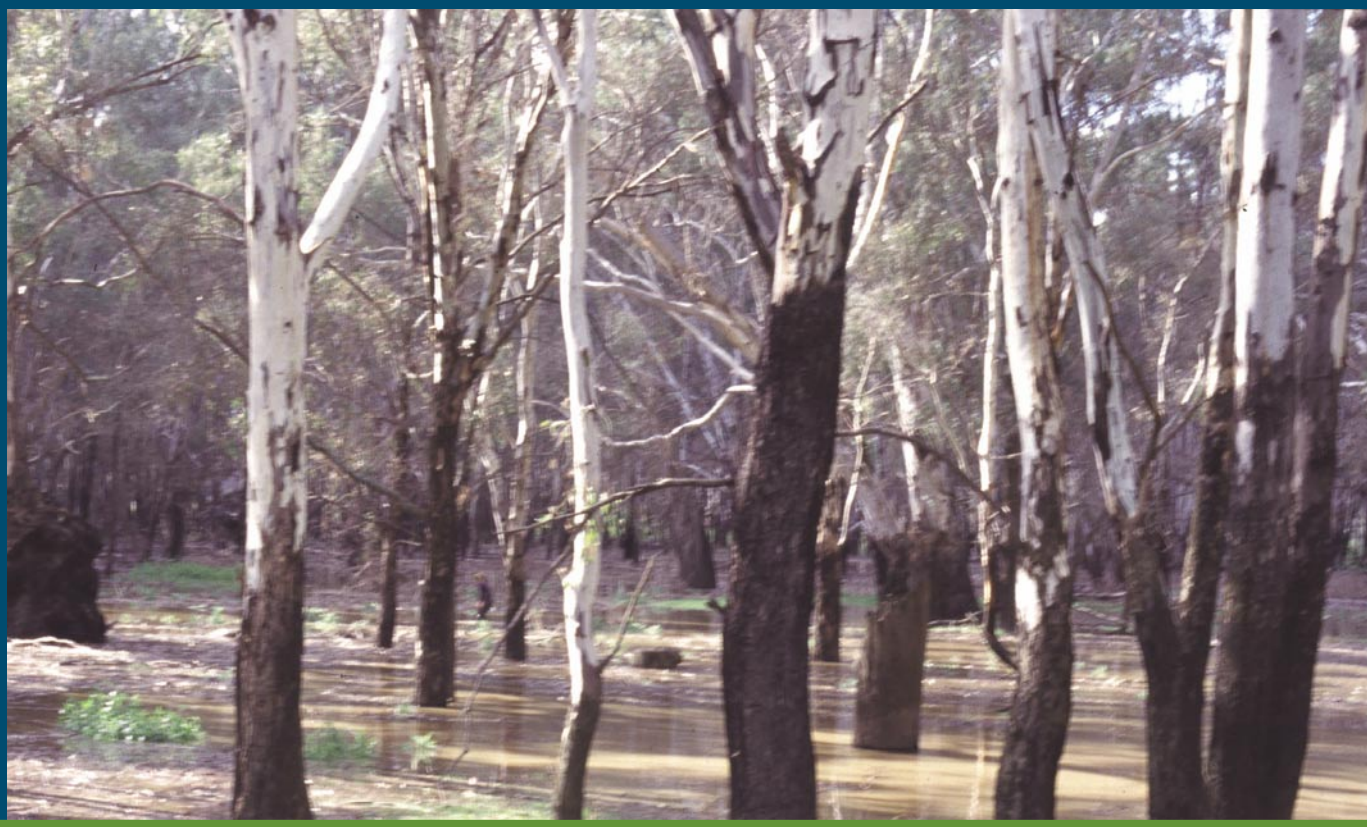


Extra winter flow in the Murrumbidgee restores function to the ecosystem

Where a river's ecological function is degraded and needs to be rehabilitated, one tool available to managers is environmental flow.

An 'environmental flow' is water released into the river, from a water storage, with the intention of maintaining habitat for freshwater animals and plants, sustaining productivity or promoting connectivity.

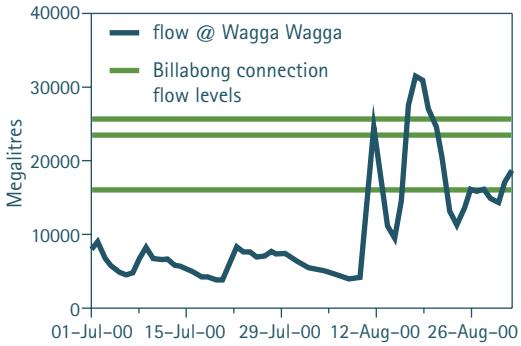
'Connectivity' is the physical and biological linkage between the various components and habitats within an ecosystem — in this case, a river, its floodplain and billabongs. It is an essential factor in maintaining the functions of this ecosystem. Connectivity often depends on the existence of connecting channels linking the main river and the billabongs. The channels come in a range of widths, depths and shapes, and the flow at which they fill is dictated by their elevation relative to the water in the main river channel. The volume of environmental flow required to achieve connectivity can easily be calculated.

