Ministry for Primary Industries
Manatū Ahu Matua

Realising Aquaculture: Aquaculture Mid-Term Research Strategy 2016

Contents

Publisher
Ministry for Primary Industries
PO Box 2526, Wellington, 6140
Email: brand@mpi.govt.nz
Phone: 0800 00 08 33
Web: www.mpi.govt.nz

ISBN No: 978-1-77665-199-3 (online)

Disclaimer
While every effort has been made to ensure the information is accurate, the Ministry for Primary Industries does not accept any responsibility or liability for error of fact, omission, interpretation or opinion that may be present, nor for the consequences of any decisions based on this information. Any view or opinion expressed does not necessarily represent the view of the Ministry for Primary Industries.

newzealand.govt.nz

Introduction

The Government's *Aquaculture Strategy and Five-Year Plan to Support Aquaculture* was launched in 2012. It supports industry's target to reach $1billion in value by 2025. It contains seven objectives, one of which is to "Increase Value through Research and Innovation".

One of the identified work streams under this objective is to improve collaboration around research and innovation across the sector. To progress this work stream, MPI's Aquaculture Unit established an Aquaculture Research Forum in 2013. Through a collaborative process, working with industry, science providers and academic institutions, we developed an *Aquaculture Mid-Term Research Strategy* (2013). This document is a refresh of the 2013 Strategy, and has been developed using a similar, collaborative process. It captures current issues and priorities, and aims to inform collaboration between industry, research providers, academic institutions and government.

The aquaculture industry in New Zealand currently comprises three key species: salmon, oysters, and Greenshell mussels. It generates approximately $400 million in exports per annum, and is working towards a target of $1 billion in exports per annum by 2025. There is an opportunity to grow additional species.

The sector is supported by an industry body, Aquaculture New Zealand (AQNZ). AQNZ's current *Research Strategy, Seeking Solutions*, can be found online at www.aquaculture.org.nz.

Aquaculture Research Forum's Vision

Our vision is to fully realise the potential of the sector through the delivery of innovations from a focused and collaborative research and development community.

We will work to achieve this vision by:

» Communicating a bold vision for industry development.

» Promoting our coordinated commitment to research.

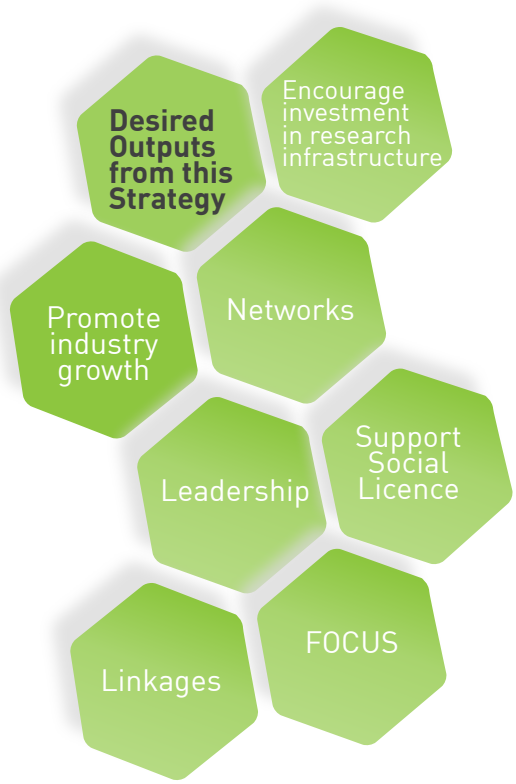
» Identifying critical research needs, gaps in capacity, gaps in technology, and opportunities for innovation.

» Identifying synergies – areas of common interest (either strengths or weaknesses) – that would benefit from further investment.

» Working together to shape research investment to meet industry priorities.

» Evaluating and addressing our critical constraints.

» Encouraging partners to engage in collaborative research.



Aquaculture across the R&D Pipeline

Science and innovation in the aquaculture sector occurs across the Research and Development pipeline as below.

Available funding instruments provide good coverage across this pipeline. Key sources of funding for the aquaculture sector include:

- The Ministry for Primary Industries: Primary Growth Partnership and Sustainable Farming Fund; Aquaculture Planning Fund.
- The Ministry for Business, Innovation and Employment: Contestable Research Fund, Vision Mātauranga Capability Fund, Catalyst Fund.
- Crown Research Institute Core Funding (Plant & Food Research, NIWA).
- National Science Challenges (although this funding space is still evolving).
- Seafood Innovations Limited.
- BioResource Processing Alliance.
- NZTE.
- Tertiary Education Commission: Performance Based Research Fund.
- Callaghan Business Grants.
- Marsden.
- Seed Co-investment Fund (managed by the Government's NZ Venture Capital Fund).
- Direct investment from aquaculture companies.

Despite the number of funding instruments available, challenges remain to achieving an across-sector, whole-of-pipeline approach to research and development.

Some common barriers are:

- Lack of industry funding to meet the co-funding requirements of various funding instruments.
- Repetition of similar research and innovation undertaken by different organisations and companies.
- Research and innovation is not followed or 'collaboratively incubated' as it moves across the pipeline, especially if different organisations and companies are involved at different stages of the pipeline.
- There is effort and costs associated with implementation and this is not always recognised.
- Some funding programmes are less flexible in their ability to respond to industry requests for more frequent funding rounds.

Setting our Research priorities

The Aquaculture Research Forum met in November 2015 and discussed priorities for this strategy. Some general points raised during these discussions have been captured in Appendix One.

Our four priority research areas for 2016–2018 are:

» Growing Space
» Biosecurity
» Growing Better
» Consumers and Communities.

Mātauranga Māori

This Strategy acknowledges the opportunity to integrate scientific research with Mātauranga Māori. The value of collaborative projects that draw on both methodologies is cross-cutting across all four priority research areas.

Growing Space

We want industry to have access to quality water space for growing aquaculture products.

Issues

» Adverse anthropogenic effects on water quality

» Access to new growing space

» Balancing aquaculture's need with competing requirements of other water users

» Retention of existing growing space

» Balancing the value and impacts of human activities (on land and water)

» Climatic effects on growing space

» We have to assume that awny science undertaken to inform coastal planning will end up in litigation at some point – how do we work together to avoid duplication of effort and a "circus of debating experts"?

» The public's perception of the "free" use of water space by industry.

Projects and opportunities

» Science to support coastal planning and allocation of new growing space

» Science to help determine what new space best suit different species

» Science to support offshore aquaculture

» Baseline monitoring data and streamlining monitoring activities – are we profiling activities in a way that profiles the right information for effective management?

