Case Study

SIMA

Key findings

CSIRO's work on the Sistema Integrado de Manejo para la Acuícultura (SIMA) project in Chile has the potential to improve the environmental, social and economic sustainability of the Chilean salmon farming industry. The information dashboard developed as part of this project will allow for tailored reporting of current state of the industry and environment, more rapid responses to incidents and access to operational scale environmental information that can be used to define a sustainable carrying capacity that minimises disease risks. The improved access to information that regulators and aquaculture businesses will have as a result of the SIMA project is expected to lead to more accurate and rapid disease detection and hence more timely and better targeted treatment in the event of a disease outbreak.

The access to better and more timely information should also help the Chilean aquaculture industry to maintain and strengthen its license to operate.

CSIRO is developing a business case for a fee for service offering to assist Chilean firms to access and analyse the data that will become available once the SIMA project is completed. There are currently discussions underway for a project that would allow CSIRO to apply its learnings from the SIMA project to the Tasmanian salmon industry.

Innovation impact

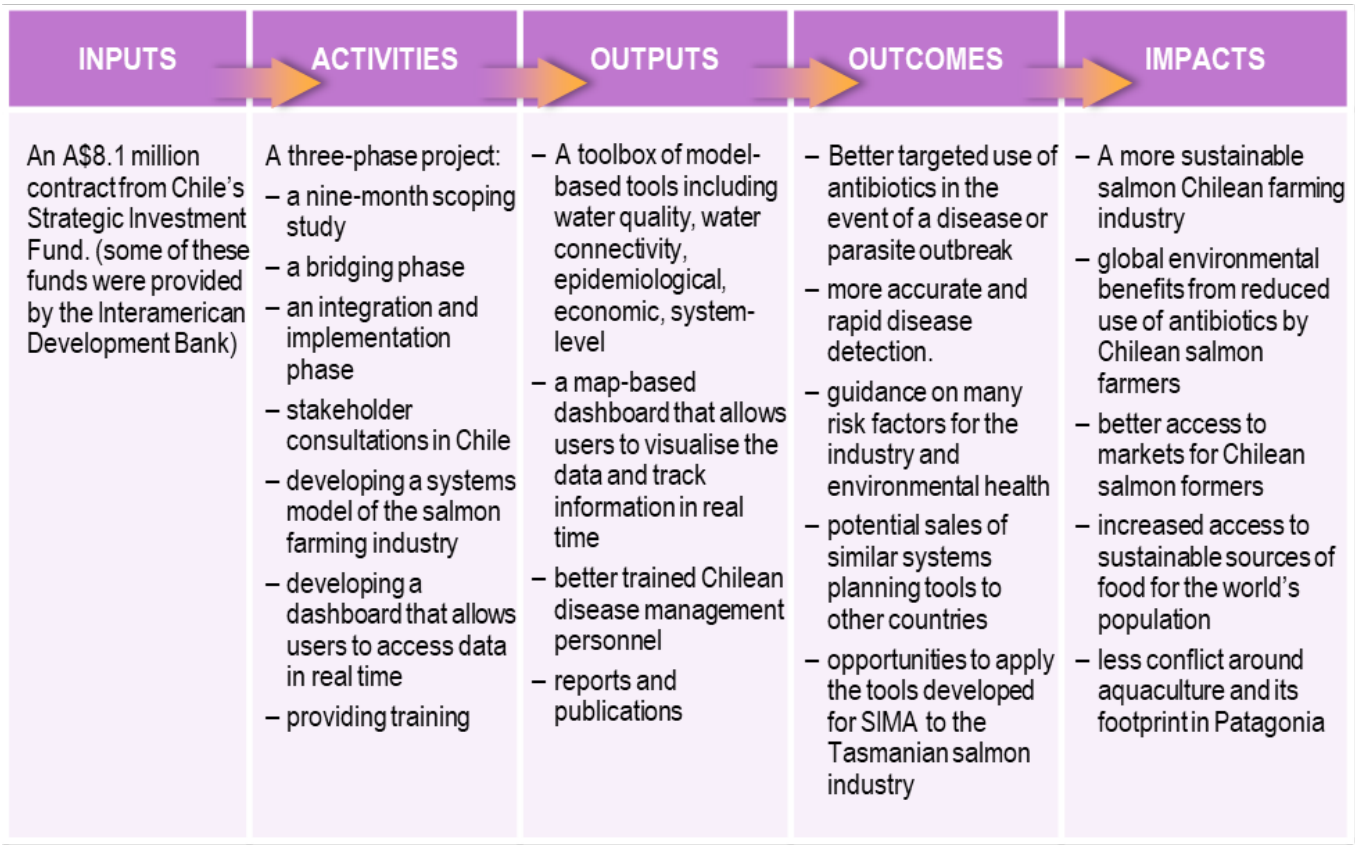
Real time information systems are revolutionising the aquaculture industry. On-farm management is increasingly automated, but regulatory systems were struggling to keep pace. The SIMA dashboard steps up to that challenge and providing Chilean aquaculture with a technological system to match or surpass what is being done in Norway or Scotland. In addition, it is providing a structured risk assessment scheme that can maximise planning potential and make best use of their diverse data streams.

