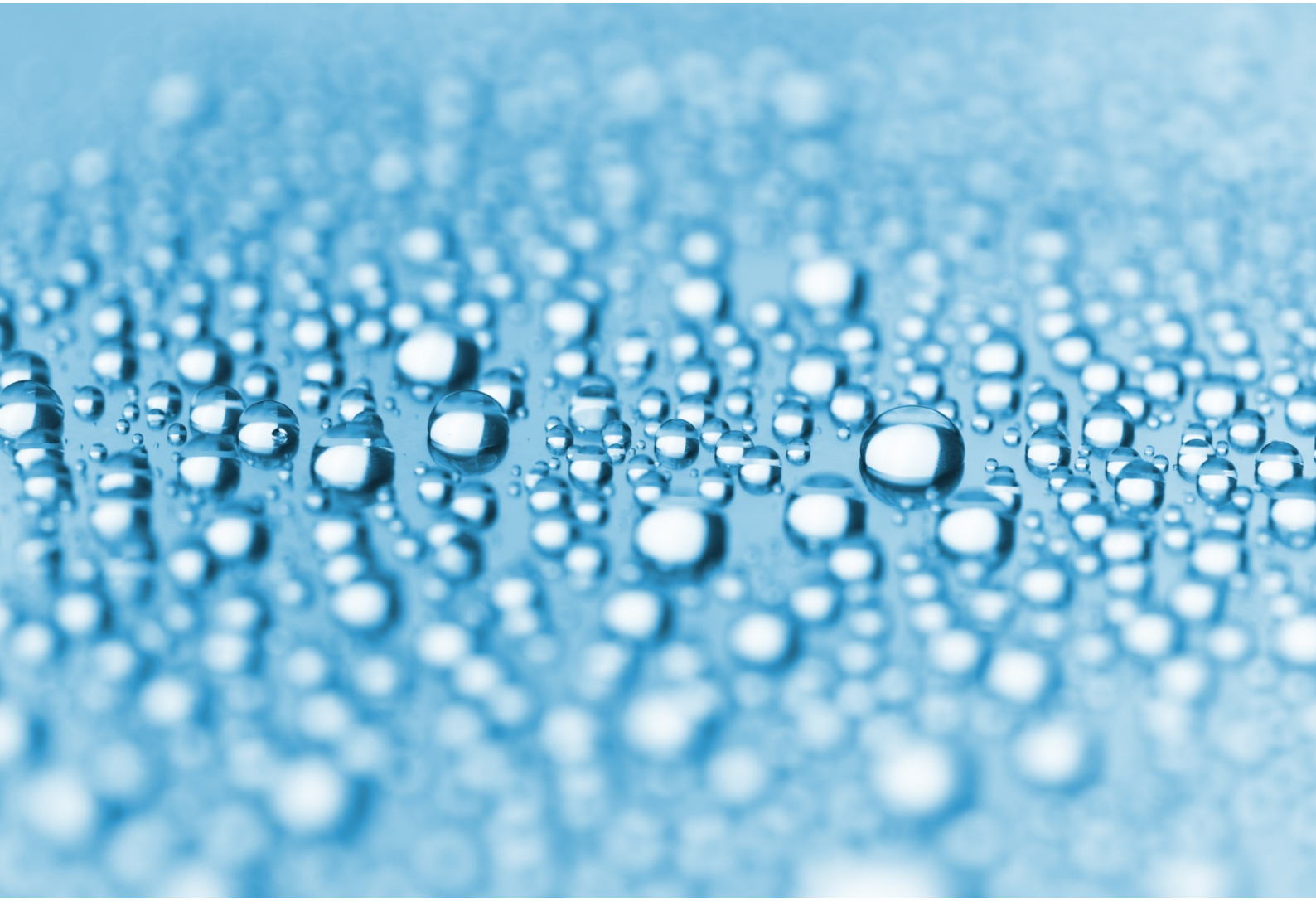

# Impact of the Cawthron Institute

## Economic contribution to Nelson and New Zealand

NZIER report to the Cawthron Institute

8 October 2015

# About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

NZIER is also known for its long-established Quarterly Survey of Business Opinion and Quarterly Predictions.

Our aim is to be the premier centre of applied economic research in New Zealand. We pride ourselves on our reputation for independence and delivering quality analysis in the right form, and at the right time, for our clients. We ensure quality through teamwork on individual projects, critical review at internal seminars, and by peer review at various stages through a project by a senior staff member otherwise not involved in the project.

Each year NZIER devotes resources to undertake and make freely available economic research and thinking aimed at promoting a better understanding of New Zealand's important economic challenges.

NZIER was established in 1958.

# Authorship

This paper was prepared at NZIER by Nick Allison and Killian Destremau.

It was quality approved by John Ballingall.

The assistance of Sarah Spring is gratefully acknowledged.

Thanks to the Cawthron Institute for providing substantial information on revenues, staff numbers and many other facts and figures on their operations provided in this report.

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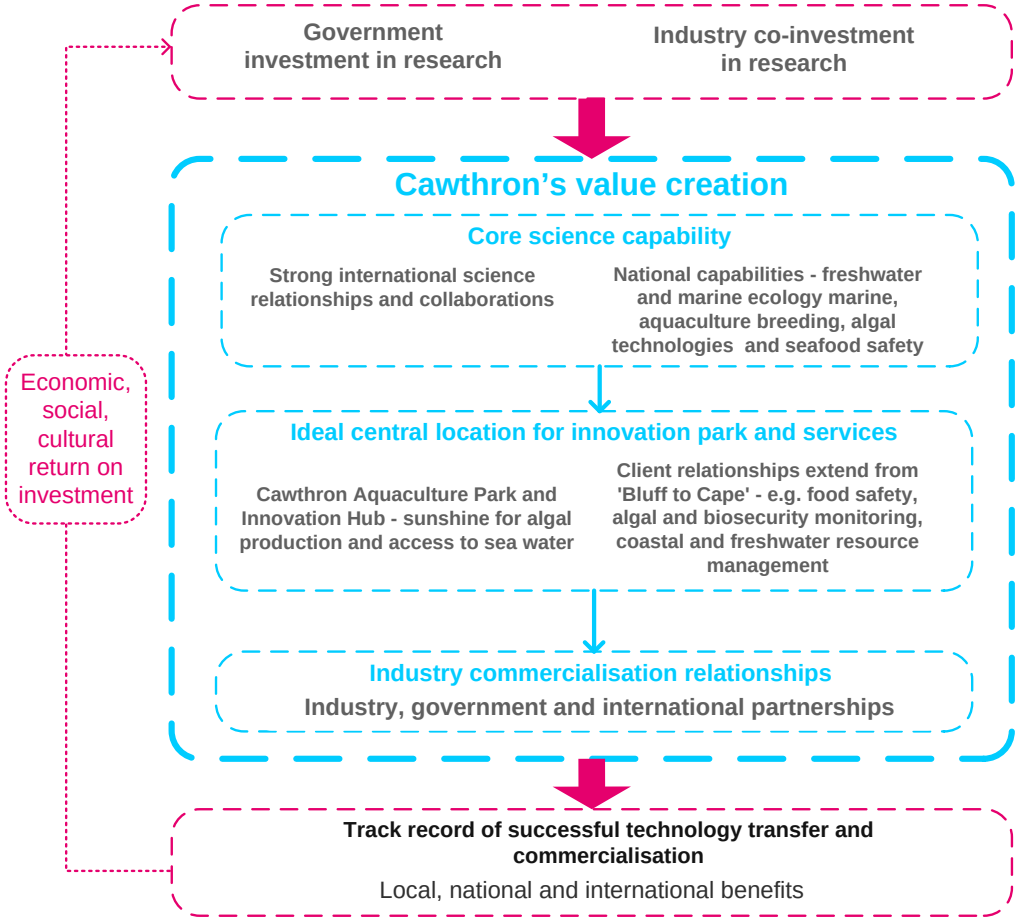
# Key points

The Cawthron Institute has created a unique business model adding value to the Tasman/Nelson region and national economies. It represents 25% of the Nelson business service sector exports, contributes $14m in added value to the local economy, and indirectly creates 91 jobs. It has a national and global reach, and its future successes could boost New Zealand's GDP by $201.7m and create 539 jobs.

## How does Cawthron create value for its customers?

Figure 1 summarises how Cawthron creates value for its clients and the wider community. Cawthron brings together three factors that create its unique value proposition. Its science capabilities, geographical location advantages and the strength of its industry relationships come together to produce a solid track record of technology transfer and commercialisation.

