FRDC FINAL REPORT

SALMON AQUACULTURE SUBPROGRAM: FACILITATION AND ADMINISTRATION

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FRDC Project 2007/229

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The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a statutory authority within the portfolio of the federal Minister for Agriculture, Fisheries and Forestry, jointly funded by the Australian Government and the fishing industry

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NON-TECHNICAL SUMMARY

2007/229	**Aquafin CRC – Salmon Aquaculture Subprogram: Facilitation and administration**

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OBJECTIVES:

The FRDC Salmon Aquaculture Subprogram aimed to research, promote and further develop a sustainable Atlantic salmon industry in Australia. The objectives were:

1. To administer and co-ordinate the activities of the SAS.
2. To review project proposals, milestone reports and final reports to ensure stakeholder relevance.
3. To facilitate and chair meetings of the SAS Implementation Committee (SASIC).
4. To ensure appropriate liaison between beneficiaries and research providers in the Salmon Sector and to integrate with other finfish sectors.
5. To communicate findings of the SAS through:
    a. An annual conference held in conjunction with the Aquafin CRC;
    b. Specialist workshops on topics identified through the course of the program; and
    c. Relevant articles in the CRC newsletters - Aquasplash and Salmon Snapshots

NON - TECHNICAL SUMMARY:

This project implemented the agreed Strategic R&D Plan for the salmon industry for the period 2007-2008.

Building on FRDC project 2003/200 it continued to provide a cost effective and economical administrative framework and process which:

- engaged stakeholders, specifically the salmon farming industry and the State mangers responsible for its development, in the process of identifying and prioritising research needs and monitoring the projects designed to meet these needs;
- enabled research groups to shape their programs to the needs of industry, government and other stakeholders; and
- transferred of useful information from research projects to end-users.

As a consequence, the projects undertaken in the SAS research portfolio were focussed on outcomes that were strongly supported by end-users, there was a high level of active collaboration between researchers and industry in carrying out these projects, and the

adoption of successful research results has been rapid. The impact of these research outcomes has already been substantial.

Planned Outcomes:

Managed research and development on production of Atlantic salmon – Achieved, effectively and economically in terms of a much reduced budget for the subprogram.

Increased level of cooperation among research providers and better use of national and international research; Increased awareness of the benefits of research and cooperation among Atlantic salmon producers – Continued to provide the framework for access, involvement, collective deliberation and information flow between researchers and end-users.

Developments in technology for related aquaculture industries; Reducing farm costs towards internationally competitive levels – Selected, supported, managed and communicated projects which have contributed to these outcomes.

Increased product volume and continuity of supply to domestic and international markets; Increased employment and re-skilling of the workforce in regional areas; Increased production and economic benefits to the Australian economy – The SAS project and its predecessor FRDC 2003/200 have coincided with a dramatic growth in the industry sector. Both are likely to have contributed to this, although final objective measurement is not yet available.

KEYWORDS: Atlantic salmon, aquaculture, cage culture, industry development, Tasmania

ACKNOWLEDGEMENTS

The SAS relied strongly on the support of a large number of organisations and individuals. We gratefully acknowledge the following organisations for making major contributions, providing guidance, and collaboration:

- Aquafin CRC
- CSIRO Marine and Atmospheric Research
- Tasmanian Aquaculture and Fisheries Institute, University of Tasmania
- Tasmanian Department of Primary Industries, Parks, Water and Environment
- Tasmanian Salmonid Growers Association, and its members.

We thank the members of the SAS Aquaculture Implementation Committee for their work on developing and evaluating projects and our special thanks go to all the industry members who provided invaluable advice and insights into the salmon industry. We also thank the Project Leaders and scientists who not only contributed to the research, but also presented their findings to industry in various seminars and conferences.

BACKGROUND

Sea cage culture of Atlantic salmon started in Tasmania in 1985 as a joint venture between government and industry. It developed quickly due to the establishment of a large hatchery, the use of proven European hatchery technology, a high level of government involvement, excellent cage culture sites and good water quality (Jungalwalla 1989; Treadwell et al. 1991). Salmon fry are hatched and on-grown in freshwater hatcheries to around 70g and the smolt are transported to sea cages for on-growing to a market size of 3.5-4.5 kg. Growth rates under Tasmanian conditions are extremely fast, the whole process taking around 30 months.

