Forestry Commission

Research Note

Converting planted non-native conifer to native woodlands: a review of the benefits, drawbacks and experience in Britain

Nadia Barsoum and Laura Henderson

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Planted forests of non-native conifers make up around 36% of Britain's total wooded area. Increasing the area of native woodlands – including converting non-native conifer to native woodland where appropriate – is an aim of the UK Forestry Standard Guidelines on Biodiversity. It is unclear how much conversion is being implemented, what the motivations might be, or how it is achieved in practice. This study used literature review and questionnaire-based approaches to explore the benefits and drawbacks of conversion, and also to evaluate the attitudes towards, and experiences of, conversion. A majority of respondents are currently, or planning to be, engaged in converting non-native conifer forest management units to native woodland. A range of methods are practised, which aim towards either partial or complete conversion. The level of effort and cost required for conversion varies with local site conditions and/or the proximity of native woodland from which colonisation processes can occur. Some managers whose primary objective is timber production are concerned that conversion will result in a reduction in levels of productivity, which leads to a reluctance to pay for the process of conversion, especially where competition, herbivory and biosecurity threats to native tree species are a potential issue. In contrast, those managers whose primary objective is conservation appear prepared to invest time and resources converting their woodlands. However, many woodland managers are reluctant to undertake large-scale conversion without more guidance and evidence of the benefits.

Introduction

Planted non-native conifer woodland became the most common woodland type in Britain from the middle of the 20th century. Managed primarily for timber, these planted woodlands frequently consist of even-aged, sometimes single-species woodlands that are clearfelled and replanted at the end of each rotation. Afforestation with non-native conifers has mostly been conducted on unmanaged moorland or poor quality, often peaty, upland soils previously used for rough grazing. These woodlands are distributed mainly across upland areas of Wales and upland and lowland areas in England and Scotland, occupying around 1 090 000 ha, or 36% of Britain's total woodland area (Forestry Commission, 2015). Where semi-natural woodland was converted to planted forest – creating sites known as plantations on ancient woodland sites (PAWS) – the large-scale conversion of these back to native woodland has been a policy aim for a number of years (Forestry Commission, 2011).

The UK Forestry Standard (UKFS) advocates a diversification in forest composition so that no more than 75% of a forest management unit (FMU) is allocated to a single species and at least 5% comprises native broadleaved trees and shrubs (Forestry Commission, 2011). The UKFS Guidelines on Biodiversity also encourages the larger-scale measure of expanding native woodlands by converting non-native woodlands, especially those on areas that will enhance existing ancient semi-natural woodlands and particularly on sites large enough to overcome edge effects (Forestry Commission, 2011). However, forest managers will not necessarily be amenable to altering the species composition of their woodlands beyond what is required under the UKFS, especially if it has impacts upon timber production. Also, while a dedicated research effort has gone into understanding how to restore PAWS, there has been significantly less research on the conversion of non-PAWS sites, potentially leaving an important knowledge gap that can hinder conversion efforts and their success.

This Research Note aims to summarise:

- evidence of the benefits and drawbacks of conversion;
- methods of conversion, highlighting the advantages and disadvantages of different approaches, including evidence of the relative costs;
- experience, attitudes and perceived barriers to conversion in Britain based on the results of two questionnaire surveys.

Forest conversion is defined here as the silvicultural process of changing the tree species composition of a FMU from one that is dominated by non-native conifers to one comprising only native tree species or where these form a substantial component (≥50%) of the FMU. The end goal of the conversion process is typically to diversify the structure and composition of the FMU rather than to create native broadleaved monocultures as an alternative crop. Defined as such, conversion is a general term which describes a range of similar processes and goals including 'forest transformation', 'closer to nature forestry', 'forest diversification' and 'restoration of semi-natural woodland' (Klimo, Hager and Kulhavý, 2000; Gärtner and Reif, 2005). Where forest conversion is intended to result in a mixture of non-native conifers and native tree species, the planting design might create an intimate or non-intimate mixture within a single forest stand or in a patchwork design across a wider FMU. Part of the ongoing redesign and conversion process may also involve the introduction of other features to enhance structural and compositional complexity (e.g. retention of deadwood, creation of open space).