**Figure 1 Cawthron's unique value creation proposition**




**Source: NZIER**

Cawthron employs 200 staff and its increasing volume of peer-reviewed publications attest to its science quality. The Institute has an impressive record of providing applied research and pragmatic solutions for industry. It partners with international companies and some of New Zealand's largest seafood companies to increase

aquaculture productivity and to create innovative products or add value to final products.

Based in Nelson Cawthron is centrally located making it well positioned to serve clients dispersed across New Zealand with needs and opportunities in freshwater and the coastal environments. The Cawthron Aquaculture Park (CAP) takes advantage of a unique seaside location, providing gravity feed sea water for research and selective breeding. It brings together some of New Zealand's largest seafood companies, collocated at CAP, alongside Cawthron science staff and industry training and education activities, creating a unique 'innovation ecosystem'.

## Cawthron local impacts

The Institute represents up to 10% of the Nelson business services sector, and is much larger, with around 50 times more staff, than the average business services sector firm in Nelson. Over 90% of Cawthron's research services represent *exports* from Nelson to the rest of the country or offshore; bringing employment and investment to the Nelson Region. Cawthron represents around 25% of Nelson's business services sector exports to the rest of New Zealand. It is the most substantial exporter of business services we know of in the Nelson Region.

In addition to employing 200 staff, other economic and social impacts include:

- adding close to $14 million in value added to the local economy
- indirect impacts on the rest of the Nelson economy through its expenditure creates a further 91 more jobs in Nelson
- seafood company investment in production facilities on the CAP site has created a further 26 jobs, which Cawthron research breakthroughs enabled
- innovation ecosystem spillovers, include facilitating the creation of two local high-tech companies and development of education programmes with Nelson Marine Institute of Technology.

Cawthron's turnover has grown from $18 million to $23 million in the last three years. Some of its surplus is regularly reinvested in local community programs. Cawthron brings highly educated people to the Tasman/Nelson region, adding to social diversity. They often participate in leadership roles in community organisations such as school committees and sporting associations.

## National and global impact

While located in the Nelson Region, Cawthron also has an increasingly global economic footprint. Cawthron is now exporting high-tech analytical services and products to the rest of the world. These overseas activities now account for around 10% of its revenue; and have doubled in value over the last two years.

Cawthron' central location enables it to provide coastal and freshwater ecology services to most regions in New Zealand. For example Cawthron is an advisor to most regional Council's in New Zealand and many other local government organisations, including Port companies.

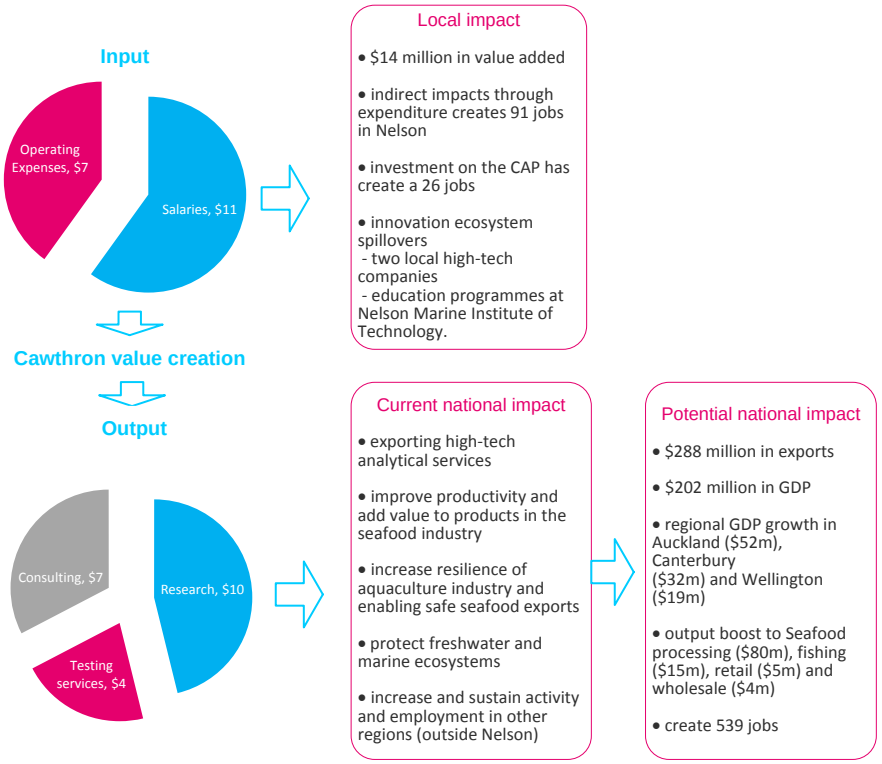
Its food safety and analytical services support several sectors of New Zealand's food production, high value products and nutraceuticals with a particular focus on export markets. For example, when the DCD contamination affected New Zealand's milk powder exports several years ago the Cawthron rapid response food safety

certification services were a key to the early release of contaminant free milk powder to Asian markets.

Cawthron's national impact is amplified by its ability to improve productivity and add value to products in the seafood industry, particularly aquaculture production. Working from the CAP site companies such as Sanford and Aotearoa Fisheries Ltd are now producing mussel and oyster spat (juveniles) for growing in aquaculture sites from Southland to Northland.

To illustrate the potential impact of Cawthron's research, we have used our CGE[1] model of the New Zealand economy, to estimate the economic impact of an increase in seafood export[2] by $288 million. This export increase could arise if Cawthron is successful in commercialising new aquaculture species being researched. The result is a boost in New Zealand GDP of $201.7 million and creations 539 jobs.

## Figure 2 The economic, social and cultural impact of Cawthron Institute




**Source: NZIER**

Two case studies we undertook also illustrate some of the value being added to the aquaculture industry. Oyster and mussel production suffers from exposure to disease and climatic conditions. Until recently, they relied entirely on the collection of wild spat; the supply of which fluctuates with ocean conditions. Cawthron's research has been instrumental in assisting the industry to move to controlled hatchery production of spat. Its selective breeding programmes are promising significant productivity gains, improved product quality and management of viruses that recently devastated Pacific oyster production.

1 Computable General Equilibrium Model

2 Seafood exports consist of Fish, Crustaceans, and Prepared fish. The database of the model is updated to match 2013/2014 national account data.

# Contents



## Figures



## Tables

# 1. Introduction

The Cawthron Institute is New Zealand's largest community-owned research organisation, employing close to 200 staff with an annual turnover of around $23 million. The Institute was established in the early 1920s under an Act of Parliament in accordance with a bequest made by local philanthropist, Thomas Cawthron, to establish a science and learning institute in Nelson.

Cawthron asked us to investigate the extent of their local economic impact on the Nelson Region and undertake case studies that illustrate its wider economic contribution to New Zealand. The report is structured in three parts:

- first we explain Cawthron's value creation proposition
- second we review Cawthron's value creation by summarising the national and local impact of the Institute
- finally we provide two case studies, from research initiation to the national economic impacts created, to illustrate how the Institute adds value to the wider economy.

Cawthron has expertise in freshwater and marine ecology, coupled with leadership in food safety, adding value to food products and aquaculture. The two case studies we selected are the Greenshell™ mussels (GSMs) and Pacific oysters. These industries are spread across New Zealand, and are an important part of New Zealand's seafood exports and thus good for illustrating Cawthron's national reach.

## 1.1. Cawthron's historical and potential impact

Cawthron has evolved over the last 90 plus years from its initial focus on agriculture and horticulture through to its current focus on freshwater and marine ecology, food and its emerging aquaculture speciality. Historically Cawthron's main science capability was not aquaculture related and incidentally the bulk of its revenue today still stems not from aquaculture but from freshwater and coastal research and laboratory testing services to industry and government.

Our assessment emphasizes the breadth of the Institute's research and hence the breadth of its impact, with particular attention given to aquaculture. The Institute plans to invest further in the Cawthron aquaculture park (CAP). That said, Cawthron is a significant provider of research and analytical services to government and to industry, and has an expanding national and international demand for its food safety and specialised food chemistry services.

Because of Cawthron's success in its research supporting the New Zealand aquaculture industry, as well as its future CAP investment plans, the case studies included in this report both relate to aquaculture.

# 2. Cawthron's value creation

Cawthron has three factors that together create a unique value proposition. Its science and technical capabilities, geographical location advantages and the strength of its industry relationships come together to produce a solid track record of technology transfer and commercialisation.

We outline below Cawthron's research capabilities, its collaborative relationships and then its innovation track record. This provides important contextual information for understanding the scope of the impacts.

## 2.1. Core science capability

Cawthron Science aims to support the sustainable development of New Zealand's primary sectors. It specialises in the aquaculture, fisheries and seafood processing; and freshwater and marine ecological research; and in associated consulting services. The research capabilities and services it provides to industry and government are built on several core science competencies including:

- freshwater and marine ecology
- analytical chemistry
- aquatic epidemiology
- biotechnology
- eco-toxicology.

