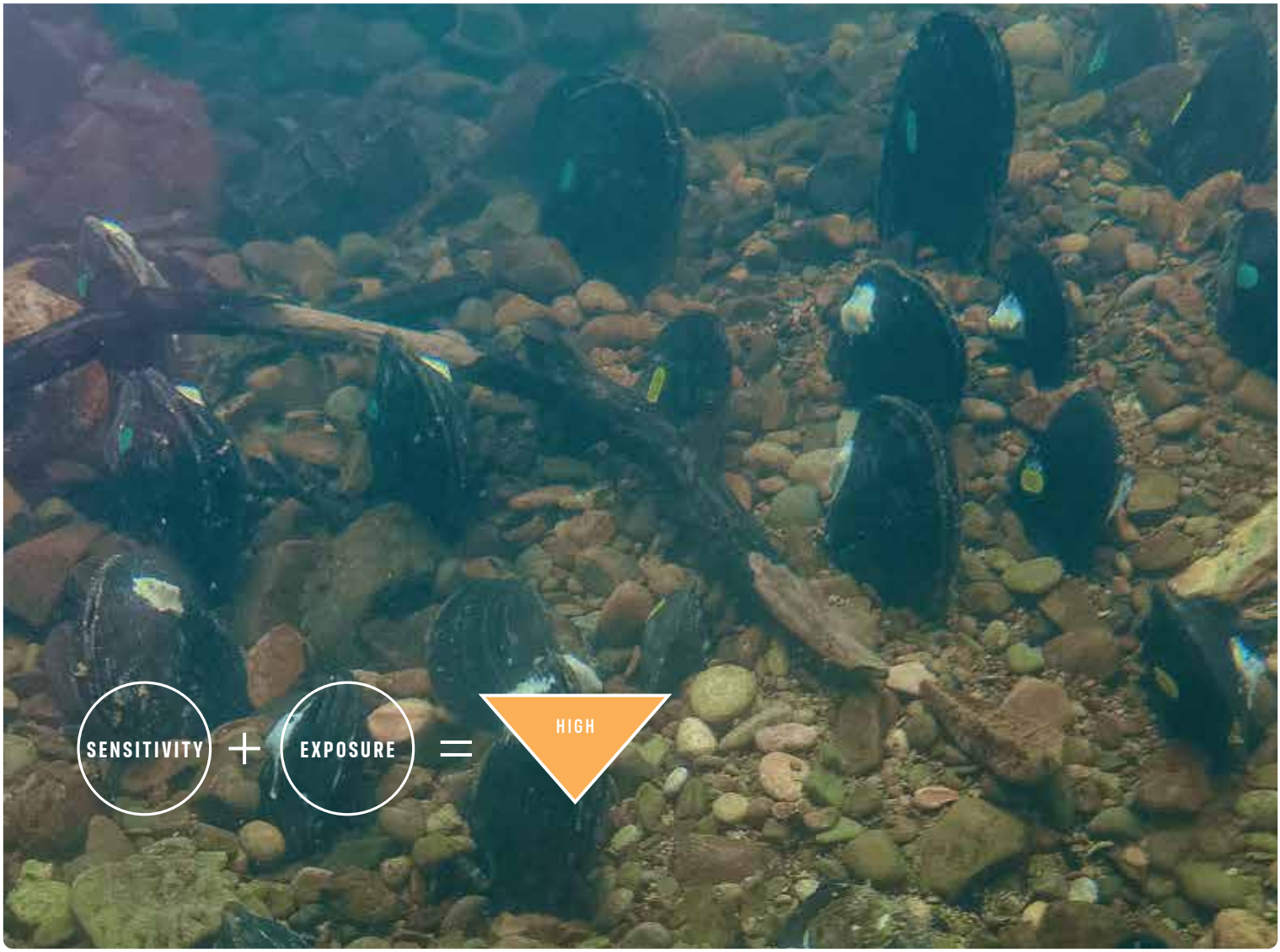
Assessing the vulnerability of taonga freshwater species to climate change – species summary:

Kākahi / Kāeo (Freshwater mussels)

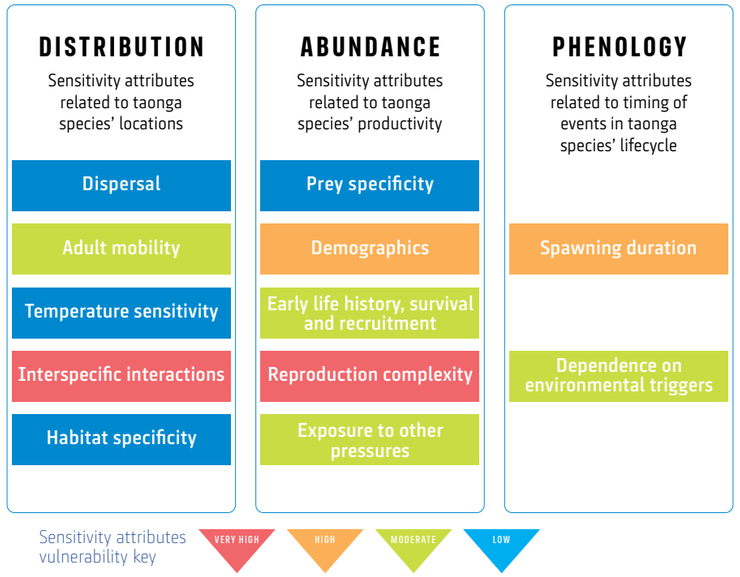
Echydriella menziesii



HIGH VULNERABILITY

SENSITIVITY

Kākahi are a long-lived species with relatively restricted movements as adults. They are found in both rivers and lakes.