The multi-tiered risk framework developed by CSIRO for SIMA is the first ever use of such an approach for aquaculture. The approach is now gaining attention from the Australian industry and international certification bodies such as the Aquaculture Stewardship Council. The UN has rated the Atlantis model (which formed a conceptual basis for the risk framework used for the SIMA project) as the best ecosystem model in the world for the evaluation of strategic development and management options for marine industries – especially fisheries and aquaculture.

The mathematical techniques developed for epidemiological modelling as part of the SIMA project are innovative. CSIRO is the first research organisation to use an applied mathematician to model disease spread in this way. This approach has the potential to revolutionise epidemiological modelling by moving away from classical static assumptions to a more realistic and data anchored approach.

This case study uses the evaluation framework outlined in the CSIRO Impact Evaluation Guide. The results of applying that framework in the case study into CSIRO's engagement in O&A work are summarised in **Figure 1**.

FIGURE 1 SIMA CASE STUDY – IMPACT FRAMEWORK DIAGRAM



SOURCE: ACIL ALLEN

1. Purpose and audience for case study

This case study describes the economic, environmental and social benefits arising from CSIRO's involvement in the SIMA project.

This evaluation is being undertaken to assess the positive impacts of some of the research by the CSIRO Oceans and Atmosphere (O&A) Business Unit. However, it can also be used to inform a range of other stakeholders. The case study can be read as a standalone report or aggregated with other case studies to substantiate the impact and value of the Oceans and Atmosphere (O&A) Business Unit's activities as a whole relative to the funds invested in these activities.

This information in this case study is provided for accountability, communication and continual improvement purposes. This case study is primarily intended to inform the independent review of the O&A Business Unit. Other audiences for this report may include Members of Parliament, Government Departments, CSIRO and the general public.

2. Background

Chile is the world's second biggest salmon farmer (after Norway). The salmon farming industry in Chile has grown very rapidly. However, the Chilean salmon industry has been through several crises. These are primarily due to disease outbreaks in the

salmon farms (including a major disease crisis in 2008 that threatened the future viability of the industry). These difficulties have had an impact both locally and internationally on the sector's social license to operate.

Currently Chilean salmon gets around two thirds the price of Norwegian salmon due to a perceived lack of quality. The main reason for this view is the large amount of antibiotics used by Chilean salmon farmers. Chile uses 600 times more antibiotics than Norway. A major north American supermarket has halted its purchases of Chilean salmon due to its concerns about the amounts of antibiotics found in the salmon. Members of the local communities around the salmon producers are also concerned, with the growing incidence of antibiotic resistant bacterial strains in local hospitals and wildlife.

To ensure the long-term health and prosperity of the aquaculture industry four facets of sustainability (social, economic, environmental, and governance) need to be addressed. Carrying capacity needs to be defined at a regional level and in doing so needs to consider the following factors' impact on the viability of the industry:

— physical (limits on suitable space available)
— production (based on operational details)
— ecological (broader environmental impacts on water quality and the food webs surrounding farms)
— economic (dictates when the industry is profitable)
— social (details when the industry is considered socially acceptable by the broader community).

In 2015, the Ministry of Economy created the Strategic Investment Fund (FIE for its initials in Spanish) to support public agencies, as part of a productivity, innovation and growth agenda. The fisheries regulator, Servicio Nacional de Pesca y Acuicultura (SERNAPESCA) jointly with CSIRO proposed a project entitled "*Integrated health and environmental management system for aquaculture with an ecosystem approach*". That project was ultimately selected and awarded a grant (FIE 2015 – V008).

The project, which was regarded as one of high strategic importance, aimed to strengthen SERNAPESCA's decision-making capabilities to better manage and control diseases affecting Chilean aquaculture and to protect the environment, but also to proactively provide SERNAPESCA with decision support and planning tools to deliver on the multi-faceted aspects of sustainability. The Chilean Minister for Fisheries and the Economy stated that the project's purpose was to improve the global competitiveness of Chilean salmon. CSIRO, as SERNAPESCA's strategic partner, received a specialised consultancy contract. Work on the project commenced in November 2015 and it is due to be completed by the end of December 2018.

