Forestry Commission

Managing England's woodlands in a climate emergency

A guide to help foresters and agents implement adaptation actions

Contents

We will keep this document iterative and will refresh our advice as and when new evidence becomes available.
Date of publishing: March 2020, version 2.

Introduction

The UK Forestry Standard (UKFS)[1] sets out the government's approach for sustainable forest management with regard to climate change. The UKFS provides the basis for the advice and guidance found within this guide, which looks specifically at woodlands and forests in England.

To be UKFS compliant, a woodland should have an approved creation or management plan.[2] The management plan should consider the risks that climate change represents to the management objectives of the woodland, and how those risks might be minimised.

England's woodlands have been managed during previous centuries under the assumption that the environment they are growing in will be relatively stable. This key assumption is no longer valid.[3]

Managing climate change risk is now a critical part of managing our woodlands, and we must make significant changes to widely accepted and practised forest management in England.

This century, there has been a large increase in the number of pests and diseases attacking our trees, and this is compounding the challenges of adapting to a changing climate.

The UKFS can be found at:

www.gov.uk/government/publications/the-uk-forestry-standard

(See chapter 6.2 for climate change)

Our forests and woodlands are dominated by relatively few tree species:

- Five conifer species account for 88% of the softwood forests.
- Five broadleaf species make up over 72% of the hardwood woodland resource.
- Many of these species are grown in monoculture.

Proactive management of our woodlands to mitigate climate change risks is critical to ensuring adaptation happens without loss of the ecosystem services they provide.

1 www.gov.uk/government/publications/the-uk-forestry-standard
2 www.gov.uk/guidance/create-a-woodland-management-plan
3 www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-derived-projections.pdf

Climate change and woodland: key points

England's woodlands and forests have **developed in a stable and predictable climate.**

For the past 8,500 years, the **English Channel** has acted as a **natural barrier** to species migration.

Winters are predicted to become **wetter, and summers drier,** with more **frequent and severe** periods of summer drought and intense rainfall events.

These changes are predicted to be **more severe** in the east and south.

With the current projections[4], global warming is projected to **increase by a further degree** within the next two decades. However, global temperatures could **rise to 4°C** above pre-industrial levels by the end of the century, and summer maximum temperatures could **rise by up to 10°C** in parts of England.

Because the earth's climate system responds slowly to past emissions, **we are locked into a level of climate change** over the coming decades, regardless of future emissions.

Global emissions are currently tracking close to **some of the more extreme projections** that have been published.

Without human action, it's probable that **the rate of change is greater than which our woodlands can adapt to.**

4 www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-derived-projections.pdf. To see future climate matching: http://193.185.149.20/t4f/cmt

Likely impacts of climate change on England's trees and woodlands

There is considerable uncertainty about how trees, woods and forests in England will respond to climate change, but **this must not be used as a reason not to act now** as our research and knowledge is informing us that the following impacts are likely.

- The current range of broadleaf species, assuming appropriate species and origin/provenance are used, will most likely remain suitable for forestry across much of England. Towards the end of the century, southern and eastern England are likely to be the exception.
- Existing conifer stands are likely to reach maturity before serious direct impact of climate change, although this does not account, for instance, for new pests and diseases.
- Where water is not a limiting factor, tree growth rates for most species are predicted to increase as a result of longer growing seasons, increased warmth and the rising level of CO_2.
- Tree pests and diseases, both those present in the UK and those that may be introduced, are likely to remain a greater threat to woodlands in the immediate future than the direct effects of climate change.
- The impacts of climate change are likely to be first seen with declining tree health in some species, increasingly difficult establishment, and limited mortality. However, as climate change progresses, some mature trees are very likely to die as a result of both direct and indirect impacts.
- Even where the composition of the tree canopy of woodlands remains unchanged, the composition, structure and character of the ground flora may change significantly. It is very likely that climate change will have serious impacts on drought sensitive tree species on shallow free-draining soils, particularly in southern and eastern England.
- Extreme rainfall is likely to cause flooding and the current forest road drainage network may be inadequate.
- A higher frequency of winter gales leading to increased levels of damage and wind blow.
- Wildfires are almost certain to become an increasing factor affecting the condition and longevity of some woods and forest areas.

