Climate Adapted Finfish

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Programme update | June 2026

Breeding, genomics and adaptation planning for a climate-resilient finfish aquaculture sector

Selected tāmure/snapper retained for future breeding.

In this update

The Climate Adapted Finfish (CAF) programme has reached several important milestones. This newsletter shares progress across salmon and tāmure/snapper resilience research, adaptation planning with industry and iwi partners, Māori Data Sovereignty, breeding strategy design, PhD projects and recent publications.

400	60,000+	8,000	2026
elite tāmure/snapper breeding candidates transferred to BSI	high-resolution snapper images generated	x-ray images collected	next salmon family trial scheduled to begin in September, multiple resilience traits

Why this matters

Climate change is already affecting aquaculture. CAF is building the evidence, tools and partnerships needed to select fish that can perform well under warmer, more variable and more extreme future conditions.

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Programme snapshot

Fast-Tracking Finfish Climate Change Adaptation (CAF) is a five-year collaborative research programme (2023-2028) enabled by the MBIE Endeavour Fund. The programme is designed to protect and add value to Aotearoa New Zealand aquaculture by enabling practical adaptation and long-term growth under climate change.

CAF combines breeding, genomics, phenotyping, adaptation planning and partnership. The goal is to develop integrated multi-trait breeding objectives that value genotypes that are able to remain productive and resilient under climatic and environmental stress.

Programme aim

To enable and fast-track finfish adaptation to the moving target of climate change by delivering environmental-resilience breeding approaches, genomic methodologies and bespoke adaptation plans with partners.

Science and stakeholder engagement

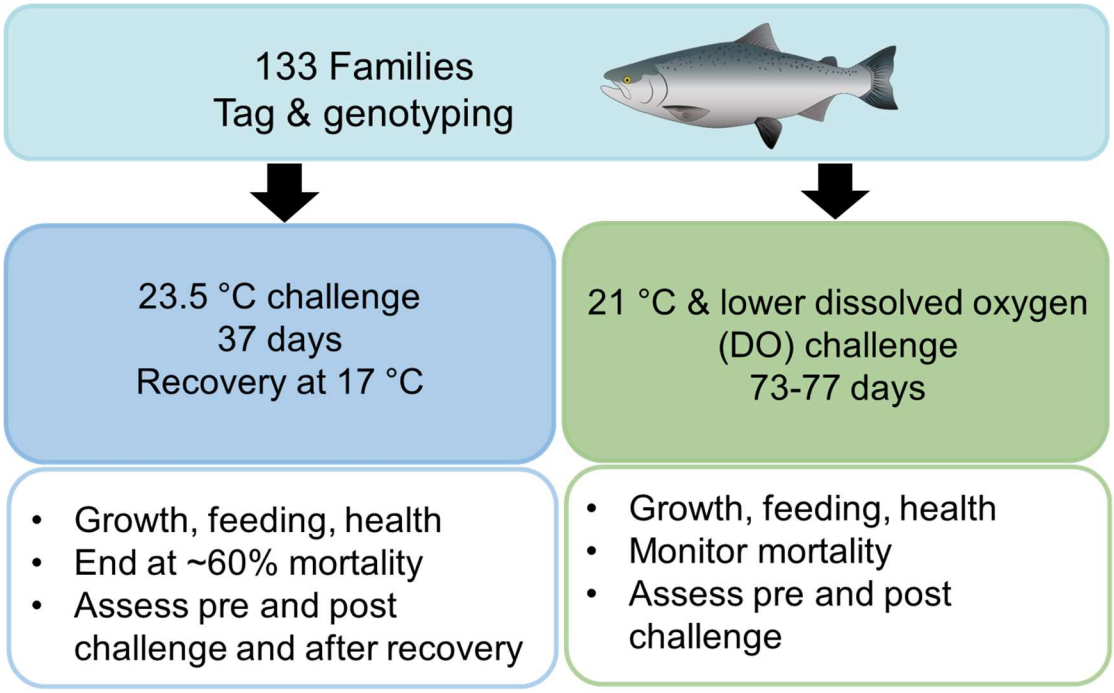
In September 2025, the CAF team hosted its first face-to-face meeting with the Science and Technical Advisory Group (STAG), researchers and stakeholders in Nelson. Over 1.5 days, the group heard 26 presentations across the programme workstreams, including PhD updates and industry perspectives. The discussions provided useful feedback for research planning and helped strengthen connections across the programme.

STAG and stakeholder meeting in Nelson, September 2025.

The visit included sessions at Cawthron Aquaculture Park and a tour to New Zealand King Salmon's Takaka Hatchery. The STAG response was positive and constructive, with recommendations now being used to refine the research programme.

Identifying climate-resilient salmon

CAF's first experiment to be completed was a temperature challenge using families from the New Zealand King Salmon (NZKS) breeding programme at Cawthron's Finfish Research Centre. Families were tagged and genotyped, then assessed in two challenge environments: a 23.5 °C high-temperature challenge and a 21 °C challenge with lower dissolved oxygen.



Salmon trial 1 experimental design.