Originally the project was expected to be funded by both government and industry. However, the Chilean Government decided to fully fund the project to avoid any potential conflicts of interests with industry since the outputs of the SIMA project could have a role on the enforcement of environmental regulations.

It is worth noting that CSIRO's Chile office had been established for around four years prior to the contract being won. That time was fundamental in laying the groundwork for the winning the contract. This included building relationships and increasing the level of trust in CSIRO's skills and capabilities within the government. That trust was crucial to creating the confidence within the Chilean authorities that was needed to ensure that they would be willing to share sensitive data with an overseas organisation.

Another reason for CSIRO's success in winning this contract was its modelling and informatics capability. CSIRO could demonstrate its capacity to deliver data at large scales, linked to near real time models, via dashboards, as had been done for eReefs (focused on the Great Barrier Reef, Queensland). This capacity meant data of different forms could be easily and rapidly accessed at scales relevant for day-to-day decision making. The other CSIRO capacity of note was the CSIRO developed Atlantis model (see **Box 1**) and the associated marine socioecological systems approaches developed by O&A's Ecosystem Modelling and Risk Assessment Group. This modelling approach is unique in the world in that it takes a full socioecological system lens and applies it quantitatively to marine and coastal systems – representing oceanographic and climate drivers, habitat and food webs, marine users (industrial, recreational, indigenous) across multiple industries, management rules and social / economic / cultural drivers. Systems thinking is not unique to the CSIRO, but its application within a multiple use management context that is predicated on full feedback representation of all aspects of adaptive

management is. The UN has rated the Atlantis model as the world's most innovative and progressive ecosystem modelling tool for the evaluation of strategic development and management options for marine industries – especially fisheries and now extending into aquaculture and other nearshore and marine industries.

BOX 1 THE ATLANTIS ECOSYSTEM MODEL

Atlantis an ecosystem model that considers all parts of marine ecosystems – biophysical, economic and social. Originally focused on the biophysical world and then fisheries it is now being used for multiple purposes, including studying the impact of climate changes. At the core of Atlantis is a deterministic biophysical sub-model, coarsely spatially-resolved in three dimensions, which tracks nutrient flows through the main biological groups in the system. The primary ecological processes modelled are consumption, production, waste production, migration, predation, recruitment, habitat dependency, and mortality.

Atlantis also includes a detailed industry (or exploitation) sub-model. This model deals with the impact of pollution, coastal development and broad-scale environmental factors (e.g. climate change) but was originally focused on the dynamics of fishing fleets. It allows for multiple fleets, each with its own characteristics of gear selectivity, habitat association, targeting, effort allocation and management structures. This typological representation has now been extended to other marine and coastal sectors – such as aquaculture, shipping, mining and coastal land use industries. The exploitation model interacts with the biotic part of the ecosystem, but also supplies 'simulated data' to the sampling and assessment sub-model, which is designed to generate sector dependent and independent data based on the outputs from the biophysical and exploitation sub-models. The 'simulated data' are then fed into assessment models and decision rules are applied that match those used by the real-world management and industry bodies. The output of these assessments are the input to management sub-models, which are typically a set of decision rules and management actions such as: gear restrictions, controls of operation, quotas or stocking limits, spatial and temporal zoning, discarding restrictions, size limits, bycatch mitigation, and biomass and other reporting reference points.

Scenarios using Atlantis provide insight into the benefits and drawbacks associated with different management and development options. It explicitly highlights trade-offs and potentially perverse outcomes that may eventuate from different management or industry strategies. This information can help decision makers plan future development along desirable pathways (meeting sustainability objectives) and restructure management approaches to deliver on legislatively or societally defined ecosystem objectives.

SOURCE: CSIRO

3. Impact Pathway

3.1 Project Inputs

The total funding of the SIMA project was $8.135 million. Funding was provided in three tranches, matching the three phases of the project. The three phases were for:

- scoping of the project ($1.688 million)
- developing the model of the salmon farming model ($1.066 million)
- delivery of the model to the Chileans and training in its use ($5.381 million).

The funding for the SIMA project was entirely provided by Chile. No other party (including CSIRO) provided any cash or in-kind support for the work. ACIL Allen has sought to allocate the funding provided by Chile across the duration of the project (see **Table 1)**.