Forest Research resource: www.forestresearch.gov.uk/research/climate-change-impacts/climate-change-impacts-and-adaptation-in-englands-woodlands/adapting-englands-woodland-to-climate-change-main-issues

Table 1: The table below summarises the main impacts of climate change and possible adaptation strategies for England's woodlands and forests. (Taken from www.forestresearch.gov.uk/documents/286/fcrn201_ezJuook.pdf)

Factor	Impact	Adaptation measure
Longer growing season	Earlier bud burst, later bud set, and more shoot growth in late summer.	Encourage natural regeneration and select planting stock with an origin up to 2° latitude south of site, and up to 5° south as a small component of mixed provenance stock in species of low frost sensitivity.
Warmer growing season – increased CO_2 concentration	Increased growth rates, improved yield.	Choose conifer and broadleaf species that will produce better quality timber grown in a warmer climate, but beware of frost sensitive species on frost prone sites.
Fewer frost days – milder winters	Reduced hardening, later dormancy, and increased risk of autumn frost damage to sensitive species with extended growing season.	Change to less frost sensitive species/ provenances; change to species requiring less cold to harden, and increase genetic diversity.
Reduced summer rainfall	More frequent and drier summers, reduced growth, increased drought stress, secondary pest/disease outbreaks resulting from drought stress, increased fire frequency.	Change/mix species to drought tolerant types on sensitive sites. More thinning to reduce moisture demand in open stands. Increase public awareness and vigilance. Contingency plan and regular training for fighting fire.
Increased winter rainfall	Increased waterlogging and anaerobiosis, increased wind damage, increased soil erosion and slope failure, increased Phytophthora infection.	Shorter rotation, switch to species tolerant of wet soil on sensitive sites, smaller coupes, self-thinning mixtures, forest operations controls.
Longer growing season	More generations of insect pests per year (increased voltinism).	Increase tree species diversity; enhanced monitoring and intervention where possible or appropriate.
Milder winters, warmer growing season – increased CO_2 concentration	Increased productivity; increase in woodland mammal populations, insect pests and tree diseases and colonisation by alien invasive species.	Increase deer and squirrel management effort; enhanced pest and disease monitoring and intervention where appropriate. Increase tree species diversity.
Increased wind	Increased wind damage and resultant bark beetle outbreaks and increased bluestain fungus infection.	Reduce risk through shorter rotations, species diversification and early thinning, and self-thinning mixtures.

Principles for adapting England's woodlands

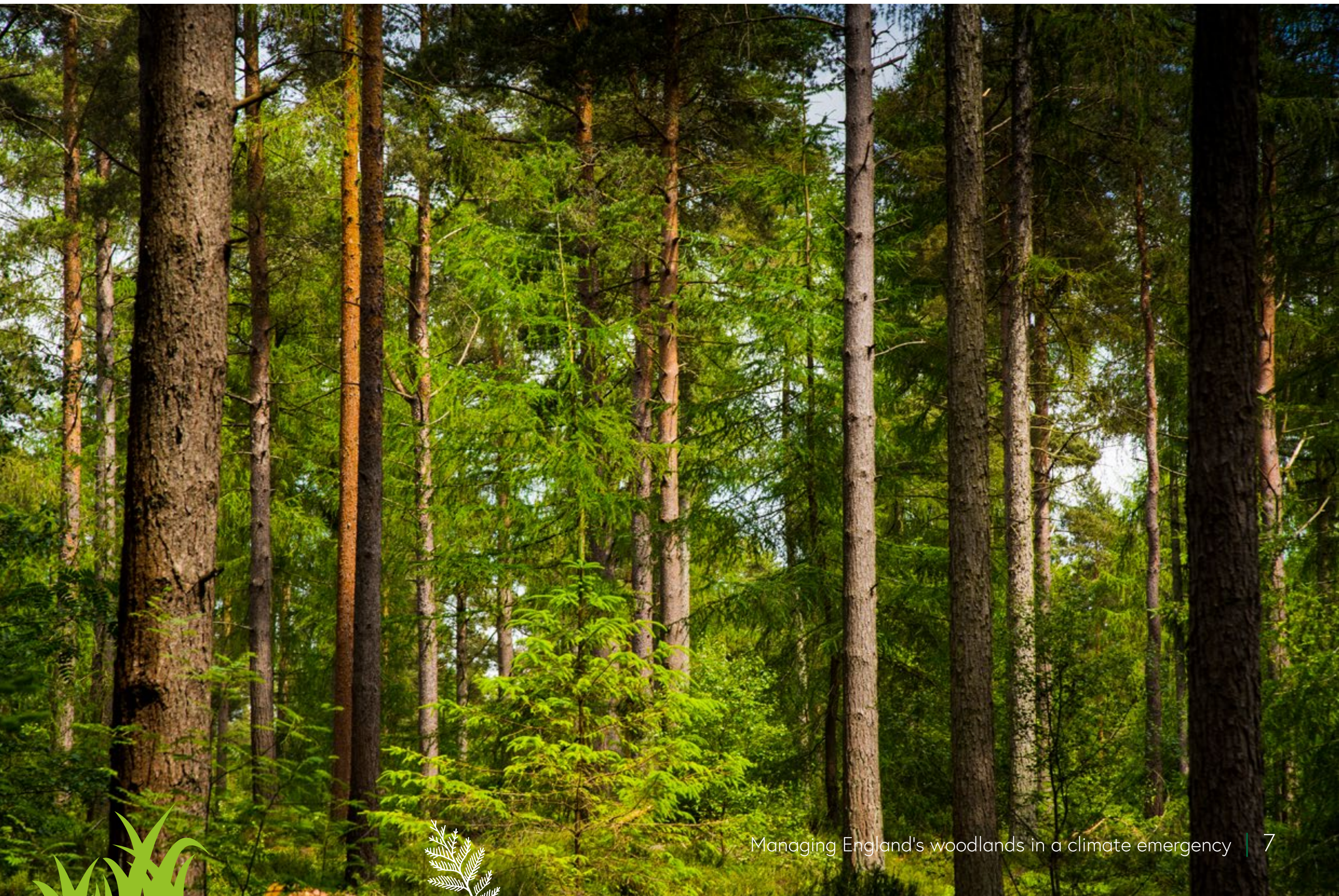
Since tree crops take many years to mature, we need to plan and plant appropriately for both the current, and future climates.