Over the five years to 2006-07, the State's aquaculture sector has approximately doubled in value in real terms. The 65 per cent growth in volume of salmonid production and a 28 per cent increase in salmon price contributed to that success. The volume of farmed salmonid harvested in 2006-07 was 23,637 tonnes with a value of $272 million, accounting for 57% of the state's gross value of production.4 In the 2007/08 period, the value of farmed salmonid rose to $291 million (DPIPWE 2009).

Tasmania's environmental conditions are ideal for salmonid farming and the state industry supplies most of its product to the domestic market. In 2005-06, farmed salmonids overtook tuna as Australia's most valuable commercial finfish species. In 2006-07 salmonids ranked second in the top five fisheries by volume and value, accounting for 11 per cent of total fisheries production in Australia (ABARE 2007).

There are five companies engaged in salmonid farming in Tasmanian waters. Most farming activity is concentrated in the D'Entrecasteaux Channel and Huon River in the State's south. Sea-based grow-out operations are also situated in the waters around the Tasman Peninsula, in Macquarie Harbour, and the Tamar River.

Nearly 93 per cent of Tasmanian salmonid production was sold in the domestic market in 2006-072. Interstate sales of salmon account for 85 per cent of Tasmanian salmon production, and local sales account for 8 per cent. The chart below demonstrates how important interstate markets are, with sales generating more than $300 million revenue in 2006-07.

Despite this the sustainability and profitability of the industry is constantly challenged in terms of problems associated with feeding, growth rate and treatment of parasites and disease. Major industry challenges include (in no special order):

1. The threat of importation of fresh salmon from overseas (concepts: disease and economics).
2. The impact of cage aquaculture on the environment and the cost of monitoring and compliance (concepts: multiple users and carrying capacity).
3. The cost, control and management of disease and predation, particularly AGD and seal predation (concepts: AGD and emerging diseases, diagnostics, vaccine development).
4. Impact of urban and industrial development.
5. The increasing cost of salmon food (concepts: animal protein replacement and optimal protein to energy ratios).
6. Global changes in sea water temperatures (concepts: declining fertility, genetic improvement, determination of optimal salmon sites).
7. Control of maturation (concepts; ability to provide year-round supply of fresh fish to the

markets).

During the past 15 years the salmon industry has overcome a number of technical and market constraints through an active R&D program. This has been funded from four primary sources:

- Application of direct funding and research levies by industry from Salmon Enterprises of Tasmania (SALTAS) and Tasmanian Salmonid Growers Association (TSGA);
- Tasmanian Government through the Department Primary Industries, Parks, Water and Environment (DPIPWE) and Tasmanian Aquaculture and Fisheries Institute (TAFI);
- Fisheries Research and Development Corporation (FRDC); and
- Both the Aquaculture CRC and its successor, the Aquafin CRC.

The Tasmanian Salmon Growers Association (TSGA) is the industry peak representative body and its six members represent all of the growers of salmon and trout in the State. Through an MOU with the FRDC this industry is one of the few aquaculture or wild fishery industries in Australia that commits its full 0.25% GVP contribution to research. The MOU aims to provide a greater certainty of intent in relation to the planning, funding and managing of R&D and the adoption and commercialisation of results.

In 2000 the FRDC established a managed Atlantic Salmon Aquaculture Subprogram (ASAS) as the vehicle for implementing the MOU. The objectives were to address risks, improve technology transfer and improve industry communication, all integral to Industry meeting its full potential. Following its initial period the ASAS was renewed for a further 3 years and this application represents a third renewal, with a change in name to the Salmon Aquaculture Subprogram (SAS)

SAS continued to provide a high level of research service to industry and management, addressing key production issues in support of industry's strategic plans. Programs in the Aquafin CRC, CSIRO, TAFI and DPIW were all linked through the Subprogram.

REFERENCES

ABARE 2007 Australian Fisheries Statistics.

CRC, 1999. Aquaculture CRC Ltd. Annual Report 1997-1998.

Jungalwalla, P., 1989. The development of an integrated saltwater salmonid farming industry in Tasmania, Australia. Proceedings of the Special Session on Salmonid Aquaculture – World Aquaculture Society, Feb 1989, Los Angles, USA

Treadwell, R., McKelvie, L.and Maguire G.B., 1999. Profitibility of selected aquacultural species. Australia Bureau of Agricultural and Resources Economics, research Report 92.2, Canberra, ACT, 85pp.