Subset of the sensitivity attributes that contributed to kākahi CCVA scores

What is a CCVA?

Climate Change Vulnerability Assessments (CCVAs) are used to assess species' vulnerability to climate change. They identify which species may be most vulnerable to climate change in the future based on:

(1) their exposure to predicted changes in the environment (e.g., warming oceans or more frequent droughts)

(2) their sensitivity or ability to cope with changes in their environment based on their unique characteristics (e.g., food, habitats, reproduction).

Together, exposure and sensitivity form a species' climate change vulnerability score.

Complexity in reproduction

To successfully complete their life cycle, freshwater mussels are dependent on a fish host species (including kōaro, tuna, bullies, banded kōkopu). Males release their sperm into the water in spring. The females then grab the sperm and use it to fertilise their eggs which are located in a special brood pouch in the gill. The eggs develop into larvae known as glochidia which are released into the water column in spring and summer, possibly when the female senses the presence of a suitable fish host. The glochidia parasitise a fish host until they transform into a juvenile mussel. After about two or three weeks the juveniles detach from the fish host to develop further.

Dependence on interspecific interactions for lifecycle completion

Freshwater mussels have an obligate host-dependent stage in their life cycle and are therefore not only limited but their own environmental tolerances but also by those of their host species. This means kākahi may be indirectly and adversely affected by climate change because of their close relationship with other fish species.

Juvenile kākahi attach to a host fish and are transported away from the release site. Barriers to fish movement, stopping recruitment upstream pose a localised threat. This means kākahi may be indirectly and adversely affected by climate change because of this close relationship with other fish species. *E. menziesii* and *E. aucklandica* often occur together (side-by-side in the sediment) which may indicate that their ecological relationship is more complex than is currently understood.

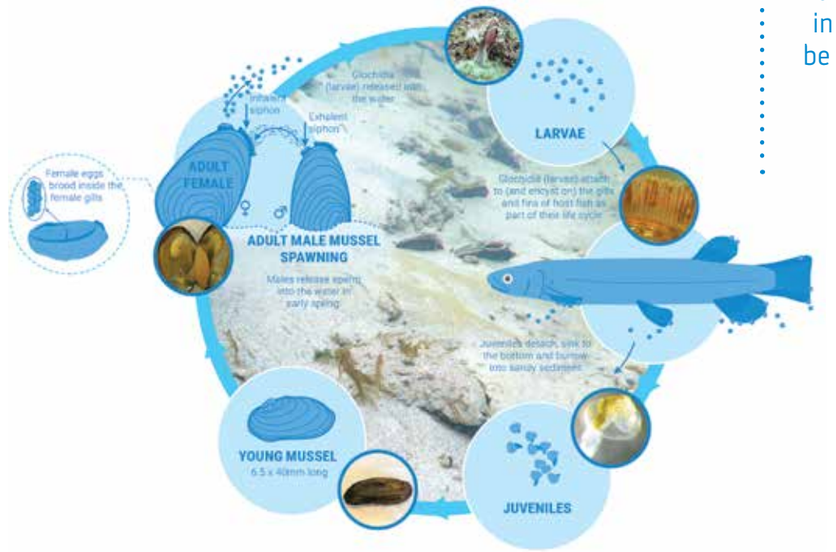
Demographics

Life history traits such as long generation length and slow growth rate are associated with a heightened vulnerability to climate change.

The freshwater mussel *E. menziesii* is a long-lived species, with some individuals reaching at least 50 years of age. *E. menziesii* with a shell length longer than 30 mm (and therefore older individuals) often dominate populations, and it is rare to find juvenile mussels indicating recruitment failure.

Skewed sex ratios are found in some populations. For example, in Lake Horowhenua, there is a 67:33 ratio of female:male mussels in the lake. It is not known if sex is determined by an environmental variable.

Although there may be reasonable populations of adult mussels in lakes and rivers, there are many example where these populations are not viable, because of low reproduction and juvenile survival. These populations are called "geriatric" populations and are at risk of local extinction which might be increased by climate change.



EXPOSURE

Kākahi (*E. menziesii*) are only found in Aotearoa–New Zealand. They are widespread throughout the North and South Islands and are locally common in some places. They can be found in streams, rivers and lakes.

