Resilience of the
New Forest woodlands

Ecosystem services and biodiversity recovery time following a 'pulse' disturbance event over a 100 years timespan. Note how recovery times for the woodland ecosystem are much higher in the presence of browsing (red line on graphs). Source: Cantarello *et al.* (2016).

Disturbance type
- ■ Pulse
- ▲ Pulse + Press

Simulation of recovery following an initial disturbance event (pulse) over a 100 year timespan. Different measures of biodiversity: ECM, ectomycorrhizal fungi species richness; GF, ground flora species richness; EL, epiphytic lichens species richness; Trees, tree species richness. Source: Cantarello *et al.* (2016).

Simulation of woodland recovery following a one-off disturbance, such as drought or pathogen attack, in which the sudden death of the dominant tree species (oak, beech, or four tree species) occurs. In these simulations, the amount of initial woodland cover (0% - 100%) is varied, and the disturbance event happens after 20 years. Note again how recovery of the woodland ecosystem is impaired in the presence of browsing (red line on graphs). Source: Evans *et al.* (2016).

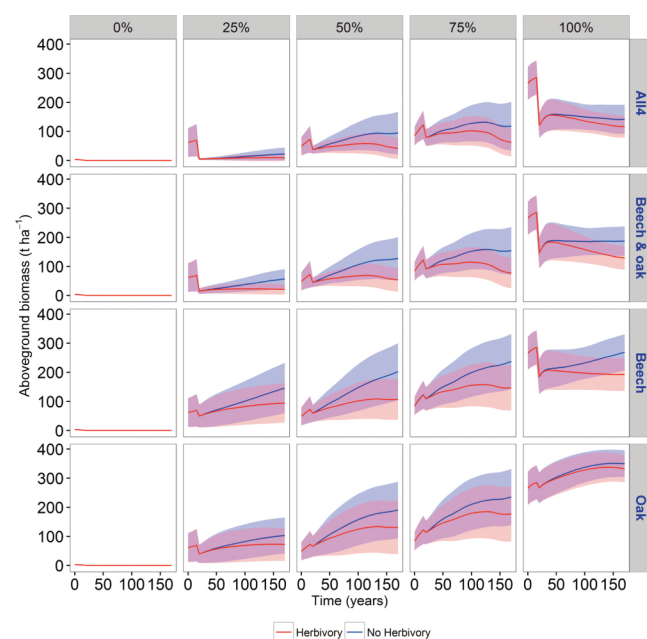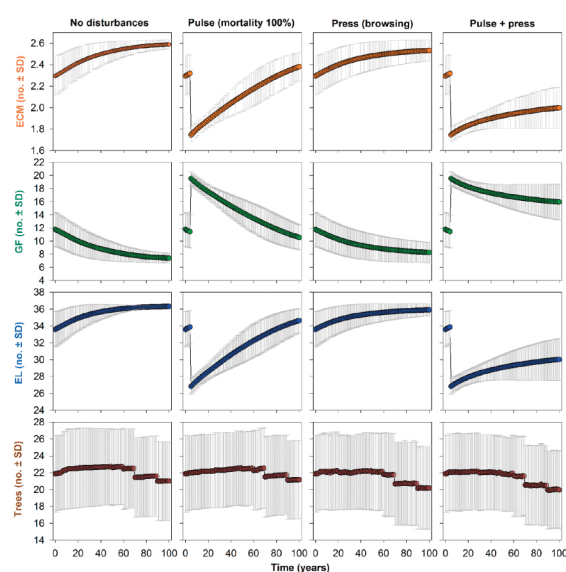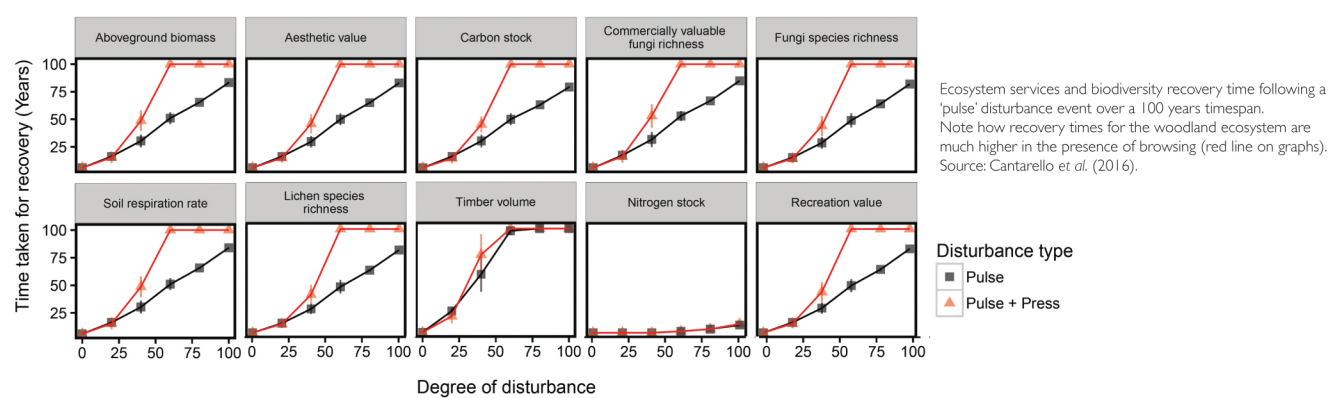## Could the woodland ecosystems of the New Forest recover from a major dieback event?