NEED

Like any thriving aquaculture industry, the Atlantic salmon industry needs to continually address biological challenges, market and development opportunities and production efficiencies through a coordinated research effort. This enables the industry to ensure sustainability, profitability and to develop to its full potential. The salmon industry does this through a mix of tactical (projects that addresses issues of immediate concern) and strategic (projects addressing longer-term development issues) research. This is achieved through industry strategic plans and to developing collaborative research projects that address industry bottlenecks and avoid duplication and unnecessary expenditure of a finite research funding base.

The SAS provides the delivery mechanism for this approach by ensuring that research is:

- addressing strategic research priorities,
- outcome focussed,
- supported by industry and management,
- adequately funded,
- properly managed and reviewed,
- properly delivered to stakeholders.

The SAS Aquaculture Implementation Committee is also a fundamental management instrument of the Aquafin CRC, providing a vehicle through which the objectives of both the FRDC and Aquafin CRC are realised.

OBJECTIVES

The FRDC Salmon Aquaculture Subprogram will research, promote and further develop a sustainable Atlantic salmon industry in Australia. The objectives were:

1. To administer and co-ordinate the activities of the SAS.
2. To review project proposals, milestone reports and final reports to ensure stakeholder relevance.
3. To facilitate and chair meetings of the SAS Implementation Committee (SASIC).
4. To ensure appropriate liaison between beneficiaries and research providers in the Salmon Sector and to integrate with other finfish sectors.
5. To communicate findings of the SAS through:
    a. An annual conference held in conjunction with the Aquafin CRC;
    b. Specialist workshops on topics identified through the course of the program; and
    c. Relevant articles in the CRC newsletters - Aquasplash and Salmon Snapshots

METHODS

SUBPROGRAM MISSION, VISION, AND GOALS

Mission:
To provide R&D that will underpin the sustainable development of the Atlantic salmon industry in Australia.

Vision:
To provide timely R&D outcomes that help to secure rapid and sustainable growth of the Atlantic salmon industry in Australia

Goals:

1. To involve industry and government in all facets of R&D thus maximising the adoption of outcomes.
2. To develop research outcomes that result in increased profitability and reduced risk for the salmonid aquaculture industry.
3. To ensure that research results are delivered in a timely and readily usable form.

SUBPROGRAM STRUCTURE

The aim of the Subprogram (SAS) was to ensure that salmon aquaculture R&D was coordinated, made the most efficient use of available resources, and integrated industry and research providers. The administrative arrangements in collaboration with the Aquafin CRC were designed to ensure that the SAS continued to address the proposed industry requirements and that effective and efficient communication was maintained.

Relationship between the Principal Investigator and the AIC Chair

The PI (Buxton) was responsible for the infrastructure support from TAFI and ultimately responsible for the milestone reporting of this project to FRDC. This latter task was achieved with the support of the Aquaculture Implementation Committee (SASIC) Chair (Jungalwalla).

Role of the SASIC Chair

The SASIC Chair (Jungalwalla) acted as project officer and was the conduit for all communications between the FRDC and stakeholders. The role of the SASIC Chair was as follows:

- Strategic Planning – to ensure that the 5-year Salmon Strategic R&D Plan was reviewed and updated as appropriate.
- Meetings - schedule, call, chair and record all meetings of the Subprogram, delegating this task when appropriate, for example, workshops where a Program Leader may take this responsibility.

- Workshops & seminars – liaise with the CRC Program Leaders and stakeholders to identify topics & speakers. To capture outcomes in the form of workshop proceedings.
- Annual conference – While this is a primary role of the CRC Communications Manager, the chair will liaise with the CRC Communication Manager and assist in planning of the annual conference.
- Project review – through the SAIC, to review initial proposals, milestone reports, and final reports, particularly from the perspective of Industry and Government stakeholder relevance, therefore meeting the needs of FRDC and the CRC.
- Liaison – to effectively engage and facilitate liaison between the salmon sector stakeholders (Industry, Government and Research Providers) on matters of R&D.
- Internal flow of information – oversight of internal flow of information between salmon sector stakeholders.
- PR & Communication – while this is a primary function of the CRC Communications Manager, the role is to identify inputs for the CRC newsletters Aquasplash or Salmon Snapshots, and to identify and authorise any media releases on salmon.

Role of the Aquafin CRC Communications Officer

- Annual Conference – the ASAS annual conference held in conjunction with the Annual Aquafin CRC conference, with specific salmon workshop included in the program.
- PR and Communication - to provide a regular flow of information in the CRC newsletters, Aquasplash and Salmon Snapshots, which summarised the latest findings of the research.

