Exploring links in the food chain

BEN GAWNE UNLOCKS SOME KEY INFORMATION ON THE EFFECTS OF FLOW ON NATIVE FISH AND WATERBIRDS.

The Murray–Darling Basin Environmental Water Knowledge and Research (MDB EWKR) project is investigating how environmental flows may be used to ensure there is enough food to support the recruitment of native fish and waterbirds. Recruitment, which is the survival of offspring to adulthood, is believed to be sensitive to changes in flow, and declining populations of native fish and waterbirds have been linked to the effects of human flow modification.

The influence of flow on food resources is just one of a number of direct and indirect pathways by which flow may influence recruitment. There is, however, little known about how flow influences the amount, type and quality of food available to support recruitment. One of the reasons for this is that flow can influence food availability in a variety of ways, each of which has implications for environmental water managers.

Flow modification may influences both the transport of matter downstream and the import of material from riparian vegetation. Photo Haydn Burgess.

Influence 1: Overall productivity

For our food web research, 'overall productivity' is considered to be the amount of organic material generated by an ecosystem which is then converted into food for fish and waterbirds. There is now strong evidence that flow has a major influence on a river's overall productivity. Flow timing is important because changing temperatures and day lengths across the seasons influence the productivity of plants including algae and macrophytes. For example, a summer flow will be associated with a more rapid and greater response than flows in autumn or winter.

Influence 2: Nutritional value of basal resources

Nutritional value refers to the composition of organic matter, with variations in protein, amino and fatty acid composition contributing to nutrient content and affecting animals consuming the material. Flow is known to influence the types of primary production that occur (i.e. species of trees, macrophytes or algae), and this in turn, has an influence on the nutritional value of the organic matter produced. The nutritional value of the organic matter can significantly affect the growth rates and condition of consumers and their predators. One example is the effect of low flows in the Murray River and Murrumbidgee River which are associated with blooms of blue-green algae. Blue-green algae lack essential fatty acids and are a poor quality food resource. This nutritional deficiency then moves up the food chain affecting the health of fish, other aquatic organisms and predatory birds.

Influence 3: Critical connections that support transport of basal resources or food

Flow regulation has affected patterns of connectivity in freshwater systems through changes in flow regimes (e.g. reduced flooding, reduced short-term variation) and the installation of infrastructure like dams and levees. Protecting and restoring connectivity can influence waterbirds and fish by modifying food webs and facilitating the exchange of material between different parts of the river system like wetlands and floodplains.

One example is lateral connectivity (flows going overbank out onto floodplains) created during floods that promote the exchange of material between the river and the floodplain. This movement of organic matter make up a significant proportion of the total organic matter available to the system over the course of a year. Flows that restore lateral connectivity have the capacity to improve the amount and type of organic matter available to river channels in regulated systems.

Influence 4: Availability of critical foraging habitats

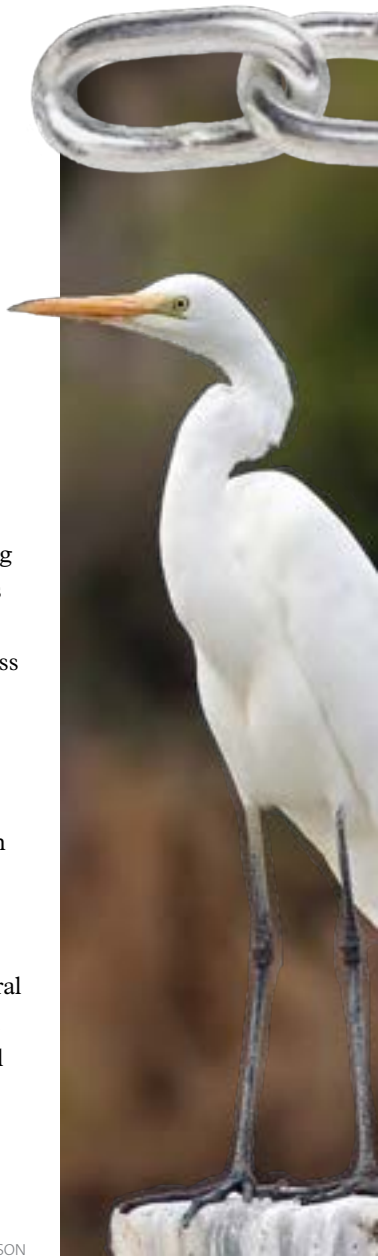
In addition to the amount and type of organic matter produced by an ecosystem, flow may also affect the availability of food. Colonial nesting waterbirds rely on floodplain inundation to support recruitment and provide food. Within the inundated area it is likely that some habitats are of greater value as a waterbird food resource than others in both productivity and availability. Changes to flooding characteristics may affect the area and availability of critical foraging habitats with potential consequences for waterbird breeding. See articles starting on page 6 about our work with waterbirds.

