

The potential of 44 native and non-native tree species for woodland creation on a range of contrasting sites in lowland Britain

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Summary

A series of species trials were set up to investigate the establishment and early growth (up to 14 years old) of 44 native and non-native tree species on a variety of different site types in lowland Britain. On good quality lowland afforestation sites, *Platanus x hispanica* (London plane) established and grew more successfully than the native trees tested, and may be an example of a species that could theoretically be established in anticipation of future climate change. Experiments on a variety of community woodland sites indicated that a range of exotic species, such as *X Cupressocyparis leylandii* (Leyland cypress), may have the potential for establishing a woodland cover on poorly restored land where few other trees would grow. However, on less challenging, better restored sites, a wide range of native species also grew successfully. Further long-term and larger scale trials on a wider variety of sites are required to confirm the potential of the species tested for British conditions. The results from these experiments also showed that relative growth rates of different species can vary through time, highlighting the danger in making premature judgements about species suitability based solely on very early tree growth.

Introduction

During the 20th century, much of the expansion of the forest area in Great Britain was driven by the objective of developing a strategic national reserve of timber. As the heathland, moorland and unimproved pasture that became available for large-scale afforestation was usually of relatively low soil fertility, and often located in the exposed uplands or northern and western parts of the country, exotic co-

nifers such as *Picea sitchensis* (Bong.) Carrière (Sitka spruce), *Picea abies* (L.) H. Karst. (Norway spruce), *Pseudotsuga menziesii* (Mirb.) Franco (Douglas fir), *Larix kaempferi* (Lindl.) Carrière (Japanese Larch), *Larix decidua* Mill. (European Larch), *Pinus nigra* ssp. *laricio* Maire (Corsican pine), *Pinus contorta* Loudon (lodgepole pine) and the native *Pinus sylvestris* L. (Scots pine) became the species of choice on these sites where timber production was the primary aim (Macdonald *et al.*, 1957).

In the late 1980s, the introduction of the Woodland Grant Scheme and in particular the Farm Woodland Scheme, followed in the early 1990s by the Farm Woodland Premium Scheme, provided increased government incentives for private landowners to convert surplus, better quality agricultural land into forests. Initially, the primary aim of many woodlands established under these schemes was timber production, and although more fertile sites potentially offered improved growth rates, there were also particular silvicultural challenges to address such as defining appropriate cultivation and weeding regimes and selection of appropriate species (Hibberd, 1988; Williamson, 1992; Willoughby and Moffat, 1996). Research into species selection for the afforestation of abandoned agricultural land has taken place in other countries (e.g. Michaud and Permingeat-Couty, 1994; Vares *et al.*, 2003). However, although some work has since taken place in the UK on a limited range of species, involving studies of yield potential (Matthews *et al.*, 1996), tree improvement (Cundall *et al.*, 2003; Savill *et al.*, 2005) and agroforestry systems (Incoll *et al.*, 1997; Hislop and Claridge, 2000), in the 1980s there was little contemporary British evidence on which to base comparisons of species performance on better quality, more fertile land recently converted from agriculture.

The instigation of initiatives such as the Community Forests, the National Forest and the National Urban Forestry Unit in Britain in the 1990s stemmed from an increasing recognition of the importance of providing multiple benefits to local urban communities when new woodlands are created (Countryside Commission, 1987; Forestry Commission, 1998, 2000, 2001). Most community woodlands have an emphasis on meeting the needs of local people, to be achieved in part through adopting a suitable planting design. Local demands on woodlands can include a requirement for recreational opportunities, landscape improvement, conservation and the provision of locally utilizable produce (Hodge, 1995). In recent years, the presumption of many practitioners has been that native species can best fulfil these needs. However, a wide range of generally untested, non-native species exist that may offer a similar or greater potential.

Many urban forests are characterized by the relatively poor quality of the sites that become

available for woodland establishment. Particular opportunities exist to improve the local environment through woodland establishment, after suitable restoration, on brownfield sites such as landfills, colliery spoils, quarries and contaminated land (Moffat and McNeill, 1994; Hutchings, 2002). Recommendations for species choice on restored industrial sites exist (Dobson and Moffat, 1993; Moffat and McNeill, 1994; Kennedy and Moffat, 1999; Roots, 2005), and Rawlinson *et al.* (2004) have recently reported on the early growth of a wide range of species on poorly reclaimed sites. However, there appear to be few reports of comparative studies, particularly covering longer term growth and performance of native species both on poorly restored and on other challenging, non-man-made, urban woodland sites in the UK.

