NIWA
Taihoro Nukurangi

Te Wai Māori

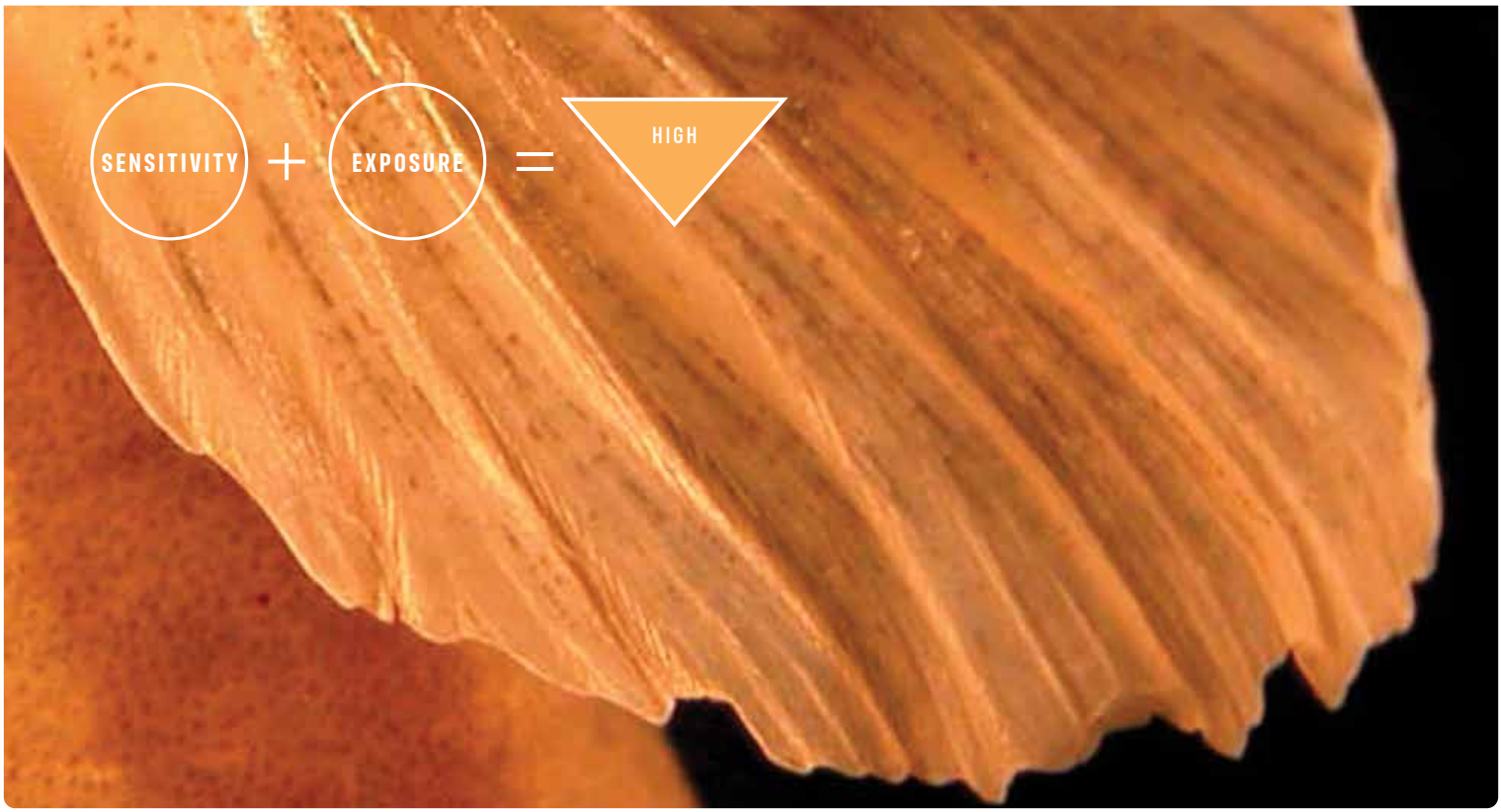
HIGH
VULNERABILITY

Rob Suisted

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

Kōaro (Whitebait)

Galaxias brevipinnis



SENSITIVITY

Kōaro migrate between freshwater and the sea to complete their lifecycle but can also form land–locked populations in lakes. Kōaro are a relatively long–lived species (~15 years) that can reproduce every year from about three years of age, with a generation length of eight years.

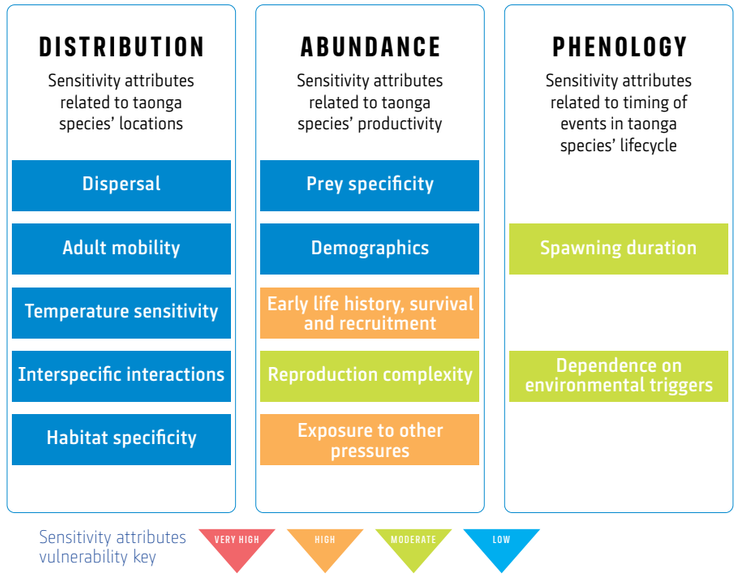
What is a CCVA?

