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**The Effect of Water Regime on  
*Juncus articulatus* L. and *Glyceria australis* C. E. Hubb.  
in the New England Lagoons**

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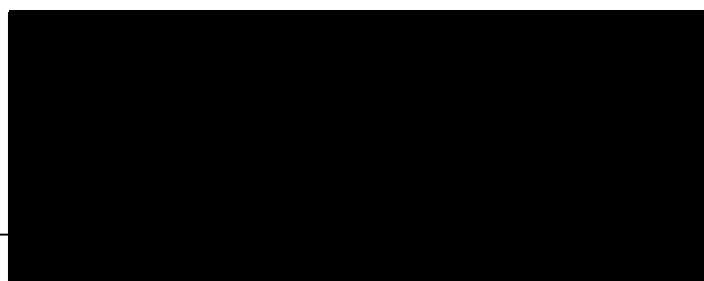
**A thesis submitted for the degree of  
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**Declaration**

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree.

I certify that to the best of my knowledge any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.



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## Preamble

Two papers have been published and one accepted for publication that are based on material in this thesis:

Smith, R. G. B. and M. A. Brock. 1996. Coexistence of *Juncus articulatus* L. and *Glyceria australis* C. E. Hubb. in a temporary shallow wetland in Australia. *Hydrobiologia/Developments in Hydrobiologia*, **340**, 147-151. (Chapter 5)

Smith, R. G. B. and M. A. Brock. 1998. Germination potential, growth patterns and reproductive effort of *Juncus articulatus* and *Glyceria australis* in temporary shallow wetlands in Australia. *Wetlands Ecology and Management*. **5**, 203-214. (Chapters 5 and 7)

Brock, M. A., Smith, R. G. B. and P. J. Jarman In press. Drain it, dam it: alteration of water regime in shallow wetlands on the New England Tableland of New South Wales, Australia. *Wetlands Ecology and Management*. (Section 1.4)

Copies of these papers are appended (Appendix D). The work in the first paper is my PhD work presented in Chapter 5. The work in the second paper is also my PhD work but contains seed bank data from Dr Margaret Brock. The analysis, presentation and interpretation of this data are my work. In the third paper I was responsible for collation of historical data and for some of the ideas addressed and partook in analysis and discussion on much of the content.

## Abstract

The New England lagoons are shallow and temporary wetlands on the northern tablelands of New South Wales, Australia. *Juncus articulatus* is an exotic aquatic species that occurs over large areas of Mother of Ducks Lagoon and parts of Little Llangothlin Lagoon, but is rare in other lagoons. The other dominant perennial species at Mother of Ducks and common in many lagoons, including Little Llangothlin, is the native grass *Glyceria australis*. Of primary importance to the ecology of the lagoons is the pattern of water level fluctuations or water regime. Little is known of the ecology of either species in relation to water regime or of the potential of *J. articulatus* for invasion of wetlands.

Unlike the more tropical climates to the north and the more temperate climates to the south, the water regimes in the lagoons do not have a seasonal pattern. Water levels in a range of lagoons measured over several years showed fluctuations at time scales greater than one year as well as shorter intervals. A hydrological model of water depth in the lagoons showed water levels to be sensitive to rainfall, evaporation, groundwater flow as well as the geology and physical characteristics of the lagoons and their catchments. Plant community composition in the lagoons was related to latitude, geology and proximity to other lagoons and also to damming.

A combination of field, glasshouse and outdoor experiments confirmed that water regime affected the seed bank dynamics, growth, reproduction, interaction and coexistence of *J. articulatus* and *G. australis*. An experimental methodology was developed to test the effect of individual components of water regime. There was no difference in biomass allocation between the two species in response to the proportion of time flooded, whereas the contrasted reproductive allocation of the two species varied in response to the amplitude or frequency of water level fluctuations in combination with proportion of time flooded. *G. australis* growth was less reduced by dry periods than *J. articulatus* and *G. australis* had a consistently higher ratio of root to shoot biomass. *G. australis* flowered infrequently in pot experiments, whereas *J. articulatus* consistently allocated biomass to inflorescences under all water regimes,

even when growth was restricted. Both species produced stolons in all experiments, most often when water levels were high and stable.

In a manipulative field experiment that measured changes in species composition in response to changed lagoon bed levels, *G. australis* and *J. articulatus* were intermediate in the speed of response compared to other coexisting species. Some species responded rapidly, whereas others showed little change. Species strategies, based on tolerance or response to water level changes, should be considered when interpreting plant community changes at different time scales. In field and pot experiments, *J. articulatus* displayed less drought tolerance than *G. australis* and other native species, including some that usually grow in wetter situations than *J. articulatus*. In a pot experiment investigating competitive interactions in response to water regime, *J. articulatus* had greater competitive ability during the first year, but *G. australis* was the better competitor during the second, especially when not flooded. Therefore, *J. articulatus* needs to reproduce from seed more often than native species to survive in the New England lagoons.

*J. articulatus* germinated in very high numbers from Mother of Ducks Lagoon sediment but rarely from other lagoons in the region. In contrast, *G. australis* germinated in comparatively low numbers from Mother of Ducks Lagoon sediment and rarely from other lagoon sediments, despite being present in the extant vegetation in many lagoons. In glasshouse and field experiments, both species had persistent seed banks from which only a small percentage of seeds germinated in repeated wetting events and from sediment stored dry. Grazing stimulated above ground vegetative and sexual reproduction for *J. articulatus* and production of high numbers of tillers facilitated sexual reproductive effort.

*J. articulatus* occurs throughout the region in drains and creeks but is rare in lagoons other than Mother of Ducks. Our results suggest that management of this exotic species should be directed towards minimising competitive advantage and recruitment opportunities. This could be achieved by manipulating water regimes to ensure there are drought periods, in combination with minimising soil disturbance from grazing by maintaining vegetative cover.