



**The
Aotearoa
Circle**

Mā te Kaitiakitanga
ko te Tōnuitanga
Prosperity Through
Guardianship

Seafood Sector Adaptation *Aquaculture Toolkit*

Contents



Aquaculture Adaptation Toolkit

Introduction

Over the past three years, a diverse group of farmers, scientists, regulators, and other industry stakeholders - convened by The Aotearoa Circle - has come together to examine the future of New Zealand’s aquaculture sector in the face of climate change. Our goal was twofold: to understand the unique challenges posed by climate change and to identify practical strategies for adaptation tailored specifically to aquaculture.

Through this collaboration, we assessed the impact of rising temperatures, pathogens, pests, harmful algal blooms, reduced oxygen levels, increased rainfall, and other environmental changes on finfish and shellfish. We also considered broader issues such as feed and fuel costs, transport routes, policy impacts, and consent limitations.

This effort led to the development of eight adaptation strategies designed to strengthen the aquaculture sector’s preparedness for future changes and uncertainties:

- 1. **Climate-Resilient Stocks:** Develop and promote aquaculture species that can thrive in changing climate conditions, ensuring long-term viability.
- 2. **Tactical Farm Adaptation:** Adopt flexible farming practices to quickly adjust to environmental changes while maintaining production efficiency.
- 3. **Diversification:** Encourage a variety of species and farming methods to spread risk and enhance resilience against market and environmental fluctuations.
- 4. **Fit-for-Purpose Feeds:** Develop and optimise feeds designed for climate resilience and efficiency.
- 5. **Feed Security:** Establish domestic feed production to ensure a stable and sustainable supply.

- 6. **R&D Test Sites:** Develop experimental farms to trial innovative aquaculture practices and feed formulations for enhanced sustainability.
- 7. **Aquaculture Research Platform:** Create a collaborative research hub to facilitate knowledge exchange and innovation in aquaculture practices.
- 8. **Decarbonising Freight and Packaging:** Implement strategies to reduce carbon emissions associated with the transportation and packaging of aquaculture products.

These strategies have now been developed into practical project plans, providing a clear starting point for adaptation that aligns with the specific needs and realities of the New Zealand aquaculture sector.

What is the purpose of this document?

This toolkit presents strategies and actions that can be undertaken to strengthen the resilience and sustainability of New Zealand’s aquaculture industry. Designed as a resource for stakeholders across the aquaculture sector - including industry groups, research institutions, government agencies, farmers, and environmental organisations - the toolkit outlines practical actions to secure the sector’s long-term viability and competitiveness in the face of a changing climate.

How to use this document?

Each strategy includes a series of projects designed to help achieve its overarching objective, with required stakeholder involvement indicated for each project. The ticks in the table indicate which key stakeholders are required to implement the strategies and actions outlined in this document. Where relevant, the notes section provides additional context on current work underway, commercial dependencies, and prerequisites. Users are encouraged to actively engage with the strategies, collaborate with relevant partners, and use the outlined actions to guide their implementation efforts.

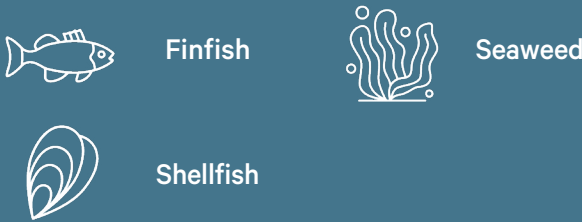
What is the opportunity?

By embarking on the projects outlined within, the industry can increase its resilience to climate change. This action plan presents a significant opportunity to position New Zealand as a global leader in sustainable aquaculture when faced with climate change uncertainty. Benefits will include to enhance its international reputation, to meet consumer demands for sustainability, and driving economic growth.

What impact do we hope to have?

We aim to grow New Zealand’s sustainable and thriving aquaculture industry and support the industry’s ongoing adaptation to climate change; ultimately contributing to the economic and environmental sustainability of the sector.

Due to the breadth of strategies and actions included in this document, we’ve used symbols on each page to help guide the reader. These symbols appear in the top right corner of each page to help you quickly identify the relevant focus area.



Stakeholder Explanations

Consumer Markets

End-users or buyers of New Zealand aquaculture products-both domestic and global consumers. Influence sustainability and traceability efforts; also involved in feedback on novel products or feed ingredients.

ENGOS (Environmental, non-governmental organisations):

Non-governmental organisations working toward for environmentally friendly and sustainable practices. Provide input into biodiversity, bio-remediation, and marine spatial planning. Examples include WWF.

Funding Agencies

Public or private organisations that fund aquaculture initiatives. Support the development of feed mills, research platforms, innovation projects, and infrastructure. Examples include Sustainable Food and Fibre Futures (SFFF) fund, MBIE, SSIF (Strategic Science Investment Fund).

Government & Councils: Central and local government bodies. Responsibilities include setting out strategic direction and regulatory frameworks as well as supporting development through advice and funding.

Industry Groups

Sector organisations representing the interests of aquaculture operators. Often involved in coordination, advocacy, and sector-wide strategy development. Examples include Aquaculture New Zealand, New Zealand Salmon Farmers Association and the Marine Farmers Association.

Processors & Retailers

Companies that process, distribute, and sell aquaculture products domestically or internationally. Critical for value chain and market alignment, including packaging, freight, and customer demand.

Research Institutes

Organisations conducting scientific and applied research. Deliver R&D on species, systems, climate adaptation, feed development, genomics, etc. Examples include NIWA (National Institute of Water and Atmospheric Research), Cawthron Institute, Plant & Food Research.

Rights Owners & Farmers

Entities or individuals who own, operate, or control the rights to aquaculture operations or marine/fishery resources (e.g. marine farm consents, stock genetics, intellectual property). Includes companies, Māori enterprises, or individuals holding commercial aquaculture licences or marine farm areas.

