In July 2010, scientists and community became aware of alarming changes to tree crown health within pockets of marri (*Corymbia calophylla*) and jarrah (*Eucalyptus marginata*)-dominated forest. Severe shoot and foliage mortality was reported throughout large portions of the north-western jarrah forest, with marri suffering foliage dieback on the crown periphery and jarrah leaves first turning distinctly purple in colour prior to dying and shedding. Interestingly, affected trees appeared to be restricted to distinct patches, suggesting the phenomenon was microsite-dependent. Patches of affected forest were restricted to drainages. It was hypothesised that relatively uncommon frost events were at least partially responsible for the unusual foliage mortality (marri) and discoloration (jarrah). Parts of the northern jarrah forest experienced their coldest year in 40 years of records. Ecosystems throughout Western Australia (WA) experienced minimum air temperatures below -2°C on several nights, which likely translate to temperatures less than -4°C at the leaf surface. This study is investigating whether low temperatures could explain foliage loss in these trees.

Methods & Results

A field study was initiated in spring 2010 to advance our understanding of frost in WA forests and determine the impacts of the crown disorder observed during winter 2010. Field assessment of the extent of damage was recorded over 12 study plots (six ‘affected’ and six adjacent ‘unaffected’ plots), each measuring 40m in radius. For each plot, all trees over 4cm in diameter (DBH) were measured for a range of crown health parameters. Estimates of damage incidence (percentage of crown foliage damaged) and severity (average percentage of damage to affected leaves) were combined to establish a Crown Damage Index (outlined in Stone *et al.* 2003) to capture the immediate effects of the disturbance and provide a baseline for future monitoring.

On ‘affected’ sites, marri foliage suffered most, with trees losing between 5% and 100% of their canopy (avg. 40%) due to the disturbance. Damage to jarrah foliage ranged from 0% to 100% of the canopy (avg. 20%). By contrast, co-occurring wandoo (*E. wandoo*) trees were largely undamaged. All tree size classes were affected by the disturbance. Severely affected trees (>40% of crown foliage dead) ranged from 4–141cm in diameter and 2.4–24m in height. The field plots with the highest crown damage (Figure 1, left-hand side of the graph) can be collectively characterised as pockets of jarrah-marri overstorey within ‘typical’ wandoo-dominated flats. However, transition areas on middle slopes (e.g. plots A2, A4, and A7) were also affected. On unaffected plots, serving as ‘healthy’ controls, damage incidence was <3%, with most damage the result of foliage-feeding insect pests.

Future monitoring and data collection will determine how affected trees respond and if the observed damage results in an overall decline in tree health.

Subsequent laboratory experiments further developed our understanding of tolerance to low temperatures by young (three-year-old) marri and wandoo leaves. The method described by Raymond *et al.* (1986) was used to quantify damage to leaves exposed to low temperatures. As leaf cells are damaged by cold temperatures, they break, releasing their intracellular contents (including many ions, which conduct electricity through solutions). Using this attribute of leaves, we measured the conductivity of solution following exposure of leaf disks to 5 test temperatures, and derived a measure of relative conductivity (defined by Tibbits and Reid 1987).

Preliminary results suggest most cell damage occurs between -4 and -6°C for both marri and wandoo leaves (see Figure 2). These
Frost damage to *Eucalyptus* species is commonly observed in eastern Australian ecosystems, where research has developed an understanding of frost tolerance of local plant species, as well as prediction of the impacts of frosts. The impacts of frost on Western Australian ecosystems are not well understood and this study is the first to explore frost as a disturbance agent in these ecosystems. It is likely that frost damage is one of the many contributing factors to tree decline in WA, and a greater understanding of the effects of frost is essential to well-informed management decisions.

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References