



Australian Government
 Fisheries Research and
 Development Corporation



Aquatic Animal Health & Biosecurity Subprogram Research Development & Extension Plan 2016-2020 (updated July 2019)

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1. Introduction

This strategic RD&E plan ('the Plan') of the Fisheries Research and Development Corporation's Aquatic Animal Health and Biosecurity Subprogram ('the Subprogram') will guide the Subprogram to fulfill its objectives to provide leadership, direction and focus for aquatic animal health and biosecurity research, development and extension (RD&E) and other related non-RD&E activities and taking into consideration non-AAHBS research projects. The Plan will assist the Subprogram in assessing aquatic animal health and biosecurity project applications. A compilation of current RD&E issues is included.

This strategic RD&E plan is applicable to the four-year period 2016-2020 after which a full review will be conducted.

However, the Plan will also be reviewed annually, as needed.

The Plan:

- Describes the Subprogram including its role, objectives and structure;
- Describes criteria used in defining a project under the Subprogram;
- Outlines the key research areas;
- Will be used by the Subprogram to assist in assessing aquatic animal health and biosecurity project applications;
- Lists current RD&E priorities; and
- Will be reviewed annually with wide stakeholder consultation.

2. Background

Australia's fisheries/aquaculture continues to be a major sector of our primary industries in terms of both job creation and value of production. Commercial fishery and aquaculture production was valued at \$3.06 billion in 2016-17 (Abares, 2018). Globally, Australia produces less than 0.16% of the world's fishery and aquaculture supply but does export a range of high value products, e.g. SBT to Japan, lobster and abalone products to other Asian countries (Whittle et al., 2015). Salmonids, rock lobster, prawns, tuna and abalone dominate, being valued at over \$2 billion. Aquaculture production was valued at \$1.35 billion and is dominated by salmonids (52,779 tonnes valued at \$756 million (Abares, 2018)). The National Aquaculture Strategy (2017-27) vision is to grow the value of aquaculture to \$2 billion by 2027 by improving market access, investing in RD&E, strengthening biosecurity, improving environmental performance, reducing regulatory burden and investing in education and training.

Australia is fortunate to have an aquatic animal sector free from many diseases that cause significant economic impact elsewhere in the world. It is vital for Australia to maintain this relative disease-free status, not only to enhance our competitiveness but also to protect Australia's natural resources. However, Australia also has a unique and poorly understood range of endemic pathogens including local strain variations of pathogens of international concern, which is becoming increasingly important and of significance to our export trade. Examples include local genotypes of YHV (YHV2, YHV7) in prawns, *Bonamia* sp. in edible oysters, oedema oyster disease in pearl oysters, *Penaeus monodon* hepatopancreatitis and pilchard orthomyxovirus. Furthermore, as aquaculture expands, the range of native aquatic animals being farmed is increasing which, in turn, increases the need for further research on aquatic animal health issues. In Australia there are approximately 70 aquatic species under

aquaculture development of which 40 are farmed commercially. Research on all types of aquatic animals (finfish, crustaceans and molluscs) from all environments, i.e. tropical or temperate, marine, brackish or freshwater environments, is required. It is noteworthy that, clearly, investment in aquatic animal health and biosecurity RD&E provides a better return on investment over post-outbreak response and recovery (cf. 2016 SE Queensland WSD outbreak)

Industry and government have recognised the importance of an integrated and planned approach to aquatic animal health. This recognition led to an industry/government cooperative effort in developing *AQUAPLAN 1998-2003*, Australia's first five-year National Strategic Plan for Aquatic Animal Health, and its successors *AQUAPLAN 2005-2010* and *AQUAPLAN 2014-2019*. A common theme within these strategic plans is the recognition of the need for research, and the adaptability of the plan to include emerging aquaculture industries. Research has a critical role in expanding this knowledge and enhancing management practices to prevent disease or limit its impact on the expanding fisheries/aquaculture sector, including recreational fisheries and natural resources.

