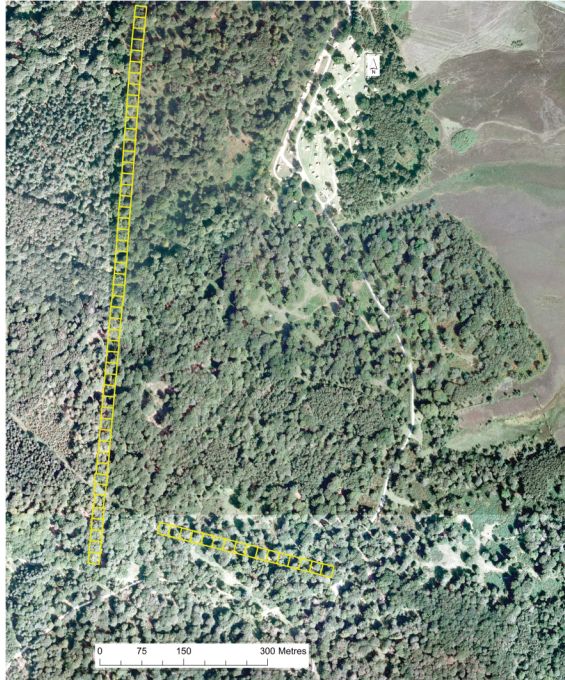




Long-term changes in Denny Wood



Location of the survey transects in Denny Wood.



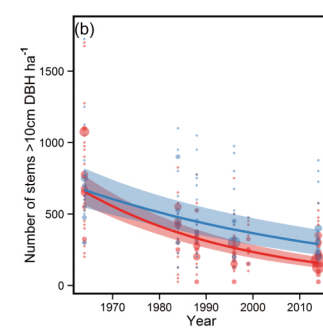
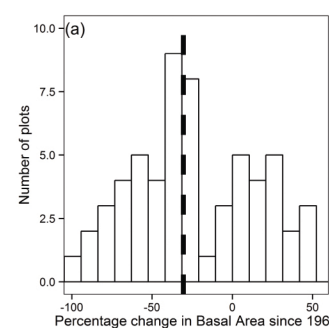
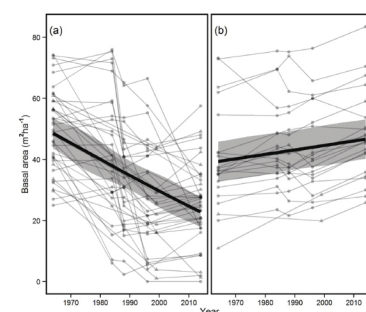
Areas of the enclosed transect in Denny Wood. Note the large numbers of dead beech trees.



Areas of the unenclosed transect that are now open parkland, but were dense beech woodland in 1964.

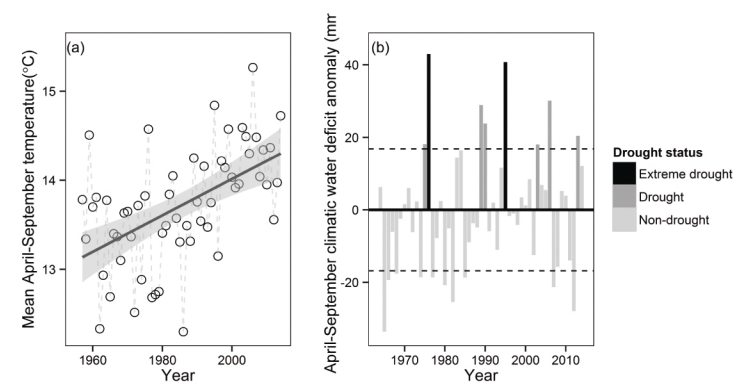
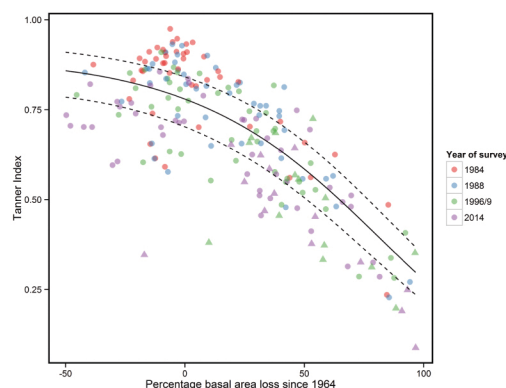


Trends in basal area of trees in the Denny Wood transects. Each line represents an individual subplot, which are grouped into (a) those that have declined, and (b) those that have increased over the past 50 years. Note the rapid decline in some of the subplots. Source: Martin *et al.* (2015).



(a) Change in basal area in different subplots in the Denny Wood transects. (b) Change in the number of tree stems over time. Source: Martin *et al.* (2015).

Relationship between percentage loss in plot basal area and species composition changes as measured using the Tanner Index. Where values are closer to 1, species composition is more similar to the same plot in 1964. Points represent individual plots surveyed in 1984 (red), 1988 (blue), 1996/1999 (green), or 2014 (purple). Source: Martin *et al.* (2015).



Climate records from 1964 to 2014 showing that (a) mean temperature during April-September increased from 1960s to present day at a rate of 0.02 ± 0.004 °C per year; and (b) there were numerous drought years in addition to 1976. Data from Hurn weather station, 24 km from Denny Wood. Source: Martin *et al.* (2015).

Why have so many large trees died in Denny Wood over the past 50 years?

Ancient woodlands are one of the most important habitats of the New Forest, being home to many hundreds of different species. This reflects their development over hundreds, or even thousands of years. They are also greatly valued by people for recreation.

All woodlands are dynamic places, with older trees continually dying and younger trees replacing them in the woodland canopy. It is difficult for us to appreciate how woodlands change over time, as trees often live much longer than people. Consequently, the pace of change can seem slow to us. However, the impact of such changes can be dramatic.

Long-term monitoring provides one of the best sources of evidence about how woodland ecosystems change over time. In the 1950s, two survey transects were established in Denny Wood, in the New Forest, respectively of 1 km and 320 m in length. All of the trees were mapped and measured in each 20 x 20 m subplot of each transect. The transects have been resurveyed several times since then, most recently in 2014.

Results show that Denny Wood has undergone some remarkable changes in the past 50 years. Both the number of trees, and the basal area occupied by their trunks, has declined. Overall, basal area has declined by 33%, and juvenile tree densities have also been reduced by approximately 70%. In some parts of the transect, all of the trees have died, and these areas are now a grassy parkland rather than the dense woodland that was present 50 years ago. It is now difficult to imagine how these woodlands appeared originally.

Most of the decline in basal area was the result of the death of relatively large trees, especially beech (*Fagus sylvatica*), but also oak (*Quercus robur*). In some cases, their death has been very rapid, whereas in other cases, the process has been much slower.

What has caused the death of these trees? We believe that climate change has been a significant factor. Growing season temperature increased from the early 1960s to 2014 at a rate of 0.02 °C per year. Severe droughts occurred in 1976 and 1995, and three additional drought years have occurred since the year 2000. These droughts were associated with increased mortality of beech. Increased winter rainfall, leading to soil waterlogging and impeded root growth, may also have been a factor. Fungal pathogens, which preferentially attack trees weakened by drought, are another potential cause. Young trees are also being killed by livestock and deer; the number of saplings has declined by 75% over the past 50 years. Consequently, the woodlands are not recovering.