Role of the Aquaculture Implementation Committee

The Subprogram was managed with the recommendations and advice of the Salmon Aquaculture Implementation Committee (SASIC). The membership of the SASIC remained essentially the same as it was during FRDC 2003/039 and included:

- TSGA Executive Officer (Chair), Pheroze Jungalwalla
- CRC Chief Executive Officer, Dr Peter Montague
- FRDC Program Manager, Dr Crispian Ashby
- Aquafin CRC Program Leaders
    - Production, Mr Steven Clarke
    - Health, Dr Barbara Nowak
    - Environment, Dr John Volkman
    - Education, Professor Chris Carter
- Two (2) Government representatives, (namely Mr Colin Sheppard and Mr Wes Ford)

- Six (6) Industry representatives, nominated by TSGA (namely Dr Dom O'Brien, Dr Steve Percival, Mr Craig Selkirk, Mr David Mitchell, Dr Harry King and Mr Mick Hortle).

The tasks of the SASIC were:

- To develop the research strategy.
- To prioritise new research pre-proposals and to identify and select new projects.
- To recommend budget allocations for selected projects.
- To review research progress against milestones so as to ensure that research directions were commercially focussed and are outcome driven.
- To recommend the selection of researchers and students funded by the CRC.
- To recommend and manage changes to projects and where necessary make recommendations on the termination of projects.
- To organise industry liaison and technology transfer workshops.

These tasks are consistent with those set out in the Aquafin CRC agreement.

The SASIC will also be assisted through the activities of Farm Managers Meetings, which take place under the auspices of the TSGA.

SUBPROGRAM COMPONENTS

The research mix for the duration of the project included:

Project 2004/074: A whole-of-ecosystem assessment of environmental issues for salmonid aquaculture. PI: Dr John Volkman (CSIRO)

Project 2004/210: Use of immunomodulation to improve fish performance in Australian temperate water finfish aquaculture. PI: Assoc Prof Barbara Nowak (TAFI)

Project 2004/213: Commercial AGD and salmon health. PI: Dr Mark Powell (TAFI)

Project 2004/214: Effects of husbandry on AGD. PI: Assoc Prof Barbara Nowak (TAFI)

Project 2004/215: Establishment of challenge system for AGD. PI: Assoc Prof Barbara Nowak (TAFI)

Project 2004/217.1: Development of an AGD vaccine - phase 2. PI: Dr Chris Prideaux (CSIRO)

Project 2004/217.2: Development of an AGD vaccine - phase 2 (UTS). PI: Dr Bob Raison (UTS)

Project 2004/218: Molecular markers for selective breeding for AGD resistance. PI: Dr Nick Elliott (CSIRO)

Project 2004/221: Aquafin CRC - Enhanced hatchery production of striped trumpeter, *Latris lineata*, in Tasmania through system design, microbial control and early weaning. PI: Assoc Prof Stephen Battagelen (TAFI)

Project 2004/237: Aquaculture Nutrition Subprogram: Assessment of growth performance under limiting environmental conditions. PI: Prof Chris Carter (TAFI)

Project 2005/201: Aquafin CRC - Atlantic Salmon Aquaculture Subprogram: Environmental control of growth and early maturation in salmonids. PI: Prof Chris Carter (TAFI)

Project 2007/229: Salmon Aquaculture Subprogram: Facilitation and administration. PI: Prof Colin Buxton (TAFI) – This project.

Project 2008/217: Atlantic Salmon Sub Program: Effect of temperature on reproductive development of maiden and repeat spawning Atlantic salmon: understanding the basis for improved egg survival and quality. PI: Prof Ned Pankhurst (Griffith University)

Project 2008/218: Atlantic Salmon Subprogram: Extension funding application- AGD Vaccine phase III. PI: Assoc. Prof Barbara Nowak (TAFI)

Project 2008/221: Atlantic Salmon Aquaculture Subprogram: whole genome selection to improve selection efficiency for AGD resistance. PI: Dr Sonja Dominik (CSIRO)

Project 2008/750: Seafood CRC: AGD vaccine phase III; Sea-based trials, vaccine refinement and commercialisation. PI: Dr Matthew Cook (CSIRO)
Time frame:

RESEARCH FUNDING

The total value of the salmon projects managed by the SAS was $5,12M.

Inclusion of in-kind contributions by research organizations would approximately double this value.

STRATEGIC PLANNING

Central to the activities of the SAS was the Industry's Strategic R&D Plan. This plan was broadly categorised into six key areas: Health, Production, Nutrition, Reproduction, Genetics, and Environment. The SAS continued to periodically review the Strategic R&D plan, and perhaps most importantly focussed available research resources to the highest research priorities.