Species summary: Kākahi / Kaeo (Freshwater mussels)

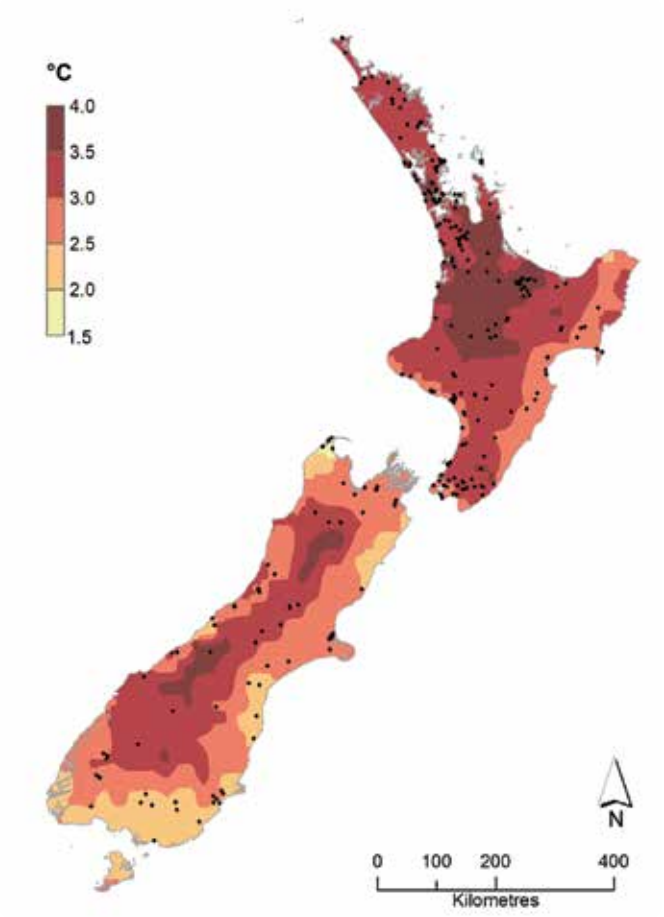
HIGH VULNERABILITY

Subset of the exposure variables that will likely increase the vulnerability of kākahi to climate change

Autumn air temperature

For the late century (2081–2100) and RCP 8.5, kākahi will likely be highly exposed to projected changes in autumn mean air temperatures. The thermal tolerances for Aotearoa–New Zealand freshwater mussel species (and the various life stages) are not well known. Kākahi have a very broad range of depth distribution in warm well-mixed lakes indicating they tolerate a wide range of temperatures. However, in highly productive lakes, their distribution is much more restricted and is defined by the thermocline (abrupt changes in water temperature). This indicates that in increasingly degraded habitats, their thermal window may be more restricted. Adult freshwater mussel mobility is relatively restricted and localised, and they must be able to tolerate local environmental conditions including temperature changes to survive.

Kākahi reproduction may be affected by changes in temperatures. Peak glochidia release occurs in summer (February) when average monthly water temperatures are >18.8°C. In the North Island, ripe female mussels brooding glochidia have been routinely collected from November to March. Planktonic glochidia were found in Lake Taupō when seasonal water temperature increased from 14°C (November) up to 20°C. Changes in autumn air temperatures may affect glochidia release. Freshwater mussels are not only limited by their own thermal tolerances, but also by those of their host fish which increase their vulnerability to environmental change.



Current kākahi distribution (dark circles) mapped with projected changes in mean autumn air temperature (for 2081–2100 under RCP 8.5).

Winter precipitation

For the two time periods (mid–century [2046–2065] and late century [2081–2100]) and RCPs (4.5 and 8.5), kākahi will likely be highly exposed to changes in mean winter rainfall. Winter rainfall is projected to increase by up to 40% along the west coast of the South Island while the east coast of the North Island will likely experience up to 20% reduction.

Kākahi brood in the wintertime. Increases in winter rainfall may result in large floods and disturbance events that could dislocate adult mussels that are brooding, resulting in changes in their distributions.

The seasonal movements of fish over winter may affect the dispersal of mussels. However, some mussel species may have multiple broods or use multiple reproductive strategies, including host overwintering (glochidia being attached to fish over winter) which could lead to large-scale dispersal.

Drought intensity

For the late century (2081–2100) time period and RCP 8.5, kākahi will likely be highly exposed to projected changes in potential evapotranspiration deficit (as proxy for drought intensity). Internationally, freshwater mussels are experiencing increased mass mortality events linked to hydrologic drought, with mussel loss associated with drought severity, location within the river network, and species–specific drought tolerances. Little is known about the effect of drought on kākahi in New Zealand. In streams with degraded riparian vegetation, mussels may be more vulnerable to drought conditions as there is little shading provided by overhead canopy. Mussels can bury indicating they could avoid harsh conditions but they need suitable substrate conditions to do this.

This document summarises some of the key findings from the report: Egan, E., Woolley, J.M., Williams, E. (2020) Climate change vulnerability assessment of selected taonga freshwater species: Technical report. NIWA Client Report: 2020073CH. April 2020. 85 p.

For more on the methodology of CCVAs and the assessment of 10 freshwater taonga species (eight fish and two invertebrates) visit: **niwa.co.nz/te-kuwaha/CCVA**