Increasing the adaptation potential of native tree species to global change

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Introduction

Global environmental change will have numerous impacts on native tree species that may lead to alterations in:

- regeneration success where problems arise at key life stages such as seed production, dispersal, germination and seedling emergence
- phenology (e.g. timing of budburst, leaf fall)
- growth rates, growth forms and productivity

Changes in any of the above are likely to have 'knock-on' impacts for forest structure, functioning and/or biodiversity. This is particularly true where a native tree species is a 'keystone' species; its decline or loss from the forest ecosystem can threaten the very existence of that ecosystem and its associated ecosystem services.

Aims

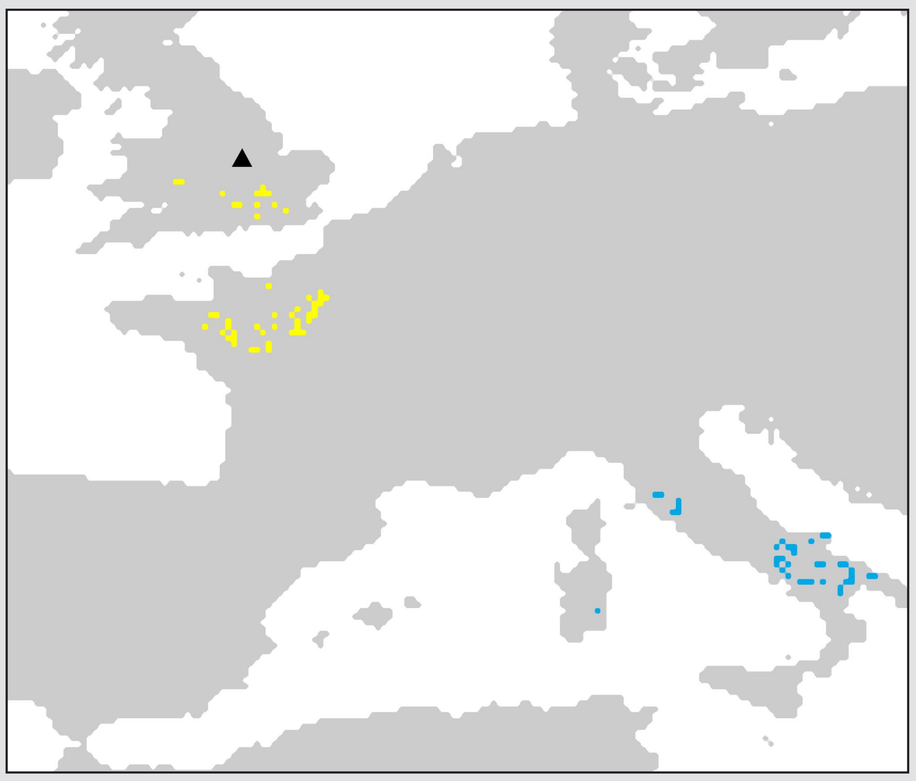
Efforts towards ensuring that native tree species continue to deliver valuable ecosystem services should be directed towards maximising their resilience under global environmental change. Genetic resilience is conferred by maintaining high genetic diversity, promoting gene flow between populations and ensuring consistent regeneration events. Forest Research's Climate Change Adaptation Programme is:

- Seeking to gain an understanding of how the regeneration and phenology of native British tree species might be affected by global environmental change.
- Exploring how the adaptation potential of native tree species can be enhanced through the targeted selection of non-native provenance material that may be better suited to future projected climatic conditions.

