

Genetic conservation of native trees

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Over recent years, the genetic conservation of British native tree populations has become an increasingly important part of the work of Tree Improvement Branch (TIB). This has been in response to a greater interest from forestry policy-makers in the genetic basis of forest biodiversity conservation, both at the UK and, more especially, the European level.

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Hornbeam at Brickett's Wood Common, Hertfordshire



Ash at Castle Eden Dene, Durham



Birch at Borrowdale, Cumbria



Introduction

The Forestry Commission (FC) recently published Technical Paper 31: *Genetic variation and conservation of British native trees and shrubs: current knowledge and policy implications* (Ennos *et al.*, 2000) which is based on a literature survey carried out for the FC by the University of Edinburgh. One of the main conclusions was that there is a need to explore the extent and implications of genetic variation within the gene-pools of British native tree species. It was acknowledged that this is an area which has been under-researched in the past.

In 1999 the FC introduced a voluntary scheme which recommended the use of local-origin planting stock for native trees and shrubs, especially where these are being planted in or near existing ancient woodland. This scheme is set out in Practice Note 8 (Herbert *et al.*, 1999). The scheme is based on a system of local seed zones, defined using topographical criteria. We do not yet have sufficient knowledge of actual genetic variation within individual tree species to delineate zones on any other basis, such as the 'biochemical zones' adopted earlier for Caledonian Scots pine. The new Forest Reproductive Material (FRM) Regulations, which came into force at the beginning of 2003, now cover a much wider range of British native tree species than was previously the case: 31 species relevant to forestry in Britain and 15 of these are native.

The FC is a member of EUFORGEN, a European organisation set up to co-ordinate research and policy on the conservation of forest genetic resources in Europe and participates in its Species Networks relevant to British forestry.

Biochemical and molecular research

Tree Improvement Branch (TIB) has previously participated in a small number of biochemical research projects to explore the nature of variation in selected British native tree species. This variation reflects the long-term genetic structure of tree

populations, largely defined by their refugial distributions during the periods of Quaternary glaciation, and the spread out from these refugia thereafter.

Research led by Ian Forrest in the 1970s and 1980s on Caledonian Scots pine (*Pinus sylvestris* var. *scotica*) showed that the Scottish gene-pool was made up of a number of distinct regional-scale genetic units, based on the monoterpene composition of resin. Those on the north-west coast of Scotland were particularly divergent, and might indicate descent of populations in these areas from oceanic as opposed to continental glacial refugia. This work led to the establishment of a system of biochemical seed zones which have guided the sourcing of seed stock for the extensive Native Pinewood Scheme planting programme. Currently Scots pine is the only species for which we have this level of genetic understanding.

More recently, Joan Cottrell has led research into the genetic structure of British native oak populations, as part of a wider European investigation of post-glacial migration routes of oak species from glacial refugia. This work was described in the *Forest Research annual report and accounts 1999–2000* (Cottrell, 2001). Chloroplast DNA investigations have continued and include work on veteran oak trees and the refugial origins of black poplar (*Populus nigra* var. *betulifolia*).

Population inventory project

Biochemical and molecular research make use of neutral markers which are unlikely to be affected by local selection pressures. With the publication of Technical Paper 31, it became clear that it was necessary to initiate work on *adaptive* genetic variation in British native trees. This is the type of genetic diversity that allows individual populations of native trees to become well adapted to their local environmental conditions. Knowledge of such variation is essential to inform seed sourcing and zonation regimes and to ensure the use of well-adapted planting stock for new native woodland planting schemes in



the future. It should help to address the question, ‘How local is local?’ that is often asked by practitioners in this area.

Adaptive variation must be examined by carrying out *provenance trials* or *common garden experiments* which test the performance of material derived from a range of seed origins of a particular tree species under a range of environmental conditions. These are usually rather long-term studies due to the slow growth rates and long life cycles of native trees.