3. Aquatic Animal Health and Biosecurity Subprogram

The Aquatic Animal Health & Biosecurity Subprogram (AAHBS) was established by the Fisheries Research and Development Corporation (FRDC) in mid-2001 to provide a cohesive and national approach to aquatic animal health research and development in Australia, and in particular to address *AQUAPLAN 1998-2003* Program 6: Research and Development. The Subprogram has a national focus, linking government and industry research priorities, consistent with international obligations. The subprogram was initially known as Aquatic Animal Health Subprogram but in 2016 it was re-named the Aquatic Animal Health & Biosecurity Subprogram (AAHBS) to reflect an increased focus on biosecurity by the Australian Government, the FRDC and industry.

From the Subprogram perspective, *aquatic animal health* concerns the health of the animal *per se* and the resources and procedures to maintain aquatic animal health (for the subprogram this relates to infectious disease). *Aquatic animal biosecurity* refers to all the resources and procedures in place to prevent pathogens affecting aquatic animal health from entering our country, regions, or farms; and to prevent their subsequent spread or establishment. Research and training activities that support this aim would be relevant for the Subprogram.

3.1. Mission

“To provide oversight and guidance to aquatic animal health and biosecurity RD&E and its adoption in Australia”.

3.2. Objectives

The Subprogram's key objectives are to:

1. Provide expert advice, coordination, management and planning for aquatic animal health and biosecurity RD&E;
2. In consultation with stakeholders, set and review FRDC Subprogram RD&E priorities, and on request provide advice on external projects addressing aquatic animal health and biosecurity;

3. Ensure that FRDC-funded projects are implemented and progressed according to stated project objectives; and
4. Facilitate the communication and extension of results of FRDC aquatic animal health and biosecurity research projects undertaken under the auspices of the AAHBS.

3.3. Role

The role of the Subprogram is to:

- Implement the Subprogram strategic RD&E Plan;
- Set Subprogram RD&E priorities in aquatic animal health and biosecurity to maximise investment for the greatest potential return;
- Invite RD&E applications to address those priorities;
- Provide FRDC with expert technical advice on proposals submitted to the Subprogram and, where appropriate, RACs, IPAs and other funding agencies - particularly on methodology, capability and value for money, to identify technical risks/challenges, to identify potential linkages with other activities, to identify whether the Subprogram wishes to co-invest.
- Promote collaboration among researchers, and between researchers and the beneficiaries (of the research);
- Encourage co-investment from other RD&E funding sources;
- Communicate regularly with potential beneficiaries; and
- Influence the adoption of RD&E results.

3.4. Outcomes

The Subprogram's activities will contribute to improved productivity and profitability of the fishing and aquaculture sectors through:

1. Reduced risks of exotic and new diseases in Australia's fisheries and aquaculture sectors.
2. Mitigation of the impacts of endemic disease on Australia's fisheries and aquaculture sectors.
3. Improved biosecurity
4. Improved market access
5. High quality and cost-effective research
6. Increased awareness of aquatic animal health and biosecurity issues

3.5. Scope and links within FRDC

The scope of the Subprogram is 'health and biosecurity' with a focus on infectious diseases and their causative agents. The Subprogram is responsible for coordinating research projects that are funded under the following two separate components:

a) R&D projects in sectors with no dedicated subprograms

The Subprogram adopts a special responsibility for health and biosecurity related project applications relevant to industry sectors for which there is no other specific subprogram or IPA. In particular, the Subprogram manages health and biosecurity related projects on new or emerging species ('orphan species') for aquaculture.