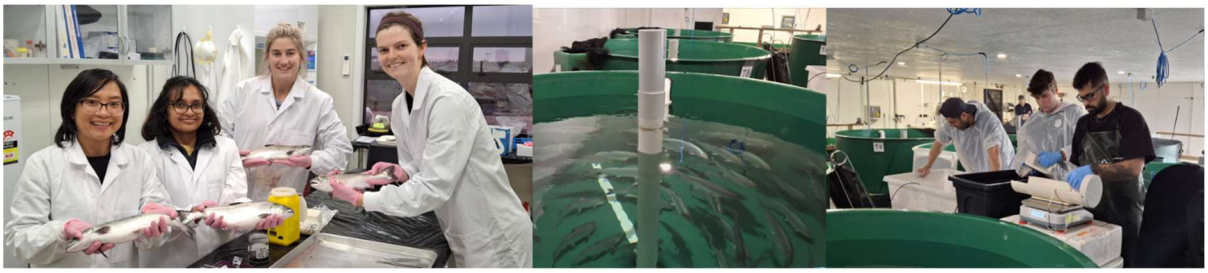
Early signal

Preliminary genetic parameters are encouraging. Moderate to high heritability estimates for growth and survival traits indicate that selecting for improved thermal tolerance in Chinook salmon is possible.

What the first salmon trial is showing

The survival traits measured under high temperature and lower dissolved oxygen were only weakly and negatively correlated, indicating that they are biologically different traits. This means breeding objectives will need careful design: selecting for one type of tolerance may not automatically improve another.

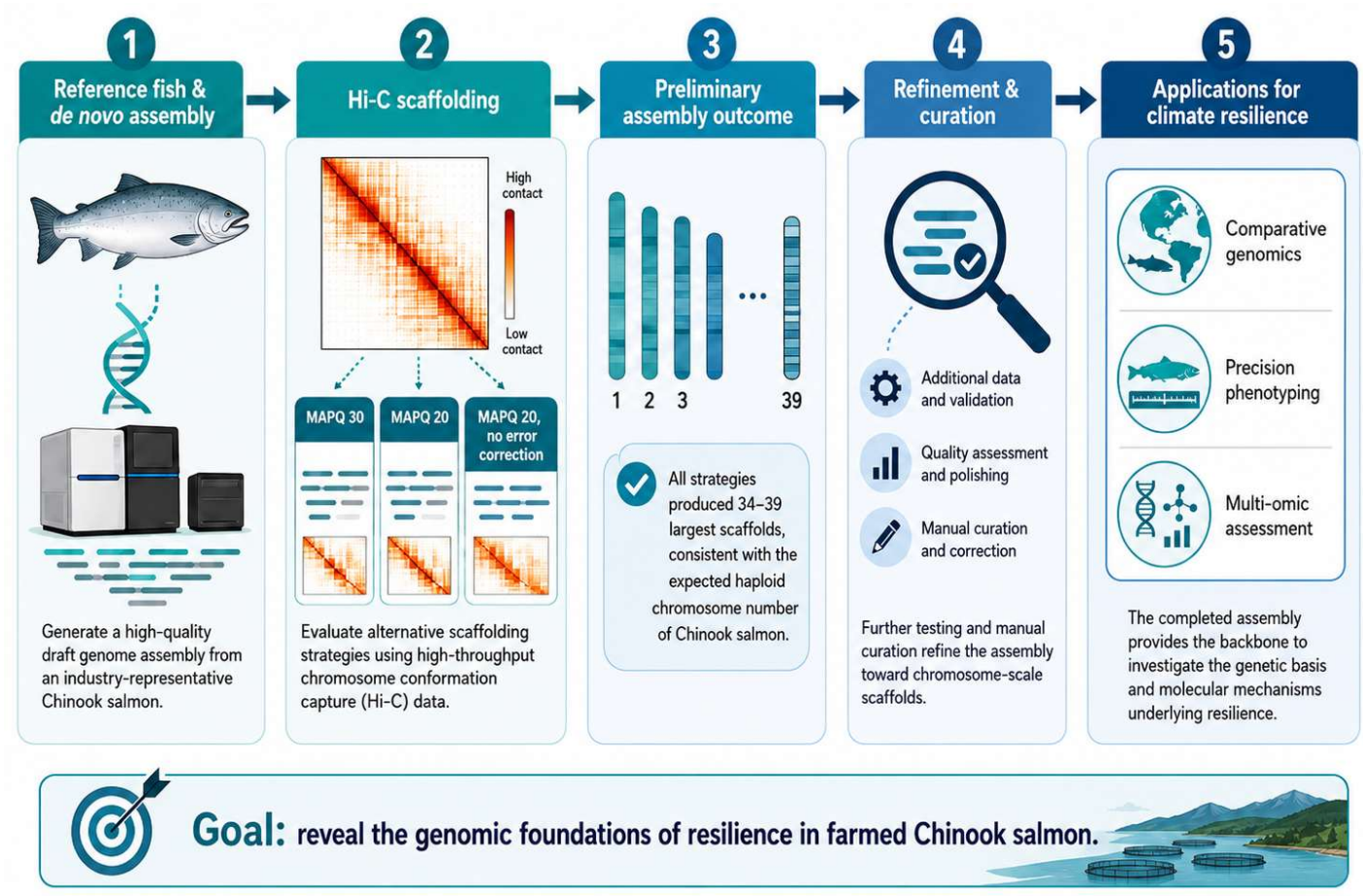
Trait	Heritability h^2 +/- standard error
Weight pre-challenge	0.37 +/- 0.03
Weight post-challenge 21.0 °C and lower dissolved oxygen	0.43 +/- 0.08
Weight post-challenge 23.5 °C	0.34 +/- 0.04
Specific growth rate 23.5 °C	0.37 +/- 0.09
Specific growth rate 21.0 °C and lower dissolved oxygen	0.21 +/- 0.04
Days to death 23.5 °C	0.29 +/- 0.06
Days to death 21.0 °C and lower dissolved oxygen	0.38 +/- 0.20
Binary survival 23.5 °C	0.23 +/- 0.04
Binary survival 21.0 °C and lower dissolved oxygen	0.25 +/- 0.05



Assessing salmon after thermal challenge at the Finfish Research Centre.

