



Department of
Primary Industries

Aquaculture Research Advisory Committee

Annual Report

July 2015 to June 2016

Professor Ian White (Chairperson)
Ms Jo Pickles (Executive Officer)



Title: Aquaculture Research Advisory Committee – Annual Report 2015/16

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (August/September 2016). However, because of advances in knowledge, users are reminded of the need to ensure that information on which they rely is up to date and to check the currency of the information with the appropriate officer of the NSW Department of Primary Industries or the user’s independent advisor.

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Chairpersons Report



Our corner store family-owned supermarket has started stocking locally produced smoked trout, pictured above. The demand for it has been phenomenal. The other day a customer had just bought 15 fillets. When I asked her why so many she replied “It’s superb tasting, has great health benefits and it comes from a pristine environment.” I was impressed both by her knowledge and enthusiasm, but also a little miffed as she had bought out the remainder of the entire weekly stock.

After she had left, I reflected on the cumulative and collective effort that had gone into producing and marketing those filets. They are the net result, not just of the immense effort and investment of the farmer, but also of the long-term, collaborative effort of farmers, their associations, regulators, researchers and governments. An effort which has faced many challenges such as our highly variable climate, changing land-uses, diseases and financial crises. It has been a privilege, over the past two decades, to see the role that the Aquaculture Research Advisory Committee has had and continues to have in contributing to that effort.

This year has seen some significant gains in aquaculture. ARAC has long-argued that extension of research and best practices is a fundamentally important strategy for aquaculture to increase efficiency, boost production and assist new entrants to the industry. ARAC is delighted that Ocean Watch has secured funding to appoint an oyster industry extension officer. This is a timely appointment. Disease challenges, which have hit the Tasmanian oyster industry hard, are ever present. Fortunately with the researchers, fisheries officers and testing and diagnostic facilities within NSW Department of Primary Industries (DPI) and the Food Authority, together with vigilant farmers, we can now respond rapidly and effectively to these challenges.

I am extremely grateful to the farmer members for their outstanding and selfless contributions. I am also indebted to NSW DPI and Food Authority staff who have contributed to ARAC. Their professionalism, dedication and diligence have been exemplary. The FRDC and the now-closed Australian Seafood CRC have been generous supporters of the NSW aquaculture industry for which ARAC is very appreciative. Finally ARAC is grateful to the Minister and NSW DPI for their continued support for and encouragement of aquaculture.

ARAC remains committed to increasing the sustainability, profitability and growth of the aquaculture in NSW and its contribution to human health and regional communities through applicable, targeted, high-quality research and innovation. It is a great pleasure to present this report on activities of the NSW Aquaculture Research Advisory Committee.

A handwritten signature in black ink, appearing to read 'Ian White', is written in a cursive style.

Emeritus Professor Ian White FTSE
CHAIR ARAC

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This report was compiled in August/September 2016

Preamble

This is the eighth Annual Report for the Aquaculture Research and Advisory Committee (ARAC). The Minister for Primary Industries approved the formation of the Aquaculture Research Advisory committee in October 2005 to provide advice on industry contributions and R&D expenditure for all aquaculture industries in NSW. Confirmation for ARAC's establishment was confirmed in 2006 after the completion of a NSW Government review of Boards and Committees. ARAC has replaced the Oyster Research Advisory Committee (ORAC) and the former Advisory Council on Aquaculture (ACoA).

ORAC was formally disbanded after its meeting in December 2005.

The Committee

The Aquaculture Research Advisory Committee (ARAC) was established in October 2006 and held its inaugural meeting on 31 January 2007.

ARAC is a statutory committee that advises the Minister on the amount of contributions payable by the NSW aquaculture industries into trust accounts for aquaculture research and development and the expenditure of those trust funds. The NSW prawn aquaculture industry is not included as it pays research levies directly to the Commonwealth.

ARAC is established under Section 157 of the *Fisheries Management Act 1994*.

Terms of Reference

- 1 Investigate and evaluate the requirement for aquaculture research and development in NSW, after consultation with NSW aquaculture industries and with reference to NSW, Australian and overseas experience, and whether funded by the Fisheries Research and Development Corporation or otherwise;
- 2 Revise as appropriate research and development plans for NSW aquaculture research and development and promote it to the wider research community;
- 3 Advise the appropriate NSW Fisheries Research Advisory bodies and the Fisheries Research and Development Corporation on NSW aquaculture research and development matters and priorities;
- 4 Advise the NSW Minister for Primary Industries on the level of funding from industry required for aquaculture research and development in NSW and on its expenditure.
- 5 Oversee the management of annual contributions for aquaculture research collected under Section 156 of the *Fisheries Management Act 1994*, and placed in separate trust accounts under Section 157 of the *Fisheries Management Act 1994*.
- 6 Report on a regular basis, including an Annual Report based on a financial year, to the NSW aquaculture industry, the NSW Minister for Primary Industries and NSW researchers on aquaculture research and development initiatives;
- 7 Facilitate the dissemination, adoption and commercialisation of the results of aquaculture research and development; and
- 8 Promote aquaculture research and development in NSW.

Membership and Selection Process

The *Fisheries Management (Aquaculture) Regulation 2012*, schedule 1 provisions relating to members and procedure of committee, section 2, states:

- 1 The Minister may convene a selection committee (including representatives of the aquaculture industry) for the purpose of recommending persons for appointment as members of a committee.
- 2 The Chairperson of a committee is to be the member of the committee for the time being appointed by the Minister as Chairperson.
- 3 Section 157 (7) of the Act requires the Minister to ensure that a majority of the members of the committee are representatives of the aquaculture industry.

Industry members of ARAC are appointed by the Minister through a competitive selection process from Aquaculture Permit holders who have submitted expressions of interest to join the committee. A selection committee is appointed, comprised of a representative from the NSW Farmers Association, one representative from the Seafood CRC and the NSW Department of Primary Industries (Fisheries Division). Industry members are selected on merit.

The Chairperson is appointed to the committee by the Minister.

To aid the committee with their function, NSW Department of Primary Industries personnel attend meetings and undertake the role of facilitator and secretariat.

Deputy Members

The *Fisheries Management (Aquaculture) Regulation 2012*, schedule 1 provisions relating to members and procedure of committee, section 3, states:

- 1 The Minister may, from time to time, appoint a person to be the deputy of a member, and at any time revoke any such appointment.

Committee Members in 2015/16

Member	Representing	Date of Appointment	Expiry Date
Prof. Ian White	Independent Chair	Oct 2006	Sept 2018
Ms Milada Safarik	Industry	Oct 2009	Sept 2018
Mr Tony Troup	Industry	Oct 2006	Sept 2018
Mr Ewan McAsh	Industry	Oct 2009	Sept 2015
Mr Russell Sydenham	Industry	Mar 2012	Sept 2018
Dr Matthew Wassnig	Industry	Sept 2012	Sept 2018
Ms Jessica Zealand	Industry	April 2014	Sept 2018
Ms Anne Loftus	Industry	Sep 2015	Sept 2018

There are six members on ARAC, four lease-based (oyster) representatives and two land-based (non-oyster) representatives, which reflects the relative sizes of the industry sectors in NSW. All members of ARAC, including the independent Chairperson, are appointed for a term of three years.

In September 2015, all seven terms of appointment were due to expire. NSW DPI mailed expressions of interest to all aquaculture permit holders in NSW, seeking to fill these vacancies. A selection panel was convened to consider the applications and recommend suitable candidates to the Minister for NSW Primary Industries. Mr Ewan McAsh did not seek re-appointment. All other ARAC members were re-appointed for a further 3 year term. The Minister appointed Mrs Anne Loftus as the new member to replace Ewan McAsh. Mrs Loftus and her family have been connected to oyster farming for 57 years and their business, Loftus Oysters on Wonboyn Lake, has been farming with modern infrastructure and a passion for the environment.

Dr Wayne O'Connor (Research Leader, Aquaculture), Dr Michael Dove (Research Scientist, Molluscs), Mr Ian Lyall (Manager, Aquaculture) and Ms Debra Doolan/Mr Ben Rampano or Mr Jeffrey Go (Aquatic Biosecurity Officer, Aquatic Biosecurity and Risk Management) from NSW Department of Primary Industries sat as observers on the Committee for 2015/16. Ms Jo Pickles from NSW Department of Primary Industries is the Executive Officer. Mr Anthony Zammit (NSW Food Authority) also sat as an observer.

Meetings

Three meetings were held during the financial year 2015/16:

Member	20 August 2015	19 November 2015	13 April 2016
Prof. Ian White	x	✓	x
Mr Tony Troup	x	✓	✓
Ms Milada Safarik	✓	✓	✓
Mr Ewan McAsh	✓	✓	✓
Mr Russell Sydenham	✓	✓	✓
Dr Matthew Wassnig	✓	✓	✓
Ms Jessica Zealand	x	✓	x
NSW Department of Primary Industries			
Dr Wayne O'Connor	✓	✓	✓
Dr Michael Dove	✓	✓	✓
Mr Ian Lyall (or rep)	✓	✓	✓
Ms Debra Doolan (or rep)	✓	✓	✓
Mr Anthony Zammit	✓	x	✓
Ms Jo Pickles	✓	✓	✓

Disclosure of Pecuniary Interests

Schedule 1 of the *Fisheries Management (Aquaculture) Regulation 2012* sets out provisions relating to members and committee procedure. Clause 8, sub clause 1 states a member of a committee:

- a who has a direct or indirect pecuniary interest in a matter being considered or about to be considered at a meeting of the committee, and
- b whose interest appears to raise a conflict with the proper performance of the member's duties in relation to the consideration of the matter

must, as soon as possible after the relevant facts have come to member's knowledge, disclose the nature of the interest at a meeting of the committee.

No pecuniary interests were declared in this financial year.

Trust Accounts for the 2015/16 Financial Year

Advice on Level of Contribution

Section 156 of the *Fisheries Management Act 1994* states a permit holder is required to contribute to the cost of administration or research or to other industry costs. Under section 157(4) of the *Fisheries Management Act 1994* the Minister is to appoint a committee of persons to advise the Minister on the amount of contributions payable into any trust account. Research contributions made by the aquaculture community (excluding the prawn industry) are reported to the Minister by ARAC.

Research contributions from the oyster industry have been set at \$37.00/ha/year. The amount of research contributions billed for 2015/16 was \$134,603.00.

Research contributions from the non-oyster aquaculture industry have been set at \$28/ha/year or \$134 for a minimum of 5 ha/year. The amount of research contributions billed for 2015/16 was \$24,817.00.

The required annual contribution to the Fisheries Research Development Corporation is calculated at 0.25% average gross value of production (AGVP), based on three year rolling calculations. The contribution from the oyster industry for 2015/16 was \$81,119.00 (\$89,012.00 less the fee waiver of \$7,893.00). The contribution from the non-oyster aquaculture industry for 2015/16 was \$20,819.00 (\$22,355.00 less the fee waiver of \$1,536.00).

Advice on Level of Expenditure

Section 156 of the *Fisheries Management Act 1994* states a permit holder is required to contribute to the cost of administration or research or to other industry costs. Under section 157(4) of the same Act the Minister is to appoint a committee of persons to advise the Minister on the expenditure of money in the trust account.