We recommend that foresters should:

- Ensure their woodlands have a comprehensive management plan[5] that includes contingency plans.[6]
- Make changes before the impact is observed, as this offers the highest potential gains for forest resilience.
- Accept that this approach also contains an element of risk. Take actions today which accommodate the more extreme climate projections up to the end of the century.
- Recognise the diversity of woodland types in England and that appropriate actions will vary with woodland type and management objective.
- Work with nature and natural processes to enable successive generations of trees and shrubs to adapt to climate change.

5 www.gov.uk/guidance/create-a-woodland-management-plan

6 www.climatexchange.org.uk/media/3050/the-role-of-contingency-planning-in-climate-change-adaptation-for-the-forestry-sector-in-scotland.pdf



Managing adaptation of England's woodlands

The makeup of England's woodlands is the result of human activity over centuries. This has resulted in many types of woodland having a limited species diversity and limited age structure. Changes in the needs of society have resulted in many woodlands becoming neglected and not in active woodland management. Simultaneously the abundance of grazing and browsing fauna has increased which has had negative impacts on the regeneration opportunities for trees and diversity and abundance of ground flora. For our woodlands to be able to thrive and adapt to climate change it is important that we consider the threats our woodlands face and manage them to increase their resilience.

- Where considered appropriate continuous cover forestry[7], low impact silvicultural systems, coppice and coppice with standards should be practised more extensively as systems for managing existing woodlands.
- Opportunities should be taken to diversify the species mix within woodlands. This may include planting native species outside their natural range in the north and west. Naturalised tree species should be considered to increase species diversity where appropriate.
- Underplanting of shade tolerant species will help increase species diversity.
- Where site conditions permit, new plantations should have a greater tree species diversity, and existing plantations should be diversified. Where necessary, some loss of yield should be accepted to achieve enhanced resilience; species trials have shown us that we can grow a much wider range of species with good timber properties.
- Forests and/or individual stands should have a greater diversity of origin within each species.
- Evidence is clear that the planting of more southerly provenances of native species, from origins up to two degrees south of the planting site, is likely to enhance growth rates and timber production; they will also have evolved in a hotter drier climate so should, theoretically, be better adapted to a changing climate at the planting site – although the effectiveness as an adaptation measure will only become apparent as climate change progresses.
- More southerly seed origins flush earlier and the risk of damage from late frosts is therefore higher, particularly for large latitudinal 'migration' and in frost pockets; earlier flushing of southerly provenances may also have an impact on local ecology, which may be a consideration in some woodlands.