Technical Service Providers

Engineering, technology, or aquaculture services companies providing equipment, systems, or consultancy. Enable development of new aquaculture systems and site operations. Examples include RAS (Recirculating Aquaculture Systems) system engineers, marine infrastructure suppliers.

We acknowledge that Iwi have not been identified as a distinct stakeholder group within this document. This is a deliberate choice that reflects the integral and embedded role Iwi play across all parts of the seafood sector - including ownership, rights, and kaitiakitanga (guardianship) responsibilities. Rather than treating Iwi as a separate stakeholder, their influence and contributions are recognised as foundational to the sector’s structure and operations.

To accompany the toolkit, dedicated Guidance Documents have been created to support seafood sector organisations in incorporating Tiriti-based approaches into their practice. This Guidance acknowledges the central importance of mātauranga Māori and te ao Māori in shaping the development, sustainability, and future of the sector. It offers practical advice for aligning organisational practice with te Tiriti o Waitangi, thereby supporting the effective implementation of the Seafood Sector Adaptation Strategy and its associated toolkits in a way that honours Māori perspectives and leadership.

1 | Climate-Resilient Stocks

What is the problem we are trying to solve?

Current aquaculture stocks are vulnerable to changing environmental conditions, diseases, and other stressors.

Why are we trying to solve it?

Developing climate-resilient stocks is crucial for several reasons: it ensures the long-term sustainability of aquaculture, supports economic stability by maintaining production efficiency, contributes to food security, and helps preserve genetic diversity while improving the health and survival of species.

What actions are required to solve it?

We need informed breeding programmes aimed at enhancing resilience, market value, and genetic diversity. Selecting for disease resistance and implementing non-genetic strategies, such as improved husbandry practices and optimised diets, are essential steps. Additionally, leveraging genomics can enhance selection processes and genetic diversity can be improved through methods like cryopreservation.

It is also crucial to establish proactive health measures, including health surveillance, biosecurity protocols, and vaccine development, to improve overall stock health. Finally, ensuring a reliable supply of climate-resilient juveniles from controlled hatchery systems will further support the productivity of the aquaculture industry. By taking these actions, we can develop stocks better equipped to withstand environmental changes.

Strategy 1.1: Climate-Resilient Stocks

Climate-resilient stock through adaptation planning, breeding and husbandry



Develop company specific adaptation plans that include informed breeding programmes designed to improve resilience and survival, enhance market value and maintain good genetic diversity as well as developing non-genetic strategies for improved stock resilience.

Outcome: Climate-resilient stocks are farmed

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Technical Service Provider	Consumer Markets	Notes
Action: Now Completion: Ongoing	Adaptation plans	Develop and update company specific adaptation plans that identify breeding objectives, now and into the future	✓	✓	✓		✓		Resources & Accountability: <ul style="list-style-type: none">Climate adapted finfish programme,Shellfish Aquaculture Research Platform (ShARP)
		Develop good climate forecasting models to inform adaptation planning and future breeding objectives			✓				
		Determine what’s ahead by completing cost-benefit analysis	✓	✓	✓		✓		
		Develop decision support tools			✓		✓		
		Maintain the New Zealand Aquaculture Development Plan				✓			
	Breeding Programme for climate resilience	Optimise breeding programme design including climate considerations not just business as usual	✓		✓		✓		Prerequisites: <ul style="list-style-type: none">The Cross-Cutting Initiative Climate Change and Vulnerability Forecasting is essential for supporting robust climate forecasting models to inform adaptation planning and guide future breeding objectivesClarify Wai 262 implications for breeding Programmes.
		Maintain climate-resilient stock plans	✓	✓					
		Understand genetics and environment interactions and trade offs among traits	✓		✓		✓		
		Incorporate genomic selection for improved gains	✓		✓		✓		
		Assess attitudes to genetics, genomics and breeding						✓	
		Maintain genetic diversity by combining optimised design with methods such as genomics and cryopreservation	✓	✓	✓			✓	

Strategy 1.3: Climate-resilient Stocks

Climate-resilient stock through improved health management



Develop and implement improved health, surveillance, biosecurity, diagnostic and vaccine strategies to improve health and survival.

Outcome: Stock survival is improved

Strategy 1.5: Climate-resilient Stocks

A reliable supply of climate-resilient spat



Developing a reliable supply of climate-resilient spat through scaled production of climate-resilient stock, production of sufficient hatchery spat to deliver the required volumes of juveniles.

Outcome: Reliable climate-resilient spat supply

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	ENGOS
Action: Now Completion: Ongoing	Communicate spat challenges	Communicate spat challenges	✓	✓	✓	✓	
	Identify reliable new wild spat collection sites	Explore new wild spat collection sites	✓		✓		
		Provide funding support & issue consents	✓			✓	
	Develop farming methods to increase spat retention	Explore farming methods to increase spat retention	✓	✓	✓		
		Collaborate and share knowledge	✓	✓	✓		
		Explore farming methods to increase spat retention	✓	✓	✓		
	Enhance wild populations	Provision of live mussels for re-seeding	✓	✓	✓		✓
		Provide enhancement and rejuvenation of wild populations and ecosystems	✓		✓		

Strategy 1.6: Climate-resilient Stocks (cont.)

A reliable supply of climate-resilient spat



Developing a reliable supply of climate-resilient spat through scaled production of climate-resilient stock, production of sufficient hatchery spat to deliver the required volumes of juveniles, and rejuvenation of wild populations.