Expenditure Purpose and Level

The allocated expenditures for the 2015/16 financial year are outlined below:

ARAC REVENUE AND EXPENSES – 1 July 2015 to 30 June 2016		
*Note: this is an accrual accounting report for WBS E116-1 (Oyster Research Levy)		
Revenue:	Credit	Debit
Balance carried forward 30.06.2015	\$129,424.51	
Research Contributions billed 01.07.2015 to 30.06.2016 (with fee waivers from 2014/15 deducted)	\$112,419.91	
Interest earned on Trust account	\$5,616.00	
Total Revenue	\$247,460.42	
Expenses:		
Internal Transfer to Committee Account		\$8,963.32
FRDC Contribution (reduced by fee waivers for research)		\$81,119.00
Dr Kate Barclay, Uni of Technology, Sydney		\$10,000.00
Travel and associated costs for 1 ARAC member to represent on RAC		\$500.00
Total Expenses		\$100,582.32
Balance of Cost Centre as at 30.06.2016	\$146,878.10	

ARAC REVENUE AND EXPENSES – 1 July 2015 to 30 June 2016		
*Note: this is an accrual accounting report for WBS E119-1 (Aquaculture [non-oyster] Research levy)		
Revenue:	Credit	Debit
Balance carried forward 30.06.2015	\$68,185.47	
Research Contributions billed 01.07.2015 to 30.06.2016 (with fee waivers from 2014/15 deducted)	\$22,108.20	
Interest earned on Trust account	\$2,250.00	
Total Estimated Revenue	\$92,543.67	
Expenses:		
Internal Transfer to Committee Account		\$4,481.68
FRDC Contribution (reduced by fee waivers for research)		\$20,819.00
Travel and associated costs for 1 ARAC member to represent on RAC		\$500.00
Total Expenses		\$25,800.68
Balance of Centre Centre as at 30.06.2016	\$66,742.99	

ARAC COMMITTEE EXPENSES – 1 July 2015 to 30 June 2016		
*Note: this is an accrual accounting report for WBS D2492-1		
Revenue:	Credit	Debit
Balance carried forward 30.06.2015	\$0	
To be transferred from Oyster Trust account (E116-1)	\$8,963.32	
To be transferred from Non-Oyster Trust account (E119-1)	\$4,481.68	
Total Revenue	\$13,445.00	
Operating Expenses:		
Travel		\$6,532.58
Committee Fees		\$5,771.59
Consumables and postage		\$1,140.83
Total Expenditure		\$13,445.00
Balance of Cost Centre as at 30.06.2016	\$0	

Levy Collection

Billing is conducted on the financial year and permit holders have the option of paying in full by 30 September or by quarterly instalments at 30 September, 31 December, 31 March and 30 June of that year.

Money held in the NSW Department of Primary Industries Crown Trust Account does receive interest.

Forward Budget

ARAC REVENUE AND EXPENSES – 1 July 2016 to 30 June 2017 (Oyster Research Levy)		
Revenue:	Credit	Debit
Balance carried forward 30.06.2016	\$146,878.10	
Research Contributions billed 01.07.2016 to 30.06.2017	\$134,603.59	
Interest earned on Trust account	\$5,500.00	
Total Estimated Revenue	\$286,981.69	
Expenses:		
FRDC Contribution (estimate)		\$90,000.00
ARAC Committee Expenses (Internal transfer)		\$8,000.00
Travel and associated costs for 1 ARAC member to represent on RAC		\$500.00
Total Estimated Expenses		\$98,500.00
Estimated Balance as at 30.06.2017	\$188,481.69	

ARAC REVENUE AND EXPENSES – 1 July 2016 to 30 June 2017 (Aquaculture [non-oyster] Research levy)		
Revenue:	Credit	Debit
Balance carried forward 30.06.2016	\$66,742.99	
Research Contributions billed 01.07.2016 to 30.06.2017	\$24,817.49	
Interest earned on Trust account	\$2,000.00	
Total Estimated Revenue	\$93,560.48	
Expenses:		
FRDC Contribution (estimate)		\$22,000.00
ARAC Committee Expenses (Internal transfer)		\$4,000.00
Travel and associated costs for 1 ARAC member to represent on RAC		\$500.00
Total Estimated Expenses		\$26,500.00
Estimated Balance as at 30.06.2017	\$67,060.48	

ARAC COMMITTEE EXPENSES – 1 July 2016 to 30 June 2017		
Revenue:	Credit	Debit
Balance carried forward 30.06.2016	\$0.00	
Internal transfers	\$12,000.00	
Total Estimated Revenue	\$12,000.00	
Expenses:		
Consumables		\$500.00
Travel		\$7,000.00
Committee fees		\$4,500.00
Total Estimated Expenses		\$12,000.00
Estimated Balance as at 30.06.2017	\$0.00	

Recommendation on Level of Contribution

On 31 January 2007, the Committee agreed the oyster research levy should increase to \$35.00/ha/yr from \$29.00 as this amount was insufficient to maintain the contribution to FRDC at 0.25% of AGVP and operate ARAC. Letters were then written to lease-based farmers explaining the reasons for the increase. An amendment in the Regulation Review was prepared and approved to raise the levy which came into effect 2008/09. The Committee has agreed that levies be reviewed on an annual basis at the first meeting in the calendar year.

Aquaculture Permit Holders in NSW

In NSW, aquaculture occurs in fresh, estuarine and marine waters. There are several classes of aquaculture permits that are issued for the different types of aquaculture, with some farms having more than one permit. Most forms of aquaculture include Intensive farming; when the species being grown is given specially prepared feeds and Extensive farming; when the natural ecosystem of the water provides feed for the species grown.

As at June 2016 there were 298 lease-based permits (primarily involved in oyster production) and 135 land-based aquaculture businesses that have 206 permits between them authorising extensive and intensive (leases), fishout, hatchery and intensive land based activities.

List of Activities

- New research for the Marine Aquaculture Research Lease (MARL) was included in the \$100 million 'Rural Research and Development for Primary Productivity' Plan announced by Senator Barnaby Joyce (early 2015). A consortium led by FRDC, including NSW DPI, South Australian Research and Development Institute (SARDI) and Cleans Seas Tuna Ltd, was successful in securing funds. The application titled 'Growing a profitable, innovative and collaborative Australian Yellowtail Kingfish aquaculture industry: bringing 'white' fish to the market' has a total value of \$4.65 million with \$3 million being provided by the federal Department of Agriculture. The research will in part be carried out on the experimental MARL established by NSW DPI to promote marine finfish culture in NSW and the research will focus on diet development and production technology of YTK. The commercial partner for this development is Huon Aquaculture, a prominent Australian Atlantic Salmon producer. It is anticipated the five year term for experimentation/production on the MARL will commence in late 2016.
- ARAC supported an application (late 2015) from Oceanwatch who sought funding for an Extension Officer. This was through the Local Landcare Coordinators Initiative for not-for-profit organisations (such as Oceanwatch) to apply for funding to appoint Landcare coordinators - in this case with the sole purpose of providing extension services to the oyster industry. The application was successful and Mr Andy Myers is now a part-time extension officer for the oyster industry. ARAC will seek to support extension activities and encourage farmer interaction.
- The NSW DPI Aquatic Biosecurity team updated the Committee on a number of items, namely:
 - a) The *Biosecurity Act 2015* was passed by NSW Parliament. The next step was extensive consultation with industry and the community to provide feedback on any issues of concern and views on the best method to consult and engage with stakeholders. The timeline to provide feedback was February 2016. It is unlikely to result in significant changes to industry.
 - b) Biosecurity have established a technical committee developing changes to disinfectant protocols with best scientific practice. The new protocol is still being progressed.
 - c) A marine pest exercise was held in mid-November 2015 to review marine pest incursion processes and how government and industry could improve emergency response arrangements.
 - d) Pacific Oyster mortality investigations in the Clyde, Tweed, Crookhaven Rivers and Port Stephens estuary, during January to March 2016, found no evidence to indicate any disease. The only common factor seemed to be high water temperatures.
 - e) The Committee asked if there been research on the impacts of prolonged high temperatures on Pacific Oysters? Or major variations in water temperature on a regular basis?
 - f) There was a detection of Epizootic Ulcerative Syndrome (EUS) or Red spot disease in a Murray Cod facility in the Darling River (early 2016). EUS is caused by a fungus (*Aphanomyces invadans*) and shows as red lesions (sores) or deep ulcers. The source has not been determined. No further outbreaks were noted.
- ARAC provides a representative to the Research Advisory Committee (RAC) (formerly known as the FRAB) on a rotational basis. One of the RAC's key roles is to provide advice to FRDC on research proposals. Dr Matthew Wassnig has

represented ARAC since late 2014 and provided our Committee with information relating to the FRDC restructure (that took place in early 2016) and the direction for the new RACs (formerly known as the FRABs).

- Oysters Australia (OA) provided information on the OA RD&E budget and outlined the process for reviewing proposals. Unfortunately, Rachel King decided to vacate the Executive Officer position in late 2015. Rachel will be sorely missed by industry leaders and members not to mention those of us from ARAC and other research organisations. Mr Wayne Hutchinson is now the RD&E Manager for OA based in Adelaide, tel: 0439636375 or email: oystersaustralia@gmail.com.
- The UTS application by Dr Kate Barclay to investigate the socio-economic value of the NSW aquaculture industry was supported by the FRAB and successful in obtaining funding of \$132,253.00 allocated by FRDC. ARAC also contributed \$10,000.00 to the project. The NSW coastal aquaculture industry needs sound information about its economic and social contributions to coastal communities. This is important for its continued access to coastal resources and to address prevalent negative perceptions. Competing coastal uses, such as marine protected areas for conservation purposes or urban/industrial/tourism developments may compromise the viability of aquaculture. Currently there is no information available about the contribution aquaculture makes to NSW regional communities beyond the value of farm gate sales. The interviews with 34 oyster and coastal land based facilities who volunteered to take part have been completed. The final report should be completed in late 2016.
- The NSW Oyster Industry initiated, through a Steering Committee set up at the NSW Shellfish Committee meeting in May 2014, a strategic planning study to identify the critical impediments to improved profitability and growth of the NSW Oyster Industry and develop strategic actions to mitigate them. ARAC contributed \$10,000.00 to the project. ACIL Allen Consulting were contracted for the work and the NSW Oyster Industry Strategy is now complete and includes a vision and 12 strategic priorities to improve the prosperity of the industry. The strategy was presented and discussed at the two Oyster Field Days in late May 2015. An Implementation Group has been created (11 growers with geographically spread representation) to prioritise recommendations and develop milestones to achieve outcomes. The co-Chairs of the Steering Committee and JP Van Moort (ACIL Allen) met with the Minister Niall Blair in August 2015 to highlight the development of the plan and discuss future industry/government collaboration. The Implementation Group held a workshop in February 2016 at the Sydney Fish Markets and developed a series of short, medium and long term actions to address key priorities. These were provided to the broader industry by SMS. The Group will be writing to Shellfish Committee to update them and seek concurrence to move forward on priorities.
- A draft of a NSW Aquaculture Investment Strategy was provided to ARAC for comment. NSW DPI has been linking in with the International Engagement Team to discuss opportunities for foreign investment and export promotion of oysters and Murray Cod. NSW DPI will keep seeking financial resources to promote investment.
- The Marine Estate Management Authority advised of the Hawkesbury Shelf Marine Bioregion Assessment with the aim of developing options to enhance marine biodiversity conservation while achieving balanced outcomes including opportunities for boating, fishing and other uses. The bioregion extends from Newcastle in the north to Shellharbour in the south and includes the coastline, estuaries, coastal lakes and lagoons, beaches and ocean waters out to three nautical miles. The community

are being asked to provide information on benefits and threats associated with their favourite sites within the region. To provide your views, access the web portal at: <http://www.marine.nsw.gov.au/key-initiatives/hawkesbury-shelf-marine-assessment/hawkesbury-shelf-marine-bioregion-assessment-webportal>

- Minor Use Permits (MUPs) remain an important issue nationally. The Australian Pesticides and Veterinary Medicines Authority (APVMA) administers a permits scheme that allows for the legal use of chemicals in certain ways that are contrary to the label instructions or, in certain circumstances allows for the limited use of an unregistered chemical product. There are differences between states at present and we are constrained in NSW regarding veterinary scripts as they only apply to one individual animal (not practical with a tank or pond full of fish). Industry requires MUPs and there are trade implications without them. NSW DPI and education facilities such as schools, TAFE's and Universities require MUPs. At present the National Aquaculture Council (NAC) approved MUPs only available to their members. The issue was raised with the national Aquaculture Committee to seek a resolution.
 - The Australian Government has committed \$8 million over 4 years to help farmers gain improved access to safe and effective agricultural and veterinary (agvet) chemicals, to assist them in producing food for Australia and the world.
 - The federal Dept of Agriculture is working closely with the APVMA, grower groups, rural Research and Development Corporations and the chemical industry to deliver this commitment.
 - NSW DPI is linking with the Freshwater Native Fish Assoc. (previously the Silver Perch Growers Assoc.) and the NSW Aquaculture Assoc. to put forward that registration should be more broadly spread for researchers ie. NSW DPI and education facilities such as schools, TAFE's and Universities who require MUPs.
 - Efforts are ongoing, however, industry are frustrated with the timeline. ARAC's preference would be for this to be resolved at a national level.

