Use and transfer of forest reproductive material in England in the context of climate change

This paper is based largely on a report produced by the European Forest Genetic Programme (EUFORGEN), which is synthesised here with permission. With the addition of specific geographic and policy information the paper has been made relevant to the forestry sector in England, and is intended to provide practical information for foresters.


Download the full report: www.euforgen.org/publications
Background

A working group of EUFORGEN considered the use and transfer of forest reproductive materials or FRM in the context of the challenges of climate change. They examined scientific research on provenance and adaptation, including several case studies of transfer, the existing regulatory framework and recent policy developments, guidelines on FRM transfer and their scientific basis, and future challenges and opportunities.

Forest owners, managers and policy-makers may remain unaware of the potential that the use of forest genetic resources offers for facilitating the adaptation of forests to climate change. It is hoped that this paper will prompt discussion and a demand for more information among England’s forestry practitioners.

Forest Reproductive Material

Forest regeneration, whether natural or artificial, relies on forest genetic resources: i.e. genetic material of forest trees that is of actual or potential use for humans. Natural regeneration relies on genetic material that is already available on a particular site, while artificial regeneration, carried out through seeding or planting, typically involves transferring forest reproductive material (i.e. the parts of a tree that can be used for reproduction) from other locations to the site.

The selection of suitable FRM has assumed a new importance because trees are long-lived species and therefore rapid climate change will have an impact on the environmental conditions of the trees as they grow and mature. The long-standing importance of FRM to forestry and the cross-border trade in FRM have resulted in several European countries exercising some control over sources of FRM and their selection. Climate change is one reason why countries need to re-evaluate and modify their policy framework and guidelines on the use of FRM. An important additional practical challenge is the unprecedented degree that forest managers must now consider the climate that a new generation of trees might experience in future, in order to select material that will thrive now, under the present climate, and be able to withstand predicted climate. Furthermore, many forest owners think of FRM as a cost to be minimised rather than as an investment for which they should be seeking better returns.

As forest managers and owners seek to minimise the costs of establishing new forests, mistakes can be made in matching the material purchased with ecological site conditions, and in ensuring high genetic and physiological quality of the material. This phenomenon is nothing new as FRM has been traded for centuries. However, climate change is likely to increase the future demand for imported FRM as forest managers and owners seek to identify tree species and provenances that will be able to grow and thrive under new climatic conditions.

Climate Change

Mitigation of, and adaptation to, climate change through a proper choice of FRM requires that there is genetic variation in resistance or tolerance to damaging factors related to climate change. The recent Intergovernmental Panel on Climate Change report concludes that it is very likely that temperature will continue to increase throughout the 21st Century. The general consequences are likely to be:

- altered environmental conditions that England’s forest trees are currently adapted to, and may even create novel climatic conditions.
- some parts of the current distribution ranges of forest trees are expected to become unsuitable while new areas are likely become suitable for many species in higher latitudes or altitudes.
- accelerating speed of climate change has raised serious concerns on how tree species can cope with the projected changes.
- warming climate will probably facilitate the spread of pests and diseases, creating an additional threat to forest trees and their populations.
Practical recommendations concerning FRM

FRM transfer is a valuable option for adapting forests to climate change. Local is not always best. Use provenances instead of species in assisted migration schemes. Transfer of FRM also has its limits. Tree breeding offers opportunities for forestry under climate change. Forestry practitioners should ask for, and keep, a record of FRM. Dissemination of information on the value of FRM needs to be improved.

FRM transfer is a valuable option for adapting forests to climate change

Forest tree populations have adapted over a long period—and are still adapting—to their respective habitats and, because of this adaptation, have formed provenances.

Climate change is expected to alter forest habitat conditions in Europe at such a pace that the natural processes (selection, gene flow, migration) that drive evolution and adaptation will not act fast enough.

Therefore, human intervention in the form of FRM transfer (assisted migration) is a valuable option to adapt forests to climate change, especially in those areas that are most severely threatened by climate change.

Local is not always best

Indigenous local tree populations originate from complex selection processes acting on a restricted regional gene pool.