» Integrated catchment management – better understanding the links between land and water

» Improved science on the ecosystem services of filter feeders and non-filter feeders (e.g. seaweed)

» Best Practice Guidelines on Ecological Carrying Capacity

» What we already know and agree on

» Key indicators and qualitative values

» Link to new MFE water standards

» Aim to agree thresholds

» Climate change:

- Better understand potential future changes and new thresholds (changing risk profiles). Capture baseline data now, before change occurs (links to MPI Science Strategy strategic framework)
- Build resilience to changing long-term trends as well as extreme weather events
- Develop adaptive management tools

» Feasibility on the potential to use irrigation water/canals for land-based aquaculture

» What support do regional councils need to harmonise their approaches to monitoring and management?

Growing Space: some research and science successes since 2013

» MPI has run a multi-agency consultative process [on-going] to develop National Direction for Aquaculture, which, if successful, will include improved regulatory processes for changing species, on-farm innovation and improved biosecurity.

» MPI has funded research on forecast future growth, the economic contribution of aquaculture to the regions, and the consequences of RMA re-consenting uncertainty on industry investment.

» NIWA has developed spatially explicit biophysical models of the Marlborough Sounds incorporating the influences of shellfish and finfish farms. These models are being used by Marlborough District Council and others as a part of their decision-making around aquaculture.

» MPI and a range of partners, including NIWA and Cawthron, held a collaborative bilateral NZ–USA workshop on ocean acidification and shellfish aquaculture, at which farmers, scientists and policy makers from the US and New Zealand shared knowledge on policy, farm management and ocean monitoring practices. From this workshop lasting networks have been developed.

» NIWA have led a project to establish a New Zealand-wide ocean acidification monitoring network, using world-leading monitoring equipment as well as fortnightly water sampling.

Biosecurity

We want to protect the productive capacity of the industry and maintain access to markets

Issues

» Balancing priorities – managing the animal population versus managing the invasive species population

» Invasive species versus native species

» Better understand our current state – improved surveillance of what's already here

» Better understand risks to industry

» Turning problems into opportunity – e.g. new invasive species, can we use it?

» Access to PC2 wet labs, so we can grow and manipulate animals in a laboratory setting

» As better tools are developed we will detect more things to respond to

» What is needed (science/frameworks) to allow faster responses when something new is detected?

» Do we have the means of treating internal infections in shellfish? (What is technically and financially viable?)

» Spat production is still a vulnerability for industry.

Projects and Opportunities

» Understanding the diseased, subclinical, physiologically abnormal and normal populations through novel tools

» Managing pathways of aquatic sectors – commercial and recreational boating

» Hydrodynamic models

» How to improve our understanding of emerging pathogens and risks?

» Develop new screening and diagnostic tools

» Improved pathway management

» Better tools to manage pest and infection

» PC2 wet lab – business opportunity to attract new business and new expertise from overseas

» Consideration of wild/farmed stock interactions (parasites, pathogens and genetics)

» Descriptive epidemiology – collect good data on "what is out there" in relation to health and production performances and environmental parameters

» Epidemiological modelling relating to infectious disease in shellfish, to inform whether farming strategies need to adapt.

Biosecurity: Some research and science successes since 2013

» MPI, in collaboration with AQNZ, has produced on-farm biosecurity guidance material, to enable industry to strengthen their own on-farm biosecurity management practices.

» MPI, Cawthron and the University of Sydney ran a very successful collaborative workshop between New Zealand and Australian oyster farmers and research providers, at which we shared experiences with on-farm biosecurity and adaptive management practices relating to the OsHV-1 virus.

» Farmers are managing their farming activities more efficiently using predictive models of blue mussel (bad!) and Greenshell mussel (good!) spat settlement developed under Cawthron's Cultured Shellfish Programme, and with additional funding from the Marine Farmers Association and Sustainable Farming Fund.

» Cawthron's selective breeding for OsHV-1 resistance in Pacific oysters has been successful with a second cohort of selectively bred oysters produced in 2013 demonstrating further gains in virus resistance. The best families from this cohort are now being used in commercial production of triploid oyster spat.

» A lab-based oyster herpes virus challenge has been established at Cawthron enabling scheduled controlled challenges for selective breeding purposes.

Growing Better

We want to improve our ability to grow more, high quality products, more sustainably, and more cost effectively

Issues

» There is little baseline productivity or nutritional data on NZ aquaculture species

» We don't understand the interaction, and effect on productivity, of feed and environment

» Limited areas available for marine aquaculture – so allocated space needs to be used more effectively to increase value and profitability

» Only one finfish species (not native to NZ) and a few shellfish species make up commercial production

» Biological potential of existing and potentially new aquaculture species are not well understood and therefore largely untapped.

» Undeveloped fish feed industry in NZ and lack of feeds designed for NZ species

» Industry must continue to work towards improved productivity and added value

» Identifying completely new product areas

» Identifying opportunities to leverage areas of the value chain

» Identifying opportunities to use aquaculture to enhance/restore wild fisheries – snapper, blue cod, toheroa, paua, etc.

Projects and Opportunities

» Reduction of production costs

» Maximise growth via improved nutrition and feed

» Consider alternative protein sources for feed – what is reliable, inexpensive, nutritionally appropriate, and domestic?

» Better understanding of production values of new species

» Science to support nutrition and feed requirements of new species

» Application (in a NZ context) of alternative farming structures and new technologies

» Underpinning science around the biology of our key species

» Value added non-food and food products

» Improving our research capacity for achieving basic value chain productivity gains

» Improved culture and husbandry technologies for existing and new species

» New production systems

» Genetic improvement of key species to realise volume and value gains

» Value uplift via application of post-harvest technologies

» By-product development – e.g. marine nutraceuticals

» Ability to differentiate product based on New Zealand story and validated health claims

» Wild fish and shellfish enhancement opportunities

Growing Better: some research and science successes since 2013

- MPI hosted a collaborative workshop to discuss Research Priorities For Greenshell Mussel Spat, and commissioned an associated report from the University of Auckland.
- Successful, reliable production of snapper juveniles by Plant and Food Research.
- Plant and Food Research have developed of a range of marine nutraceuticals from GSM, including commercial processes to develop mussel powders and the development of methods to assess efficacy to support health claims.
- Scion and Plant and Food Research have developed and tested new biomaterials for fish bins to retain post-harvest quality of finfish.
- Development of Aqui-s for use by salmon industry.
- Development of new biomaterials for fish bins to retain post-harvest quality of finfish.
- Plant and Food Research have sequenced the snapper genome.
- The SPATnz greenshell mussel hatchery at the Cawthron Aquaculture Park is now operational using technology developed by Cawthron's Cultured Shellfish Programme and its predecessors. SPATnz enables research developed at Cawthron to be applied at commercial scale. The industry will benefit through the reliable supply of genetically superior spat that is of consistent physical quality enabling them to extract maximum value from their existing space.
- Low cost methods of chemical manipulation of seawater for embryo incubation have been developed at Cawthron that improve shellfish hatchery reliability and efficiency.
- Probiotic strains of bacteria that increase shellfish larval survival and reduce the risk of larval batches "crashing" have been identified at Cawthron.
- Triploidy induction methods for Pacific oysters have been further refined at Cawthron to improve triploidy success.