Influence 5: Food chain length

The length of a food chain is described by the number of times organic matter from the base of the food web is consumed before it reaches the top predators. Systems in good condition have longer food chains than systems in degraded condition. The shortening is often caused by the loss of higher predators such as large predatory fish and waterbirds. Shortening may also occur because there is less energy available to higher levels in the food web. This may occur in a number of ways.

1. There is less energy in the system (see Influence 1: Overall productivity).
2. The amount of energy that moves through the microbial loop increases. Some of the organic matter in aquatic ecosystems is consumed by microbiota such as bacteria and fungi. The material may be used several times by microbial communities, and each time it cycles through there is less material available for other consumers in the food chain.

The MDB EWKR project is funded by the Australian Government's Commonwealth Environmental Water Office.



EASTERN GREAT EGRET, PHOTO JJ HARRISON

3. As flow affects the food web, the number of links in the food chain also change. If less food is consumed, only a small proportion is then available to the next link in the chain. As a consequence, adding another link would significantly reduce the amount of food available at the top of the food chain. Flow regulation in the Murray River has led to a change in macroinvertebrates from large long-lived specialist species such as crayfish and mayflies, to smaller short-lived generalist or opportunistic species such as chironomids and worms. Such changes to community composition add *trophic* links, because smaller invertebrates need to be consumed by something larger before their energy is available to larger fish. This change may mean a significant reduction in the energy available to predatory fish.

The potential for these types of food web changes to affect the outcomes of environmental flows reinforces the need to take an ecosystem perspective when managing our rivers and wetlands. Taking an ecosystem perspective means understanding the processes that sustain fish and waterbirds, and in some instances, delivering flows that support food webs and the condition of the ecosystem, rather than targeting direct benefits for particular species.

The trophic level of an organism is the position it occupies in a food chain. The word trophic derives from the Greek τροφή (trophē) referring to food or nourishment. A food chain represents a succession of organisms that eat another organism and are, in turn, eaten themselves.

Influence 6: Food web structure

The amount and type of food available to species may be affected by changes to the species present within the system. Two extreme examples are the introduction of an invasive species or the loss of a key species.

1. **Invasive species**

a. Willows: In lowland systems where flows are highly variable, the spread of willows has been promoted by flow modification. In addition to the effects they have on native vegetation, recent work has revealed that willow leaves entering streams leach carbon more rapidly than native litter, subsequently fuelling a different component of the food web. They are a poor base for algae to attach to, with cascading effects on the macroinvertebrate communities dependent on that algae.

b. Carp: A well-known invader whose spread and success has been linked to flow. Recent modelling of the effects of carp on food webs suggests that carp sequester a large proportion of the food available to fish. If this is the case, then carp probably interact with other food web changes to increase the stress on the fish community.

2. **Species loss**

a. Frogs: One group affected by reduced flooding is frogs. Frogs and tadpoles represent a major food resource for waterbirds such as herons and bitterns. The loss of frogs may have contributed to declines in these bird populations.