- Wallis Lake oyster farmers sought research on why growth rates in their estuary are declining. NSW DPI funded an extension of the NSW Oyster Strategy consultancy brief to better understand the productivity decline in Wallis Lake. This was carried out by ACIL Allen and JP Van Moort met with growers in May 2015. The review identified: productivity decline; production systems; marketing and training, access to business support and intra-industry collaboration as key areas that need attention.
 - A working group has been established to investigate possible causes for the poor oyster performance at the major nursery areas. The working group includes representatives from NSW DPI, Great Lakes Council, Local Land Services, Office of Environment & Heritage (OEH), Wallis Lake commercial fishers and the Wallis Lake oyster industry.
 - It was confirmed that since 2011, Wallis Lake has been experiencing poor oyster growth with production falling by around 40% by 2015.
 - In early April 2016 Wallis Lake oyster farmers have, in cooperation with NSW DPI, commenced a trial of alternative farming methods at two poorly performing nursery sites. The objective of this trial is to determine if these methods offer a commercially viable alternative to currently used poorly performing post and rail lease infrastructure in these areas.

- The land-based aquaculture industry in the last 12 months has seen an increase in the development of aquaculture farms growing Murray Cod. Griffith region Murray Cod producers came together at a NSW DPI workshop in June 2015 to investigate

how they could cooperatively develop their industry. The group considered: development approvals and Council interaction; fish husbandry; health management; feed; water quality; and access to markets both in Australia and overseas. The group is moving forward and has funding. NSW DPI is assisting with information regarding the export market. These farms are being developed predominantly in the Griffith region of NSW and the farms are using floating cage systems in small irrigation dams. The water from these facilities is then used on neighbouring agriculture crops. FRDC and NSW DPI funded a review of the Murray Cod Industry RD&E needs in early 2016. The outcomes will be presented at an industry workshop planned for August.

- NSW DPI is preparing a NSW Marine Waters Sustainable Aquaculture Strategy that will be available for comment in the near future. The strategy (like OISAS) will provide a platform for future marine aquaculture development.
- Steve McOrrie provided information on the 2016 Sydney Royal Fine Food Show - Aquaculture Competition. Aquaculture products are now sharing the stage with fine wines, and other more traditional branded fine food products. The Aquaculture Competition provides a unique opportunity for producers to have their products rigorously assessed and benchmarked by a panel of expert judges and increase the profile of their product and their aquaculture industry sector with consumers and food industry professionals. A Sydney Royal medal also provides a unique opportunity for producers to promote their brand, leverage a better price in the market place and open new market opportunities. More information regarding the Sydney Royal Fine Food Show is available at: <http://www.sydneymarsh.com.au/1587.htm>
- The FRDC Contribution for 2015/16 was discussed ie. the research levies that had been calculated for oysters and non-oyster aquaculture in NSW that are due to the FRDC. The money collected from oyster based levies goes to FRDC and, on advice from Oysters Australia, is used to support aquaculture research in NSW. A small portion of the levy contributes to the running of ARAC and to fund other small research activities. The contribution to FRDC is calculated at 0.25% average gross value of production (AGVP), based on three-year rolling averages. ARAC approved the dispersal of these funds to FRDC.
- Concerns were raised about logging in the catchment and the runoff into Wonboyn Lake (causing the lake to turn orange in late 2014). An independent soil scientist found this is a rare clay based soil and the sediment does not breakdown. The soil creates major water quality issues after rainfall. Forestry are logging 350 km² in that area and Wonboyn Lake is 6 km inland from the sea and so the runoff is not easily dispersed. Anne Loftus is seeking assistance to have forestry/agriculture practices changed. There is also the question of toxic retardants when Forestry burn off and the run-off into the lake. Professor Sandy Jones from the EPA, local industries and the community has been assisting with this issue.
- DPI assisted the Environmental Protection Authority (EPA), NSW Health and Hunter Water as part of a multi-agency response following a contamination incident at the Williamstown Royal Australian Air Force (RAAF) Base, near Newcastle (September 2015).
 - Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are substances that were historically used in fire-fighting foams. They were used at RAAF Williamstown in fire-fighting training and operations prior to a change in Defence policy.

- The NSW Government has established an Expert Panel led by the NSW Chief Scientist & Engineer, Mary O'Kane. Under Professor O'Kane's leadership, the EPA, NSW Health, the DPI, NSW Food Authority, Hunter Water and independent experts in contamination and public health will assess and confirm the nature of any potential risk of the contamination and what has to happen next.
 - Tilligerry has been closed to fishers for almost 12 months. Oysters have been tested and are not a threat to human health, however, strong concerns were raised that the local Oyster industry is suffering brand damage.
 - Oyster farmers received no compensation, whereas fishers were given an income assistance package. Other primary producers were not included.
- ARAC has started sending an SMS alert to all Aquaculture Permit holders after each of our meetings. Along the lines of 'ARAC just met' and attaching a link to the Summary of Discussions. This arose from the NSW Oyster Industry Strategy that found industry engagement is lacking and extension is important.
 - NSW DPI is continuing to support a range of post-graduate students investigating Aquaculture related questions in 2014/15. Projects include:
 - a) Angela Liu (Hons UNSW). Stable isotope analysis of the contribution of microalgal diets to growth and survival of Pacific oyster *Crassostrea gigas* larvae (Michael Dove).
 - b) Tatt Sheng Lai (Hons UNSW). The effects of iron precipitates on settlement, survival and early stage growth of the Sydney rock oyster *Saccostrea glomerata* (Michael Dove).
 - c) Monika Alic (Hons USyd). Effects of photoperiod and larval density on production of larval mulloway, *Argyrosomus japonicas* (Stewart Fielder).
 - d) Jack O'Connor (PhD UTS and Australian Museum). Sensory ecology of orientation behaviour in larval Perciform fishes (Stewart Fielder).
 - e) Stephan O'Connor (PhD UTAS). Improved rearing and settlement technology for flat oysters (Natalie Moltschaniwskyj and Wayne O'Connor).
 - f) John Wright (PhD UWS). Climate change and predator prey interactions with Pacific oysters (Wayne O'Connor).
 - g) Elliot Scanes (PhD UWS). The effects of multiple stressors including climate change on the oyster populations of Port Jackson NSW (Wayne O'Connor).
 - h) Vu Van In (PhD USC). Transcriptomic changes during reproductive development of Sydney rock oysters (Wayne O'Connor).
 - i) Nicole Ertyl (PhD USC). Transcriptomic responses to stress in Sydney rock oysters (Wayne O'Connor).
 - j) Olivia Goncalves (PhD MqU). Adapting to climate change: Identification of molecular markers associated with ocean acidification in oysters (Wayne O'Connor).
 - k) Mitch Gibbs (Hons UWS). Climate change impacts on lipid metabolism in Sydney rock oysters (Wayne O'Connor).
 - l) Vivian Cumbo (Post Doc MqU). Genetic solution or dilution: can selective breeding future-proof oysters? (Wayne O'Connor).
 - m) Laura Parker (Post Doc USyd). Climate change impacts on Sydney Rock Oysters (Wayne O'Connor).
 - n) Caleb Rankin (Hons UoN). Shell shape in cultured Sydney Rock Oysters (*Saccostrea glomerata*): the influence of growout methods and selective breeding (Natalie Moltschaniwskyj).
 - o) Michael Lewis (PhD Deakin University Warrnambool). Comparative digestibility of in-vivo and in-vitro techniques (Mark Booth).

- p) Dam Thi My Chinh (PhD USC). The effects of ingredient mixtures on gene expression and microbial communities in the digestive tract of yellowtail kingfish (Mark Booth).
- q) Angela Liu (PhD UNSW). Use of stable isotopes to evaluate ingredient utilisation in juvenile YTK (Mark Booth).
- r) Marina Rubio Benito (Master Degree, Wageningen University, Netherlands). Effect of dissolved oxygen on utilisation of digestible protein and energy in juvenile YTK (Mark Booth).
- s) Caroline Candebat (Hons Macquarie University & University of Hamburg, Germany). Effect of diet on routine metabolic rate and hypoxia tolerance in juvenile YTK (Mark Booth).

Information on any of these projects can be obtained by contacting the appropriate supervisor at the PSFI.

Aquaculture Research and Development currently being undertaken by NSW Department of Primary Industries

The priorities for aquaculture research are largely driven by the need to overcome constraints to profitable culture. These are assessed on the basis of the estimated potential for environmentally-sustainable growth of the industry relative to the costs and benefits involved. The key species that should be studied need to be identified and the most important aspects of their hatchery production, grow-out technology or post-harvest treatment need to be researched.

The NSW Department of Primary Industries' Sustainable Aquaculture program will continue to concentrate on the major themes identified in the current Aquaculture Research RD&E Strategic Plan. Research activities for the Sustainable Aquaculture Program are structured according to three research themes and several key research areas within each theme.

Research themes and key research areas for the Sustainable Aquaculture Program

Program / Research Theme	Key Research Areas
Sustainable Aquaculture	
Mollusc research	Selective breeding
	Mollusc production
	Alternative species
Finfish production	Fingerling production
	Stock enhancement
Fish nutrition	Diet improvement
	Improved feeding strategies

The table on the following page identifies the current and anticipated research projects for the Sustainable Aquaculture Program Plan 2014–2018 against the research themes and key research areas. The projects relate specifically to those that DPI Fisheries is undertaking directly or through collaboration with external research providers.

Sustainable Aquaculture Program Plan 2014-2018 (C = Current, P=Proposed, A= Anticipated, F = Finished)

Priority program	Research theme	Key areas	Projects	2014/15	2015/16	2016/17	2017/18			
Sustainable Aquaculture	Mollusc production	Selective breeding	Sydney rock oyster breeding (SOCo support)	C	C	C	C			
			Incorporation of selection for reproductive condition marketability and survival into a breeding strategy for Sydney rock oysters and Pacific oysters	C	F					
			Breeding better oysters	C	C	C				
			Adapting to climate change: Does enhanced metabolism provide heritable protection against ocean acidification and increasing temperature in oysters?	C	C	C				
			Polymicrobial involvement in oyster diseases				P	P		
			Genetic solution or dilution: can selective breeding future-proof oysters				C	C	C	
			Mollusc production	Mollusc hatchery production	C	C	C	C		
				Improved hatchery and nursery production of flat oysters	C	C				
				Improved knowledge of molluscan diseases				A	A	
				Alternative species	Building bivalve hatchery production capacity in Vietnam and Australia (Pipis, Clams, Flat Oysters)	C	C	C	C	
Finfish production	Finfish production	Finfish production	Promoting marine finfish aquaculture in NSW (YTK)	C	F					
			Developing marine finfish aquaculture in NSW (YTK)			C	C			
			Enhanced fish production of Australian bass		C	C	C			
			Microbial Innovation in Aquaculture				P	P		
			Stock enhancement	Evaluation of nodavirus carrying Australian bass in NSW waterways	C	C	C	C		
				Mulloway stocking to enhance recreational fisheries	C	F				
				Utilisation of premium feed ingredients by Barramundi		C	C	C		
			Fish Nutrition	Improved Diets		Tactical feed ingredient assessment	C	C		
						Neutraceutical assessments	C	C	C	
						Asian Seabass: Validation of aquafeeds in Vietnam	C	C	C	C
Improved feeding strategies	Development of monogastric industries	C				F				
Yellowtail Kingfish for Profit		C				C	C			

Oyster Research and Development currently being undertaken in Australia

1	Project Title Principal Investigator Time Frame Funding Sources	ASI Quantitative Genetics Analysis and Training Services Matt Cunningham 2015 Seafood CRC (2014/721)
2	Project Title Principal Investigator Time Frame Funding Sources	Overcoming technical constraints to Sydney rock oyster hatchery production Emma Wilkie 2015 Seafood CRC (2015/706)
3	Project Title Principal Investigator Time Frame Funding Sources	Evaluating the impact of an improved retailing concept for oysters in Fishmongers Meredith Lawley 2012 - 2015 Seafood CRC (2012/740), University of Sunshine Coast and Oysters Australia Pty Ltd
4	Project Title Principal Investigator Time Frame Funding Sources	Genetic selection for resistance to Pacific Oyster Mortality Syndrome Peter Kube 2012 - 2016 Seafood CRC (2012/760) and CSIRO
5	Project Title Principal Investigator Time Frame Funding Sources	Enhancing bivalve production in northern Vietnam and Australia Wayne O'Connor 2014 - 2018 ACIAR (FIS/2010/100)
6	Project Title Principal Investigator Time Frame Funding Sources	Pearl industry development in the western Pacific Paul Southgate 2013 - 2017 ACIAR (FIS/2009/057)
7	Project Title Principal Investigator Time Frame Funding Sources	Developing pearl industry based livelihoods in the western Pacific Paul Southgate 2015 - 2020 ACIAR (FIS/2014/060)
8	Project Title Principal Investigator Time Frame Funding Sources	NSW Oyster Industry Strategic Development Plan Rachel King 2015 FRDC (2014/243)
9	Project Title Principal Investigator Time Frame Funding Sources	Oyster Australia IPA: Pacific Oyster Mortality Syndrome – closing knowledge gaps to continue farming <i>C. gigas</i> in Australia Richard Whittington 2015 - 2018 FRDC (2014/040)