Dave Allen, NIWA.

- Geoduck spat, produced in the hatchery by Cawthron, have been seeded out in grow-out trials and shown survival rates exceeding expectations.
- The feasibility of extending Greenshell mussel shelf life using selective breeding, which is important for the elevation of GSM product value and the development of new markets has been demonstrated.
- Scampi larvae have hatched and been on-grown successfully at Cawthron from female broodstock that have been maintained in the hatchery in newly designed systems.
- Algal photobioreactor systems and rigorous experimental design matrices have been used to determine optimal conditions for maximising product yield of bioactives from algae.

- A high-throughput SNP genotyping protocol for GSM using next-generation genotyping-by-sequencing has been developed through a collaboration between Cawthron, AgResearch and BreedCo. This enabling technology will allow new techniques to be applied in shellfish breeding.
- A cryopreservation method for Greenshell mussel sperm has been refined and can now be reliably incorporated in selective breeding.
- Algal and greenshell mussel derived extracts demonstrated to have beneficial effects in in vitro and in vivo models of inflammation and allergy.
- NIWA has initiated nationwide study of the seasonal evolution of fatty-acid and amino-acid profiles in Greenshell mussels with a view to high value nutraceuticals.
- NIWA has established that three month forecasts of mussel productivity can be made for Pelorus Sound and this is now being developed into a web-delivered product with SIL funding.
- NIWA has developed a telemetered system that is capable of delivering (near) real-time data to a receiving centre even in areas with poor cell-phone coverage. A web interface provides ready graphical summaries of the data.
- NIWA has developed a system of replicated incubation chambers which enable us to run long-term (months–years) benthic incubations under differing flow etc. in order to better assess the capacities of benthic sediments to withstand continuous, elevated rates of organic loading.
- NIWA have developed both the infrastructure and technology to provide a fit-for-purpose yellowtail kingfish hatchery suitable for 2 million fingerlings per annum.
- NIWA has developed a return-on-research-investment model and applies this to proposed outcome-focused research and development initiatives.
- NIWA has developed and validated a detailed bioeconomical model for the commercial production of yellowtail kingfish suitable now for commercial engagement and uptake.
- NIWA has developed and validated a detailed bioeconomical model for the commercial production of hapūku to explicitly define the commercially critical development gaps to insure effective ends-means alignment.
- NIWA has constructed and tested an on-land marine system wastewater anaerobic treatment system to support the development of large scale on-land recirculating aquaculture system or treating saline wastewater streams.

Customers and Communities

We want to produce products that are valued by our customers.
We want our communities to value our industry and support its growth.

Issues

» We constantly need to update our understanding of the products our consumers want (domestic and export)

» We need to improve community understanding of our industry

» We need to improve community trust in our industry and our practices

» Limited understanding of consumer's responses to specific seafood products and therefore what drives consumer's purchasing decisions

» Better understanding of the benefits of seafood consumption and putting recommendations/figures around that.

Projects and opportunities

» Work with the industry's Social Licence Working group to identify social science research needs

» Customer insight research

» Understanding and responding to consumer preferences for seafood and seafood-based products

» Understanding unique health and nutritional

» properties of seafood products

» Understanding and managing risks to food safety

» Food safety tracking tools

» Health benefits and recommendations

» Value of protein of other foods.

Customers and Communities: Some research and science successes since 2013

» MPI has published a series of guidance documents aimed at improving community understanding of the aquaculture industry and its spillover social and economic benefits:

- *How to Improve Your Social Licence to Operate: A NZ Industry Perspective*
- *The Social Value of a Job*
- *The Social and Community Effects of Aquaculture: a case study of Southland Aquaculture*
- [Pending publication] *The Social and Community Effects of Salmon Aquaculture: a case study of the Top-of-the-South Island*

» MPI and AQNZ ran a collaborative process which established a new industry working group on Social Licence.

» Plant and Food Research has provided MPI and industry advice regarding Vibrio levels in NZ oysters, resulting in the establishment of a new monitoring programme to ensure consumer safety.

» Plant and Food Research and Cawthron have developed tools to measure consumer responses to GSM families.

» Plant and Food Research has undertaken initial studies on consumer responses to a selection of NZ shellfish species

» A new test method for paralytic shellfish toxins has been developed and validated for shellfish species important to New Zealand. The method has been approved for use by MPI and implemented at Cawthron as part of the marine biotoxin monitoring programme. International acceptance of the method in now being sought.

» The 16th Int. Conf. on Harmful Algae was hosted by Cawthron in October 2014 in Wellington. Attended by 385 delegates from 34 countries, there were 196 oral and 150 poster presentations and the Proceedings papers are available online (http://www.issha.org/Welcome-to-ISSHA/Conferences/ICHA-conference-proceedings).

Links to other Government funding

The National Science Challenges – Sustainable Seas

The National Science Challenges are designed to take a strategic approach to the Government's science investment by targeting a series of goals which will have major and enduring benefits for New Zealand.

The Sustainable Seas Challenge is one of 11 National Science Challenges.

The objective of the Sustainable Seas National Science Challenge is to "enhance utilisation of our marine resources within environmental and biological constraints".

To meet this objective, the following Mission has been developed to guide the research focus, priorities and activities of the Challenge as it progresses:

> Sustainable Seas will drive the transformation of New Zealand's marine economy. Through input into resource management, we will realise the value, increase use, and maintain the ecosystem health of our vast oceanic and coastal assets. The Challenge will focus on societal participation in marine governance and management to balance the aspirations and rights of Māori, communities and industry, and build New Zealand's reputation as a world leader in the use and stewardship of its marine estate.

The Sustainable Seas case study area takes in a vector from the Taranaki Bight, Golden Bay, Tasman Bay, Marlborough Sounds, and out to the Chatham Rise.

The aquaculture industry is engaged in Sustainable Seas, and it is important that we remain aware of research priorities and outputs of this National Science Challenge.