The main research and associated services cover the following areas:

- **algal technologies** – new compounds based on the biology and biochemistry of microalgae and optimised algae production
- **aquaculture production** – shellfish spat production, broodstock improvement, animal husbandry and new species farming systems
- **coastal and freshwater resource management** – providing ecological knowledge and technology and products for environmentally sustainable management of coastal and freshwater ecosystems
- **biosecurity** – managing risks posed by aquatic pests to the environment, economy and society
- **analytical testing services** – food testing, natural toxin testing, export certification and analytical research and method development services
- **food safety, quality and adding value** – ensuring the safety and quality of New Zealand's seafood products and determining nutraceutical concentrations.

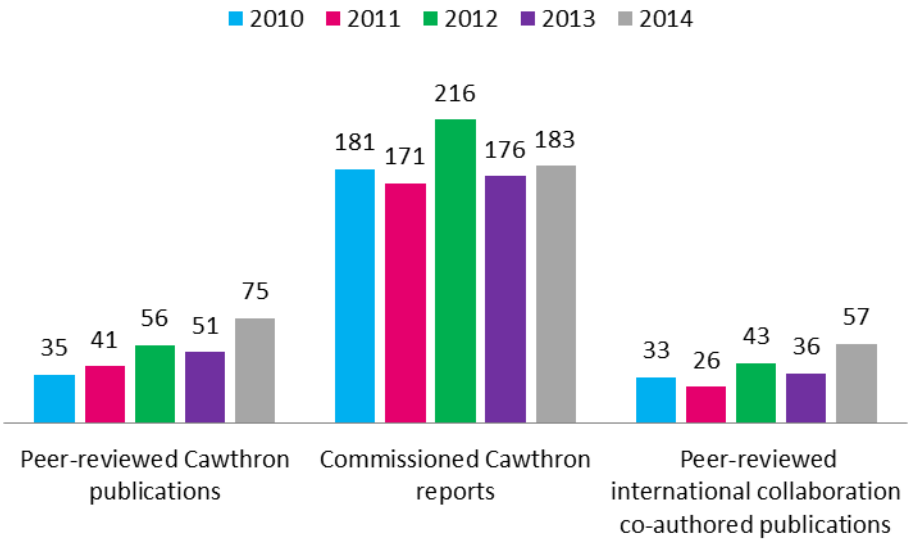
Although better known for its services to aquaculture and seafood, Cawthron also provides services for other sectors such as the food export industry generally; and for the hydroelectric, water supply, sewage treatment, irrigation, oil and gas industries (underpinned by aquatic research and knowledge). The Institute's analytical testing laboratories help ensure the safety of honey, milk , nutraceuticals and other food products exported from Nelson and nationally. This enables the ongoing success of many other local small and medium-sized enterprises, which themselves create economic value and jobs.

### 2.1.1. Quality of research capability

While very much focused on applied industry problems, Cawthron needs to stay at the forefront of research to serve local industry and the Institute regularly publishes its results. Publication of peer-reviewed journal articles is also critical to establishing internationally accepted assay techniques that lead not only onto setting international standards for detection of seafood toxins, but also flow onto creating international revenue streams from supplying standard testing materials.

Figure 3 shows that the number of peer-reviewed journal articles has progressively increased over the last 5 years from 35 to 75.

**Figure 3 Qualitative indicators of impacts**




**Source: Cawthron Institute**

## 2.2. Aquaculture park innovation ecosystem

Located at Nelson, Cawthron has several natural advantages and is centrally located to clients spread from the South and North Islands of New Zealand.

Cawthron has created the Cawthron Aquaculture Park (CAP) located at Glenduan, some 14 kilometres east of Nelson. The site is below the high tide level adjacent to a natural sea boulder barrier, which means that sea water can be supplied to the site by gravity for much of the tidal cycle. Cawthron realised in the 1990's that a gravity fed system could help launch research efforts without the need for extensive capital investment.

Nelson has a warm temperate climate with high sunshine hours. This is ideal for efficient mass production of algae used in Cawthron's research for the seafood and nutraceutical industries, and used as a shellfish hatchery feed source. Nelson is adjacent to the Marlborough region that contains the largest aquaculture production areas in New Zealand (see Figure 9).

The site has attracted several industry partners that have located operations on site forming an innovation ecosystem, including:

- SPATnz
- Kono Seafood
- New Zealand King Salmon
- Nelson Marine Institute of Technology
- Pacific Marine Farms
- Aotearoa Fisheries Ltd.

The Nelson Marlborough Institute of Technology (NMIT) has a teaching and research facility at CAP; creating a mix of industry training, research and development, and product commercialisation processes in one site. The Institute has created an innovation ecosystem that is unique in New Zealand.

## 2.3. Industry partners and research collaborators

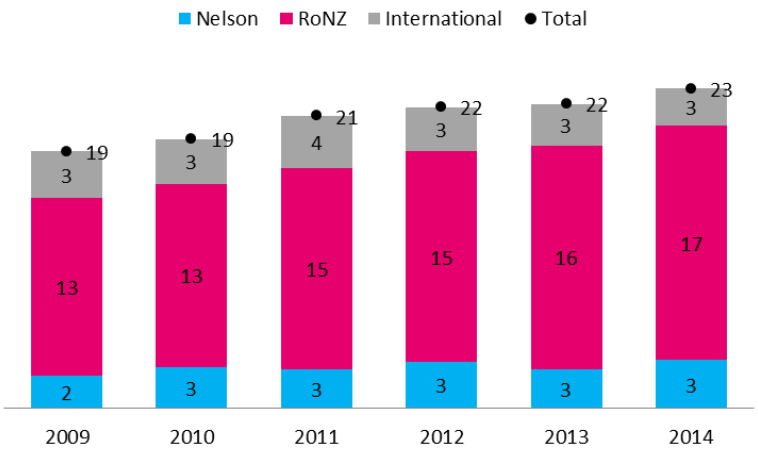
An important measure of Cawthron's success is its ability to build and sustain international and national research and industry relationships. These relationships generate services export revenues for the Nelson region.

### 2.3.1. Clients and partners

Cawthron's revenue mostly comes from New Zealand (about 90%) including Nelson (less than 10%). Its international business is relatively small with revenue of $3 million (13%) but is expected to grow in the future with the development of new products (see Figure 4).

**Figure 4 Cawthron's local, national and international revenue**

$ million turnover




**Source: Cawthron Institute**

Cawthron's main clients represent a mix of small and large industry and government organisations, many of who are well known to New Zealanders due to their market presence. For example Cawthron has provided environmental and coastal ecology advise to most of New Zealand's regional Council's over recent years. We have listed below some of Cawthron's top clients:

- Ministry of Business, Innovation and Employment
- NIWA
- Ministry for Primary Industries
- Marlborough Shellfish Quality Programme
- New Zealand King Salmon
- Sanford
- Shell Todd Oil
- Healtheries
- US Food and Drug administration
- Meridian Energy
- Seafood Innovations Ltd
- Fonterra Co-operative Group Ltd
- Westland Milk

About half of its revenue is from government, which is important for maintaining and developing national science capability in algae research, food safety, aquaculture and new technologies and approaches for protecting freshwater and coastal environments.

As noted CAP's infrastructure, research laboratories and expertise have attracted a cluster of companies and continue to attract national and international interests around the aquaculture sector.

Cawthron's principal domestic industry partners at CAP (Sanford, Kono, Aotearoa Fisheries Ltd, New Zealand King Salmon) and companies that form part of the Marlborough Shellfish Quality Programme, represent the bulk of New Zealand's shellfish aquaculture industry exporters. The case studies in Section 4 show how Cawthron's research is generating productivity gains and other benefits for these companies and other seafood companies.

Cawthron's Coastal and Freshwater and Analytical services groups also provide services to a diverse range of international clients. These include oil companies, the South Australian and Tasmanian governments, international salmon food companies, European food safety agencies and international drug companies.

## Māori client base

Māori have a significant stake in the New Zealand seafood industry and thus in research outcomes. Māori owners are involved in Kono and Aotearoa Fisheries Ltd, which invested at the CAP site. Other collaborators include:

- Mahurangi Technical Institute, which is developing commercial and cultural opportunities for eel and whitebait production

- Whakatohea Māori Trust Board (WMTB),[3] based in Ōpōtiki, to develop existing and new aquaculture species.

### 2.3.2. Research collaborators

International collaborators are extremely valuable to New Zealand research institutes. Due to New Zealand's relatively small size and distance from other countries, we need to leverage off other countries' research investments and adopt innovation from overseas quickly to maintain the international competitiveness of our export industries.

