www.csiro.au

CSIRO Submission 19/697

Inquiry into Fin Fish Farming in Tasmania

Legislative Council, Tasmania

November 2019

Main Submission Author:

Dr. Alistair Hobday
Marine Resources and Industries
CSIRO Oceans and Atmosphere
T 03 6232 5310
E alistair.hobday@csiro.au

Table of Contents

Executive Summary

CSIRO provides scientific knowledge and tools to support sustainable development and management of Australia's marine waters and resources. With regard to finfish aquaculture, our research has provided knowledge regarding the mitigation and amelioration of environmental impacts including climate change, informed management of environmental risks via system modelling, and improved aquaculture production and animal husbandry.

CSIRO is committed to providing world-class research and publishing the research that we undertake. We provide a list of that research attached to indicate the evidence base for decision makers to use.

In this submission we summarise the research that has contributed to

1. improving the productivity of the finfish industry that has supported industry growth and profitability while increasing animal welfare
2. sustainable marine farming practices, and
3. risk management approaches to a changing environment.

With regard to the terms of reference, CSIRO

- notes the public release of information we collect as part of our research, and encourages transparent reporting by the finfish industry
- supports evidence-based decision making, based on the best science available at the time, and notes the need for continual improvement as new information becomes available, while following the precautionary principle, and
- supports the development of an industry-wide biosecurity plan.

Finally, we provide examples of how modelling tools and systems can be used to support biosecurity planning and industry use of the marine environment.

Introduction

CSIRO welcomes the opportunity to provide input to the Legislative inquiry into Finfish Aquaculture in Tasmania.

Scientists working for CSIRO provide scientific knowledge and tools to support sustainable development and management of Australia's marine waters and resources. Our scientists seek to understand interactions across all sectors and in particular, the interactions between aquaculture, fisheries and conservation sectors. We have developed assessment methods, harvest strategies, management frameworks and evaluation tools used by Commonwealth, state and territory, neighbouring international and regional resource managers to build capacity in the assessment and management of the marine environment, ensure sustainable resource use and enable engagement in regional and international management and conservation fora. We have capability to provide social and economic assessments for resource management and use decisions.

In particular, CSIRO provides research to underpin evidence-based decision making for marine resource management in Australia and internationally. With regard to finfish aquaculture, our research has provided knowledge regarding the mitigation and amelioration of environmental impacts, management of environmental risks, and improved aquaculture production and animal husbandry.

In addition to Australian research, in recent years we have provided expertise to salmon aquaculture management and industry in Chile. Chile is one of the largest salmon producers in the world and have now taken a spatially structured approach to their productions zones. This spatial management supports aquaculture industries producing finfish, shellfish, and algae.

CSIRO has a long history of involvement in Australian finfish aquaculture – in Tasmania this is primarily Atlantic salmon. Our contribution to the evidence-base for finfish aquaculture falls into three main areas, noting that overlaps exist between the research and the scientists undertaking that research:

Production science – research to improve the productivity of the finfish industry has supported industry growth and profitability while increasing animal welfare.

- CSIRO developed applied breeding techniques in partnership with the salmonid industry to increase performance, ameliorate disease and improve productivity in the face of climate change (https://www.csiro.au/en/Research/AF/Areas/Aquaculture/Premium-breeds/breeding-salmon)
- Develop disease surveillance techniques and improved treatments for early disease intervention
- Sustainable diet development and dietary interventions to improve fish welfare (Wade et al, 2019)

Environmental science – research to support sustainable marine farming practices

- CSIRO evaluated broadscale environmental impacts of salmon aquaculture in the Huon Estuary and D'Entrecasteaux Channel with modelling and observations in the Aquaculture CRC (Volkman et al., 2009). This study quantified the nutrient load from fish farms (Wild-

Allen et al., 2010) and designed the Broadscale Environmental Monitoring Program (BEMP) (Thompson et al., 2008).

- CSIRO has built and deployed desktop decision support tools to investigate connectivity for the evaluation of spatial and temporal environmental 'footprints' of fish farm sites, the potential transfer of disease agents between leases and for the rapid evaluation of water quality following changes to farm site stocking and/or relocation; these tools have been deployed and used in Southeast Tasmania (Condie et al., 2017).
- CSIRO has deployed models in Macquarie Harbour to evaluate residual circulation and flushing time, simulate water quality (including dissolved oxygen) in near real time and provide a 3 day forecast. Model results and near real time observations are routinely displayed on a web dashboard that informs industry operations.
- Conducting integrated environmental baseline studies and the development and application of risk assessment protocols in support of ecosystem based management.

Climate change, extreme events and environmental forecasting - research to support risk management approaches to a changing environment

- CSIRO was involved in the first report exploring the implications of climate change for salmon aquaculture (Battaglene et al. 2008). This report explored many of the issues that are now emerging in Tasmania, including the need to manage risk in a changing environment, breed salmon for a warmer environment, and develop disease responses.
- CSIRO has investigated historical changes in the marine environment on the east coast of Tasmania, and shown this is a fast warming area relative to the rest of the world (Hobday and Pecl, 2014). We estimate rates of warming, and thus the likely future conditions that marine farming must consider. Our work on marine heatwaves (Hobday et al. 2016) has also shown that extreme events can impact the marine environment and industries (Oliver et al. 2018).
- In partnership with the Bureau of Meteorology, we have developed seasonal forecasts for finfish farming regions which are provided to salmonid companies that seek this information (Spillman and Hobday, 2014; Hobday et al. 2017). These forecasts are used by the industry to manage environmental risk associated with, for example, warm or cold conditions that affect salmon growth and survival.

CSIRO is also a partner in the CRC for the Blue Economy. The goal of the 10 year CRC program is to develop the infrastructure, energy systems, and production options for offshore aquaculture. We expect that the Blue Economy CRC will be covered by a submission from the University of Tasmania, and so do not provide additional details here.

This CSIRO submission draws on a range of CSIRO expertise. Our research on this topic is publicly available via publication in peer-reviewed journals (**Appendix 2).**

CSIRO response to the Terms of Reference (ToR)

To inquire into and report on the planning, assessment, operation and regulation of finfish farming in Tasmanian, with particular reference to:

1) The implementation of the Sustainable Industry Growth Plan for the Salmon Industry and its impact on commercial finfish farming operations and local communities, including:

a. data collection and publication;

b. progress in the development of an industry wide biosecurity plan;

a) CSIRO Response to data collection and publication;

- CSIRO scientists seek to publish their findings in project reports and reputable peer-reviewed journals (**Appendix 2)**, and this provides an evidence base to support decision makers and regulators.
- Our world-class models rely on both scientifically collected and industry data and we have a strong history of collaboration for data collection in joint research projects.
- Additional data on environmental conditions are collected by industry as part of their operational monitoring and regulatory/compliance requirements. There is an opportunity for greater transparency and more timely publication of industry monitoring and compliance data. Industry data are often held confidentially (as is standard in many industries), and some is published on company websites. Some of this confidential data practise is likely in response to a history of negative media attention and within-industry commercial competition.
- Other aquaculture farming regions outside Australia regulate the release of industry-collected data. In Scotland for example, the regulatory agency (SEPA) report industry monitoring and compliance data on a public website for transparency in environmental condition and associated decision making. The Tasmanian regulator could follow this route. With resources, CSIRO could also deliver data systems to support real-time environmental reporting.

b) CSIRO response to progress in the development of an industry wide biosecurity plan;

- Based on the recommendations from the *Planning for a Blue Future Report* CSIRO supports development of an industry-wide biosecurity plan
- With regard to informing biosecurity management, CSIRO has recently delivered a comprehensive modelling and risk assessment information system to the Chilean Government environmental agency SERNAPESCA for strategic and tactical decision support and management of biosecurity issues in their salmon industry (see **Appendix 1**). This expertise is available to inform the strategic development of a salmon biosecurity plan for Tasmania.