There are also National Science Challenges on High Value Nutrition and Our Land and Water. For further information go to http://www.mbie.govt.nz/info-services/science-innovation/national-science-challenges

MBIE-funded CARIM project (Coastal Acidification: Rate, Impacts & Management)

This four-year project will provide new knowledge on acidification of coastal waters to enhance protection and management of New Zealand coastal ecosystems.

CARIM is led by NIWA, with partners at the Cawthron Institute and the Universities of Auckland and Otago. Research will include monitoring of pH and the carbonate system at three sentinel sites, in the Firth of Thames, Nelson Bays and the East Otago Taiapure in Karitane. Information will underpin development of models to identify the main drivers of acidification, which will subsequently inform land and coastal management.

The ecosystem impacts of coastal acidification will be assessed, with a particular focus on the sensitivity of different life stages of three iconic species, paua, Greenshell mussel, and snapper. Research will also investigate the potential for

adaptation within different families of paua and Greenshell mussel.

MBIE Funding

MBIE's **Contestable Research Fund** is an important source of funding for the aquaculture industry. The strategic context and investment areas are set out in the 3-year Investment Plan. Under the Economic Objective the 2016-2018 Investment Plan signals that investment will focus on research that builds on areas of emerging, as well as existing, competitive advantage, in the manufacturing and primary sectors, supporting knowledge-intensive, high value-add and export growth areas.

Successful aquaculture projects from the 2013-2015 rounds (formerly called Biological Industries) are listed in Appendix Two.

MBIE also offers a **Research Partnership** mechanism, from which Seafood Innovations Limited (SIL) is funded. The **Vision Mātauranga Capability Fund** and **Catalyst Fund** are also of relevance to the industry.

SpatNZ.

More information can be found at www.mpi.govt.nz

Seafood Innovations Ltd (SIL)

SIL is research partnership funded by MBIE. Seafood companies and their research providers can apply for SIL funding to support seafood research projects. SIL is an on-demand funder – applications for funding can be made at any time.

SIL pays for 50 percent of the costs of research projects it supports. SIL fund projects that:

» involve science or technology stretch;

» have a strong project team;

» have significant potential benefits for the seafood sector;

» have a clear "path to market" for deriving benefits from research outcomes.

For more information, see www.seafoodinnvoations.co.nz

Ministry for Primary Industries Investment Programmes

Sustainable Farming Fund (SFF)

» The SFF invests in applied research and projects led by farmers, growers or foresters with the purpose of delivering economic, environmental and social benefits to New Zealand by solving shared problems and/or developing new opportunities.

» Applicants can apply for up to $200,000/year for a maximum of 3 years and projects require non-government funding contribution of at least 20 percent.

» The funding round runs annually with the round opening approximately July each year. All applications are submitted through the online grants portal and are managed through the Grants Management System (GMS). Applications go through a shortlisting and peer review process, followed by an external panel assessment which recommend which projects to fund.

» SFF received between 60–70 applications in each of the last two annual funding

rounds. The number of successful projects depends on the amount of money available and the amount requested by the applicants (on average 39 percent of applications are funded).

Primary Growth Partnership (PGP)

- The PGP is a long-term innovation programme to increase the market success of the primary industries.
- Successful projects are business led and market driven.
- They aim to boost productivity and profitability and deliver long-term economic growth and sustainability across the primary sectors.
- Industry must co-invest a minimum of $500,000. This must at least 60 percent of total project costs.
- Projects may run up to a maximum of seven years.
- There are no annual funding rounds, and PGP staff will work with businesses at the pre-application stage to help them prepare their bids. Applications are assessed by an Independent Advisory Panel.

A list of aquaculture projects funded through these mechanisms is provided in Appendix Three.

More information can be found at www.mpi.govt.nz.

Supporting Science Documents

National Statement of Science Investment (NSSI) 2015-2025

The NSSI sets out the main mechanisms of the Government's science investment and explores how they interact to encourage the application of science and innovation in New Zealand, and some high level goals for the next ten years. It also outlines the rationale for existing and future directions for science funding, particularly contestable funding. The draft NSSI launched a review of the MBIE managed contestable fund to align it with the future direction of the science system. The NSSI takes a ten year view but will be refreshed every three years, and an Investment Plan communicated who, when and why the Government will invest over a three-year horizon.

Ministry for Primary Industries Science Strategy

MPI has recently published a **Science Strategy**. As a major funder, user, and generator of science, it is imperative that MPI has a robust and efficient Science System. The Science Strategy will be used internally to provide strategic direction for planning and prioritising MPI's science needs and future investment. It sets out MPI's vision, principles, current state, and strategic science outcomes for the next five years.

Ministry for Primary Industries Extension Handbook

Over the Fence is a practical handbook developed to assist in the sharing and adoption of new ideas and technology. It was developed initially for people implementing Sustainable Farming Fund projects, but will be of guidance to a range of potential users. It includes MPI's Extension Framework, a summary of which is included in Appendix Four.

2016 Research, Science and Innovation Domain Plan

MBIE is currently working with a range of Government Agencies on the 2016 Science and Innovation Domain Plan. The purpose of this plan is to achieve clarity and broad agreement about the main statistical and information priorities for science and innovation, and provide the strategy and key actions for addressing these priorities over the coming years.

The Fisheries and Aquaculture Research Series

In 2013, the newly formed Aquaculture Research Forum identified the need to improve communication between industry and science providers on a) the industry's science needs and b) science innovation that has the potential to be applied within the aquaculture industry. In 2013 an organising committee from MPI, Cawthron, NIWA, Seafood Innovations Limited, and Aquaculture New Zealand developed the concept of an Aquaculture Technical Day. The Technical Days aimed to facilitate information dissemination and networking, and were held the day before established national aquaculture and seafood conferences.

In 2014, Seafood New Zealand joined the organising committee and we established the Fisheries and Aquaculture Research Series brand. Attendance at our events has risen from 70 at our first event in 2013, to over 140 at our most recent event.

In 2014 we also established a working relationship with Kiwinet who have run two Business Challenges at our events. These allow industry to highlight five key challenges they are facing which require science solutions. These challenges are distributed to all science providers, who are invited to "pitch" their ideas to an industry panel. $5000 is awarded to the winning scientist for general proof of concept design and prototype development.

A full list of speakers and topics from all events can be found in Appendix Five.

Next Steps

» The Aquaculture Research Forum will continue to collaborate on research and innovation issues and support the delivery of key projects outlined within this strategy.

» The organising committee for the Aquaculture and Fisheries Research Series events are committed to delivering one or two events per year.

» This research strategy will be reviewed bi-annually.

