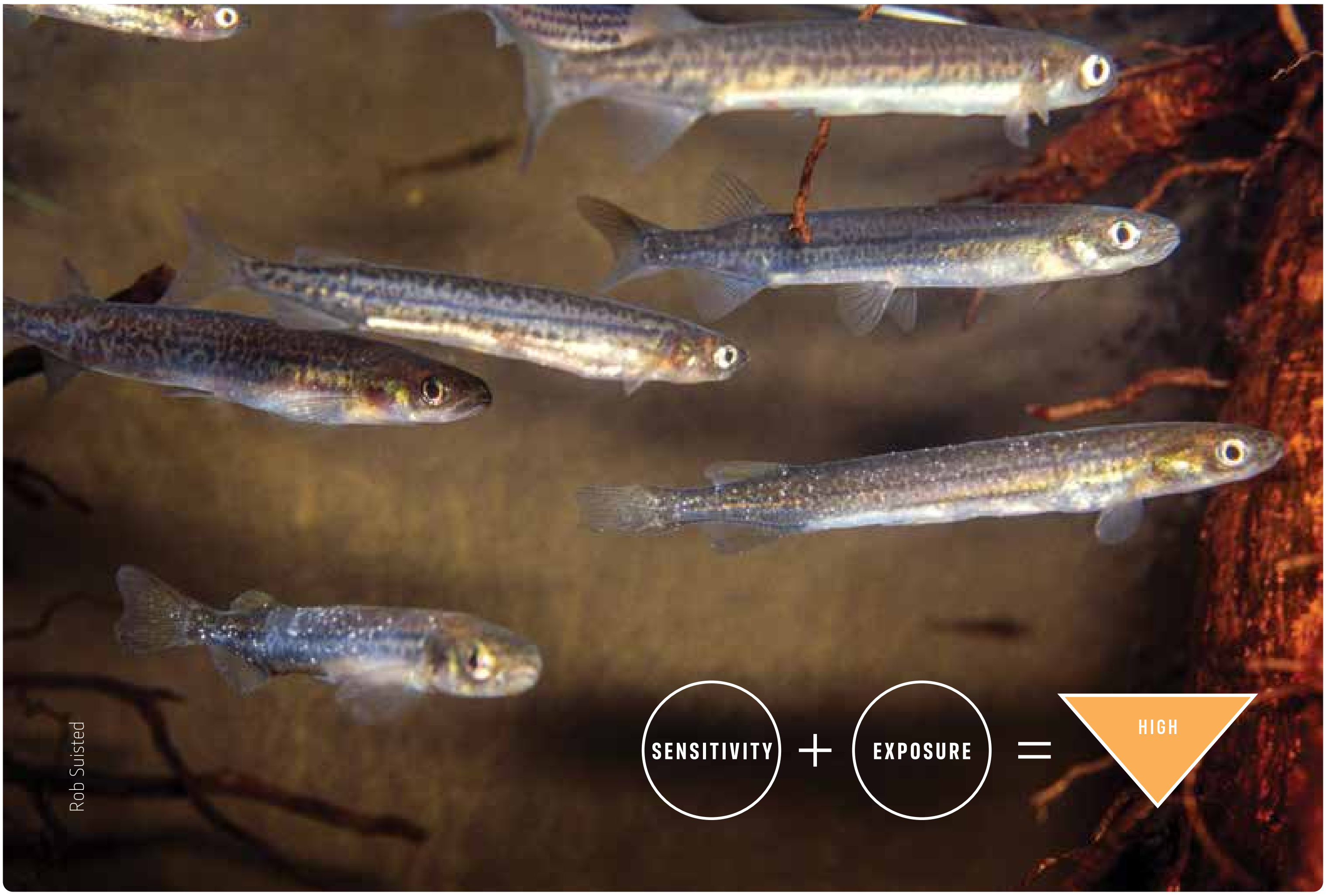
NIWA
Taihoro Nukurangi

Te Wai Māori

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

Īnanga / Inaka (Whitebait)

Galaxias maculatus



Rob Suisted

Species summary: Īnanga / Inaka (Whitebait)

HIGH VULNERABILITY

SENSITIVITY

Īnanga have an amphidromous life cycle that typically involves downstream larval transport, dispersal and development in the marine environment followed by inward migration of post–larvae (whitebait) to freshwater where most feeding and growth occurs.