TABLE 1 SUPPORT FOR SIMA PROJECT

Contributor/type of support	2015-16	2016-17	2017-18	2018-19
Cash				
SENAPESCA (Chile)	$1,687,476	$2,149,000	$2,149,000	$2,149,000

The project was initially proposed as a partnership between the government and the salmon farming industry in Chile. In fact, the private sector was the primary driver for the project as they saw it as a means of getting better access to data they were all providing to the government and for that data to be in a more useful form – as actionable intelligence rather than raw unchecked data streams from limited spatial domains and with significant time delays (for data processing and handling). However, the government formed the view that there would be the potential for an actual or perceived conflict of interest if the industry funded the project, and it therefore decided to provide all the funding for the project.

The overarching aim of the project was to transform and boost the national aquaculture sector of Chile, through the implementation of a public-good Integrated Ecosystem-based Sanitary and Environmental Management System.

3.2 Project activities

A key first step in this project a nine-month scoping study (completed in September 2016). The aim of the scoping study was to ensure that the questions that the project was seeking to answer were the right ones. This stage of the project consisted of an extensive program of stakeholder engagement workshops. CSIRO researchers visited Chile and met with salmon, mussel and algae farmers. They also met with the local representatives of NGOs (such as the World Wildlife Fund), the local population (including indigenous representatives), regulatory bodies and government departments.

The aim of the consultations was to further build the level of trust and confidence that stakeholders had in CSIRO. This was essential for CSIRO to gain access to the data that was needed to populate the CSIRO models. The data collected was held in a wide range of formats (on-line, hard copy and electronic formats). The different sources of data had to be converted into a common format, so they could be integrated into a comprehensive model of the Chilean salmon fishing system that was being developed by CSIRO.

Delivery of the project was managed through five separate technical work packages. The first of these developed systems models for risk assessment. A purpose-built systems model was constructed from several sub-models including economic (micro- and macro-), epidemiological, production, connectivity, food web, benthic habitat, land use, human demographic, water quality and aquaculture industry (salmon, mussels, algae) models, as well as models of the operation of other adjacent industries (such as forestry, agriculture, shipping, service industries). The risk framework and systems model will be used to provide advice on the many forms of aquaculture carrying capacity. The risk framework was developed from a CSIRO tiered-risk assessment approach originally developed for fisheries, this is the first ever use of such an approach for aquaculture and has involved providing a means for SERNAPESCA to use regularly gathered environmental and production data to rate the risk level per farm and who that may be modified if farming operations are modified or management regulations adjusted. The final stage of the risk framework was the systems model which was based on CSIRO's Atlantis modelling conceptual framework. CSIRO had to adapt both the risk and modelling approaches to ensure that they were tailored to the factors that Chile was concerned about. CSIRO also had to test and validate the approaches by collecting in-situ data.

The risk and modelling tools scales from farm to regional levels and the model can be used in at least three modes:

— routine operations and reporting
— scenario assessment for planning
— forecasting of environmental conditions or disease spread.

The systems modelling work is innovative in a number of ways – first in the scope of the model (the scale and number of interacting components included); second the way in which different modelling methods were joined together to form the overall model (extending far beyond what had been achieved with the Atlantis approach elsewhere); and lastly how it tackled the representation of disease and farm operations. The mathematical techniques developed for this component of the systems model by CSIRO have been shown to be more effective and quicker to use than standard epidemiological models.

The second work package delivered mechanisms for *data management, integration and visualisation.* This will provide SERNAPESCA and other end-users with integrated assessment, reporting and visualisation products, a series of data systems and services were built upon existing computation infrastructure to draw together and present existing and new information

drawn from structured and unstructured data sources.

The third work package produced a means for *environmental monitoring and modelling*. The package developed improved environmental monitoring methodologies and a coupled hydrodynamic and biogeochemical model that was implemented over the northern, most intensively used, area of Patagonian coastal waters. This will provide tactical marine intelligence for understanding currents and evolving conditions, the most relevant management options, and how to minimise economic loss and/or environmental degradation.

A fourth work package focussed on *sanitary diagnostics and biosecurity*. This package delivered training and capacity building for the agencies' monitoring, sanitary diagnostics and biosecurity standards, which will enhance Chile's capacity to perform aquatic animal disease diagnosis, specifically virus isolation, and use molecular diagnostics for the detection and identification of significant pathogens of major aquatic animals cultured in Chile.

A fifth work package managed the overall coordination of the project, the interface with the client and other stakeholders, reporting finance and communication.

