RESEARCH AND DEVELOPMENT

- Research into all aspects of our operations is a cornerstone of our business and it is through ongoing investment that we remain at the forefront of our industry internationally. Research is and always has been an important intellectual partnership between Huon and external research providers.
- Huon employs over 30 university graduates including PhDs, marine biologists, aquaculture and veterinary graduates and has collaborated with over 17 universities and research institutes across Australia.
- The Tasmanian salmonid industry developed a strong research and development (R&D) culture right from its very inception. Salmon Enterprises of Tasmania (SALTAS) funded R&D during the first 10 years of the industry through a 25% levy on the sale of smolt and the operation of a model sea farm at Dover. The R&D undertaken by the salmon industry has resulted in many hundreds of published papers in scientific literature, reports and seminar/conference proceedings.
- Huon has spent in the order of $250 million on R&D since 2012 alone.
- Through an MOU with the national Fisheries Research and Development Corporation (FRDC), the salmon industry was one of few aquaculture and wild fishery industries in Australia that committed its full 0.25% Gross Value of Product (GVP) to research under the Federal Research and Development Corporation system.
- The FRDC and salmonid farming industry have been investing in research on salmon farming since the early 90's ($46 million worth of research across some 120 projects). In that same period, there have been more than 260 FRDC collaborative projects (includes salmon industry partnership agreement (IPA) projects) which have been relevant to the Tasmanian salmon industry totalling over $130 million of investment by FRDC, industry and third parties such as universities, CSIRO etc.
- The Tasmanian salmon industry has been involved in four Cooperative Research Centres (CRCs) since its inception - Aquaculture CRC, Sustainable Aquaculture of Finfish CRC (Aquafin CRC), Seafood CRC and the Blue Economy CRC.
- Huon also undertakes a large number of internal R&D projects providing results that underpin scientifically-based decision-making in commercial operations which enables Huon to remain at the leading edge of salmonid farming expertise and technology.
    - Huon operates a dedicated trial unit comprising thirty-five pens at its Hideaway Bay lease and three dedicated trial units (a total of 51 tanks variously capable of holding 0.2 gram to 15 kg size fish) located at freshwater hatchery operations.
- Huon is a one-third partner in the Experimental Aquaculture Facility (EAF) located at the University of Tasmania's Taroona site.
- Huon has been a strong supporter and funding contributor to the Centre of Excellence for Aquatic Animal Health and Vaccines located in Launceston. This facility is critical in providing research and development of vaccines and diagnostic tests for the salmon industry.

HUON'S INVESTMENT IN R&D

Huon has expended considerable funds on R&D over the past 30 years. Since 2012 alone, Huon has spent in the order of $250 million on R&D projects. Huon's research and development portfolio is diverse and involves collaboration with a number of external organisations including:

- CSIRO
- University of Tasmania (UTAS)
- Institute of Marine and Antarctic Studies (IMAS)
- Centre of Excellence for Aquatic Animal Health and Vaccines (Tasmanian DPIPWE)
- University of Queensland
- Griffith University
- James Cook University
- University of Melbourne
- University of Victoria
- Flinders University
- Murdoch University
- Deakin University
- University of Adelaide
- University of Technology Sydney
- University of Newcastle
- Port Stephens Fisheries Institute
- Australian Centre for Applied Aquaculture Research

In addition to recognised research organisations, Huon also undertakes an extensive amount of research and development and/or collaboration with major feed and equipment suppliers. Examples include:

- Huon's major feed suppliers (Biomar and Skretting) are both large global aquaculture feed companies. Companies like Biomar and Skretting have extensive R&D networks across the world, interacting with research organisations in many countries providing Huon with ready access to the latest results from feed R&D globally to improve fish performance and health.
- Huon also collaborates directly with many overseas R&D organisations on a range of topics including for example:
    - University of Stirling (Scotland)
    - NOFIMA, SINTEF, MATRE, Norwegian Veterinary Institute (Norway)
    - Fish Vet Group, Vet-Aqua International (Global)

Huon is recognised internationally for leading innovation in salmon farming and regularly hosts visits from overseas farmers and suppliers, exchanging information on the latest technology and innovation. Some key examples include:

- Wellboat design in collaboration with Solvtrans;
- Underwater lighting regimes in collaboration with Planet Lighting;
- Recirculation hatcheries in collaboration with Billund; and
- World-leading fortress pen designs and feeding software.