Outcome: Reliable climate-resilient spat supply

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Notes
Action: Now Completion: Ongoing	Successful hatchery expansion	Drive hatchery expansion programme, investment, scope options	✓				Commercial dependencies: <ul style="list-style-type: none">Contractors and equipment suppliers
		Support hatchery expansion programme		✓	✓	✓	Decision Points: <ul style="list-style-type: none">Feasibility financing & suitable sites
		Research spat and hatchery production improving quality and resilience (e.g. through breeding & conditioning)	✓	✓	✓		Work already underway: <ul style="list-style-type: none">Spat NZ hatchery (expanding), Te Huata hatchery (consented)
	Produce and distribute hatchery spat	Produce and distribute hatchery spat	✓		✓		
		Support hatchery production and distribution	✓	✓	✓		
		Research spat production improving quality and resilience			✓		
	Ensure access to wild spat	Adhere to Te Oneroa-a-Tohe Beach Management Plan and harvesters' Code of Practice	✓				
		Research on ecosystem enhancement and restoration			✓		
		Setting total allowable catch limits, facilitating alternative collection methods, enable through special permits				✓	

2 | Tactical Farm Adaptation

What is the problem we are trying to solve?

Some current methods are vulnerable to climate-related risks, which can adversely affect the health and productivity of aquaculture operations.

Why are we trying to solve it?

Adapting these practices is vital for several reasons. It ensures long-term sustainability by mitigating the impacts of climate change, supports economic stability by improving operational efficiency and reducing losses, and enhances the resilience of operations, guaranteeing a reliable supply of products. Additionally, it promotes the health and welfare of farmed species, contributing to greater productivity for the industry.

What actions are required to solve it?

To tackle these challenges, we must conduct climate risk assessments and develop sector-wide adaptation plans that incorporate improved operational management practices. This includes optimising stocking densities, diversifying production sites, and responding proactively to harmful algae blooms and temperature fluctuations. Individual company adaptation plans are also essential, alongside optimising smolt and spat stocking strategies through cost-benefit analyses and workshops.

Strategy 2.1: Tactical Farm Adaptation

On-farm adaptation planning and options for improved performance



Develop and implement on farm adaptations to improve performance and climate resilience of salmon, including risk assessment, adaptation planning, optimised stocking and harvesting strategies and improved management practices.

Outcome: Improve performance and survival

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Notes
Action: Now Completion: ongoing	Climate risk assessment	Conduct climate risk assessment	✓			
		Develop sector wide assessments		✓		
		Science inputs, impacts of climate change, forecasting			✓	
	Improved operational management	Deploy operational management practices to improve performance and survival (e.g. stocking density management, diversity of production sites, active responses for harmful algae or temperatures etc)	✓			
		Collaboration across the sector	✓	✓	✓	
		R&D around priorities	✓	✓	✓	
	Develop individual company adaptation plans	Develop individual company adaptation plans	✓			Work already underway: <ul style="list-style-type: none">• Adaptation planning workshops• Climate Adapted Finfish case studies
		Continue sector adaptation planning		✓		
		Science inputs, impacts of climate change, forecasting	✓	✓	✓	
	Optimisation of smolt stocking strategies	Cost-benefit analysis of different smolt sizes	✓			
		Coordinate smolt workshops to share results		✓		Work already underway: <ul style="list-style-type: none">• SFFF Project
		Continue smolt research			✓	

Strategy 2.1: Tactical Farm Adaptation (Cont.)

On-farm adaptation planning and options for improved performance



Develop and implement on farm adaptations to improve performance and climate resilience of salmon, including risk assessment, adaptation planning, optimised stocking and harvesting strategies and improved management practices.

Outcome: Improve performance and survival

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Funding Agencies	Technical service providers
	Development of RAS production for smolt	Reduce risk by using land based RAS as an alternative production strategy, from juveniles to harvest	✓					
		Collaboration across the sector		✓				
		RAS production protocols and optimising conditions	✓	✓	✓			
		Issue consents				✓		
		Provide equipment and infrastructure Facility design and engineering						✓
	Reduced harvest size for improved survival	Harvest smaller fish for reduced risks	✓					
		Industry sector investment with NZTE to develop markets, and bringing those findings to company boards, sales, marketing		✓				

Strategy 2.2: Tactical Farm Adaptation



Dynamic geography farming

Develop production strategies to enable dynamic geography farming and flexibility, including developing new sites and integrated, flexible production systems.

Outcome: Dynamic geography farming

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Notes
Action: Now Completion: ongoing	Identify good sites for production and new approaches to land use	Review site performance and adjust operations accordingly	✓				Work already underway: <ul style="list-style-type: none">Some operators have already adjusted operations, fallowed sites but affecting overall production
		Identify new sites	✓		✓		
		Define risks and opportunities for utilisation of flood-prone coastal land	✓		✓		
		Environmental assessments and monitoring	✓		✓		
		Issue consents				✓	
	Develop ability to move farms	Continue R&D on moveable systems			✓		
		Develop flexibility for consents				✓	
	Combine different production strategies and locations for efficient farming	Improve production management strategies	✓				
		Combine RAS hatchery, nursery, inshore and open ocean farming for efficient production	✓				
		Issue consents				✓	

Strategy 2.3: Tactical Farm Adaptation



Improved efficiency of farm systems with technology

Developing smart and more energy efficient farming through technological innovation including automation and AI, operational energy efficiency, including fuel, and electrification of land vehicles.

Outcome: Improved efficiency of farm systems with technology

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Funding Agencies	Notes
Action: Now Completion: ongoing	Develop SMART farming sites and structures, automation and AI	Develop SMART farming sites and structures, automation and AI	✓	✓	✓			
	Options for increased operational energy efficiency	Explore options for increased operational energy efficiency	✓					
		Investigate boat-based processing and novel vessels (e.g. electric, autonomous)	✓					Commercial dependencies: <ul style="list-style-type: none">Alternative fuel infrastructure (e.g. charging stations on wharves)
	New vessel innovations	Fund and support R&D and critical infrastructure (e.g. charging stations at wharves)				✓		Work already underway <ul style="list-style-type: none">EECA co-Funding for tech demonstration and lowering emissions
	Electrification of land vehicles	Use electric vehicles on land	✓					
	Improve fuel efficiency	Improve fuel efficiency	✓					

Strategy 2.4: Tactical Farm Adaptation

Co-location with offshore facilities



Investigation of the potential for co-location of offshore facilities to enable lower overall emissions and better climate resilience.