Table 1 provides examples of Cawthron's collaboration with other international research organisations. The collaborations include countries which are key export destinations for aquaculture products – Australia and China. These relationships are important for building trust around food safety, which is important for market access.

**Table 1 Cawthron's international collaborations**

| Country | Collaboration |
|---|---|
| USA | Safe New Zealand Seafood programme and coastal water monitoring. Cawthron has a long-standing collaboration with the Monterey Bay Aquarium Research Institute based in California. |
| Japan | University of Tokyo. Led to collaboration with University of Hokkaido in relation to functional food ingredient research in relation to marine derived compounds. |
| China | Safe New Zealand Seafood programme. |
| Australia | SARDI – long-standing collaboration in relation to marine toxin research expertise which is an area of strength provided by Cawthron within Australasia. |
| France | IFREMER – various aspects of aquaculture. |
| UK | CEFAS – various aspects of aquaculture and co development of faster more accurate early detection methods for life threatening toxins in seafood. |
| Germany | University of Konstanz - recent collaborative quote for MfE tender. |
| Pacific Region | Cawthron's Analytical Services team have assisted the establishment and review of analytical laboratories. |

**Source: Cawthron Institute**

Cawthron also has ongoing collaborative relations with a number of Crown Research Institutes (including NIWA, Plant & Food Research, ESR and AgResearch) and works with New Zealand universities and the Nelson Marlborough Institute of Technology (NMIT). It also has research collaborations with both large and small industry partners, who include clients described above. This substantially enhances the chance that research knowledge and findings are transferred into industry and put into practice.

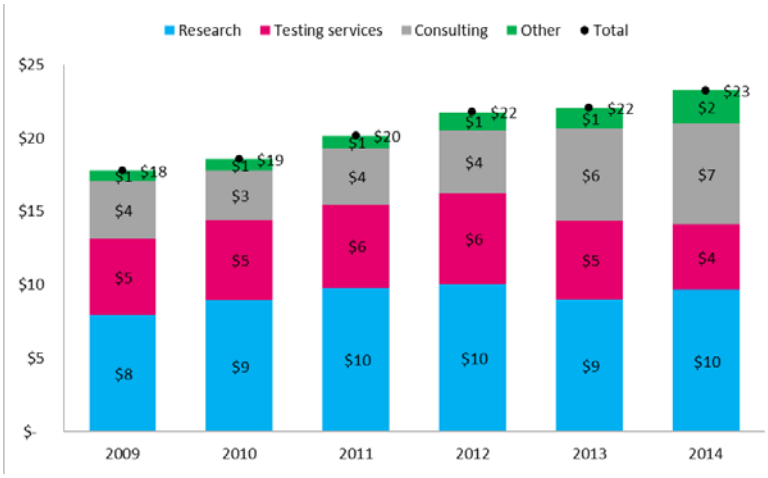
[3] http://www.whakatohea.co.nz/Business/Aquaculture.aspx

## 2.4. Services and commercialisation

Cawthron's revenue for 2014/15 was $23 million, up from $18 million in 2010. The Institute's revenue from consulting services has increased significantly over the last 5 years, from 22% of total revenue to 29%. This is due to stronger links with industry and local government established over time as Cawthron has focused more on addressing practical issues faced by the New Zealand businesses and government agencies.

### Figure 5 Cawthron revenue by service type

In $ million




**Source: Cawthron Institute**

Revenue from analytical services has fallen. In 2012 Cawthron sold a section of its analytical services group that was involved in the provision of low value bulk testing to focus on higher value specialist analytic services and food testing.

### 2.4.1. Commercialisation

Cawthron has a strong track record of successful commercialisation of innovation. This is most visible through their success in closure of life cycle enabling the breeding of Greenshell™ Mussels and Pacific oysters, and then adding product value to them through selective breeding. We cover these successes in the case studies. However, other notable successes include:

- **Algae high-value compounds** – Cawthron is one of just a handful of organisations worldwide with the capability to produce rare marine biotoxins
- **Health compounds** – Cawthron developed a technology to grow algae used by the nutraceutical industry worldwide
- **Food safety risks** – Combined skills in identification of algae, their biology, and the chemistry of their compounds enable industry to avoid very significant food safety risks.
- **Assessing irrigation consent impacts** – this draws on Cawthron's long historically established freshwater ecology capabilities

## Algae high-value compounds

Algae production technologies were developed at Cawthron to extract isolate and purify bioactive compounds. The products from this process are used in commercial laboratories to help identify human health risks from algae.

Cawthron has signed a global distribution agreement with Sigma-Aldrich Corporation[4] (an international analytical and chemical company) to supply compounds to laboratories worldwide. These are extremely high-value manufactured exports for niche markets, with the equivalent of a teaspoon of product valued at over $100,000.

Cawthron also supplies these high-value compounds to the US Food and Drug Administration (FDA), the US Centres for Disease Control and Prevention (CDC) and a number of European government agencies.

## Health compounds

Technologies used for extracting organic compounds from algae have been designed and built by scientists at the Cawthron Institute to enhance the production of valuable products and healthy food ingredients from algae. Cawthron's key client is Supreme Biotechnology Ltd a nutraceutical company located in Nelson. Supreme grows and extracts the high-value algae compound for the global market.[5]

## Food safety

Cawthron has more than 30 years' experience in ecology, biology, chemistry and toxicology of microalgae and the compounds they produce. Cawthron has also developed unique expertise in extraction of high-value natural compounds from algae, which underpins its ability to supply an export market for reference standards used in seafood safety testing as well as for nutraceuticals.

Cawthron's scientists were heavily involved in supporting NZ food integrity in a recent food safety scare over concern that milk was contaminated by DCD (a chemical applied to pasture to reduce greenhouse gas emissions).

Cawthron developed the first instrument-based test method for marine toxins in seafood replacing inaccurate mouse bioassay methods. This expertise has now been adopted by laboratories worldwide, most notably through EU regulations in 2014.

This adoption of Cawthron's reference standard and accepted analytical methods are important for New Zealand market access, avoiding technical barriers to trade that might arise without a reference standard. It enabled countries to agree to a common threshold standard for a recurring seafood safety issue.

[4] Sigma-Aldrich global customers include more than 1.3 million scientists and technologists in life science companies, universities, government institutions, hospitals and industry. Sigma-Aldrich operates in 35 countries and has nearly 9,000 employees.

[5] http://www.cawthron.org.nz/biotechnology/news/2014/smart-technology-helps-scientists-enhance-high-value-algae/

## Assessing irrigation consent impacts

Irrigation contributed an additional net farm gate contribution to GDP of $2.17 billion in 2011/12.[6] There are growing concerns about the ecological effects of existing irrigation schemes and expansion of irrigation has become contentious.

Cawthron is and has been involved in the recent major irrigation expansion proposals including Waimea Plains, Ruataniwha, Central Plains, Hurunui, Hunter Downs and Wairarapa.

Cawthron plays a critical role in determining the scale of likely ecological effects for each proposal. If negative ecological effects are substantial and cannot be avoided or mitigated then consent is unlikely to be granted for such schemes.

Cawthron provides trusted and robust understanding of the potential environmental effects and if/how they can be addressed. Cawthron helps to design the various mitigation options to address the likely effects of schemes. It provides expert evidence at the consent hearings for the proposed scheme and participated in caucusing with expert witnesses.

[6] NZ Institute of Economic Research Inc and AgFirst Consultants NZ (014), file:///C:/Users/nicka/Downloads/NZIER-17040-Output-Value-of-Irrigation-final-report-17Nov.pd

# 3. Economic impacts

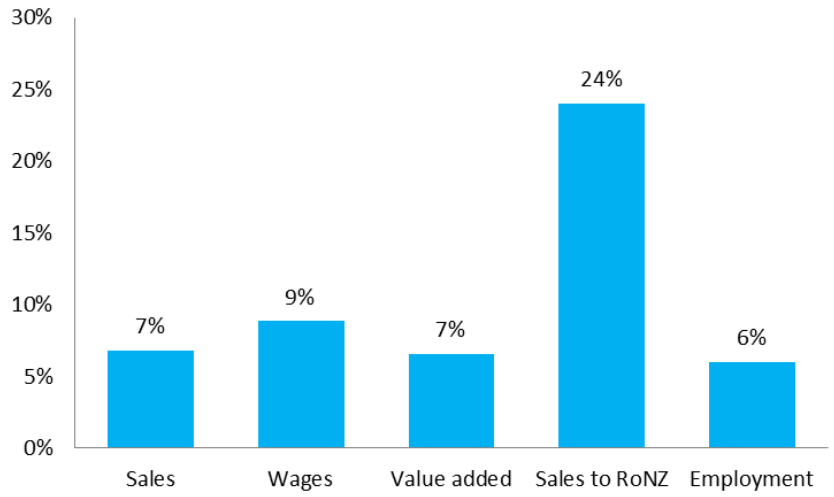
In this section, we summarise the economic and social impacts of the Institute's business operations.