Being long-lived species our trees’ populations have been experienced natural selection, possibly over multiple generations, on a given site. However, the original population on which natural selection acted consisted only of those seedlings present at the start of selection. They may not have the genetic diversity or phenotypic plasticity to guarantee good performance under changed conditions.

For various biotic and abiotic reasons, local populations do not always demonstrate optimum fitness (for important forestry traits) compared with other FRM in common-garden experiments.

A different population from further away, which may have experienced selection under conditions more like those forecast for the site to be reforested, might represent a more suitable seed source.

In England, as for most of Europe, locally found populations often originate from historical FRM transfer but for which passport data are lost.

Local FRM will not always be the answer to climate change challenges. As local environmental conditions change, forest managers should extend their options to both local and non-local FRM.

Use provenances instead of species in assisted migration schemes

Science has repeatedly shown that adaptive genetic diversity within forest tree species is often very large and yet it seems that, under the pressure of climate change, forest managers often consider changing species than provenances when designing reforestation efforts.

Forestry practitioners need to understand better the adaptive potential that is readily available from different FRM within tree species.

Transfer of FRM also has its limits

With increasing temperature and periods of drought there is an increasing demand from forestry for provenances sourced from warmer southern regions.

As long as extreme events such as late frosts occur, these provenances can be recommended only in exceptional cases, and the transfer of the material used should be well documented.

Short rather than long-distance transfers will often be more ecologically relevant and should be preferred. The conservation of local genetic resources should be taken...
Use and transfer of forest reproductive material in England in the context of climate change

Forest managers should protect threatened FRM—mostly peripheral populations from rear edges of geographical distributions—that could be of use in other, more suitable, locations.

Tree breeding offers opportunities for forestry under climate change

Breeding programmes have typically focused on improving yield, wood quality, and resistance to pests and diseases. Resistance or tolerance to drought or increased water stress periods are becoming a priority for new generations of breeding programmes, and so does keeping large breeding populations.

Such FRM can be tailored to managers' needs, from very specific to large portfolio uses. Long-distance transfers will often be less ecologically relevant and should be less preferred.

The conservation of local genetic resources should be taken into account when assisted migration is being considered.

Provenance experiments provide a wealth of resources for evolutionary ecology and climate change studies, and they are the most reliable basis for formulating practical recommendations for FRM.

Existing networks of provenance experiments need to be upgraded to include under-represented (e.g., Peripheral) populations and sites, and need to be regularly monitored and measured.

Forestry practitioners should ask for, and keep, a record of FRM

The best-adapted FRM of today may not prove the best-adapted FRM of tomorrow under climate change. By keeping track of successes and failures in management decisions, forest managers will be able to adjust their strategies.

Data on FRM geographic origin, harvesting conditions, genetic diversity and production methods are likely to be key information sources for future afforestation efforts. Forest managers should be particularly keen to ask for and to keep a record of FRM.

Dissemination of information on the value of FRM needs to be improved

The scientific community has extensive knowledge and information on the potential that the use of FRM offers for facilitating the adaptation of forests to climate change.

Education and training for increasing awareness of stakeholders, such as forest owners, forest and forest habitat managers, and policy-makers, needs to be continued and intensified.

Ways to increase capacity building for using science-based knowledge and to foster an efficient and mutually rewarding science-management-policy dialogue, must be fully explored, more than ever before.

Reference:
Use and transfer of forest reproductive material in England in the context of climate change

Current guidance on the use of FRM in England

The EURFORGEN report summarised above highlights that the use and control of FRM varies among EU member states. Approaches mostly rely on the concept of provenance regions, which will be areas selected to provide reproductive material that can be transferred with little risk of being poorly adapted to their new location, usually supported by evidence from field trials. In general, climatic parameters are not given any preferential consideration.

Since the commissioning of the EURFORGEN report, significant progress has been made concerning policy advice for FRM in England, and this is summarised on this page. Further details and links are provided on page 5. Forestry Commission England provides advice on FRM and climate change within its comprehensive web resources. Forest Research provides a clear summary of relevant evidence, and offers decision support tools such as the Ecological Site Classification.