CSIRO is also providing training to government agencies in the use of the systems model that they have built. In addition, animal health scientists from CSIRO travelled to Chile to provide training on disease management and tracking.

3.3 Project outputs

The SIMA project will deliver a comprehensive, interoperable information system and modelling platform that has been designed and developed to provide the Chilean Aquaculture industry, other stakeholders and governmental agencies with access to improved environmental intelligence allowing them to make better informed strategic and operational decisions. The information dashboard will allow for tailored (and rapid) reporting of the current state of the industry and environment, rapid incident response (via a connectivity modelling dispersal tool showing downstream footprints), and access to operational scale environmental information that can be used to define sustainable carrying capacity that minimises disease risks. This dashboard is similar to the one that was developed for the eReefs project. The dashboard enables users to access data about the salmon farms in real time. The dashboard includes visualisation, reporting and risk-based decision support tools. These tools allow users to model the implications of any decisions or actions that they may be considering implementing.

The SIMA modelling suite (via the systems model) also supplies information that shows how aquaculture can be supported within the system sustainably and with least conflict with other users – this is important as Chile does not have the same history of planning and zoning laws as Australia and there is significant potential for quite violent protests when tensions boil over. The systems model developed by CSIRO includes modules that incorporate the various users of the system and their complex relationships and responses – for example between: fish behaviour; land use; local populations; transient and resident labour force; benthic habitats; water quality; aquaculture production (salmon, mussels, algae); and other industries (forestry, agriculture, shipping, service industries).

Finally, the capacity building undertaken during SIMA – via the training of SERNAPESCA staff and the provision of sanitary diagnostics and biosecurity training – has increased Chile's capacity to avert future industry collapse due to emerging disease.

Publications

To date this project has resulted in the publication (or submission) of the of the following reports:

- A, Steven, et. al., *FIE V008 - Integrated Ecosystem-based Sanitary and Environmental Management System for Aquaculture – Final Scoping Report*, CSIRO, September 2016
- A, Steven, et. al., FIE V008 - *Informe de avance Consultoría Programa Sistema Integrado de Gestión Sanitaria y Ambiental de la Acuicultura con Enfoque Ecosistémico*, Etapa 1 [FIE V008 – Progress report Consultancy Program Integrated System of Sanitary and Environmental Management of Aquaculture with Ecosystem Approach, Stage 1], Report to SERNAPESCA, December 2016

- A, Steven, et. al., FIE V008 - *Integrated Ecosystem-based Sanitary and Environmental Management System for Aquaculture*, Report to SERNAPESCA, November 2017
- A. Steven et. al., *SIMA Austral: An operational information system for managing the Chilean Aquaculture Industry with international application*, submitted to the Journal of Operational Oceanography in August 2018.

A final report on the project is expected to be submitted to the client (SERNAPESCA) by the end of 2018. Further journal articles (e.g. on the epidemiological, economic and system modelling components; and the risk framework) are also in preparation.

Patents

There have been no patents awarded as a result of this project.

Awards

There have been no awards made in relation to this project as yet. However, ACIL Allen notes that the UN has rated the Atlantis model as the best ecosystem model in the world for the evaluation of strategic development and management options for marine industries – especially fisheries and aquaculture.

Innovation/commercialisation

There are plans in preparation by CSIRO to offer services to Chilean businesses in the aquaculture sector. A business case is currently being developed for a fee for service offering that would assist Chilean firms that want to access and analyse the data that will become available once the project is completed and the dashboard is operational.

If successful, this will generate an income stream for CSIRO. However, at this stage the business plan is not sufficiently advanced to be able to project potential earnings.

The mathematical techniques developed for epidemiological modelling is an innovative approach. CSIRO is the first research organisation to use an applied mathematician to model disease spread in this way. This approach has the potential to revolutionise epidemiological modelling by moving away from classical static assumptions to a more realistic and data anchored approach.

The multi-tiered-risk risk framework developed by CSIRO for SIMA is the first ever use of such an approach for aquaculture. It is now gaining attention from the Australian industry and international certification bodies such as the Aquaculture Stewardship Council.

3.4 Project Outcomes

At this time the project is still to be completed. Once it has been concluded the tools that it will provide have the potential to improve the environmental, social and economic sustainability of the Chilean salmon farming industry.