2) Application of the *Marine Farming Planning Act 1995* relating to:

a. preparation and approval process for marine farming development plans, including modifications and amendments to marine farming development plans;

b. allocation of leases, applications for and granting of leases;

c. management of finfish farming operations with respect to the prevention of environmental harm;

CSIRO Response – general response to the development plans, leases and prevention of environmental harm

- There is an opportunity to integrate current environmental data, future environmental projections, societal values and economic industry data into a spatial planning GIS to inform decisions around the allocation of new farm leases.
- We note that the climate change and projections of suitable habitats in future for finfish were not considered in developing the zoning plan, and are not required in the development of marine farming plans. With general warming of the ocean waters in the east and south coasts of Tasmania under climate change, there will still be areas that are relatively cool, and could be used by finfish aquaculture operations on seasonal or annual time scales. Risk management may support moving operations between warm and cool areas in summer, or cool and warm areas in winter to maximise survival and growth. A biosecurity plan may need to consider the safe movement of fish between areas to reduce environmental risk.
- Management of finfish farming operations with respect to minimising environmental harm is currently achieved by the EPA through exacting compliance regulation. More transparency in the reporting of industry compliance (and action taken when non-compliance occurs), would improve public understanding of this process. There are likely to be benefits in bringing environmental compliance reporting for aquaculture, agriculture and all industries using environmental services into a unified framework.

3) Any other matter incidental thereto.

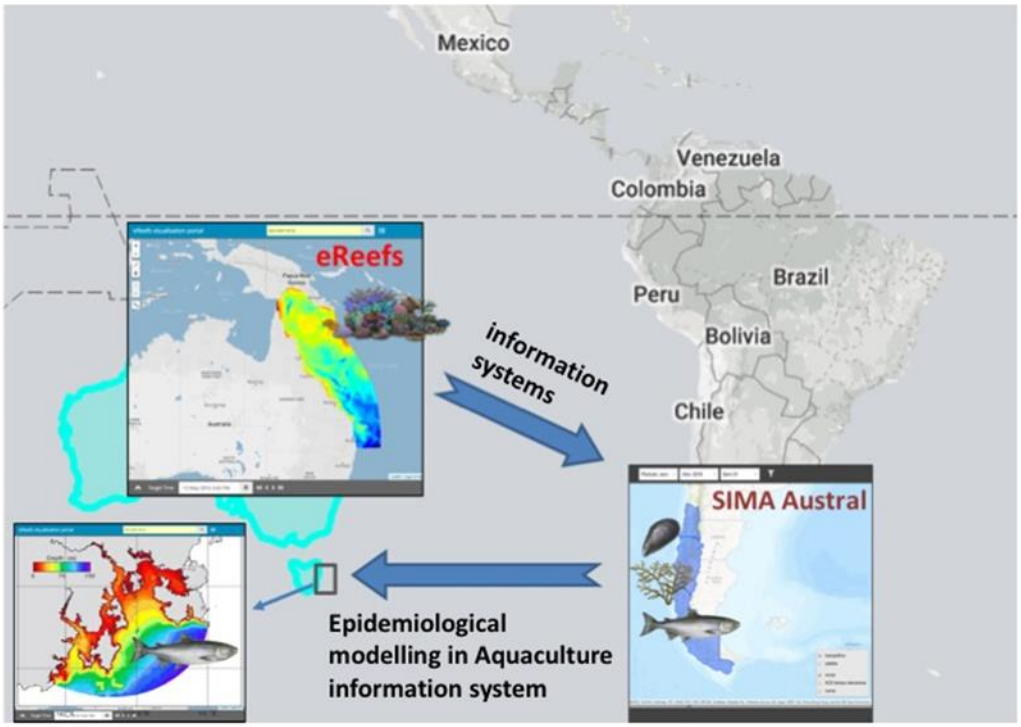
CSIRO Response – additional comments

- Scientific understanding that can be used to improve environmentally sustainable finfish aquaculture production is continually improving.
- CSIRO, and other research agencies, provides the research that is available at the time for use by industry, decision-makers and regulators. We note the need for updates as new information is collected and analysed.
- Regulators, industry and the community generally realise that management and regulations will need to be updated over time. This approach is adaptive, and allows for continual improvement. This adaptive approach should not be at the expense of the precautionary principle. While there is no single definition of the this principle, it was included in the 1992 Rio Declaration on Environment and Development where it was positioned as an underlying element of the broader framework for sustainable development.

  > *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. (Principle 15, Rio Declaration on Environment and Development, 1992).*

  The precautionary principle has been included in a range of Australian law and policy, including the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), and legislation in most States.

- Tasmanian finfish aquaculture, while world-leading in some areas, can also learn from experiences and approaches developed elsewhere in the world. For example, CSIRO has recently completed work with Chilean partners (SIMA Austral) to develop system approaches to manage environmental impacts and biosecurity risks (see **Appendix 1)**. CSIRO and partners are taking some of the elements of the SIMA project in Chile, and applying them in a project centered on Storm Bay.