10	Project Title	Pearl Consortium IPA: Control of reproduction of the silver-lip pearl oyster, <i>Pinctada maxima</i> .
	Principal Investigator	David Mills
	Time Frame	2012 - 2016
	Funding Sources	FRDC (2011/248) and Paspaley Pearling Company
11	Project Title	Pearl Consortium IPA: improving reliability and efficiency of spat nursery and growout for the silver-lip pearl oyster (<i>Pinctada maxima</i>)
	Principal Investigator	David Mills
	Time Frame	2011 - 2015
	Funding Sources	FRDC (2011/236) and Paspaley Pearling Company
12	Project Title	Aquatic Animal Health Subprogram: Pacific oyster mortality syndrome (POMS) risk mitigation, epidemiology and OsHV-1 biology
	Principal Investigator	Richard Whittington
	Time Frame	2012 - 2015
	Funding Sources	FRDC (2012/032) and University of Sydney
13	Project Title	Survey of foodborne viruses in Australian oysters
	Principal Investigator	Valerea Torok
	Time Frame	2014 - 2015
	Funding Sources	FRDC (2013/234)
14	Project Title	Australian edible oyster RD&E investment via Oysters Australia Strategic Plan 2014-2019
	Principal Investigator	Rachel King
	Time Frame	2015 - 2019
	Funding Sources	FRDC (2014/405)
15	Project Title	Aquatic Animal Health Subprogram: Identifying the cause of Oyster Oedema Disease (OOD) in pearl oysters (<i>Pinctada maxima</i>), and developing diagnostic tests for OOD
	Principal Investigator	David Raftos
	Time Frame	2013 - 2016
	Funding Sources	FRDC (2013-002)
16	Project Title	Aquatic Animal Health Subprogram: Bonamiasis in farmed Native Oysters (<i>Ostrea angasi</i>)
	Principal Investigator	Tracey Bradley
	Time Frame	2015 - 2017
	Funding Sources	FRDC (2015-001)
17	Project Title	Oysters Australia IPA: the use of FRNA bacteriophages for rapid re-opening of growing areas after sewage spills
	Principal Investigator	Kate Hodgson
	Time Frame	2016 - 2018
	Funding Sources	FRDC (2015-037)

18	Project Title Principal Investigator Time Frame Funding Sources	Assessing occurrence of pathogenic species of the marine bacteria <i>Vibrio</i> in Tasmanian oysters from St Helens Thomas Madigan 2016 FRDC (2015-042)
19	Project Title Principal Investigator Time Frame Funding Sources	Oysters Australia IPA -workshop – identifying knowledge gaps for development of the native oyster aquaculture industry in South Australia Xiaoxu Li 2016 FRDC (2015-229)
20	Project Title Principal Investigator Time Frame Funding Sources	Oysters Australia IPA: genetic services for the multi-trait, single pair mated Sydney Rock Oyster breeding program Emma Wilkie 2015 - 2019 FRDC (2015-230)
21	Project Title Principal Investigator Time Frame Funding Sources	Oysters Australia IPA: Australian Seafood Industries Pacific Oyster Mortality Syndrome (POMS) investigation into the 2016 disease outbreak in Tasmania Matthew Cunningham 2016 FRDC (2015-232)
22	Project Title Principal Investigator Time Frame Funding Sources	Rural R&D for Profit: Easy-Open Oyster automation Len Stephens 2016 - 2018 FRDC (2015-238)
23	Project Title Principal Investigator Time Frame Funding Sources	Oysters Australia IPA: Pacific Oyster Mortality Syndrome - resistant Oyster breeding for a sustainable Pacific Oyster Industry in Australia Matthew Cunningham 2016 - 2017 FRDC (2015-239)
24	Project Title Principal Investigator Time Frame Funding Sources	Oysters Australia IPA: development of a national Pacific Oyster Mortality Syndrome (POMS) response plan Jan Davis 2016 FRDC (2015-406)
25	Project Title Principal Investigator Time Frame Funding Sources	Pearl consortium IPA: Environmental and technical influences on pearl production from <i>Pinctada maxima</i> David Mills 2016 - 2021 FRDC (2016-046)

26	Project Title	Pearl consortium IPA: understanding stress and its impact on pearl quality in the silver-lip pearl oyster, <i>Pinctada maxima</i> , using transcriptomic, proteomic and metabolomic tools
	Principal Investigator	Abigail Elizur
	Time Frame	2016 - 2019
	Funding Sources	FRDC (2016-232)
27	Project Title	Translating genomic discoveries into improved commercial outcomes for the South Sea Pearl Industry
	Principal Investigator	Degnan, B.
	Time Frame	2009 - 2016
	Funding Sources	UQ, ARC, Autore Pearling Pty Ltd, Pearl Oyster Propagators (LP130100086)
28	Project Title	See page 32 of this report
	Principal Investigator	Melanie Bishop
	Time Frame	2015 - 2017
	Funding Sources	ARC (DP150101363), Macquarie University
29	Project Title	See page 34 of this report
	Principal Investigator	Laura Parker
	Time Frame	2014 - 2016
	Funding Sources	ARC (IN140100025), University of Sydney
30	Project Title	See page 35 of this report
	Principal Investigator	Kyall Zenger
	Time Frame	2014 - 2016
	Funding Sources	ARC (LP140101001), Jame Cook University

Aquaculture Research and Development currently being undertaken in Australia



Australian Centre for International Agriculture Research (ACIAR)

Active and Pipeline ACIAR Aquaculture Projects. NB. All ACIAR-funded Projects have an Australian component with the Commissioned Organisation [responsible for administering the funds] being an Australian University or State or Commonwealth Government Department or other Statutory Organisation. *More information visit www.ACIAR.gov.au*

Project ID	Project Title
FIS/2016/005	Pearl industry research infrastructure recovery post-cyclone Winston, Fiji
FIS/2015/038	Improving seaweed production and processing opportunities in Indonesia
FIS/2015/031	Fish in national development: contrasting case studies in the Indo-Pacific region
FIS/2015/028	Investigating the long-line nursery system for giant clam (<i>Tridacna</i> sp.) farming in Savusavu Bay, Fiji
FIS/2015/006	Application of fish passage design principles to enhance sustainability of inland fishery resources in the Southeast Asian region
FIS/2014/103	Pearl livelihood development in Fiji
FIS/2014/063	Restoring damaged coral reefs using mass coral larval reseedling
FIS/2014/062	Improving technologies for inland aquaculture in Papua New Guinea
FIS/2014/061	Improving technical and institutional capacity to support development of mariculture based livelihoods and industry in New Ireland, Papua New Guinea
FIS/2014/060	Developing pearl industry-based livelihoods in the western Pacific
FIS/2014/059	Expanding spiny lobster aquaculture in Indonesia
FIS/2014/041	Quantifying biophysical and community impacts of improved fish passage in Lao PDR
FIS/2014/018	Understanding pearl oyster mortality in Fiji
FIS/2013/015	Sustainable management of sport fisheries for communities in Papua New Guinea
FIS/2012/102	Sustainable management of the shark resources of Papua New Guinea: socioeconomic and biological characteristics of the fishery
FIS/2012/101	Developing technologies for giant grouper (<i>Epinephelus lanceolatus</i>) aquaculture in Vietnam, the Philippines and Australia
FIS/2012/100	Improving the design of irrigation infrastructure to increase fisheries production in floodplain wetlands of the Lower Mekong and Murray-Darling Basins
FIS/2012/076	Improving community-based aquaculture in Fiji, Kiribati, Samoa and Vanuatu
FIS/2012/074	Improving community-based fisheries management in Pacific island countries
FIS/2011/052	Improving research and development of Burmas' inland and coastal fisheries
FIS/2011/013	Culture-based fisheries development in Lao PDR and Cambodia
FIS/2010/101	Improving fish health management and production protocols in marine finfish aquaculture in Indonesia and Australia

FIS/2010/100	Enhancing bivalve production in northern Vietnam and Australia
FIS/2010/098	Diversification of seaweed industries in Pacific island countries
FIS/2010/097	Exploring options for improving livelihoods and resource management in Timor-Leste's coastal communities
FIS/2010/096	Evaluating the impacts of improving postharvest processing of sea cucumbers in the western Pacific region
FIS/2010/055	Building research and project management skills in fisheries staff in Papua New Guinea
FIS/2010/054	Mariculture development in New Ireland, Papua New Guinea
FIS/2010/042	Expansion and diversification of production and management systems for sea cucumbers in the Philippines, Vietnam and northern Australia
FIS/2009/059	Developing research capacity for management of Indonesia's pelagic fisheries resources
FIS/2009/057	Pearl industry development in the western Pacific
SMCN/2010/083	Improving the sustainability of rice-shrimp farming systems in the Mekong Delta, Vietnam
Recently completed projects	
FIS/2016/002	Developing fisheries and aquaculture reviews on Myanmar's fishery sector
FIS/2015/034	Research support for lobster restocking in Indonesia
FIS/2014/104	Small-scale fisheries in Indonesia: benefits to households, the roles of women, and opportunities for improving livelihoods
FIS/2011/069	Technical support for pearl culture in coastal Tanzania
FIS/2010/058	Assessing economic and welfare values of fish in the Lower Mekong Basin
FIS/2008/023	Increasing production from inland aquaculture in Papua New Guinea for food and income security

New and ongoing research projects and fellowships funded by the Australian Research Council. *For more information visit www.arc.gov.au*

Project ID	Project Summary
LP130100242	Evolution of new pathogen strains causes major problems in vaccinated animals because these variants can reinfect and cause severe disease in previously protected animals. This project will use state-of-the-art genomics to find new targets that are essential to all strain variants, enabling development of broadly cross-protective vaccines for farmed animals.
LP130100086	The purpose of this project is to understand the relationship between gene expression and pearl quality. By identifying the relationship between genes and pearls this project will determine the best conditions to grow selected pearl oyster stocks for the Australian South Sea pearl industry.
LP130100118	This project aims to use radiocarbon ageing, conservation genetics and modelling to identify threats to the long-term survival of the Australian lungfish, the world's oldest living vertebrate. This project will provide managers with a powerful tool to prioritise management interventions to ensure the conservation of the species and to pull it back from extinction.
LP130100007	This project will determine the genetic basis of sex control in barramundi and develop technologies to allow barramundi hatcheries to have increased control over reproduction leading to more efficient propagation and removing impediments to selective breeding.
LP130100040	Pharmaceutical and personal care products (e.g. antihistamines, caffeine, antibiotics) have recently been shown to suppress rates of the critical processes providing food resources to fish and insects, threatening viability of aquatic ecosystems. Using novel methods, this project will investigate acute and longer term impacts of these chemicals.
DP130102859	Fish-killing microalgal blooms cause multi-million dollar losses to global aquaculture and wild fisheries. This project brings together leading Australian and Canadian research teams, applying sophisticated cell line and biologically active molecule technologies, to elucidate precise fish-kill mechanisms and design effective mitigation strategies.
IC130100009	A molecular technology platform for enabling the next revolution in the food industry. Society needs new approaches for solving the difficulties of providing enough food for the future. This Training Centre will train young scientists in the application of applying molecular analysis skills to solve specific problems that the food industry faces in the whole process of taking food production from "field to fork".
LP140100327	The western and central Pacific Ocean supports the world's largest tuna fishery with catches contributing up to 40 per cent of revenue for many Pacific communities. These nations are dependent on these fisheries for livelihoods and economic development. Continued sustainable management of this valuable resource in the face of rapid population growth and climate variability and change is a challenge. Using observationally derived information of skipjack tuna, the project aims to develop a novel tuna behavioural model. This is intended to be integrated into a state-of-the-art biophysical model at resolutions capable of reproducing critical meso-scale

