National Environmental Research Program

LANDSCAPES & POLICY *hub*

A place of refuge. As Tasmania's summers get hotter, fish and water bugs that are vulnerable to heat stress will need to find cooler places of refuge. Photo: Suzie Gaynor

Aquatic life in the Tasmanian Midlands: escaping the summer heat

- Tasmanian summers are expected to become hotter over the coming decades.
- As rivers become warmer than usual, fish and water bugs could be severely stressed by the heat and lack of oxygen.
- We have developed a method for identifying potentially cooler river sites in the Tasmanian Midlands where species could take refuge. Conservation managers can use it to identify sites that may need to be prioritised for conservation.
- Most sites are in the upper catchments and in shady gullies where groundwater enters the river, mainly in forests or reserves. The Meander River catchment stood out as having few such sites.

Research summary

Tasmanian summers are expected to become hotter over the coming decades. As rivers become warmer than usual, aquatic life such as fish and water bugs could be severely stressed by the heat and lack of oxygen, and may need to seek refuge from the short-term spikes in summer temperature.

We have developed a method for identifying potentially cooler river sites in the Tasmanian Midlands. Conservation managers can use it to identify sites that may need to be prioritised for conservation.

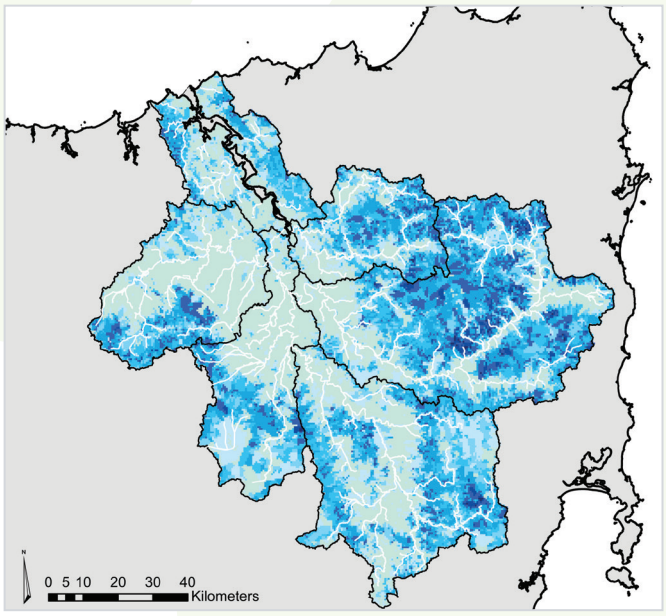
We found most of the sites to be in the upper catchments and in shady gullies where groundwater enters the river, mainly in publicly owned forests or reserves. The Meander River catchment stood out as having few such sites.

Warmer summers, warmer rivers

Climate projections from the Climate Futures for Tasmania project suggest that Tasmania's rivers are likely to experience increases in summer temperature which will severely impact aquatic plants and animals, including fish and macroinvertebrates.

High temperatures can directly affect aquatic life through heat stress, and can also lead to indirect effects such as oxygen stress. Native fish species and the introduced brown trout are particularly vulnerable to both heat stress and oxygen stress.

Predicting the implications of these temperature changes is difficult because the health of a river is a combined result of processes occurring both in the river and in the surrounding catchment.



Refuge analysis: Potential refuges for aquatic life in the Tasmanian Midlands (darker blue = higher potential). Credit: Regina Magierowski

Features that keep rivers cool

While the rise in air temperatures is likely to affect all of Tasmania, local and catchment-scale features can prevent or reduce rises in river temperature, potentially creating places of refuge for aquatic organisms during the hotter summer periods.

These features include topographical features that offer shade, groundwater flowing into the river, tree cover, and increased river flows associated with climate change or with the transport of irrigation water along natural waterways ('shandying').