For example, as part of this project, CSIRO also developed an economic model of a fish farm that will be integrated into the systems model but could also be used as a free-standing model. The economic model draws on production data, mortality rates and treatment data to enable farmers to gain a better understanding of treatment costs and benefits. This coupled with other information available from the systems model will allow Chile to better target its use of antibiotics in the event of a disease or parasite outbreak. In addition, the connectivity model allows for the footprint of a potential outbreak to be appreciated ahead of time, meaning unnecessary treatment of farms outside the path of dispersal of the disease will no longer be required. In the past regulators/farmers tended to adopt a broad scale response to any outbreaks. Now only those farms at risk from the outbreak (based on the water connectivity model) would need to apply antibiotics.

The improved access to information because of the SIMA project is expected to lead to more accurate and rapid disease detection (earlier detection, mitigation and control) and more timely and better targeted treatment being applied. This will be an important outcome as the Chilean salmon industry has been through several crises, primarily due to disease outbreaks in the salmon farms, including a serious sanitary crisis in the industry in 2008. As a result, 20,000 people lost their jobs and some $2 billion in export sales were lost. The outcomes of this project would facilitate early detection of similar problems in the future and help to prevent a reoccurrence of the 2008 outbreak

3.5 Adoption

While this project is yet to be completed (it is due to be finalised by the end of 2018), the very high priority assigned to it by Chile gives strong grounds for expecting that adoption will be relatively rapid. The likelihood that this will be the case is further enhanced by the extensive training that CSIRO is delivering to Chilean users of the system model and the dashboard interface.

CSIRO took a conscious decision to try to develop and apply the Atlantis derived socioecological systems modelling approach in Chile and to develop a coastal (aquaculture) oriented information system. The reason for this were fourfold, namely:

- the information system contains components that would be common needs in any country, providing a useful architecture for use elsewhere
- the Chilean work provided the opportunity to test the application of the risk and modelling approaches in a salmon aquaculture industry that was very similar to the one that operates in Australia. The Chilean salmon farming industry faces many of the same issues as the Australian industry
- the industry in Chile has scale and being able to demonstrate that CSIRO can help the industry to address its problems sends a very strong message about the skills and capabilities that CSIRO can bring to the table
- all the global players in the salmon farming industry are active in Chile. By demonstrating the its capabilities in this are CSIRO can potentially gain access to a much larger market for these kinds of services. Norway has already sent some of its scientists to work with CSIRO researchers and that country is a potential customer for a similar aquaculture oriented systems model (particularly as they have already picked up the approach for fisheries in the Barents and Norwegian Seas).

3.6 Impacts

Most of the benefits from this project flow to Chile because the project will help them to create a more socially, environmentally and economically sustainable salmon farming industry.

There is also a potential global environmental benefit to the extent that the SIMA project enables Chile to reduce the use of antibiotics by their salmon farmers.

It is too early to be able to quantify the benefits of this project. However, a more sustainable salmon Chilean farming industry could provide considerable benefits. The 2008 disease outbreak illustrated the potential scale of the avoided losses if such outbreaks could be prevented. There is also the potential for Chile to increase the size of its market and to gain a higher price for its salmon if it can reduce the amount of antibiotics used in its fish farming operations.

3.7 Potential future impacts

There have been several expressions of interest from other countries in doing similar projects. For example, Norway does not have any similar system planning tools and sees this as a way of assessing the risks associated with cumulative impacts of salmon farming.

There is interest in applying the learnings from the SIMA project to the Tasmanian salmon industry. As can be seen from **Box 2**, the Tasmanian salmonid industry is a significant contributor to the State's economy and a major source of employment. Any

collapse of the industry, similar to what occurred in Chile, would have significant negative consequences for Tasmania.