Evidence of the benefits and drawbacks of conversion

Published evidence points to several potential benefits, but also some drawbacks, of converting planted non-native conifer woodlands to native woodland, including productive woodlands comprising native species. These are outlined in the sections below.

Impacts on soil and water

Many of the commonly planted non-native conifer species such as Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*) and Douglas fir (*Pseudotsuga menziesii*) have dense canopies that intercept a high proportion of light and reduce forest floor temperatures. A lowering of soil temperatures has the effect of reducing rates of decomposition, leading to an accumulation of organic matter (Crawford, Jeffree and Rees, 2003). Conifer needles also typically have a lower base cation concentration than many broadleaved tree species, contributing to a reduction in the pH of the upper horizons of some forest soil types (Brantberg *et al*., 2000). This can compound a slowing of nutrient cycling rates and a reduction in overall levels of soil fertility. At the same time, the accumulation of organic matter will lead to raised levels of soil carbon and thus contribute towards carbon sequestration. Conversion is likely to result in higher levels of light at the forest floor, improving growth conditions for ground vegetation as a potentially important component of the woodland carbon balance (Morison *et al*., 2012). More light will also lead to a rise in soil temperatures and faster rates of nutrient cycling, which provide greater nutrient availability (Légaré, Paré and Bergeron, 2005). This has clear advantages in nutrient-poor soils, but can be detrimental to water quality in nitrogen-saturated soils (Kennedy, 2003).

Impacts on woodland biodiversity

Native woodland species abundance and diversity can increase substantially following conversion (Augusto *et al*., 2001), although for some species colonisation may take some time or might never happen (Spracklen *et al*., 2013). At a regional scale, the species pool has a strong influence on the colonisation potential of a given species (Lawton, 1999). Site conditions such as herbivore pressure, adjacent and previous land use prior to afforestation and the management regime of the former conifer crop (e.g. thinning cycles and intensity, number of rotations) will also play a determining role in the composition and diversity of woodland species which emerge in converted woodland stands. Research findings of the post-conversion colonisation success of a range of taxa are summarised in the following sections.

Ground vegetation

Conifer monocultures, especially those with a dense canopy in the pole stages (canopy cover >65%), tend to support mainly mosses, lichens and vascular plant species such as ferns that tolerate acidic substrates and low light and nutrient conditions (Wallace, Good and Williams, 1992). Conversion, even if partial, to more open canopy tree species (e.g. Scots pine (*Pinus sylvestris*), many broadleaved species) has been shown to result in an evolution towards a ground vegetation community composed of species requiring higher levels of soil pH, nutrients and soil water, although these may not necessarily comprise typical native woodland flora (Gärtner and Reif, 2005). Many 'true' woodland vegetation species do not remain dormant in the seedbank for long and are also notable for their poor dispersal and colonisation abilities (Hermy *et al*., 1999). Thus, where native woodlands do not occur in close proximity and light levels have not been maintained for the duration of a non-native conifer crop on a site, the developing ground flora may comprise mostly ruderal and moorland species depending on adjacent and pre-afforestation land use (Spracklen *et al*., 2013). These species can retain a viable seedbank despite afforestation with conifer over 40 to 50 years (Walker *et al*., 2004) and can also colonise rapidly.

Vertebrates – birds, bats, red squirrels

Woodland birds are influenced primarily by woodland structure and the distribution of resources (e.g. food, shelter) within woodlands rather than tree species identity (Fuller, 1997). More abundant shrub and herb layers in response to an opening up of the canopy are likely to increase the nesting opportunities for woodland birds and reduce risks of predation (Peck, 1989; Sweeney *et al*., 2010). Equally, the introduction of a significant native broadleaved component will diversify the range and seasonal availability of specific resources; for example, birch leaf buds can be an important food source for black grouse (*Tetrao tetrix*) during the winter months (Nilsson, 1997).