Outcome: Aquaculture co-location with offshore energy sites

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils
Action: Now	Investigate wind farm and aquaculture co-location	Investigate wind farm and aquaculture co-location	✓	✓	✓	
		Modelling, monitoring, impacts and benefits			✓	
Completion: ongoing	Off-shore industry engagement	Investigate offshore co-location options, engage with the off-shore energy industry	✓	✓	✓	
		Modelling, monitoring, impacts and benefits	✓		✓	
		Develop enabling regulations for water space access and processes around zoning and rights				✓

Strategy 2.5: Tactical Farm Adaptation



Nursery Site Performance

Enable the development of high quality nursery sites for improved climate resilience for the shellfish industry, including demonstrating the importance of high quality nursery sites, identification of key nursery sites, deployment of stock at these sites and research to support their development.

Outcome: Improved nursery site performance

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Notes
Action: Now Completion: ongoing	Demonstrate the importance of high quality nursery sites	Communicate the importance of high-quality nursery sites	✓	✓	✓	✓	Work already underway: <ul style="list-style-type: none">SFFF projects & Fisheries New Zealand Environmental Drivers of Spat performance project
	Identify and map location of high quality nursery sites	Identify key regions for high-quality nursery sites, support creation of map showing key regions for nurseries	✓	✓			
		Provide assessment of site suitability			✓		
	Deploy stock at high quality nursery sites to demonstrate benefits	Deploy nurseries at targeted sites	✓				
		Drive R&D for nursery development (Sea-based and land-based)	✓	✓	✓		
		Identify drivers of nursery site performance				✓	
		Develop enabling regulations for sea-based and land-based aquaculture in regional plans				✓	

Strategy 2.6: Tactical Farm Adaptation

Data integration and efficiency for resilience



Develop data integration methods/models (including early warning systems) and coordinate to enable better decision making.

Outcome: Data integration and efficiency

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Notes
Action: Now Completion: ongoing	Data integration, communication and modelling	Increase real-time data collection, increase automated monitoring on farms	✓		✓		Work already underway: <ul style="list-style-type: none">Cawthron, NIWA and multiple other data science programmes e.g. Data Science for Aquaculture MBIE SSIF Funded project through Victoria University of Wellington
		Sector communication and co-ordination		✓			
		Continue research on epidemiology, modelling, data analysis, risk analysis			✓		
		Develop models and apps for forecasting and early warning systems			✓		
		Identify ways through which Councils can help and co-ordinate data collection and sharing				✓	

3 | Diversification

What is the problem we are trying to solve?

Diversifying species that are farmed will improve the resilience and sustainability of the aquaculture industry. Currently, reliance on a limited number of species leaves the industry vulnerable to environmental changes, market fluctuations, and disease outbreaks.

Why are we trying to solve it?

Diversifying species is important for several reasons. It reduces risks by spreading them across multiple species, supports economic stability by creating new market opportunities, and enhances the industry’s adaptability. Moreover, it improves resilience to environmental shifts and disease outbreaks while promoting sustainable practices by encouraging the farming of species with lower environmental impacts.

What actions are required to solve it?

To tackle these challenges, we need to identify suitable new species through decision-making processes and workshops, which should include conducting cost-benefit analyses, adjusting processing methods, and developing markets for these species. Integrating multi-species production into both inshore and offshore sites, along with implementing protective yet enabling biosecurity measures, would be beneficial.

Pilot testing new species and developing appropriate rearing methods, assessing species compatibility, and scaling production to commercially viable levels are necessary steps. Additionally, exploring co-culture with warm-adapted species and harvesting fouling organisms can create added value. Considering related strategies, environmental certification, and biodiversity credits, will further support diversification efforts.

Strategy 3.1: Diversification

Species Diversification for Resilience



Derisking investment in species diversification and adaptation with science supported decision making (e.g. cost-benefit analysis), including identifying key species for different options, markets and locations, then testing these species at pilot scale.

Outcome: Species diversification

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Processors and Resellers	Consumer Markets	Notes
Action: Now Completion: ongoing	Identify suitable new species for aquaculture	Decision to diversify and test new species - part of adaptation planning	✓						Decision Points: <ul style="list-style-type: none">Farming salmon, oysters or mussels is no longer viable Work already underway <ul style="list-style-type: none">Shellfish Aquaculture Research Platform (ShARP)Plant & Food Research
		Identify priority species - workshop, driven by what is feasible and what market research identifies	✓	✓	✓				
		Species development, closing the life-cycle and juvenile supply; species thresholds			✓				
		Cost-benefit analysis	✓	✓	✓	✓			
		Adjusting processing methods					✓		
		Markets for new species; Need a market decision point; if wild fishery collapsed, be able to respond to market demand						✓	
	Develop traffic light system of species suitability for different options, markets and locations	Assess species suitability	✓	✓	✓				Decision Points: <ul style="list-style-type: none">Clarify Wai 262 implications
		Traffic light system for key parameters: biology & ecology, hatchery technology, farming technology, market, multi-species potential, climate resilience, genetic risks	✓	✓	✓				
		Strategic support; Issue consents				✓			
	New species pilot testing	Pilot testing	✓	✓	✓				Decision Points: <ul style="list-style-type: none">Inadequate seed supply of target crop species (e.g. Te Oneroa-a-Tohe spat)
		Develop rearing and juvenile supply methods and scaling production to commercially-relevant quantities	✓		✓				
		Issue consents				✓			
		Supportive legislation e.g. facilitated, enduring access to water space and seabed.				✓			
		Expedite biosecurity regulations				✓			

Strategy 3.2: Diversification

Species Diversification for Resilience

Derisking investment in species diversification and adaptation with science supported decision making: multi-species integrated aquaculture feasibility and development and exploration of new options such as extracting value from fouling organisms and environmental certification strategies (e.g. biodiversity credits).



