The influence of depth-to-groundwater on the ecology of woodland vegetation

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Certificate of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This research is supported by an Australian Government Research Training Program Scholarship.

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Abstract

Groundwater-dependent ecosystems (GDEs) must have access to groundwater to maintain their ecological integrity. Groundwater extraction for human needs, however, is threatening GDEs globally. Consequently, an understanding of relationships between naturally occurring spatial gradients in depth-to-groundwater (DGW) and the ecological properties of vegetation assemblages is urgently needed. Currently, little is known about relationships between DGW and the ecology of mesic woodlands within GDEs. I used field work, desktop analyses and a novel experimental system to further our understanding of ecological relationships between DGW and woodland vegetation assemblages.

Plant species composition varied significantly with DGW across mesic woodland vegetation within the Kangaloon study region of south-eastern Australia, with spatial shifts in abundance of nine understorey species driving most of this variation. The compositional differences among assemblages were not underpinned by interspecific variation in several important plant traits (e.g. LMA, plant height, seed mass) in desktop analyses of literature-based trait data and in separate analyses using fresh field collections from the study region.

In a glasshouse experiment, I grew seedlings from seeds of *Hakea dactyloides* collected from both the shallow and deep ends of the DGW gradient at Kangaloon. Both shallow and deep seedlings were exposed to two treatments that simulated differences in soil-water infiltration rates between shallow (slow-draining) and deep (fast-draining) ends of the gradient. Seedlings demonstrated varying degrees of phenotypic plasticity in a range of traits to track changes in water availability of the local environment. For instance, seedlings derived from both populations reduced stomatal conductance and transpiration rates in the fast-draining treatment to increase water use efficiency. There

was little evidence for local adaptation to differentiate the seedlings of populations from the two ends of the DGW gradient.

In a complementary study of arid-zone woodlands of the Ti Tree Basin in central Australia, I found that woodland assemblages with high total plant abundance were correlated with shallow DGW. In addition, the proportion of perennial species increased and the proportion of annual species decreased as DGW increased, and the number of shrub species increased with increasing DGW. These findings, so different from mesic woodlands, indicate that relationships between DGW and the ecology of woodland plant assemblages are not broadly generalizable between ecogeographic regions.

My research provides compelling evidence that DGW influences the ecological properties of vegetation assemblages in idiosyncratic ways between different regions. This research contributes important baseline information vital for the sustainable management of woodland vegetation of GDEs.