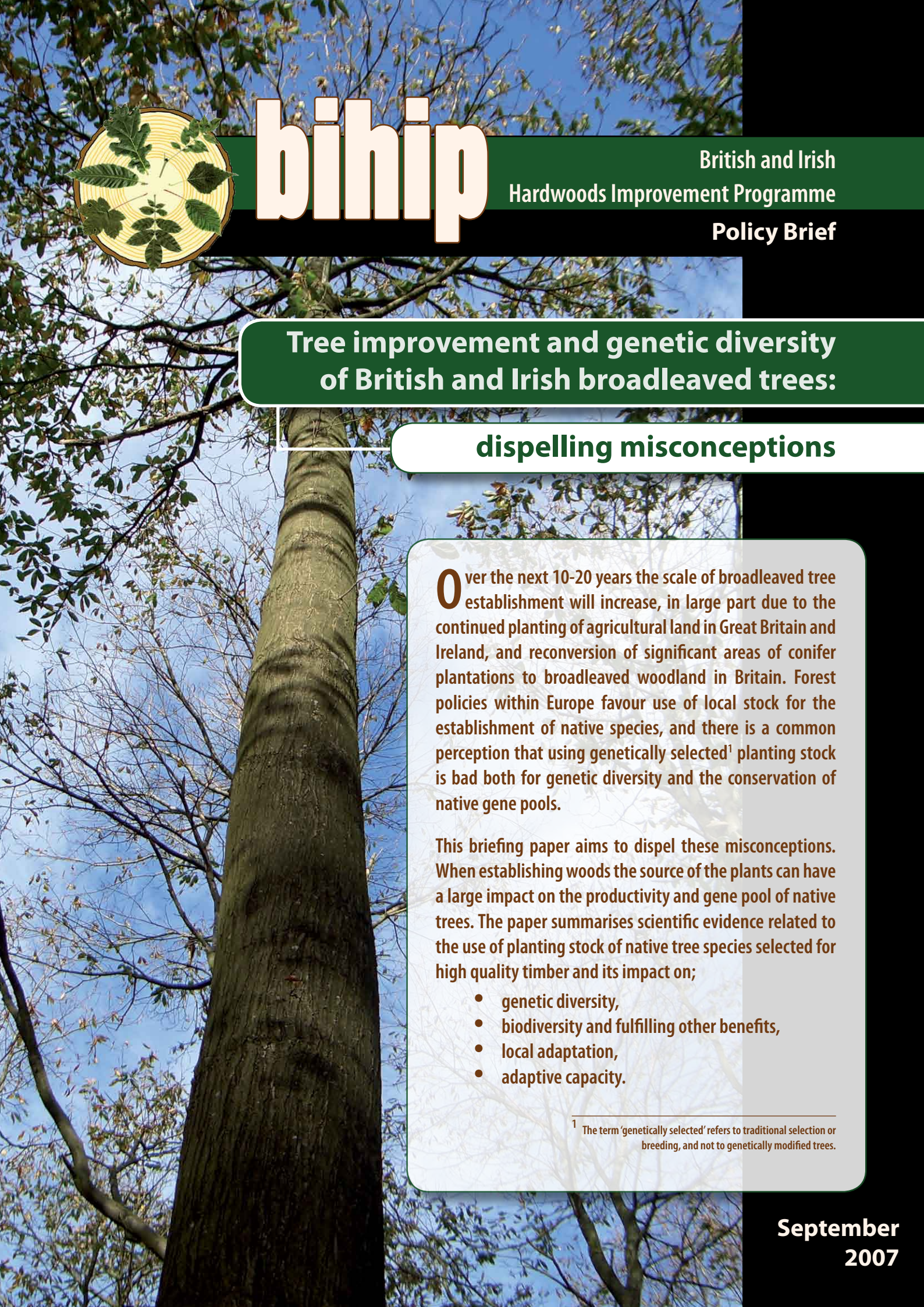

bihip

British and Irish
Hardwoods Improvement Programme

Policy Brief

Tree improvement and genetic diversity of British and Irish broadleaved trees:

dispelling misconceptions

Over the next 10-20 years the scale of broadleaved tree establishment will increase, in large part due to the continued planting of agricultural land in Great Britain and Ireland, and reconversion of significant areas of conifer plantations to broadleaved woodland in Britain. Forest policies within Europe favour use of local stock for the establishment of native species, and there is a common perception that using genetically selected[1] planting stock is bad both for genetic diversity and the conservation of native gene pools.

This briefing paper aims to dispel these misconceptions. When establishing woods the source of the plants can have a large impact on the productivity and gene pool of native trees. The paper summarises scientific evidence related to the use of planting stock of native tree species selected for high quality timber and its impact on;

- genetic diversity,
- biodiversity and fulfilling other benefits,
- local adaptation,
- adaptive capacity.

[1] The term 'genetically selected' refers to traditional selection or breeding, and not to genetically modified trees.

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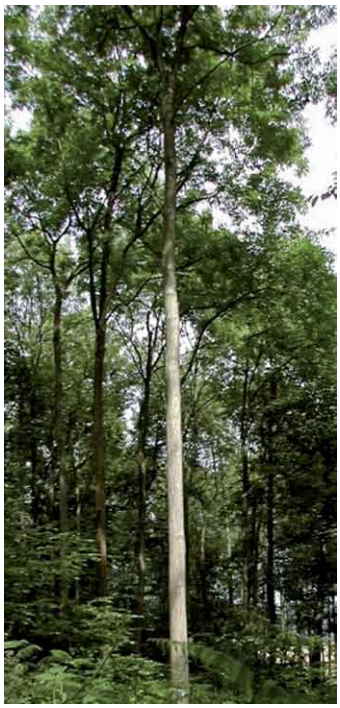
Tree improvement and genetic diversity



The misconception exists that tree improvement inevitably leads to reduced genetic diversity.

