2019 Australian Wildlife Society

UTS Wildlife Ecology Research Scholarship

The 2019 Australian Wildlife Society (AWS) Wildlife Ecology Research Scholarship has been awarded to UTS School of Life Sciences PhD student Laura Michie for her research on mitigation of cold water pollution using novel thermal curtain.

Thermal pollution in Australian freshwater ecosystems; effects on native fish populations

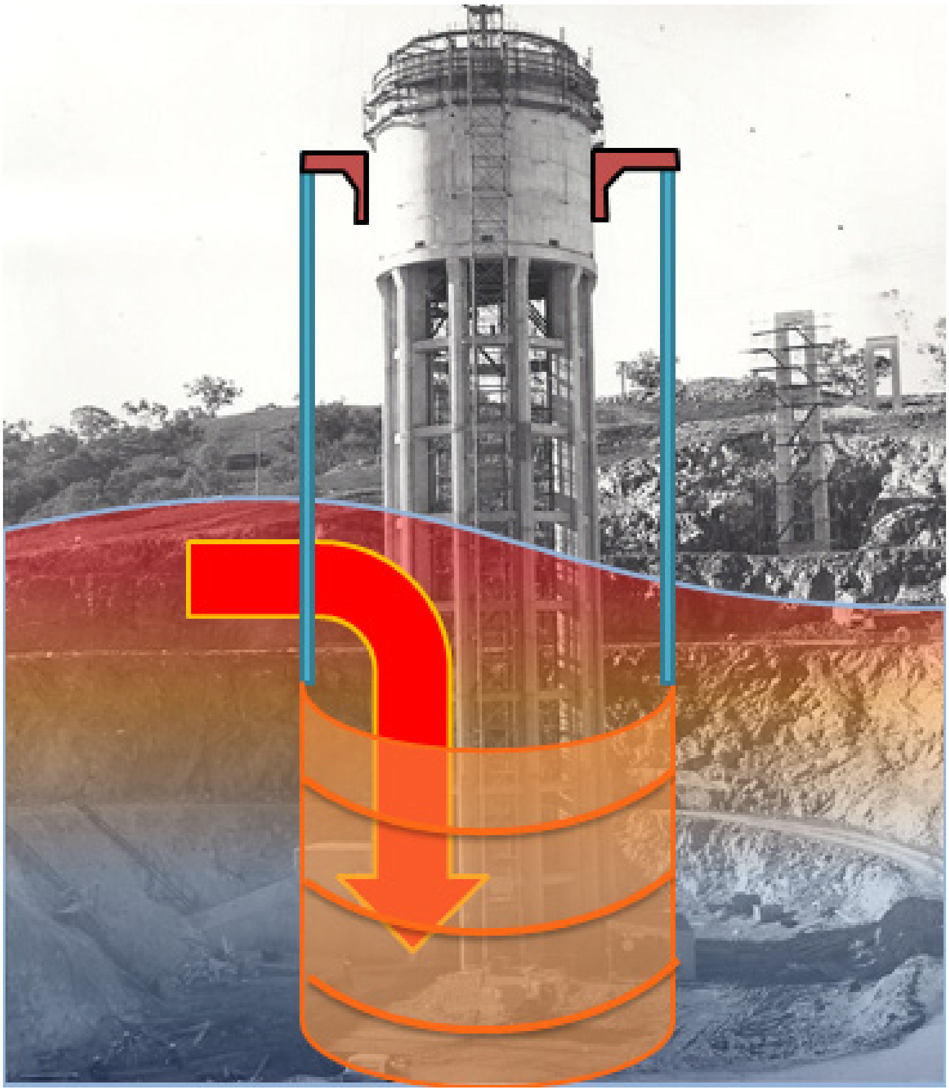
Laura Michie

Freshwater ecosystems compose such a tiny part of the earth's surface but are crucial in supporting the global economy, the environment and human survival. Wildlife decline in freshwater ecosystems has occurred at much faster rates than in oceans or on land, with Australia being no exception. When we think about issues that may be causing these declines in fish populations, cold water pollution probably isn't the first thing that comes to mind. In Australia, this largely understudied phenomena affects large stretches of river, particularly in the Murray–Darling Basin.

Cold water pollution occurs downstream of large dams when water is released from the bottom of the water column. Due to the depth of water within dams, this water can be much cooler than what is naturally found in the rivers. Water released from these large dams can be as much as 12-16 °C cooler than natural river temperatures.

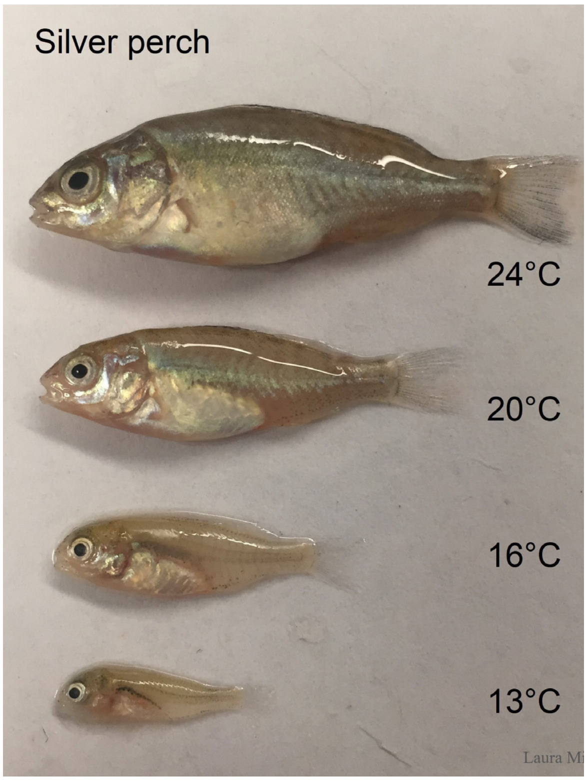
This is a particularly large problem in Australia where native fish populations are adapted to a typically warm climate. In Australia, population declines of endangered species of fish such as Murray cod, silver perch, freshwater catfish and trout cod have been partially attributed to cold water pollution. Reduced water temperatures can affect fish populations in a number of ways, causing mortality, reduced reproductive success, altered metabolic function, reduced potential for growth and reduced swimming ability.