BOX 2 THE ECONOMIC CONTRIBUTION OF THE TASMANIAN SALMONID INDUSTRY

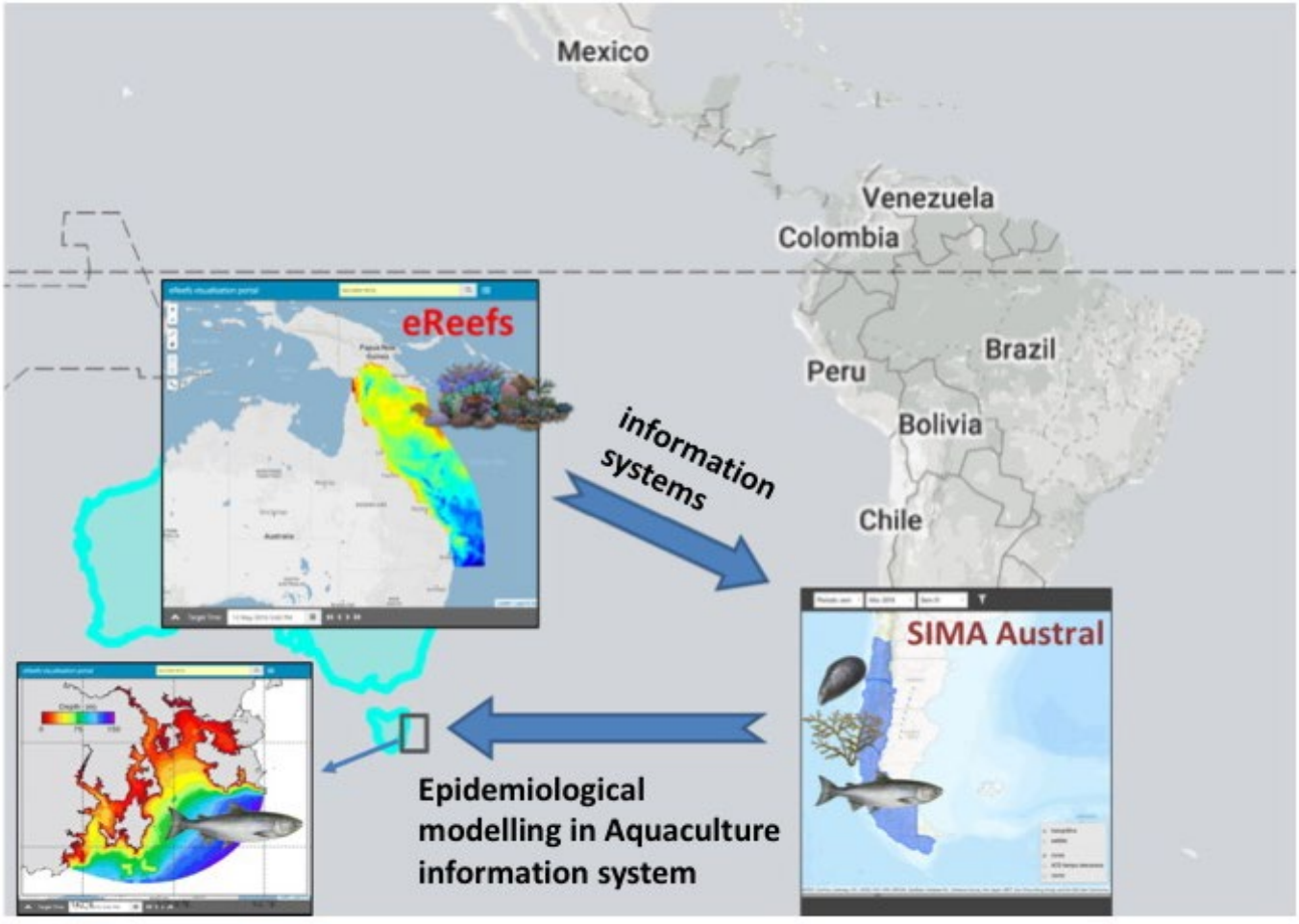
In 2015 a joint study by KPMG and the University of Queensland examined the economic contribution of the salmonid (Atlantic salmon and Ocean trout) aquaculture industry to the Tasmanian economy. Their analysis found that the industry in Tasmania generates the following results per annum:

- average annual Turnover or Gross Output of $1.12 billion (the total value of industry production)
- annual value added or net additions to Gross State Product (GSP) of $625.9 million
- annual gain to factor income of $366.8 million (income paid to individuals and firms), and
- approximately 2,786 FTE jobs (full time positions employed in, or supported by the industry).

SOURCE: HTTPS://WWW.TSGA.COM.AU/ ACCESSED OCTOBER 2018

The experience gained in Chile will enable the CSIRO to more quickly build similar models for Australian salmon farms. CSIRO has already been awarded a $3 million project to build a water quality model for Storm Bay. A proposal to build a connectivity model for the same region is currently being considered. See **Figure 2**.

FIGURE 2 ILLUSTRATION OF HOW BENEFITS FLOW FROM AUSTRALIA TO CHILE AND BACK TO TASMANIA



SOURCE: CSIRO

CSIRO may also be able to build a business providing services to Chilean firms in the aquaculture sector and to support regional planning or the sustainable development of other industries.

A business case is currently being developed for a fee for service offering that would assist Chilean firms that want to access and analyse the data that will become available once the project is completed and the dashboard is operational.

In addition, business cases are being developed to provide information systems to support regional planning. The development of such plans was recently mandated for all regions (states) in Chile and there is a keen interest in any group who can provide a clear set of tools to assist those processes.