The following table provides a brief summary.

Issue	**Short term** **1 to 2 years**	**Medium term** **2 to 5 years**	**Long term** **5 years plus**	**Current funding**
1. Health				
AGD	Improve bathing Improve detection Better understanding pathology	Alternative treatments Immunological reaction Preventative measures Epidemiology	Vaccine development (subject to ASAS review) Genetic improvement	Ongoing support from FRDC- ASAS and Aquafin CRC

Diagnostics	See AGD	See AQUAPLAN	See AQUAPLAN	Supported through FRDC Health Subprogram
Disease control	Registration of Yersinia vaccine			Supported by industry
2. Production				
Seal predation	Cage and net design Stiffening nets			Completed FRDC project
Post harvest technology		Effect of harvest practice on flesh quality Effect of nutrition on flesh quality		Supported subject to $ from sources other than FRDC
Control of biofouling	Industry trials of Aquaculture CRC and other anti-fouling products			Supported by development companies
3. Nutrition				
Feed and feeding efficiency	Evaluation of high energy feeds	Australian feed ingredient evaluation		Supported through FRDC Diet Development Subprogram
4. Reproduction				
Control over maturation	Reconditioning mature fish	Delay reproductive development Develop out of season spawning Inhibit early maturation in sea water	Autoimmune sterilisation Genetic improvement	Ongoing support from FRDC-ASAS and Aquafin CRC
Egg quality	Better management of abiotic factors	Broodstock management Egg quality assessment tools		Supported from other sources including industry
Failed smolt syndrome	Better management of abiotic factors in fresh and saltwater			Support from other sources including industry
5. Genetics				
Stock improvement	Select model from scoping study	Development of genetic tools	Family selection program	Ongoing support from FRDC
6. Environment				
Environment management: On farm effects	Evaluation of limiting abiotic factors on fish performance (eg O_2) and responses to changes in husbandry practices	Novel tool development for benthic health Identification of key physical , biological and chemical processes controlling local environmental conditions in the water column		Ongoing support from FRDC-ASAS and Aquafin CRC
Environment management: System wide effects	Review CSIRO model for predicting environmental impacts	Development of key sustainability indicators Improved technology for the management of effluent from land based systems	An ability to predict the environmental impact of cage aquaculture at the system-wide scale	Ongoing support from FRDC-ASAS and Aquafin CRC
Jellyfish	Understanding the biology of jellyfish and ways to			ARC - Linkage project with support from Industry

	ameliorate harmful effects			
Algal blooms		Understanding the dynamics of algae blooms and their effects on gill health		Support subject to $ from other sources

RESULTS & DISCUSSION

INDUSTRY DEVELOPMENT

Nearly 93 per cent of Tasmanian salmonid production was sold in the domestic market in 2006-07. Interstate sales of salmon account for 85 per cent of Tasmanian salmon production, and local sales account for 8 per cent. These generated an estimated $300 million revenue in 2006-07.

A significant factor contributing to rapid growth in domestic markets has been the focus on promoting and marketing salmon to Australian consumers. The high quality of Tasmanian salmon has been a key factor in establishing a strong domestic market. Projected sales data for 2005-06 to 2006-07 demonstrate the success of the marketing program and the impact it has had on Tasmanian salmonid production and revenue. Around 7 per cent of salmon is exported to overseas countries. Apart from confectionery, salmon is now Tasmania's largest food trade item. Domestic consumption of salmon within Tasmania accounts for some 8 per cent of production. Tasmania's high quality product has also found niche markets overseas, with fish currently being exported to Japan, USA, Hong Kong, Singapore, and other opportunistic markets in SE Asia.

A factor behind the salmonid farming sector's strong growth is the role of research and development which has enabled the industry to adopt better feeding techniques and implement improved disease control measures. Despite this success, the sustainability and profitability of the industry is constantly challenged and threatened.

At the commencement of this project in 2007, the industry had emerged from three hot, dry summers that presented problems for feeding, growing and the treatment of Amoebic Gill Disease (AGD). By the completion of the project in 2006, more favourable climatic conditions and a range of technical advances, including more suitable feeds, had permitted substantial growth in production and stimulated a greater interest in the carrying capacity of the salmon aquaculture regions.