The next salmon trial is scheduled to begin in September 2026, again in partnership with NZKS. It will use 2026 year class families from their breeding programme and will investigate disease resistance, swimming performance and temperature tolerance.

Building salmon genomic and epigenetic tools

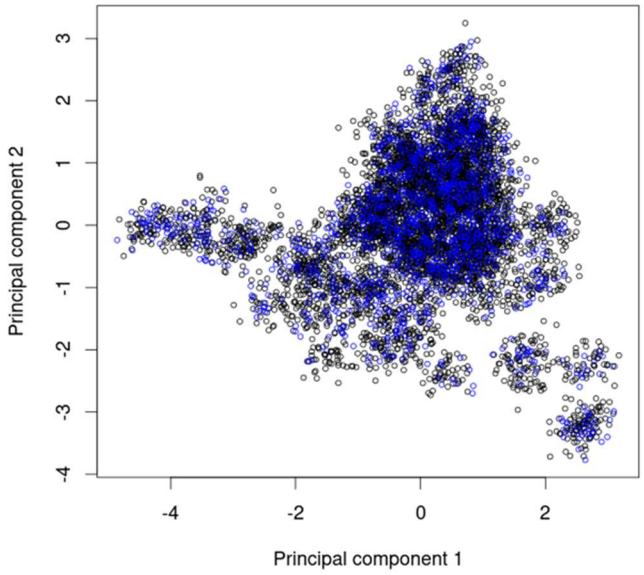


A general overview of the Chinook salmon genome assembly and resilience pipeline

To underpin CAF's phenome-to-genome resilience pipeline, PhD student July Ariñez is completing a *de novo* assembly and annotation of an industry-representative Chinook salmon. High-throughput chromosome conformation capture (Hi-C) data are being used to scaffold the assembly toward chromosome scale.

Preliminary scaffolding results produced 34-39 largest scaffolds, potentially aligning with the haploid chromosome number of Chinook salmon. Further testing and manual curation will refine the assembly. Once complete, it will provide a backbone for comparative genomics, precision phenotyping and multi-omic assessments of resilience.

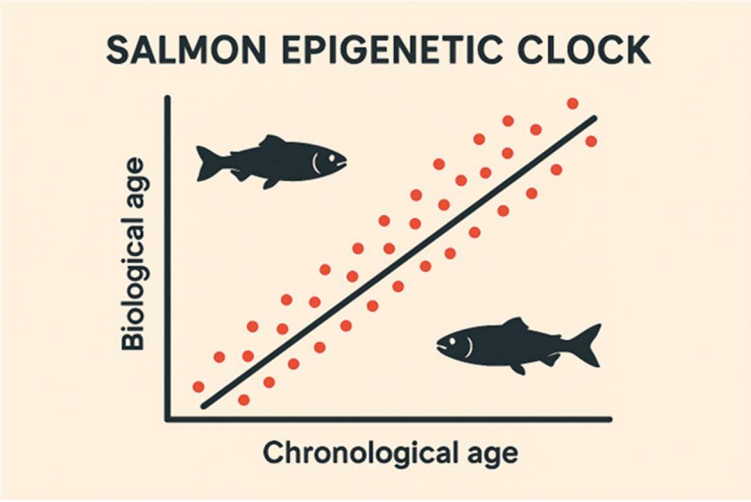
Genomic profiling using genotyping-by-sequencing is being carried out on all individuals in the CAF tank trials and in the family evaluation sea pen for genomic prediction. The principal component analysis of the individuals from CAF tank and sea pen trials shows there is good overlap of individuals between the different family groups, which is great for the analysis.



Genomic relationship structure across CAF tank and sea-pen trial individuals using approximately 40K GBS markers.

A salmon epigenetic clock

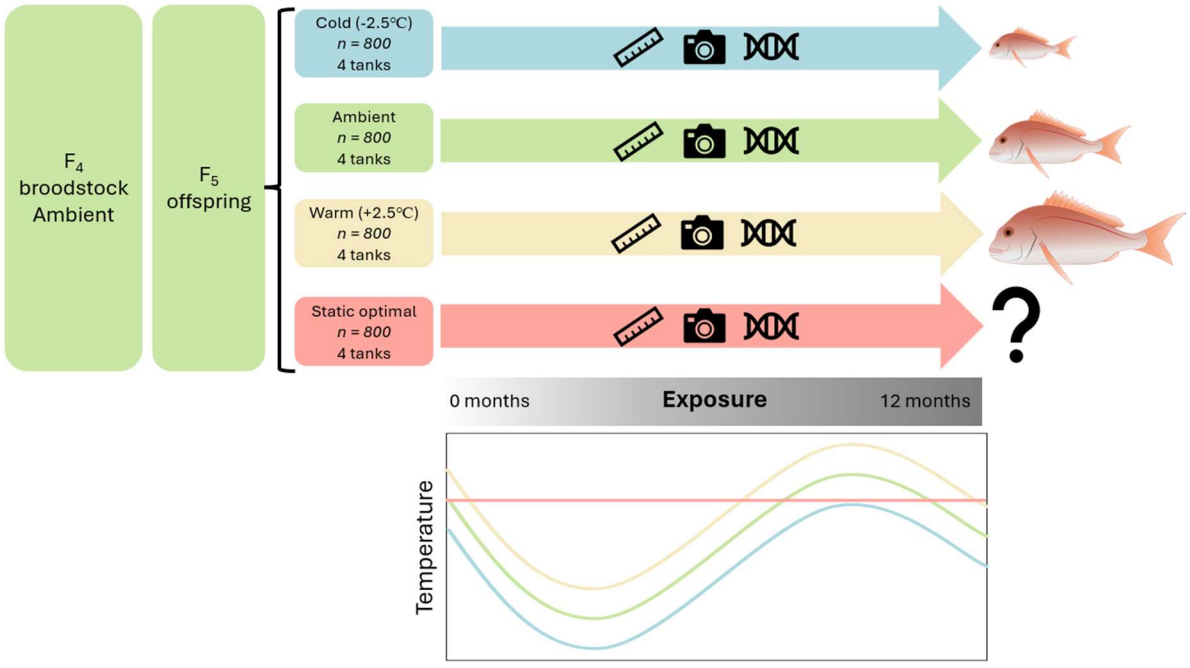
CAF is also developing epigenetic tools to understand resilience. An epigenetic clock uses methylation profiles at key genome sites to compare biological age with chronological age. Tissues collected from thermotolerance trials are being analysed to test whether more resilient individuals show a lower biological age than expected for their chronological age.