The members of the Aquaculture Forum's Committee are shown in Appendix Six, and may be contacted regarding any questions related to this *Mid-Term Aquaculture Research Strategy.*

Appendix One

Comments Raised at Aquaculture Research Forum Meeting, November 2015

» Govt role in de-risking and establishing new species
» Govt role in helping industry get to scale
» Importance of core funding to CRIs in managing and retaining their staff e.g. when projects end
» Attracting people to science, across the whole pipeline of school>university>post-Doc>industry
» We need to consider the value of tech transfer as well as new research

Constraints

» Inconsistency across Councils
» Cost of research
» Uncertainty around future space availability may deter research investment
» Lack of collaboration, both lack of collaboration between researchers and lack of collaboration between end-users
» Until industry gets to scale, students will vote with feet; they don't see aquaculture as an industry with prospects, regardless of quality of training available

Opportunities

» Build investor confidence
» Science led advancement
» Invest in research infrastructure – trial farms (tank and sea pen), people, how industry inputs into skills gap
» Extension – access existing success stories
» Better integrated catchment management
» New species

What do we need?

» Communicate science to the public, politicians and policy makers, to build social licence
» To understand political risks as well as biological risks!
» To address the public's genuine concerns
» Transparency of data and monitoring – make it understandable and accessible
» To share what we already know, including the models we already have (under farm, far-field, cumulative effects)
» Science around other non-aquaculture effects
» Science to help us better understand inter-annual variability
» Do we know which ecological effects are "good" (ecosystem services)
» Can we extend our models across/up the food web?
» Formal water quality standards for coastal water? Need best practice document.
» Biosecurity response funding, so that when a crisis happens, the research community can react. (Researchers currently have to reprioritise funding budgets in order to respond.)
» Post-doc funding
» A Research Register. Revisit and simplify 2013 proposal. Investigate linking it to a SIL Research Register
» Development of new technology to support new production systems

Gaps in Technology

» A suite of tools for detecting changes and understanding sub-lethal effects in animals and ecosystems (e.g. changes to the transcriptome, proteome metablome, epigenome, etc.)
» Real-time food safety monitoring
» BMS biofouling – managing the risk through better pathway management

Gaps in Capacity

» Tank-based PC2 and PC3 facilities for pathogen and non-pathogen studies
» Space and infrastructure for sea based trials at different sites

Gaps in Research Knowledge

» Nutritional requirements of finfish: salmon, hapuka, snapper
» Immunological capacity
» Impact of aquaculture versus land based activities on water catchments

Opportunities for Innovation

» New species. e.g. snapper
» Cheap deployable surveillance tools for health monitoring to assist husbandry decisions and as flag indicators
» Integrated network monitoring systems

Appendix Two

MBIE Funding: Contestable Research Fund

Successful 2013 Projects

Aquaculture related projects were awarded $56 million across five projects. The sector, with $56 million allocated funding, secured approx 25 percent of the total Biological Industries allocated funding of $218 million.

The Cultured Shellfish Programme **Cawthron Institute** **$20,987,169 over 7 years**	» Funding to continue innovative research and selective breeding of shellfish species. » Areas of research: NZ mussels, Pacific oysters, the oyster herpes virus, biosecurity resilience, commercialisation of new species, diversification, finding solutions to technical barriers.
Safe New Zealand Seafood **Cawthron Institute** **$14,190,589 over 7 years**	» This programme is led by Cawthron, in partnership with AgResearch, Plant & Food, and the Institute of Environmental Science and Research, and aims to safeguard NZ's seafood industry and reinforce its reputation for safe, premium quality food from a pure environment. Areas of research: monitoring and testing programmes, management of pre and post-harvest risks, understanding and characterising marine toxins, determining safe growing waters, cost-effective tools for rapid detection and quantification of bacteria and viruses.
Export Marine Products **Plant & Food** **$10,800,000 over 6 years**	» Marine extracts offer new opportunities as high-value export products for NZ. This research programme aims to improve utilisation of our marine resources and extracts with demonstrated commercial end-products, in areas such as bioactives for body, skin and hair health, flavours and colours, and large polymers for biomaterials. Areas of research: innovative manufacturing processes, optimising product yield, reducing waste, new process technologies, research towards future export market needs. The programme takes a whole value chain approach, working with universities and commercial partners.
Revolutionising the Scampi Industry **Cawthron Institute** **$7,787,826 over 6 years**	» There is a 43 percent under-harvest of scampi quota due to high fuel costs and low catch, and trawling methods that cause serious damage to the sea bed. This programme aims to realise the potential of scampi (premium whole grade sells for $300 per kg in China) by using wild caught female scampi eggs as broodstock to form the basis of a new land-based aquaculture industry. » The programme links Māori innovation with research, design and innovation, by employing Māori based potting technologies and novel post-harvest systems to optimise catch and product value. Cawthron is working in partnership with the University of Auckland and guided by a Technical Advisory Group including Māori quota holders and international experts.
Healthy Food Ingredients **Cawthron Institute** **$2,520,000 over 4 years**	» This programme will provide proof of efficacy that molecules extracted from Greenshell mussels and algae can reduce allergies and inflammation. Cawthron lead the programme, collaborating with the University of Otago, the Malaghan Institute, and industry partners. Industry partners will commercialise the research into functional food ingredients and functional foods.

Successful 2014 Projects

Good Enough to Eat **Cawthron Institute** **$1,150,000 over 3 years**	» New technology to replicate the natural diet for high value seafoods. The project aims to transform New Zealand's high value seafood into a reliable and steady supply through aquaculture.

Successful 2015 Projects

Developing Sustainable Fish Aquaculture Foods from Seaweed **University of Auckland** **$990,500 over 2 years**	» Aims to develop batch cultures of the microbial communities from the gut of herbivorous fish to produce finfish aquaculture feeds from waste seaweed, that we know support growth in wild fish populations. This will circumvent (a) the economic and environmental costs of feeding capture fish to cultured fish, and (b) the problems of using terrestrial protein sources that can contain compounds that may interfere with digestion, and/or lack critical nutrients for growth of cultured fish.