In situations where a species-specific aquaculture subprogram or IPA exists (see FRDC website for details), these subprograms and IPAs are responsible for the prioritisation and management of any health and biosecurity related projects involving those specific species. The Subprogram provides advice on these health and biosecurity related projects where requested. The

Subprogram may also co-invest with these subprograms and IPAs in projects with a national focus.

b) R&D projects that may provide benefit across all aquatic industry sectors

These projects contribute to maintaining and increasing Australia's capacity and capability to manage aquatic animal health and biosecurity. They may support national objectives in the area of aquatic animal health and biosecurity; for example, as reflected in AQUAPLAN and the FRDC's Research, Development and Extension Plan 2015-20. The Australian Government through FRDC supports the FRDC's mission to increase economic and social benefits for the fishing and aquaculture industry and the people of Australia through planned investment in research and development in an ecologically sustainable framework. Such projects are managed by AAHBS on behalf of the FRDC.

3.6. Scope and links with other bodies

The Subprogram consults on health and biosecurity R&D priorities and strategies with the Animal Health Committee (AHC) which has primary responsibility for public policy decision-making on aquatic animal health and biosecurity. Consultation is primarily through AHC's Subcommittee on Aquatic Animal Health (SCAAH). SCAAH consists of the Sub-committee Chair (a member of AHC), core members (aquatic animal health and biosecurity specialists nominated by the Federal and each State/Territory Government and New Zealand Government, CSIRO-AAHL and a university representative), co-opted members (as deemed necessary to undertake SCAAH business), and observers including the Chair of the National Aquaculture Council.

3.7. Operation of the Subprogram

The operation of the Subprogram is supported by a Steering Committee (STC), and a Scientific Advisory Committee (SAC), both appointed by the FRDC.

3.7.1 Steering Committee (STC)

The *Terms of Reference* of the STC are:

- To provide a Strategic RD&E Plan with key performance measures and timeframes.
- To ensure that research objectives are commercially-focused, and outcome-driven.
- To coordinate industry and research provider involvement to maximise usage of available resources.
- To provide advice on aquatic animal and biosecurity projects to facilitate industry extension and technology transfer.
- To communicate between AAHBS and its major stakeholders.

The AAHBS STC provides for linkages to the National Aquaculture Council (NAC), Subcommittee on Aquatic Animal Health (SCAAH), Australian Government Department of Agriculture, Water and the Environment (DAWE), CSIRO Australian Animal Health Laboratory (CSIRO-AAHL), state and territory diagnostic laboratories, and the FRDC.

STC members

Membership of the STC is representative and includes industry and government (state and the Australian Government) representatives, and representatives of the FRDC and CSIRO-AAHL (See Table 1). Changes to membership are to be recommended by the STC to the FRDC for approval.

Table 1. Current membership of the FRDC AAHBS STC

Name	Affiliation
Mark Crane (Subprogram leader, Chair)	Commonwealth laboratory (AAHL Fish Diseases Laboratory, CSIRO-AAHL)
Joanne Slater (Subprogram coordinator)	Commonwealth laboratory (AAHL Fish Diseases Laboratory, CSIRO-AAHL)
Tracey Bradley	SCAAH/State Government (Principal Veterinary Officer - Aquatic Animal Health, DEDJTR, Victoria)
Ingo Ernst	Australian Government (Director - Aquatic Pest and Health Policy, Department of Agriculture, Water and the Environment)
Wayne Hutchinson	FRDC (Research Portfolio Manager)
Aaron Irving	Industry (Chair - National Aquaculture Council and Executive Officer - Pearl Producers Association)
Steve Percival	Huon Aquaculture Company Pty Ltd

3.7.2 Scientific Advisory Committee (SAC)

The purpose of the formal Scientific Advisory Committee (SAC) is to provide the STC with timely scientific and technical advice in all matters relating to aquatic animal health & biosecurity and to facilitate communication between AAHBS and other scientific experts.

The *Terms of Reference* of the SAC are:

- To assess new research proposals, *inter alia* to ensure that the research proposed is scientifically feasible.
- To advise on scientific problems with project progress as well as identify remedial action, to ensure scientific objectives and milestones are met.
- To foster and develop collaboration amongst researchers.
- To provide advice on projects to facilitate research extension and technology transfer.
- To assess Milestone Progress Reports and draft Final Reports.