STRATEGIC PLANNING

The Strategic R&D Plan is revisited annually, however, no substantial amendments were made. The Plan was re-issued with minor revision in 2007:-

Atlantic Salmon Aquaculture Subprogram – Annual Operating Plan – 2007

Working within the scope of this Strategic R&D Plan, industry met on numerous occasions, to develop the research project portfolio. This was complemented by the Aquaculture Research Advisory Group process at the Tasmanian Aquaculture & Fisheries Institute

PROJECTS

The key project management activities of the SAS are summarised below.

Steering development of and assisting applications for new projects approved by FRDC

FRDC Project ID	PI	Short title
2008 - 217	Pankhurst	Temperature and egg quality
2008 - 218	Nowak	AGD Vaccine III - extension
2008 - 221	Dominik	AGD – genotyping fish
2008 – 750 (Formerly 2007 – 234)	Cook	AGD Vaccine III

Project Milestone Progress Reports reviewed / revised / endorsed*.

FRDC Project ID	PI	Short title
2003 - 200	Buxton	Salmon Subprogram – Facilitation & administration
2004 – 074	Volkman	System wide assessment of environmental issues
2004 – 210	Nowak	Immunomodulation in finfish
2004 – 213	Powell	AGD and salmon health
2004 – 214	Nowak	AGD and husbandry
2004 – 215	Nowak	AGD challenge model
2004 – 217.1	Prideaux	AGD Vaccine II (CSIRO)
2004 – 217.2	Raison	AGD Vaccine II (UTS)
2004 – 218	Elliott	AGD – molecular assessment of resistance
2004 - 221	Battaglene	Hatchery production of Striped Trumpeter
2004 – 237	Carter	Effect of temperature on feeding and growth
2005 - 201	Wilkinson	Environmental control of growth and maturation

* - One or more Milestone Progress Reports were handled for each of the listed projects.

Final Reports approved and issued (note that some of these Reports were issued after the formal end of project 2007-229)

M. D. Powell, J. A. Becker, J. Ransome, R. L. Florent and M. Jones (2007) Aquafin CRC - Atlantic Salmon Aquaculture Subprogram: commercial AGD and salmon health. FRDC Project 2004/213. 77pp. **Commercial-in-confidence.**

Barbara Nowak, Andrew Bridle, Kally Gross, Benita Vincent,Neil Young and Richard Morrison (2007) Aquafin CRC - Atlantic Salmon Aquaculture Subprogram: Use of immunomodulation to improve fish performance in Australian temperate water finfish culture FRDC Project 2004/210. 103pp.

Mathew Cook, Nicholas Elliott, Giles Campbell, Jawahar Patil, Bronwyn Holmes, Vivian Lim and Chris Prideaux (2008) Amoebic gill disease (AGD) vaccine development Phase II – Molecular basis of host parasite interactions in amoebic gill disease. FRDC Project 2004/217. 85pp.

N.G. Elliott. (2008). Molecular assessment of resistance to AGD in Atlantic salmon. FRDC Project 2004/218. 148pp.

Chris G. Carter, Robin S. Katersky, Julia C. Barnes, Andrew R. Bridle & Rhys C. Hauler. (2008). Assessment of fish growth performance under limiting environmental conditions: aquaculture nutrition subprogram. FRDC Project 2004/237. 147pp

R. Wilkinson, H. Woolcott, R. Longland, C. Carter and M. Porter (2008) Environmental control of growth and early maturation in salmon. FRDC Project 2005/201. 72pp.

Robert Raison, Margarita Villavedra, Kevin Broady, Michael Wallach, Joyce To, Susan Lemke, Rohan Panwar, Gaganpreet Sandhu, Philip Crosbie, Michael Attard, Mark Adams, Mark Powell and Barbara Nowak (2008). Atlantic salmon Aquaculture Subprogram: Development of an AGD vaccine: phase II (UTS). FRDC Project 2004/217.2. 81pp.

J. K. Volkman, P. Thompson, M. Herzfeld, K. Wild-Allen, S. Blackburn, C. Macleod, K. Swadling, S. Foster, P. Bonham, D. Holdsworth, L. Clementson, J. Skerratt, U. Rosebrock, J. Andrewarth, and A. Revill (2009). Aquafin CRC - Atlantic Salmon Aquaculture Subprogram: a whole-of-ecosystem assessment of environmental issues for salmonid aquaculture. FRDC Project 2004/074.

N. Pankhurst, H. King, K. Anderson, A. Elizur, P. Pankhurst and N. Ruff (2009) Effect of temperature on reproductive development of maiden and repeat spawning Atlantic salmon: understanding the basis for improved egg survival and quality. FRDC Project 2008/217.