	processes, providing projections of tuna distributions that aim to aid in developing sustainable management practices.
DE130101089	The androgenic gland is responsible for maleness in crustaceans. This project will characterise the genes that control the masculinisation process in crustaceans, discovering new targets for sex reversal and sterility induction. These findings will have implications for aquaculture and the development of innovative tools for invasive/pest crustacean control.
DP140101537	This project is a multifaceted, innovative cultural analysis of the crucial role of fish and fishing in feeding a growing global population. Estimates are that the world's population will be nine billion by 2050. It is imperative that innovative research strategies are developed to explore how to best respond to questions of food security in a sustainable manner. This brings challenges across numerous scales, including: changing consumer tastes, new State, Commonwealth and international regimes of marine governance, and adapting fishing communities to new forms of livelihood. This project will provide the first in-depth cultural account of the complex entanglement of the economy, the environment and the humans involved in fish and fishing.
DP140100122	In a world where few intact reefs remain, the goal of this project is to find ways to restore degraded reefs. Recent research has identified the species responsible for removing harmful algae from coral reefs, while advances in mariculture provide us with the capacity to rear these critically important reef fish species. Combining captive rearing, experimental manipulations, and a global analysis of the functional capacity of herbivorous fishes, in intact, degraded and human-modified systems, the research will explore the potential for restoring, or boosting, the capacity of reefs to withstand disturbance. The goal is to provide the scientific knowledge required to directly modify the key processes operating on coral reefs.
DP140101377	Seafood production is an important part of Australia's economy and future food security. In a dual relationship, fisheries are both vulnerable to and a cause of changes in the marine environment. This project will identify the maximum limits to Australian seafood production and will determine the impacts of future perturbations. To achieve this, the project will: combine existing rich historical data sources with state-of-the art ecosystem and fisheries models; analyse environmental impacts that will complement national fisheries stock assessments that are essential for future competitive exports; and determine our growing seafood imports and their role in Australia's and the world's food security.
LP140100087	Estuaries are iconic recreational areas providing both ecological habitat and millions of dollars in revenue to the tourism and fisheries industries. How estuaries respond to human pressures is highly variable with some such as the Gippsland Lakes succumbing to algal blooms, whilst other heavily nutrient laden systems such as the Werribee Estuary support extremely high fish populations. This project aims to lead to an understanding of the links between freshwater flow, blue-green algal blooms, and recruitment of a key fishery species, black bream. The outcome of the project aims to give catchment managers greater confidence in setting levels of environmental flows that will both support fish populations but also mitigate against algal blooms.
LP140100428	The project aims to develop applied genetic strategies to eradicate <i>Gambusia</i> , a serious invasive pest fish species, from a Tasmanian estuary. The goal is to advance the Trojan Y chromosome model from theory to an applied solution. The project aims to employ an integrated ecological, physiological, behavioural, genetic and genomics approach, within the unique island-within-an-island status of <i>Gambusia</i> infestation in Tasmania.

LP140100722	New and existing lipases will be applied to the concentration of omega-3 lipids from fish and algal oils. The primary aim of this project is to replace current chemical processes and high temperature distillation with milder enzymatic methods, providing high quality omega-3 concentrates for food and pharmaceutical purposes. The project aims to develop new immobilisation technology to enable multiple re-use of lipases for the cost effective production of omega-3 concentrates and to apply new microencapsulation strategies to the stabilisation of omega-3 concentrates, enabling the delivery of omega-3s and other bioactive ingredients to a range of food and beverage products.
LP140100855	As Australians migrate towards the coast, the demand for recreational boating facilities such as moorings and marinas is increasing rapidly. These structures can remove habitat and fragment the seascape in a similar manner to roads and clearings in forest and grasslands. Coastal infrastructure can also reduce the quality of existing habitats and their full impact must be assessed if the diversity and function of coastal seascapes is to be conserved. This project aims to use a combination of novel modelling, surveys, and large experiments to understand how threatened seagrass, fish, and sediment habitats are altered in human modified seascapes, and to assess the success of habitat restoration following the removal of boating structures.
LP140100319	Sharks are vital components of marine ecosystems and contribute significantly to ecotourism and fisheries. Due to their slow rate of growth and reproduction, sharks are susceptible to over exploitation. A lack of knowledge regarding their behaviour and movement patterns is a key impediment to effective management. This project aims to examine social interactions and migration patterns of Port Jackson sharks using a unique combination of genetic techniques, novel acoustic tag technology, behavioural manipulations and modern social network analysis. Once verified, the approach developed can be applied to other marine predators of particular management concern. The data generated will directly inform fisheries and conservation management policy.
FT130100505	The overarching aim of this project is to advance knowledge on the long-term impacts of ocean acidification on marine fish and fisheries. An interrelated set of projects will be developed that tests the capacity of marine fish to adapt to projected future rises in ocean carbon dioxide and will investigate the effects of ocean acidification on apex predators and key fisheries species. The research will address critical knowledge gaps in ocean acidification research and provide advice about the impacts of ocean acidification on marine biodiversity and fisheries productivity on time scales relevant to strategic management and policy decision-making in Australia and internationally.
DP140100431	The power to recognise individuals of a species requires significant image and pattern discrimination abilities. Yet, individual recognition has been found in a huge range of species, from humans to invertebrates demonstrating its importance for social interactions. The project will investigate this ability in lower vertebrates (fish, with no visual cortex), so as to understand the underlying mechanisms of pattern discrimination. The project will also test how robust this ability is during changes in water quality (elevated carbon dioxide levels and increased turbidity). The outcomes will further our knowledge base in lower vertebrate vision and evolution, and also have implications for human vision, image analysis, and artificial vision.

DE140100701	Coral communities of the Great Barrier Reef are facing multiple disturbances, in particular the coral-eating crown-of-thorns starfish <i>Acanthaster planci</i> (<i>A. planci</i>) that can occur as large-scale outbreaks. This project aims to provide innovative guidance in support of the management of <i>A. planci</i> , based on a metapopulation modelling framework broadly applicable to the control of marine pests. Expected outcomes include the identification of the environmental triggers of <i>A. planci</i> outbreaks; the identification of target reefs and critical thresholds of management intervention needed to limit the impact of <i>A. planci</i> under different climate and land use scenarios; and future forecasts of coral and fish biodiversity under these scenarios.
IN140100025	This project will investigate the impact of environmental change on larval energetics of molluscs on the southeast (SE) coast of Australia. The SE coast of Australia is a climate hotspot characterised by rising ocean temperatures, fluctuations in salinity and we expect in the near future ocean acidification (OA). Mollusc larvae show extreme sensitivity to OA, but the impacts of other stressors remains unknown. It is predicted that OA will reduce the capacity of larvae to cope with temperature and salinity, particularly when food supply is low and in populations which have had no previous exposure to OA. Understanding the response of mollusc larvae to environmental change will support ecologically and economically significant mollusc populations over this century.
IH120100032	Commercial development of rock lobster culture systems: the cutting edge of aquaculture. This Research Hub will develop unique aquaculture systems, using novel engineering manufacture to mass produce lobster seed stock. A reliable, large-scale supply of seed will enable seacage culture, evaluation of wild stock enhancement and lead to sustainable food production.
FT130100202	Primary productivity by marine phytoplankton directly controls global climate, supports fisheries and is an indicator of marine ecosystem health. Successful management of the world's marine ecosystems rests on improving the accuracy with which primary productivity is measured and monitored. This internationally collaborative research program will develop a new sensor-based approach – fast repetition rate fluorometry – to measure different phytoplankton groups that regulate primary productivity in Australia's complex marine environments. Application of these measurements will enable more accurate monitoring of the status of Australia's marine systems to inform ocean resource management decisions in order to safeguard marine ecosystem health.
DP140101800	Preserving biodiversity in the face of environmental degradation and climate change is the greatest challenge of our time. Although habitat fragmentation is considered a key cause of the current extinction crisis, the effects of changing habitat configuration on species persistence and recovery is almost completely unknown. Coral reefs are among the most diverse and threatened ecosystems on the planet and this project will provide the first insights into how coral reef fish diversity responds to increased subdivision and isolation of reef habitat. It will identify critical aspects of habitat change that either enhance local diversity or threaten populations with extinction and provide new ecological data to refine conservation strategies.

LP140101001	The primary impediment to achieving rapid genetic progress in aquaculture is an inability to accurately and rapidly identify high-performance animals for selection as parents in animal breeding programs. This project aims to develop an innovative genomic selection breeding system for the silver-lipped pearl oyster to overcome current limitations associated with traditional animal improvement methods. The use of genomic selection will not only transform the Australian pearl oyster industry, but it will also showcase the potential of genomic selection in aquaculture globally. Furthermore, knowledge gained from this project can also be applied to a variety of other Australian aquaculture species to accelerate the uptake of this technology.
FT130101068	This project will integrate comparative ecological genomics (in the wild and in the lab), phenotypic data and spatially-explicit modelling approaches to assess adaptation and vulnerability of aquatic biodiversity to environmental change. It focuses on a family of Australian freshwater fishes that evolved in response to hydrological disturbance and shows contemporary patterns of biodiversity shaped by hydroclimatic variation and anthropogenic pressures. The project expects to disclose a positive correlation between family-wide adaptive capacity and variance in ecological disturbance. This work will address fundamental and novel questions about factors shaping adaptation and resilience along naturally and anthropogenically disturbed ecosystems.
LP140100412	Antarctic krill are an important species in the Southern Ocean supporting most of the Antarctic birds and mammals. A sustainable krill fishery is developing with krill products used in aquaculture and increasingly for human consumption. A new omega 3 krill oil industry has emerged and is rapidly expanding. The aim of the project is to predict the factors governing oil levels and the biochemical composition in krill which will help us understand growth, reproduction and recruitment. The research aims to also assess the possible effects of climate change on krill. Outcomes of this research aim to be used to manage the expanding krill fishery.
LP140100225	Man-made in-stream structures (for example, dams and road crossings) have contributed to major declines in native fish numbers, with more than 6,000 barriers to fish migration occurring in New South Wales alone. Recognising this, Fisheries New South Wales led the development of national guidelines for the design and construction of fish friendly road crossings. Unfortunately, these guidelines have little empirical backing. This project will integrate data on the swimming ability of Australian fish species with culvert hydrodynamic modelling to better understand fish requirements in and around road crossings. These data will strengthen national design guidelines and provide the tools engineers and planners need to balance fish migration with effective water management.
DE150100321	Climate variation will continue to impact biodiversity on our globe. Exciting new evidence has suggested that terrestrial ectotherms can minimise their vulnerability to changing temperatures by altering their thermoregulatory behaviour. Fish, unlike terrestrial ectotherms do not possess the same ability to thermoregulate and it is unclear how behavioural changes may reduce a population's vulnerability to climate change. This project aims to combine bio-logging technology, energy budget theory and climate models to predict the potential role that changing behaviours may have in reducing the vulnerability of fish populations to climate change.

