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Using stable isotopes to identify soil moisture sources of key species in riparian woodlands of the northern Murray-Darling Basin

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Remnant riparian woodlands on the Upper Condamine floodplain of the northern Murray-Darling Basin are characterised by the dominant canopy species *Eucalyptus camaldulensis* (river red gum), a facultative phreatophyte, preferentially accessing shallow groundwater sources particularly during drought conditions. The invasive alien species *Phyla canescens* (lippia) is also dominant in these ecosystems. Lippia is a low-growing clonal species, readily dispersed by flooding, with potential to spread throughout much of the Murray-Darling system with significant economic and environmental impact. Lippia is highly abundant in mesic situations, while under harsher conditions, it may be abundant only in refugia beneath tree canopies. It is likely that trees facilitate the persistence of lippia in these landscapes, enabling it to survive and reproduce (establishing significant propagule/seedbanks); it is also probable that interactions with lippia are detrimental to the health of canopy eucalypts in these woodlands, where significant dieback/declining condition is reported.

Natural abundance stable isotopes offer a means by which the water sources of these two ecologically-important species can be identified and better understood. Clarification of water relations contributes to better understanding of environmental constraints on species, particularly under stressful conditions. It can also highlight the potential risk associated with future climate change which may see increased incidence of prolonged drought and intense flooding, increased dispersal of invasive weed species, accelerated groundwater decline, and increased vulnerability of important keystone species such as dominant woodland eucalypts.

Natural abundance stable isotopes have been used to investigate tree-water source relations and interactions between trees and groundcover vegetation in seasonally water-stressed environments. This research proposes to use this approach to investigate the relative importance of water sources utilised by *E. camaldulensis* and *P. canescens* under low ambient soil moisture conditions in riparian woodlands of the northern Murray-Darling Basin.

This study aims to resolve species-specific and location-specific differences in the relative importance of water sources in this landscape, by addressing 3 hypotheses:

(i) that, during drought (low soil moisture) conditions, water sources of *E. camaldulensis* and/or *P. canescens* do not change with increasing depth to groundwater (H1);

(ii) that, under drought (low soil moisture) conditions, water sources of *P. canescens* do not change with increasing distance from trees (E. camaldulensis) (H2); and

(iii) that, during drought (low soil moisture) conditions, water sources of *E. camaldulensis* and/or *P. canescens* do not vary between healthy trees and trees exhibiting poor tree health (H3).

Hydrogen (deuterium) isotope ratios (d2H) - or variation in the natural abundance stable isotope ratio of water (2H and 18O) - will be assessed in *E. camaldulensis* twig and *P. canescens* stem xylem water and four potentially-important water sources: surface soil (10-30 cm), subsurface soil (60-80 cm), groundwater and in-stream surface water.

This study will help to clarify the extent of variation in the isotopic signatures of source waters in this landscape.

If the technique proves useful, it may help to define the role of shallow groundwater resources in ecosystems subject to seasonal and long-term drought, and/or potentially at risk associated with floodplain development and predicted climate change. It will also help to elucidate potentially important interactions between *E. camaldulensis*, an important structural and functional species in these ecosystems, and the invasive weed, *P. canescens*.

This research question has arisen from a recent study of the systems ecology of riparian woodlands on the highly-modified Upper Condamine floodplain, part of an important headwater catchment of the Murray-Darling Basin in southern Queensland. A key focus of the research has been the role of altered hydrological regimes and of invasive weeds in driving changes in the condition and function of these important remnant ecosystems. The research has taken a functional approach, where possible, to develop a more mechanistic understanding of system responses. This current investigation follows on from that by asking about the interactions between two key structurally- and functionally-dominant species in accessing scarce but essential available water resources in this landscape. Natural abundance stable isotopes offer a relatively reliable method to resolve this type of question.

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