Minimum time to complete woodland creation admin:</i> 4 years	
	<i>Availability of free advice on native woodland creation:</i> Unavailable	<i>Availability of free advice on native woodland creation:</i> Available	
	<i>% of all initial costs received as interest free loan:</i> 30%	<i>% of all initial costs received as interest free loan:</i> 30%	
Your choice (tick your preferred scenario)	☐	☐	

29.

9/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £60 per ha a year	<i>Expected average net income:</i> £180 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 1 year	<i>Minimum time to complete woodland creation admin:</i> 4 years	
	<i>Availability of free advice on native woodland creation:</i> Unavailable	<i>Availability of free advice on native woodland creation:</i> Available	
	<i>% of all initial costs received as interest free loan:</i> 30%	<i>% of all initial costs received as interest free loan:</i> 70%	
Your choice (tick your preferred scenario)	☐	☐	☐

30.

10/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

Scenario A	Scenario B	
<i>Expected average net income:</i> £240 per ha a year	<i>Expected average net income:</i> £180 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
<i>Minimum time to complete woodland creation admin:</i> 6 months	<i>Minimum time to complete woodland creation admin:</i> 2 years	
<i>Availability of free advice on native woodland creation:</i> Available	<i>Availability of free advice on native woodland creation:</i> Available	
<i>% of all initial costs received as interest free loan:</i> 70%	<i>% of all initial costs received as interest free loan:</i> 100%	
Your choice (tick your preferred scenario)	☐	

31.

11/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £180 per ha a year	<i>Expected average net income:</i> £120 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 4 years	<i>Minimum time to complete woodland creation admin:</i> 2 years	
	<i>Availability of free advice on native woodland creation:</i> Unavailable	<i>Availability of free advice on native woodland creation:</i> Available	
	<i>% of all initial costs received as interest free loan:</i> 0%	<i>% of all initial costs received as interest free loan:</i> 30%	
Your choice (tick your preferred scenario)	☐	☐	☐

32.

12/12. When considering the creation of native woodland managed for biodiversity on your landholding, which scenario do you prefer?

	Scenario A	Scenario B	
	<i>Expected average net income:</i> £120 per ha a year	<i>Expected average net income:</i> £60 per ha a year	I would not create native woodland managed for biodiversity under any of these two scenarios.
	<i>Minimum time to complete woodland creation admin:</i> 2 years	<i>Minimum time to complete woodland creation admin:</i> 1 year	
	<i>Availability of free advice on native woodland creation:</i> Available	<i>Availability of free advice on native woodland creation:</i> Unavailable	
	<i>% of all initial costs received as interest free loan:</i> 100%	<i>% of all initial costs received as interest free loan:</i> 0%	
Your choice (tick your preferred scenario)	☐	☐	☐

BLOCK 8

33. Full name:

34. Email:

35. Year of Birth:

36. Postcode for the landholding subject of your response:

37. What is the highest level of formal education you have attained?

- ☐ Doctoral University Degree
- ☐ Masters University Degree
- ☐ Undergraduate University Degree
- ☐ High (Secondary) School Graduate
- ☐ Primary School Graduate
- ☐ No formal education
- ☐ Refuse to answer
- ☐ Other, please specify:

38. Please indicate whether you would like to enter the study's raffle and/or receive a copy of its results when they are published.

- ☐ I would like to take part in the raffle to win a voucher for a value of up to £100.
- ☐ I would like to receive a copy of the study's results when they are published.

39. We are running a parallel research project investigating the factors influencing landholders' decisions to create new native woodlands or not in the UK. It consists of a survey that aims to understand how characteristics of landholders, their context and woodland creation interventions themselves, influence land managers' decisions to create native woodland or not. If you are interested in learning more about it and would consider participating, please tick the box below and we will send you more details.

- ☐ Yes, I am interested. Please send me more details about your parallel research project.

Appendix I – Sample descriptive statistics for the Native Woodland Creation Preferences Survey

Full sample descriptive statistics

My final sample included 87 landholders. Only 71 responses (57 in-person, 14 online) were complete and within my study area, thus included in analysis.

	Count
Landholding type	
Farm	36
Estate	26
Croft	5
Nature reserve	1
Other	3: Freehold/smallholding; Mini Estate; Farm and Croft.
Land ownership	
<i>*Respondents could choose several options, 19 did so. All landholdings saw this question.</i>	
Landowner directly managing the landholding	69 (One landholder specified they were an agent representing the landowner)
Tenant	9 (One landholder specified tenancy was through seasonal grazing agreements)
Landlord	11
Licensor	1
Licensee	0
Crofter	2
Other	0
Organisation type	
Family organisation	66
Non-family organisation	0
Other	5: Family and non-family organisation; Family home; Charity; Public body; Sole trade.
Financial aims	
For profit	57
Not for profit	8
Other	6: Mix of profit and non-profit; Self sustenance and satisfaction; For profit, but also to leave land better than I found it; Break even; For profit and community; To get a balance between sustaining the needs of the family and land tenure and stewardship.
Length of management	
Under 1 year	1
1 to 4 years	1
5 to 9 years	4
10 years or more	65
Do not know	0
Other	0