DE150101266	This project aims to examine the effects of ocean acidification on coral reef fishes due to increasing atmospheric carbon dioxide (CO ₂). Physiological performance of fish vary under elevated CO ₂ , but behaviour is consistently, negatively impacted. This project aims to investigate evolutionary trade-offs between behaviour and performance, physiological mechanisms key to compromising, maintaining, or enhancing metabolic performance under elevated CO ₂ , and the importance of habitat in how fish respond to elevated CO ₂ . As fish play critical roles in marine ecosystems by structuring food webs and driving ecological processes, this information will be critical for predicting the effects of ocean acidification on marine ecosystems and biodiversity.
IH130200013	ARC Research Hub for advanced breeding to transform prawn aquaculture. This Research Hub aims to bring together world-leading animal geneticists, research and service providers, and Australia's largest prawn farm to gather the genomic resources, commercial phenotypic data, and apply cutting-edge genetic and genomic selection methodologies, leading to the transformative improvement program for a black tiger prawn aquaculture species globally.
DP150101363	This project aims to test whether the flow of beneficial genes from farmed oysters into wild oysters can make natural oyster beds and the ecological communities that they support more resilient to environmental change. Wild oysters are critical to the function of coastal ecosystems. However, wild oyster populations are threatened by environmental change in Australia and around the world. Selectively bred oysters bearing stress resistance genotypes are now commercially farmed in many estuaries on Australia's east coast and may be used to bolster wild oyster populations. This project endeavours to develop novel genetic strategies to future-proof oysters. Thus, the outcome of this project has potential to benefit entire ecosystems that depend upon oysters.
DP150103820	The general aim of this project is to exploit the advantages of the zebrafish system and our access to the embryology of Australian shark species to generate an understanding of the basis for muscle fibre diversity and evolution. While there is some understanding of the fundamental genetic basis of how to make an individual muscle cell from a nascent myoblast there is far less knowledge on how individual muscle cells generate mature muscle types and patterns. The intended outcome of this research is to generate understanding of the complex molecular basis of muscle patterning in the simple paradigm of the zebrafish myotome that could be applied across the vertebrate phylogeny.
DP150100912	Thermal stratification is common in Australia's rivers due to our hot, drought-prone climate and high human demands relative to available supply, which has led to a significant reduction in flows relative to natural levels. Thermal stratification inhibits mixing, creating stagnant conditions characterised by low oxygen levels and increased concentrations of contaminants, leading to algal blooms, fish kills and systemic damage to ecosystems. The aim of this project is to develop predictive models for the effects of physical processes such as night-time cooling, wind, turbulence and currents on riverine thermal stratification. This is expected to enable a more accurate determination of the flow rates required to maintain the health of our river systems.
DP150104006	As humans modify the biosphere, many complex landscape-level problems are emerging. New methods are required to work on these large-scale problems. The aim of this project is to develop novel methods involving trace elements and isotopes, opening up new ways to explore the large-scale connections between terrestrial ecosystems and downstream estuaries. It is

	planned to use these new methods to test for unexpected positive benefits of floods for estuarine fisheries. The project is significant and innovative because it develops two fundamentally new types of tracer work, one at the sediment-animal level and one at the within-molecule level. The expected outcomes include a new toolkit for tracing the hidden connections between terrestrial and aquatic ecosystems.
DP150102903	This project aims to use an evolutionarily young and ecologically important fish clade to understand adaptive resilience and to test predictions derived from the 'climatic variability hypothesis' for the major climatic regions of mainland Australia. Correlative surveys along landscapes and mechanistic experimental studies will be integrated to implement a comparative evolutionary genomics framework capable of assessing the genetic basis of adaptation and the evolutionary resilience of populations and lineages. This is expected to clarify climatic and geographic correlates of adaptation across a vast area of Australia and to disentangle responses to environmental change in an emerging model system for adaptation research.
DP150102656	This project aims to develop innovative numerical methods to understand the dynamics, carbon export, and trophic structure of zooplankton. The trophic links between phytoplankton, zooplankton and fisheries are unknown. The size- frequency distribution of zooplankton (size spectrum) is an innovative method for estimating their growth, predation and production as food for fish. Analysis of a global synthesis of zooplankton size distributions from tropical to polar environments are expected to reveal these vital rates of pelagic ecosystems. The zooplankton rates will reveal, for the first time, the link between phytoplankton and fisheries, and will significantly improve ecosystem models and global assessments of environmental change.
FT140100964	Environmental endocrine disrupting chemicals (EEDs) from introduced plants, pesticides and wastewater are dramatically increasing in the Australian environment. EEDs have been shown to cause dramatic reproductive and developmental abnormalities in vertebrates ranging from fish to humans. This project plans to investigate the impact that these chemicals might have on marsupial development. Marsupials have a unique reproductive strategy and how this might affect their ability to respond to EEDs is unknown. This project aims to define the effects of three of the predominant EED risks for marsupials in the Australian environment; estradiol, genistein and atrazine.
FT140100383	In modern fish aquaculture, parasite infections threaten efficient production. Ecological problems also arise when fish farms amplify parasite populations and cause outbreaks in surrounding wild fish populations. Present control methods rarely integrate the behaviour of the host fish. This project aims to assess the behaviours of hosts and the mechanisms that lead to parasite outbreaks. It will develop behavioural approaches that separate host and parasite, reduce infection, and altering host behaviour to improve the effectiveness of treatments and minimise their environmental impacts. This project aims to create novel methods to control parasites in ways that limit their ability to evolve resistance.

DP150101491	Continual recruitment of young is fundamental to the replenishment of populations, especially when a stock is fished. Existing theory suggests that species with very long planktonic larval stages disperse widely, ensuring their genes are well mixed. However, recently identified genetic differences between populations of rock lobster challenge this paradigm and demonstrate that despite larvae mixing in the ocean for years, local recruitment and/or adaptation are at play. Recent developments in genomics and bioinformatics should allow this project to understand the ecological processes underpinning these genetic signatures and determine their evolutionary implications. Such findings could direct targeted rebuilding of depleted fisheries stocks.
DP150100608	Carp gudgeons are the most abundant, widespread and biodiverse freshwater fishes in southeastern Australia. The unacknowledged presence of many cryptic species and sexually-parasitic lineages severely taints all research on this cornerstone group. This project aims to provide unrivalled evolutionary, genomic, and taxonomic insights into this new instance of vertebrate sexual parasitism, which offers a unique mix of research advantages not displayed by any other sexual/unisexual complex. The knowledge gained could impact many research fields, including evolutionary theory addressing the unexplainable prevalence of sex, native fish ecology, and environmental monitoring of the Murray-Darling Basin, an ecosystem of world significance.
DP150100017	Coherent structures in geophysical flows play fundamental roles by organising fluid flow and obstructing transport. For example, ocean eddies strongly influence the transportation of heat, nutrients, phytoplankton, and fish larvae, in both the horizontal and vertical direction. Many coherent structures are very difficult to detect and track by direct measurement (for example satellite observations), and current mathematical techniques cannot provide an adequate global description. This project aims to create innovative new mathematical theory and numerical methods to discover and track coherent structures over time frames of physical importance, contributing significantly to our understanding of their role in the oceans' biosphere and climate.
DE160100636	This project aims to unravel microbiological processes in the ocean to help quantify the ecosystem services carried out by microbes that support our economy and environment. By recycling vital nutrients, microbes form the basis of the marine food web. In Australia, their contributions support fisheries worth \$4.2 billion. Their role in carbon cycling also controls our climate. Yet, their direct productivity remains unquantified. Technical limitations have restricted our ability to identify the key microbes most responsible for ocean carbon cycling, and to measure their impact. This project plans to combine new approaches in microfluidics, chemistry and oceanography to quantify carbon uptake by individual microbes and provide new understanding of microbe-mediated chemical cycling processes.
DP160100573	The project aims to decipher the fundamental mechanisms governing stem cell specification and formation. All animals rely on stem cells to replenish, repair and regenerate tissues. Stem cells are also often a conduit to malignant tumours. This project seeks to uncover the rules governing stem cell formation through the study of a simple and ancient animal – the marine sponge <i>Amphimedon queenslandica</i> . The project plans to combine insights from the simple, experimentally-tractable sponge stem cell system with existing knowledge of stem cell specification in humans and other animals, to reveal the essential features of stem cell formation. These insights may

	inform future pursuits to generate, control and use stem cells in cancer and regenerative medicines.
DE160100247	This project will seek new fossil discoveries from Australian Devonian sediments to address questions of the origins, diversification and biogeographical dispersal of early jawed vertebrates. In particular, there is the potential to test or refine recent evolutionary hypotheses based on fossil finds from the Siluro-Devonian of southern China which served as a likely point of origin for several key vertebrate groups. Likely finds include fishes that test dermal bone-homologies between osteichthyans and placoderms, jawless fishes that may unveil details of the origin of jaws, and calibration of paleoatmospheric models via the observed size of Early Devonian fossil fishes.
DP160101539	This project aims to unlock the molecular basis of a partnership between a microscopic plant and an animal that powers coral growth. Most corals depend on microscopic algae living inside their bodies to nourish them. Most corals have to recruit new algae each time they reproduce, but only a particular strain of algae is accepted. This project aims to establish how anemones and corals identify and take in the right alga, how the alga gives them food, and how the animal hosts regulate growth of their algae to optimise food production but avoid being overrun by algae. Understanding the partnership that drives reef growth and survival may better equip us to protect this threatened resource.
DP160100285	This project aims to test how populations of introduced mosquitofish have adapted to local differences in water temperature (such as Tasmania versus Queensland). To what extent has natural selection (for survival) and sexual selection (the ability of males to acquire mates and/or females to resist unwanted matings) driven the local adaptation of populations? Many species have traits that evolve under intense sexual conflict – notably when males harass or coerce females into mating and females resist these attempts. It is assumed that sexual conflict traits are rarely affected by the local environment. The project will test the hypothesis that temperature can actually drive the evolution of such traits, specifically coercion and resistance to mating.
DE160100668	The project aims to develop a new understanding of fundamental mechanisms responsible for coral calcification and its ability to acclimate to global warming and ocean acidification. Mineral skeleton formation by coral is the key process controlling the creation of reef structures upon which entire ecosystems depend. Despite the importance of coral to the function of reef ecosystems, how calcification works mechanistically within coral itself, and why small modifications of their physical and chemical habitat can have large effects on growth is presently poorly understood. This project seeks to provide this basic knowledge to improve our ability to assess the future of corals and help policy-makers take adequate measures to preserve coral reefs.

DP160103320	This project uses the astonishing lifecycle of lobster larvae to better define the pathways and discover the key genes that regulate crustacean metamorphosis. Where, when, why and how metamorphosis occurs in crustaceans are important factors affecting fisheries recruitment and aquaculture production. The project suggests that the current accepted paradigm for the molecular control of metamorphosis does not apply to lobsters and possibly other crustaceans where larval metamorphosis and the juvenile transformation are uncoupled. Using a unique supply of cultured lobsters and advanced molecular techniques, the project aims to develop tools to trigger and synchronise metamorphosis for use in aquaculture and invasive species management.
DE160101141	This project aims to measure the degree of connectivity between isolated reefs in Australia's Coral Sea and the Great Barrier Reef and identify the biological and environmental mechanisms that enhance management strategies or mitigate against disturbances. The movement of individuals in fragmented landscapes plays a central role in the ecology and evolution of species. The project seeks to measure connectivity at multiple scales and identify critical regions for the design of networks of marine protected areas. This is anticipated to improve our understanding of connectivity in marine seascapes and benefit management of important fishery species and current efforts in coral reef conservation.
DE160101207	This project intends to quantify the role that aquatic habitats play in fisheries, and to help identify where to restore degraded aquatic habitats. Fisheries are a globally important resource but their status is declining in many regions, often because of the loss of aquatic habitats. However, the role of habitat in fishery declines is poorly quantified, and new models are needed that integrate existing datasets to attribute change in a fishery to change in its habitats. The project aims to develop a new statistical analysis to examine the role of habitat loss in the global status of fisheries and how multiple human impacts to habitats affect fisheries, to decide how we can best protect aquatic habitats.
DP160100271	The objective of this project is to advance knowledge on the healthy functioning of the coral–algal symbiosis, which defines the response of coral reef ecosystems to worldwide environmental change. Current approaches to address this problem have linked coral health to algal symbiont diversity but have been unable to resolve the fundamental symbiont functional traits that govern this link – the “key performance indicators (KPIs)”. This project plans to couple advanced physiological and functional genomics techniques to transform our understanding of how algal symbiont metabolic KPIs regulate coral growth and stress susceptibility. This may provide new diagnostic capability for the assessment of coral health and may enable us to improve coral reef ecosystem management.
DP160104427	The project seeks to understand how different muscle populations within the embryo form and have evolved within the vertebrate phylogeny. All amniote muscles, except that of the head, derive from a transient embryonic structure termed the dermomyotome. The formation of muscle from the dermomyotome of amniotes uses a highly conserved mechanism that is distinct from that deployed by bony fish and amphibians. How the dermomyotome evolved to generate the distinct types of locomotor systems we see deployed throughout the vertebrate phylogeny remains unresolved. This project aims to contribute to an understanding of how different locomotor strategies deployed at important evolutionary transitions were generated.

