Salinity and Nutrients; Growth and Water Use of Aquatic Macrophytes Under Controlled and Natural Conditions

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A thesis submitted to The University of Adelaide for the degree of Doctor of Philosophy

April 1998
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Summary

Both salinity and eutrophication are regarded as significant threats to freshwater habitats. This research addresses several issues related to these critical problems. The first was to evaluate the potential for nutrient load to alter plant performance under saline conditions. In *Bolboschoenus medianus*, salinity was found to reduce the relative growth rate (RGR), whilst higher nutrient loads generally increased the RGR. The benefits of higher nutrient loads however diminished as salinities increased, suggesting a limited potential for nutrients to improve plant performance. Responses to nutrient load and salinity were specific; with nutrient load increasing the RGR via an increase in the leaf area ratio (LAR), and salinity reducing the RGR via a reduction in the net assimilation rate (NAR). Reductions in NAR in response to salinity were associated with lower rates of photosynthesis. Increases in LAR in response to higher nutrient loads were associated with a shift in biomass allocation from roots to leaves. A prominent response of *B. medianus* to higher salinities was a change in biomass allocation from culms to tubers.

The second objective was to determine if species with contrasting RGRs would demonstrate differential responses to salinity-nutrient regimes, as predicted by the plant strategy model of Grime. To explore this, the influence of salinity-nutrient regimes on the performance of *Typha domingensis* and *Baumea arthropylla*, with putative high and low RGRs, respectively was tested. As anticipated *B. arthropylla* was found to have a considerably lower RGR compared to *T. domingensis*. As predicted by Grimes’ model the RGR of *B. arthropylla* was unaffected by nutrient load regardless of salinity, whilst the RGR of *T. domingensis* was increased by higher nutrient loads. In both species productivity was reduced by salinity. The decline in RGR in response to salinity was however steeper in *T. domingensis* than *B. arthropylla* at the higher nutrient loads, demonstrating a greater sensitivity to salinity, and again a limited capacity for nutrients to enhance growth as salinities increase. As found in *B. medianus*, the response to nutrient load and salinity were specific in *T. domingensis*; with LAR increasing in response to higher nutrient loads and NAR declining in response to salinity. In *B. arthropylla*, growth analysis did not clearly
demonstrate specificity in responses to salinity and nutrient load. LAR was reduced by salinity and unaffected by nutrient load, however, NAR was reduced by both salinity and the high nutrient load. Despite this, specificity to salinity and nutrient load in B. arthrophylla was demonstrated, since most other measured parameters were affected by salinity but unaffected by nutrient load. As observed in B. medianus, B. arthrophylla responded to increasing salinity by a shift in biomass allocation from stems to rhizomes.

The third aspect of this research was to assess the influence of saline ground water on soil and surface water salinities within ephemeral wetlands. Salinities were monitored within three sites at Bool Lagoon; a major wetland in the lower south east of South Australia. Substantial changes in surface water, and soil salinities in the 0-15 cm depth class, occurred in response to drawdown at all sites, even where the salinity of the ground water was only 3 dS m⁻¹. Salinities in the 15-30 cm were more stable. The presence of a fresh water lens over saline ground water (18 dS m⁻¹) appeared to minimise the impact of ground water on soil salinities. Soil and surface water salinities were considerably higher at a site isolated from the main wetland system with a ground water salinity of 15 dS m⁻¹, and demonstrated the significance of drawdown duration and flushing on the salt balance.

The water balance of wetlands was considered an essential factor influencing salinities within wetlands systems. Therefore rates of evaporation for two morphologically distinct macrophytes, T. domingensis and B. arthrophylla, were estimated using the Penman-Monteith equation and compared to open water. This permitted the potential impact of vegetation, vegetation type and salinity on the water balance of wetlands to be evaluated. Canopy transpiration differed between vegetation types and between sites. Differences were driven primarily by differences in leaf area indices (LAI) rather than by differences in vegetation height or stomatal resistance. Although lower LAIs yielded lower rates of canopy transpiration, it also increased the penetration of solar radiation to the water body below the canopy. Consequently, differences in canopy transpiration were less apparent when total water loss; the sum of canopy transpiration and evaporation of water below the canopy, were compared. Water loss from vegetation was found to be strongly influenced by VPD, whilst
evaporation from open water was determined primarily by net radiation. As such, differences in rates of water loss from open water and vegetation varied depending on climatic conditions. Calculations based on meteorological conditions in February '97, when the mean vapour pressure deficit was high, indicated that under these conditions water loss from *T. domingensis* or *B. arthropylla* canopies were greater than open water when the LAI was greater than 3. When water loss below the canopy is also considered, then water loss from these stands exceeded open water when the LAI was greater than 0.5. The findings highlight the importance of water loss below the canopy in evaluating the impact of vegetation on the water balance.