Outcome: Species diversification across the industry

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Consumer Markets	Notes
Action: Now Completion: ongoing	Integrate multi-species production into inshore and off-shore sites	Integrate multi-species production into inshore and off-shore sites	✓					Work already underway: <ul style="list-style-type: none"> Nga Punga o te Moana: Anchoring our open ocean future Shellfish Aquaculture Research Platform (ShARP)
		Multi-species development, closing the life-cycle and juvenile supply	✓		✓			
		Ensure protective yet enabling biosecurity measures & Issue consents	✓	✓		✓		
	Cost-benefit analysis and pilot testing	Review cost-benefits and pilot test if appropriate	✓					Decision Points: <ul style="list-style-type: none"> Cost-benefit analysis
		Understand the potential of farming selected new species within the regulatory context	✓	✓		✓		
		Pilot testing. Develop rearing methods, species compatibility	✓	✓	✓			
		Investigate new warm-adapted species and potential for co-culture	✓	✓	✓			
		Issue consents				✓		
		Supportive legislation e.g. facilitated, enduring access to water space and seabed				✓		
		Expedite biosecurity regulations	✓	✓		✓		
		Ensure protective yet enabling regulatory measures				✓		
	Harvesting fouling organisms to add value	Consider harvesting of “fouling” species from farms to add value	✓					Decision Points: <ul style="list-style-type: none"> Unpredictable resource Work already underway: <ul style="list-style-type: none"> Plant & Food Research Cybermarine programme
		Assess the potential of harvesting fouling	✓	✓	✓			
		Develop new markets for biofouling					✓	

Strategy 3.2 (Cont.): Diversification



Species Diversification for Resilience

Derisking investment in species diversification and adaptation with science supported decision making: multi-species integrated aquaculture feasibility and development and exploration of new options such as extracting value from fouling organisms and environmental certification strategies (e.g. biodiversity credits).

Outcome: Species diversification

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	ENGOs	Consumer Markets	Notes
Action: Now Completion: ongoing	Assess the potential benefits of related value strategies, such as carbon credits, life cycle assessment (LCA), environmental product certification, and biodiversity credits	Consider related value strategies - e.g. carbon credits/LCA, environmental certification of products, biodiversity credits	✓	✓					Work already underway: <ul style="list-style-type: none">MfE-lead Biodiversity Credit Scheme development
		Input into public consultations	✓	✓	✓		✓		
		Assessment framework to support biodiversity accreditation and carbon reduction efforts		✓	✓				
		Develop marine biodiversity accreditation scheme, and funding support for LCA and carbon reduction efforts				✓			

4 | Fit for purpose feeds

What is the problem we are trying to solve?

The finfish aquaculture sector in New Zealand faces significant challenges related to feed optimisation and emissions. Current feed formulations may not adequately support the health and welfare of farmed species under changing climate conditions, and they contribute considerably to the sector’s carbon footprint.

Why are we trying to solve it?

Optimising feeds is essential to enhance the health and welfare of New Zealand finfish species, increase production efficiency, and ensure the sector’s sustainability. Additionally, reducing emissions from feeds is crucial for minimising environmental effects and meeting consumer and regulatory expectations.

What actions are required to solve it?

To address these challenges, we must develop climate-resilient diets tailored for New Zealand farmed species. This involves conducting nutrition research, testing diets in real-world farm settings, and implementing effective feed management strategies to maintain and improve animal welfare while boosting production efficiency. Additionally, we should focus on creating feeds with lower emissions by conducting life-cycle assessments and trialling various feed ingredients.

Strategy 4.1: Fit For Purpose Feeds



Optimising feeds to improve health and welfare of New Zealand Species.

Develop climate-resilient and open ocean diets optimised for New Zealand farmed species by conducting nutrition research, real world farm diet testing, and testing feed management strategies.

Outcome: Optimised feeds for New Zealand species, improved health and welfare, improved efficiency.

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Funding Agencies	Notes
Action: Now Completion: Ongoing	Nutrition Research	Work with feed companies or suppliers to develop better diets	✓	✓	✓			Work already underway: <ul style="list-style-type: none">• Feed company research• Other R&D Research
		Industry led nutrition research to address priority issues, influence what feed companies do	✓	✓	✓			Commercial Dependencies: <ul style="list-style-type: none">• Encourage feed companies to develop adaptation strategies• Feed companies conduct research and report back• Increased R&D on climate-resilient diets and open ocean diets• Feed companies able to produce small volumes of trial diets• Feed companies provide co-funding for external research.• Ability to source small volumes of trial diets to test
		Co-ordinated and prioritised research plan - aquafeed workshop	✓	✓	✓			
		Increased R&D on nutrition priorities, secure funding. Need fundamental research	✓	✓	✓			
		Provide additional funding for aquafeed R&D	✓	✓		✓	✓	
	Real world farm diet testing	Conduct real world trials on farm or in the hatchery	✓	✓	✓			
		Strategic support and co-funding (e.g. SFFF)	✓			✓	✓	
		Provide additional funding for aquafeed R&D	✓	✓		✓	✓	

Strategy 4.1: Fit For Purpose Feeds



Optimising feeds to improve health and welfare of New Zealand Species (cont.)

Develop climate-resilient and open ocean diets optimised for New Zealand farmed species by conducting nutrition research, real world farm diet testing, and testing feed management strategies.