DP160100372	This project aims to uncover how a ubiquitous pharmaceutical pollutant – fluoxetine, known as Prozac – alters the course of reproduction and sexual selection in a freshwater fish. Drugs used in human and veterinary medicine enter the environment and pose a serious threat to wildlife. The project plans to integrate morphological, behavioural, and experimental evolution approaches to yield insights into how fluoxetine affects sexual traits and behaviours, and how this in turn can affect offspring viability and the evolutionary process. Findings are expected to add to our understanding of how species respond to rapidly changing environments, with consequences for the persistence of populations and the survival of species in the wild.
DP160103668	This project aims to investigate how environmental experiences shape phenotypes, engender variance in populations and ultimately contribute to evolution. It targets new discoveries for how environmental effects can multiply throughout ontogeny and/or propagate across generations. Although widely speculated to support new evolutionary paradigms, such knowledge lacks scrutiny according to the formal metric of quantitative genetics. This project seeks to expose guppy pedigrees to unique manipulations and reconcile adaptive evolution across captive and wild populations. The outcome is expected to address knowledge gaps in the life and human sciences and potentially inform goals in primary production and conservation.
LP150100761	This project aims to improve our understanding of inshore ecosystems to facilitate better management of our living marine heritage. The project first aims to extend field datasets on the density and distribution of thousands of marine fishes, invertebrates and macro-algae. These will then be combined using recent advances in quantitative ecological modelling to describe transfer of biomass between species at hundreds of sites, with a primary focus on southern Australia. It is anticipated that this will provide site-level indices of major food web processes that, when combined with ‘before, after, control, impact’ data, will improve prediction of ecological consequences of fishing, climate change, pest outbreaks and pollution.
DP160104292	This project intends to develop novel statistical tools for more accurate prediction by taking account of model complexity and uncertainties associated with the fitting procedure. The project also plans to develop a novel shrinkage approach via new penalty functions to avoid over-fitting and asymptotic properties. The key applications may include genetic studies where the number of predictors is large and biological experiments where multivariate and temporal data are often collected – for example economical breeding in animal and fish farming and more effectively detecting the genes of interest in genetic studies on human, animals and plants.
LP150100934	This projects aims to develop models that can determine the ecological and economic impacts of land-use changes (e.g. agriculture) on fisheries and assess alternative land-use plans that seek to maximise economic opportunity while protecting fisheries. Fisheries support the livelihoods of 12 per cent of the world’s population. Land-based activities are among the most significant threats to coral reef fisheries because sediments and nutrients degrade reefs, yet they are often ignored in fisheries management. By improving the sustainability of coastal development, biodiversity conservation, and health of fisheries, the models developed by the project could deliver socio-economic and environmental benefits for millions of people reliant upon fisheries for their livelihoods.

DP160102460	The project aims to investigate very early Australian tetrapod trackways and conduct fieldwork to resolve the place of origin and timing of the evolution of the first tetrapods. The evolution of fishes to tetrapods was one of the key events in evolution. Studies on Northern Hemisphere fossils place an origin for the group around 380 million years ago. Australian fossils suggest a much older origin. New micro computed tomography data from Australian 3-D fossil fishes, combined with study of rare tetrapod gill arch bones, would enable us to determine the origins of tetrapod air-breathing and its ecological setting. The project may facilitate a rewriting of vertebrate evolution's most significant first step.
DP160103387	The project aims to improve our understanding of light–matter interactions in the waters of the Southern Ocean (SO), in particular the role of phytoplankton and associated material of biological origin. Phytoplankton are the energy source for the food web and a critical component of carbon cycling in the SO. However, their dynamics in the SO cannot be quantified using satellite observations because bio-optical data processing algorithms perform poorly due to a lack of field data. This project seeks to remedy this by improving understanding of SO bio-optics, and by providing novel algorithms of known uncertainty, based on in situ data.
LP150100923	This project aims to improve fisheries management of economically important baitfish by increasing our understanding of the ecosystem demand of predatory fish. The ecosystem demand of predatory fish is currently not understood, because it fails to include the considerable impact of juvenile fish, especially when they reside in an estuary. The project intends to implant acoustic transmitters, calibrated in a flume, to discover bioenergetic rates in the field by determining the diet and the size- and temperature-dependent growth and biogenetics of a predatory fish species, from juvenile to adult, from estuary to the open sea. The outcomes include an ecosystem synthesis of related pelagic fish predators from catchment to coast.
LE160100146	The marine productivity buoy is an innovative multi-parametric moored underwater profiler that would provide key information on phytoplankton primary productivity (PP), phytoplankton blooms, and water quality in coastal waters around Australia. The aim is to better understand changes in phytoplankton PP and abundance by synergistically using observations from the new facility made several times a day from the surface to the seafloor, and spatially extended surface observations from Earth-orbiting ocean colour satellites. Anticipated outcomes are more accurate phytoplankton PP estimates and water quality parameters in Australian coastal waters in support to research and to monitoring of these critical environments.
LP150100064	This projects plans to explore the causes of the worldwide decline in the highly lucrative spiny lobster fisheries that has occurred in recent decades. This decline has been attributed to ocean warming, however, the exact mechanism contributing to the demise of lobsters is not known. This project will use a hierarchy of oceanic models of increasing complexity combined with a unique spiny lobster data set to investigate the relationship between larval health, physiology and environmental variables and how this affects survival and successful recruitment into the fishery. An understanding of these complex relationships is expected to enable the first predictions of larval survival and settlement in a region of accelerated ocean warming, and provide critical information for sustainable fisheries management.

LP150100669	<p>The project aims to answer key questions about the biology, ecology and sustainability of the world's manta ray species to provide the information and tools for management and conservation of these charismatic and valuable species. In particular, the project aims to determine the likely impact of climate variability and fisheries that operate to Australia's north on manta-based ecotourism in the Indo-Pacific region, as climate change and active low-value fisheries may both jeopardise a high-value ecotourism industry. The project seeks to explore geographic distributions, local and large-scale movements, population sizes, structure, and inter-connectivity in the region to assess the effect of climate and fisheries on manta ray populations.</p>
LP150100388	<p>This project aims to use a traits-based modelling framework, incorporating variability both within and between species, to forecast the resilience of freshwater fishes in northern Australia to impending environmental change. While northern Australian rivers are among the most pristine and productive on earth, they face profound change due to human activity. Emerging evidence suggests that flexibility in functional traits (e.g. life history, physiology, behaviour, diet) may result in resilience to environmental change. This project aims to provide decision-makers with essential information and new tools to underpin future planning and resource management.</p>

Fisheries Research and Development Corporation (FRDC)

The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a federal statutory authority jointly funded by the Australian Government and the fishing industry. *For more information visit: www.frdc.com.au*

Project ID	Project Title
2009-315.28	People development program: Aquatic animal health training scheme-Fish disease diagnosis, biosecurity and disease management training for fish farming industry of Australia
2009-315.34	Aquatic Animal Health Training Scheme - Training for prawn farmers in sample collection
2010-032	TSGA IPA: Tasmanian Aquabirnavirus vaccine development: Towards achieving pan-specific protection of cultured salmonids in Australia using multivalent vaccines
2010-034	Aquatic Animal Health Subprogram: Investigation of an emerging bacterial disease in wild Queensland gropers, marine fish and stingrays with production of diagnostic tools to reduce the spread of disease to other states of Australia
2010-201	Feasibility study for integrated multitrophic aquaculture in southern Australia
2010-233	PIRSA Innovative Solutions: Investigations to address key policy gaps associated with the development of clam farming in South Australia: genetic and health issues aligned to translocation and stock identification
2011-005	Aquatic Animal Health Subprogram: Investigation of inclusions in Australian prawns
2011-040	FRDC- DCCEE: estuarine and nearshore ecosystems – assessing alternative adaptive management strategies for the management of estuarine and coastal ecosystems
2011-042	Atlantic Salmon Aquaculture Subprogram: clarifying the relationship between salmon farm nutrient loads and changes in macroalgal community structure/ distribution (Existing Student Support)
2011-070	Atlantic Salmon Aquaculture Subprogram: Comparative susceptibility and host responses of endemic fishes and salmonids affected by amoebic gill disease in Tasmania
2011-071	Atlantic Salmon Aquaculture Subprogram: AGD resistance - learning from other species to bolster the natural Atlantic salmon response
2011-205	Spencer Gulf Research Initiative: development of an ecosystem model for fisheries and aquaculture
2011-223	TSGA IPA: development of an RLO vaccine: Proof-of-Concept to commercial application
2011-224	TSGA IPA: Aquareovirus (TSRV) vaccine development for the Tasmanian salmonid aquaculture industry
2011-235	Atlantic Salmon Aquaculture Subprogram: design, testing and assessment of seal exclusion systems for salmon (<i>Salmo salar</i>) farm netpens and leases in Tasmania
2011-236	Pearl Consortium IPA: Improving reliability and efficiency of spat nursery and growout for the silver-lip pearl oyster (<i>Pinctada maxima</i>)
2011-248	Pearl Consortium IPA: Control of Reproduction of the silver-lip pearl oyster, <i>Pinctada maxima</i>

2011-263	PIRSA Innovative Solutions: review of the aquaculture environmental monitoring program (EMP) in South Australia to inform a review of EMP regulations
2012-001	Aquatic animal health subprogram: Strategic planning, project management and adoption
2012-024	INFORMD Stage 2: Risk-based tools supporting consultation, planning and adaptive management for aquaculture and other multiple-uses of the coastal waters of southern Tasmania
2012-032	Aquatic Animal Health Subprogram: Pacific oyster mortality syndrome (POMS) - risk mitigation, epidemiology and OsHV-1 biology
2012-047	Atlantic Salmon Aquaculture Subprogram: characterising benthic pelagic interactions in Macquarie Harbour - organic matter processing in sediments and the importance for nutrient dynamics
2012-048	Atlantic Salmon Aquaculture Subprogram: Culture and cryopreservation of <i>Neoparamoeba perurans</i> (AGD)
2012-051	Workshop to facilitate epidemiological analysis of unexplained mortality of South Australian Pacific Oyster
2012-052	Aquatic Animal Health Subprogram: development of a laboratory model for infectious challenge of Pacific oysters (<i>Crassostrea gigas</i>) with ostreid herpesvirus type-1
2012-209.40	Develop and promote the Australian Fish Names Standard (AS-SSA 5300) and ensure reaccreditation as a Standards Development Organisation
2012-211.20	Securing trade and market access for the Australian seafood industry
2012-217	Atlantic Salmon Aquaculture Subprogram: trial of a stock protection system for flexible oceanic fish pens
2012-300	Social Science Research Coordination Program (SSRCP) II
2012-506	The Australian Animal Welfare Strategy (AAWS): Development of welfare guidelines for restaurants and retail outlets who holding 'live fish and shellfish in aquaria - an initiative of the Animal Welfare Working Group of AAWS
2013-001	Aquatic Animal Health Subprogram: Determination of susceptibility of various abalone species and populations to the various known AbHV genotypes
2013-002	Aquatic Animal Health Subprogram: Identifying the cause of Oyster Oedema Disease (OOD) in pearl oysters (<i>Pinctada maxima</i>), and developing diagnostic tests for OOD
2013-008	Movement, habitat utilisation and population status of the endangered Maugean skate and implications for fishing and aquaculture operations in Macquarie Harbour
2013-011	Assessment of the impacts of seal populations on the seafood industry in South Australia
2013-027	ASBTIA: Optimising the use of praziquantel to manage blood fluke infections in commercially ranched SBT
2013-033	TSGA IPA: Establishing viral diagnostics for salmonid aquaculture in Tasmania: characterisation and identification of Salmon Orthomyxo-like virus (SOMV) and associated pathology in Atlantic Salmon
2013-036	Tactical Research Fund: Aquatic Animal Health Subprogram: Viral presence, prevalence and disease management in wild populations of the Australian Black Tiger prawn (<i>Penaeus monodon</i>)
2013-048	TSGA IPA: Amoeba Lifecycle Biology: Development and application of molecular tools for detection of parasite in host and environment

