Engineered change: How invasive macrophytes restructure communities in springs

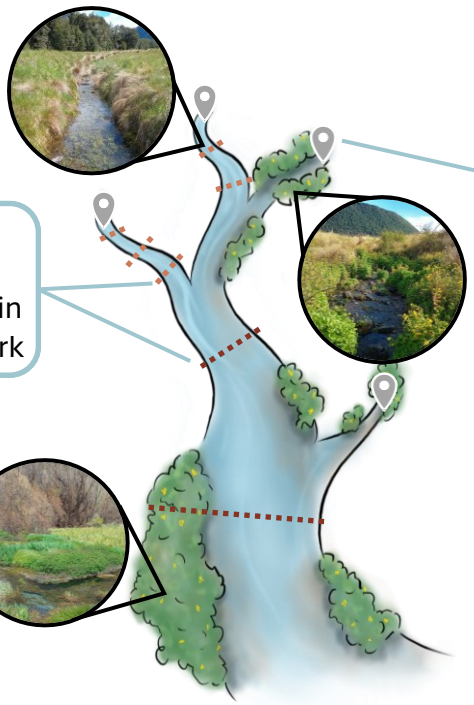
The spread of invasive habitat-altering aquatic weeds into biodiverse spring-fed waterways is driving shifts in freshwater communities from early in the invasion process. These changes highlight the need for timely, integrated management.

Importance

- Ecosystem engineering species can drastically modify their environment, with cascading effects on communities and ecosystem functioning.
- Invasive engineering plants including aquatic macrophytes like monkey musk (*Erythranthe guttata*) and watercress (*Nasturtium officinale*) are invading highly biodiverse spring-fed systems in the Canterbury high country.
- These species tend to have the largest impact in hydrologically stable springs which are vulnerable to modification.

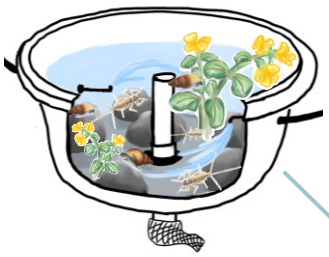
What we did

Sampled six spring systems along the Waimakariri River, at each ...



We took transects to assess the **extent of macrophyte invasion** in the wider spring network

We resurveyed springheads after 19 years using a **before-after control-impact** (BACI) survey to ascertain how native macrophyte and macroinvertebrate communities have been changed by invasion



Finally, we tested habitat preferences and compared macrophyte management approaches using a **mesocosm experiment**

Experimental treatments

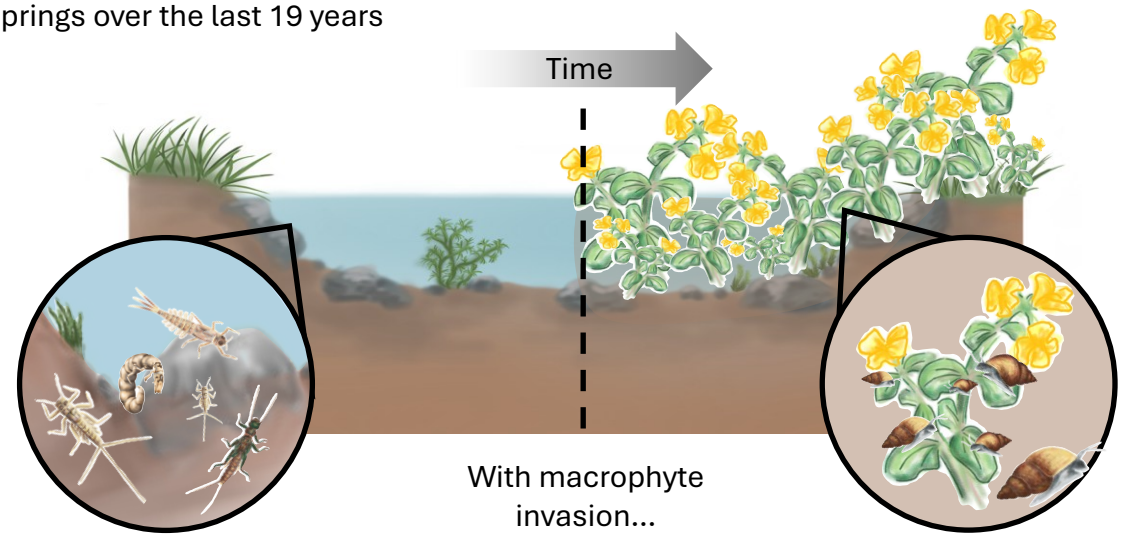
Unmanaged stream
Leave macrophytes in mesocosm

Shading/spraying
Remove macrophytes & return macroinverte-brates to mesocosm

Hand-weeding
Remove macrophytes & associated macroinvertebrates

Key findings

- Ecosystem engineering macrophytes have invaded many isolated, previously pristine springs over the last 19 years



Sensitive cobble-affiliated taxa like mayflies and stoneflies declined

The snail *Potamopyrgus antipodarum* which benefited from macrophyte habitat proliferated

- With invasion, diverse spring macroinvertebrate communities homogenised, becoming dominated by shelled species (e.g., snails).
- Macroinvertebrates respond faster and to lower levels of invasion than the native macrophyte assemblages, suggesting that significant shifts in macroinvertebrate communities may precede full system invasion.
- The mesocosm experiment suggested that hand-weeding (simultaneously removes macrophytes and associated macroinvertebrates), most effectively and selectively reduced macrophyte-associated taxa.

Implications & recommendations

- Increases of the snail *Potamopyrgus antipodarum* are particularly concerning given their predisposition to become ecologically dominant, and their potential resistance to restoration.
- Effective management will need to address both physical and biotic consequences of invasion, likely requiring an integrated approach. We identified hand-weeding as a promising strategy to counteract biotic resistance by leveraging habitat preferences to selectively reduce macrophyte-associated taxa.
- Springs often serve as the last refuges of biodiversity and play a significant role in the provisioning of ecosystem services and functioning, making their protection a priority.

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