Vision Mātauranga Capability Fund – Successful Projects

Kura ki Uta, Kura ki Tai: Developing Whakatohea Aquaculture Research Capacity **Cawthron Institute, (2013)** **$180,000 over 2 years**	Currently the Whakatohea Māori Trust Board have kaitiaki over significant marine resources in the Bay of Plenty that are largely dormant. Their aspirations for long-term sustainable development, incorporating the principles of Kaitiakitanga, remain unfulfilled. At the same time, Cawthron has significant technical and R&D skills and knowledge about aquaculture. There is therefore an opportunity to put these together and: » increase Mātauranga Māori in aquaculture research R&D » improve research understanding and utilisation by Māori. Understanding and using appropriate VM research the project will unlock the potential of Whakatohea resources, and realise several outcomes: » The generation of a collaborative five year VM based research strategy and two year action plan will increase Whakatohea's research capacity and focus the board toward targeted development of existing and new species; » Aquaculture species not currently used on the farm will be reviewed and their potential identified; » The Whakatohea training curriculum will be adapted to respond to the identified needs for the future developments; » The scientist and the Cawthron Institute will get an in-depth perspective of Mātauranga Māori. This perspective will increase their capacity to undertake VM related R&D, improve ways of effectively transferring knowledge to Māori and fostering collaboration with Māori.
Capability Building in Kono Seafood **Plant and Food Research (2014)** **$180,000 over 2 years**	Kono is a successful grower and processor of GSM mussels, with 150 hectares of marine farms in the Marlborough Sounds of New Zealand. Kono's owners are descendants of the original Māori landowners of the Nelson Tasman region who migrated to Nelson in the early 1800s. They came from the Kāwhia, Marokopa and Taranaki regions, being of Ngāti Tama, Ngāti Rārua, Te Ātiawa and Ngāti Koata iwi. Kono staff placed with PFR will learn the basics of lipid chemistry, experimental design, data capture, analysis and interpretation. They will also learn specialist skills (interpreting complex lipid analysis) pertinent to GSM research and other areas of interest in which PFR can offer R&D assistance. PFR staff placed within Kono will learn about Vision Mātauranga values and aspirations. The principal outcome from this project will be to develop collaboration between PFR and Kono Seafood which enables Kono to develop the potential of its seafood and other business areas fully, for the benefit of its shareholders and New Zealand.
Flounder Enhancement in the Marlborough Sounds **Plant and Food Research (2014)** **$180,000 over 2 years**	Working with the Māori-owned company Shark Nett Ltd, and the broader Māori community in the Marlborough Sounds, we will explore the feasibility of rearing yellow-belly flounder (YBF, *Rhombosolea leporina*) in a hatchery environment to support aquaculture and wild stock enhancement. This project will support the development of fish rearing capability within Shark Nett that will benefit the local ecology and economy via commercial, recreational or tourism-based activities. If successful, this project could create a model by which iwi throughout New Zealand can actively participate in the enhancement of taonga species in their rohe consistent with the values of kaitiaki and manaaki. This project will contribute to building awareness of Vision Mātauranga-relevant research opportunities within Plant & Food Research (PFR) and provide increased confidence in working with Māori at the community level in future projects to achieve Vision Mātauranga outcomes. It will allow part-time placement of Nelson-based PFR seafood staff with Shark Nett fishery staff and vice versa. All activities will take place in the top of the South Island.

Aotearoa Fisheries Limited: New Value-Added Developments in Fish Oils & Marine Bio-actives **Massey University** **(2014)$180,000 over 2 years**	Māori are the largest single owner of fishing quota, an asset which is primarily managed through Aotearoa Fisheries Limited (AFL). The 2010 BERL report estimated that the potential value of the Māori economy was around $37 billion. Like many Māori businesses, AFL has been successful, but is now recognising that there is an opportunity to significantly grow the business through strategic use of R&D to add value to its products and identify opportunities for new or improved products and processes. AFL are looking to apply some of the lessons from Iceland's transformation of their fishing industry to AFL. They have commissioned a strategic review of similar options and opportunities that are available to AFL, which will be complete by September. AFL is anticipating that the results will lead it to commit to a number of significant new projects. A hurdle in AFL's transformation is its current lack of innovation or research capability, with no committed resource in this area. It is likely that a number of the projects identified in the strategic review will require significant input from specialist scientists and technologists, at a range of levels. This Placement application is to enable AFL to access the type of expertise and capability that would usually be provided by a Director of R&D or similar internal role.

Catalyst Fund – Successful Projects

Quadrilateral Scientific Collaboration in Marine Biosecurity **NIWA (2015)** **$448,340 over 3 years**	Biological invasions are a global problem that require collective, international responses to limit their spread and mitigate their impacts. This project will establish an enduring pathway for scientific co-operation and information exchange with Australia, the USA and Canada to enhance New Zealand's marine biosecurity. The collaboration will initially focus on three areas of research that have been identified as strategic priorities for each of the partner countries: (a) development of more sensitive, cost-efficient tools for surveillance, (b) innovative technologies and tactics for control and eradication, and (c) methods to evaluate social and cultural impacts from invasive marine species, particularly for indigenous communities. Advances in high-throughput DNA sequencing (HTS) could revolutionize surveillance for invasive marine species by enabling rapid, sensitive, simultaneous detection of an array of harmful species within complex biological samples. This partnership aims to overcome current technical challenges in application of HTS to marine surveillance through collaborative development and testing of methods with our research partners and by exchange of data on risk species. It will also leverage novel ideas and technologies for eradication and control methods for invasive species in marine environments by creating an 'ideas incubator' across the four countries to develop new research collaborations. The partnership will develop better methods to assess the social and cultural impacts of invasive marine species within New Zealand by establishing a research and training collaboration to investigate how social and cultural values and desired levels of protection ('maintenance thresholds') are defined and measured across different cultures and societies (New Zealand, AUS, Canada, USA). This component will have a specific emphasis on indigenous perspectives and will provide a platform for capability development through student exchange with overseas institutions engaged in the partnership.

Appendix Three

Ministry for Primary Industries Funding Mechanisms: successful projects 2012

Sustainable Farming Fund and Aquaculture Planning Fund		
Project	**Lead Partner**	**Region**
Oyster Industry Modernisation	Aquaculture New Zealand	Tasman
Kaitaia Spat – Information and Communication	Aquaculture New Zealand	Tasman Northland
Malformations in Salmon	NZ King Salmon	Tasman
Koura Aquaculture	Ernslaw One	Otago
Tuna Aquaculture	Rangitane	Manawatu
Integrated Aquaculture Solutions	Mahurangi Technical Institute	Auckland
Converted dairy-waste	Bay of Plenty Regional Council	Bay of Plenty
Hauraki Gulf Marine Spatial Plan – new aquaculture areas	Waikato Regional Council	Waikato
Marlborough Sounds Hydrodynamic and Ecological Modelling	Marlborough District Council	Marlborough
Blue Mussel Over-settlement	Marine Farmers Association	Tasman
Env. Certificate for New Zealand Aquaculture	Aquaculture New Zealand	Tasman
Primary Growth Partnership		
Shellfish – the next generation A world-first Greenshell mussel hatchery and laboratory (SPATnz) will enable the selective breeding of high-value shellfish	Sanford	–
Precision Seafood Harvesting Developing a new wildfish harvesting technology that will allow precise catches to be landed in better condition/live. A wildfish project that will have aquaculture applications.	Aotearoa Fisheries, Sanford and the Sealord Group	–