## 3.1. Local impact

The Institute represents about 6% to 9% of the Nelson business services sector, depending on the impact measure used (see Figure 6). It represents a quarter of all business services' sales out of Nelson to the rest of the New Zealand economy.

### Figure 6 Cawthron's impact relative to all Nelson's business services

Share of the total business services in Nelson in 2014




**Source: Cawthron Institute, Statistics New Zealand and NZIER**

The Institute is a significantly larger organisation than the average business service firm in Nelson. The impact of the Institute relative to the average services firm in Nelson is an order of magnitude greater. For example, the average business service in Nelson has 4 employees while Cawthron employs 200 staff; fifty times larger (see Table 2). Also Cawthron provides 6% of Nelson's employment in business services, but pays 9% of the wages in this sector.

### Table 2 Cawthron compared to other service businesses in Nelson

There are 858 business services in Nelson

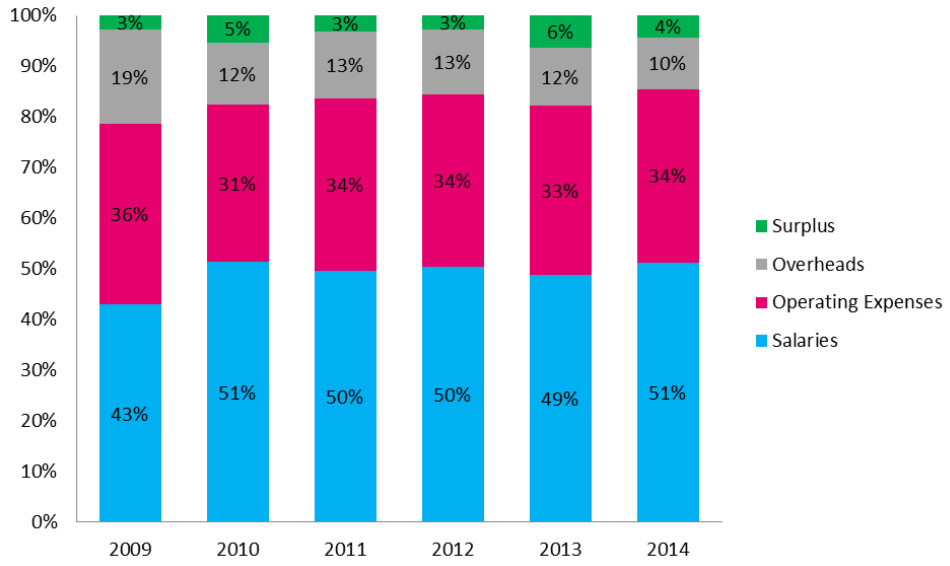
| Measure | Average Nelson business services firm (in $ thousands) | Cawthron Institute (in $ thousands) |
|---|---|---|
| Staff | 4 | 200 |
| Output | $398 | $23,211 |
| Value added | $244 | $13,694 |
| Wages | $147 | $11,113 |

**Source: Cawthron Institute and Statistics New Zealand**

Because Cawthron's revenue largely comes from elsewhere in New Zealand or from international sources, its impact is largely in the form of a direct transfer into the Nelson economy from other regions or countries.

## Figure 7 Cawthron's expenditure and contribution to the Nelson economy

Percentage of expenditure, excluding depreciation




**Source: Cawthron Institute**

The Institute's direct impact from wages and salaries is an injection of over $11 million per annum into the local economy. A further $6 to $8 million to local businesses is made through operating cost expenditures, employing local businesses to provide services such as building and machinery maintenance.

We estimate the indirect impacts arising from wages and operating expenditures create an additional 91 jobs in Nelson. The successes of Cawthron's research partnerships have facilitated industry investment in production facilities at CAP. We refer to these as 'associated' jobs stemming from research commercialisation spillovers. Around twenty six now exist at CAP following the Sanford/Shellfish Production and Technology New Zealand (SPATnz) hatchery opening in April 2015. Table 3 summarises the local job creation.

## Table 3 Direct and indirect impacts to the Nelson economy

| Measure | Impact |
|---|---|
| Direct employment | 200 |
| Indirect employment | 91 |
| Associated CAP employment | 26 |

**Source: NZIER**

Cawthron's employees include a number of highly skilled staff from all over the world with relatively high wages. Cawthron is a regular host for both national and international scientists visiting the Institute. Each year Cawthron sponsors or hosts four to six science conferences in Nelson with 50-350 attendees over several days. Additionally, Cawthron hosts between 20 and 25 visiting overseas academics and scientists at its facilities over the course of a year. These science activities create a further injection of cash into the Nelson economy through visitor spending. They are also important for ensuring Cawthron scientists stay at the forefront of international research advances important for New Zealand.

## 3.2. Educational investment

In addition to Cawthron's core science and learning institute, the Institute's Trust Board has responsibility for the community and education initiatives as set out in the Institute's Act. These activities are funded from Cawthron's operating surplus. The Trustees have a legal responsibility to provide for these activities.

The Institute is highly engaged with:

- community education
- supporting science open days at facilities
- supporting science fairs
- enabling high school students to participate in research.

An integrated research and education facility has been created at CAP. Classrooms, laboratories and lecture theatres are all co-located with existing aquaculture facilities.

Nelson Marlborough Institute of Technology and Cawthron collaborate to provide tertiary-level education to aquaculture students, sharing facilities with scientists and industry. NMIT's presence at CAP further ensures education is well aligned with industry and researchers.

NMIT also provides:

- maritime and fisheries training through its Nelson Maritime School with over 900 course enrolments for 2014. It offers a Diploma in Aquaculture (Fish Farming and Fisheries Management), which involves teaching time at CAP
- a Bachelor of Aquaculture and Marine Conservation degree and a Postgraduate Diploma in Sustainable Aquaculture. It is the first marine science degree in New Zealand to focus on current and future needs of the aquaculture industry
- NMIT lecturers also participate in Cawthron-led research. The aquaculture industry also has a ready supply of employment candidates, qualified beyond the classroom.

It is difficult to estimate in any robust manner the value of these joint education and research investments. We can say however, that as the aquaculture industry moves from wild harvesting of spat to expanding selective breeding and producing more sophisticated products markets more skilled staff will be needed.

## 3.3. National impacts

The Institute's expertise is sought by organisations throughout New Zealand and internationally, which are looking to invest in, and establish or enhance commercial and sustainable operations, particularly in aquaculture, food safety, high value food and freshwater and coastal ecology.

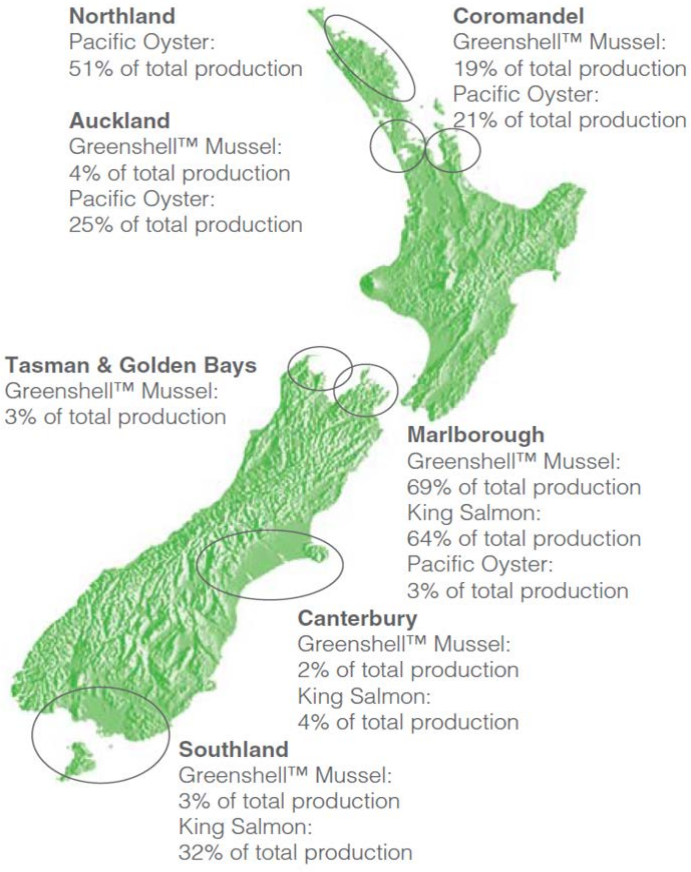
One dimension of the national impact of Cawthron can be illustrated by its influence on the aquaculture industry. New Zealand's principal aquaculture exports are mussels, oysters and salmon. Total aquaculture exports were $313 million in 2014.