'Climate-matched' provenance trials of native tree species

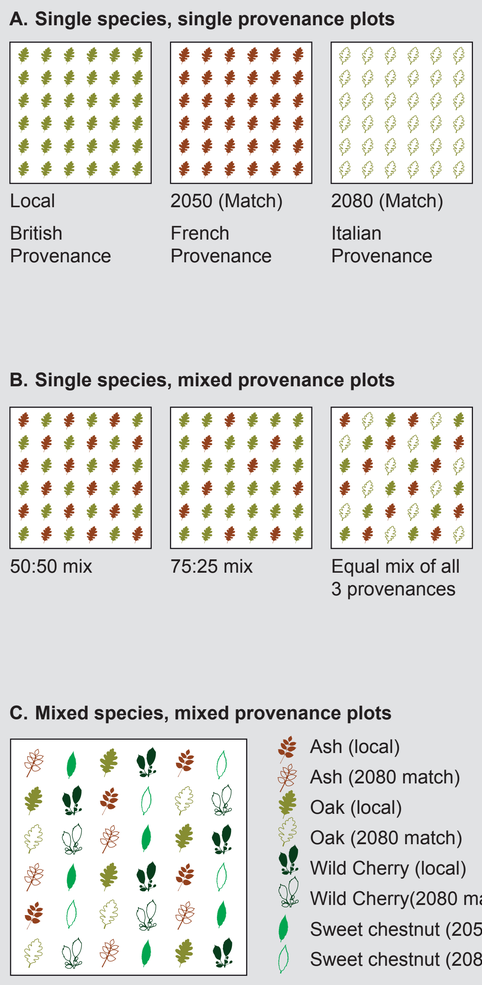
Many native tree species are unlikely to be able to migrate rapidly enough to adapt to climate change and it is not known whether native populations contain enough genetic diversity to adapt to rapid environmental change. A strategy to maintain or increase the adaptation potential of native tree species under climate change is the artificial translocation of material from provenances that currently experience the predicted future climate for Britain 50 to 80 years from now.

Using the ESC-climate matching model (Ray *et al*., 2002), regions of southern England, northern France and central Italy have been identified as regions that currently experience climatic conditions that are expected to occur in the Midlands area in 2050 and 2080. Provenance material of oak (*Quercus robur*), wild cherry (*Prunus avium*), sweet chestnut (*Castanea sativa*) and ash (*Fraxinus excelsior*) have been collected from 'local' and 'climate-matched' provenances and have been planted at three trial sites; one site in Kent and two sites in the Midlands of contrasting soil type (free-draining sands vs. clays). The experimental planting design explores different levels of mixing of native and non-native provenance material and species mixtures to better understand how the survival, growth and adaptation potential of stands can be maximised.



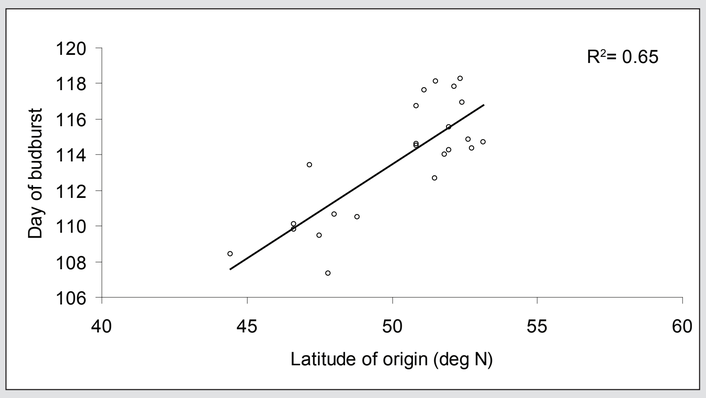
Matching source regions for projected climates.

Experimental planting designs



Variations in the timing of budburst among different provenances of oak

The date of budburst was assessed in 24 European provenances of oak (*Quercus robur; Q. petraea*) over a seven year period (2004–2010) at a trial site in the South Downs, West Sussex, UK. Budburst of the most southerly provenances was consistently earlier compared with northern provenances. These results indicate the degree to which the timing of budburst can be altered (by up to 15 days) if non-native provenances are selected for climate change adaptation planting in Britain. This degree of change could have major consequences for dependent organisms – particularly herbivorous insects and their predators which include many woodland bird species.



Budburst dates for different oak provenances at a trial site in West Sussex, UK.

Effect of tree seed origin on germination profiles

Tree seeds from different provenances have been exposed to a range of current and projected temperatures to determine whether there are any differences in their germination profiles and to quantify likely impacts of warmer and shorter winters on regeneration potential (McCartan *et al*., 2014). This work will elucidate the likely impacts of warmer and shorter winters on the regeneration potential of native and non-native provenance material. Seeds of two contrasting native tree species are being tested; *Quercus robur* which has large, recalcitrant seeds and *Prunus avium* which has 'orthodox', deeply dormant seeds. Seeds of *Q. robur* and *P. avium* have been sourced from a local provenance (Midlands, England) and from 'climate-matched' provenances including specific regions in southern England, northern France and central Italy.

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