HUON TRIAL FACILITIES

Huon undertakes routine and detailed comparative assessments of commercial pens and fish performance as part of its commercial operations. The company also operates a number of marine and freshwater trial units that enable extensive ongoing testing of research topics including health, diet and fish performance. The results from these trials provide a scientifically-sound basis for ongoing decision-making in commercial operations enabling Huon to remain at the leading edge of salmon farming expertise and technology.

HUON MARINE TRIAL UNITS

Huon has three dedicated marine trial units located at its Hideaway Bay lease near Dover. These facilities comprise a total of 35 specialised pens.

The R Pens unit consists of 16 x 20 metre circumference pens located within a perimeter predator net and is used for comparing the performance (i.e. growth, feed conversion and health) of commercially available diets. Trials are undertaken in these pens every winter and every summer so are therefore in operation 12 months of the year. These benchmarking trials are undertaken in conjunction with several local and overseas feed companies to ensure Huon is using the best available commercial feeds.

The T Pens unit consists of 18 x 5 metre square pens located within a perimeter predator net and is used for testing feed ingredients or feed formulations that could improve the health and performance of commercially available diets. Trials are undertaken in these pens every winter and every summer so are therefore in operation 12 months of the year. These trials are normally undertaken in conjunction with Huon's major feed supplier to ensure Huon is using the best available commercial feeds.

The dedicated trial pen unit at Huon's Hideaway Bay site forms a key facility in the industry's Selective Breeding Program.

HUON FRESHWATER TRIAL FACILITIES

Huon also has three dedicated trials units in freshwater operations that enable replicated trials to be run in-house in controlled conditions in 0.2 gram to 15 kg fish. Most trials tend to be run in two main subject areas:

- Diets and health often in collaborations with feed companies
- Brood stock rearing conditions and how these affect spawning timing and success and subsequent egg production and survival.

The Springfield Hatchery Feed Trial Unit is a freshwater recirculation facility with light, photoperiod, flow and oxygen control. It consists of 15 x 0.25 m^3 tanks for diet trials. These tanks are suitable for fish from 0.2 to 5.0 grams.

The New Norfolk Trial Unit is a freshwater recirculation facility with light, photoperiod, flow and oxygen control. It consists of 4 x 10m^3 tanks for brood stock trials suitable for fish from 50 grams to > 15 kg and 12 x 2 m^3 tanks for diet trials suitable for fish from 20 grams to 1.0 kg.

The Bagdad Trial Unit is a freshwater recirculation facility with light, photoperiod, flow and oxygen control. It consists of 20 x 8 m^3 tanks for production trials with brood stock. These tanks are suitable for fish from 20 grams to 15 kg.

EXPERIMENTAL AQUACULTURE FACILITY

The Experimental Aquaculture Facility (EAF) was jointly funded by the University of Tasmania, Huon, Skretting Australia, and the Federal and State Governments. The $6.5 million facility was constructed at the University's Taroona site. Huon and Skretting have a Partnership Agreement with the University to access the facility for 10 years in rotating 6-month blocks. The facility comprises three main components, including:

- 12 x 7000 L outside tanks
- 12 x 2500 L inside tanks with individual recirculation systems
- Two 13,000 L intermediate tanks that can hold fish for distribution to the other systems as required.

The EAF provides an international standard research facility for undertaking nutrition and amoebic gill disease (AGD) research under very controlled conditions and with the ability to manipulate temperature between 16 - 22^{o}C. The facility also enables research to be undertaken in salmon right up to harvest size.

CENTRE OF EXCELLENCE FOR ANIMAL HEALTH AND VACCINES

The Centre of Excellence for Aquatic Animal Health and Vaccines (CEAAHV) is a tri-partite arrangement between the salmon industry, DPIPWE Biosecurity Tasmania and FRDC. Each partner derives significant benefit from the CEAAHV activities that they have commissioned. The specialised facilities are the result of co-investment by the three partners in 2013.

Establishment of the CEAAHV was key to meeting the salmon industry's need for solutions to known and new disease threats.

