Patterns and processes in zooplankton and water quality across the Chowilla Floodplain during a large flood.

by

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Deborah Jane Furst

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SUMMARY

Within riverine ecology a generalised concept such as the Flood Pulse Concept or the River Continuum Concept is yet to be developed that accurately describes patterns and processes within lowland rivers of arid or semi-arid climates (hereafter termed dryland rivers). A lot of the difficulty associated with developing a concept for these systems is in part due to the extreme hydrological variability. Australian dryland systems are rated amongst the most variable systems in the world where the variability in flow plays a crucial role in driving ecological processes.

The objective of this thesis was to investigate how a large dryland river floodplain responds to flood and the quantity of nutrient, phytoplankton and zooplankton resources contributed to the riverine food-web. Five permanent channel and four ephemeral floodplain sites were sampled within the Chowilla Floodplain and adjacent River Murray in South Australia from the 17 December 2010 until 18 November 2011. Five hydrological phases were defined based upon the degree of hydrological connectivity.

During the first hydrological phase water flowed through the anabranch system yet remained confined within the banks of the creeks and lakes. Zooplankton communities were diverse with up to 63 species per site and these communities were dominated by rotifers. Supplemented by the pre-existing egg bank, communities within the floodplain lakes (up to 10,409 individual's litre^{-1}) were considerably more abundant in comparison to the permanent sites (up to 613 individual's litre^{-1}).

During the expansion phase, water began to spill over the banks of creeks, lake and wetland depressions onto the flatter areas of the floodplain. This significantly increased the inundated area, the area of lotic habitat and floodplain discharge. During this phase the dissolved oxygen concentration and turbidity differed between sites but the bulk river flow drove similarities in conductivity, chlorophyll-a and particulate organic material[1] and increased mixing of zooplankton communities across the floodplain. Substantial export of nutrients from the floodplain occurred in dissolved and particulate forms and continued into the contraction phase as river flows decreased causing floodplain drawdown. The recession of water into the main river channel brought with it high concentrations of filterable reactive phosphorus (FRP), phytoplankton, zooplankton and other fine particulate

[1] Particulate organic material = volatile solid concentration which is the concentration of solids in water that are lost on ignition of the dry solids at 550 degrees C.

organic material. The calculated load of each of these resources were approximately 182 tonnes of FRP, 466 tonnes dry weight phytoplankton, 368 tonnes dry weight zooplankton and 7515 tonnes of fine particulate organic material in the two phases from 11 February until 5 May 2011. Both alpha (habitat) and gamma diversity (landscape) were highest during floodplain connectivity (phases 1-3).

The major waterbodies were isolated during the disconnection phase and during the fifth water evaporated and habitats became dry. Isolated habitats became increasingly dominated by copepods and were associated with increasing conductivity. Due to the production of diapause eggs primarily by species that were imported within the floodwaters the egg bank was more diverse after than before flooding.

The findings discussed above enhance our broader and integrative understanding of the natural processes that occur within the system during large scale and magnitude floods within the lowland reaches. This understanding is an essential perquisite to viable ecosystem management. This study has highlighted a number of key factors that need to be considered when managing regulators. This includes:

(1) The inundation of a range of habitat types to promote physico-chemical diversity with the aim of satisfying a wider range of organisms and life history stages and therefore promoting high biodiversity.

(2) The generation of high lateral connectivity between the river and the floodplain promoting the exchange and mixing of resources between habitats fuelling both the riverine and floodplain food-webs.

(3) The use of regulators and environmental flows in tandem. This could include the use of multiple floodplains using the same environmental water to ensure that resources and propagules exiting upstream floodplains are delivered to downstream floodplains using the main river channel as a conduit. This is especially important following periods such as drought as egg banks degrade during these periods, decreasing the resistance and resilience of these environments.

Flows within these systems vary in scale both spatially and temporally. There are large flood such as that in this study which are low in frequency and cover large areas of floodplain and play an important role in resetting the environment to earlier successional stages(Pettit, Froend *et al.* 2001; Stanley, Fisher *et al.* 1997), stimulating ecological

processes, connecting habitats, transferring resources between floodplain and main channel environments and dispersing microfauna. However smaller and more frequent floods are important for other biological and biogeochemical functions. Other aspects such as the duration, timing and frequency of inundation also play a crucial. The next step in dryland river management and possibly one of the biggest challenges is in understanding how these different flooding characteristics interact and then to use this knowledge to restore the ecological health of what are now and are likely to remain highly regulated systems.

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 sense of individual chapters, this has inevitably led to some repetition between chapters.