Population decline in native fish and loss of submerged aquatic plants are two of the common symptoms of ecological damage to the function of a river.

To investigate the function of such a connection between river and billabongs, we examined the movement of materials between several billabongs and the main channel of the Murrumbidgee River during a manipulated high flow.

We found that the high flow restored water to billabongs near the river and stimulated a population boom in the microscopic animals that are an important source of food for juvenile and small fish.

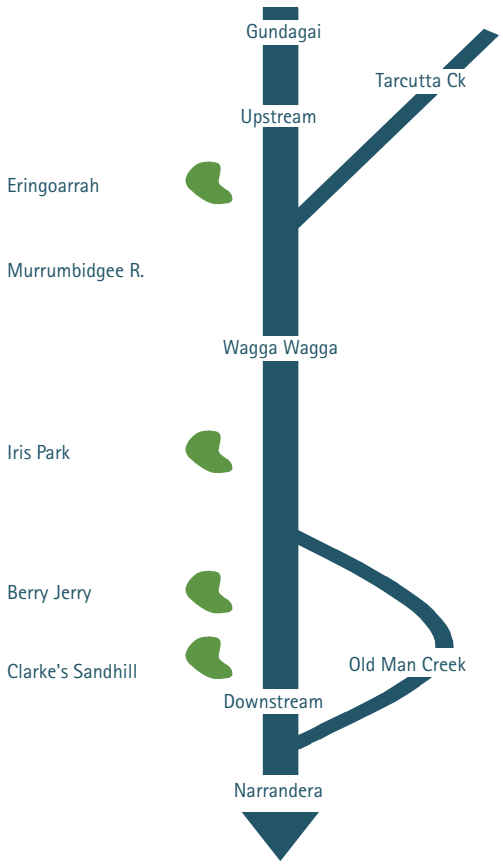
Murrumbidgee River flows and billabong connection levels in July and August 2000



High flow

The study was made possible when the Murrumbidgee Community Reference Committee on Environmental Flows allocated 38,710 megalitres of discretionary water to the Murrumbidgee River. The extra flow boosted natural late-winter flow events down the river and kept water in the billabongs for a longer time.

Our study area on the Murrumbidgee (about 200 kilometres of river) is shown in the sketch map. It consisted of four billabongs and their connecting channels, and two reaches of the main river — the reaches upstream and downstream of its junction with Tarcutta Creek.



The upstream reach, with one billabong beside it, received water from dam releases. The downstream reach was alongside three billabongs and it received significant flow from Tarcutta Creek as well as dam releases.

The extra flow was sufficient to flood into the study billabongs, but it was well below bank-full capacity for the river. Each billabong filled up, became overfull and then drained to full volume as the river height dropped. Each study billabong was connected to the river for between five and twelve days.

Billabongs

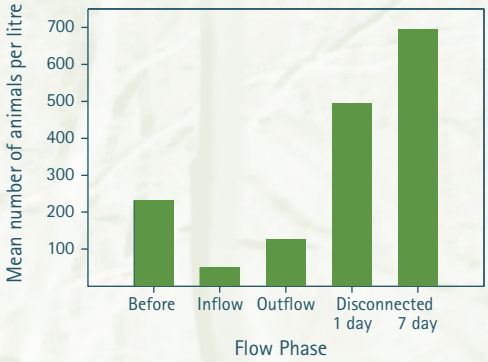
Before this discretionary release of water, there had been a few dry years, and many of the floodplain billabongs were relatively empty. The high flow flooded many of these, but there was little overland flow or through-flow. Filling the billabongs through their connecting channels took 1 to 5 days depending on their size and position. The water slowed once it entered each billabong; then, as the river height declined, overfill water returned to the river, leaving most of the coarse or particulate materials behind.

As the water rose in each billabong, more of the soil around the edges was inundated and so more aquatic habitat became available. Dissolved carbon and nutrients were released from the soils and were consumed by microbes that then became food for zooplankton (microscopic animals that are an important source of food for juvenile and small fish).

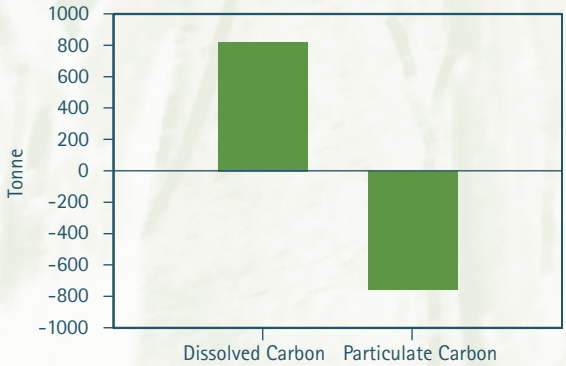
The populations of zooplankton grew following the flooding, taking advantage of the larger billabongs and a fresh supply of food, and within two weeks there were three times more animals than there had been before the populations were diluted with river water.