The resources available to the CEAAHV are highly specialised to meet the need for developing bacterial and viral vaccines. The CEAAHV operates a five-room, 60-tank biosecure fish facility, which is used for evaluating prototype vaccines, development of infection challenge models and assessing family lines from the Industry Selective Breeding Program for disease resistance. The laboratory facilities include a dedicated fermenter system for developing prototype vaccines, a tissue culture laboratory, virology laboratory, molecular biology and a general laboratory for development of vaccine antigens and vaccine formulation.

The CEAAHV is staffed by a high-performing group of scientists with unique expertise in salmonid diseases as well as experience in the development and commercialisation of vaccines for fish diseases. There is no other organisation of its type in Australia.

SALMON ENTERPRISES OF TASMANIA (SALTAS)

At the inception of the Tasmanian salmonid farming industry, Salmon Enterprise of Tasmania (SALTAS) was a cooperative company set up by the Tasmanian Government under the Saltwater Salmonid Culture Act 1985. SALTAS was 51% owned by the Tasmanian government and 49% owned by Tasmanian salmon farming companies. SALTAS had a monopoly on the production of smolt for the first ten years of the industry. It also funded research and development during this period through a 25% levy on the sale of smolt and the operation of a model sea farm at Dover. Research funding exceeded $0.5 million pa and was directed at improving productivity of marine farms in four key areas – propagation, health, nutrition and production systems.

Research and development was coordinated during the first ten years of the industry by SALTAS which ran regular scientific and industry meetings and provided a facilitation role beyond their own research program.

Since the end of SALTAS's monopoly on smolt production, there have been a number of mechanisms by which salmon industry R&D has been promoted, facilitated and managed. These include:

- Tasmanian Salmonid Growers Association (TSGA);
- Fisheries Research and Development Corporation (FRDC);
- Four major Cooperative Research Centres (CRCs); and
- Extensive internal R&D undertaken by Huon in collaboration with a wide range of R&D providers.

TASMANIAN SALMONID INDUSTRY ASSOCIATION (TSGA)

In 2000, the TSGA appointed its first full-time executive officer. Through a MOU with the Fisheries Research and Development Corporation (FRDC), the salmon industry was one of the few aquaculture or wild fishery industries in Australia that committed its full 0.25% of GVP contribution to research under the Federal Research and Development Corporation system. The MOU aimed to provide greater certainty of the intent in relation to the planning, funding and managing of R&D and the adoption and commercialisation of results.

FISHERIES RESEARCH AND DEVELOPMENT CORPORATION (FRDC)

The FRDC is one of 15 RDCs covering the main agricultural industries in Australia. RDCs bring industry and researchers together to share funding and develop strategic directions that provide industry with innovative and productive tools to compete in global markets. The Rural Research and Development Corporation model of partnerships between industry and government has been a vital element in the success of Australia's R&D effort. In the agriculture, fisheries and forestry sectors, R&D has helped Australian agriculture double its productivity over the past 25 years. The Council of Rural Research and Development Corporation Chairs is a forum for ensuring that the RDC model continues to contribute to a sustainable and profitable Australian agricultural sector. In 2017-18, the 15 Rural Research and Development Corporations invested around $750 million in research, development and extension to improve the profitability and sustainability of rural industries and communities. The funding is a combination of levies on production paid by producers, and contributions from government.

As managers and stewards of this money on behalf of government and industry, it is imperative that the RDCs are fully accountable and transparent for expenditure, and demonstrate the impact and performance of the work they do. In 2016 the Council of Rural RDCs commissioned Agtrans Research and Consulting, AgEconPLus Consulting and EconSearch to review the completed evaluations and generate an aggregated analysis of the results. The research report released in 2018 showed that for every dollar invested by RDCs in projects, there was a return to the community of $11.

FRDC is a co-funded partnership between its two stakeholders, the Australian Government and the fishing and aquaculture sectors. It was formed as a statutory corporation in 1991 and is responsible to the Federal Minister of Agriculture and Water Resources. FRDC's primary revenue source is based on:

- The Australian Government providing unmatched funds equivalent to 0.50% of the average gross value of Australian fisheries and aquaculture production (AGVP) for the current year plus the two preceding years.
- The fishing and aquaculture industry providing contributions
- The Australian Government will then match the amount contributed by industry up to a maximum of 0.25% of the AGVP.