Epigenetic clock concept: comparing biological and chronological age.

Tāmure/snapper trial reaches a major milestone

CAF has completed its 12-month tāmure/snapper temperature experiment. All seven sampling rounds have been finished, including the final post-heatwave sampling phase, and the selected breeding cohort has moved into the next phase at the Bioeconomy Science Institute (BSI) in Nelson.



Experimental setup and temperature treatments for the 12-month tāmure/snapper trial. The optimal temperature was 21.0 °C.

7	<6%	30,000	0
sampling rounds completed	mortality across treatments	high-quality SNPs retained per individual	mortality during transfer

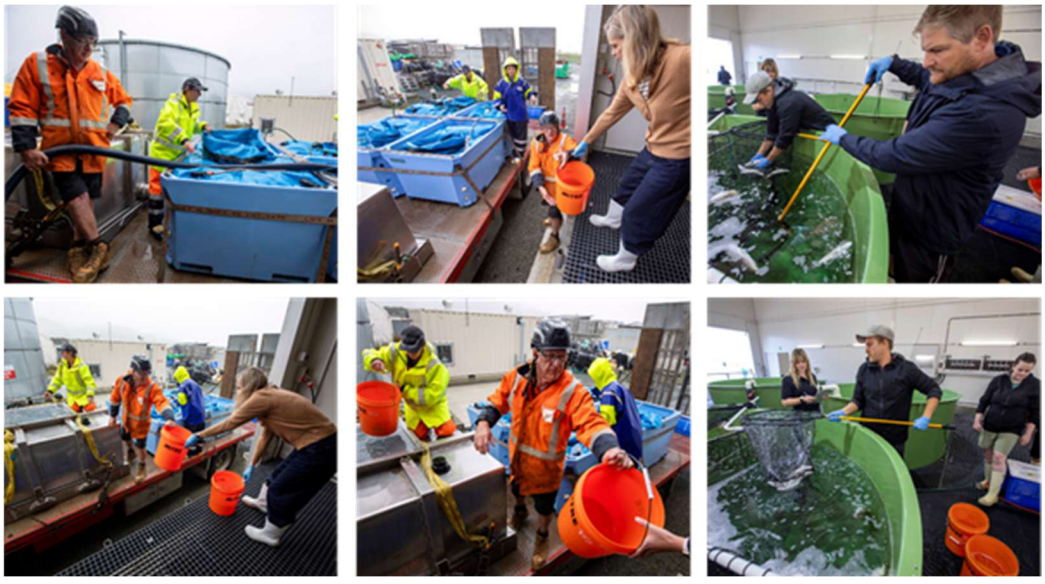
Following simulated heatwave exposure as a test of short-term resilience, the fish were returned to ambient conditions for physiological stabilisation before transport. The final transfer of 400 selected elite breeding candidates from Cawthron Aquaculture Park to BSI was completed on 8 and 16 April 2026.

Science, tikanga and careful transfer

The transition was marked by farewell and welcome ceremonies supported by Anaru Luke (Cawthron) and Hemi Cumming (BSI). These moments included waiata and formal well-wishes, acknowledging tāmure/snapper as a taonga species and recognising the cultural and relational dimensions of the programme alongside the science. These ceremonies not only remind us of our connection to tāmure in New Zealand but also show the greatest respect to the research we will conduct for the future of this species.

Farewell ceremony at Cawthron before the fish transfer.

Arrival and welcome at BSI in Nelson.



Cawthron and BSI staff working together during transfer operations.