Insectivorous bats that live and forage in forests also favour high levels of structural heterogeneity and have been shown to benefit from an increased availability of food resources and micro-habitats for foraging and roosting following the introduction of a native broadleaved component in managed stands (Jung *et al*., 2012). Gradual conversion can also potentially improve the continuity of roosting habitat where all trees are not systematically harvested at the end of a relatively short crop cycle.

Mature conifer plantations with a closed canopy and high tree density provide a comparative safe haven for red squirrels (*Sciurus vulgaris*) in Britain (Flaherty *et al*., 2012). Here, they are able to escape high levels of direct competition with the dominant grey squirrel (*Sciurus carolinensis*), which favours large-seeded broadleaves (Lurz, Garson and Rushton, 1995). Red squirrels are, therefore, unlikely to benefit from conversion to native tree species where grey squirrels are also present, unless conversion is to Scots pine or small-seeded broadleaves (Lurz, Garson and Ogilvie, 1998).

Soil fauna

Soil macro and microfauna have been observed to respond positively to the changes in soil chemistry and litter quality that ensue following conversion. Earthworms, nematodes and collembolans, for example, show significant increases in abundance, diversity and functional complexity in former conifer stands that have either been diversified (Salamon and Wolters, 2009; Chauvat *et al*., 2011) or converted to native broadleaved tree species (Heinze, Tomczyk and Nicke, 2001). Increases in the diversity and sizes of soil decomposer communities exert, in turn, a positive influence on soil quality, rates of nutrient cycling and the availability of nutrients (Heinze, Tomczyk and Nicke, 2001).

Impacts on landscape aesthetics

The uses of conifers in geometric forest designs and/or intensive management regimes are generally not favoured by the public from an aesthetic or recreational perspective. A survey conducted by Edwards *et al*. (2012) found a very strong appreciation by the British public for large, mature trees within a stand, but also variation in tree sizes and in tree spacing. In addition, the survey found a high negative response to fragmented wooded areas with 'unnatural' symmetrical edges, low levels of visual penetration into the interior, or stands that contained significant quantities of harvesting residue.

Incidence of pests and diseases

In mixed-species woodlands, a greater availability of feeding resources and micro-habitats for natural enemies of insect pests, such as parasitoid wasps, have been shown to reduce the prevalence of insect herbivore pests compared with monocultures (Jäkel and Roth, 2004; Jactel and Brockerhoff, 2007). Insect herbivores are also less effective at locating their preferred host tree when searching in mixed-species stands (Castagneyrol *et al*., 2013). A similar significant dilution effect has been found in mixed-species woodlands when considering the spread of plant pathogens such as *Phytophthora ramorum* (Haas *et al*., 2011).

When considering important vertebrate pests of British forests, such as the grey squirrel or deer, there are no clear benefits of conversion in reducing levels of bark stripping and browsing damage. Grey squirrel densities, and related levels of bark stripping, have been found to increase with the number of mature, seed-bearing broadleaved tree species present in a FMU (Kenward, Parish and Robertson, 1992). Densities of red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*) have also been observed to increase where canopies are opened up to create areas of regeneration and the development of shrub and herb layers (Latham, 2000).

Methods of conversion

Removal of planted non-native conifer woodland can be undertaken either in one clearfell operation or gradually through successive thinning cycles by adopting single or group selection silvicultural approaches. The subsequent recruitment of native tree species can be accomplished by natural regeneration, direct seeding or planting. The method of conversion which is adopted, and indeed the decision to proceed with conversion, depends on the native tree species chosen to replace or grow alongside the non-native conifer, the vulnerability of the site to windthrow, soil quality and local knowledge of levels of seed availability, granivory, browsing pressure and competition from other vegetation. In some cases, a shelterwood is required to protect saplings from frost (Mason, 2006). A phased removal of the non-native conifer crop is also often recommended to avoid disruption to wildlife (Blakesley and Buckley, 2010). Taking the time to choose the optimal location for conversion will greatly enhance conversion success and can be guided by vegetation species that are regenerating in the understorey (Hérualt, Honnay and Thoen, 2005).