Aquaculture New Zealand (ANZ) state that:

> *"With significant growth potential, the NZ aquaculture sector is well on track to be worth in excess of $1 billion to the economy by 2025."*

Aquaculture exports will need to increase by 3.2 times over the next 10 years to meet ANZ's outlook. King Salmon's exports grew to $44 million in 2014 from $36 million in 2007, and they are continuing to experience rapid growth. Mussels are New Zealand's largest aquaculture export at $253 million in 2014, of which a large share is Greenshell™ mussels (Seafood New Zealand 2015).

**Figure 8 Major aquaculture areas in New Zealand**




**Source: NZ Aquaculture Farm Facts 2012**

The aquaculture industry is spread mainly across five regions; mussels in Marlborough and Coromandel, salmon in Marlborough and Southland, oysters in Northland, Auckland and Coromandel (see Figure 8). Northland dominates Pacific oyster production (51%) with the rest of production being split between the Coromandel (26%), Auckland (21%) and Marlborough (3%).

As already noted Cawthron is strategically located in the Nelson region, which is adjacent to the Marlborough region. The Marlborough Region accounts for:

- 69% of the mussel production
- 64% of King Salmon production.

While Cawthron provides important services for Marlborough aquaculture, it also generates nationwide benefits to other regions (such as Northland, Coromandel, Stewart Island and the Bay of Plenty). Fifty million Pacific oysters are now bred at CAP every year and SPATnz is aiming to supply around 30% of mussel spat required by mussel growers by 2018.

The case studies show the shift from wild harvesting of spat to onsite hatchery production at CAP has resulted in substantial productivity gains. These arise from selective breeding and making the industry less reliant on environmental conditions. These benefits are spread across the aquaculture areas of New Zealand.

Of note, the Northland region has identified aquaculture as an area for future economic growth.[7] Cawthron's oyster research and the breeding of virus-resistant oysters are important for supporting the redevelopment of the Northland oyster industry, which substantially collapsed following a recent virus outbreak.

### 3.3.1. Illustrative national impact - aquaculture

To illustrate the potential future impact of Cawthron's research, we have used our CGE[8] model of the New Zealand economy, to estimate the economic impact of an increase in seafood export[9] by $288 million. This export increase could arise if Cawthron is successful in commercialising new aquiculture species being researched.

**Table 4 National and regional GDP impact**

| Region | GDP million | Employment |
|---|---|---|
| Auckland | $52.28 | 126 |
| Waikato | $18.10 | 53 |
| Bay of Plenty | $10.23 | 26 |
| Wellington | $19.27 | 41 |
| Nelson | $13.15 | 29 |
| Canterbury | $32.05 | 88 |
| Otago | $9.63 | 28 |
| Southland | $8.52 | 32 |
| Other | $38.47 | 117 |
| **New Zealand** | **$201.71** | **539** |

**Source: NZIER**

7 See e.g. Northland Aquaculture Development Group, Growing Northland Aquaculture (Northland Inc, 2012), Tai Tokerau Northland regional growth study opportunities report.

8 Computable General Equilibrium Model

9 Seafood exports consist of Fish, Crustaceans, and Prepared fish. The database of the model is updated to match 2013/2014 national account data.

As a result of the boost in exports, New Zealand GDP increases by $201.7 million and 539 jobs are created (see Table 6). Notable is that the impacts are widely spread across regions, reflecting the seafood industry operations are spread across the country. Regional GDP and employment growth is particularly strong in Auckland, Canterbury and Wellington.

The Seafood industry has strong linkages with the motor vehicle wholesale, wholesale, road rail and transport, retail, property service, and gas water supply sectors. These industries will strongly benefit from the rise in exports (See Table 7). While some percentages changes in output appear small, this is because sectors such as retails are large.

### Table 5 Wider industry impact

In $ millions;

| Industry | Output $million | Percentage change |
|---|---|---|
| Seafood processing | $80.1 | 4.62% |
| Fishing | $14.9 | 2.02% |
| Motor vehicle wholesale | $0.4 | 0.03% |
| Wholesale | $ 4.1 | 0.02% |
| Road rail transport | $1.2 | 0.02% |
| Retail | $5.2 | 0.04% |
| Property service | $1.0 | 0.00% |
| Gas water supply | $0.1 | 0.01% |
| Sewerage and waste | $ 0.1 | 0.01% |

**Source: NZIER**

Because resources are limited, industries that benefit will draw resources from other sectors of the economy, thereby causing a fall in activity for some sectors. However, overall there is an estimated net gain in GDP of $201.7 million.

## 3.3.2. Illustrative National Impacts – other

Cawthron provide services that are essential to a number of New Zealand's industries and exports. For example much of the country's seafood exports are dependent on the monitoring and certification services provided by Cawthron. It also provides services and scientific advice to support industries such as the oil and gas industry. For example, Cawthron has developed risk assessment approaches to manage biosecurity risks from oil rigs movements into and around coastal waters, and also contributed to the development of New Zealand's recently introduced Craft Risk Management Standard for vessel biofouling.

Cawthron is also responsible for the growth and maintenance of New Zealand's algae collection. Cawthron's collection is internationally recognised as one of the most comprehensive available and containing a number of rare strains. For example when

the US algae collection located in New Orleans was damaged by Cyclones that affected the city the Cawthron collection was used to provide important replacements.

The significance of this algae collection is increasingly apparent as both Cawthron and other scientists start to use algae's to extract selected compounds which have use in medical, cosmetic and food safety industries. The expertise of Cawthron scientists in extracting these minute compounds is now sought by international drug and medical agencies. Cawthron are forecasting annual revenues of over $1 million from the sale of its own compounds within 2-3 years.

# 4. Case studies – mussels and oysters

We undertook two case studies to illustrate how Cawthron's unique capability and expertise created value through scientific research to support New Zealand's national and local economies.

## 4.1. Industry context

Total aquaculture exports were worth $313 million in 2014. Aquaculture exports are dominated by mussels, which account for 81% of exports. They have experienced a relatively higher compound average growth rate of 5% compared to the growth rate of 3% for salmon exports from 2007 to 2014 (see Table 6). Oyster exports have stood still over the period due to a virus outbreak.

**Table 6 Key aquaculture export species growth**

In $ millions, CAGR stands for compound annual growth rate

| | 2007 | 2014 | CAGR 2007 - 2014 | % of aquaculture exports 2014 |
|---|---|---|---|---|
| Mussels | 175 | 253 | 5% | 81 |
| Oysters | 16 | 16 | 0% | 5 |
| Salmon | 36 | 44 | 3% | 14 |

**Source: Seafood New Zealand**

Mussel and oyster industries are more heavily dependent on environmental conditions than most other food exporters. They currently rely on collection of wild juvenile offspring called spat for stock to grow for market; in contrast to the selective breeding of plants and stock used in pastoral agriculture.

This leaves them highly exposed to natural climatic fluctuations of pests and diseases. Also, in the absence of selective breeding, productivity improvements and product enhancements are foregone that are available to some competitors.

Changes in environmental and ocean conditions have led to fluctuations in the production of mussels and substantial reductions in oyster production over the last five years. This pattern is evident in Figure 9, which charts the annual percentage change in output between 2009 and 2014.

