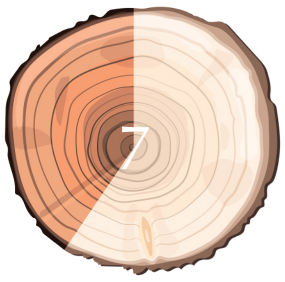
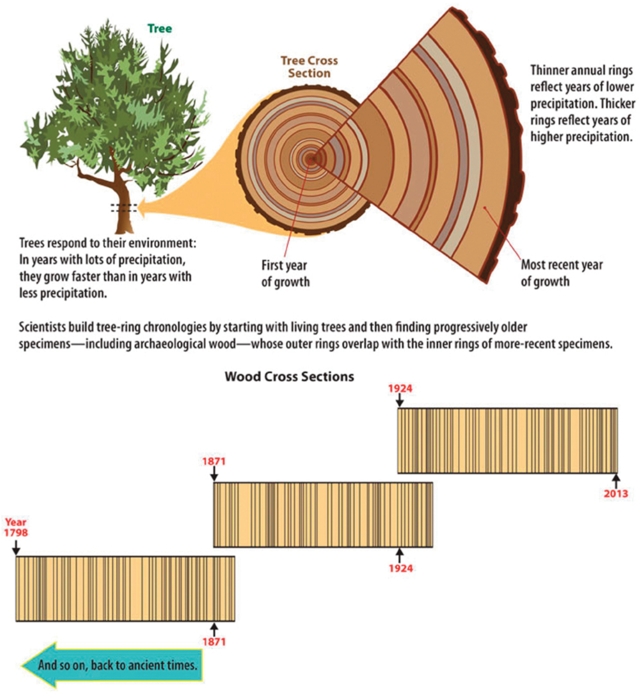
All Trees are Clocks

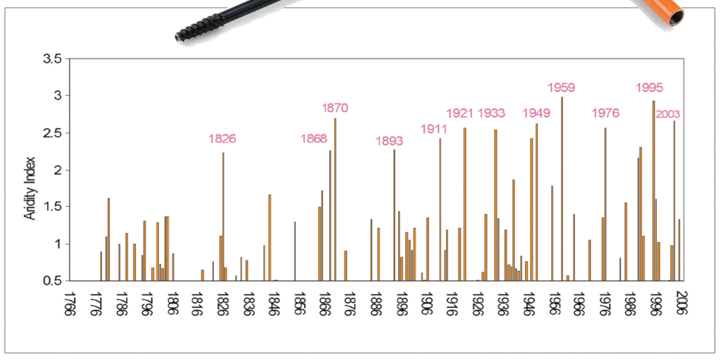


Analysis of tree rings

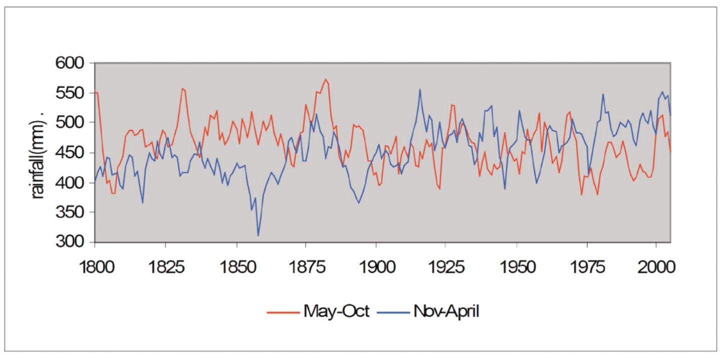
Increment borer for obtaining samples for growth ring analysis.



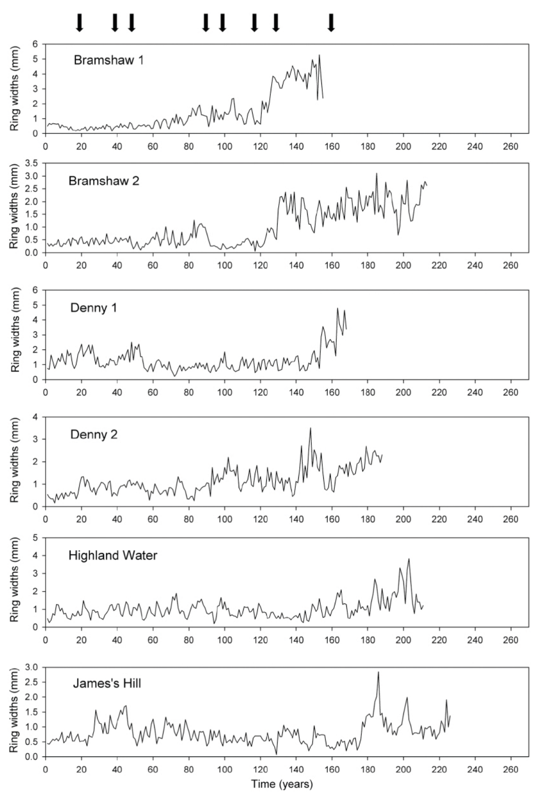
Overview of dendrochronology techniques.
Source: Crow Canyon Archaeology.