Regeneration phase

Natural regeneration is often the preferred method of establishing native tree species (Buckley, Ito and McLachlan, 2002; Jonášová, Van Hees and Prach, 2006). It has the advantage of contributing to the preservation of local genotypes and maintaining high levels of genetic diversity, which together improve the adaptive capacity of new recruits to environmental change (Hubert and Cottrell, 2007). In addition, natural regeneration can be a low-cost option that is more likely to contribute towards higher levels of stand structural diversity and can yield much higher stocking densities than can be achieved by planting (Harmer and Morgan, 2009; Hubert, 2009). Natural regeneration relies, however, on sufficient local sources of seed and the effective dispersal, germination and establishment of this seed. Early successional native tree species such as birch and willow are typically the first colonisers and can dominate stands for many decades before later successional tree species may infiltrate the canopy (Kirby and May, 1989; Truscott *et al*., 2004; Spracklen *et al*., 2013). A long-term solution to a lack of local seed sources is the establishment of 'islands' of native tree species within the broader FMU matrix that can eventually serve as sources of native tree seed for natural regeneration (Corbin and Holl, 2012).

Where natural regeneration is not feasible, direct seeding can offer comparable advantages, particularly where seed is sourced to enhance the genetic diversity of resultant populations. A potential barrier to direct seeding, however, is the quantity of seed required, which may not be readily available or affordable for some tree species. Experience of direct seeding in lowland Britain, for example, proposes that more than 100 000 seeds per hectare may be required to compensate for potentially high levels of competition from ground vegetation and also predation of seed (Willoughby *et al*., 2004). While adjustments can be made to the sowing times of some tree species to coincide with periods of low activity of potential predators, adequate seedling protection and weed control measures are still likely to be required (Willoughby *et al*., 2004; Zerbe and Kreyer, 2007).

Regeneration by planting is a comparatively expensive option, but it has the appeal of greater reliability and speeding up the recruitment process (Blakesley and Buckley, 2010), particularly among later successional native tree species such as oak. Typically, 2–3-year-old bare-rooted saplings are planted and it is recommended that a complex stand structure is created to support wildlife; this can be achieved by planting multiple native tree species and using a patchy rather than regular distribution of planted saplings (Twedt and Wilson, 2002).

Sapling establishment phase

During the establishment phase, saplings will be highly vulnerable to browsing pressure in some parts of Britain, requiring protective measures to be put in place (Truscott *et al*., 2004; Trout and Pepper, 2006). Light conditions can be compromised where there is rapid canopy closure and/or significant competition with ground vegetation, including high-density regeneration of non-native conifer. Managing this regeneration and/or other competing ground vegetation to promote the establishment of target native tree species can be costly (Stokes and Kerr, 2013). Jonášová, Van Hees and Prach (2006) have demonstrated that gap size is key to the successful regeneration of native tree species and research underway in recent years is exploring the use of models to predict 'ideal' gap sizes and/or stocking density for the regeneration and growth of target tree species (Hale *et al*., 2009; Lintunen *et al*., 2013).

Costs of conversion

There are few publications that examine in detail the economics of production-scale monocultures compared with polycultures and an even greater paucity of published information on the costs of conversion of non-native conifer to native woodland (Nichols, Bristow and Vanclay, 2006). Some general inferences can be made from economic studies considering the restoration of PAWS (e.g. Pryor and Jackson, 2002), or the transformation of non-native conifer to continuous cover forestry (e.g. Davies and Kerr, 2015), where the cost of a continuation of the existing plantation crop (i.e. clearfell and replanting) is used as a measure against which other scenarios are compared. A comparatively low-cost option that repeatedly emerges is the creation of a uniform shelterwood by heavy thinning followed by natural regeneration or, at greater cost, followed by under-planting. Higher cost options include conversion to a mixed-age structure of more than two layers or premature felling of the non-native conifer crop followed by natural regeneration or planting (Pryor and Jackson, 2002; Davies and Kerr, 2015). Costs are thus proportional to the level of management intervention required and are also dependent on both the tree species used to replace the non-native conifer crop and the quality of the site, lending weight to the need for a targeted approach to site selection for conversion.