The first task was to identify suitable source populations of each native tree species for testing in such trials as there was no such list for any species other than Caledonian Scots pine. A comprehensive inventory database of natural tree populations throughout Great Britain was thus required. It was also intended that the creation of such an inventory of potential seed source populations would support the adoption of the voluntary local-origin scheme set out in Forest Practice Note 8 and the compliance with the terms of the new FRM regulations where these apply.

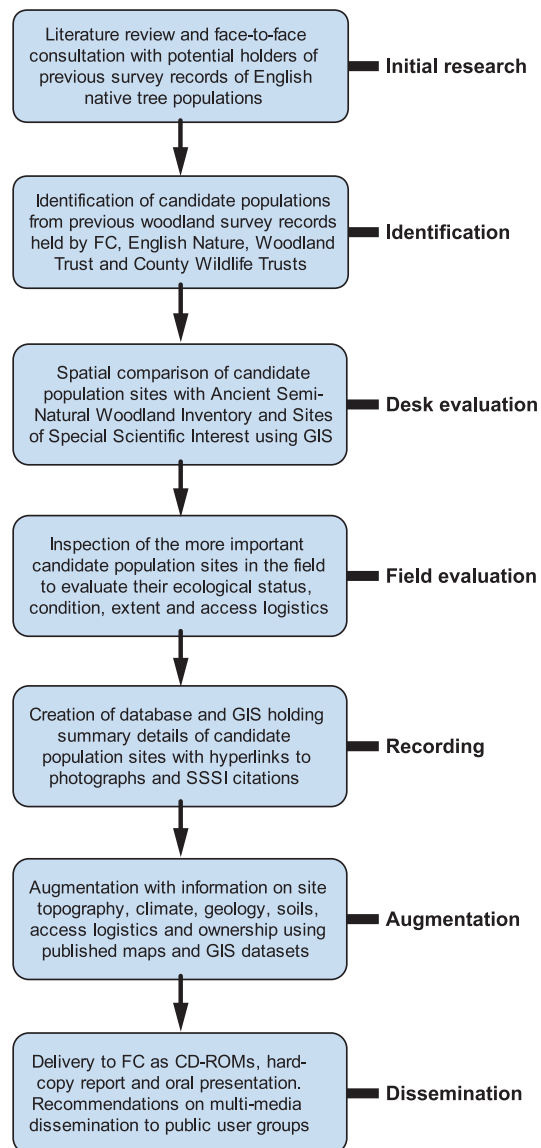
Fortuitously, such an inventory database had already been created for Scotland between 1998 and 2000 by Dr Scott Wilson, as a research project funded by the Scottish Forestry Trust. In 2000 the FC had supported the extension of this work to cover Wales, and between 2001 and 2003, coverage was also extended to include England, thereby providing a GB-wide inventory prepared to a common standard.

The inventory database comprises a register of important populations of each of the native tree species that are thought to be site-natural. The species on the database include all the native trees in each region, and some important bush/shrub species. Populations were selected, where possible, which have sufficient breeding individuals to ensure genetic sustainability (usually more than 30 trees is considered sufficient).

A summary of the stages involved in developing the inventory is presented in Figure 1.

Figure 1

From initial research to dissemination: the seven stages of the population inventory project.



The populations for inclusion on the inventory database were initially identified from existing sources of woodland survey information held by conservation bodies such as Scottish Natural Heritage, English Nature and the Countryside Council for Wales. A variety of independent organisations (such as Wildlife Trusts) and research workers also suggested appropriate populations. Following this initial review of existing resources, intensive fieldwork was carried out throughout the UK, visiting most significant areas of ancient semi-natural woodland to locate and assess native tree populations for inclusion. As a result the database includes tree populations at more than

Figure 2**Oak - Sharpnage Wood, Herefordshire.**

2000 locations throughout the country, and covers 25 species ranging from major broadleaves such as oak and ash to mature cherries and limes. Some examples of individual populations included in the inventory for a range of species appear in Figures 2, 3 and 4 and on the title page (page 56).