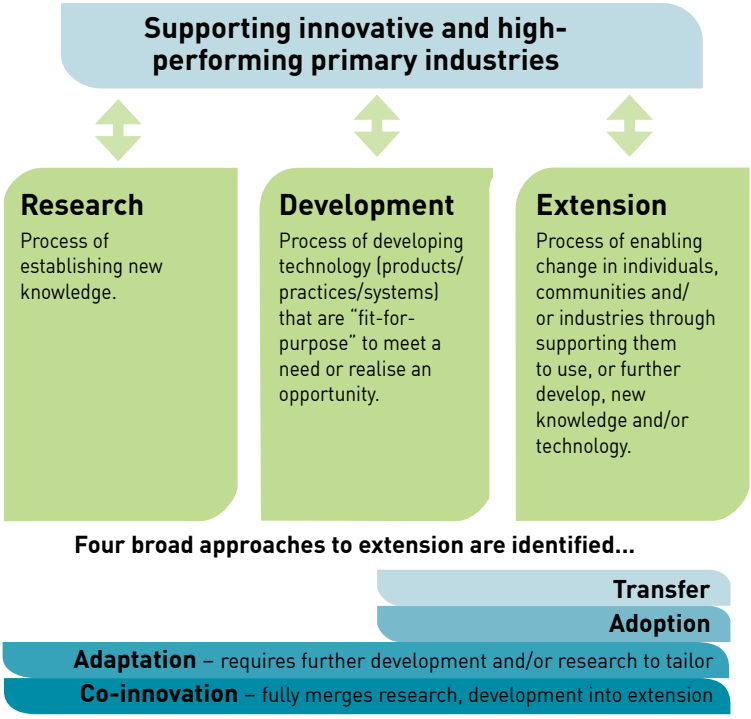
Appendix Four

MPI Extension Framework

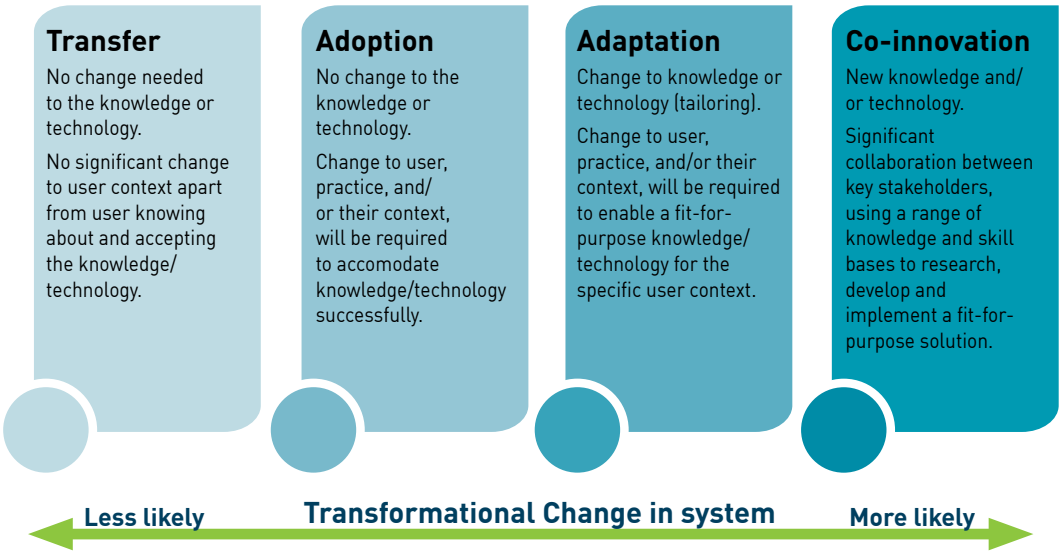
MPI has developed an extension framework as a way at looking at the different types of strategy that may be needed in an extension programme. This can be helpful in describing the different levels of complexity in both the technologies to be adopted and the systems in to which they will be adopted.

Within any programme, however, there is likely to be facets of transfer, adoption, adaptation and co-innovation, as described in this framework, as different audience groups, different components of the technology, and even different time sequences of the extension programme are designed and developed.

Requirements to support innovative and high-performing primary industries



Achieving transformation change in systems



Approaches to sharing information

Transfer	Adoption	Adaptation	Co-innovation
Appropriate if the focus of the extension: – is known and wanted by target audience; – simple or easily understandable to target audience (often an improvement on existing knowledge/ technology); and – requires no (or minimal) change to user context for successful embedding.	**Appropriate if the focus of the extension:** – is wanted or needed by target audience; – is relatively simple or clearly links to current knowledge/technology already in use; – requires changes to be made in the user context (for example, change in attitude, practice, product use, or system setup); and – has impacts that are easy to see and reversible.	**Appropriate if the focus of the extension:** – is largely unknown to or not well understood by the target audience; – is complex/includes multiple ideas/technologies working together – requires tailoring to ensure fit for purpose across different contexts; – requires changes to be made in the user context (for example, change in attitude, practice, product use, or system setup); and – has impacts that are significant and are able to be argued as a clear priority for the user or other key stakeholders (often impact is not easily reversible).	**Appropriate if:** – there is no clear problem definition; and/or – existing knowledge and technologies are not suitable for use and the nature of change: – impacts on a range of stakeholders/communities – is very complex and/or has conflicting drivers – has significant system-wide implications – requires exploration and critique of current assumptions, outcomes – requires new research and/or development work to solve problems or realise aspirations fit for most/all stakeholders involved.
Minimal support required. Support should focus on: – effective communication of availability; and – providing a means of access.	**Medium level support required.** Support should focus on: – enabling user to identify changes needed to their specific context; – trialling, monitoring and modifying as necessary – providing adequate technical knowledge; – understanding and working with user's current attitudes, values, knowledge and practices; and – understanding and working with user's contextual constraints and opportunities.	**Significant level of support required.** Support should focus on: – the establishment and maintenance of a network that allows a range of stakeholders to effectively work together – may require additional "brokers"; – ensuring expertise from all key stakeholders (including tacit knowledge) informs "tailoring" decisions; – employing strategies to ensure attitudes, values, current practices, contextual constraints and opportunities are understood by all stakeholders and these understandings inform key decisions; and – decision-making is informed by monitoring and evaluation.	**Extensive collaboration between a range of stakeholders required.** Collaboration should provide: – opportunity for stakeholders and "brokers" to work together to create effective networks; – access to a range of knowledge and skill bases including and in excess of that held by stakeholders, to maximise opportunity for innovation; – a culture of trust where valuing of multiple perspectives is inherent and the nature and direction of change is negotiated and agreed; – participatory learning environments where research and development is driven by all stakeholders; – decision-making is informed by monitoring and evaluation; and – opportunity to "extend" resulting knowledge or outcome to wider group.

