The Role of Hydrology in the Ecology of Cooper Creek, Central Australia:

Implications for the Flood Pulse Concept

Jim Puckridge BA, BSc, MSc

Cooperative Research Centre for Freshwater Ecology
Department of Environmental Biology
The University of Adelaide

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Abstract

Flow is the dominant variable in the ecology of streams and rivers. The Flood Pulse Concept of Junk, Bayley and Sparks asserts that regular overbank flows ("pulses") of river discharge govern the dynamics of lowland river-floodplain systems, because they impose wet and dry phases on the floodplain, maintaining high biodiversity and production. The concept derives principally from work on tropical and temperate floodplain rivers, where variations in the flood pulse are relatively predictable, and it implies that biotic adaptations to flow are precluded where variation is unpredictable. However, flow in dryland rivers is highly unpredictable, yet flood pulses may be ecologically no less important than in the rivers of more humid areas.

This thesis examines the generality of the Flood Pulse Concept as a model for the role of flow in large floodplain rivers of all climatic zones. It reviews the literature on hydrology-biology relations, with particular reference to the ecology of riverine fish. Using techniques of ordination, clustering and analysis of similarities (ANOSIM), it examines the relations between flow variability, ecology and climate in large rivers worldwide. Then, using a five-year database for Cooper Creek in Central Australia, it relates structures of fish, macroinvertebrate and zooplankton assemblages and indices of fish health and behaviour to hydrology at several spatial and temporal scales. These relations are established using multivariate techniques, univariate correlation and regression, and Neural Networks modelling.

The above analyses demonstrate that arid zone rivers are exceptionally variable over a wide range of temporal and spatial scales and in manifold facets of flow , and that the biota of such rivers is adapted to this variability at several levels of biological resolution. They show that individual rivers have distinctive hydrological "signatures" in these facets of flow, and that the relations between hydrology and biological responses are also multi-faceted. In such rivers low or zero flows particularly are associated with distinctive biological community structures, but the clustering (persistence) of large floods also has distinctive biological effects. Predictive models using hydrological inputs are able to

account for a substantial proportion of the variance in the biological assemblages of Cooper Creek.

These results are used to develop the Flood Pulse Concept into a general model more applicable to dryland rivers (the "Flow Pulse Model"). To accommodate the dynamism of dryland rivers, this model redefines the floodplain, encompasses all magnitudes of flow (not only overbank flows), enlarges the range of flow variability and flow complexity considered, and covers a greater range of temporal scales. The final chapter explores the implications of this model for river management and conservation. It concludes that the distinctiveness of dryland rivers is such that concepts of river function and river management for dryland rivers should be developed from studies of these neglected systems, not derived from research on rivers in humid zones.

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