ABSTRACT

Dieback, largely attributed to the fungal plant pathogen *Phytophthora cinnamomi*, is characterized in the northern jarrah forest by multiple deaths of many plant species, including the dominant, *Eucalyptus marginata* (jarrah), a species of great commercial importance. The wide host range of the pathogen has major implications for the biodiversity of the ecosystem. The first records of dieback in the jarrah forest were made in the 1920s.

Despite the magnitude and long history of the impact in the jarrah forest, little is known about the vegetation changes that result from dieback. In this dissertation, I develop a model of vegetation change related to dieback by examining the vegetation of a range of dieback sites and relating the patterns identified to the current distribution of *P. cinnamomi*. The study is the first explicit investigation of floristic and structural patterns on dieback sites in the jarrah forest.

Substantial floristic differences were found between dieback and unaffected vegetation. The patterns are strongly correlated with the age of the original dieback event. There was little difference, however, in the mean number of species/quadrat between dieback and unaffected vegetation. The time since the inception of dieback was estimated using aerial photography. The oldest dieback sites located had been affected prior to 1951. Of the species found less frequently on these old dieback sites, 64% had not previously been associated with *P. cinnamomi* infection. Some of these were assessed for their susceptibility in glasshouse pathogenicity tests. New records of susceptibility were made at the species, genus and family levels. Several species regarded as being highly susceptible to infection by *P. cinnamomi* were found as frequently on old dieback sites as in unaffected vegetation. Many of the species found more frequently on dieback sites were probably present at the time of the initial dieback event. Others, mostly annuals, may have been introduced from nearby vegetation types with open canopies, such as granite outcrops. If plant invasions have occurred following dieback, the small
differences in species richness between dieback and unaffected vegetation may hide a great reduction in species richness due to dieback.

Structural changes following dieback may have a profound effect on some species regardless of their susceptibility to infection. A spatial association with trees on dieback sites was demonstrated for a range of species. The apparent reliance of some understorey species on tree cover is discussed in relation to current theories of patch dynamics.

Two methods were used to isolate *P. cinnamomi* from dieback sites. *In situ* Banksia *grandis* baits were more effective at detecting *P. cinnamomi* than *ex situ* baited soils, especially when *P. cinnamomi* was apparently rare.

*P. cinnamomi* was frequently isolated from creek edges with a long history of dieback and from active dieback fronts but was rarely found on sloping dieback sites affected prior to 1980. It is not clear if the *P. cinnamomi* present on pre-1951 dieback sites has persisted there since the initial dieback event or been re-introduced from active dieback fronts upslope.

Very few highly susceptible species appear to be totally eliminated by the pathogen at the time of the initial dieback event. The mass deaths at that time are followed by a period of recolonization of susceptible species with highly germinable seed. The survival of the new cohort of these species is a function of the time taken to produce another crop of seed.

Susceptible species may persist on the pre-1951 dieback sites because of highly germinable seed, young reproductive age, copious seed production and animal dispersal. The rarity of *P. cinnamomi* on these sites must greatly contribute to their persistence.

Pathogenicity testing in excised stems indicated that resistance to the movement of *P. cinnamomi* in plant tissue develops in jarrah populations on many dieback sites, although
it is unlikely to be integral to regeneration. Evidence of resistance in other species investigated could not be found.

The key elements in the model of vegetation change developed in the thesis are (i) the on-going occurrence of *P. cinnamomi* on dieback sites, (ii) the susceptibility of plant species to infection by *P. cinnamomi*, (iii) the sensitivity of plant species to structural changes, (iv) the proportion of a plant population killed, (v) the capacity of plant species for rapid recruitment after dieback, (vi) the time taken for plant species from germination to reproduction, and (vii) the capacity of plant species to invade. Stochastic factors such as fire, logging, climatic perturbations, and diseases caused by other pathogens, cannot be quantified and easily incorporated into the model.

Predictions are made about the future vegetation of dieback sites, contingent on intervention by forest managers. An epidemic - recovery cycle, involving concomitant fluctuations in pathogen and host populations, has been hypothesized by some authors for sites affected by *P. cinnamomi*. There is evidence of such a cycle on a small scale. On a larger scale, epidemics on dieback sites in the jarrah forest may be isolated in space and time.

The importance of long-term ecological studies of jarrah forest vegetation to our understanding of natural forest processes and the effects of dieback is stressed.