Appendix Five

Fisheries and Aquaculture Research Series: Summary of events 2013-1015

INDUSTRY WIDE PRESENTATIONS

2015: Aquaculture Technical Day, Nelson

Donald Fowler	Highlands & Islands Enterprise, Scotland	Driving innovation in aquaculture, a new model for the application of science
Xavier Pochon Susie Wood	Cawthron	Metabarcoding as tools for aquaculture farmers
Prof. Herve Miquad	Institute of Aquaculture, University of Stirling, Scotland	Boosting productivity and sustainability of emerging aquaculture species
Kathleen Hofman	Plant and Food Research	Fishing practice and co-product functionality
John Zeldis	NIWA	Forecasting and productivity

2014: 'Linking Science and Seafood', Wellington

Danette Olsen	Plant and Food Research	NZ Food Safety Science and Research Centre
Laurence Eyres	ECG Consultants	Opportunities for NZ healthful marine lipids
Cath Kingston	Plant and Food Research	High Value Nutrition National Science Challenge
Suzy Black	Plant and Food Research	Changing the way NZ fishes
Jim Gibbs	Lincoln University	Getting value from fish waste
Andy Herbert	Nutrizeal	Development of high-value marine-sourced nutraceuticals
Sue Marshall	Plant and Food Research	Understanding Marine Molecules
Prof. David Cameron-Smith	University of Auckland	What science can offer to support nutrition claims for seafood

2014: Aquaculture Technical Day, Nelson

Rob Murdoch	NIWA	Sustainable Seas National Science Challenge
Panel discussion	MPI, SIL, Callaghan, MBIE, Kiwinet	Securing your investment in R&D

2013: Aquaculture Technical Day, Nelson

Graeme Inglis	NIWA	Biosecurity
Tim Harwood	Cawthron	Seafood Safety
Seumus McCroskery	Kiwinet	What is Kiwinet?
Sara Jaegar	Plant and Food Research	Sensory and consumer science
Sue Marshall	Plant and Food Research	New Marine Products
Colin Johnston	AQNZ	'Seeking Solutions' AQNZ Research Strategy

FINFISH PRESENTATIONS

2015: Aquaculture Technical Day, Nelson

Damian Moran	Plant & Food Research	Snapper for the next generation
Brent Glencross	Ridley	King Salmon Nutrition
Nicole Ruff	Skretting	Sustainable hatchery feed technology
Javier Gonzalez	EWOS	Physiological response of salmon to high environmental temperatures and nutritional implications

2015: Salmon Technical Day, Christchurch

Prof. Peter Davie	Massey University	Skeletal deformities
Jane Symonds	NIWA	Selective breeding

Niall Broekhouizen	NIWA	Presentation on NIWA's modelling work on far-field pelagic effects of salmon farming. Followed by Q&A session
Brett Linkcross	Ridley	Presentation on the science of salmon feeding methods.
2014: Aquaculture Technical Day, Nelson		
Stewart Hawthorne	Grieg Seafood, British Columbia, Canada	A global perspective on salmon aquaculture
Phillipe Sourd	Aquativ	Modern dietary tools to meet fish health challenges
Damian Moran	Plant and Food Research	CO_2 and finfish aquaculture on land and in the sea
Ben Wybourne	Skretting	Highly digestible diets and environmental impact
Nigel Keeley		Benthic remediation for salmon farms
Paul Steere	Clean Seas Tuna	Finfish farming in Australia and NZ
Jane Symonds/ Mark Preece	NIWA/NZKS	Salmon malformation research
2013: Aquaculture Technical Day, Nelson		
Michael Bruce	NIWA	Finfish aquaculture opportunities

SHELLFISH & CRUSTACEAN PRESENTATIONS

2015: Aquaculture Technical Day, Nelson		
Stefano Carboni	Institute of Aquaculture, University of Stirling, Scotland	Marine invertebrate hatcheries, technicalities and economies
Zoe Hilton Norman Ragg	Cawthron	Food quality and temperature responses in fast and slow growing green-lipped mussels
Tim Harwood	Cawthron	Paralytic shellfish toxin monitoring
Graham Fletcher	Plant and Food Research	Vibrio vulnificus in New Zealand oysters; risks and controls
Barb Hayden	NIWA	Applying the past to the present: catching and keeping mussel spat
Javier Atalah	Cawthron	Forecasting spat settlement; blue versus green
Aurelie Castinel Lauren Fletcher	Cawthron	OsHV-1 in Australis and NZ, the farmers' story
Aditya Kesarcodi-Watson	Cawthron	Lab-based OsHV-1 challenge; theory, methodology, results
Tim Bean/John Bignell	CEFAS, United Kingdom	Oyster herpes virus and mollusc pathology registry
2014: 'Linking Science and Seafood', Wellington		
Norman Ragg	Cawthron	Shellfish physiology and live transport
Malcolm Lawson	CRA8	Live lock lobster quality
Alison MacDiarmid	NIWA	Loss and recovery of condition in rock lobster

2014: Aquaculture Technical Day, Nelson		
Emmanuel Malpot Rodney Roberts	SPATnz and Pacific Marine Farms	Selective shellfish breeding
Richard Fraser Lauren Fletcher	MPI Cawthron	Biosecurity risk perceptions
Kevin Heasman	Cawthron	Geoduck and scampi
Andrew Jeffs	University of Auckland	Hauraki Gulf mussel project
Tim Harwood	Cawthron	Safe NZ seafood update

2013: Aquaculture Technical Day, Nelson		
Nick King	Cawthron	Shellfish aquaculture opportunities

Appendix Six

Aquaculture Forum Committee Members

Name	Organisation	Email
Anna Crosbie	Ministry for Primary Industries	Anna.Crosbie@mpi.govt.nz
Danette Olsen	Plant & Food Research	Danette.Olsen@plantandfood.co.nz
Colin Johnston	Aquaculture New Zealand	Colin.Johnston@aquaculture.org.nz
Mike Mandeno	Seafood Innovations Limited	Mike.Mandeno@seafoodinnovations.co.nz
Andrew Forsythe	NIWA	Andrew.Forsythe@niwa.co.nz
Helen Mussely	Cawthron Institute	Helen.Mussely@cawthron.org.nz