As the evidence for global climate change has increased, so has the concern over the future adaptability of tree species grown in the UK. Under the most extreme predictions of climate change, it is thought that much of southern England may become unsuitable for timber production using species such as *Fagus sylvatica* L. (beech) and *Fraxinus excelsior* L. (ash). In order to maintain a broadleaved woodland cover in the south of England, one approach that has been proposed is to plant non-native species that are better adapted for hotter and drier conditions (e.g. *Robinia pseudoacacia* L. (false acacia)) in advance of any climate change (Broadmeadow *et al.*, 2005). However, the authors also recommend that the performance of these alternative species under the oceanic climate of the UK should be determined before any widespread planting takes place.

Introduction of new species in the past has typically followed a pattern of initial establishment in gardens and arboreta, followed by small-scale plantings of promising species on estates or public land, before the most successful species are established in larger plantations 20–50 years later (Savill *et al.*, 1997). Of the wide variety of individual species growing in arboreta, most fail to progress to plantation scale establishment due to their unsuitability for the site or climate leading to poor growth or survival or difficulties in propagation. Others are rejected because they do not yield suitable timber products or otherwise fail to meet the objectives held for the woodland (Savill

Table 2: Rationale for the species choice for Experiments 2 and 3, showing summary of site characteristics, with potential species characteristics based on experience of field and arboreta studies, as reported by Hibberd (1989) and White (1994, 1996)

Species	Acid soil	Alkaline soil	Dry soil	Moist soil	Heavy clay soil	Compacted/anaerobic soil	Other characteristics
<i>Ailanthus altissima</i>	X	X	X	X	X	X	Rapid cover on very poor sites, volume, low quality timber
<i>Alnus cordata</i>			X	X	X		Best dry site alder in Britain, good nurse and site improver, amenity, soil enrichment, low quality timber
<i>Alnus incana</i>	X			X	X	X	Nurse to more valuable species, cover, shelter, soil enrichment
<i>Acer saccharinum</i>	X			X	X	X	Amenity, quality timber
<i>Betula papyrifera</i>	X		X	X			Amenity, quality timber
<i>Corylus colurna</i>	X	X	X	X	X	X	Hardy amenity tree, quality timber*
<i>X Cupressocyparis</i>	X	X	X	X	X	X	Fast growing, shelter, timber, volume, low quality timber
<i>Catalpa speciosa</i>							
<i>Fraxinus excelsior</i>	X	X		X	X	X	Amenity, wood products
<i>Fraxinus pennsylvanica</i>	X	X	X	X	X	X	Good quality fertile, moist, well-drained sites, quality timber
<i>Ginkgo biloba</i>		X	X	X	X	X	Amenity, pioneer, cover, timber
<i>Juglans nigra</i>			X	X	X		Urban tolerant, amenity
<i>Juniperus virginiana</i>		X	X				Good quality, fertile, moist, well-drained, sheltered low elevation sites, quality timber*
<i>Laburnum alpinum</i>	X	X	X				Low elevation, quality timber*
<i>Laburnum anagyroides</i>	X	X	X				Thin and rocky soils, ornamental, amenity, quality timber*
<i>Liriodendron tulipifera</i>	X	X	X	X			Thin and rocky soils, ornamental, amenity, quality timber*
<i>Platanus x hispanica</i>	X	X	X	X	X	X	Low elevation sites, tolerant of air pollution, amenity, quality timber*
<i>Populus alba</i>	X	X	X	X	X		Fast growing, tolerant of air pollution, shelter, amenity, quality timber*
<i>Pinus nigra</i> ssp. <i>laricio</i>	X	X	X	X	X		Hardy pioneer, shelter, cover, site protection, wood products
<i>Pyrus communis</i>		X	X	X	X		Shelter, timber
<i>Quercus robur</i>	X		X		X		Good quality, fertile, well-drained, low elevation sites, amenity, quality timber*
<i>Quercus rubra</i>	X		X		X		Amenity, quality timber
<i>Quercus x turneri</i>	X		X		X		Amenity, quality timber
<i>Robinia pseudoacacia</i>	X		X		X	X	Tough, good growth on poor sites, tolerates city conditions, cover, amenity, quality timber*
Site							
Fritton	X		X				
Shutebridge	X			X			
Aldewood	X		X				
Bagworth Heath				X		X	
Rockbeare				X		X	
St Neots		X		X			

* Potentially high value, decorative timber that might be readily marketable even in small quantities.