Outcome: Optimised feeds for New Zealand species, improved health and welfare, improved efficiency

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes
Action: Now Completion: Ongoing	Diet Optimisation	Refine research based on shared knowledge. Feed company collaboration	✓	✓	✓
		Share knowledge	✓	✓	✓
		Test different feeding methods and behavioural responses	✓		✓

5 | Feed security

What is the problem we are trying to solve?

The aquaculture sector in New Zealand currently relies on imported feed, which creates risks related to supply stability, cost control, and long-term sustainability in a changing climate.

Why are we trying to solve it?

Developing domestic feed production is important for ensuring a stable and secure supply while reducing dependence on imports. This shift supports local economic growth and contributes to sustainability goals by potentially lowering transportation emissions.

What actions are required to solve it?

To address this issue, we need to develop a comprehensive business case to attract investment and establish an economically viable feed mill in New Zealand as the industry scales. Collaboration with feed companies is crucial to create climate change adaptation plans for both feed and ingredients, involving suppliers and farmers. Additionally, we should focus on identifying new climate-resilient feed ingredients. By implementing these actions, we can enhance the sustainability and resilience of New Zealand’s aquaculture sector.

Strategy 5.1: Feed Security



Develop a business case for New Zealand based feed production

Develop a full business case in advance of the industry reaching a scale where it is economically viable to have an New Zealand feed mill and support industry growth to reach this goal.

Outcome: Secure feed sourced from New Zealand based feed mill

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Funding Agencies	Notes:
Action: Now Completion: 2035	Develop a business case for a New Zealand feed mill	Develop a business case for the development of a feed mill in New Zealand	✓	✓	✓	✓		Decision Points: <ul style="list-style-type: none">Develop a sufficiently large domestic fed-aquaculture sector to support the viability of commercial feed mill operations within New Zealand.Establish clear investment pathways and commercial models to attract capital and ensure long-term profitability.Industry prefers to source feed from multiple suppliers, so feed volumes need to be substantial - potentially requiring two feed mills operated by different companies.
		Discuss and confirm the industry’s position on domestic feed sourcing, including preferences & requirements	✓	✓				
		Strategic support and co-funding (e.g. SFFF)	✓			✓	✓	
	Support industry growth to reach the tonnage required for a New Zealand based feed mill	Seek and secure increased domestic production, to support overall industry reaching minimum thresholds to support a domestic feed mill operation	✓					Commercial Dependencies <ul style="list-style-type: none">Feed mill built in New Zealand
		Explore synergies with other local aquafeed producers and consumers - such as pāua and kingfish sectors	✓	✓	✓			
		Support industry growth through prioritised research	✓		✓	✓		
		Review and work to lower consenting and other barriers (land use planning) which may delay or add complexity to a domestic feed mill (e.g. importation permits for ingredients etc.)				✓		

Strategy 5.2: Feed Security



Develop climate-resilient feeds and adaptation plans

Work with feed companies to:

- Develop climate change adaptation plans for feed and ingredients (suppliers and farmers)
- Identify new climate-resilient feed ingredients

Outcome: Climate-resilient feed and ingredient sourcing

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Consumer Markets
Action: Now Completion: Ongoing	Develop climate change adaptation plans for feeds and ingredients (suppliers and farmers)	Discuss with climate resilience with feed suppliers.	✓	✓		
		Work on adaptation plans to ensure feed ingredient supply chains are capable of adapting	✓	✓		
		Manage domestically held or controlled feed stock volumes (individual operator or collective industry) to build resilience in supply and availability	✓	✓		
		Support industry wide discussion and solutions to build resilience and security of supply	✓	✓	✓	
		Agree industry wide priority actions and timelines for improved feed resilience.	✓	✓		

6 | Research & development test sites

What is the problem we are trying to solve?

The aquaculture sector has limited access to pilot scale test sites for R&D, making it difficult to test new methods or technology in relevant real world settings.

Why are we trying to solve it?

Establishing test sites is crucial for validating innovative solutions, improving production efficiency, and ensuring the sustainability of aquaculture operations in New Zealand.

What actions are required to solve it?

Develop strategies to derisk open ocean aquaculture, including site suitability, and test pilot scale open ocean farming at multiple sites

Establish commercial Recirculating Aquaculture System (RAS) production to demonstrate the opportunity for Aotearoa by building business cases to demonstrate benefits and by developing critical RAS infrastructure

Strategy 6.1: R&D Test Sites to Derisk Aquaculture Expansion



Establish pilot scale open ocean farming

Develop strategies to derisk open ocean aquaculture, including site suitability, and test pilot scale open ocean farming at multiple sites.

Outcome: Small scale, real-world testing of open ocean sites at multiple locations

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Technical Service Provider	Funding Agencies	Notes
Action: Now Completion: 2030	Develop strategic plans for pilot scale open-ocean aquaculture	Develop strategies to derisk open ocean testing (pilot scales, shared sites, shared investment)	✓	✓	✓	✓			Work already underway: <ul style="list-style-type: none"> Nga Punga o te Moana: Anchoring our open ocean future In 2025, NZKS to trial pens into the Blue Endeavour site Consents NZKS also recently invested in trial pens at one of their farm sites and undertook a successful trial Decision Points: <ul style="list-style-type: none"> Confidence to move offshore Finance Fish performance Commercial Dependencies: <ul style="list-style-type: none"> Equipment and boat suppliers
		Develop intra sector collaboration to derisk and speed up installation	✓	✓	✓				
		Provide a voice to government around barriers to open-ocean investment and the strategies to overcome	✓	✓	✓				
		Provide data and expertise for: <ul style="list-style-type: none"> Consenting process Fish swimming performance and endurance Downscaled site-specific modelling 	✓		✓		✓		
		Identify and reduce barriers for industry testing of novel aquaculture sites, species, and technologies.				✓			
	Implement a research plan for pilot scale open-ocean aquaculture	Develop research plan and climate linkages	✓	✓	✓				
		Explore funding options based on industry plan, draft collaborative proposals	✓		✓	✓			
		Support as part of strategic research plan			✓	✓			
	Invest in critical pilot scale open-ocean aquaculture infrastructure and operate the farms	Establish critical open-ocean aquaculture pilot scale infrastructure and operate the pilot scale farms	✓				✓	✓	
		Promote intra sector collaboration to derisk and speed up installation	✓	✓	✓	✓			
		Provide a voice to government around barriers to open-ocean investment and the strategies to overcome	✓	✓	✓				
		Conduct priority research on the pilot scale farms	✓		✓				
		Provide equipment, infrastructure and technical support					✓		
		Support hatchery and processing capacity for open-ocean aquaculture salmon	✓			✓		✓	

