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Protecting our catchments to conserve biodiversity in rivers and streams

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Public discussions of water issues give a sense that our river networks comprise the major streams and large in-stream dams. And, from a purely volumetric point of view, that's where many of the big problems are. But discussions have done very little to address the impacts of small dams on these small headwater systems.

Mapping of farm dams has shown half a million large off-channel dams and between two and three hundred thousand small farm dams. These are dams that can be constructed without significant barriers to the licensing. In terms of volumetric water use, they account for a really small fraction; less than 10% right across the basin. We estimated the relative impact of different forms of water resource development across the river networks of the basin, and found that a huge fraction of the network is impacted by the small dams. Managing these small dams is very important for the conservation water-dependent species within the river network.

Castle Creek near Euroa has a very narrow catchment rising in the Strathbogie Ranges and crossing the plains into the Goulburn River. When dams in the headwaters of the creek are half full, they stop the downstream flow of water. Once they fill up and start to spill, flows occur as they normally would. Farm dams have a particularly profound impact where periods of low rainfall and significant evaporative losses lead to the emptying of the dams, as this means a refilling phase which strongly influences the downstream hydrology.

Historically, Castle Creek was largely perennial with more than a megalitre of water going downstream each day for roughly 80% of the time. It would have still stopped flowing during drought periods, but not for particularly long periods, and pools within the river channel would have persisted. With farm dams in that catchment, we now see a significant reduction in the period of time over which Castle Creek flows. If we add climate change

impacts, the story gets a little bit worse. Other streams in this region have a similar story, although larger streams have a larger catchment and more permanent flow, and the impact of the farm dams tends to be smaller.

Fish and invertebrates in these systems rely on a myriad of small refuge waterholes during drought periods. In many instances, they're disconnected from groundwater, so they are dependent on surface runoff for maintaining the waterholes. They have a limited persistence time. As these waterholes are lost from the system, populations that depend on them become fragmented and isolated from one another. In years when more than 50% of the stream dries out, populations tend to decline in abundance. So any changes in the frequency and the different proportions of the stream that persist or dry out can quickly tip the balance. Over the long-term, the risk of extinction increases.

Different fish species in this river system have different requirements in terms of landscape connectivity. Carp gudgeon is very widespread across the Murray Darling Basin. They are very poor swimmers, so don't move far. And they breed during the summer low flow period. So they're highly dependent upon those isolated pools for their survival. Low-flow conditions are quite good for them as long as there's enough habitat to persist in the landscape.

In comparison, mountain galaxias tend to move around in the river network. Fish that are normally down on the floodplain move up to particular substrates available in the headwaters to breed. So when the rivers remain fragmented through their breeding season, they do not get the opportunity to breed. There's a really critical dependency between the periodic connectivity of streams and movement of this species.

Across in the broader landscape, we need to understand and manage those critical areas where populations may be at greatest risk. We collated information on the distributions of fish and macroinvertebrates with information on the characteristics of individual rivers to demonstrate the associations between hydrology, climate and landscape variables and where we do and don't find particular species. As an example, river blackfish has undergone significant contractions in its range. Like platypus, it essentially disappeared from South Australia during the millennium drought. In Victoria, the models showed significant contractions in its predicted distribution, and the loss of permanent flow appears to be a major risk factor in losing those populations.

We often talk about latitudinal or altitudinal range shifts in species in response to climate change. Our modelling showed that those really high-quality habitats for native fish are often quite distinctive spots in the landscape with relatively unique features in terms of hydrology, substrate type and channel form. And it showed that those sites with the best habitat today, predominantly tended to be the places with the best habitat in the future. So we should be protecting those areas that are currently really high-quality habitats.

Modelling also shows the importance of hydrology. For example, it shows a constant but gradual decline in the likelihood of finding river blackfish where there's more interannual variability in runoff. Overall, it shows that loss of permanent flow has profound impacts on a whole suite of fish species – and platypus.

And modelling shows the impact of climate change. Fish species show significant changes in the distribution under different climate change scenarios including the step change scenario we saw during the millennium drought.

There are some solutions to the threats in these headwater systems. Some of the water from upper catchments can be redirected past dams at times when water isn't actually spilling or seeping out of the dam. And there are ways to prevent the profound impact of stock on both water quality and on the habitat in streams, particularly the small remnant waterholes during dry periods.

The message is that climate change will increase the already urgent need to think about how we manage some of the other threats discussed in this talk.