Industry Partnership Agreements (IPAs) are developed between the FRDC and each sector body to manage a suite of sectoral projects over a specified time period against an agreed industry strategic plan. The Tasmanian salmon industry in one of 11 wild fisheries and aquaculture industry partners including sectors such as prawns, southern bluefin tuna, barramundi, pearls, abalone and rock lobster.

COOPERATIVE RESEARCH CENTRES (CRC)

The Tasmanian salmon industry has been involved in four Cooperative Research Centres (CRCs) since its inception: Aquaculture CRC, Aquafin CRC, Seafood CRC and the Blue Economy CRC.

The Commonwealth Government's CRC programme (launched in 1990) supports collaboration between researchers, industries, communities and governments to solve major challenges facing Australia, many of which are global challenges. CRCs commonly have dozens of participating organisations including universities and research institutions, businesses ranging from multinational corporations to small and medium enterprises, governments at national, state and local levels, international partners, not-for-profit organisations and industry and community associations.

Since the commencement of the program in 1991, 200 CRCs have been funded with the Australian Government committed more than $3.7 billion in funding. Participants in CRCs have committed a further $11.7 billion in cash and in-kind contributions.

THE AQUACULTURE CRC

The Aquaculture CRC started in 1994 and operated for seven years. It was a major research provider to the salmon industry investing > $1.8 million in the salmon sector. The CRC supported research projects in five categories - disease identification and control (44%), bio-fouling (28%), product quality and post-handling technology (18%), hatchery (7%) and diet development (3%).

The Aquaculture CRC comprised 13 participating research organisations and 19 industry participants. It was exceptional among CRCs at the time for the size and diversity of its network of cooperating researchers. In addition to the formal participants, about 30 other bodies became collaborators in specific research projects. The great majority of these were industry companies and associations.

The Aquaculture CRC promoted cooperation across Australian aquaculture research, provided research opportunities for aquaculture scientists and graduate students, offered access to new technology and expert advice, and delivered the benefits of new technology and research to the aquaculture industry.

Its objectives were:

- to create a world-class research centre in aquaculture with strong representation from industry in which research programs are directed at industry needs, and to provide a focus for a coordinated national research strategy for Australian aquaculture;
- to undertake high quality research in areas of importance to Australia, Australian industry and the community to provide the technology base for the sustainable development of aquaculture industries which are internationally competitive while being environmentally acceptable;
- to provide high quality postgraduate research training in aquaculture with a focus on health, nutrition, reproduction, product technology and environmental management;
- to increase the skills of persons already working in aquaculture at technical and professional levels;
- to commercialise Centre Intellectual Property and Project Intellectual Property in such a manner as to ensure that the maximum benefit accrues to Australia, including Australian industry, the Australian environment and the Australian economy generally; and
- to promote the objectives of the CRC program.

The Centre also had three main research objectives developed in consultation with the aquaculture industry:

- to strengthen the technology base of major established sectors of Australian aquaculture, assisting their sustainable development, international competitiveness and environmental acceptability;
- to undertake high quality research in generic areas of science which may have practical implications for a range of aquaculture ventures, or provide a new platform for subsequent applied R&D;
- to facilitate the development of selected new species for aquaculture in Australia.

Education and training constituted two major objectives of the CRC. The growth of Australian aquaculture requires an increasingly well-trained industry workforce, and researchers with special skills in technologies relevant to aquaculture.

The Aquaculture CRC had a strong program for PhD students, to train young scientists for the aquaculture research community. The CRC offered scholarships for PhD students to carry out work within the scope of the CRC strategic program. It also invited some students, who already had funding from other sources, to join its

program. Students were typically involved in large collaborative projects, and this gave them experience in a variety of research environments and also working with industry. There were opportunities for students to take part in conferences interstate and overseas, and a range of special training activities, such as research commercialisation and scientific writing.

With six universities involved, as well as many other research institutions and industry locations, the CRC offered a unique range of opportunities to students interested in aquaculture research. Many of the early intake of PhD students are now employed directly in the industry or in continuing research work in aquaculture. Their PhD projects have by no means been academic exercises - most of them have yielded results of commercial significance for the industry.

