

# Impacts on tree growth and function

**Mark Broadmeadow**

*Environmental and Human Sciences Division,  
Forest Research, Alice Holt Research Station, Farnham, Surrey, GU10 4LH*

Predicting the effects of climate change on trees and woodland is a difficult task. Aside from a lack of surity in how climate change will progress, the way in which the many environmental drivers will interact with one another and with the many processes associated with woodland ecosystems leads to uncertainty in prediction. However, we know much about the response of woodland to extreme past climatic events will act as pointers to how trees will respond to the hotter drier summers and milder, wetter winters that are predicted – we remember the droughts of 1975/76 and 1995, the storms of 1987 in southern England and the winter floods of 2000. But how serious were they for the survival of trees? In many areas, trees grew exceptionally well in 1976 – where they were not limited by water availability. The double drought of 1975/76 did have serious impacts, and clear patterns of drought-induced impacts are evident in the results of the Forest Condition Survey since 1987, with peaks of severe defoliation following the droughts of 1989/90, 1995 and 2005.

There will also be less dramatic effects of climate change – we have seen an advance in the date of budburst of up to 2-3 weeks over the past 30-40 years. Although a good indication of the progress of climate change, this may not seem of great relevance to a discussion of the future effects of a changing climate on tree growth. However as a rule of thumb for broadleaf species, for each week's lengthening of the growing season, carbon uptake will increase by 10%. Early flushing makes trees more susceptible to late spring frost damage, which affects both growth and timber quality. Although the climate is warming, the potential for late spring frosts has not diminished and counter-intuitively, frost damage could increase as a result of climate change, having implications for any consideration of using more southerly provenances as a measure to adapt to climate change. Rising temperature could have a number of other impacts including reduced winter hardening, the potential for chilling requirements for seed germination not being met leading to less successful natural regeneration while increased soil mineralisation may enhance nutrient supply. It should, however, be borne in mind that whatever we learn about how trees will respond to climate change, the effect of climatic warming on the prevalence of pest and disease outbreaks could have a greater impact on Britain's woodlands than any direct effects of climate change.

The rising concentration of carbon dioxide in the atmosphere, the principal driver of human-induced climate change, also has a direct effect on tree growth; rates of photosynthesis and thus growth will increase, while water loss from leaves may be limited by the stomata closing. However, in the few studies in which mature forest canopies have been exposed to elevated concentrations of carbon dioxide, the magnitude of the effects has been much smaller than those observed in the majority of experiments, which have been conducted on young trees.

In the southern half of the UK, changing rainfall patterns are likely to have the greatest impact on tree growth with the combination of more frequent winter flooding and summer droughts leading to widespread losses, particularly in hedgerow trees, street trees and young trees. Some species will be affected to greater extent than others which, in natural woodland ecosystems, will change the competitive advantage of one species over another.

The current distribution of tree species across Europe together with information on commercial productivity can, through the development of appropriate models, provide an indication of the future potential for individual species. Predictions are that although current 'native' species will not disappear from our shores, their distribution and suitability for commercial timber or biomass production will change significantly. However, the impacts will not be negative across the whole of the UK, and growth rates are likely to increase where not limited by water or nutrient availability. What is certain is that the character of woodlands in the UK will change as a result of climate change. These changes will be almost imperceptible at first but, if fossil fuel emissions at a global scale are not curbed, the impacts will become increasingly far-reaching.