How to locate potential refuges

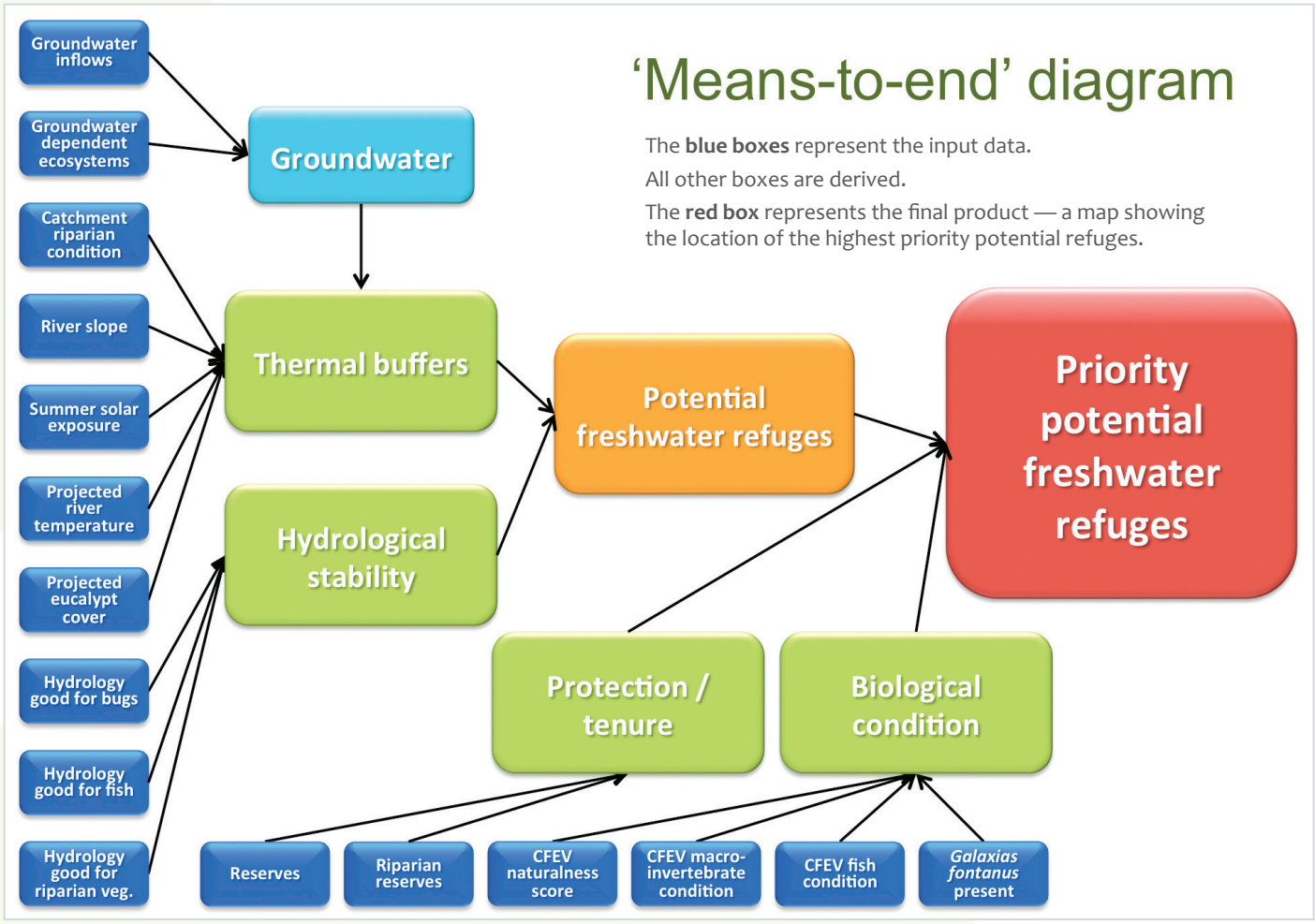
Using MCAS-S (the Multi-Criteria Analysis Shell for Spatial Decision Support), conservation managers can easily integrate a range of spatial data to explore potential scenarios for aquatic ecosystems or to see the effects of management decisions.

MCAS-S is a free decision-support tool for integrating spatial data. It was designed for non-GIS users by the Australian Bureau of Agricultural and Resource Economics and Sciences. It is especially useful in workshop situations when data may be incomplete and decisions are made by consensus.