SAC members

Membership of the SAC is expertise-based (see Table 2). Members will be chosen to ensure complimentary knowledge and skills are brought to the SAC so that it is best placed to provide the STC with scientific advice. Changes to membership are to be recommended by the STC-SAC to the FRDC for approval.

Table 2. Current membership of the FRDC AAHBS SAC

Name	Affiliation
Ian Anderson	Queensland DAF, Brisbane, Qld
Ellen Ariel	James Cook University, Townsville, Qld
Jeremy Carson	Carson BioConsulting, Launceston, Tas
Cecile Dang	DPIRD WA
Nick Moody	CSIRO AAHL Fish Diseases Laboratory, Geelong, Vic

4. Stakeholders

The key stakeholders in the Subprogram, i.e. those that have the greatest stake in the success of the Subprogram and with whom the Subprogram consults to identify aquatic animal health and biosecurity RD&E needs, are:

- Australian Government Department of Agriculture, Water and the Environment
- Animal Health Committee (AHC) and its Subcommittee on Aquatic Animal Health (SCAAH)
- Capture fisheries
- Customary fisheries
- Recreational fisheries
- FRDC
- Aquaculture industries
- National Aquaculture Council
- Research providers
- State/Territory Departments of Fisheries/Natural Resources/Agriculture

It is acknowledged that the list of beneficiaries is much larger, including e.g. the post-harvest industry, the ornamental fish industry, conservation interests, indigenous groups, pharmaceutical companies, research investors, extension services, consumers of seafood, and the public at large.

5. Method of operation

The Subprogram fulfils its role by:

- Being accountable for actions outlined in this strategic plan;
- Adopting a proactive and holistic approach to aquatic animal health and biosecurity;
- Adopting sound governance processes;
- Encouraging a collaborative/cooperative RD&E environment;
- Advocating the importance of aquatic animal health and biosecurity; and
- Communicating with Fisheries Research Advisory Councils (RACs) and other FRDC subprograms/IPAs on:
 - ✓ Research EoIs and full project applications received by the Subprogram – informing and seeking comment by RACs/subprograms/IPAs;
 - ✓ Subprogram assessment of research EoIs and full applications; and
 - ✓ Advice sought on health and biosecurity related EoIs and full applications submitted to RACs or other subprograms/IPAs.

The STC and SAC assist the Subprogram in fulfilling its role and managing its projects. The Subprogram follows the FRDC's standard operating procedures for project approval and management, especially regarding communication with other subprograms/IPAs and RACs.

The Subprogram achieves its four key objectives through the following methods:

Objective 1: Provide expert advice, coordination, management and planning for aquatic animal health and biosecurity RD&E

A) Planning

- Establishment and annual review of the strategic RD&E plan (update; identify gaps)

B) Development of applications

Project applications submitted to the Subprogram:

- Commissioned, unsolicited or forwarded (by FRDC, RACs or other subprograms/IPAs, or by AHC and SCAAH) applications are reviewed.
- Projects falling within the remit of the FRDC AAHBS are evaluated against the criteria below (C to F). Other projects referred to the FRDC AAHBS (e.g. by FRDC, RACs, other subprograms or IPAs) will be evaluated as per usual unless there are specific criteria requested with the referred project.

C) Assessment of applications

- Determine whether application fits criteria¹ (if not, provide advice/expertise/leadership)
- Evaluate need
- Evaluate feasibility
- Determine overall priority (against other applications)

D) Application funding

- Identify appropriate funding body/ies

E) Governance

- Reporting/accountability (FRDC)
- Structure (STC; SAC – expertise based)

F) Linkages

- Establish strategic alliances

Objective 2: In consultation with stakeholders, set and review FRDC Subprogram RD&E priorities, and on request provide advice on external projects addressing aquatic animal health and biosecurity.