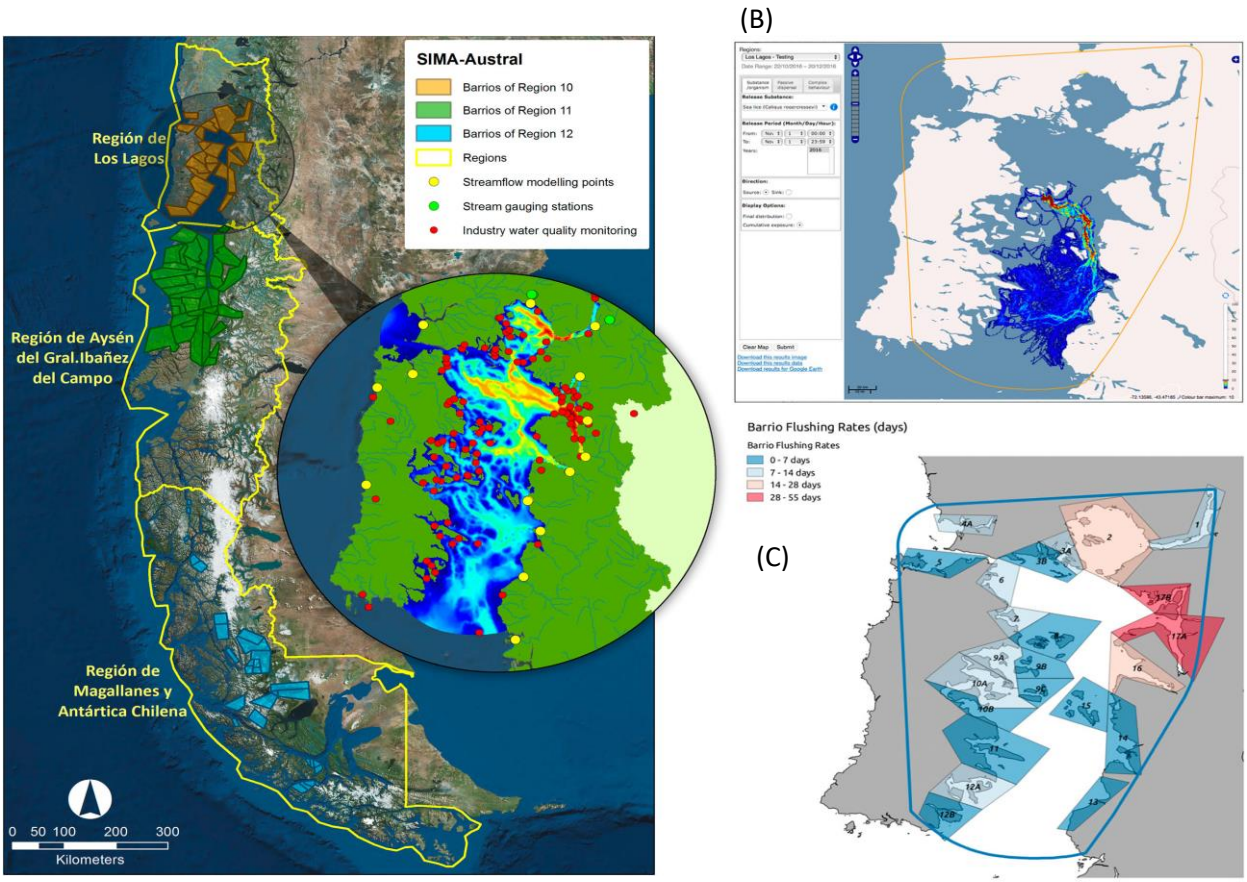
Appendix 1.

SIMA Austral: An operational information system for managing the Chilean aquaculture

CSIRO developed the Integrated Management System for the Aquaculture (SIMA in Spanish). This is a comprehensive interoperable information and modelling platform to provide the Chilean Aquaculture industry and government agencies with access to improved environmental intelligence allowing them to make better informed strategic and operational decisions. SIMA integrates environmental and sanitary contexts on an ecosystem risk-based approach. It was undertaken by multi-disciplinary team with key managers, industry and research stakeholders active in the aquaculture industries of the Patagonia of Chile (Fig A). The rationale for SIMA was to deliver a web-based platform of an operational workflow information system that includes: (i) *Products and Services* for strategic planning, evaluations, response to incidents, and the usual production of reports, (ii) *Components* including physicals, biogeochemical, ecological, productive and socioeconomic (models framed as an integrated risk analysis system), (iii) *Integration for the manager's environmental and health monitoring programs* accessing data management, integration and visualization of data through data services end tools, and (iv) *Integration and access to new data sources* including processes and procedures for the management, monitoring and modeling of data for both operational and strategic planning uses.

The modular and spatial-explicit architecture of SIMA Austral Platform include a range of tools and facilities ranging from regular near-real time reporting and visualization on monitoring data, hydro connectivity analyses, epidemiological and bioeconomic modelling, to water quality and future scenario and risk assessments. It delivers spatially-explicit information supporting the management of the production of local and regional Barrios, as well as the likely footprint of potential transmission (or potential sources) for a disease or parasites outbreak and to define and run scenarios with minimal training (Figs. B, C). The SIMA Austral architecture and components provides operational examples of applications of how it can be used to inform policy and management decisions, and discusses challenges and key learnings and considers future developments and applications.

The SIMA tools can be used to provide a detailed understanding of current status and trends, as well as likely and actual interactions between aquaculture production (primarily salmonid farming) and the surrounding ecosystem. This includes the receiving environment (biodiversity, abundance and biomass, water quality, sediment characteristics), but also the broader human system. In turn, this information can be used to evaluate both how changes in the industry (such as expansions) may affect the system, including the Industry, but also to set and evaluate regionally appropriate production reference points, environmental thresholds and adaptive management practices.



(A) Map of southern Chile showing the spatial extent of environmental and ecosystem models of the SIMA Austral project, and the occurrence of farming leases aggregated in the various polygons of the *Barrios* (Neighbourhoods) spatial management system. The inset shows stream gauge and water quality monitoring stations. (B) Example of output showing modelled dispersal of sea lice released from a central-eastern island. Dark red indicates more than 10% of the release passed through the grid cell, green 40-60% and dark blue less than 10%. (C) Computed flushing timescales for barrios in the Los Lagos Region. These equate to the average time for concentrations within a barrio to fall to e-1 = 0.368 of their starting value. Longer flushing times typically increase the risk of contaminant accumulation and associated deterioration in water quality [Modified from: Steven et al. (2019). Journal of Operational Oceanography Vol. 12: sup2, S29-S46: Ocean Observing for Societal Benefit. DOI: 10.1080/1755876X.2019.1636606]

Appendix 2

Published research papers from CSIRO relevant to finfish aquaculture in Tasmania. Selected papers are cited in the submission.

