IS THERE ADAPTIVE POTENTIAL IN ASH TO COPE WITH CLIMATE CHANGE?

Jo Clark reports on the work she is undertaking to investigate the adaptive potential of one of our native trees and how a grant from the RFS Randle Travel Fund is helping with this.

I was fortunate to be awarded the Randle Travel Bursary last year. It was very timely indeed. Five years ago I started a part time PhD to investigate the potential of one of our native trees, ash, to adapt to climate change. This idea followed a field visit to the Northmoor Trust's research wood in south Oxfordshire as part of the 'Better Trees, Better Profits' conference organised by the Royal Forestry Society in 2004 (see *QJF* Vol. 98 No. 3 and 4). At this event Mark Broadmeadow, then of Forest Research, presented results of climate matching analysis and possible yield class changes for ash, oak and beech, under various climate change scenarios. These suggest that by 2050 yield will increase for ash and oak, but decrease for beech, and all will decrease in yield under the 2080 scenarios for southern England. This got us thinking about what we should be planting, now and in the future, and what capacity, if any, there may be in our existing tree populations to deal with the effects of climate change. We put together a proposal to study the potential of ash to adapt to climate change and asked the Forestry Commission to fund it. This they duly did, and, armed with generous funding for three and a half years, I started my PhD part time with Bangor University.

The specific objectives were:

- To test the adaptability of native ash across a range of UK locations by matching it to the predicted climates in 2050 and 2080.
- To identify provenances of ash that may be closely matched to the future climate and to test them in the current climate through a series of reciprocal transplant experiments.
- To investigate time of budburst of ash provenances for their suitability for growing quality timber in the predicted climate of 2080.

Indentifying populations

The first task was to identify naturally regenerated populations growing in those locations that currently match our future predicted climate. Mark Broadmeadow's data suggested that by 2050, the climate of south Oxfordshire would be like that of the Loire Valley in France, if carbon emissions were mitigated, and like Bordeaux without mitigation. By 2080, with business as usual, the climate would be like that of the Adriatic, at high elevations.

So, starting with these scenarios, I set out to find populations of ash in the Loire Valley and around Bordeaux. To look at the effect of moving material north through Britain, sites were also selected at similar intervals (3°) north of south Oxfordshire. This resulted in ten populations of ash being selected, two from each of five geographical regions: Inverness, Yorkshire, Oxfordshire, Ile de France near the Loire Valley and the foothills of the Pyrenees. It was necessary to go further south than Bordeaux as narrow leaved ash, *Fraxinus angustifolia*, is also

common in this region and the two species readily hybridise. The plan was to establish five trials, one in each of the five geographical regions, with plants raised from each of the ten populations.

Leaf samples were collected from each population in early summer 2006 and DNA analysis carried out at the University of Oxford to ensure the nativeness of each population. Previous studies of ash DNA show that Britain was recolonised after the last ice age from the Iberian Peninsula, whereas populations in France originated from more central European sources. The DNA analysis of my samples mirrored these findings. Armed with the knowledge that my proposed populations were indeed native, I collected seed from 20 trees from each population in autumn 2006. These were stratified at the seed extractory at Alice Holt during winter 2006.

Seedling production

As young trees often exhibit carry over effects from the nursery, it was important to limit these as much as possible. Therefore, a tonne of topsoil was dug from each trial site and the seedlings raised in root trainers in the soil type that they were to be planted in. So, for example, seedlings that were destined for the Cawdor trial were sown and grown in the nursery in soil from the Cawdor site. It was hoped that provenance effects might be seen earlier than might otherwise be the case. Some provenances failed to germinate as can be seen in the yellow (Yorkshire) soil in the foreground of Figure 1 due to complications with chilling requirement across provenances. Seedling production was repeated in spring 2008 for a more uniform germination.

Figure 1. Seedlings being grown in 2007 at Maelor Forest Nurseries in Shropshire. Different colour labels represent different soil types, each with ten provenances.

