IMPACTS OF AN ALTERED WATER AND SALINITY REGIME ON THE CONDITION OF WETLANDS IN THE UPPER SOUTH EAST OF SOUTH AUSTRALIA

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ABSTRACT

The Upper South East (USE) region of South Australia covers over 1M ha and is the largest area affected by dryland salinity in South Australia. In 1999, it was estimated that 40% of the region was affected by salinity. To mitigate the threat of flooding and secondary salinisation, an extensive network of drains has recently been constructed. Whilst these drains may have a positive effect on the agricultural land, the impacts they will have on the hundreds of wetlands in the region is as yet, unknown. It is likely that the hydrologic regimes the wetlands are exposed to will be highly modified and the quality of the water that supplies them will be greatly affected by high salinity levels.

This work examined the impact of these landscape scale changes on wetlands in the South East region of South Australia and investigated ways in which water from the drainage system might be used for ecological benefit in wetlands. The aims were to:

- determine whether there have been changes in species composition that can be linked to changes in the salinity and hydrology regimes experienced in the wetlands and to gain a better understanding of the processes and mechanisms that drive the change in species composition and cause salt to accumulate in wetlands via the development of a conceptual model;
- produce curves predicting the probability of occurrence in relation to salinity for species common in wetlands in the South East of South Australia;
- investigate the effects of an increase in salinity with decreasing water depth as a result of evapoconcentration on the growth and survival of three common freshwater macrophytes, and to determine the consequences of longterm exposure to elevated salinity conditions;
- assess the impact of a pulsed discharge of saline drainage water of varying concentrations and durations on key wetland species in an effort to determine how to make best use of the scarce water resources in the region and; and
- assess the combined effects of salinity and hydrology on the seed banks of wetlands that have experienced drought and elevated salinity conditions.

The results of vegetation surveys conducted pre-2000 and post-2000, indicate an overall change in species composition; species requiring fresh conditions are rarer or not recorded and are replaced by species preferring more saline conditions. This change is accompanied by a shift from fresher to saltier conditions and from wetter to drier conditions. Data from groundwater observation bores coupled with flow volumes in the local watercourses supports the process of salt accumulation in wetlands described in the conceptual model.

The curves predicting the probability of occurrence in relation to salinity display a wide range in tolerances across the 15 species for which they were constructed, and highlight the variance due to between wetland differences. These curves, used in combination with knowledge gained from other studies will enable salinity thresholds to be set for many of the common species found in the South East region. Employing these thresholds to drain operation will allow wetlands to be managed in a way that will promote the occurrence of target species.

The study on evapoconcentration effects showed that the percentage of biomass allocated to below ground structures was > 95, > 90, > 75 and > 80% for adult and juvenile *T. procerum,* and for *B. arthrophylla* and *B. medianus* respectively, across all salinity treatments suggesting that long term exposure to elevated salinity conditions results in a large investment in below ground biomass by all species. This study also indicated that the initial lifestage at time of exposure to the salinity regimes had a significant effect on the final dry weights of the *T. procerum* plants. The differences in the dry weights and leaf length and number were greatest between adults and juveniles in the lower salinity treatments (1500 and 6250 $\mu S\ cm^{-1}$), with the adults having much larger weights and measures. At higher salinities (12500 and 18750 $\mu S\ cm^{-1}$), there were no differences. Salinities refer to the salinity of the surface water, not soil salinity.

For the plants tested in the pulse salinity regime experiment, the immediate effect of high salinity environments on non-halophytic plants was not detectable after three to six weeks of exposure, but the short term impact of the pulse did affect the ability of submerged plants to recover.

The seed bank trial showed that the previous drought and salinity conditions experienced by a wetland did affect the seed bank however the water and salinity

regime imposed mitigated these impacts. The study provides evidence that extended periods of drought conditions may lead to a seed bank which has a reduced abundance of seeds and repeated exposure to high salinity changes the species composition of the seed bank and reduces the overall diversity.

Our knowledge of wetland plants, habitats, individual wetlands and their pattern in the landscape enables interpretation of how wetland plants have changed and will continue to change in the landscape. The challenge is to use, and build on this knowledge to predict what future wetland landscapes might look like under different management or development scenarios in the USE and to decide what is sustainable.

DECLARATION OF ORIGINALITY

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Abigail May Goodman and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Abigail May Goodman

April 2012

PUBLICATIONS ASSOCIATED WITH THIS THESIS

CHAPTER 6 Pg 68

The response of freshwater plants to salinity pulses

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The effect of inundation and salinity on the germination of seed banks from wetlands in South Australia

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FOREWARD

This thesis has been prepared as a series of chapters in a format that will be suitable for future publication in scientific journals. To maintain the sense of individual chapters, this has inevitably led to some repetition between chapters.

Chapter 6: The response of freshwater plants to salinity pulses and *Chapter 7: The effect of inundation and salinity on the germination of seed banks from wetlands in South Australia*, have been published in the international journal of Aquatic Botany. In the interest of continuity of the thesis, these chapters have been included as part of the word document. In the publications, salinity was reported in mg L^{-1} but these have been converted to $\mu S\ cm^{-1}$ for inclusion in the main body of the thesis. Copies of these publications have been added as Appendices I and II respectively.

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