Conclusion

Flow influences food webs in a variety of ways, all of which have the potential to affect fish and waterbirds. As a consequence, water managers need to look at using flows to support and enrich ecosystem food webs, so that organic matter can be transformed into high quality food resources.

The Food Web Theme is now collaborating with the MDB EWKR Fish and Waterbird Themes in undertaking field sampling that will generate data on the food webs upon which native fish and waterbird recruitment depend.

Flow modification has the potential to profoundly influence food webs in lowland rivers. Photo Richard Snashall.

FOR FURTHER INFORMATION
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ARRC Australian River Restoration Centre

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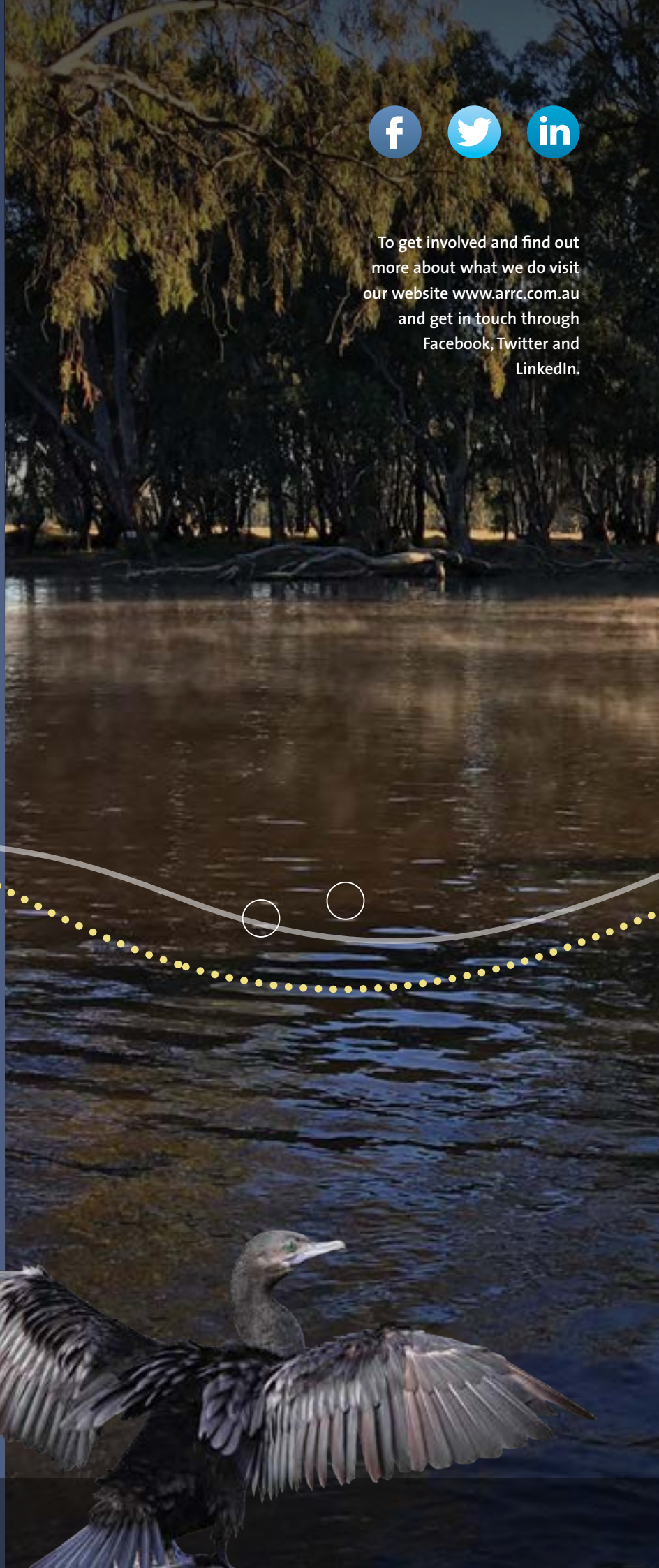

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