For my research, I was interested in understanding how to mitigate the issue of cold water pollution in Australian freshwater ecosystems for the benefit of our native fish populations. To do this, I studied the Macquarie River in central-western New South Wales downstream of Burrendong Dam. This river system was of particular interest as a novel, cost-effective 'thermal curtain' has been retro-fitted at Burrendong Dam to reduce the cold water pollution that has historically occurred downstream. This curtain works by releasing warm water from the surface of the dam into the river downstream.



Simple schematic of the thermal curtain in place at Burrendong Dam.

The thermal curtain was improving river temperatures downstream;



Average size of silver perch after thirty days of exposure to a range of water temperatures.

however, we had no idea if these improvements were significant enough to benefit fish populations. Further, we recorded dramatic reductions in water temperature (as much as 10°C) downstream of the dam when surface and bottom water releases were used interchangeably. These rapid changes in water temperature are termed thermal shock; although we know thermal shock can be detrimental to fish, very little is understood about the ability of Australian species of fish to cope with the stress associated with thermal shock.

Thanks to the generosity of the Australian Wildlife Society, I was able to conduct some experiments on Australian native fish larvae to better understand how they respond to thermal pollution in their natural habitats. The experiments focused on the two aspects of thermal pollution that were observed in the Macquarie River; chronic exposure to reduced water temperatures and the rapid reductions in water temperature, or thermal shock.

In the first round of experiments, growth and development of three species of Australian freshwater fish including trout cod and silver perch, both listed as Endangered, was severely stunted by cold water pollution. The fish were exposed for thirty days to water temperatures ranging from 13°C to 24°C, representing severe cold water pollution to natural river temperatures. Fish exposed to the cold water were more than half the size of fish exposed to natural river temperatures. The results reiterated that water temperatures need to be as close to natural river temperatures as possible to benefit fish populations fully.

To follow on from this growth analysis of fish affected by cold water pollution, I have been able to conduct an analysis of how this growth has been reflected in fish otoliths. Otoliths are a bone within the ear of fish; microstructure analysis of this bone is a technique frequently used by fish biologists to attain valuable ecological information of fish life-history events and measuring growth history during early life stages of fish.

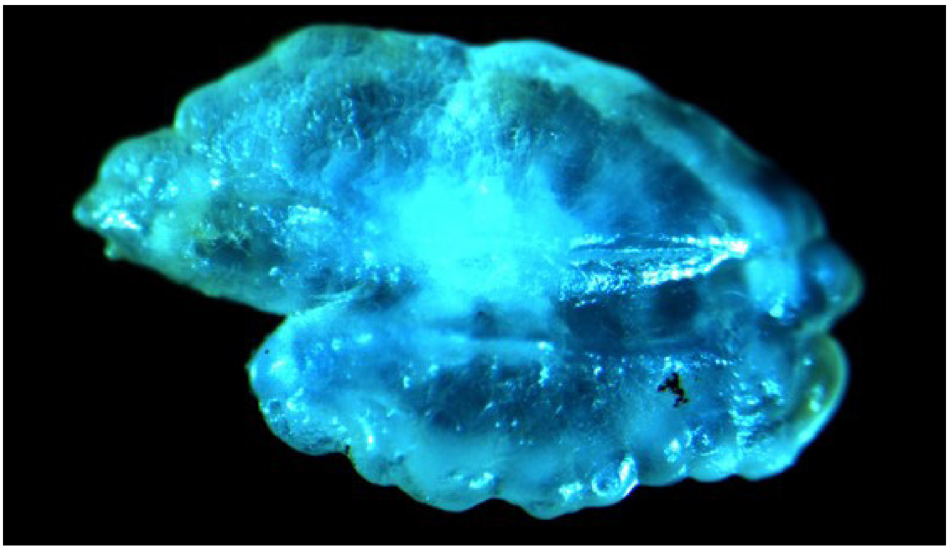
My results showed that the growth and development of otoliths were affected in cold water pollution conditions. This information is useful for researchers studying fish to determine whether they have been affected by cold water pollution at some point within their lifetime and determine if this affected their growth and development

In the thermal shock experiments Murray cod, silver perch and golden perch experienced high rates of mortality and significantly impaired swimming ability. I assessed a range of magnitude cold shocks (-10, -8, -6 and -4°C), and found that more severe reductions in temperature caused higher rates of mortality and resulted in greater impairment to swimming ability. Despite this, even small reductions in temperature still affected fish negatively, particularly younger fish.

Results from this research emphasise the need for management of this ecological problem. Infrastructure such as the thermal curtain at Burrendong Dam is a potential option, but their potential to cause thermal shock needs to be managed. Even when thermal pollution is of a magnitude that is not lethal to native fish, it still affects their swimming ability and growth in a manner that may cause indirect mortalities as fish may be more susceptible to stressors such as predation.

My project has provided essential information about the thermal tolerances of these valuable freshwater species. It has great potential to guide management plans to assist in the direct conservation of these species.

I would like to sincerely thank the Australian Wildlife Society for the contribution of funding which has made this research possible.



Example of golden perch otolith used for analysis.

Laura Michie