Draft Final Reports received

S. C. Battaglene and J. M. Cobcroft (2010) Enhanced hatchery production of striped trumpeter, Latris lineata, in Tasmania through system design, microbial control and early weaning. FRDC Project 2004/221. Book 1 92pp & Book 2 392pp.

S. Dominik, P. Kube, J. Henshall and N. Elliott - Whole genome selection to improve selection efficiency for AGD resistance. FRDC project 2008/221. 55pp. **Commercial-in-confidence.**

OTHER OUTPUTS

R&D seminar days and focus group meetings held

30th March 2007 (see Appendix 4; speaker presentations available)
30th November 2007 (see Appendix 4; speaker presentations available)
9th July 2008 - special session on AGD (see Appendix 4; speaker presentations available)

In addition to the above, several meetings focussed on specific projects or industry research priorities were held.

BENEFITS

Beneficiaries:

- The Atlantic salmon aquaculture industry in Australia.
- Other related aquaculture industries.
- Suppliers and producers of services.
- The regional economy of Tasmania.

This project implemented the agreed Strategic R&D Plan for the salmon industry.

It provided a cost effective administrative framework and processes which:

- Engaged stakeholders, specifically the salmon farming industry and the State mangers responsible for its development, in the process of identifying and prioritising research needs and monitoring the projects designed to meet these needs.
- Enabled research groups to shape their programs to the needs of industry, government and other stakeholders.
- Maximised the transfer of useful information from research projects to end-users.

As a consequence, all the projects undertaken in the SAS research portfolio aim at outcomes that are strongly supported by end-users, there is a high level of active collaboration between researchers and industry in carrying out these projects, and adoption of successful research results has been rapid.

FURTHER DEVELOPMENT

The administration of the Atlantic Salmon Aquaculture Subprogram has been continued past the completion of this project using carry forward funds.

PLANNED OUTCOMES

Managed research and development on production of Atlantic salmon.

Substantially all Australian salmon research during the period has been managed through SAS, providing a coherent framework in which industry, regulators and researchers worked together to prioritise projects, manage their progress and ensure their effective transfer to end-users.

Increased production and economic benefits to the Australian economy.

Increased product volume and continuity of supply to domestic and international markets.

The salmon farming industry in Tasmania has continued to expand during the period of this project. The research portfolio of SAS has contributed to this growth

In addition, the environmental program has given regulators and industry more confidence in the capacity for sustainable growth of the industry.

Increased level of cooperation among research providers and better use of national and international research.

Only three research providers (University of Tasmania, CSIRO and UTS) have been involved to any great extent. Several of the projects have been constructed on a collaborative basis, either as research collaborators or through joint supervision of students, and on the whole this has meant more ambitious projects have been successfully undertaken.

The research providers have developed very extensive linkages with international groups, and these have made some innovative research possible.

Increased awareness of the benefits of research and cooperation among Atlantic salmon producers.

The specific focus of the research, and the rate of attendance of company staff at SAS meetings, has meant that there is a high level of involvement and awareness by the two major companies in the Huon-D'Entrecasteaux region, but much less involvement by other companies in the north and west of Tasmania.

Developments in technology for related aquaculture industries.

No formal measurement has been made at this stage.

Reducing farm costs towards internationally competitive levels.

No formal measurement has been made at this stage.

Increased employment and re-skilling of the workforce in regional areas.

No formal measurement of any impacts on employment has been made at this stage.

CONCLUSIONS

The Salmon Aquaculture Subprogram has operated effectively and economically during the project period, albeit on a very significantly reduced budget.

The agreed strategic directions have been consistently maintained and the projects in general have been well-delivered and in some cases notably successful.

Industry workshops describing the progress of research have been well received by participants.

APPENDICES

APPENDIX 1 - INTELLECTUAL PROPERTY

There are no intellectual property issues associated with this project.

