A multi-scale investigation into the effects of permanent inundation on the flood pulse, in ephemeral floodplain wetlands of the River Murray.

The Murray-Darling Junction during the drought of 1914
Photo, taken by Sydney Milne, was kindly donated by his son Robin Milne for use in this thesis.

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Abstract

Using a multi-scale experimental approach, the research undertaken in this thesis investigated the role of the flood pulse in ephemeral floodplain wetlands of the River Murray, in order to better understand the impact of river regulation (and permanent inundation) on these wetlands.

An ecosystem-based experiment was conducted on the River Murray floodplain, to compare changes in nutrient availability and phytoplankton productivity in three ephemeral wetlands (over a drying/re-flooding cycle) with three permanently inundated wetlands. In the ephemeral wetlands, both drying and re-flooding phases were associated with significant increases in nutrient availability and, in some cases, phytoplankton productivity. It was demonstrated that the 'flood pulse', as described by the Flood Pulse Concept (FPC), can occur in ephemeral wetlands in dryland river-floodplain systems, although considerable variation in the nature of the pulse existed amongst these wetlands. Results of this experiment suggest that factors such as the degree of drying and length of isolation during the dry phase, the rate of re-filling, timing of re-flooding and the number of drying/re-flooding cycles may be potentially important in producing the variation observed.

Permanent inundation of ephemeral wetlands effectively removed these periods of peak nutrient availability and phytoplankton productivity, resulting in continuously low levels (of nutrient availability and phytoplankton productivity). It was concluded that alteration of the natural hydrological cycle in this way can significantly reduce nutrient availability, primary production and secondary production, essentially changing the structure and function, the ecology, of these wetlands. Equally, the results of this experiment indicate that some of the changes resulting from river regulation and permanent inundation can be somewhat reversed, within a relatively short period of time, given re-instatement of a more natural hydrological regime.

A mesocosm experiment was used to examine the influence of the dry phase, specifically the effect of the degree of wetland drying, on patterns of nutrient availability and primary productivity comprising the flood pulse. Compared to permanent inundation, re-flooding of completely desiccated sediments increased carbon (C) and nitrogen (N) availability while partial drying generally decreased, or had little

effect on, C and N availability after re-flooding. However, degree of drying had little effect on phosphorus availability or rates of primary production measured after re-flooding, and it is possible that these two factors are related. Partial drying reduced rates of community respiration after re-flooding, possibly a reflection of the reduced carbon concentrations measured in these mesocosms in this phase of the experiment. Degree of drying also influenced the macrophyte community (measured after three months of flooding), with plant biomass generally decreasing and species diversity increasing as the degree of drying increased (with the exception of complete sediment desiccation which had lasting negative effects on both macrophyte biomass and species diversity).

The results of the ecosystem and mesocosm experiments were utilised, in addition to results collected from the same experiment conducted at two smaller scales (minicosms and microcosms), to assess whether the effects of hydrological regime on nutrient availability at the 'wetland' scale could be replicated in smaller-scale experiments. None of the smaller-scaled experiments included in this investigation were able to replicate the specific response to hydrological regime recorded at the ecosystem scale, however the mesocosm experiment did produce results that were more similar to those at the ecosystem scale than those produced by the mini and microcosm experiments. The results of this study indicated that extrapolation of results from small-scale experiments should be undertaken with caution, and confirmed that a multi-scale approach to ecological research is wise, where large-scale field experimentation and/or monitoring provides a check on the accuracy, and hence relevance, of conclusions reached via mesocosm experiments.

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