DISTRIBUTION	ABUNDANCE	PHENOLOGY
Sensitivity attributes related to taonga species' locations	Sensitivity attributes related to taonga species' productivity	Sensitivity attributes related to timing of events in taonga species' lifecycle
Dispersal	Prey specificity	
Adult mobility	Demographics	Spawning duration
Temperature sensitivity	Early life history, survival and recruitment	
Interspecific interactions	Reproduction complexity	Dependence on environmental triggers
Habitat specificity	Exposure to other pressures	

Sensitivity attributes vulnerability key: VERY HIGH, HIGH, MODERATE, LOW

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 īnanga CCVA scores

Complexity in reproduction

The complex reproduction of īnanga likely increases their vulnerability to climate change. Īnanga are one of only a handful of species worldwide that use grasses growing on river banks for reproduction. Īnanga can use several species of grasses to deposit their eggs but water levels must be sufficient to inundate the grasses at the correct height for the eggs to hatch. Īnanga require a specific set of environmental cues (salinity, lunar and tidal) for reproduction and the timing of their reproduction is highly predictable. Īnanga usually migrate downstream to their spawning habitats and reproduction occurs in large groups. The same spawning areas are used within and between years. Individuals typically live for one year – although some individuals can survive for two years. Each individual typically reproduces once in their lifetime but a few individuals may lay eggs several times in a year.

Dispersal

The dispersal of īnanga larvae likely reduces their vulnerability to climate change. Once īnanga eggs hatch into larvae (approximately 7 mm long) they rapidly disperse downstream, through estuaries and out to the marine environment, where larvae from multiple sources may mix. However, some īnanga larvae can remain in freshwater meaning that īnanga dispersal abilities are varied which may help this species respond to a changing climate. Studies show īnanga are genetically very diverse and surface ocean currents are likely an important factor in promoting long distance larval dispersal and thus gene flow over a wide geographic scale.

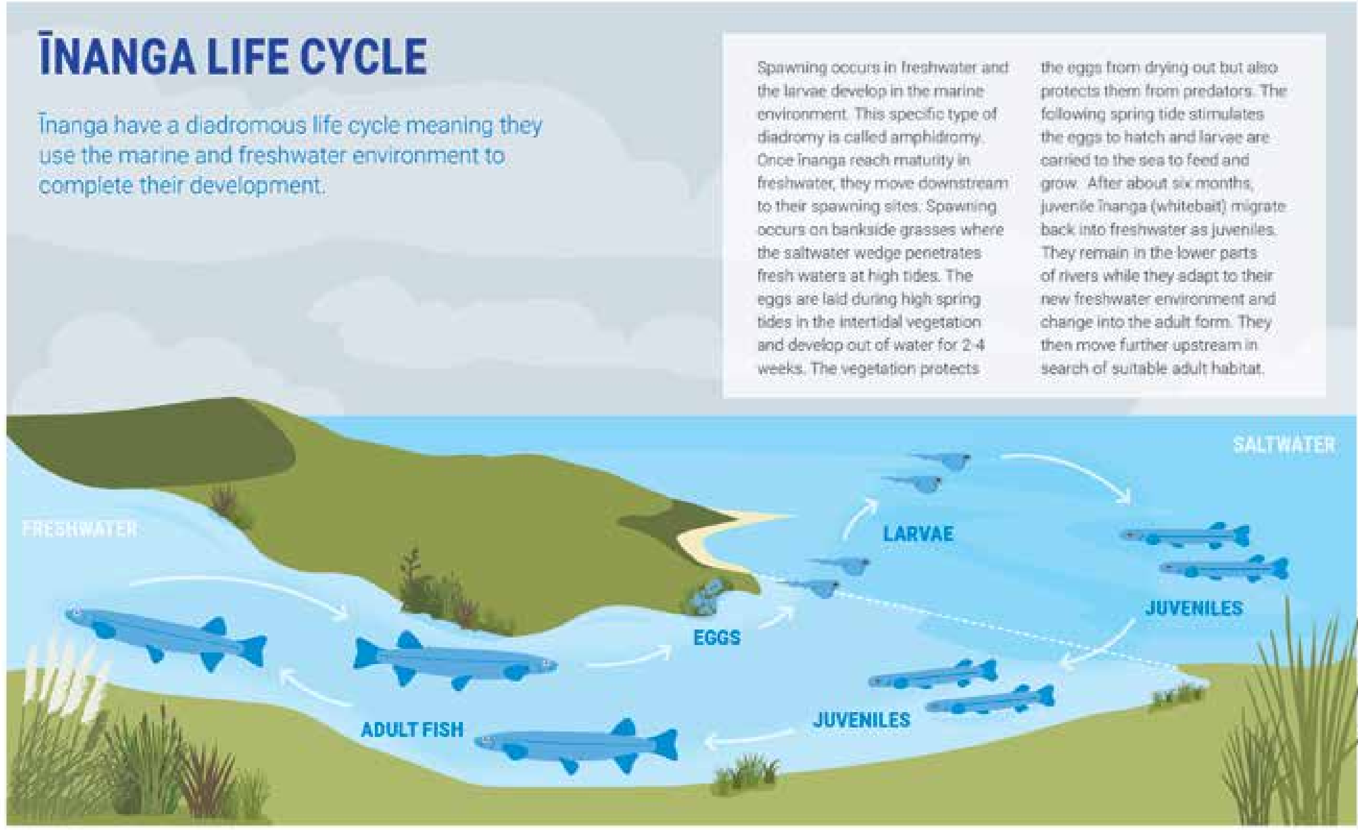
Temperature sensitivity

A species' sensitivity to temperature can be a good predictor of how it will respond to climate change. Species that experience a wide range of temperature regimes (i.e., broad latitudinal distribution) are more likely to persist in warming freshwater/marine environments than those with narrow latitudinal distributions. For species that lack specifics on temperature requirements, their altitudinal/latitudinal species distributions can be used as proxy for temperature tolerance. Aotearoa–New Zealand, īnanga distribution spans 12 degrees latitude indicating this species can tolerate a wide range of temperatures.