What the snapper trial generated

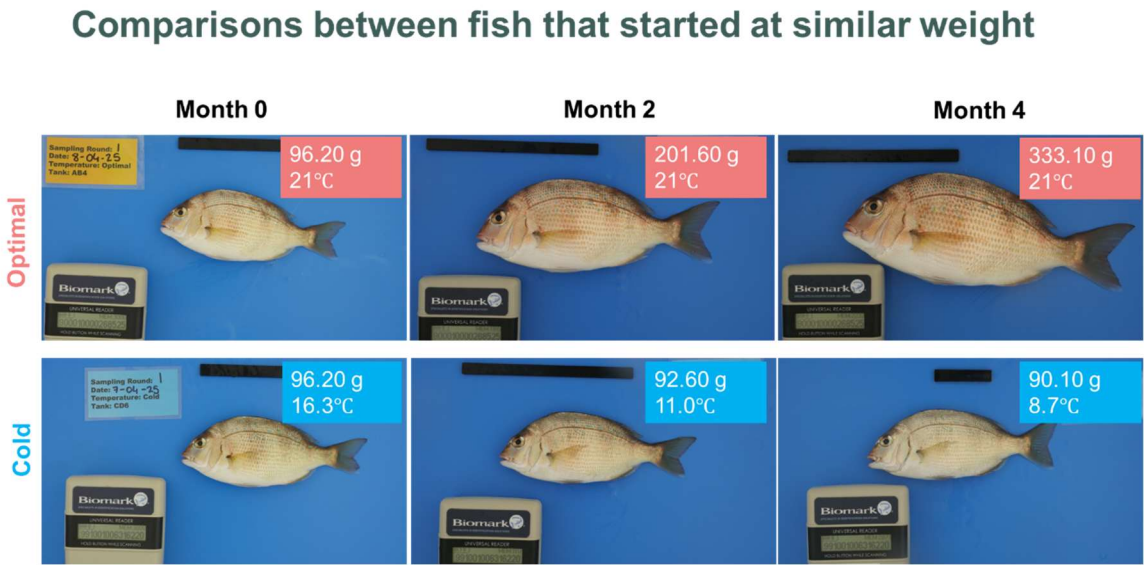
The trial generated one of the most comprehensive climate-resilience datasets for finfish to date. It includes high-resolution external images, x-rays, growth and survival records, gene expression data, methylation profiles and genotyping-by-sequencing data for all fish.

A rich resource for selection

The dataset will help identify families and individuals that combine strong growth, survival and resilience across temperature regimes. This creates a genomic foundation for future selective breeding.

Temperature drove clear growth differences

Fish across all treatments started with highly uniform baseline weights (63.4-64.5 g). Over the 12-month trial, clear and sustained growth differences emerged across temperature regimes. By the end, some fish in the optimal treatment exceeded 1.1 kg, with a group mean of about 700 g. Mean final weights were about 480 g in the warm treatment, 300 g in ambient conditions and 150 g in the cool treatment.



Weight differences over time for two PIT-tagged snapper reared under optimal and cold temperature regimes. Image: Mindy Leder.

The final simulated heatwave (+3 °C for two weeks) provided a short-term resilience test. Fish showed increased activity and feeding but no signs of stress or behavioural impairment, and mortality remained negligible.

From experiment to future breeding

The tāmure/snapper returned to BSI had the highest breeding values for performance within each treatment, while accounting for ancestry during selection. They now form the foundation for future climate-resilient breeding stocks at BSI.

Meet the BSI team behind the tāmure/snapper trial

One of the strengths behind this milestone has been the Bioeconomy Science Institute aquaculture team, whose tāmure/snapper expertise has been fundamental to the trial's success. Their work, in close collaboration with Cawthron colleagues, ensured that skills, protocols and practical capability were consistently applied across both sites.

A defining feature of the team's approach was the balance between scientific rigour and animal welfare. Regular cross-institutional coordination, support from veterinarians Garry Knowles and Jasmine Knowles, and collaboration with Awanui Veterinary meant that each step - from sampling to transport - was carefully planned and responsive to the needs of the fish. That level of care underpins both the integrity of the dataset and confidence in the biological patterns observed.

The BSI team also helped deliver the successful transition into the next phase of the programme. Coordinating the movement of the selected breeding cohort to the BSI facility in Nelson required precision, close collaboration with Cawthron and Lift & Shift logistics, and careful health checks before travel. The transfer was completed with zero mortality, reflecting the high standard of care throughout the process.

More broadly, this collaboration is building enduring capability for climate-resilient aquaculture in Aotearoa New Zealand. It has strengthened finfish research infrastructure, developed practical expertise and embedded best-practice approaches that will support future work across species, sites and production systems.

The BSI and Cawthron team after shared morning kai following the snapper transfer on 8 April 2026.

Partner spotlight: *Maren Wellenreuther, Georgia Samuels, Ellen Hill, Joshua Fantham, Flavio Ribeiro, Julie Blommaert, Dafni Anastasiadi and Leo Magnoni, together with PhD candidates Mindy Leder (BSI) and Lan Nguyen Hong (jointly supervised by Cawthron and BSI), played a central role in establishing the snapper families, refining species-specific procedures and collecting accurate data and images throughout the trial.*

Adaptation planning with industry and iwi partners

CAF is working directly with partners to convert research into practical adaptation pathways. With Mount Cook Alpine Salmon (MCAS), the team co-developed a preliminary climate change adaptation plan during a two-day workshop in Twizel. The plan has since been developed into a set of infographics and MCAS has incorporated the actions into its project management system. We have follow up meetings with MCAS and NZKS in June.