1. Abrantes, Katya; Lyle, Jeremy; Nichols, Peter; Semmens, Jayson. Do exotic salmonids feed on native fauna after escaping from aquaculture cages in Tasmania, Australia? Canadian Journal of Fisheries and Aquatic Sciences. 2011; 68(9):1539-1551. https://doi.org/10.1139/F2011-057
2. Anderson, Kelli; Pankhurst, Ned; King, Harry; Elizur, Abigail. Effect of thermal challenge on the expression of genes involved in ovarian steroidogenesis in Tasmanian Atlantic salmon (Salmo salar). Aquaculture. 2017; 479:474-478. https://doi.org/10.1016/j.aquaculture.2017.06.01
3. Anderson, Kelli; Pankhurst, Ned; King, Harry; Elizur, Abigail. Effects of GnRHa treatment during vitellogenesis on the reproductive physiology of thermally challenged female Atlantic salmon (Salmo salar). PeerJ. 2017; 5:e3898. https://doi.org/10.7717/peerj.3898
4. Anderson, Kelli; Pankhurst, Ned; King, Harry; Elizur, Abigail. Estrogen therapy offsets thermal impairment of vitellogenesis, but not zonagenesis, in maiden spawning female Atlantic salmon (Salmo salar). PeerJ. 2017; 5:e3897. https://doi.org/10.7717/peerj.3897
5. Andrewartha, Sarah; Munns, Suzanne; Edwards, Ashley. Calibration of the HemoCue point-of-care analyser for determining hemoglobin concentration in a lizard and fish. Conservation Physiology. 2016; 4:Cow006. https://doi.org/10.1093/conphys/cow006
6. Baird, Mark; Ralph, Peter; Rizwi, Farhan; Wild-Allen, Karen; Steven, Andy. A dynamic model of the cellular carbon to chlorophyll ratio applied to a batch culture and a continental shelf ecosystem. Limnology and Oceanography. 2013; 58(4):1215-1226. https://doi.org/10.4319/lo.2013.58.4.1215
7. Battaglene, S. C., C. Carter, A. J. Hobday, V. Lyne and B. Nowak (2008). Scoping Study into Adaptation of the Tasmanian Salmonid Aquaculture Industry to Potential Impacts of Climate Change. National Agriculture & Climate Change Action Plan: Implementation Programme report 83p.
8. Bennett, B. N. Blueblood Atlantic salmon for Tasmania. Fishing today. 2006; 19:3-5. http://hdl.handle.net/102.100.100/130123?index=1
9. Betancor, Monica; Howarth, Fraser; Glencross, Brett; Tocher, Douglas. Influence of dietary docosahexaenoic acid in combination with other long-chain polyunsaturated fatty acids on expression of their biosynthesis genes and phospholipid fatty acid compositions in tissues of post-smolt Atlantic salmon (Salmo salar). Comparative Biochemistry and Physiology. 2014; 173:74-89. http://hdl.handle.net/102.100.100/95072?index=1
10. Botwright, Natasha; Evans, Brad; Lubieniecki, Krzysztof; Cook, Mat; Davidson, William. Sex determination in Tasmanian Atlantic salmon. Global Aquaculture Alliance. 2015; (March/April 2015):74-75. http://hdl.handle.net/102.100.100/93105?index=1
11. Bowden, Alyssa; Andrewartha, Sarah; Elliott, Nick; Frappell, Peter; Clark, Timothy. Negligible differences in metabolism and thermal tolerance between diploid and triploid Atlantic salmon (Salmo salar L.). Journal of Experimental Biology. 2018; Online:Online. https://doi.org/10.1242/jeb.166975
12. Bransden, M. P.; Carter, C. G.; Nichols, P. D. Replacement of fish oil with sunflower oil in feeds for Atlantic salmon (Salmo salar L.): effect on growth performance, tissue fatty acid composition and disease resistance. Comparative biochemistry and physiology, Part B. 2003; 135(4):611-625. http://hdl.handle.net/102.100.100/193963?index=1
13. Brown, Malcolm; Kube, Peter; Taylor, Richard; Elliott, Nick. Rapid compositional analysis of Atlantic salmon (Salmo salar) using visible-near infrared reflectance spectroscopy. Aquaculture Research. 2014;

45(5):798-811.
https://doi.org/10.1111/are.12021
14. Buchanan, Pearse; Swadling, Kerrie; Eriksen, Ruth; Wild-Allen, Karen. New evidence links changing shelf phytoplankton communities to boundary currents in southeast Tasmania. Reviews in Fish Biology and Fisheries. 2014; 24(2):427-442.
https://doi.org/10.1007/s11160-013-9312-z
15. Carlile, Gemma; East, Iain; McColl, Ken; Ellard, Kevin; Browning, G.F.; Crane, Mark. The spatial and temporal variation of the distribution and prevalence of Atlantic salmon reovirus (TSRV) infection in Tasmania, Australia.. Preventive Veterinary Medicine. 2014; 116(1-2):214-219.
https://doi.org/10.1016/j.prevetmed.2014.06.011
16. Codabaccus, Basseer; Bridle, Andrew; Nichols, Peter; Carter, Chris. Restoration of fillet n-3 long-chain polyunsaturated fatty acid is improved by a modified fish oil finishing diet strategy for Atlantic salmon (Salmo salar L.) smolts fed palm fatty acid distillate.. Journal of Agricultural and Food Chemistry. 2012; 60(1):458-466.
https://doi.org/10.1021/jf203633z
17. Codabaccus, Basseer; Bridle, Andrew; Nichols, Peter; Carter, Chris. An extended feeding history with a stearidonic acid enriched diet from parr to smolt increases n-3 long-chain polyunsaturated fatty acids biosynthesis in white muscle and liver of Atlantic salmon (Salmo salar L.). Aquaculture. 2011; 322-323:65-73.
https://doi.org/10.1016/j.aquaculture.2011.09.014
18. Codabaccus, Basseer; Bridle, Andrew; Nichols, Peter; Carter, Chris. Effect of feeding Atlantic salmon (Salmo salar L.) a diet enriched with stearidonic acid from parr to smolt on growth and n-3 long-chain PUFA biosynthesis. British Journal of Nutrition. 2011; Online:12 p..
https://doi.org/10.1017/S0007114510005714
19. Codabaccus, Basseer; Carter, Chris; Bridle, Andrew; Nichols, Peter. The "n-3 LC-PUFA sparing effect" of modified dietary n-3 LC-PUFA content and DHA to EPA ratio in Atlantic salmon smolt. Aquaculture. 2012; 356-357:135-140.
https://doi.org/10.1016/j.aquaculture.2012.05.024
20. Condie, Scott; Gorton, Bec; Hadley, Scott; Little, Rich; Macleod, Catriona; Ogier, Emily; Wild-Allen, Karen; et al. INFORMD2 Risk-based tools supporting consultation, planning and adaptive management for aquaculture and other multiple-uses of the coastal waters of southern Tasmania. CSIRO: CSIRO; 2017. http://hdl.handle.net/102.100.100/88681
21. Cook, M. T.; Patil, J. G.; Elliott, N. G.; Prideaux, C. pbS-Sfi-CAT, a better delivery vector for experimental DNA vaccination of Atlantic salmon (Salmo salar). Aquaculture. 2007; 272:S249-S250.
http://hdl.handle.net/102.100.100/124226?index=1
22. Cook, M.T.; Patil, J.G.; Elliott, N.G.; Prideaux, C.T. pbS-Sfi-CAT, a better delivery vector for experimental DNA vaccination of Atlantic Salmon (Salmo salar). Aquaculture. 2007; 272(Suppl 1):S249-S250.
http://hdl.handle.net/102.100.100/123555?index=1
23. Corbeil, S.; Hyatt, A.D.; Crane, M. St. J. Characterisation of an emerging rickettsia-like organism in Tasmanian farmed atlantic salmon. Diseases of aquatic organisms. 2005; 64(1):37-44.
http://hdl.handle.net/102.100.100/179772?index=1
24. Creighton, Colin; Hobday, Alistair; Lockwood, Michael; Pecl, Gretta. Adapting management of marine environments to a changing climate: a checklist to guide reform and assess progress. Ecosystems. 2016; 19(2):187-219.
https://doi.org/10.1007/s10021-015-9925-2
25. Davies, Kelly; McColl, Ken; Wang, Linfa; Yu, Meng; Williams, Nette; Crane, Mark. Molecular characterisation of Australasian isolates of aquatic birnaviruses. Diseases of Aquatic Organisms. 2010; 93(1):1-15.
https://doi.org/10.3354/dao02278
26. Dominik, S.; Henshall, John M.; Kube, Peter D.; King, Harry; Lien, S.; Kent, M.P.; et al. Evaluation of an atlantic salmon SNP chip as a genomic tool for the application in a Tasmanian salmon (Salmo salar) breeding population. Aquaculture. 2010; 308(Suppl. 1):S56-S61.
https://doi.org/10.1016/j.aquaculture.2010.05.038