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.



Subset of the sensitivity attributes that contributed to kōaro CCVA scores

Early life history survival and recruitment

Kōaro deposit their eggs amongst gravels and leaf litter during periods of elevated stream flow. Spawning has also been found on macrophytes. Kōaro larvae hatch typically 3–4 weeks later if the eggs are re–inundated during high flow events. The newly hatched larvae disperse to the marine environment to feed and grow for about 17–20 weeks. Once sufficient growth has been attained, the whitebait stage enters fresh waters and migrates upstream usually in early spring. In Aotearoa–New Zealand, spawning habitats have rarely been observed with the only known spawning site occurring at the edge of riffle habitat. No specific information on the distribution of kōaro larvae during marine development exists. Little is known about the cues kōaro use for inward migration to freshwaters, but migration is likely trigged by seasonal changes in water temperature and day length along with flood flows. Kōaro whitebait select streams to enter based on that adult pheromones, which may also be used as a migration cue by this species.

Exposure to multiple pressures

Kōaro are exposed to multiple pressures. These pressures include harvesting of the juvenile whitebait stage, artificial barriers to migration, habitat destruction, pollution of waterways, changes in catchment land use and the impacts of introduced species. Localised extinctions of kōaro have occurred in Lake Rotopounamu and are attributed to the introduction of smelt (*Retropinna retropinna*) and changes in the food web structure.

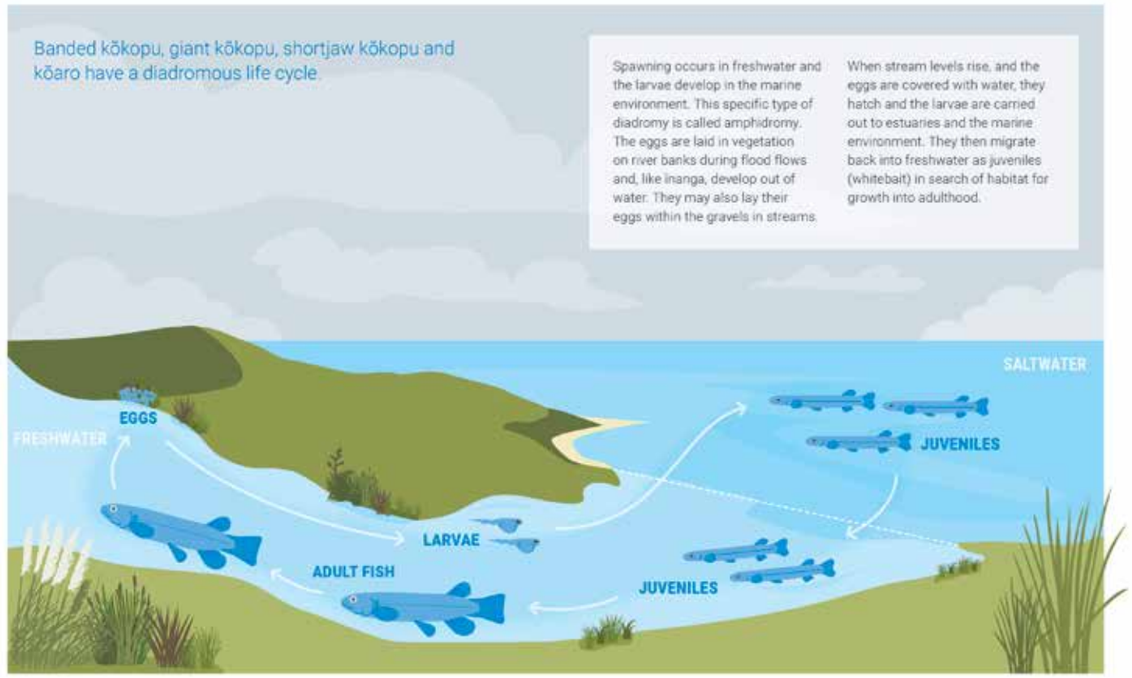
HIGH VULNERABILITY

Prey specificity

Understanding how reliant a species is on specific prey species could predict its ability to persist as the climate changes. Species that are considered specialists (i.e., they have specific prey requirements) are likely to be more vulnerable to climate change because their survival is dependent on their own response to climate change, but also on their preferred prey type. A diverse diet likely reduces the vulnerability of kōaro to climate change. Like other large galaxiids, kōaro feed opportunistically on a variety of aquatic and terrestrial invertebrates. Kōaro can be found in lakes, rivers and high altitude environments meaning they encounter a varied invertebrate community. They are also piscivourous meaing they can feed on other fish species.