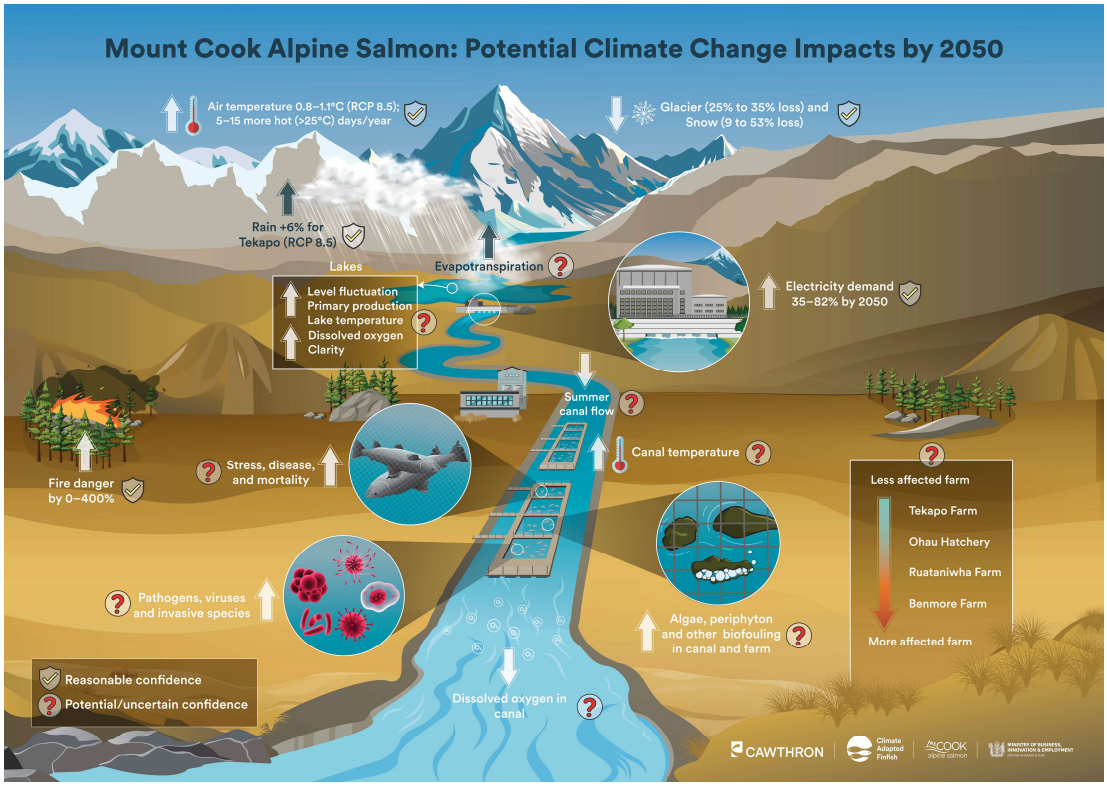
CAF and MCAS adaptation planning workshop in Twizel.

CAF team visit to the MCAS Ruataniwha farm.

How climate forecasting helps adaptation pathways planning

A schematic of potential climate change impacts was produced for MCAS freshwater aquaculture (the Aoraki/Mt Cook region) based on a review of available literature and regional climate projections. It traces effects through the glacier–lake–canal–farm system, from projected warming, glacier and snow loss, and rising electricity demand through to canal temperature, summer flows, dissolved oxygen, biofouling, and fish health. Confidence levels are indicated for each effect and a vulnerability gradient across farm sites.

Multiple climate projections were used to understand how regional climate warming is likely to affect farm conditions, particularly the number of days individual farms are likely to experience optimum temperatures and above key temperature thresholds.



Potential climate change impacts for freshwater aquaculture in the Aoraki/Mt Cook region. Infographic by Revell Design.

Adaptation in action

The MCAS work shows how a research programme can support operational planning: climate forecasting, identifying actions, mapping decisions and helping partners prepare for climate uncertainty.

Working with Te Arawa Fisheries

CAF is also working with Te Arawa Fisheries on climate change adaptation. A wānanga at Whakaue Marae, Maketū explored adaptation pathways that support marae-based aquaculture aspirations. Participants worked from a future vision and identified no-regrets strategies, actions and decisions that can remain useful despite uncertainty.

Climate change adaptation wānanga at Whakaue Marae, Maketū.

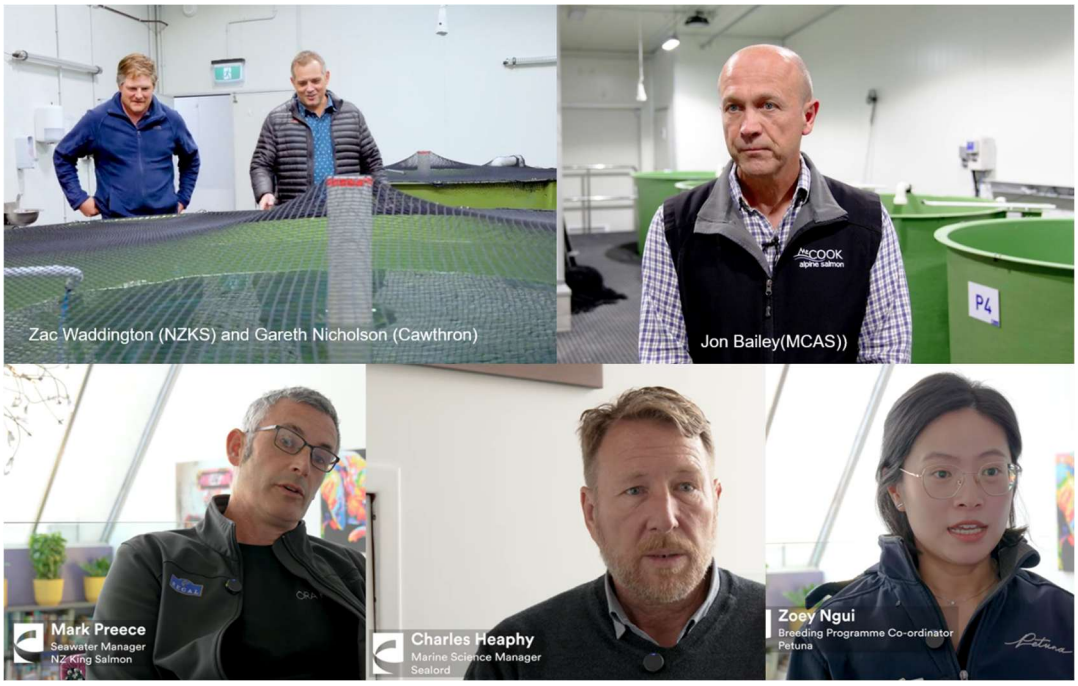
Culturally important, hard-to-source and climate-resilient taonga species suitable for nearshore cultivation.