27. Doubleday, Zoe A; Clarke, Steven M; Li, Xiaoxu; Pecl, Gretta; Ward, Tim; Battaglene, Stephen; et al. Assessing the risk of climate change to aquaculture: a case study from south-east Australia. Aquaculture Environment Interactions. 2013; 3(2):163-175. https://doi.org/10.3354/aei00058
28. Eisbrenner, William; Botwright, Natasha; Cook, Mat; Davidson, Evelyn; Dominik, Sonja; Elliott, Nick; et al. Evidence for Multiple Sex-Determining Loci in Tasmanian Atlantic Salmon (Salmo salar). Heredity. 2013; 113:86-92. https://doi.org/10.1038/hdy.2013.55
29. Elliott, N. G.; Reilly, A. Likelihood of bottleneck event in the history of the Australian population of Atlantic salmon (Salmo salar L.). Aquaculture. 2003; 215(1-4):31-44. http://hdl.handle.net/102.100.100/194066?index=1
30. English, Chloe; Sword, Fiona; Downes, Jamie; Ruane, Neil; Botwright, Natasha; Barnes, Andrew; et al. Prevalence of six amoeba species colonising the gills of farmed Atlantic salmon with amoebic gill disease (AGD) using qPCR. Aquaculture Environment Interactions. 2019; 11:405-415. https://doi.org/10.3354/aei00325
31. English, Chloe; Tyml, Tomas; Botwright, Natasha; Barnes, Andrew; Wynne, James; Walger de Camargo Lima, Paula; et al. A diversity of amoebae colonise the gills of farmed Atlantic salmon, Salmo salar with amoebic gill disease (AGD). European Journal of Protistology. 2019; 67:27-45. https://doi.org/10.1016/j.ejop.2018.10.003
32. Esmail, Amin; Verbyla, Klara; Al-Mamun, Hawlader; McWilliam, Sean; Evans, Brad; King, Harry; et al. Polygenic and sex specific architecture for two maturation traits in farmed Atlantic salmon. BMC Genomics. 2019; 20:Article 139. https://doi.org/10.1186/s12864-019-5525-4
33. Fleming, Aysha; Hobday, Alistair; Farmery, Anna; van Putten, Ingrid; Pecl, Gretta; Green, Bridget; et al. Climate change risks and adaptation options across Australian seafood supply chains - a preliminary assessment. Climate Risk Management. 2014; 1:39-50. https://doi.org/10.1016/j.crm.2013.12.003
34. Glencross, Brett; De Santis, Christian; Bisckei, Beatrix; Taggart, John; Bron, James; Betancor, Monica; et al. A comparative analysis of the response of the hepatic transcriptome to dietary docosahexaenoic acid in Atlantic salmon (Salmo salar) post-smolts.. BMC Genomics. 2015; 16:684. https://doi.org/10.1186/s12864-015-1810-z
35. Glencross, Brett; Tocher, Douglas; Matthew, Chessor; Bell, Gordon. Interactions between dietary docosahexaenoic acid and other long-chain polyunsaturated fatty acids on performance and fatty acid retention in post-smolt Atlantic salmon (Salmo salar). Fish Physiology and Biochemistry. 2014; 40:1213-1227. http://hdl.handle.net/102.100.100/95476?index=1
36. Gonzales, Laura; Taylor, Richard; Bridle, Andrew; Crosbie, Phillip; Nowak, Barbara. Parasitic isopods Ceratothoa banksii and Nerocila orbignyi of farmed Atlantic salmon and their potential as vectors of Neoparamoeba perurans in Tasmania. Aquaculture. 2019; 507(May 2019):28-34. https://doi.org/10.1016/j.aquaculture.2019.04.008
37. Hadley, Scott; Jones, Emlyn; Johnson, CR; Wild-Allen, Karen; Macleod, Catriona. A Bayesian inference approach to account for multiple sources of uncertainty in a macroalgae based integrated multi-trophic aquaculture model. Environmental Modelling & Software. 2016; 78:120-133. https://doi.org/10.1016/j.envsoft.2015.12.020
38. Hadley, Scott; Wild-Allen, Karen; Johnson, Craig R.; Macleod, Catriona. Investigation of broad scale implementation of integrated multitrophic aquaculture using a 3D model of an estuary. Marine Pollution Bulletin. 2018; 133:448-459. https://doi.org/10.1016/j.marpolbul.2018.05.045
39. Hadley, Scott; Wild-Allen, Karen; Johnson, Craig R.; Macleod, Catriona. Quantification of the impacts of finfish aquaculture and bioremediation capacity of integrated multi-trophic aquaculture using a 3D estuary model. Journal of Applied Phycology. 2016; 28(3):1875–1889. https://doi.org/10.1007/s10811-015-0714-2

40. Hadley, Scott; Wild-Allen, Karen; Johnson, Craig R.; Macleod, Catriona. Modeling macroalgae growth and nutrient dynamics for integrated multi-trophic aquaculture. Journal of Applied Phycology. 2015; 27(2):901-916. https://doi.org/10.1007/s10811-014-0370-y
41. Hobday, A. J. and E. S. Poloczanska (2008). 12. Marine Fisheries and Aquaculture. In Stokes, C (ed). An overview of climate change adaptation in the Australian agricultural sector - impacts, options and priorities. February 2008. http://www.csiro.au/resources/AgricultureAdaptationReport2008.html.
42. Hobday, A. J., R. H. Bustamante, A. Farmery, S. Frusher, B. Green, S. Jennings, L. Lim-Camacho, A. Norman-Lopez, S. Pascoe, G. Pecl, E. Plaganyi, E. I. van Putten, P. Schrobback, O. Thebaud and L. Thomas (2014). Growth opportunities & critical elements in the supply chain for wild fisheries & aquaculture in a changing climate. Final Report. FRDC-DCCEE Marine National Adaptation Program 2011/233.
43. Hobday, A. J., V. Lyne, R. Thresher, C. Spillman and A. Norman-Lopez (2011). Atlantic Salmon Aquaculture Subprogram: Forecasting ocean temperatures for salmon at the farm site. FRDC report 2010/217.
44. Hobday, A. J.; Poloczanska, E. S.; Matear, R. J. Implications of Climate Change for Australian Fisheries and Aquaculture: a preliminary assessment. Canberra A.C.T.: Department of Climate Change; 2008. http://hdl.handle.net/102.100.100/118695?index=1
45. Hobday, Alistair; Bustamante, Rodrigo; Farmery, Anna; Fleming, Aysha; Frusher, Stewart; Green, Bridget; et al. Growth opportunities for marine fisheries and aquaculture industries in a changing climate. In: Griffith, editor/s. NCCARF Adaptation. Griffith NCCARF; 2014. 139-155. http://hdl.handle.net/102.100.100/93523?index=1
46. Hobday, Alistair; Hartog, Jason; Manderson, John; Mills, Katherine; Oliver, Matthew; Pershing, Andrew; et al. Ethical considerations and unanticipated consequences associated with ecological forecasting for marine resources. ICES Journal of Marine Science. 2019; (fsy210):fsy210. https://doi.org/10.1093/icesjms/fsy210
47. Hobday, Alistair; Spillman, Claire; Eveson, Paige; Hartog, Jason. Seasonal forecasting for decision support in marine fisheries and aquaculture. Fisheries Oceanography. 2016; 25(Supplement S1):45-56. https://doi.org/10.1111/fog.12083
48. Hobday, Alistair; Spillman, Claire; Eveson, Paige; Hartog, Jason; Zhang, Xuebin; Brodie, Steph. A Framework for Combining Seasonal Forecasts and Climate Projections to Aid Risk Management for Fisheries and Aquaculture. Frontiers in Marine Science. 2018; 5:Article 137. https://doi.org/10.3389/fmars.2018.00137
49. Innes, B. H.; Elliott, N. G. Genetic diversity in a Tasmanian hatchery population of atlantic salmon (Salmo Salar L.) compared with its Canadian progenitor population. Aquaculture research. 2006; 37(6):563-569. https://doi.org/10.1111/j.1365-2109.2006.04163.x
50. Kijas, James; Elliott, Nick; Kube, Peter; Evans, Brad; Botwright, Natasha; King, Harry; et al. Diversity and Linkage Disequilibrium in Farmed Tasmanian Atlantic Salmon. Animal Genetics. 2017; 48(2):237 - 241. https://doi.org/10.1111/age.12513
51. Kijas, James; McWilliam, Sean; Naval Sanchez, Marina; Kube, Peter; King, Harry; Evans, Brad; et al. Evolution of Sex Determination Loci in Tasmanian Atlantic Salmon. PLoS Genetics. 2018; 8:5664. https://doi.org/10.1038/s41598-018-23984-1
52. Kube, Peter; Taylor, Richard; Elliott, Nick. Genetic variation in parasite resistance of Atlantic salmon to amoebic gill disease over multiple infections. Aquaculture. 2012; 364-365:165-172. https://doi.org/10.1016/j.aquaculture.2012.08.026
53. Little, Rich; Hobday, Alistair; Parslow, John; Davies, Campbell; Grafton, Quentin. Funding climate adaptation strategies with climate derivatives. Climate Risk Management. 2015; 8(- -):9-15. https://doi.org/10.1016/j.crm.2015.02.002
54. Lubieniecki, Krzysztof; Botwright, Natasha; Taylor, Richard; Evans, Brad; Cook, Mat; Davidson, William. Expression analysis of sex-determining pathway genes during development in male and female Atlantic salmon (Salmo salar). Physiological Genomics. 2015; 47(12):581-587. http://hdl.handle.net/102.100.100/91323?index=1