7 www.forestresearch.gov.uk/research/continuous-cover-silviculture

- Planting material should be sourced from improved stands, where available and appropriate.
- When sourcing planting stock, it is important to find out as much as you can about its origin and only source from reputable suppliers that you trust to help to avoid introducing pests and diseases and, preferably, has been grown in the UK.
- Some forests will be more productive, requiring management over shorter rotations to maintain stability. Forest design and operational plans should include contingency planning for intense weather events such as storms, floods, and the probability of hotter drier events that could result in wildfires.
- Opportunities should be taken to diversify species and stand structure after storm events or high mortality following pest/disease outbreaks.
- Consideration should be given to late autumn/early winter planting to reduce the impacts of spring droughts.
- The potential for improved productivity from oak and beech in the north should be explored as it may offer opportunities for the greater use of broadleaves as a timber tree.
- The design of Forest infrastructure including culverts, paths and roads should accommodate projections of changing rainfall patterns to maintain forest management and recreational activity.
- The character of the English landscape should be retained and enhanced through a proactive, anticipatory approach to adaptation that will provide the best opportunity to establish healthy woodlands.
- Appropriate biosecurity should be as embedded in practice as health and safety is today.[8]
- Ongoing monitoring of the woodland is an essential component of any woodland management plan. It is critical an 'adaptive management' approach is taken so that both successful management choices and impacts requiring further action are identified at as early a stage as possible.
- Forests and woodlands will also be seen as a refuge for wildlife under pressure from climatic extremes in the future; woodland management should also, therefore, support wildlife.

8 www.gov.uk/guidance/prevent-the-introduction-and-spread-of-tree-pests-and-diseases

Managing adaptation: native and ancient woodland

The 'Keepers of Time' policy statement[9] (2005) and supporting practice guide 'Managing Ancient and Native Woodland in England'[10] highlight good practice for conservation of native and ancient woodland. The following guidelines for managing adaptation in these woods follow the principles established in these documents.

Guidelines for woodland in England:

- Woods that are either ancient, native, or have retained key features of ancient woodland, should be managed to conserve important biodiversity and heritage features.
- Special consideration should be given to the management of ash trees[11] due to the spread of *Hymenoschyphus fraxineus* and the interest in identifying tolerant or resistant trees. For SSSIs there is specific guidance that should be followed.[12]
- Broadleaved woodlands should be managed to maximise the crop's value by balancing quality and timber yield, recognising the importance of keeping the native character of our ancient woodland, and taking into account other environmental and social benefits. Broadleaved woodlands are also a wildlife habitat.
- The projected rate of climate change we are facing is unprecedented; there is a risk that natural selection processes may not be able to keep pace with environmental change. Consequently, management interventions may need to be more frequent to enable more natural regeneration, or to make use of assisted migration where this is shown to be effective and meets the management objectives[13] for the woodland.

9 www.gov.uk/government/publications/keepers-of-time-a-statement-of-policy-for-englands-ancient-and-native-woodland

10 www.gov.uk/government/publications/managing-ancient-and-native-woodland-in-england

11 www.gov.uk/government/publications/managing-ash-in-woodlands-in-light-of-ash-dieback-operations-note-46

12 www.gov.uk/government/publications/managing-woodland-sssis-with-ash-dieback-hymenoscyphus-fraxineus

13 www.gov.uk/government/publications/provenance-choice-of-native-trees-under-climate-change-in-england-policy-advice-note

Table 2: The table below shows the possible impacts of different combinations of climatic drivers on the types of ancient and native woodland found in England. (Taken from www.forestresearch.gov.uk/documents/286/fcrn201_ezJuook.pdf)