Māori Data Sovereignty

Following workshops and discussions with the Māori research team on research with taonga species such as tāmure/snapper, Māori researcher Heni Unwin and data scientist Paula Casanovas have developed Māori Data Sovereignty tools for working with taonga species. The tools are being converted into online forms that will be tested by the CAF team, with the aim of wider Cawthron adoption in the future. Although these tools have their roots in Māori data sovereignty, they also support better models of ensuring all data are treated with care and consideration.

Industry feedback

CAF works closely with industry partners including New Zealand King Salmon and Mount Cook Alpine Salmon. Their active involvement helps ensure the research is relevant, practical and able to create real-world impact for the aquaculture sector.



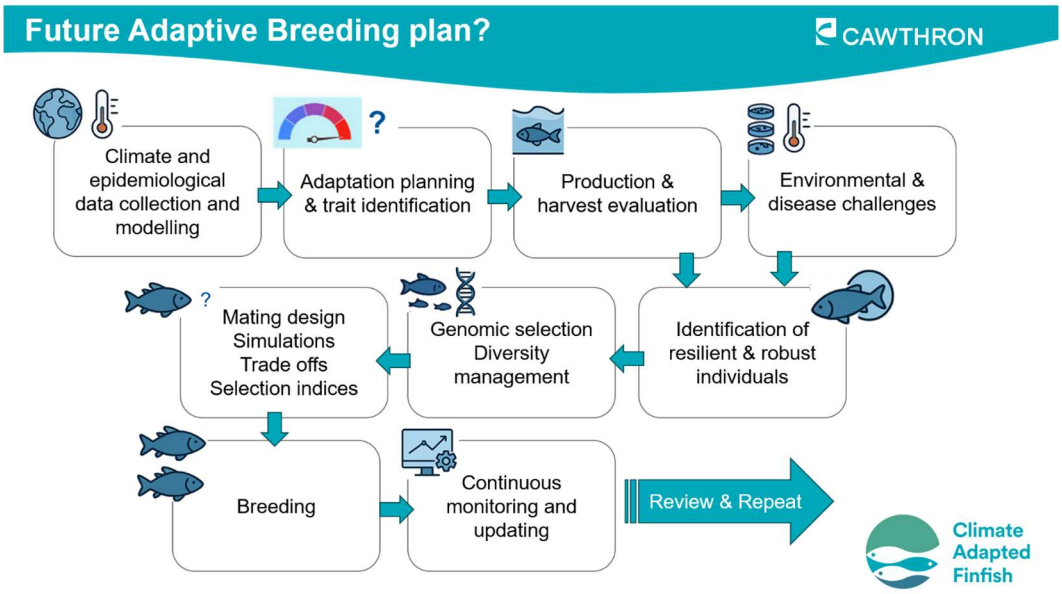
Industry stakeholder feedback captured during CAF activities.

Future adaptive breeding strategies

CAF aims to embed climate resilience into finfish aquaculture breeding systems. This requires a shift from productivity-only breeding objectives toward multi-trait breeding designs that value thermal tolerance, endurance, survival and welfare under stress, alongside growth and efficiency.

The programme is defining climate-relevant phenotypes, estimating heritability and genetic correlations, and identifying genotypes that perform robustly across environments and production systems. These outputs can be implemented in existing breeding programmes and inform the design of new programmes for emerging species.

CAF is partnering with AbacusBio to use breeding simulations as a decision-support layer. These simulations will test alternative breeding programme structures, selection indices and investment strategies under plausible future climate scenarios before they are implemented operationally.



Future adaptive breeding strategy schematic.

PhD student updates

All three CAF PhD students have successfully completed their one-year reviews and are making strong progress. All three students presented at the CAF STAG meeting and the STAG were highly complementary of their work.

July Ariñez

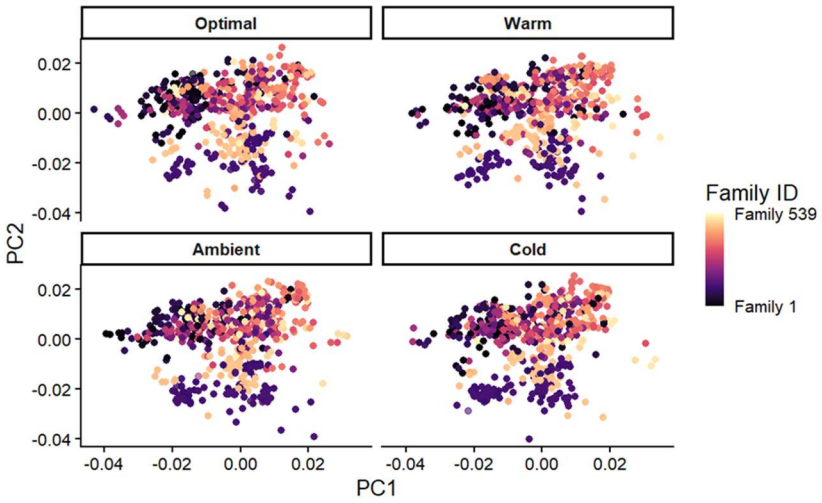
July is analysing the first salmon trial data and finalising the new Chinook salmon reference genome, a first for New Zealand farmed Chinook salmon. He presented at MapNet2025 and has submitted a proceeding paper for the World Congress on Genetics Applied to Livestock Production (WCGALP), USA. He secured travel awards from the New Zealand Society of Animal Production (NZSAP), Association for the Advancement of Animal Breeding and Genetics (AAABG) and the WCGALP Conference.