Billabong plants and animals make an important contribution to the richness of species in a riverine environment, and to the environment's structure and function. Billabongs provide habitat and food for a range of semi-aquatic organisms (including billabong plants, frogs and birds), and their plants and animals are food resources for many land animals including bats and bush birds.

Zooplankon in the billabongs during different flow phases



Riverine carbon – gain and loss in the reach during the environmental flow



We sampled the billabongs, connecting channels and river for carbon, nutrients and zooplankton, before, during and after the river rise. During the high flow we sampled the study reaches twice a day. Then, by surveying water depths and using flow data we could calculate the total amounts of materials exchanged between habitats.

If a flood were to last long enough, we would expect billabongs to contribute some dissolved carbon and nutrients as well as zooplankton to the nearby river. But in this study the connection time between the river and the billabong was too short for there to be any significant transfer of food resources from the billabong to the river.

Extra carbon

The high flow entering the study reach was a mixture of water released from Blowering Dam and natural floodwater from Tarcutta Creek. Most of the particulate organic carbon and dissolved organic carbon entering the reach originated from the creek.

During the high flow, 1600 tonnes of particulate organic carbon and 2800 tonnes of dissolved organic carbon entered the 200 kilometre reach of the Murrumbidgee River. By the time the water arrived at end of the reach over the same period, it contained 47% less particulate organic carbon and 29% more dissolved organic carbon.

The concentrations of dissolved organic carbon in the river rose unevenly during the study period. The greatest daily loads of this carbon were recorded during the first few days of the high flow event, before the billabong connections could contribute anything to the river. It is likely that the dissolved organic carbon came from the rewetting of riverbank sediments and plant litter.

The four billabongs we studied all gained particulate nutrients and carbon, and although some of the organic carbon came from the river some may also have come from rewetted floodplain areas.

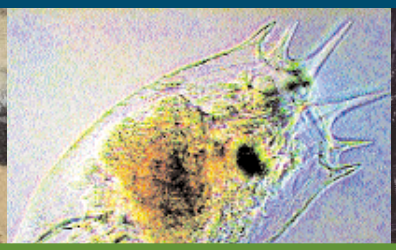
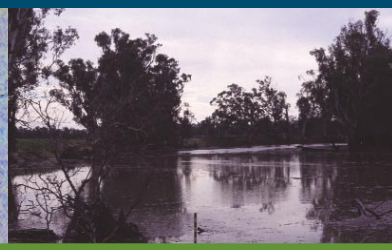
What did this environmental flow achieve?

This environmental flow extended the duration of a natural high flow from a flooding creek and allowed the study billabongs to fill, when they would have otherwise only received a small amount of water.

Organic material was transferred from the catchment of the creek to the river and its floodplain. A significant proportion of the particulate nutrients and carbon delivered by the river to the floodplain remained there after this short high-flow.

The amount of dissolved carbon in the river increased with the high flow, mostly during its 'first flush'.

Dissolved organic carbon is carbon in solution that is easily consumed by microbes. Particulate organic carbon consists of particles from a range of living organisms, such as microbes, algae, plants or animals, that need to be broken down to release carbon and nutrients.

The flow was successful in restoring important functions of the floodplain in a number of ways. Among other things,

- it maintained and temporarily increased areas of aquatic habitat;
- it delivered dissolved nutrients and carbon to promote productivity; and
- it promoted connectivity between the river and its floodplain billabongs.

Delivery of environmental flows

Water released from headwater storages carries less sediment and carbon than flow derived from catchment run-off (flood). If the aim of an environmental flow is to provide a more 'natural' high flow then it is both logical and effective to use the environmental allocation to top-up a flow consisting of catchment run-off. The environmental flow we studied was provided in that way, to promote natural function in the river. Water released from headwaters has the advantage that it can be timed to support important seasonal events such as fish spawning or bird breeding. However, we don't yet know the best timing for connectivity so that maximum benefit can be gained from the extra water.

Management plans that provide for variability of flow have the capacity to stimulate river health to some degree, particularly in rivers such as the Murrumbidgee River, which are naturally variable. Even small high flows ('freshes') wet-up areas that were previously dry within the river channel, releasing carbon and nutrients from the soils into the river water and creating new areas of habitat which river life can exploit.

Further reading

Robertson A.I., Bunn S.E., Boon P.I. & Walker K.F. 1999. Sources, sinks and transformations of organic carbon in Australian floodplain rivers. *Marine & Freshwater Research* 50, 813–829.

Nielsen D.L., Hillman T.J., Smith F.J. & Shiel R.J. 2002. The influence of seasonality and duration of flooding on zooplankton in experimental billabongs. *River Research and Applications* 18, 227–237.

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