The other main training activity in the CRC was in the form of transfer of technology to industry. In part this occurred on an ongoing basis, through the direct involvement of industry partners in projects, in part through workshops to demonstrate and explain specific new techniques. The CRC had a diversity of relationships with industry, ranging from exclusive contracts with individual companies, to open access to CRC technology for the whole of the industry sector concerned. www.aquacrc.uts.edu.au/about/index.html

In 2000, the FRDC established a managed Atlantic Salmon Aquaculture Subprogram (ASAS) as a vehicle for the MOU between FRDC and the salmon industry. The objectives were to address risks, improve technology transfer and improve industry communication, all integral to industry achieving its full potential. The ASAS provided a high level of research service and was able to address key production issues in support of industry's strategic plans. The ASAS provided a service to the Atlantic salmon industry both in Tasmania and the other mainland states. It provided a focal point for a range of other salmonid industry projects and programs in all states.

The ASAS received direction from a Steering Committee of predominantly industry leaders and managed business through the Salmon Aquaculture Implementation Committee (SAIC), comprised of key industry representatives, government and researchers. The SAIC met regularly to identify development opportunities, research priorities and funding strategies.

The ASAS produced a five-year Strategic Plan for the research and development needs of the industry in 2001. Research was broadly categorised into six key areas 1) Health; 2) Environment; 3) Nutrition; 4) Reproduction; 5) Genetics; and 6) Production

The objectives and performance indicators were listed within these areas over the short, medium and long term. In 2002, the ASAS also contributed to a Strategic Value Management Workshop run by the Department of Economic Development.

The ASAS ran effectively because it developed a good operating framework, including sound communication strategy and well-facilitated meetings, and milestone reporting standards. Key elements of the communication and technology transfer strategy were the Annual Operating Plan, Annual Scientific Conference and Newsletter. The identity and promotion of the Subprogram was further improved through the establishment of a website. Three issues of the ASAS newsletter (*Salmon Snippets*), and detailed annual handbooks were produced and three highly successful Scientific Conferences and a range of specialist workshops and seminars were held. A publication and communication committee was established with function of reviewing over 38 publications, press releases and other media.

THE AQUAFIN CRC

In 2001, the leverage of industry research funding was enhanced through the CRC for Sustainable Aquaculture of Finfish (Aquafin CRC). The Aquafin CRC contributed an additional $17 million in support of the salmon and tuna aquaculture sectors in Australia over 7 years.

www.imas.utas.edu.au/__data/assets/pdf_file/0004/743296/AquafinCRC_ProjectNo5-Aquaculture-Subprogram.pdf

THE SEAFOOD CRC

The Seafood CRC involved 29 participants, investing a total of approx. $140 million between 2007 and 2014. Its mission was to assist end-users of its research to profitably deliver safe, high-quality, nutritious Australian seafood products to premium markets - domestically and overseas.

www.seafoodcrc.com/salmon/finfish/salmon.html

THE BLUE ECONOMY CRC

Australia has the third largest Exclusive Economic Zone globally with over 80% being classified as offshore, beyond two nautical miles from the coast and subject to oceanic waves, tidal currents and wind. Renewable energy from these sources can be captured and converted into electricity for both onshore and offshore use, as well as transformed into energy 'carriers' such as hydrogen, for storage or export. Australian aquaculture is challenged by the lack of suitable inshore sites and the knowledge to operate effectively in remote and/or exposed offshore environments. By overcoming these challenges, Australia can substantially develop its tropical, sub-tropical and temperate aquaculture industries.

The Blue Economy CRC will for the first time, bring the aquaculture and renewable energy sectors together to address the challenges of offshore food and energy production, that leverages the benefits of co-location, vertical integration, infrastructure and shared services. Offshore engineering will be central to this emergence, leveraging decades of experience drawn from the shipping, defense, oil and gas industries.

The Blue Economy CRC will bring together, for the first time, national and international expertise in aquaculture, marine renewable energy and marine engineering as part of a single, collaborative project. Through integration of the knowledge and expertise across these sectors, this CRC will pave the way for innovative, commercially viable and sustainable offshore developments that will see step changes in marine renewable energy output and seafood production.