Conversion experience in Great Britain

Two different questionnaire surveys were employed to ascertain levels and types of conversion activity in Britain, as well as to gain a better understanding of attitudes of woodland managers to conversion. These were a short online questionnaire and a longer questionnaire formulated for a semi-structured telephone interview. The short online questionnaire comprised eight questions with multiple-choice answers. It was disseminated to woodland managers by email, newsletter or the web pages of the following organisations: Confor, Forest Policy Group, Institute of Chartered Foresters, a Scottish land agent, Royal Forestry Society, Royal Society for the Protection of Birds, Scottish Land & Estates, Scottish Woodlands (land agents) and Small Woodland Owners Group. For the longer questionnaire, woodland managers were sought from the public and private sectors in all areas of Great Britain. They comprised representatives from the Forestry Commission, managing agents, professional bodies and landowners. No constraint was put on the selection of participants according to the size of woodlands managed or woodland management objectives.

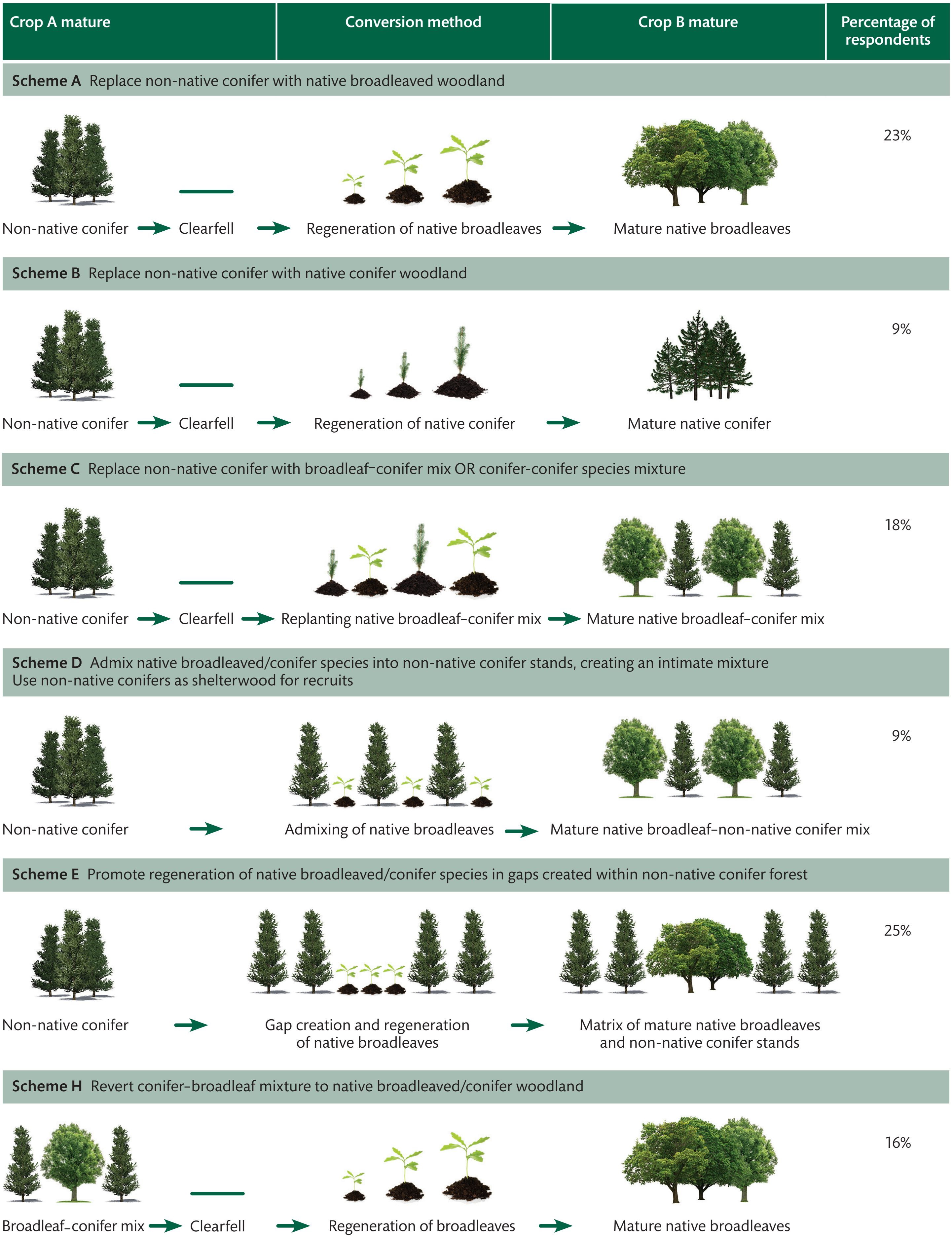
Levels and types of conversion activity

There were 36 respondents to the short online questionnaire. Respondents managed publicly or privately owned woodland in England, Scotland and/or Wales and were responsible for woodlands of various sizes, ranging from ≤10 ha to 80 000 ha. Of these respondents, 90% managed privately owned woodlands and 77% were engaged in, or committed in future to, converting the non-native conifer woodland that they manage. The expected conversion rate of the total woodland area was unrelated to woodland size, and for individual woods ranged from 5% to 100%; 42% of woodland managers committed to conversion planned on converting ≥50% of their non-native conifer woodlands.

Of the 36 respondents, 20 were able to detail the specific conversion method(s) practised, of which an equal proportion practised conversion either by clearfell or by single/group selection methods (Figure 1). In both cases, natural regeneration of broadleaves was the most common recruitment method employed. Planting was less common, particularly as an admixture to the non-native conifer crop.