APPENDIX 2 - STAFF

Prof Colin Buxton
Mr Pheroze Jungalwalla (Executive Officer, TSGA)

APPENDIX 3 - R&D SEMINAR PROGRAMS

Industry R&D Seminar

TAFI MRL, Taroona – Fri 30th Mar 2007

Program

09:05 – 09:15	**Arrival / Introduction**
09:15 – 10:00	**Environmental management** Karen Wild-Allen – Scenario modelling results Peter Thompson – Proposals for monitoring
10:00 – 10:30	**AGD** Barbara Nowak – Highlights of AGD research Benita Vincent – Antibody response in AGD
10:30 – 11:00	**Break**
11:00 – 11:45	**Chemical treatments for AGD** Joy Becker - Ionophores Mat Jones – Metabolic costs of AGD.
11:45 – 12:15	**AGD Vaccine development – UTS** Michael Wallach – Update on antibody/protein approach.
12:15 – 12:30	**AGD Vaccine Phase III - CSIRO** TBA – Update on new CSIRO research proposal.
12:30 – 13:00	**Tas. Salmonid Fish Health Surveillance Program** Kevin Ellard – Summary of 2006 Report

Salmon Aquaculture Subprogram R&D Seminar
TAFI MRL, Taroona – Fri 30th Dec 2007

Program

10:30 – 10:40	**Arrival / Introduction**
10:40 – 11:00	Matt Cook – AGD Vaccine Phase III
11:00 – 11:15	Barbara Nowak – Health Program overview/highlights
11:15 – 11:35	Richard Morrison – AGD host-pathogen interactions
11:35 – 11:55	Renee Florent – Bithionol as oral treatment against AGD
11:55 – 12:15	Ryan Wilkinson – Control of reproduction & growth
12:15 – 13:00	**Lunch**
13:00 – 13:45	Chris Carter – Nutrition; temperature & lupins
13:45 – 14:10	Karen Wild-Allen – Results of "2009 Scenario" modelling
14:10 – 14:30	Peter Thompson – Proposals for monitoring
14:30 – 14:45	Pheroze Jungalwalla – Other & future research projects
14:45 -	**Seminar close**
15:00 – 15:30	SAIC members meeting (if required)

Review of CSIRO AGD resistance research

Date Wednesday 9th July 2008

Venue Conference Rooms
CSIRO Marine Laboratories
Castray Esplanade, Hobart

Attendees

CSIRO:	Nick Elliott (chair), Giles Campbell, Matt Cook, Sonja Dominik, Peter Kube, Richard Taylor, James Wynne
HAC:	Dave Mitchell, Dom O'Brien, Steve Percival, Davey Whyte
Saltas:	Harry King
Tassal:	Lance Hubbert, David Main, Grant Purdon, Craig Selkirk
TSGA:	Pheroze Jungalwalla
UTas:	Barbara Nowak and/or Phil Crosbie

Purpose

Discuss and review the CSIRO research on understanding and improving resistance to amoebic gill disease (AGD) in the Tasmanian Atlantic salmon population. Intented outcomes are to:

- Identify short comings in the current understanding of AGD resistance;
- Identify and prioritise immediate and long-term research needs related to AGD resistance;
- Identify ways to strengthen linkage with the AGD vaccine and associated research.

Agenda

0845 Session 1 – Welcome and introduction ***(Nick)***
0900 Session 2 – Evidence for genetic resistance to AGD and how we measure AGD

- Hypothesis - Acquired and innate resistance
  - Data from the selective breeding program ***(Peter)***
  - Industry experience
  - Gene expression studies ***(James)***
- Measurement methods for AGD resistance and genetic ranking ***(Richard)***
- General discussion

1030 Morning break
1050 Session 3 – Incorporating AGD resistance in a commercial breeding program ***(Peter)***

- Breeding objective
  - What is the realistic breeding objective for AGD?
  - How should we measure progress towards the goal?
- Developing a strategic and operational plan
- Practical issues in managing AGD in a breeding program
  - Are current procedures compromising measures of AGD resistance or other traits?
  - Using AGD tested fish as broodstock
  - What measures of AGD infection should be include in selection decision?
  - Will AGD selection compromise general immunity, should we measure and maintain 'general health variation' (e.g. MH genes) in selection decisions ***(James)***

1250 Lunch break (provided by CSIRO in canteen)
1330 Session 4 – Summary on where we got to ***(Nick)***

- Summary of morning discussion, and any issues discussed over lunch to be noted

1345 Session 5 – How can we improve our selection efficiency and genetic gains?

- Introduction to 'whole-genome-selection' and proposed project ***(Sonja)***
- General discussion

1430 Session 6 – Integrating selection with AGD vaccine and associated research?

- Summary of AGD vaccine and associated research ***(Matt)***
- General discussion including:
  - Proposed selective breeding research with 2008 smolt input
  - Comparing and integrating current vaccine development and selection strategies

1500 Session 7 – Wrap-up and summary ***(Nick)***

- Issues raised
- Immediate and long-term research needs
- Proposed actions and priorities