2013-051	TSGA IPA: The Australian Aquatic Animal Health and Vaccine Centre: First Phase to Establish Atlantic Salmon Biosecure Fish Facility Capabilities and Develop Strategy for an Australian Centre of Excellence
2013-054	Reducing the impact of paralytic shellfish toxins on Australian shellfish industries
2013-056	Tactical Research Fund: revision of the Australian Shellfish Quality Assurance Program manual - in light of the FRDC funded PST review report
2013-221	Stock enhancement of the Western School Prawn (<i>Metapenaeus dalli</i>) in the Swan-Canning Estuary; evaluating recruitment limitation, environment and release strategies
2013/222	TSGA IPA: Tassal: Innovative Seal Exclusion Technology
2013-231	IPA APFA: Characterising and managing harmful algal blooms that cause production loss on Australian prawn farms
2013-409	ASBTIA Southern Bluefin Tuna Research Program: Coordination, Facilitation and Administration
2013-413	IPA APFA: Planning, implementation and commercialisation of the Australian prawn farming industries two year R&D Plan 2014-2016
2014-012	Tasmania's coastal reefs: deep reef habitats and significance for finfish production and biodiversity
2014-027	Pacific oyster feeds and feeding in South Australian waters: towards ecosystem based management
2014-028	Mud cockle (<i>Katelysia</i> spp.) stock enhancement/restoration: practical implementation and policy evaluation
2014-031	TSGA IPA: Predicting marine currents, nutrients and plankton in the coastal waters of south eastern Tasmania in response to changing weather patterns
2014-032	Improved understanding of Tasmanian harmful algal blooms and biotoxin events to support seafood risk management
2014-034	Revision of the existing AQUAVETPLAN: 'Viral Encephalopathy and Retinopathy Disease Strategy Manual'
2014-037	TSGA IPA: DPIPWE Fish Health Unit- Centre for Excellence Standard Operational Procedure development
2014-038	TSGA IPA: Understanding Dorvilleid ecology in Macquarie Harbour and their response to organic enrichment
2014-042	TSGA IPA: understanding broadscale impacts of salmonid farming on rocky reef communities
2014-045	TSGA IPA: Amoeba Biology Diagnostics and Farm Management Strategies for Amoebic Gill Disease
2014-213	Developing new seafood opportunities in Victoria – scallop ranching
2014-214	Investigating critical biological issues for commercial Greenlip Abalone sea ranching in Flinders Bay, Western Australia
2014-241	TSGA IPA: Reassessment of intertidal macroalgal communities near to and distant from salmon farms and an evaluation of using drones to survey macroalgal distribution
2014-242	NEAO Subprogram: Commercialising the production of Cobia in Australia
2014-246.20	New & Emerging Aquaculture Opportunities Subprogram: establishment
2014-247	TSGA IPA: Design and testing of well-boat bathing systems including the development of full freshwater re-circulation capability, and, the safe and reliable use of hydrogen peroxide treatment in both seawater and reusable freshwater baths for Atlantic Salmon

2014-248	TSGA IPA: understanding skeletal deformities in Salmonids: effects of farm settings and genetic background on prevalence
2014-403	Aquatic Animal Health Subprogram: Development of a national aquatic animal health curriculum for delivery by tertiary institutions
2014-503.20	Sector Overview Assessment for Fishing and Aquaculture RD&E Framework
2015-001	Aquatic Animal Health Subprogram: Bonamiasis in farmed Native Oysters (<i>Ostrea angasi</i>)
2015-003	Aquatic Animal Health Subprogram: Development of standard methods for the production of marine molluscan cell cultures
2015-005	Aquatic Animal Health Subprogram: Determining the susceptibility of Australian <i>Penaeus monodon</i> and <i>P. merguensis</i> to newly identified enzootic (YHV7) and exotic (YHV8 and YHV10) Yellow head virus (YHV) genotypes
2015-024	TSGA IPA: Managing ecosystem interactions across differing environments: building flexibility and risk assurance into environmental management strategies
2015-033	Revision of the AQUAVETPLAN for Infectious Salmon Anaemia (ISA) virus
2015-040	ABFA IPA: an assessment of the risk of exotic disease introduction and spread among Australian Barramundi farms from the importation of Barramundi products
2015-042	Assessing occurrence of pathogenic species of the marine bacteria <i>Vibrio</i> in Tasmanian oysters from St Helens
2015-212	SafeFish - research to support food safety, trade and market access
2015-213	Enabling land-based production of juvenile Yellowtail Kingfish in NSW
2015-228	IPA Australian Barramundi Farmers Association - ABFA RD&E investment model
2015-231	AAGA IPA: obtaining approvals for abalone relaxants
2015-235	TSGA IPA: scoping study for alternative energy sources at off-shore/remote salmon farms to reduce or eliminate the need for large diesel generators
2015-238	Rural R&D for Profit: Easy-Open Oyster automation
2015-300	Social Science and Economics Research Coordination Program (SSERCP)
2016-045	TSGA IPA: development of Pilchard orthomyxo virus vaccine for salmonids
2016-046	Pearl consortium IPA: Environmental and technical influences on pearl production from <i>Pinctada maxima</i>
2016-200	Rural R&D for Profit: Growing a profitable, innovative and collaborative Australian Yellowtail Kingfish aquaculture industry: bringing 'white' fish to the market
2016-200.20	Growing a profitable, innovative and collaborative Australian Yellowtail Kingfish aquaculture industry: bringing 'white' fish to the market - RnD4Profit-14-01-027
2016-200.30	Growing a profitable, innovative and collaborative Australian Yellowtail Kingfish aquaculture industry: bringing 'white' fish to the market - RnD4Profit-14-01-027 - SA Component
2016-200.40	Growing a profitable, innovative, collaborative Australian Yellowtail Kingfish aquaculture industry: bringing 'white' fish to the market. WA Component
2016-227	The FRDC's Australian Seafood Retailer's Network
2016-229	TSGA IPA: HAC: Identifying the nature, extent and duration of critical production periods for Atlantic salmon in Macquarie Harbour, Tasmania, during summer
2016-232	Pearl consortium IPA: understanding stress and its impact on pearl quality in the silver-lip pearl oyster, <i>Pinctada maxima</i> , using transcriptomic, proteomic and metabolomic tools

Oyster Projects	
2011-236	Pearl Consortium IPA: improving reliability and efficiency of spat nursery and growout for the silver-lip pearl oyster (<i>Pinctada maxima</i>)
2011-248	Pearl Consortium IPA: Control of Reproduction of the silver-lip pearl oyster, <i>Pinctada maxima</i>
2012-032	Aquatic Animal Health Subprogram: Pacific oyster mortality syndrome (POMS) - risk mitigation, epidemiology and OsHV-1 biology
2012-051	Workshop to facilitate epidemiological analysis of unexplained mortality of South Australian Pacific Oyster
2012-052	Aquatic Animal Health Subprogram: development of a laboratory model for infectious challenge of Pacific oysters (<i>Crassostrea gigas</i>) with ostreid herpesvirus type-1
2012-223	Tactical Research Fund: Assessment of heavy metals in tropical rock oysters (blacklip and milky) and implications for placement into the Australian seafood market and for Indigenous enterprise development in the NT.
2013-002	Aquatic Animal Health Subprogram: Identifying the cause of Oyster Oedema Disease (OOD) in pearl oysters (<i>Pinctada maxima</i>), and developing diagnostic tests for OOD
2013-056	Tactical Research Fund: revision of the Australian Shellfish Quality Assurance Program manual - in light of the FRDC funded PST review report
2013-234	Survey of Foodborne Viruses in Australian Oysters
2014-040	Oyster Australia IPA: Pacific Oyster Mortality Syndrome - closing knowledge gaps to continue farming <i>C. gigas</i> in Australia
2014-243	NSW Oyster Industry Strategic Development Plan
2014/405	Oysters Australia IPA: Australian edible oyster RD&E investment via Oysters Australia strategic plan 2014-2019
2015-001	Aquatic Animal Health Subprogram: Bonamiasis in farmed Native Oysters (<i>Ostrea angasi</i>)
2015-037	Oysters Australia IPA: the use of FRNA bacteriophages for rapid re-opening of growing areas after sewage spills
2015-042	Assessing occurrence of pathogenic species of the marine bacteria <i>Vibrio</i> in Tasmanian oysters from St Helens
2015-229	Oysters Australia IPA -workshop – identifying knowledge gaps for development of the native oyster aquaculture industry in South Australia
2015-230	Oysters Australia IPA: genetic services for the multi-trait, single pair mated Sydney Rock Oyster breeding program
2015-232	Oysters Australia IPA: Australian Seafood Industries Pacific Oyster Mortality Syndrome (POMS) investigation into the 2016 disease outbreak in Tasmania
2015-238	Rural R&D for Profit: Easy-Open Oyster automation
2015-239	Oysters Australia IPA: Pacific Oyster Mortality Syndrome - resistant Oyster breeding for a sustainable Pacific Oyster Industry in Australia
2015-406	Oysters Australia IPA: development of a national Pacific Oyster Mortality Syndrome (POMS) response plan
2016-046	Pearl consortium IPA: Environmental and technical influences on pearl production from <i>Pinctada maxima</i>
2016-232	Pearl consortium IPA: understanding stress and its impact on pearl quality in the silver-lip pearl oyster, <i>Pinctada maxima</i> , using transcriptomic, proteomic and metabolomic tools

The Australian Seafood Cooperative Research Centre is Australia's first entity to stimulate and provide comprehensive seafood-related research and development and industry leadership on a national basis. *For more information visit: www.seafoodcrc.com.au*

Project ID	Project Title
2009-743	Incorporation of selection for reproductive condition, marketability and survival into a breeding strategy for Sydney rock oysters and Pacific oysters
2015-706	Overcoming technical constraints to Sydney Rock Oyster hatchery production
2012-760	Genetic selection for resistance to Pacific oyster mortality syndrome
2012-740	Evaluating the impact of an improved retailing concept for oysters in fishmongers
2008-772	Education and training exchange program with NOFIMA, a world leading aquaculture research institute
2009-730	Development of barramundi selective breeding entity II
2010-736	Development of formulated diets for cultured abalone
2010-767	Prevention and control of maturation to address multiple key abalone production constraints
2010-768	Broodstock and genetic management of SBT and YTK
2010-780	PhD: Molecular and quantitative genetics studies to improve breeding programs for key Australian aquaculture species
2011-726	Wanted Dead or Alive: Novel Technologies for Measuring Infectious Norovirus Particles
2011-735	An evaluation of the options for expansion of salmonid aquaculture in Tasmanian waters
2011-736	National prawn market category planning
2011-740	Addressing causes of early mortality in hatchery produced Southern Bluefin Tuna larvae
2011-771	Genetic selection for Amoebic Gill Disease (AGD) resilience in the Tasmanian Atlantic salmon (<i>Salmo salar</i>) breeding program
2012-708	Quantifying physiological and behavioural responses of cultured abalone to stress events
2012-740	Evaluating the impact of an improved retailing concept for oysters in fishmongers
2012-756	Aquaculture Production Innovation Hub: Phase II – communication, extension and opportunities
2012-760	Genetic selection for resistance to Pacific oyster mortality syndrome
2013-710	Securing the future of SBT propagation R&D
2013-726	Utilisation of improved varieties of soybean meal and poultry offal meal by Barramundi (<i>Lates calcarifer</i>)
2013-729	Promoting Marine Finfish Aquaculture in NSW
2013-730	Refining Yellowtail Kingfish feeds and feed management
2013-731	Improving fluke control in Yellowtail Kingfish culture
2013-737	Propagation of South Bluefin Tuna - addressing constraints to larval rearing
2014-706	Co-ordination of fish health and nutrition research for the WA Yellowtail Kingfish trial 2
2014-708	Stamping quality across the Australian farmed Barramundi industry

2014-712	Disease challenge testing at the Centre of Excellence- Scope for estimating the genetics of resistance
2014-721	ASI Quantitative Genetics Analysis and Training Services 2014-15 (2014/721 Communal)
2014-722	APFA Web update to incorporate R & D and market development results for members
2014-727	Assessing histamine production in aquaculture Yellowtail Kingfish and determining the appropriateness of the predictive FSSP histamine model for Clean Seas
2014-729	Improving the taste, bioavailability and efficacy of orally administered praziquantel for yellowtail kingfish with lipid nanoparticles and hybrid lipid carrier systems
2015-707	Research Travel Grant - Veterinary Student Clinical Rotation in Aquaculture Health Management (VET SC 7306RW DVM)
2015-711	New directions in Australian seafood whole of chain traceability and supply chain technologies
2015-712	Sustainability Certification Australian farmed prawns