THE ROLES OF SEED BANKS AND SOIL MOISTURE IN RECRUITMENT OF SEMI-ARID FLOODPLAIN PLANTS: THE RIVER MURRAY, AUSTRALIA

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Declaration of Originality

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List of Papers

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Jensen, A.E., Walker, K.F., & Paton, D.C. (2006). The Secret Life of Tangled Lignum, *Muehlenbeckia florulenta* (Polygonaceae): little known plant of the floodplains. In *Wetlands of the Murrumbidgee River Catchment* (eds I Taylor, P. Murray & S. Taylor), 79-85. Murrumbidgee Catchment Management Authority, Leeton, NSW.

Jensen, A.E., Walker, K.F., & Paton, D.C. (2007). Using phenology to determine environmental watering regimes for the River Murray floodplain, South Australia. In *Australian Rivers: making a difference* (Eds A.L. Wilson, R.L. Dehaan, R.J. Watts, K.J. Page, K.H. Bowmer & A. Curtis). Proceedings of 5th Australian Conference on Stream Management, 175-180. Charles Sturt University, Albury, New South Wales.

Jensen, A.E., Walker, K.F., & Paton, D.C. (2008a). Smart Environmental Watering: getting most benefit from scant flows for floodplain trees (River Murray, South Australia). In *Proceedings of Water Down Under 2008 Conference,* (Eds) Daniell, T., Lambert, M. & Leonard, M., 15-17 April, Adelaide, 1426-1437. Engineers Australia, Melbourne, Australia.

Jensen, A.E., Walker, K.F., & Paton, D.C. (2008b). The role of seed banks in restoration of floodplain woodlands. *River Research & Applications*, 24, 632-649 (2008). *Special Issue: Proceedings of Riverine Ecohydrology Conference,* Stirling Scotland, 2006.

Jensen, A.E., Walker, K.F., & Paton, D.C. (2008c). The floodplain seed bank of a regulated lowland river: composition and responses to wetting treatments for the River Murray floodplain, Australia. *In prep*.

Jensen, A.E., Walker, K.F., & Paton, D.C. (2008d). Soil Moisture for Seedling Survival: a key factor in woodland decline on the Lower Murray, Australia. *In prep*.

Statement of Authorship

For the first four published papers listed above:

Anne Elizabeth Jensen performed analysis on all samples, interpreted data, wrote the original draft manuscript and coordinated all amendments, and acted as corresponding author. Keith Forbes Walker and David Cleland Paton supervised project design and data collation, reviewed data interpretation and manuscript content, and provided editing comments on the final papers.

For the last two submitted papers listed above:

Anne Elizabeth Jensen performed analysis on all samples, interpreted data, wrote the original draft manuscript and coordinated all amendments, and will act as corresponding author. Keith Forbes Walker and David Cleland Paton supervised project design and data collation, reviewed data interpretation and manuscript content, and provided editing comments on the final papers.

ANNE ELIZABETH JENSEN

I hereby certify that the statement of contribution is accurate

Signed Date

KEITH FORBES WALKER

I hereby certify that the statement of contribution is accurate and I give permission for the inclusion of the paper in the thesis

Signed Date

DAVID CLELAND PATON

I hereby certify that the statement of contribution is accurate and I give permission for the inclusion of the paper in the thesis

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Abstract

The decline of floodplain vegetation along the Lower River Murray, South Australia, has evoked recommendations for 'environmental flows' to restore and maintain the health of the ecosystem. To assist managers to maximize benefits from environmental flows, this thesis considers the significance of water for germination and recruitment in key floodplain plant species. Three dominant species are considered, including two trees, river red gum (*Eucalyptus camaldulensis*) and black box *(E. largiflorens*), and an understorey shrub, tangled lignum (*Muehlenbeckia florulenta*).

The soil seed bank was dominated by terrestrial annual native plants. Among 1400 seedlings, a single river red gum was found, and no black box or lignum, suggesting that these species do not contribute to the persistent soil seed bank and rely instead on aerial seed banks (*serotiny*). Sampling of the soil seed bank was continued to determine when seed fall might coincide with appropriate soil moisture conditions. Responses of the soil seed bank to varied water regimes were compared to determine requirements for seedling survival. The results indicated that species richness, rapidity of response and survival time were all promoted by sustained soil moisture.

Stands of eucalypts in various states of health (from very stressed to very healthy) were monitored to identify seasonal patterns in bud crops, flowering, fresh leaves and volumes of seed released from the aerial seed bank. Distinct seasonal phenological patterns were apparent, and suggested alternating flowering among individual trees (biennial for red gum, bi-annual for black box), producing an annual peak in summer. Peak seed rain occurred in summer (December–March) in healthy trees for both red gum and black box, with light seed rain continuing throughout the year. Seed fall from stressed trees was much reduced. Stressed trees responded after a second watering event, with much more varied and extended annual seed fall patterns.

Lignum showed a spring peak in flowering and seed production. There was a prolific response of flowering and seeding to rainfall, but few seedlings survived. Vigorous vegetative growth occurred in existing plants in response to rainfall and watering but no new cloned plants were found during the study. An investigation of chromosomes as a potential tool to appraise the balance between sexual and asexual reproduction in lignum proved inconclusive, although a previous report of octoploidy in lignum was confirmed.

Seeds from all three species and lignum cuttings were tested for their responses to varied watering regimes, based on combinations of simulated rain and flood conditions. The optimal soil moisture for continued growth and survival in all seeds and cuttings was 10-25%, with moisture values <10% causing wilting and death. The results also suggested that red gum and black box seeds which germinate in water under flooded conditions need to be stranded onto moist soil at the water's edge within 10 days, for the seedling to continue to grow. It was also concluded that germination on rain-moistened soil is a key supplementary mechanism for recruitment, particularly between irregular flood events.

For greatest benefit, the timing of environmental flows should complement any seasonal rainfall and irregular flooding that may occur. Extension of suitable soil moisture conditions (10-25%) for as long as possible after >5 mm rainfall, or after over-bank flows, would increase chances for survival of seedlings. December is the most likely month for maximal benefit from watering in the Lower Murray Valley, for germination and recruitment, based on regional rainfall and flooding patterns.

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