There are 45 participants across 11 countries contributing over $300 million. Outcomes from the Blue Economy CRC include:

- Seafood and renewable energy systems that are robust to offshore conditions.
- Commercially viable seafood and energy products for the domestic and export markets.
- Demonstration of the benefits of co-location and integration of the seafood and renewable energy industries.
- Intellectual property, including products and knowledge, for export
- Future research leaders and a skilled workforce.

Research Program No. 1 - Offshore Engineering and Technology

Design of novel stand-alone and integrated offshore aquaculture and renewable energy infrastructure.

The objective of the Offshore Engineering and Technology program (Program 1) is to generate the infrastructure that supports the development of offshore systems. It brings together industrial engineering expertise to collaborate with the aquaculture (Program 2) and offshore renewable energy (Program 3) sectors to build the required infrastructure for integrated offshore operations.

IP will emerge in the design of sea-cage infrastructure, support systems for operating (e.g. anchoring devices), innovative maintenance technologies (e.g. anti-corrosive or antifouling devices), and monitoring (e.g. advanced materials for longevity and structural reliability; in-built sensors in composite materials to detect fatigue in offshore platforms). Commercial prototypes will be developed for monitoring and maintenance using robotics, artificial intelligence, integrated sensors and real-time visualisation.

Research Program No. 2 – Seafood and Marine Products

Supporting existing industries move offshore and develop, test and evaluate innovative product, production and processing systems for a range of seafood species.

The objective of the Seafood and Marine Products Program (Program 2), is to develop offshore aquaculture systems that provide viable and sustainable growth opportunities for this sector.

Commercialisation opportunities include novel aquaculture system designs for emerging species in collaboration with Program 1, and new seafood products, as well as the development of supply chain aquaculture activities (e.g. platform-based hatcheries and processing). Identification and development of premium export products and new export markets will ensure the expectations of high end-users are met.

Research Program No. 3 – Offshore Renewable Energy Systems

Identify and develop offshore renewable energy systems capturing generation, storage and control aspects optimised for co-located offshore operations.

The objective of the Offshore Renewable Energy Systems program (program 3), is to support offshore aquaculture (Program 2) through supplies of lower cost energy and ancillary products (oxygen and freshwater) and to contribute to the cost of offshore infrastructure through the development of exportable energy carriers (e.g. hydrogen).

Commercialisation opportunities include the design and development of renewable energy conversion devices; optimal offshore storage solutions and export products and micro-grid architecture solutions and control systems for intelligent management of integrated end-user demands. ORES will also focus on essential resources such as freshwater (via desalination) and oxygen (for hatchery and fish culture) which could be commercialised.

Research Program No. 4 – Environment and Ecosystems

The environment and ecosystems program offers an integrated, whole of life-cycle, adaptive approach to placement, operation and decommissioning of offshore infrastructure and livestock.

The objective of the Environment and Ecosystems Program (program 4) is to understand the environmental footprint of the infrastructure (Program 1), culture systems (Program 2) and energy generating devices (Program 3).

The EE program connects with Program 5 to develop management systems to monitor environmental impact and interactions with other sectors, and with programs 1-3 to monitor the impacts of the environment on health, maintenance and performance of species,

infrastructure and devices respectively. Commercialisation opportunities include the development of novel monitoring systems including models and user interfaces to deliver real time data and information for use by government, industry and the public.

Research Program No. 5 – Sustainable Offshore Developments

Using multidisciplinary analysis and tools to create workable design options for sustainable blue economy operations.

The objective of the Sustainable Offshore Developments program (program 5), is to profile and advocate for the regulatory frameworks that will provide confidence for aquaculture and renewable energy industry to invest and for the public to be confident that offshore developments operate to the highest environmental standards for sustainability and ecosystem integrity.

The Blue Economy CRC places heavy emphasis on education and training, with an unprecedented scale of research opportunities on offer, including 50 fully funded Higher Degree by Research PhD scholarships and 50 Postdoctoral Research Fellows appointments across its five research programs. HDRs and Postdoctoral Research Fellows are expected to present at a national and international conference, co-funded by the CRC and their host institution. The CRC will hold showcase events to communicate CRC research outcomes and provide training opportunities for students, researchers and professionals. https://blueeconomycrc.com.au/