Land use	
<i>*Respondents could choose several options if land uses were mixed, 42 did so. All landholdings saw this question.</i>	
Farming	63
Forestry	33
Game/Hunting	20
Wildlife conservation	20
Public recreation	17
Private enjoyment	26
Do not know	0
Other	8: Holiday lets; Land-based crafts; Hospitality; Horse grazing; Wind farm; Community involvement; Holiday lets and fishing; Horse stables.
Landholding size	
<50 acres	10
50 to <250 acres	13
250 to <1,250 acres	23
1,250 to <2,500 acres	5
2,500 to <5,000 acres	2
5,000 to <7,500 acres	4
7,500 to <10,000 acres	0
10,000 to <15,000 acres	4
15,000 to <20,000 acres	3
20,000 to <35,000 acres	2
35,000 to <50,000 acres	2
50,000 or more	1
Do not know	0
Other	1: Directly around 10K-15K acres but part of an organisation whose landholdings exceed 50K acres.
Blank	1
Organisation size	
<5 members	50
5 to 9 members	12
10 to 29 members	4
30 to 49 members	3
50 or more	2
Do not know	0
Other	0

New woodland descriptive statistics

A total of 44 (62%) of my 71 respondents had created new woodland since they started managing the landholding, in many cases repeatedly.

	Count
Created new woodland	
Yes	44
No	27
Created more than one new woodland	
Yes	29
No	15
How was/were the new woodland(s) created?* <i>*Respondents could choose more than one option, 14 did so. Only landholdings that had created new woodland could answer this question.</i>	
Tree planting	43
Natural regeneration	15
Do not know	0
Other	0
External sources of funding <i>*Respondents could choose more than one option, 3 did so. Only landholdings that had created new woodland could answer this question.</i>	
Government funding	36 (One specified this was local government funding).
Non-government funding	1
Bank loan	1
No external funding	8
Do not know	0
Other	1: Compensated by power company for trees that were cut down.
Type of trees <i>*Respondents could choose more than one option, 9 did so. Only landholdings that had created new woodland (mixed native or other) could answer this question.</i>	
Native – One species only	3
Non-native – One species only	0
Native – Mix of species	34
Non-native – Mix of species	4
Mixed – Predominantly native	6
Mixed – Predominantly non-native	10
Mixed – Even split native and non-native	1
Do not know	0
Other	0

Acreage of new woodland created	
<12 acres	15
12 to <25 acres	3
25 to <125 acres	13
125 to <250 acres	3
250 to <500 acres	1
500 to <1,000 acres	3
1,000 to <2,000 acres	3
2,000 to <4,000 acres	2
4,000 to <8,000 acres	0
8,000 or more	0
Do not know	1
Other	0

Existing woodland descriptive statistics

Seventy-six percent (n=54) of the 71 landholdings in my sample contained existing woodland, either before new woodland was created (n=32 (59%)) or at present otherwise (n=22 (41%)).

	Count
Any existing woodland before new woodland was created or at present (if no new woodland had been created)?	
Yes	54
No	17
Type of trees in existing woodland* <i>*Respondents could choose more than one option, 17 (31%) did so. Only landholdings with existing woodland could answer this question.</i>	
Native – One species only	6
Non-native – One species only	13
Native – Mix of species	28
Non-native – Mix of species	11
Mixed – Predominantly native	20
Mixed – Predominantly non-native	15
Mixed – Even split native and non-native	3
Do not know	0
Other	0
Existing woodland management* <i>*Respondents could choose more than one option, 21 (39%) of landholdings with existing woodland did so, meaning they had a mix of management objectives for different patches of existing woodland. Only 15 (28%) of landholdings with existing woodland did not manage it at all. Two (4%) managed some patches but not others.</i>	
Coppice	3
Even-aged and clearfelling	23
Uneven-aged through regular or irregular felling	16
Managed for game/hunting	8
Actively managed for wildlife	15
Passively managed for wildlife	17
Not managed	17
Do not know	0
Other	2: Amenity woodland; The plantation forestry elements of the site are managed to UKFS standards.

Acreage of existing woodland	
<12 acres	16
12 to <25 acres	8
25 to <125 acres	6
125 to <250 acres	4
250 to <500 acres	1
500 to <1,000 acres	4
1,000 to <2,000 acres	5
2,000 to <4,000 acres	3
4,000 to <8,000 acres	5
8,000 or more	1
Do not know	0
Other	0
Blanks	1

**Appendix J – Databases and R code for all analyses described in this thesis,
including database of correlation coefficients for DOIT variables.**

The data and R code used in this study are available at: <https://github.com/Alvaro-RoelBellot/PhDThesisDataAndCode>