55. Miller, M. R.; Bridle, A. R.; Nichols, P. D.; Carter, C. G. Increased Elongase and Desaturase Gene Expression With Stearidonic Acid Enriched Diet Does Not Enhance Long-Chain (N-3) Content of Seawater Atlantic Salmon (Salmo Salar L.). Journal of Nutrition. 2008; 138(11):2179-2185. http://hdl.handle.net/102.100.100/118558?index=1
56. Miller, M. R.; Nichols, P. D.; Barnes, J.; Davies, N. W.; Peacock, E. J.; Carter, C. G. Regiospecificity profiles of storage and membrane lipids from the gill and muscle tissue of atlantic salmon (Salmo salar l.) grown at elevated temperature. Lipids. 2006; 41(9):865-876. http://hdl.handle.net/102.100.100/130039?index=1
57. Miller, M. R.; Nichols, P. D.; Carter, C. G. Replacement of dietary fish oil for Atlantic salmon parr (Salmo salar L.) with a stearidonic acid containing oil has no effect on omega-3 long-chain polyunsaturated fatty acid concentrations. Comparative biochemistry and physiology, part B. 2007; 146(2):197-206. http://hdl.handle.net/102.100.100/124801?index=1
58. Miller, M. R.; Nichols, P. D.; Carter, C. G. Replacement of fish oil with thraustochytrid Schizochytrium sp. L oil in atlantic salmon parr (Salmo salar l) diets. Comparative biochemistry and physiology, Part A. 2007; 148(2):382-392. http://hdl.handle.net/102.100.100/124101?index=1
59. Miller, M.; Nichols, P. D.; Carter, C. The Digestibility and Accumulation of Dietary Phytosterols in Atlantic Salmon (Salmo salar L.) Smolt Fed Diets with Replacement Plant Oils. Lipids. 2008; 43:549-557. http://hdl.handle.net/102.100.100/118150?index=1
60. Mohr, Peter; Moody, Nick; Williams, Nette; Hoad, John; Crane, Mark. Molecular characterization of Tasmanian aquabirnaviruses from 1998 to 2013. Diseases of Aquatic Organisms. 2015; 116:1-9. https://doi.org/10.3354/dao02903
61. Morrison, R. N.; Crosbie, P. B. B.; Cook, M. T.; Adams, M. B.; Nowak, B. F. Cultured gill-derived neoparamoeba pemaquidensis fails to elicit amoebic gill disease (agd) in atlantic salmon salmo salar. Diseases of aquatic organisms. 2005; 66(2):135-144. http://hdl.handle.net/102.100.100/180569?index=1
62. Nichols, Peter; Glencross, Brett; Petrie, James; Singh, Surinder. Readily Available Sources of Long-chain Omega-3 Oils: Is Farmed Australian Seafood a Better Source of the Good Oil Than Wild-Caught Seafood?. Nutrients. 2014; 6(3):1063-1079. https://doi.org/10.3390/nu6031063
63. Nichols, Peter; Nuez-Ortin, Waldo; Carter, Chris; Cooke, Ira; Wilson, Richard. Liver proteome response of pre-harvest Atlantic salmon following exposure to elevated temperature. BMC Genomics. 2018; 19:133. https://doi.org/10.1186/s12864-018-4517-0
64. Nichols, Peter; Nuez-Ortin, Waldo; Carter, Chris; Wilson, Richard; Cooke, Ira; Amoroso, Gianluca; et al. Triploid Atlantic salmon shows similar performance, fatty acid composition and proteome response to diploids during early freshwater rearing. Comparative Biochemistry and Physiology D-Genomics & Proteomics. 2017; 22:67-77. https://doi.org/10.1016/j.cbd.2017.02.005
65. Nichols, Peter; White, Chris; Ross, D.J.; Dempster, Tim. Dispersal and assimilation of an aquaculture waste subsidy in a low productivity coastal environment. Marine Pollution Bulletin. 2017; 120(1-2):309-321. https://doi.org/10.1016/j.marpolbul.2017.05.042
66. Nuez-Ortin, Waldo; Carter, Chris; Wilson, Richard; Cooke, Ira; Nichols, Peter. Preliminary Validation of a High Docosahexaenoic Acid (DHA) and -Linolenic Acid (ALA) Dietary Oil Blend: Tissue Fatty Acid Composition and Liver Proteome Response in Atlantic Salmon (Salmo salar) Smolts. PLoS ONE. 2016; 11(8):e0161513. https://doi.org/10.1371/journal.pone.0161513
67. Oliver, Eric; Lago, Veronique; Hobday, Alistair; Holbrook, Neil; Ling, Scott; Mundy, Craig. Marine heatwaves off eastern Tasmania: Trends, interannual variability, and predictability. Progress in Oceanography. 2018; 161:116-130. https://doi.org/10.1016/j.pocean.2018.02.007