Chilean fisheries are also severely degraded and in desperate need of rebuilding. There has been some low level (mainly capacity building) engagement with Chilean fisheries agencies thus far, but there is interest in extending this to information systems that can assist near real time reporting for the purposes of compliance and tracking the provenance of landings

4. Counterfactual and Attribution

4.1 Counterfactual

SERNAPESCA, with CSIRO as its strategic partner, won this project in an open tender that sought solutions to address the challenges facing Chilean aquaculture. CSIRO's proposal was selected because it took a systems wide approach to risk management. While there might be other competitors, it is unlikely that any other organisation would have been able to bring together the necessary breadth of expertise from within a single organisation.

There were two main reasons why CSIRO won the contract to undertake this project, namely:

- The level of engagement and trust in CSIRO and the credibility that had been established. This meant that CSIRO was asked by SERNAPESCA to be its strategic partner in bidding for the project.
- The fact that CSIRO had proven capacity to deliver informatics platforms at large scales, and systems models such as the Atlantis model is unique in the world and that CSIRO also had world leading capacity in biosecurity - the level 4 biosafety facilities available at CSIRO's Australian Animal Health Laboratory have no equivalent in Chile providing a capacity to advise on exotic animal disease diagnosis that was beyond what was available in Chile.

Engaging with CSIRO ensured that Chile had access to world leading science and research.

4.2 Attribution

This work was conducted entirely by CSIRO and it is difficult to see how this project could have been completed without CSIRO's skills and expertise in this area. The funding for the project was provided entirely by Chile. Attribution should also be made Chilean government agencies, in particular SERNAPESCA who selected CSIRO as its strategic partner, but also provided information and guidance towards the completion of the project. For this reason, ACIL Allen proposes that the benefits associated with this work should be split evenly between CSIRO and SERNAPESCA.

We note that having people on the ground in the CSIRO Chile office has been crucial to the success of the project.

5. Evaluating the Impacts

The benefits to Australia from the SIMA project include:

- Further developing CSIRO's R&D capability to help solve Australia's future challenges in the aquaculture industry and in salmon production in particular. The IP created by SIMA will be used back in Australia.
- The breath, scale and complexity of the issues faced by Chilean aquaculture has offered a unique opportunity for CSIRO's scientific expertise and capability to evolve to a world-class level. The size of the Australian salmon industry would not have allowed this level of investment to occur.
- A potential source of new revenue for Australia from global partners (such as governments, Development Banks and aquaculture businesses).

The project also demonstrates the benefits that can flow from CSIRO's offices abroad. It is unlikely that these funds would have been available to CSIRO in the absence of the Chile office. The annual costs of the Chilean office are around $1.4 million. The O&A business unit covers 25 per cent of that. The remaining 75 per cent is covered by three other business units (Minerals, Land & Water and Data61) plus CSIRO Global. The aim is for CSIRO's support for the office in Chile to return a minimum $1.50 (contract research back to Australia) for every $1 invested. However, in the case of the SIMA project the return has been closer to $8 for every $1 invested (by the O&A business unit) in the Chilean office. In other words, the investment by O&A has delivered a 'return on investment' that was significantly above expectations.

5.1 Cost-Benefit Analysis

It is not possible to do a conventional CBA for the SIMA project. There are two main reasons for this. One is that the project will only be completed at the end of 2018 and it is therefore too early to see what benefits the project will deliver. The other reason is that when the project begins to deliver benefits they will flow primarily to the Chilean aquaculture industry.

Nonetheless, the support that the O&A business unit has provided to the CSIRO's Chile office was crucial in winning the contract for the SIMA project. Furthermore, the expertise that CSIRO has developed as a result will be important if (or when) the CSIRO is asked to do similar work for the Tasmania salmon farming industry. ACIL Allen understands that CSIRO has already been awarded a $3 million project to build a water quality model for Storm Bay and a proposal to build a connectivity model for the same region is currently being considered There is also considerable scope for CSIRO to earn revenue by provide similar services to aquaculture businesses in Chile and around the world.

As can be seen from **Box 2,** the salmonid farming industry in Australia is an important one and having access to the science that can help protect the addition of over $600 million to Tasmania's Gross State Product (GSP) provides a valuable insurance for the industry and Tasmania.

5.2 Externalities or other flow-on effects on non-users

There will likely be a range of benefits to non-users of this research project. This could include more resilient communities as a result of more sustainable and profitable aquaculture operations and better environmental outcomes as a result of lower, better targeted, use of antibiotics.