A total of 15 woodland managers in England, Scotland and Wales participated in phone interviews; nine of these participants managed privately owned woodlands and six managed woodland on the public forest estate. All participants managed some area of planted non-native conifer woodland (excluding PAWS), ranging in area from 11% to 95% of the total woodland area (i.e. 430 ha to 46 000 ha). Expected conversion rates of non-native conifer woodland varied significantly; for example, two participants who managed small areas of woodland planned to convert 90–100% of the total woodland area (i.e. 500 ha and 1000 ha), while the other 13 interviewed respondents planned to convert between 0% and 15% of the

Figure 1 Conversion methods practised by respondents.



total woodland area. Decisions regarding which areas to convert were based on suitability of soil conditions, site access, distance to seed sources of native broadleaved species and the occurrence of damaging mammals such as deer and squirrels. In some cases, areas for conversion occurred in areas of a failed conifer crop due to pathogen infection, or windthrow. Interviewees said that conversion by clearfell followed by natural regeneration was the ideal recruitment strategy, but in practice clearfell followed by replanting with 100% native tree species was the most commonly used technique. Numerous native tree species were used for conversion; among these were oak, ash, Scots pine, juniper, birch and aspen.

Attitudes to conversion

Questionnaire respondents were asked to give reasons for or against forest conversion, and to rank their reasons in order of importance. The results show a broad spectrum of views, but that the reasons given for or against conversion were strongly influenced by the dominant forest management priority (e.g. timber production, recreation or biodiversity conservation) (Box 1).

Reasons cited for converting

Figure 2 shows the different reasons given by respondents of the short online questionnaire for converting planted non-native conifer forest to native species. Among those respondents of the short online questionnaire who had the intention to convert woodland, or who actively practised conversion, 28% had timber production and 71% had biodiversity conservation as a principal woodland management objective. Where timber production was a key woodland management objective, motivations cited for conversion

Box 1 Perspectives on the pros and cons of forest conversion where wildlife conservation or timber production are primary forest management goals

The following quotes were selected to illustrate the range of views from a comments box in the short online questionnaire and from transcripts of the telephone interviews.