Table 12: Suitability of the species tested based on establishment success

	Boxworth (moist, rich, alkaline clay, sheltered)	Fritton (slightly dry, rich, sheltered)	Shutebridge (moist, rich, clay, sheltered)	Aldewood (acid, dry)	St Neots (moist, rich, alkaline clay)	Rockbere (compacted/ anaerobic/ clay)	Bagworth Heath (compacted anaerobic spoil)	Barton (moist, rich, sheltered)	Church Gresley (low-grade restoration)
<i>Acer campestre</i>	-	-	-	-	-	-	-	****	**
<i>Acer platanoides</i>	****	-	-	-	-	-	-	-	-
<i>Acer saccharinum</i>	-	-	-	****	****	****	*	****	*
<i>Ailanthus altissima</i>	-	-	-	*	**	*	*	-	-
<i>Alnus cordata</i>	-	-	-	*	**	****	*	-	-
<i>Alnus glutinosa</i>	-	-	-	-	-	-	*	**	*
<i>Alnus incana</i>	-	-	-	****	****	****	*	*	*
<i>Betula papyrifera</i>	-	****	-	-	-	-	-	-	-
<i>Betula pendula</i>	-	-	-	-	-	-	**	**	*
<i>Catalpa speciosa</i>	-	-	-	*	*	*	*	-	-
<i>Cornus sanguinea</i>	-	-	-	-	-	-	*	****	*
<i>Corylus avellana</i>	-	-	-	-	-	-	*	****	*
<i>Corylus colurna</i>	-	****	-	*	**	*	*	-	-
<i>Crataegus monogyna</i>	-	-	-	-	-	-	*	****	**
<i>Euonymus europaeus</i>	-	-	-	-	-	-	*	****	**
<i>Fagus sylvatica</i>	**	-	-	-	-	-	-	-	-
<i>Fraxinus excelsior</i>	****	****	****	-	-	-	**	**	**
<i>Fraxinus pennsylvanica</i>	-	-	-	**	****	****	*	-	-
<i>Ginkgo biloba</i>	-	-	-	*	*	*	*	-	-
<i>Juglans nigra</i>	-	****	**	-	-	-	-	-	-
<i>Juniperus virginiana</i>	-	****	****	-	-	-	-	-	-
<i>Laburnum alpinum</i>	-	-	-	*	**	*	*	-	-
<i>Laburnum anagyroides</i>	-	****	-	-	-	-	-	-	-
<i>Liriodendron tulipifera</i>	-	*	-	-	-	-	-	-	-
<i>Malus sylvestris</i>	-	-	-	-	-	-	*	****	**
<i>Pinus nigra ssp. laricio</i>	****	-	-	****	****	****	*	-	-
<i>Platanus x hispanica</i>	-	****	****	*	**	**	*	-	-
<i>Populus alba</i>	-	-	-	*	****	****	*	-	-
<i>Populus tremula</i>	-	-	-	-	-	-	*	****	*
<i>Populus x canadensis</i>	****	-	-	-	-	-	-	-	-
<i>Prunus avium</i>	****	-	-	-	-	-	*	****	*
<i>Pyrus communis</i>	-	****	****	-	-	-	-	-	-
<i>Quercus robur</i>	****	****	****	****	**	**	*	****	*
<i>Quercus rubra</i>	-	-	-	****	**	**	*	-	-
<i>Quercus x turneri</i>	-	-	-	*	*	*	*	-	-
<i>Rhamnus cathartica</i>	-	-	-	-	-	-	*	****	**
<i>Robinia pseudoacacia</i>	-	****	-	**	*	*	*	-	-
<i>Salix caprea</i>	-	-	-	-	-	-	*	**	*
<i>Thuja plicata</i>	****	-	-	-	-	-	-	-	-
<i>Tilia cordata</i>	****	-	-	-	-	-	*	****	*
<i>X Cupressocyparis leylandii</i>	-	-	-	****	****	****	**	-	-

This table presents a summary of the data only. For direct comparison of species and sites refer to Tables 5–13, with associated statistical analysis which takes into account the variability in the data. ****, very suitable for the site type in question, >80% survival at the end of the experiment, greater than average growth for the site; ***, suitable for the site, >80% survival, lower than average growth for the site; **, potentially suitable for the site, 50–79% survival, greater than average growth for the site; *, potentially unsuitable for the site, 50–79% survival, lower than average growth for the site, or survival >80%, but average annual height increment <10 cm; -, unsuitable for the site, <50% survival; -, untested.