Likely change	Lowland mixed broadleaved woodland	Lowland beech and yew woodlands	Upland oakwoods	Upland mixed ashwoods	Wet woodlands
Woodland community expansion/ range shift	Range possibly restricted on more drought prone soils with conversion to semi-arid scrub communities. **Drier summers.**	Spread to north and west. **Milder winters, springs and summers.** Habitat restricted to deeper soils and north-facing slopes. **Drier summers.**	Range restricted to wetter regions and replaced by communities more typical of lowland broadleaved and mixed woodland. **Warmer and drier summers.**	Colonisation of wet woodland sites along river tributaries that arise in lowland areas. **Drier summers.**	Colonisation of open ground habitat in lower reaches of catchments fed by upland headwater tributaries. **Wetter winters.**
Composition of woodland vegetation	Increased colonisation by beech (*Fagus sylvatica*) and increased growth rates of sycamore (*Acer pseudoplatanus*) over ash (Fraxinus excelsior), oak (*Quercus robur*) and elm (*Ulmus glabra*). **Milder winters, springs and summers.** Increased growth and fruiting of lime (*Tilia cordata*), hornbeam (*Carpinus betulus*) and other warm-temperate species. **Warmer summers.** Localised dominance by young ash (*Fraxinus excelsior*) in areas damaged by wind and drought. **Increased frequency of winter gales and summer drought.** Localised change in ground flora and under-storey composition. **Increased frequency of fire.**	Replacement by pedunculate oak (*Quercus robur*) on heavier soils as older beech trees (*Fagus sylvatica*) die due to increased levels of fungal disease, root die-back and windblow. **Drier summers and wetter winters.** Localised change in ground flora and understorey composition. **Increased frequency of fire.**	Beech (*Fagus sylvatica*) encroachment where climate is warmer and wetter. **Milder winters, springs and summers.** Rowan and birch increase in dominance in areas affected by windblow. **Increased frequency of winter gales.** Change in composition of epiphytic lichen and bryophyte communities. **Warmer and drier summers.** Localised change in ground flora and understorey composition. **Increased frequency of fire.**	Rowan (*Sorbus aucuparia*), downy birch (*Betula pubescens*) and silver birch (*Betula pendula*) increase in dominance in areas affected by windblow. **Increased frequency of winter gales.** Change in composition of epiphytic lichen and bryophyte communities. **Warmer and drier summers.**	Reduction in alder (*Alnus glutinosa*) dominance due to *Phytophthora spp.* **Milder and wetter winters.**
Change in woodland age and/ or growth structure	Woodland reduced to scrub in extreme cases; in milder cases, mortality of older trees and levels of deadwood increase. **Warmer and drier summers plus increased frequency of winter gales.** Localised loss of seedling regeneration and established saplings. **Drier summers and an increased frequency of fire.**	Woodlands with scrubbier growth as older beech trees (*Fagus sylvatica*) die due to increased levels of fungal disease, root dieback and windblow. **Drier summers and wetter winters.**	Localised loss of seedling regeneration and established saplings. **Drier summers and an increased frequency of fire.**	Even aged, young stands of ash (*Fraxinus excelsior*) in areas affected by windblow. **Increased frequency of winter gales.**	Mortality of older trees and development of scrubby stands due to increased damaging floods. **Increased winter rainfall.** Localised change in ground flora and understorey composition. **Increased winter rainfall.**

Reducing risk through diversification

Diversity is at the core of woodland adaptation and ensuring resilience in the future. This should be achieved through diversification of:

1. Species

Encourage a greater range of tree and shrub species, from a wider range of origins. Advice and information on what species to consider can be found using the resources below, although local site knowledge will be paramount.

- Forest Research's Tree Species Advice.[14]
- The Ecological Site Classification Decision Support System[15] (ESC-DSS); an online tool to help forest managers and planners select species ecologically suited to a site.
- Visit local arboreta, forest and botanical gardens. They are particularly useful if planting in urban environments.
- The SilviFuture website provides a catalogue of existing sites where the performance of lesser planted species can be evaluated.[16]

The diversity of species (or origins of native species) that would be appropriate to establish or restock resilient woodlands may not be available from nurseries today. It is therefore recommended to plan ahead and advise nurseries of your requirements at least two years in advance.

2. Genetics within species

The Forestry Commission, Natural England and the Woodland Trust have recently published a joint policy advice note titled 'Provenance choice of native trees under climate change in England'.[17]

Other advice from the Forestry Commission on choosing origins for planting stock is taken from Forest Research Information note 086, 'The Role of Forest Genetic Resources in Helping British Forests Respond to Climate Change',[18] FCRN 'Climate Change Impacts and Adaptation in England's Woodlands',[19] and the Forestry Commission's practice guide 'Managing Ancient and Native Woodland in England'.[20]

A "portfolio approach" (for example, using natural regeneration, local planting stock, and planting stock from appropriate, more southerly origins) using species matched to site characteristics and managers' objectives could help to spread the risks associated with making any one provenance choice and increase the likelihood that some trees will thrive.