- Establish current RD&E issues in consultation with stakeholders, e.g. through the annual meetings of SCAAH, and FRDC-representative organisations
- Annual update of the strategic RD&E plan
- Full review of the strategic RD&E plan every 5 years
- Where requested, provide scientific advice and communication to other subprograms/IPAs and RACs regarding aquatic animal health and biosecurity research pre-proposals, applications, projects and results

Objective 3: Ensure that FRDC-funded projects are implemented and progressed according to stated project objectives

- Assess project milestone progress reports with reference to the project objectives
- Assess the project communication/extension plan
- Encourage/facilitate adoption of results

Objective 4: Facilitate the communication and extension of results of FRDC aquatic animal health and biosecurity research projects undertaken under the auspices of the AAHBS

Provide a communication strategy that may include:

¹ See 6.1 below

- *Health Highlights* (AAHB Subprogram newsletter)
- Scientific workshops (convened to prioritise and facilitate a national approach to specific RD&E problems, for example, the national workshops on “Development of a national aquatic animal health curriculum for delivery by tertiary institutions”, Adelaide 13-14 February 2014 and “White spot disease R&D needs”, Brisbane 18 October 2017)
- FRDC National Aquatic Animal Health Conferences (previously held in 2003, 2005, 2007, 2009)
- FRDC Australasian Scientific Conference on Aquatic Animal Health & Biosecurity (previously held in 2011, 2013, 2015, 2017, 2019)
- Webpage on the FRDC Website
- Databases on the FRDC Website

6. Research Development & Extension

This section outlines the criteria used to determine whether a project falls within the Subprogram. Key research areas for the Subprogram are listed as a guide for applicants in developing projects for funding under the Subprogram.

6.1 Scope

The following factors are used to prioritise projects for funding by the Subprogram:

- Exotic or endemic aquatic animal disease of putative infectious aetiology, with potential or existing significant impact on Australian fisheries and aquaculture (includes also capture fisheries, recreational fisheries, indigenous fisheries and/or aquatic ecosystems)
- Emergency disease of national significance (e.g. based on Australia’s *National List of Reportable Diseases of Aquatic Animals*)
- Addresses gaps in existing aquatic animal health research and biosecurity and contributes to the future understanding of infectious aquatic animal diseases and their control (including diseases of new or potential species for aquaculture)
- Leads to increased productivity and/or profitability the Australian fisheries and aquaculture by improving the health status of target aquatic animals
- Facilitates collaborative research to avoid duplication or gaps
- Facilitates capability and capacity development within Australia
- Identified as a stakeholder priority (including industry, government and research providers)
- Addresses RD&E needs identified in *AQUAPLAN 2014-2019*.

6.2 Key research areas in aquatic animal health and biosecurity

When developing project applications for funding through the Subprogram, the outcomes of the project should address at least one of these key research areas. Current priorities for AAHBS in the next funding cycle are listed under pertinent areas.

6.2.1 Nature of diseases and their epidemiology

SCOPE

- Improved knowledge of the biology of enzootic diseases (including epidemiology, taxonomy of pathogens, pathophysiology, histology, etc)
- Improved knowledge on the host response to disease agents (aquatic animal immunology and immunomodulators)

- Knowledge about new and emerging infectious diseases

CURRENT PRIORITIES

- Development of robust methodologies for investigation of disease outbreaks
- Develop generic response/key strategies to manage an outbreak of a new (previously unknown) disease, including epidemiology and a guideline for undertaking initial investigation
- Research on newly emerging diseases
- Integrated health management practices for commercial enterprises

6.2.2 Biosecurity

SCOPE

- RD&E to inform risk analyses (including disease risk minimisation procedures for exported and imported aquatic animals and products)
- RD&E to facilitate translocation of aquatic animals and their products
- Development of protocols and methods to manage routine biosecurity and emergency disease outbreaks
- Treatments to prevent spread of disease (e.g. disinfection and decontamination)