Although īnanga populations may be experiencing localised declines in specific areas throughout their range, this species is widespread and abundant throughout the southern hemisphere. Īnanga can be found in temperate zones (usually at low elevations up to 230 m) except for South Africa. These areas include south eastern and south western Australia (east and south of the Great Dividing Range from Brisbane, Queensland (28°S) to Albany, Western Australia (117°S, 50°E) and from Flinders Island and King Island, Bass Strait), Tasmania, and the southern tip of South America including Chile (from 35°S to 55°S), Patagonia, Argentina and the Falkland Islands.

EXPOSURE

Īnanga are considered the most widely distributed freshwater fish species in the world and are abundant in the Southern Hemisphere. In Aotearoa–New Zealand, they are found throughout the country, usually close to the coast. There are a few landlocked populations, particularly in the North Island.



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

Rainfall (annual, autumn, winter, spring, summer)

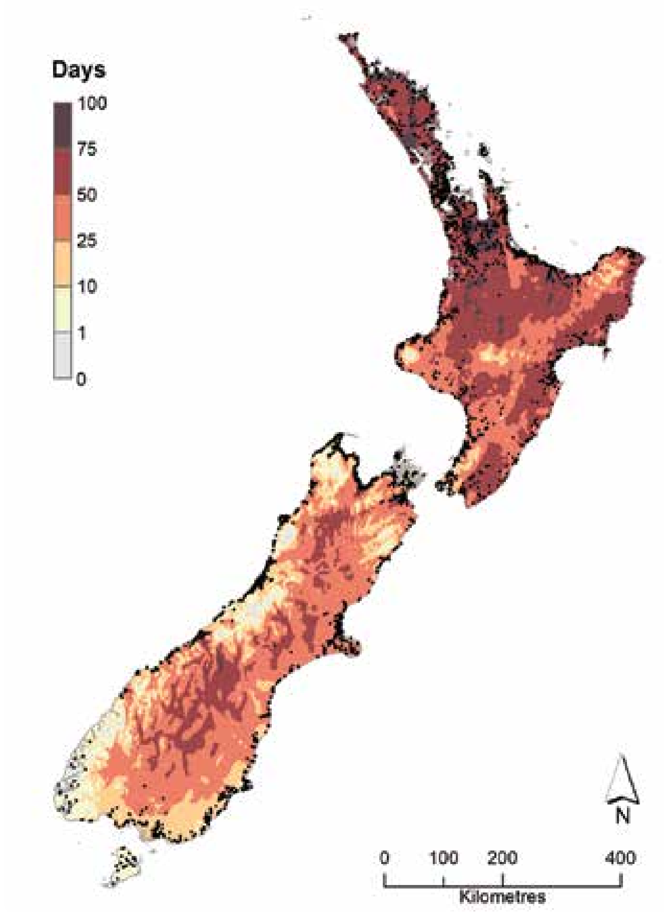
For the two time periods (mid-century [2046–2065] and late century [2081–2100]) and RCPs (4.5 and 8.5), īnanga will likely be moderately to highly exposed to changes in mean annual and seasonal (spring, summer autumn and winter) rainfall.

The early life history stages are likely to be the most sensitive to changes in rainfall. This is because seasonal cues from increased rainfall stimulate the inward migration of post-larvae (whitebait) from the marine environment to freshwater. If rainfall is reduced, particularly during winter and spring, then whitebait recruitment may be episodic, which in turn may impact on the whitebait fishery. Hydrological cues are needed to stimulate spawning in the non-migratory (i.e., landlocked) component of populations.

Sea surface temperature

For RCP 8.5, īnanga will likely be exposed to changes in mean annual sea surface temperatures. By 2100, Aotearoa-New Zealand's mean sea surface temperature is projected to increase by +2.5°C. These projections show regional variability with the greatest increases along the east coast of the South Island. There will also be a broad band of sea surface temperature changes more than 3°C extending across the Tasman Sea.

During larval life, īnanga grow faster in the summer and slower in winter months presumably due to seasonal variation in sea surface temperatures. The peak swimming ability of larval īnanga is at 15–20°C, with swimming ability declining markedly at temperatures above 20°C. Larval īnanga may therefore be more susceptible to predation in warmer conditions. Climate change and associated changes to sea surface temperatures and ocean circulation patterns have been implicated in the decline of īnanga in south-west Australia, but this is not yet known for Aotearoa-New Zealand populations.



Current īnanga distribution (dark circles) mapped with projected changes in annual number of hot days (maximum temperature >25°C) (for time period 2081–2100 under RCP 8.5).

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**