14 www.forestresearch.gov.uk/tools-and-resources/tree-species-and-provenance
15 www.forestresearch.gov.uk/tools-and-resources/ecological-site-classification-decision-support-system-esc-dss
16 www.silvifuture.org.uk
17 www.gov.uk/government/publications/provenance-choice-of-native-trees-under-climate-change-in-england-policy-advice-note
18 www.forestresearch.gov.uk/research/archive-the-role-of-forest-genetic-resources-in-helping-british-forests-respond-to-climate-change
19 www.forestresearch.gov.uk/research/climate-change-impacts-and-adaptation-in-englands-woodlands-2
20 www.gov.uk/government/publications/managing-ancient-and-native-woodland-in-england

- On sites of high biodiversity interest, for example ancient woodlands or SSSIs, we do not know whether there are unintended negative consequences of using assisted migration; limiting the amount of any non-local provenance planting stock to only a small proportion addresses this risk.
- Seed must not be collected from a small number of seed trees as this can give a narrow genetic base.
- Seed from the same region should make up a third of the planting stock, and if timber is an objective then a significant portion of the restocking should be with improved planting stock from qualified or tested stands.
- At least one seed source from a warmer region should be considered, typically from 2 to 5 degrees south of the planting site. Eastern European sources should generally be avoided as they have often proven unsuitable in England.
- Where timber production is high in the woodland management objectives, or the planting is not adjacent to a site recognised for its local genetic integrity, then it is recommended that, depending on the owners view[21] towards accepting risk, that an assisted migration approach is followed, based on:
    - Provenances from 2 degrees south of the planting site, as these generally outperform the local provenance and this is considered a safe distance over which to transfer material.
    - Provenances from up to 5 degrees south that match to current climate change projections to 2050.

3. Stand structure and age structure

Stand structure is dependent on the nature of the woodland, site location and previous management interventions. Diversification of stand structure is often cited as a way to spread the risk to the woodland associated with a range of potentially damaging impacts. How this is achieved is dependent on management objectives for the site.

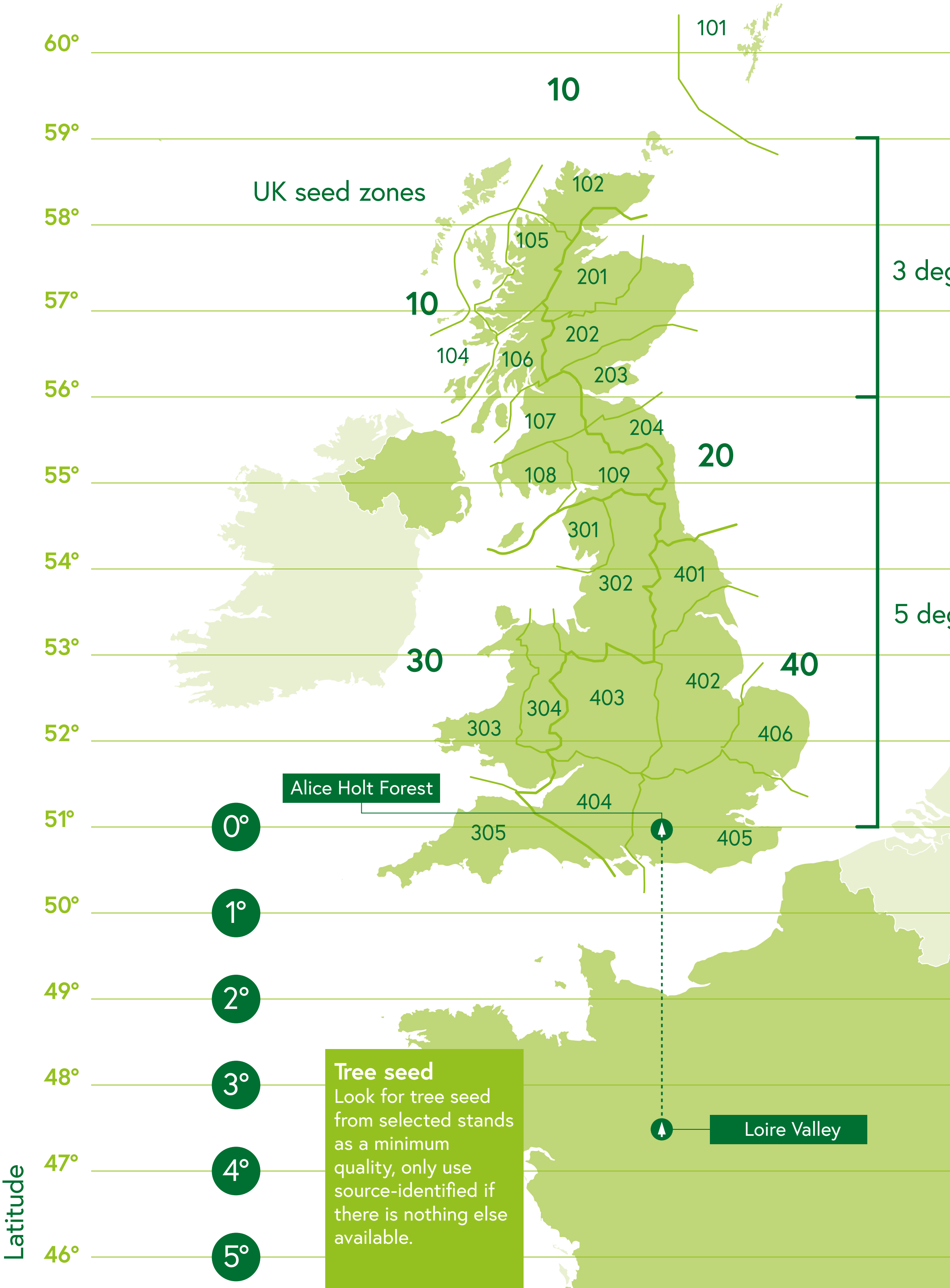
Significant reforestation in the inter-war period and after the Second World War resulted in large areas of single age forests with limited species diversity. Forest design planning and the effects of gales have subsequently resulted in diversification of age structure. However large areas of single age conifer plantations continue to be managed as clear fell systems.