Wildlife conservation as a primary goal
'I am prepared to take the necessary financial loss on conversion because my [woodland management] objectives are conservation based.' (Conservation charity, Scotland)

'Non-native regeneration can be very prolific and we must use our resources wisely. Money and time might be better spent planting new woodland than fighting natural regeneration of non-native species.' (Conservation charity, Scottish Highlands)

Timber production as a primary goal
'We have to be very careful about reducing productive capacity – also in light of carbon sequestration. With a priority on PAWS conversion it could be risky to start converting [non-PAWS] plantations too. Many broadleaved species are compromised by squirrels and deer – investing in it is doomed until they are under control. Broadleaves are desirable but risky.' (Private estate manager, lowland England)

'Conversion is likely to compromise timber production and the Forestry Commission need to be careful as so much of their income is dependent on it. With mixed objectives we have to look at sites individually – sometimes conversion is advisable sometimes not.' (Forestry Commission District Forester, England)

'We need to get away from prescriptive ways of management and allow proper site-specific silviculture back. We used to be able to do sensitive thinning programmes but contractors are now too big and machinery too large so contractors are calling the shots.' (Forestry Commission District Forester, Scotland)

'Scale is critical to develop the market in new species – contractors won't pay for new machinery unless the crop is large ... compromising productivity also compromises local economy and a whole chain of events.' (Forestry Commission Operations Manager, England)

'There is little or no point to practising ethnic cleansing of non-native minor conifer species like Douglas fir, European larch and western red cedar when these are the highest value crops growing in our mixed woodland today alongside 23 other different trees growing happily alongside each other. We have lost elm and are beginning to lose oak and ash so why deliberately take out high value and very useable conifer timber trees when there is not a native equivalent that will produce such good quality timber.' (Small woodland owner, England lowlands)

'I do not actively encourage conversion to native species. I believe that where practical we should be producing timber. The conversion to native species with such high deer pressure is a waste of time as regeneration will not occur once the deer fence falls down with limited additional capital provided by landowners for such operations. I agree with UKWAS, and all sites should be managed properly with appropriate corridors etc but the hard reality is we will have no timber to cut in this region in 10 years' time because of the amount of native planting and native conversion. Is this sustainable? I would argue in most cases it is not.' (Private managing agent, Scottish uplands)

Source: Henderson and Barsoum (2014)

Figure 2 Reasons given in support of conversion.

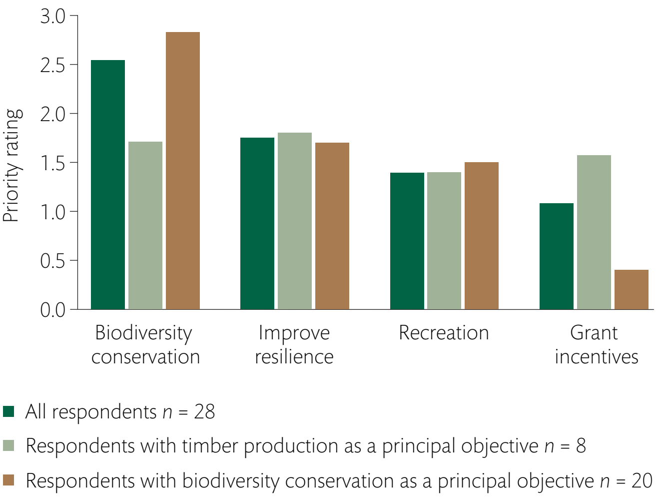
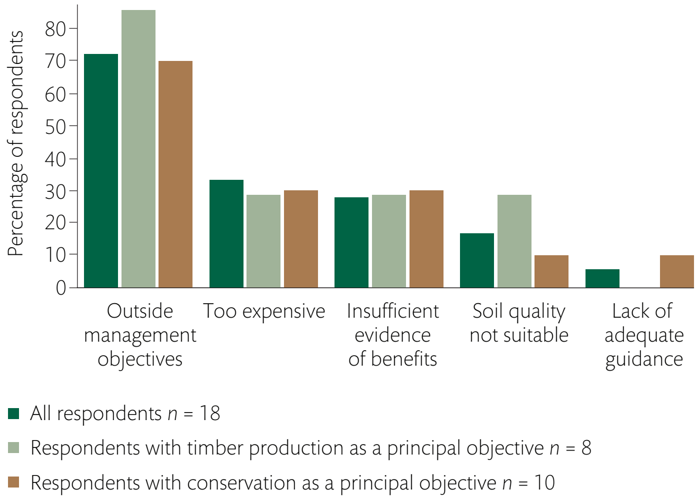