Large numbers of mature trees are currently dying in the New Forest. This situation is likely to deteriorate further in future, as emerging pests and diseases of trees arrive in the area. For example, Chalara dieback of ash has now been recorded in neighbouring areas of Dorset and Hampshire. This fungal pathogen has caused dieback of more than half of the ash trees in parts of Scandinavia, and is likely to cause major losses of ash in the UK. Acute oak decline has been recorded recently in the New Forest, and could also potentially lead to the death of many native trees. Other tree pathogens include Phytophthora disease of alder, which is already killing significant numbers of trees in the New Forest.

In order to answer this question, we need tools that can be used to forecast how woodland ecosystems might change in future in response to different forms of disturbance. One approach involves the use of computer models to simulate ecological dynamics. Such models have rarely been used to examine woodland ecosystems in the UK, but their use is widespread in other parts of the world, such as the USA.

We used the LANDIS II computer model to simulate the impact of tree mortality on the New Forest woodlands. This model was originally developed to simulate the dynamics of hardwood forests in the USA, but has since been used in many parts of the world. The model incorporates ecological information about different tree species, and the characteristics of the sites where they occur, across entire landscapes. To use the model in the New Forest, we first had to conduct a survey of all of the New Forest woodlands, to describe their stand structure and species composition. We then had to carefully calibrate and test the model, to ensure that its projections are accurate. We also used an extension of this model, called CENTURY, which enables the impact of woodland dynamics on the functioning of the ecosystem to be analysed in greater depth.

Our results show that woodland ecosystems can potentially recover from a significant disturbance event, as might be caused by a major drought or an outbreak of tree pathogens. It can take many decades for a woodland ecosystem to fully recover, depending on the processes of seed dispersal, tree establishment and growth. The survival and growth of young trees is particularly important to this recovery process.

However, our results also clearly show that the ability of woodland ecosystems to recover from a disturbance event is impaired by herbivory. The current levels of browsing by livestock and deer, which we included in our simulations, significantly reduce the rate of woodland recovery. This is because many young trees are eaten by these herbivores. This same result was found for different measures of biodiversity, such as the species richness of ectomycorrhizal fungi and lichens, and measures of ecosystem function, such as soil respiration, carbon stocks and biomass. This highlights the profound impact that herbivores have on this woodland ecosystem.