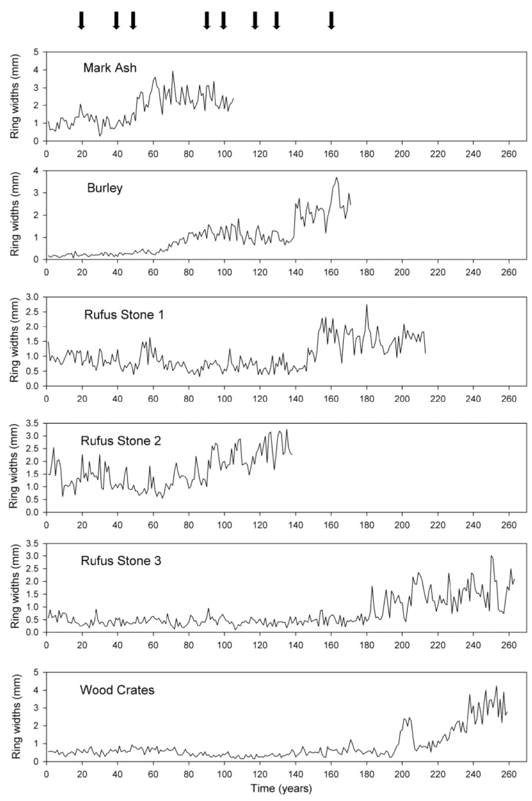
Timing of significant droughts in England during the past 250 years.
Source: Marsh *et al.* (2007).



Rainfall trends in England in the past 200 years. Source: Marsh *et al.* (2007).

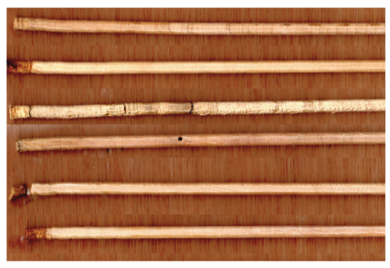


Measurements of growth ring widths in New Forest beech trees. The zero value represents the present day.



Measurements of growth ring widths in New Forest beech trees. The zero value represents the present day.

Tree rings in fallen beech, Wood Crates, New Forest.



Core samples from New Forest beech trees that have recently died.

In a sense, all trees are clocks: they store a record of time in their growth history.

Analysis of their growth rings can provide insights into the history of individual trees, and the impact of factors that affect tree growth, such as climate.

The science of dendrochronology, or the study of tree rings, dates back to Leonardo da Vinci. He was the first person to report that trees form rings annually and that their thickness is determined by the conditions under which they grow. Studying the variation in tree growth rings can therefore provide insights into past environmental conditions. In recent decades, dendrochronology has become a widespread technique in a range of scientific disciplines, including archaeology, palaeoecology and climate science.

How can you read a tree as a clock? Ring measurements are typically taken on sawn sections of a tree trunk, or by using an increment borer, which can be used to extract a core of wood from a tree. The wood sample can be examined using a lens or microscope, or scanned for analysis using a computer. This enables variation in ring widths to be measured. Each growth ring results from the change in growth rate that occurs during each year; growth rates are generally higher in the spring than later in the summer or autumn. The width of the growth ring reflects the weather conditions of that growing season, and may vary with factors such as rainfall, temperature, plant nutrition and soil pH.

We extracted increment cores from beech trees that had recently died in twelve different areas of the New Forest, and analysed variation in ring widths using a computer-based system. Results indicated that mature beech trees grow very slowly during the latter part of their lives; often the growth rates were less than 1 mm per year. Typically, growth rates were much higher when the trees were younger. All of the sampled trees showed marked annual variation in growth rate, particularly when they were relatively young. Some of this variation appears to be attributable to weather events, such as drought.

Weather records indicate that there have been more than 70 significant drought events in England in the past 250 years, which falls within the lifespan of many mature beeches. Major droughts occurred around 160 and 130 years ago, and these appear to have affected many of the beech trees that were sampled, as growth rates were significantly reduced. More recent major droughts, such as 1976, 1990 and 1995, appear to have had less impact on tree growth, although growth rates of all sampled trees were very low during this period.

Can analysis of growth rings explain why time ran out for these trees? Their low growth rates show that they were stressed before they died, often for many decades. From the Denny Wood survey data, we know that trees that grow more slowly are at higher risk of death. We also know that a severe drought, such as 1976, can lead to the death of a tree many years later. Even if fungal pathogens are involved, it can take many years to kill a tree. Many of the trees that were sampled blew down in recent storms, but had been weakened by fungal attack, which damaged both their root systems and their canopies. This highlights how multiple interacting factors can contribute to large-scale woodland dieback.