EXPOSURE

Kōaro are found in New Zealand and Australia. They are noted climbers with corrugated fins to help them climb. They are often found in the headwaters of many catchments. Kōaro are less common on the east coast of the South Island but can easily be found in areas of suitable habitats and are usually at higher altitudes.



Species summary: Kōuro (Whitebait)

HIGH VULNERABILITY

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

Autumn air temperature

For the late century (2081–2100) and RCP 8.5, kōaro will likely be highly exposed to projected changes in autumn mean air temperature. Changes in water temperatures are already considered a significant threat to kōaro populations according to the International Union of Conservation threat rankings.

In the South Island, high altitude environments show the largest predicted increases in autumn air temperature (>3°C). Large populations of kōaro are found in these high altitude environments meaning this portion of the population will likely be the most exposed to changes in autumn air temeprature. Landlocked kōaro move into lake tributaries during autumn prior to spawning, meaning spawning adults may be the most affected by potential changes in autumn air temperatures.

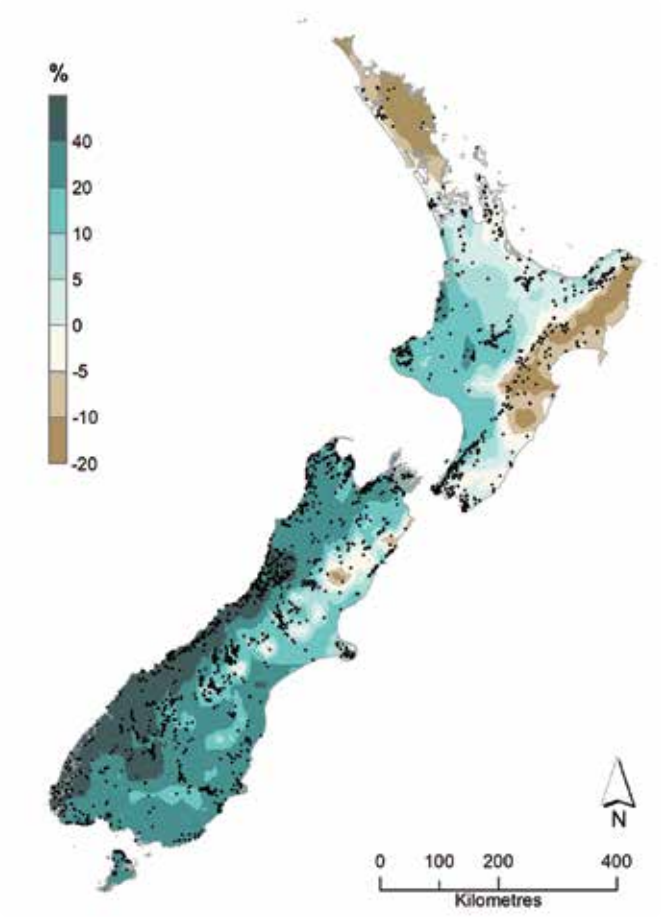
Kōaro are thought to form landlocked populations in colder, less productive lakes, indicating that larvae could be limited by temperature, but this could also be associated with productivity and food abundance (also linked to temperature). A recent vulnerability assessment for the Auckland region suggests that kōaro are one of three native fish species that are likely to be the most vulnerable to warming associated with climate change in this region.

Winter precipitation

For the two time periods (mid–century [2046–2065] and late century [2081–2100]) and RCP 8.5, kōaro highly exposed to projected 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.

Winter is a peak migration time for the post-larvae (whitebait) life stage. Juvenile galaxiids prefer low velocity waters for migration (less than 0.1 m s^{-1}) and fish often move upstream in the low velocity surface waters (less than 1.0 m deep) along riverbank margins. Increases in winter rainfall may affect the upstream migrations of kōaro however data specific for kōaro is needed.

Most populations in the montane environments of the central South Island are landlocked and non-migratory. Winter is the key spawning period for these populations. These populations will likely experience less pronounced changes in winter rainfall. In riverine populations, kōaro spawning occurs during autumn/winter. However, for landlocked populations, reproductive development and spawning is more protracted.



Current kōaro distribution (dark circles) mapped with projected changes in mean winter rainfall (for time period 2081–2100 under RCP 8.5)

Changes in the frequency, timing and magnitude of winter flood events may alter the reproductive cues used by kōaro. Recent studies show that kōaro larvae in lakes display strong signals to flows meaning that the dispersal of larvae and thereby population connectivity, is likely influenced by flows. However, at present, these potential effects are not well understood.

Drought intensity

For the late century (2081–2100) time period and RCP 8.5, kōaro will likely be highly exposed to projected changes in potential evapotranspiration deficit (as proxy for drought intensity). The vulnerability of 43 freshwater fish species in Australia was done using 14 traits for each species (e.g., fecundity, adult size, spawning temperature). In the analysis, kōaro were ranked as the 11th most drought vulnerable freshwater fish species. The effects of drought on kōaro populations in Aotearoa–New Zealand are unknown.

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**