Minimise risks
A portfolio approach is recommended so that risks are minimised. For example: ⅓ local origin native species; ⅓ exotic origin native species; ⅓ non-native species.

Ensure diversity in seed
Seed from the same region of provenance should make up no more than ⅓ of the planting stock.

Use improved planting stock
Where timber production is an objective then a significant portion of the restocking should be with improved planting stock from ‘qualified’ or ‘tested’ stands under FRM regulations. If improved material is not available then stock should come from registered seed stands.

Use a range of provenances
Where biodiversity is the prime objective, a mix of provenances should be included alongside the current population.

Local material for conservation
For Sites of Special Scientific Interest (SSSIs) current advice from FC England and Natural England is to use planting stock from within the site or nearby. The aim is to protect native biodiversity, where SSSIs will act as a natural touchstone for environmental change. Similar advice applies to gene conservation units: see Further Reading.

Regeneration may need some intervention
Natural regeneration is encouraged; however, where there is a low chance of successful regeneration, then planting will be required. Note however, that evidence suggests local is not always best (see page 2).

Avoid narrow choice seed collection
Seed must not be collected from a small number of seed trees as this can result in a narrow genetic base, with insufficient diversity to adapt to future conditions.

Choose material from warmer climates
Exotic origin material (native or non-native) should be included from slightly warmer climates sources from 2-5° latitude further south than the site to be planted. These should be from areas under maritime and not continental climatic conditions. Eastern European sources should generally be avoided, as they are proven unsuitable for England.

Choose well-adapted exotic material
Evidence shows that provenances from 2° latitude south of the growing site generally outperform the local provenances. This is considered a safe distance over which to transfer material as it is likely to be relatively well-matched to current conditions, while having more capacity to adapt to ‘future climate’.

Accept risks from ‘future climate’ material
Provenances from up to 5° latitude south have been matched to climate change predictions for 2050 but do carry risks, for example from frost damage, as they are more adapted for ‘future climate’ than current climate. See map on page 5.

Similar challenges face our urban trees
In the urban environment, the challenges facing trees may be more severe than in a forest environment. However, there is a wider range of species to choose from than there are in forestry.

Plan ahead with your nursery
Many of the tree species and provenances may not be available from nurseries today. Think ahead and advise nurseries of your future requirements at least two years in advance.

Make informed decisions
Use the various decision support tools to understand better the future conditions projected for your location, and to understand the options available for planting materials. See Resources.
Further Reading


Climate Change Accord, signed in 2015 by more than 35 organisations, states: "We believe that it is necessary to act now to provide a secure future for our forests, woods and trees, that significant changes are required to widely-accepted and practiced systems of management to make them resilient, and we are committed to help realise the vision set out in this Accord."

Combating Climate Change – A Role for UK Forests The first National Assessment of Forestry and Climate Change. Report provides peer-reviewed information at the national level following on from the recommendations from the global evaluation provided by the Intergovernmental Panel on Climate Change (IPCC). The report is published by TSO (The Station Office).

Climate Change and British Woodland By M. Broadmeadow and D. Ray. Forestry Commission Information Note 69.

Climate change: Impact on UK Forests Describes current thinking on the most likely effects of climate change on UK forests and woodlands. Forestry Commission Bulletin 125.


Resources

Ecological Site Classification Decision Support System - a PC-based system to help guide forest managers and planners to select ecologically suited species to sites, instead of selecting a species and trying to modify the site to suit. www.forestry.gov.uk/fr/infd-5v8jd8

Right Trees for a Changing Climate – a database providing information of over 300 species to help identify suitable species for the future. Especially useful for urban forestry. www.right-trees.org.uk

SilviFuture - a network established to promote and share knowledge about novel forest species across Britain. www.silvifuture.org.uk

Managing woodland and climate change – main web page from FC England providing information and guidance: www.forestry.gov.uk/climatechangeengland

Glossary

FRM forest reproductive material, meaning parts of a tree that can be used for reproduction (e.g. seeds, cuttings).

Origin the geographic locality within the natural range of a species where the parent FRM or its wild ancestors grew.

Provenance the geographic locality of a stand of trees from where FRM was collected.