Strategy 6.2: R&D Test Sites to Derisk Aquaculture Expansion



Real world Recirculating Aquaculture System Production for New Zealand

Establish commercial Recirculating Aquaculture System (RAS) production to demonstrate the opportunity for Aotearoa by building business cases to demonstrate benefits and by developing critical RAS infrastructure.

Outcome: Real-world testing of RAS for production

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Technical Service Provider	Funding Agencies	Notes
Action: Now Completion: 2028	Prepare and build the case for RAS commercial production and share the knowledge	Review business cases for RAS production and take appropriate action: <ul style="list-style-type: none">Complete economic modelling and cost-benefit analysisCollaborate with others in industry to derisk and share use	✓						Work already underway: <ul style="list-style-type: none">NIWA kingfish facility;Cawthron FRC pilot scale Decision Points: <ul style="list-style-type: none">Financing business case, economic viability
		Share knowledge of RAS operations, build capacity	✓	✓	✓				
		Conduct research to optimise juvenile, smolt and grow out production in RAS: <ul style="list-style-type: none">Test species suitabilityCommunicate results from research, help build capacity	✓		✓				
		Support as part of strategic research plan	✓		✓	✓			
		Promote co-funding avenues and opportunities	✓			✓		✓	
		Issue consents and permits				✓			
		Provide facility design, engineering and costs	✓		✓		✓		

Strategy 6.2 (cont.): R&D Test Sites to Derisk Aquaculture Expansion



Real world Recirculating Aquaculture System Production for New Zealand

Establish commercial Recirculating Aquaculture System (RAS) production to demonstrate the opportunity for Aotearoa by building business cases to demonstrate benefits and by developing critical RAS infrastructure.

Outcome: Real-world testing of RAS for production is completed

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Technical Service Provider	Funding Agencies	Operator	Notes
Action: Now Completion: 2028	Invest in RAS infrastructure and operate a commercial RAS facility	Establish critical RAS infrastructure and use for commercial production	✓							Commercial Dependencies: <ul style="list-style-type: none">RAS system design, Electricity grid (capacity, connectivity, security)Water intake/ discharge, ports for well-boat access
		Promote intra sector collaboration to derisk and speed up installation	✓	✓						
		Provide a voice to government around barriers to RAS investment and the strategies to overcome.	✓	✓	✓					
		Share operational knowledge	✓	✓	✓		✓			
		Conduct priority research to optimise commercial RAS production	✓		✓					Work already underway: <ul style="list-style-type: none">NIWA kingfish facility;Cawthron FRC pilot scale
		Support as part of aquaculture development plan: <ul style="list-style-type: none">Promote co-funding avenues and opportunitiesIssue consents and permits				✓				
		Provide equipment, infrastructure and technical support					✓			
		Bring in staff with RAS experience and expertise to upskill New Zealand staff	✓		✓				✓	

7 | Aquaculture Research Platforms

What is the problem we are trying to solve?

There is immediate need for long-term aquaculture research platforms to address priority issues and provide ongoing innovation. While a national, cross-sector research strategy is outlined in our ‘Cross-Cutting Initiatives’ document (which addresses overarching barriers to adaptation for the seafood sector), there is an immediate need for a dedicated aquaculture research platform. This platform would provide coordinated support for sector-specific adaptation and resilience.

Why are we trying to solve it?

Establishing long-term research platforms promotes innovation and helps improve farming practices while addressing climate change impacts on aquaculture. These platforms also support ongoing capability development, strong local economies and ensure compliance with environmental regulations.

What actions are required to solve it?

We need to establish a collaborative national research platform that integrates workstreams across finfish, shellfish, seaweed, open ocean technology, and restoration. This platform should be co-designed with industry, research institutions, and government and aligned with strategic priorities such as climate resilience, product quality, biosecurity, and sustainable growth.

Strategy 7.1: Aquaculture Research Platforms



Establish National Aquaculture Research Platforms

Establish collaborative research platforms focussed on delivering a climate-resilient and prosperous sector.

Outcome: A coordinated, long-term, and multi-species research platform that advances sustainable aquaculture.

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Govt & Councils	Technical Service Provider	Processors & Retailers	Consumer Markets	Funding Agencies	Notes
Action: Now, platform established funding secured, 2026 Completion: Ongoing	Develop and maintain a strategic research plan and design research platforms based on these and obtain funding.	Identify key priorities for species/production research (consider short, med, long term horizons)	✓	✓	✓						Resources & work already underway: <ul style="list-style-type: none">• Climate Adapted Finfish (CAF) Programme• ShARP (Shellfish Aquaculture Resilience Platform)• Nga Punga o te Moana – MBIE Open Ocean Research Programme• SSIF-funded initiatives (Finfish, Shellfish, Seaweed)• Bioremediation and restoration pilot projects• Plant & Food Research ‘Re-imagining Aquaculture’ programme
		Identify R&D priorities beyond the short term and business as usual - share with others, work collaboratively	✓	✓	✓						
		Develop an inclusive and collaborative R&D hub to work with researchers to set up the platform and get funding	✓	✓	✓						
		Develop and maintain an industry sector strategic research plan (industry, all salmon stakeholders, government)	✓	✓	✓	✓					
		Working with the R&D hub design and Develop proposals and research based on priorities and obtain funding	✓	✓	✓						
		Provide funding e.g. SSIF funding or similar	✓			✓				✓	
		Analytical labs, technology, AI, robotics, engineering			✓		✓				
		Consider product quality as part of the prioritisation process	✓	✓	✓			✓	✓		
		Consumer/Market research to determine species and products with potential to drive R&D as opposed to figuring it out afterwards	✓	✓		✓		✓	✓		

8 | Decarbonise Freight and Packaging

What is the problem we are trying to solve?