Increasingly, forest managers are recognising the potential benefits of continuous cover forestry and close to nature systems, which are considered as providing:

- Increased resistance to the impacts of storms.
- Natural regeneration and improved microclimate for young trees.
- Reduced vulnerability to pests and diseases.
- Visually attractive woodland.
- Promotion of evolutionary adaptation.
- Reduced risk to establishment from dry soil conditions in spring through natural regeneration avoiding the need to plant.

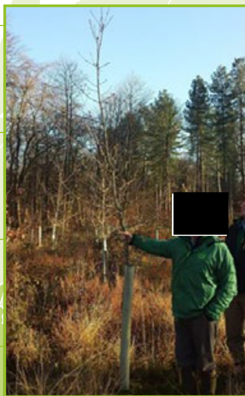
21 www.gov.uk/government/uploads/system/uploads/attachment_data/file/809733/Policy_Advice_Note_Final180619.pdf

Assisted migration of native trees



What to grow
Supplement local provenance with origins from 2 to 5 degrees latitude south, that are from a similar altitude and distance from the Atlantic Ocean.

Tree seed
Look for tree seed from selected stands as a minimum quality, only use source-identified if there is nothing else available.



Loire provenance 5-year-old oak growing in Alice Holt Forest

More information

The Forestry Commission has a key role to play in managing our woodlands for the future and, as one of many signatories of the Climate Change Accord, we know that we must take urgent action. We will continue to work closely with our Climate Change Action Plan partners and all parts of the tree, woods and forestry sector to protect our woodlands for future generations.

You can download the Climate Change Accord at: **www.sylva.org.uk/forestryhorizons/downloads/Climate_Change_Accord_2015.pdf**

You can download the Forestry Climate Change Action Plan Progress Report (prepared by the Forestry Climate Change Working Group) at: **https://www.rfs.org.uk/media/605364/fccwg-climate-change-adaptation-progress-report.pdf**

There are a range of grant and incentive schemes available for woodland creation, maintenance, management and tree health. Visit the Forestry Commission homepage at www.gov.uk/government/organisations/forestry-commission to find out more.

Alternatively, you can speak to your local Forestry Commission Woodland Officer.

Find us on social

@ForestryComm /ForestryCommission LinkedIn

Published by Forestry Commission