### Greenshell™ mussels

Over the last couple of years adverse ocean weather conditions led to a reduction in the supply of wild mussel spat. As a result production levels fell, which led to industry layoffs. Sanford Limited, a major mussel exporter, closed its Christchurch plant in April 2015, making around 200 staff redundant. At the time Sanford Chief Executive

Volker Kuntzsch, is reported as saying the "supply of wild spat was the single-biggest constraint on the mussel industry". [10]

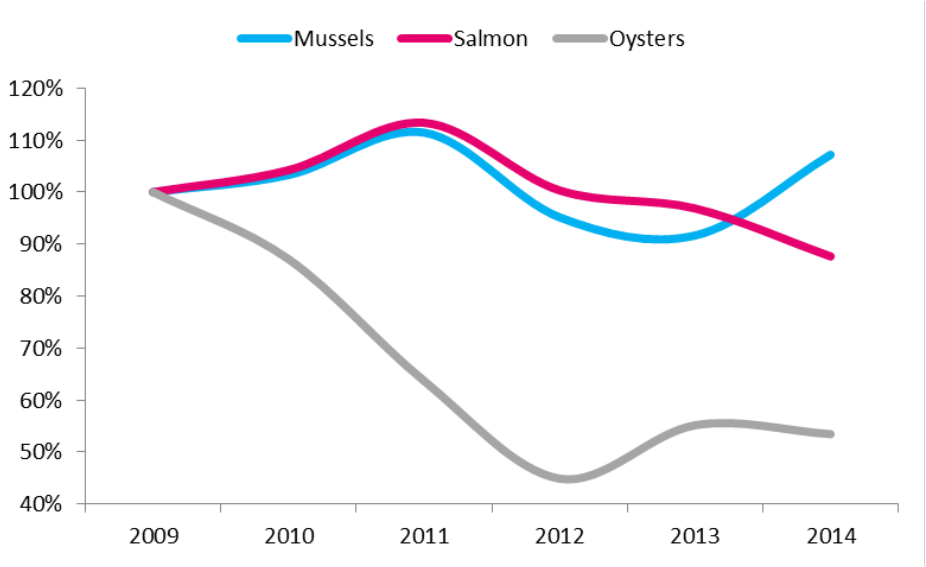
Cawthron has played a critical role in helping the mussel and oyster industries move onto a sustainable and productive path. We begin telling the story by looking at the recent crisis faced by the industries. We then turn to show how Cawthron has assisted these industries and outline economic benefits that flow from this involvement along industry investment.

## Oysters

Prior to 2009 the New Zealand Pacific oyster industry was worth $28 million per annum, with $16.5 million (2.2 tonnes) exported. The oyster herpes virus decimated farmed and wild stocks alike in 2010, such that export volumes dropped around 40% to 1.4 tonnes in 2012.[11] This industry setback had an adverse effect on industry employment in Northland, a province with relatively high unemployment.

### Figure 9 Aquaculture production by broad species

Index: 2009 = 100




**Source: Aquaculture New Zealand**

In 2011, the virus also led to the temporary shut-down of Cawthron's pioneering oyster hatchery that supplied 20%of New Zealand's stock. This shut-down allowed Cawthron to divert attention/research efforts to disease identification and disease mitigation; to in turn accelerate the industry recovery. Based on our industry discussions production levels are only now recovering to 2009 volumes.

[10] http://www.stuff.co.nz/business/67670124/sanford-mussel-factory-to-cut-230-jobs

[11] 2005 sales. *The New Zealand Aquaculture Strategy*, http://aquaculture.org.nz/wp-content/uploads/2011/05/Strategy.pdf

## 4.2. Greenshell™ Mussels

Cawthron's involvement began in the early stages of development of the mussel industry in the 1990s. We outline below how this involvement evolved and the recent investment by industry, supported by government co-investment, which is building the basis for a much more sustainable and productive industry.

### 4.2.1. Cawthron's science leadership

As noted the security and consistency of spat supply is a fundamental concern for the Greenshell™ mussel industry. Cawthron produced the world's first Greenshell™ mussel hatchery spat in 1997 as it targeted a reduced reliance on wild spat.

After the hatchery life cycle breakthroughs, Cawthron's focus was redirected to selective breeding producing the best spat for market. This includes selecting for traits such as flesh weight, consistent shell length and growth rate.

Table 7 outlines the major milestones and key events in Cawthron's research and progressive industry involvement between the early 1990s through the present day.

**Table 7 Greenshell™ mussel research and development chronology**

| Date | Milestones and key events |
|---|---|
| **1993 - 1999** | **Early research pioneering closes the breeding cycle**<br>Cawthron scientists work on closing the life cycle of the Greenshell™ mussel and use that information to work out how to breed them in an artificial environment.<br>This was funded by the Foundation for Research Science and Technology. |
| **2000 - 2002** | **Research establishes feasibility of mussel hatchery**<br>Successful breeding of Greenshell™ mussels in hatchery conditions confirmed. Cawthron explores commercial possibilities for selective breeding with government investment. |
| **2003 - 2008** | **Government-led research of selective breeding begins**<br>Research into scaling up breeding for industry requirements and selective breeding for commercial traits begins. Major Government financial backing secured towards selective breeding research with Plant and Food Research and cryo-preservation of shellfish. |
| **2009 - 2012** | **Knowledge transfer as industry partnership invests in research and development**<br>Glenhaven Aquaculture Centre developed at the Glen, north of Nelson. Aquaculture research facilities expanded. Mussel companies form SPATnz and work together on research and development. SPATnz secures funding from Primary Growth Partnership programme with the Ministry for Primary Industries at Cawthron Aquaculture Park. |
| **2013 - 2014** | **Scale up of commercial hatchery production**<br>Pilot scale commercial hatchery built at Cawthron Aquaculture Park to develop methods for reliable commercial scale supply of spat.<br>SPATnz in process of scaling-up production to provide spat for 30,000 tonnes a year of Greenshell™ mussels. Cawthron research and selective breeding continues working with SPATnz. |
| **2014 - 2015** | **Industry production hit due to continued reliance on wild spat collection**<br>Weather conditions led to a reduction in the supply of wild mussel spat (offspring). As a result, production levels fell, which led to industry rationalisation and layoffs, as much of the output is reliant on the collection of wild spat. As SPATnz scales up production, and the industry becomes less reliant on wild spat, these production fluctuations should be avoided. |

**Source: Cawthron Institute and NZIER**

Ongoing research will allow extraction of further value. For example, savings in processing operations are possible if shellfish are bred for uniform processing, as currently some 50% of mussels do not meet the requirements for first-grade product due to size fluctuations.

Cawthron research and selective breeding continues to work with SPATnz which is located at the Cawthron Agriculture Park.

### 4.2.2. Industry investment

In November 2012, the Government co-invested with Sanford to develop the largest mussel hatchery at CAP. The hatchery is operated by SPATnz – a Sanford subsidiary. The programme involves each party investing $13 million in its development. It directly builds on Cawthron's research achievements.


The hatchery aims to produce 30% of the industry's total spat needs. This will enable production of 30,000 or around one-third of the industry's annual production of 100,000 tonnes. The hatchery is currently at a pilot production stage and on track to produce 10,000 tonnes by next year.

SPATnz is led by Dr Rodney Roberts, an ex-Cawthron employee, who was heavily involved in Cawthron's early mussel breeding research efforts. This is a great example of research knowledge and capability being transferred to an industry, which is just commencing significant investment in research and development.

A hectare of ponds have been developed by SPATnz to produce algae as a food source for their commercial Greenshell™ mussel production. SPATnz also plans to produce gourmet algae inside their new facility using Cawthron technical support and research. When fully operational, 30,000 green weight harvest tonnes of Greenshell™ mussel worth $60 million per annum will have begun their life at the CAP site.

### 4.2.3. The economic benefits

The main benefits that come from successful hatchery spat production and selective breeding arise from improved:

- reliability of annual GSM production output arising from reduced reliance on wild harvesting of spat
- productivity – annual tonnes grown per hectare
- growth rates which reduce time to harvest, thereby also adding to productivity
- price increases arising from product consistency and quality improvements e.g. consistency of shell length.

### Improved reliability of spat production

Hatchery spat production saves the risk of potential total loss of production due to zero spat arrivals in some future year. As reported by Berl (2010), the industry experience is a 1:25 year probability of a total annual production loss. If this loss could be avoided it equates to an annual benefit of 4% of production, or about 4,000 tonnes per annum, worth $36m at export price, over the next decade based on current production levels.

### Productivity and growth rates

Assuming mussels behave like the other molluscs (oysters, scallops and clams) the expected increase in growth rate per generation will be in the range of 10 to 15%, where the breeding is for that single trait such as weight gain. As breeding is now into the third generation, growth rates and reductions in maturing time of 10 to 20% or more may be achieved. It is too early to say, and commercially confidential, as to what productivity gains are being made. To illustrate, if the industry achieved a 15% reduction in growing time this would equate to an additional annual production output of 14,616 tonnes with a 2014 export value of $136 million.

### Consistency of product quality

The lack of size consistency in the present wild spat-based product means most sales fall in into the range of 30 to 45 pieces per kg. It is preferable to be able to pack at 30 to 40 piece size or better. Berl (2010) estimates that only about 35 to 40% of the product can be packaged to this grade, whereas, at least 70% to 80% of hatchery spat will be able to be packed to this grade. An expected price premium of at least 10% will be generated by this improvement. The average price for mussel export in 2014 was $9.3 per kilogramme, a 10% increase would increase the price to $10.2. This price premium would provide additional annual export revenue of $12.3 million (assuming 80% of hatchery spats are first grade).