68. Ortin, Waldo; Carter, Chris; Nichols, Peter; Wilson, Richard. Sequential protein extraction as an efficient method for improved proteome coverage in larvae of Atlantic salmon (Salmo salar). Proteomics. 2016; 16(14):2043-2047.
https://doi.org/10.1002/pmic.201600051
69. Polymeropoulos, Elias; Elliott, Nick; Frappell, Peter. The maternal effect of differences in egg size influence metabolic rate and hypoxia induced hatching in Atlantic salmon eggs: implications for respiratory gas exchange across the egg capsule. Canadian Journal of Fisheries and Aquatic Sciences. 2016; 73(8):1173-1181.
https://doi.org/10.1139/cjfas-2015-0358
70. Polymeropoulos, Elias; Plouffe, D; LeBlanc, S; Elliott, Nick; Currie, S; Frappell, Peter. Growth hormone transgenesis and polyploidy increase metabolic rate, alter the cardiorespiratory response and influence HSP expression to acute hypoxia in Atlantic salmon (Salmo salar) yolk-sac alevins. Journal of Experimental Biology. 2014; 217:2268-2276.
http://hdl.handle.net/102.100.100/94688?index=1
71. Reilly, A.; Elliott, N. G.; Grewe, P. M.; Clabby, C.; Powell, R.; Ward, R. D. Genetic differentiation between Tasmanian cultured Atlantic salmon (Salmo salar L.) and their ancestral Canadian population: comparison of microsatellite DNA and allozyme and mitochondrial DNA variation. Aquaculture. 1999; 173(1-4):459-469.
http://hdl.handle.net/102.100.100/214242?index=1
72. Salinger, Jim; Hobday, Alistair; Matear, Richard; O'Kane, Terry; Risbey, James; Dunstan, Piers; et al. Decadal - Scale Forecasting of Climate Drivers for Marine Applications. Advances in Marine Biology. 2016; 74:1-68.
https://doi.org/10.1016/bs.amb.2016.04.002
73. Skerratt, Jenny; Wild-Allen, Karen; Rizwi, Farhan; Whitehead, Jason; Coughanowr, Christine. Use of a high resolution 3D fully coupled hydrodynamic, sediment and biogeochemical model to understand estuarine nutrient dynamics under various water quality scenarios. Ocean and Coastal Management. 2013; 83:52-66.
https://doi.org/10.1016/j.ocecoaman.2013.05.005
74. Spillman, Claire; Hobday, Alistair. Dynamical seasonal ocean forecasts to aid salmon farm management in a climate hotspot. Climate Risk Management. 2014; 1:25-38.
https://doi.org/10.1016/j.crm.2013.12.001
75. Stokes, C.; Howden, M. Adapting Agriculture to Climate Change : Preparing Australian Agriculture, Forestry and Fisheries for the Future. Melbourne: CSIRO Publishing; 2010.
http://hdl.handle.net/102.100.100/109287?index=1
76. Taylor, R. S.; Crosbie, P. B.; Cook, M. T. Amoebic Gill Disease Resistance Is Not Related to the Systemic Antibody Response of Atlantic Salmon, Salmo Salar L. Journal of Fish Diseases. 2010; 33(1):1-14.
http://hdl.handle.net/102.100.100/108765?index=1
77. Taylor, R. S.; Kube, P. D.; Muller, W. J.; Elliott, N. G. Genetic Variation of Gross Gill Pathology and Survival of Atlantic Salmon (Salmo Salar L.) During Natural Amoebic Gill Disease Challenge. Aquaculture. 2009; 294(3-4):172-179.
http://hdl.handle.net/102.100.100/112591?index=1
78. Taylor, R. S.; Wynne, J. W.; Kube, P. D.; Elliott, N. G. Genetic variation of resistance to Amoebic Gill Disease in Atlantic salmon (Salmo salar) assessed in a challenge system. Aquaculture. 2007; 272(Suppl 1):S94-S99.
https://doi.org/10.1016/j.aquaculture.2007.08.007
79. Taylor, R; MULLER W; Cook, M; Kube, P; Elliott, N. Gill observations in Atlantic salmon (Salmo salar, L.) during repeated amoebic gill disease (AGD) field exposure and survival challenge. Aquaculture. 2009; 290(1-2):1-8.
http://hdl.handle.net/102.100.100/113867?index=1
80. Thompson, P.; Wild-Allen, K.; Macleod, C.; Swadling, K.; Blackburn, S. I.; Skerratt, J.; et al. Monitoring the Huon Estuary and D'Entrecasteaux Channel for the effects of finfish aquaculture. In: Volkman, J. K.; Thompson, P.; Herzfeld, M.; Wild-Allen, K.; Blackburn, S. I.; Macleod, C.; Swadling, K. ; Foster, S.; Bonham, P. I.; Holdsworth, D.G.; Clementson, L. A.; Skerratt, J.; Rosebrock, U.; Andrewartha, J. R.; Revill,

A.T., editor/s. A whole-of-ecosystem assessment of environmental issues for salmonid aquaculture. Hobart: CSIRO Marine and Atmospheric Research; 2008. http://hdl.handle.net/102.100.100/121970
81. Volkman, J. K.; Thompson, P.; Herzfeld, M.; Wild-Allen, K.; Blackburn, S. I.; Macleod, C.; et al. A whole-of-ecosystem assessment of environmental issues for salmonid aquaculture. Hobart: CSIRO Marine and Atmospheric Research; 2009. http://hdl.handle.net/102.100.100/115263
82. Wade, Nick; Clark, Timothy; Maynard, Ben; Atherton, Stuart; Wilkinson, Ryan; Smullen, Richard; et al. Effects of an unprecedented summer heatwave on the growth performance, flesh colour and plasma biochemistry of marine cage-farmed Atlantic salmon (Salmo salar). Journal of Thermal Biology. 2019; 80:64-74.
https://doi.org/10.1016/j.jtherbio.2018.12.021
83. Walger de Camargo Lima, Paula; Botwright, Natasha; Harris, James; Cook, Mat. Development of an in vitro model system for studying bacterially expressed dsRNA-mediated knockdown in Neoparamoeba genus. Marine Biotechnology. 2014; 16(4):447-455.
https://doi.org/10.1007/s10126-014-9561-4
84. Walger de Camargo Lima, Paula; Taylor, Richard; Cook, Mat. Involvement of contractile vacuoles in the osmoregulation process of the marine parasitic amoeba Neoparamoeba perurans. Jounal of Fish Diseases. 2015; 39(5):629-633.
https://doi.org/10.1111/jfd.12408
85. Walger de Camargo Lima, Paula; Taylor, Richard; Cook, Mat. Pseudocyst formation in the marine parasitic amoeba Neoparamoeba perurans: a short-term survival strategy to abrupt salinity variation. Journal of Fish Diseases. 2017; 40(8 .):1109-1113.
https://doi.org/10.1111/jfd.12588
86. Ward, R. D.; Grewe, P. M.; Smolenski, A. J. A comparison of allozymes and mitochondrial DNA in Atlantic salmon from Tasmania and from the ancestral population in Canada. Aquaculture. 1994; 126:257-264.
87. Wild-Allen, Karen; Andrewartha, John. Connectivity between estuaries influences nutrient transport, cycling and water quality. Marine Chemistry. 2016; 185:12-26.
https://doi.org/10.1016/j.marchem.2016.05.011
88. Wild-Allen, Karen; Herzfeld, Mike; Thompson, Peter; Rosebrock, Uwe; Parslow, John; Volkman, John. Applied coastal biogeochemical modelling to quantify the environmental impact of fish farm nutrients and inform managers. Journal of Marine Systems. 2010; 81(1-2):134-147.
https://doi.org/10.1016/j.jmarsys.2009.12.013
89. Wild-Allen, Karen; Herzfeld, Mike; Thompson, Peter; Rosebrock, Uwe; Parslow, John; Volkman, John. Applied coastal biogeochemical modelling to quantify the environmental impact of fish farm nutrients and inform managers.. Journal of Marine Systems. 2010; 81(1-2):134-147.
https://doi.org/10.1016/j.jmarsys.2009.12.013
90. Wild-Allen, Karen; Rayner, Mark. Continuous nutrient observations capture fine-scale estuarine variability simulated by a 3D biogeochemical model.. Journal of Marine Chemistry. 2014; 167:135-149.
https://doi.org/10.1016/j.marchem.2014.06.011
91. Wild-Allen, Karen; Skerratt, Jenny; Whitehead, Jason; Rizwi, Farhan; Parslow, John. Mechanisms driving estuarine water quality: a 3D biogeochemical model for informed management. Estuarine, Coastal and Shelf Science. 2013; 135:33-45.
http://hdl.handle.net/102.100.100/95727?index=1
92. Wild-Allen, Karen; Thompson, Peter; Volkman, John; Parslow, John. Use of a coastal biogeochemical model to select environmental monitoring sites. Journal of Marine Systems. 2011; 88(1):120-127.
https://doi.org/10.1016/j.jmarsys.2011.02.017
93. Wong, F. Y.; Carson, J.; Elliott, N. G. Application of SSU rRNA sequence analysis to the identification and detection of the agent of amoebic gill disease in sea-caged Atlantic salmon (Salmo salar). Aquaculture. 2002; 204(3-4):251.
http://hdl.handle.net/102.100.100/198990?index=1
94. Wood, Andrew; Clark, Timothy; Andrewartha, Sarah; Elliott, Nick; Frappell, Peter. Developmental hypoxia has negligible effects on long-term hypoxia tolerance and aerobic metabolism of Atlantic