Mindy Leder

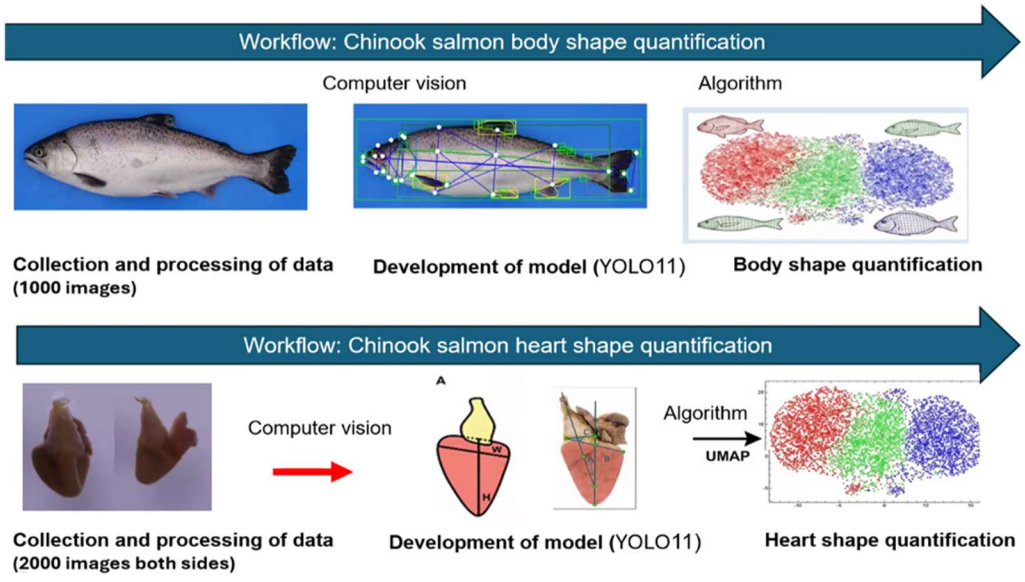
Mindy is using genotyping-by-sequencing data to characterise snapper genetics and build pedigree information. Preliminary parentage assignment identified 539 families from 40 mothers and 92 fathers, enabling family performance analyses across temperatures. These results have validated that the initial random assignment of snapper across the four temperature profiles have produced a random and relatively even distribution of genetic diversity across treatments

Lan Nguyen Hong

Lan's PhD covers research on snapper and Chinook salmon with a focus on measuring phenotypic traits critical for selective breeding such as growth, spinal health and morphometrics and their genetic parameters. Lan is developing a computer vision pipeline using deep learning to quantify phenotypic traits such as growth, spinal health, body shape and heart shape from thousands of images and x-rays across snapper and salmon trials.



Mindy Leder: preliminary PCA based on approximately 20K SNPs among experimental snapper.



Lan Nguyen Hong: computer vision workflows for salmon body and heart shape quantification.

Publications and further information

Recent outputs include:

- Butler, J.R.A., Cradock-Henry, N.A., Behrens, E., Chaput, R., Cook, K.M., Cummings, V.J., Davidson, I., Ericson, J.A., Howarth, L.M., Knight, B., Lundquist, C., Major, R., O'Driscoll, R.L., Parsons, D.M., Ragg, N.L.C. and Symonds, J.E. 2026. Can public-private partnerships drive transformational climate adaptation? Seafood sector pathways in Aotearoa New Zealand. Environmental Research Letters.
- Chen, Z., Blommaert, J., Mei, Y., Jesson, L., Wellenreuther, M. and Zhang, M. 2025. Machine learning for genomic prediction of growth traits in aquaculture: a case study of the Australasian snapper (*Chrysophrys auratus*). BMC Bioinformatics 26(1): 278.
- Samuels, G., Ribeiro, F., Ashton, D.T., Ford, S., Fantham, J., Blommaert, J., Moran, D. and Wellenreuther, M. 2026. Selective breeding and production strategies to support snapper farming in the warming waters of New Zealand's South Island. New Zealand Journal of Marine and Freshwater Research.
- Symonds, J.E., et al., 2025. Growing Aotearoa New Zealand's aquaculture industry through breeding and genomics: progress, challenges and future opportunities. Proceedings Association for the Advancement of Animal Breeding and Genetics 26: 6-12.
- Symonds, J.E. et al., 2025. Fast-tracking farmed king salmon climate change adaptation. Proceedings Association for the Advancement of Animal Breeding and Genetics 26: 130-133.

Watch and read more

Industry and STAG feedback video: vimeo.com/1082702815

Programme webpage: Fast-Tracking Finfish Climate Change Adaptation Research Programme - Cawthron Institute

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To subscribe to the annual CAF newsletter or hear more about the programme, please email jane.symonds@cawthron.org.nz.