### National impact GDP impacts

We have not conducted any modelling of the national impacts. In its economic assessment of the proposed SPATnz investment, Berl (2010) report if hatchery-bred spat were available to the whole production and processing industry by 2026, this would be worth:

- GDP per year increase of between $135 to $193 million
- an employment increase of between 800 to 1,100 FTES.

## 4.3. Pacific oysters

Like GSM's the New Zealand Pacific Oyster industry is still a relatively young, with the industry only gathering traction in the 1990s.

### 4.3.1. Cawthron's science leadership

Like mussels, the Pacific oyster industry is based on the wild catch of spat, and hence production is sensitive to changing environmental conditions. Cawthron's research at CAP addressed this problem by developing the science, disciplines and infrastructure that enable the consistent and repeatable growth from egg to larvae to spat.

This work on selective breeding commenced with Government R&D funding in 2000. Cawthron now produces 50 million spat annually, which are sold to industry after being grown to juvenile spat in a nursery on the CAP site. Table 8 outlines the milestones and key events that shaped the development of the research from the early 1990s through to today.

## Table 8 Pacific oyster research and development chronology

| Date | Milestones and key events |
|---|---|
| **1994 - 1996** | **First stage research began with industry secondments**<br>Cawthron starts involvement with oyster industry by seconding a full-time staff member to work in Okiwi Bay in the Marlborough Sounds. The aim is to develop a sub-tidal farming method. The same staff member is then seconded full-time to Clifford Bay with the aim of establishing a hatchery and nursery.<br>The secondments were supported by funding grants from government. |
| **1999** | **Industry engagement and first sale of spat**<br>Clevedon Oysters Ltd supported testing of a new larval rearing method (flow-through) with Pacific oysters at the Cawthron Aquaculture Park is successful.<br>Clevedon Oysters Ltd was supported by the Technology for Business Growth scheme. |
| **2000 - 2007** | **Selective breeding breakthroughs and commercial sales commence**.<br>Cawthron funded development of Pacific oyster hatchery technology and starts a selective breeding programme.<br>The first Pacific oyster families were produced in 2000 and by 2002 Cawthron had a base population for selective breeding. By 2003, small commercial quantities of spat were being produced, which helped fund the ongoing selective breeding programme.<br>In 2003 Pacific oyster sperm are successfully cryo-preserved and by 2004 and in a world-first Pacific oyster eggs are successfully cryo-preserved. This research was supported by government funding (Research for Industry Grant). |
| **2008 - 2010** | **Scale up, further breeding breakthroughs and commercialisation**<br>Commercial production of Pacific oyster spat was established, supported by Pre-Seed Accelerator Funding intended to support scaling up of production. Between October 2008 and February 2009, a raceway nursery was built specifically for single-seed spat production.<br>By November 2009 Triploid (3N) oysters were be produced for industry partners. These oysters grow faster and become larger with meat content increased by as much as 70%, compared to oysters harvested from the wild. |
| **2010 - 2011** | **Virus attacks oyster farms and Cawthron redirects research**<br>In autumn of 2010 the Ostreid Herpes Virus (OsHV) hits the industry in the North Island, but stays under the radar. By the spring of 2010, a full-scale virus outbreak is affecting all major North Island oyster growing areas.<br>In spring of 2011, Cawthron re-directed its selective breeding towards enhancing OsHV tolerance. Biosecure standards of practice were established for the oyster hatchery. |
| **2011 - 2014** | **Virus resistant oysters selected and nursery production transferred to private sector**<br>Cawthron recommendations for short-term recovery from OsHV are implemented successfully and industry begins a slow recovery.<br>In March 2012, Pacific Marine Farms Ltd took over nursery production and extended the raceway nursery at Cawthron's aquaculture park. They contract with Cawthron for the supply of spat from the Cawthron hatchery.<br>In 2013-14 a biosecure oyster PC2 lab is built. This enabled higher efficiency of selective breeding for OsHV tolerance. |

**Source: Cawthron Institute and NZIER**

## 4.3.2. Industry investment

The successful development and testing of pilot-scale production facilities at CAP for research has enabled commercial-scale production.

In 2013, Cawthron experienced commercialisation success when Aotearoa Fisheries Ltd (AFL) purchased its Pacific oyster spat nursery as a going concern.

AFL has expanded the infrastructure for this operation, which includes ponds, raceways, nursery buildings and machinery. AFL now has eight to nine staff located at CAP. Newly settled spat are supplied to AFL's farm operations in Northland and elsewhere in the country. Aotearoa Fisheries Ltd is the largest producer of Pacific oysters, accounting for around half of the industry's output.

Three hectares of CAP's algae ponds are used exclusively by Aotearoa Fisheries Ltd's oyster subsidiary Pacific Marine Farms, for producing algae as a food source for their commercial oyster production.

Cawthron and AFL have an ongoing business relationship. Cawthron has an oyster spat supply agreement for 48 million spat p/a, increasing to 60 million p/a by 2018. Cawthron is the exclusive provider of breeding services and the preferred supplier of other services. New Zealand's main market is frozen oysters to Australia.

## 4.3.3. The economic benefits

Like mussels the main industry benefits that come from successful hatchery spat production and selective breeding arise from improved:

- reliability of annual Oyster production output due to reduced reliance on wild harvesting of spat
- productivity – annual tonnes grown per hectare
- growth rates which reduce time to harvest, thereby also adding to productivity
- price increases arising from product consistency and quality improvements, particular shell shape being attractive for Asian markets

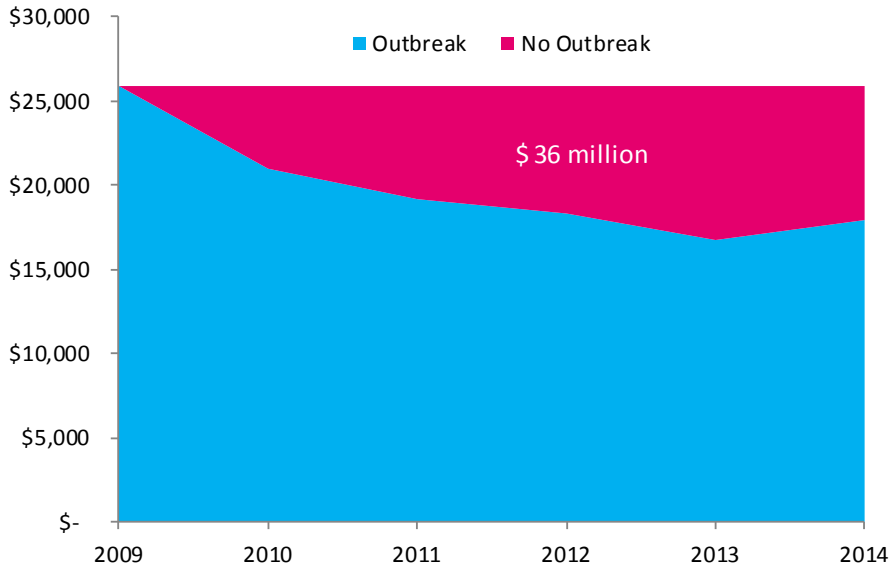
The expected increase in growth rate per generation will be in the range of 10 to 15%, where the breeding is for that single trait such as weight gain. Also, consistency of oyster size and shape can open up higher value markets where oysters are sold live in their shell at a price premium of 15%. In 2014 only around a quarter of mussel exports were live, the remainder being frozen.

The most immediate and pressing problem for the industry is recovery from OsHV that devastated production starting in 2010. As outlined above, Cawthron moved quickly to identify families of oysters resistant to the virus in 2011 that are now being grown. However, we understand around half of the industry is still reliant on wild spat collection.

To illustrate the potential value of selective breeding to the industry, we have assessed what the virus may have cost the industry. This is shown at $36 million between 2009 and 2014, assuming price and output levels of 2009 had continued. While only illustrative, rather than a precise estimate of value, it demonstrates the potential value of selective breeding, assuming it will lead to avoiding such losses in the future.

**Figure 10 The cost of the oyster virus outbreak**

$ million production value at FOB price




**Source: NZIER**

## 4.4. Conclusion

The aquaculture industry, specifically oysters and mussels, suffer from significant exposure to disease and climatic conditions. The two case studies illustrate how Cawthron has successfully commercialised innovative research to support the resilience and growth of the aquaculture industry in New Zealand.

The research was initiated by government research grants which Cawthron's unique research capability (scientists and geographical location) led to the development of practical innovation that generates national economic benefits.

Links between industry and Cawthron strengthened as the CAP provided a co-location space for science and the major aquaculture firms in New Zealand.

We provide indicative statistics on the extent of the impact of these research breakthroughs which are significant to the Nelson and New Zealand economies. These research successes provide Cawthron with a strong reputation and credibility that allows the Institute to pursue its growth strategy.