The aquaculture industry needs to lower its carbon footprint, particularly in freight and packaging to adapt to changing customer expectations regarding the industry’s contribution to climate change.

Why are we trying to solve it?

Reducing emissions from freight and packaging is crucial for several reasons: it helps combat climate change, supports the sustainability goals of the aquaculture sector, leads to cost savings, and enhances the industry’s reputation while meeting consumer demand for eco-friendly products.

What actions are required to solve it?

To tackle these challenges, we need to implement several actions. For domestic freight, we should initiate efficiency programmes that involve discussions with freight providers to find solutions and encourage collaboration among companies.

For international freight, we need to explore technologies that facilitate a shift from air to sea transport without sacrificing market value. Economic and in-market assessments will help determine the feasibility of different product formats.

We must research low-carbon packaging options, identify new materials, and redesign processing facilities to reduce packaging quantities, improve recyclability, and develop biodegradable options, potentially through partnerships with seaweed aquaculture.

Strategy 8.1: Decarbonise Freight and Packaging to deliver further reductions on the (already low) emissions profile of New Zealand aquaculture



Decarbonising domestic freight

Establish freight efficiency initiatives to reduce emissions when accessing domestic markets.

Outcome: Reduced freight emissions to markets (domestic)

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Processors & Retailers	Consumer Markets	Notes
Now > ongoing	Organise freight efficiency discussions and identify solutions to be implemented	Discuss freight efficiency and emissions reduction initiatives with freight providers	✓	✓	✓			Resources & work already underway <ul style="list-style-type: none">Cold chain freight partnerships
		Support discussion and shared learning between companies	✓	✓				
		Participate in freight efficiency discussions and solutions (e.g. use of reseller cold chain networks)	✓	✓	✓	✓	✓	

Strategy 8.2: Decarbonise freight and packaging to deliver further reductions on the (already low) emissions profile of New Zealand aquaculture



Decarbonising international freight

Establish efficiency initiatives to reduce emissions when accessing international markets, including freight efficiency, new technology and methods and economic and market viability.

Outcome: Reduced freight emissions to markets (international)

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Processors & Retailers	Consumer Markets	Notes
Action: Now Completion: Ongoing	Organise freight efficiency discussions and identify solutions to be implemented	Discuss freight efficiency and emissions reduction initiatives with freight providers	✓	✓		✓		Commercial Dependencies: <ul style="list-style-type: none">Airline and international shipping industry decarbonisation plans and commercial implications
		Support discussion and shared learning between companies	✓	✓		✓		
		Extending product shelf-life	✓		✓	✓		Resources & Work already underway <ul style="list-style-type: none">Airline industry initiatives
	Investigate new technologies and methods	Consideration of ways to enable mode shift from air to sea freight without unduly affecting customer value (e.g. investigating different refrigeration or freezing technology, transport technology)	✓		✓	✓		Decision Points: <ul style="list-style-type: none">Economic viability
		Explore acceptance of other product formats and companies willingness for change, and promotion	✓	✓		✓	✓	Resources & Work already underway <ul style="list-style-type: none"><u>International shipping industry initiatives (incl. IMO)</u>
	Complete economic and market viability assessments to determine whether shifting to different product formats is viable	Economic and market viability assessments to determine whether shifting to more frozen product formats is possible	✓	✓		✓	✓	

Strategy 8.3: Decarbonise Freight and Packaging to deliver further reductions on the (already low) emissions profile of New Zealand aquaculture



Decarbonising packaging

Identify low carbon packaging options by conducting packaging research, identifying new materials and incorporating packaging into processing facility designs.

Outcome: Packaging to support emissions reductions and low carbon freight to market

Timeline	Projects	Actions	Rights Owner & Farmers	Industry Groups	Research Institutes	Processors & Retailers	Consumer Markets	Notes
Action: Now	Conduct packaging research to determine how to reduce packaging quantities and improve materials for recyclability and reduced emissions	Implement projects to reduce packaging quantities and improve materials for recyclability and reduced emissions	✓	✓		✓		Support discussion and shared learning between companies (across all actions)
		Consider packaging needs when designing and building new processing plant (e.g. internal temperature controls)	✓	✓		✓		
		Packaging Research	✓		✓	✓		
Completion: Ongoing	Identify new packaging materials based on circular economics and develop biodegradable packaging	Develop circular economies: e.g. partner with seaweed aquaculture for biodegradable packaging	✓		✓	✓	✓	Resources & Work already underway <ul style="list-style-type: none">Packaging reduction and recyclability initiatives by companies Decision Points: <ul style="list-style-type: none">Economic viability
		Packaging Research	✓		✓	✓		

Conclusion

New Zealand’s aquaculture sector is facing a future shaped by climate change, evolving markets, and growing expectations around sustainability. This toolkit provides a clear, practical framework for building a resilient, innovative, and low-emissions aquaculture industry.

Through collaboration among diverse stakeholders, we can collectively implement strategies that strengthen environmental performance, support the health and welfare of farmed species, and future-proof the sector.

The adaptation strategies outlined here are not fixed plans, but flexible starting points, designed to evolve with new science, technologies, and partnerships. With a shared commitment to action, New Zealand can continue to lead in sustainable aquaculture sector and realise the potential of a thriving blue economy.



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