Figure 3 Reasons cited against conversion.



included grant incentives and a commitment to follow UKFS guidelines, an anticipated enhancement of recreational and biodiversity conservation features of the woodland, and the expectation of improved levels of woodland resilience. These reasons for converting were considered to be of equal relevance. Respondents with biodiversity conservation as a main woodland management driver gave the same reasons for conversion, although biodiversity conservation was cited as a major incentive and grant incentives as a minor motivation.

Participants in the telephone interviews described similar motivations for conversion, but were able to provide more detailed responses than online respondents. They specified resilience to disease and climate change as main motivating factors for their interest in forest conversion. Other reasons given were obligations under grant schemes and anticipated benefits in terms of gains for biodiversity conservation and landscape appearance.

Reasons cited against conversion

Reasons cited against conversion by respondents of the online questionnaire (Figure 3) and participants in telephone interviews included, in order of importance:

- not considered to be well aligned with woodland management objectives;
- high perceived costs involved, which includes the cost of protective measures associated with deer browsing;
- insufficient evidence of benefits;
- impoverished soils that are not considered to be suitable for native woodland species;
- a lack of adequate guidance;
- no native equivalent tree species that will produce good quality timber.

The majority (80%) of participants of the telephone interviews did not consider that conversion was likely to be an economically viable option. Reasons cited included the expectation that timber productivity would be compromised, but also that contractors and the market were not well set up currently to process timber from converted woodland where novel forest management and harvesting practices are required (e.g. selective felling in diversified stands). There was also scepticism about the sustainability of native tree species, including productive broadleaves, as an alternative source of timber compared with non-native conifers in light of the high incidence of disease among many native tree species at present, but also overgrazing of saplings by deer and bark stripping by squirrels in some regions. In such cases, diversification of non-native conifer stands by introducing >50% native tree species was favoured over complete conversion to native tree species. Another key reason given by participants for not supporting forest conversion in their woodland was a lack of well-suited sites. In many cases, soils were considered to be too impoverished, slopes too steep and/or windthrow a serious risk. Seed sources of native broadleaves were also considered to be too far away for viable natural regeneration, requiring direct seeding or planting, which were perceived to be overly expensive alternatives.

Conclusions

Planted non-native conifer woodlands were created on a large scale during the twentieth century with the primary objective of timber production. The UKFS (Forestry Commission, 2011) now promotes a diversification of their stand structure and composition, through partial or complete conversion to native woodland, in appropriate locations for a range of woodland ecosystem benefits. The level of effort and related costs required to convert non-native conifer stands vary according to local site conditions. A greater investment is required at some sites where there are issues relating to soil quality, windthrow, levels of herbivory and competition and/or the proximity of native woodland from which colonisation processes can occur. Where timber production is a priority, revenue will also be influenced by the tree species replacing the non-native conifer crop, particularly if it has slower growth. Our results suggest that some woodland managers with conservation as a primary woodland management objective are prepared to spend time and resources in converting their woodlands, but other woodland managers are reluctant to do so without a better understanding of the financial implications, more evidence of benefits accrued and guidance on prioritising sites for conversion. Woodland managers with timber production as a primary objective are concerned that conversion will result in a reduction in sustainable levels of production, especially considering recent biosecurity threats to many native tree species; they are also concerned that competition and herbivory can affect conversion success.

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Enquiries relating to this publication should be addressed to:

Nadia Barsoum
Forest Research
Alice Holt Lodge
Farnham
Surrey GU10 4LH
+44 (0)300 067 5600

nadia.barsoum@forestry.gsi.gov.uk
www.forestry.gov.uk/forestresearch

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