MCAS-S can be used with different 'datapacks'. A datapack consists of spatial data and a guide to combining the data to support decision-making.

Potential places of refuge in the Tasmanian Midlands

We developed the Aquatic Refuge MCAS-S Datapack for the Tasmanian Midlands which allows conservation managers to identify river locations that are potential



Means-to-end: Creating a means-to-end diagram is the important first step in an MCAS-S analysis. We created this diagram for identifying aquatic refuges in the Tasmanian Midlands. Each box is a map that can be exported to a GIS or Google Earth™, or saved as an image.

places of refuge for fish and macroinvertebrates from short-term spikes in summer temperature.

The datapack includes:

- the location of landscape features that may influence river temperatures
- projected river temperatures
- projected eucalypt cover
- projected hydrology.

Land tenure/protection and biological condition are also included for the purpose of prioritising the potential places of refuge.

The datapack is designed so that managers can make their own decisions about which locations should be prioritised for conservation. However, in compiling the datapack we made several observations.

No refuge in the Meander River catchment

The most striking finding was that a large proportion of the land area in the Meander River catchment lacked obvious features that might buffer rises in river temperature. The catchment is home to native fish species and the introduced brown trout which are vulnerable to heat stress and oxygen stress.

Other catchments have some potential as refuge due to groundwater inflows and/or good riparian tree cover.

Shady gullies and cooling groundwater

Most of the river sites with high refuge potential are in the upper parts of the region's five catchments and in shady gullies where groundwater enters the river, mainly in publicly owned forests or reserves.

On flatter land, which is mostly private farmland, we identified a few locations of catchment-scale riparian vegetation in good condition, which provides shade; however, for much of this flatter land groundwater inflows are the only buffer to high summer temperatures. Groundwater inflows are influenced by rainfall and are likely to decline under a changing climate. Also, the groundwater data we used is inferred from satellite data; actual groundwater inflows across the region have not been measured in enough detail to be used in our analysis. Research is required to validate whether these inferred flows reflect actual inflows into rivers.

Few locations with stable flows

Another stark finding was the lack of locations that are projected to have flows stable enough for aquatic life to survive. The bigger flows projected are largely a result of shandying water for irrigation rather than changes in climate. These projections are based on water allocations and do not guarantee that the water will actually be shandied. The timing and duration of these water releases will also have a bearing on the survival of aquatic life.

Water trading is likely to influence the flows and may also allow for the purchase of water for environmental benefits.

Where to from here?

We are working with staff from the Tasmanian Government, natural resource management bodies and non-government organisations to make sure they can use MCAS-S and the various datapacks produced by the Landscapes and Policy Hub.

Who are the researchers?

Dr Regina Magierowski

Reg is a freshwater ecologist at the University of Tasmania. Her research focuses on understanding patterns and processes in aquatic ecosystems to better understand the influence of humans on aquatic ecosystem health.

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Oberon Carter

Oberon works for the Tasmanian Department of Primary Industries, Parks, Water and Environment. He has a particular interest in the management of biodiversity refuges in the face of climate change, and specialises in integrating spatial data.

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Collaborators

Professor Peter Davies from the University of Tasmania led the Landscapes and Policy Hub Freshwater Ecosystems Project.

Further reading

Magierowski R, Carter O, Gilfedder L, Anderson G, Gaynor S, Lefroy T & Davies PE (2014) *Aquatic refuge MCAS-S Datapack for the Tasmanian Midlands. Report number*. Landscapes and Policy Hub, University of Tasmania, Hobart.

About the NERP Landscapes and Policy Hub

The Landscapes and Policy Hub is one of five research hubs funded by the National Environmental Research Program (NERP) for four years (2011–2014) to study biodiversity conservation.

We integrate ecology and social science to provide guidance for policymakers on planning and managing biodiversity at a regional scale. We develop tools, techniques and policy options to integrate biodiversity into regional-scale planning.

The University of Tasmania hosts the hub.

www.nerplandscapes.edu.au

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