salmon (Salmo salar). Physiological and Biochemical Zoology. 2017; 90(4):494-501. https://doi.org/10.1086/692250
95. Wood, Andrew; Clark, Timothy; Elliott, Nick; Frappell, Peter; Andrewartha, Sarah. Physiological effects of dissolved oxygen are stage-specific in incubating Atlantic salmon (Salmo salar). Journal of Comparative Physiology B. 2019; 189(1 -):109-120. https://doi.org/10.1007/s00360-018-1199-5
96. Wynne, J. W.; Cook, M. T.; Holmes, B. H.; Elliott, N. G. Allelic and haplotypic diversity at the major histocompatibility class II within domesticated Australian Atlantic salmon (Salmo salar L.). Journal of fish biology. 2007; 70(sa):45-59. https://doi.org/10.1111/j.1095-8649.2007.01364.x
97. Wynne, J. W.; Cook, M. T.; Nowak, B. F.; Elliott, N. G. Major histocompatibility polymorphism associated with resistance towards Amoebic Gill Disease in Atlantic Salmon (Salmo Salar L.). Fish and shellfish immunology. 2007; 22(6):707-717. https://doi.org/10.1016/j.fsi.2006.08.019
98. Wynne, J. W.; Cook, M. T.; Nowak, B. F.; Elliott, N. G. Possible links between MH polymorphism and resistance to AGD in Atlantic salmon Salmo salar. Aquaculture. 2007; 272(Suppl 1):S318-S319. https://doi.org/10.1016/j.aquaculture.2007.07.203
99. Wynne, J. W.; O'Sullivan, M.; Cook, M.; Stone, G.; Nowak, B.; Lovell, D.; et al. Transcriptome Analyses of Amoebic Gill Disease-affected Atlantic Salmon (Salmo salar) Tissues Reveal Localized Host Gene Suppression. Marine Biotechnology. 2008; 10(4):388-403. https://doi.org/10.1007/s10126-007-9075-410.1007/s10126-007-9075-4
100. Wynne, J.W.; Cook, M.T.; Nowak, B.; Lovell, D.; O'Sullivan, M.G.; Stone, G.; et al. Associations between differential gene expression and increased aged resistance in Atlantic salmon Salmo salar. Aquaculture. 2007; 272(suppl. 1):S318. https://doi.org/10.1016/j.aquaculture.2007.07.202
101. Zainathan, Sandra; Carlile, Gemma; Carson, Jeremy; McColl, Ken; Crane, Mark; Williams, Nette; et al. Development and application of molecular methods (PCR) for detection of Tasmanian Atlantic salmon reovirus. Journal of Fish Diseases. 2015; 38(8):739-754. https://doi.org/10.1111/jfd.12291
102. Zainathan, Sandra; Carson, Jeremy; Crane, Mark; Nowak, Barbara. Laboratory evaluation of sample collection methods (organs vs swabs) for Tasmanian salmon reovirus detection in farmed Atlantic salmon, Salmo salar L.. Journal of Fish Diseases. 2013; 36(4):427-436. https://doi.org/10.1111/jfd.12012
103. Zainathan, Sandra; Carson, Jeremy; Crane, Mark; Williams, Nette; Hoad, John; Moody, Nick; et al. Preliminary characterization of Tasmanian Aquareovirus (TSRV) isolates. Archives of Virology. 2016; 162:625-635. https://doi.org/10.1007/s00705-016-3132-0
104. Zarkasi, Kamarul; Abell, Guy; Taylor, Richard; Glencross, Brett; Tamplin, Mark; Bowman, John. In vitro growth characteristics of dynamic Atlantic salmon (Salmo salar L.) gastrointestinal microbial community in relation to different diet formulations. Aquaculture Nutrition. 2017; 168(8):751-759. https://doi.org/10.1016/j.resmic.2017.07.003
105. Zarkasi, Kamarul; Abell, Guy; Taylor, Richard; Neuman, Christina; Hatje, Eva; Tamplin, Mark; et al. Molecular and culture based characterisation of gastrointestinal tract bacteria of Atlantic salmon (Salmo salar L.) within a commercial mariculture system in south-eastern Tasmania. Applied and Environmental Microbiology. 2014; 117(1):18-27. http://hdl.handle.net/102.100.100/94560?index=1
106. Zarkasi, Kamarul; Abell, Guy; Taylor, Richard; Neuman, Christina; Hatje, Eva; Tamplin, Mark; et al. Pyrosequencing-based characterization of gastrointestinal bacteria of Atlantic salmon (Salmo salar L.) within a commercial mariculture system. Journal of Applied Microbiology. 2014; 17(1):18-27. https://doi.org/10.1111/jam.12514
107. Zarkasi, Kamarul; Taylor, Richard; Abell, Guy; Tamplin, Mark; Glencross, Brett; Bowman, John. Atlantic salmon (Salmo salar L.) gastrointestinal microbial community dynamics in relation to digesta

properties and diet. Microbial Ecology. 2016; 71(3):589-603.
https://doi.org/10.1007/s00248-015-0728-y