As well as the map locations and native tree species present, the database records a range of site ecological details (e.g. climate, geology and soils). This will be of value in selecting a representative portfolio of source populations for provenance trials or in matching the ecological needs of particular planting schemes with potential seed sources. The database also contains appraisals of the accessibility of the individual sites for seed collections and of their conservation designations and ownership. A large catalogue of digitised site photographs can also be accessed from the database. In addition it is equipped with a Geographical Information System (GIS) map interface which makes it straightforward to carry out spatial analyses of population distribution, clustering and proximity.

Figure 3**Beech - Workman's Wood, Cotswolds.****Figure 4****Alder - New Forest, Hampshire.**

Examples of population distribution of two species (bird cherry and hornbeam) in England are given in Figure 5a and b.

Figure 5

Distribution of (a) bird cherry and (b) hornbeam populations in England; black dots are key populations.

(a)



(b)



One of the main research challenges which the inventory work has highlighted is the difficulty in establishing objectively whether native tree populations are indeed site-natural. Given the very long record of tree planting in this country, frequently using seed or plants imported from mainland Europe, it is often impossible to be certain from site inspections that populations of mature trees are natural. A variety of spatial analysis techniques have been used to attempt to deal with this, such as comparing the

population site locations with the Ancient Woodland Inventory and the boundaries of Sites of Special Scientific Interest. Coincidence with this type of record was used to support identification of material as site-natural. However it is recognised that in many cases only a 'balance of probability of naturalness' can be established. A pilot evaluation of the use of detailed historical archives (e.g. estate papers) was undertaken by the first author to assess the naturalness of tree populations, but this proved extremely time consuming and rarely yielded the degree of certainty sought.

At a more logistical level it has also become apparent that seed collection from many natural woodlands may raise potential practical difficulties and incur increased costs. In the lowlands, the density of many former coppice woodlands almost certainly limits seed production and may make it physically arduous to collect seed. In some woodlands on designated sites seed collection may conflict with conservation objectives (e.g. when cutting back undergrowth for access). For these reasons it may be necessary to consider arranging single collections of seed or vegetative material which could be used to generate seed production on another site in a seed orchard or other specific plantation.

Future work

The Forestry Commission intends to develop the work by making the inventory database contents more widely available to the research, seed-collecting, nursery and tree-planting sectors throughout Great Britain. In Scotland this process was initiated by a publication by the Scottish Forestry Trust (Wilson *et al.*, 2000). In Wales the Forestry Commission has now established an advisory contact who can deal with seed sourcing queries, making reference to the inventory database (Wilson and Jenkins, 2001). Consideration is now being given to how this can best be handled for England, and for GB as a whole, recognising that both printed and

electronic media approaches could be used. Before this can proceed it is necessary to consult with population site owners and to make provision for future updating and revision of the inventory database as required.

With the completion of the inventory work in 2003, TIB is now much better placed to initiate the establishment of the planned provenance trials for selected native tree species. Work is already under way on silver birch, in which trials of over 60 natural populations sampled throughout Great Britain have been laid out in 10 contrasting and widely distributed sites, including one in the south of the Republic of Ireland. The approach follows the objectives of the British and Irish Hardwood Improvement Programme (BIHIP) Silver Birch Group and the database has been used to identify candidate populations. The BIHIP Ash Group has also benefited in searching for populations in which to select superior candidate trees for breeding work. TIB is currently evaluating the best way forward for establishing provenance trials for other native tree species, for which seed collections from populations on the inventory database are likely to be made in due course. As with many topics in forestry research this is inevitably a long-term programme.

The Forestry Commission is currently reviewing its policy on encouraging the use of local-origin planting material for creating new woodlands of native species. The overall objective is to reduce the proportion of planting material which comes from geographically distant locations or from overseas.

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