Predicting the Effects of Restoring Tidal Connectivity on the Vegetation of Fresh and Oligohaline Wetlands: Clarence River Floodplain, Northern NSW

Caitlin Verity Johns
B.Sc., Australian National University, 1998
Honours, Macquarie University, 2001

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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 or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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Signature

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Abstract

Tidal wetlands are decreasing in number and extent worldwide due to the effects of drains and tidal barriers. These disrupt salinity gradients, reduce the depth, duration and frequency of inundation, prevent exchange of organic and inorganic materials, and interrupt movement of aquatic biota and propagules. Common effects include reductions in bird and fish populations, invasion by terrestrial and freshwater macrophytes, sediment subsidence caused by peat degradation, and activation of acid sulfate soils leading to land degradation and water quality problems.

Active management of floodgates has been proposed to restore tidal exchange to waterways and wetlands of the Clarence River floodplain, on the north coast of New South Wales, Australia. Predicting the potential effects of tidal restoration on macrophyte communities is of high priority, particularly for wetlands in the fresher half of the estuarine salinity gradient. The vegetation at these sites provides important foraging and nesting habitat for rare waterbirds and a valuable pasture resource. Our ability to predict the effects of increased tidal connectivity on macrophyte communities in these wetlands is limited. Previous research in Australia has focused on saltmarsh species found in saline habitats and few data are available on the salinity and inundation tolerance ranges of macrophytes found further upstream. Existing models for predicting the effects of tidal restoration on macrophyte community composition are generally inapplicable to these communities because of the need for reference data, either from natural tidal wetlands located nearby or from surveys carried out at rehabilitation sites prior to drainage and tidal restriction. Neither of these are available for wetlands on the Clarence River floodplain.

An extensive survey was used to determine distributions of macrophyte species in floodgate-affected wetlands along the Clarence River floodplain, and to relate these distributions to environmental variables, including salinity, relative elevation, acidity, water management and grazing intensity. Strong significant correlations were found between community composition and both site salinity and water depth, indicating the

potential value of these variables as predictors of species occurrence. Five focal species were identified that were both abundant and widely distributed across a range of salinities and depths, including *Bacopa monnieri* (L.) Pennell, *Bolboschoenus caldwellii* (V. J. Cook) Soják, *Cynodon dactylon* (L.) Pers, *Eleocharis equisetina* C. Presl and *Paspalum distichum* L..

Two tub experiments were used to demonstrate differences in the salinity and inundation tolerance ranges of focal species, the first testing the impact of salinity alone and the second the impacts of both increasing depth and salinity. The inundation tolerance thresholds of all species decreased with increasing salinity although tolerance to salinity and inundation varied considerably between species. For example, based on survivorship *C. dactylon* was least tolerant of high salinity in waterlogged conditions, while *P. distichum* was most tolerant, and when submerged *E. equisetina* and *P. distichum* grew rapidly to the water surface, while *C. dactylon* did not.

Finally, a broadly applicable conceptual model is described for predicting the effects of tidal flow manipulation on the persistence of focal species at rehabilitation sites. This model incorporates state and transition models into an overarching assembly rule model framework, and can be applied using experimental data on species salinity and inundation tolerance ranges and field data on site conditions. A specific model was then developed for focal species at a number of sites on the Clarence River floodplain, and predictions were made about the effects of floodgate manipulation on the persistence of 13 different species. The actual and predicted distributions of seven of these species were then compared. Five of the seven species were found at sites predicted to be too saline for their survival, indicating a need for further model refinement.

The conceptual model framework and data collection methods employed here are not site- or species-specific, and could potentially be used in other projects where managers wish to predict the effects of tidal flow restoration on macrophyte communities. Unlike previous tidal restoration models, this type of model is not dependent on community composition data from reference sites or historical sources, which are often not available in extensively modified areas.

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Photo: Floodgate for regulating tidal exchange at the Little Broadwater Wetland on the Clarence River floodplain, May 2007.