Trial establishment

Due to complications with seed germination highlighted above, the trials were not planted until winter 2008. Each trial comprises 1600 trees that were only 4cm high on average at time of planting. At two of the sites the existing forest cover was cleared to provide the trial site. Two other sites were pasture, and the final site was a nursery area within the forest that had historically been sown partly with lupins for forage (Figure 2). This proved to be both a blessing and a curse. Lupins grow substantially faster than little ash trees, and where they were dense quickly swamped the ash causing much mortality. However, they also provided shelter and presumably some degree of fertilisation through nitrogen fixation, as the ash that survived amongst the lupin were over three times taller than those growing without the lupin, as well as being dark green as opposed to the others which looked distinctly chlorotic. It does mean however that the site needs weeding regularly. The two sites in France, both hosted by the Office National des Forêts have both stipulated no chemical weed control. Therefore, each tree has been protected with a black mulch mat. Again, there are problems as mulch mats provide perfect habitat for voles, so mortality has also occurred due to this.

Figure 2. The trial at Dourdan, south west of Paris, showing the extent of lupin colonisation. Trees are planted at 1 x 1m spacing, each protected with a mulch mat.

Spring phenology

Having established the trials, which cost a great deal more than I anticipated (boar proof fence costs a lot more than deer proof fence!), I could start collecting data. Height and diameter at root collar were measured at the time of planting, and spring budburst was scored in 2009 at three fortnightly intervals. The aim here was to ascertain whether trees can adapt to a different climate in terms of timing of budburst, or is this genetically hardwired? That is to say, will trees from Cawdor, in Inverness, always flush late, or, if planted further south, will they flush earlier?

There was very little difference in time of bud burst regardless of provenance or site, which is not what experience of other more mature ash provenance trials tells us. Also, the trials were planted between November and March and so many trees would have received their required winter chilling in south Oxfordshire, rather than at the site where they were planted. It was therefore highly desirable to collect another set of data, but, unfortunately, I had used all my funding from the Forestry Commission. Here, the Royal Forestry Society stepped in with the Randle Travel Bursary, which enabled me to visit the trials in France this spring, to score bud burst again.

Although the trees were still very small at each site, on average only 7cm tall, this was almost twice the previous year's height. It was a strange spring here in the UK, and similar patterns were seen across France. The first data were collected in the week commencing 12th April 2010. Budburst progressed as usual, but then the late spring frosts killed much of the new growth. At the second visit, two weeks later, most provenances had started to flush again. However, this was a particularly harsh spring, and on most provenances this second flush of growth was also killed by frosts. Only the material from Inverness, which is so late flushing that budburst had not commenced, escaped frost damage. Being so small, and hit so hard by frost twice, resulted in additional mortality as some individuals were unable to flush a third time. The trial in the south of France mostly escaped frost damage.

Each trial was visited again in summer 2010

Figure 3. Downloading weather data at Dourdan.

for weeding (weeds come up through the slot of the mulch mat and often swamp the small seedlings) and to record survival. While mortality had increased since 2009, growth of the surviving trees was usually good. Sensitivity to frost is an important selection criterion as can be seen by increased mortality in 2010. Time of budburst is also important where timber production is the aim, as loss of the terminal bud in ash often results in forking due to the two lateral buds taking over. If we are to bring material from France for timber production in the UK, it is important that they can both survive and not be damaged by spring frosts.

Although frost damage was very severe in 2010, again resulting in an unclear set of data, there were noticeable differences in timing of bud burst amongst provenances. All trees will be assessed at the end of the 2010 growing season for year 2 growth and forking. Due to the trees still being so small in the spring of 2010, it is possible that heat radiation from the mulch mats was still the over-riding influence on time of budburst. If funding permits, a final phenological data set will be collected in the spring of 2011.

It is hoped that results from this study will help to influence policy as to use of local seed sources and how far provenances can be moved north safely. I hope to finish the PhD within the next two years, including writing the thesis and publishing a number of papers. Although the PhD study will finish at this point, the trials will remain in situ to provide long term data.

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