Genetic diversity is the basis for adaptability and essential for long term stability and short term productivity of trees, whether planted or naturally regenerated. The misconception exists, however, that tree improvement inevitably leads to reduced genetic diversity. While trees share their biology with other plants, certain distinct features influence their genetic conservation. Trees are long-lived and reach sexual maturity at a relatively late age. They are generally out-crossed, maintaining high levels of genetic diversity, but are susceptible to inbreeding depression (e.g. reduced vigour, fertility) through inbreeding or reduced population size. For forest trees, breeding genetically narrow populations is dangerous as, a) each plantation endures varied environments, and b) breeding cycles are long, forcing greater time for incorporation of new material.

Levels of genetic diversity in breeding and production populations reflect the number and geographic spread of selected trees. Seed collection in native populations for reforestation is usually restricted to a relatively small area, whereas selection of plus trees for breeding is from a wider geographic area. Selection of plus trees typically involves more trees (>50 per provenance region) such that the gene pool sampled is far wider and more diverse than in commercial collections (often <10 trees from a single stand). Comparisons of seed from tree breeding programmes and corresponding natural populations show very similar, high levels of genetic diversity. Hence, the reductions in genetic diversity seen in agricultural crop breeding programmes are not seen in trees.

What about biodiversity?

Plantation of native trees will improve habitats, and water and soil quality and quantity.

Questions are raised as to whether selection for high quality timber reduces the capacity of native trees to benefit biodiversity. Biodiversity levels primarily reflect silvicultural practice (e.g. mixed continuous cover woodland vs. monospecific short rotation plantation). Plantations of native trees on deforested land will usually have positive effects by improving habitats for plants and animals along with other benefits (e.g. improvement of soil and water quality/quantity). Whilst natural regeneration may, with reason, be viewed as desirable for woodland restoration, the low density of remnant native trees, poor seed years and animal damage make this impractical in many cases, except with expensive fencing. Use of selected seed improves the economics and increases the area suited to restoration with native broadleaves.

How local is local?

The paradigm of local adaptation is widely invoked in habitat restoration and more general seed sourcing for planting. Local genotypes are assumed to be better adapted to local conditions as natural selection increases the frequency of genes for fitness. The scale over which species show adaptation to their environment depends on the variability of the habitat characteristics that affect them. Local adaptation, which is widespread in herbaceous plants, is not an inevitable outcome. Key differences between herbaceous plants and trees suggest that many widespread native broadleaved trees may fail to show local adaptation at a narrow geographic scale. It may be hindered by extensive pollen/seed dispersal and opposed by selection due to environmental variation over time. Long life spans mean a site no longer necessarily experiences the same environment under which the trees originally evolved. Yearly variation in frosts, rainfall, etc., is likely to have a stabilising effect rather than the directional selection that leads to highly localised adaptation.

Performance differences between provenances are seen in many native broadleaved trees but these are not caused by greater fitness of the local seed source. Trials suggest extensive scales of adaptation with British and Irish material showing adaptation to their respective islands, whereas seed from continental Europe suffers from late spring frosts typical of Britain and Ireland. Adaptive differences are most likely to be found at the geographic and altitudinal extremes of species' ranges e.g. north and south extremes of Britain and Ireland, and the northwest and other regions where climates are more oceanic. Indeed material from maritime mainland Europe adapts better than more inland continental European sources.

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Adaptation and climate change

Temporal variation in the environment is particularly significant for trees, not only with respect to past adaptation but also for climate change where a narrow view of the scale of the local seed source may cause problems. Will trees that are adapted to current conditions flourish under conditions 25 to 75 years or more hence? Current models suggest that local adaptation will not be an issue in predicting responses of temperate lowland tree species to climate change. While material from Eastern Europe may be poorly adapted and compromise local British and Irish gene pools, it is unlikely that material from maritime France matching future climate predictions will face such problems, nor lead to outbreeding depression on mixing with British or Irish material. Outbreeding depression can occur when mixing of introduced and native populations breaks up adapted gene complexes or reduces the proportion of locally adapted genes leading to reduced vigour. Evidence for outbreeding depression comes from herbaceous plants; there is little to no evidence for its occurrence in trees at distances of less than several hundreds of kilometres.

Will trees adapted to current conditions flourish under conditions 50 to 100 years hence?

Conclusions

Planting of native broadleaves in Britain and Ireland continues apace and demand for source certified seed increases. It has been argued that given a lack of extensive field trials of adaptive variation in native trees the "precautionary principle" should be adopted in sourcing germplasm. This is expressed as the use of local seed, irrespective of quality, with views of what constitutes the local population varying from a particular wood to, for example, a Forestry Commission native seed zone. However, given the evidence; i.e. clear dangers from inbreeding and loss of genetic diversity, with extensive gene flow and adaptation at a broad scale equivalent to the British or Irish provenance regions, it is more logical to apply the precautionary principle in terms of ensuring the use of genetically diverse material with the capacity to adapt to current and future conditions.

There is good evidence to suggest that a very restricted view of what is 'local' will not ensure optimally adapted tree populations and is more likely to lead to the use of stock of limited genetic diversity which will in turn impose future limitations. Threats to the maintenance of genetic diversity come mainly from poor practices in seed collection. An emphasis on restricting the area of collection or poor instruction of collectors can limit the number of trees and hence genetic diversity sampled. Well managed tree improvement programmes not only help maintain the genetic diversity of native tree populations, but also increase the economic viability of woodlands and so promote their establishment.

Details of the theoretical and empirical evidence summarised here are given in a background paper of the same title as this policy brief (see www.bihip.org).

Visit the website of the
British and Irish Hardwoods Improvement Programme

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