CURRENT PRIORITIES

- Research on risks from infectious disease agents carried by imported species/products
- Simplified, risk-based approach to translocation of live animals, harmonised across State/Territory boundaries. Improving regional and enterprise level biosecurity to underpin health accreditation for trade (including translocations and export) and best practice disease management
- Research to support the evaluation of quarantine risks to Australia, including susceptibility of Australian species to emerging and exotic diseases
- Pathways involved in incursion, transmission and establishment of emerging and exotic disease
- Pathogen persistence

6.2.3 Diagnostics

SCOPE

- Development of tissue sampling and processing methodology to detect sub-clinical infections at low levels of prevalence
- Development of case definitions and diagnostic criteria
- Development and validation² of screening and diagnostic tests
- Facilitate transfer of knowledge and technology in diagnostics

²Validation, as defined in Chapter 1.1.2. Principles and methods of validation of diagnostic assays for infectious diseases of the OIE Manual of Diagnostic Tests for Aquatic Animals (the *Aquatic Manual*), is “the process that determines the fitness of an assay, which has been properly developed, optimised and standardised, for a specific, defined diagnostic purpose.” Projects aimed at diagnostic test development and validation should be guided by the validation pathway described in this OIE Chapter. The stage to which an assay will be validated needs to be described.

- RD&E

CURRENT PRIORITIES

- Development, improvement and harmonisation of procedures (tissue sampling, tissue processing, nucleic acid extraction, result interpretation) for molecular tests
- Development/establishment of cell culture systems for the isolation of viruses from finfish, crustaceans and molluscs
- Develop and validate fit-for-purpose diagnostic tests for significant diseases including detection of sub-clinical infections.

6.2.4 Strategic surveillance

SCOPE

- Support projects to enhance existing and proposed surveillance programs
- Research into surveillance methodology
- Strategic RD&E to inform disease control programs, translocation, zoning, surveillance, and risk analyses in relation to disease organisms

CURRENT PRIORITIES

- Identify possible improvements in the sensitivity of Australia's surveillance systems (including early detection of disease, disease management, confirmation of Australia's disease status etc.) for aquatic animal diseases.

6.2.5 Disease mitigation

SCOPE

- RD&E that supports the application of veterinary medicines for the treatment of infectious diseases of aquatic animals
- RD&E (microbiology/immunology) that underpins development of autogenous vaccines for aquatic animals
- RD&E that supports selective breeding programs for disease resistance

CURRENT PRIORITIES

- Research on resistance to viral, bacterial and parasitic diseases of Australian aquaculture species that supports development and assessment of alternative therapeutics/vaccines.
- Research that supports the application (MUP/label registration) of veterinary medicines for the treatment of infectious diseases of aquatic animals
- Research that supports understanding the mechanisms of disease resistance

6.2.6 Training and capacity building

SCOPE

- Human capital development
- Facilitate the development of, and access to, training and extension tools
- Sustain and further develop technical skill-base in aquatic animal health and biosecurity
- Facilitate RD&E knowledge transfer in aquatic animal health and biosecurity

CURRENT PRIORITIES

- Improve the breadth of data included in the Neptune information facility, particularly the histopathology slide collections.
- Develop generic short-course training material for industry on management of aquatic animal disease incidents (including reporting procedures, collecting samples for laboratory diagnostics, record keeping).

6.2.7 New technologies and applications

SCOPE

- Next Generation Sequencing

Next-generation sequencing (NGS) is non-Sanger-based DNA sequencing (also referred to as massively parallel sequencing) technologies. Millions of DNA strands are generated from single or multiplexed samples that are sequenced in parallel. Commonly used platforms include MiSeq, PacBio, MinION and Ion Torrent.

- Bioinformatics

Bioinformatics is the computational analysis and interpretation of NGS data using either GUI- or Command Line-based computer programs.

- Transcriptomics

Transcriptomics is the study of the transcriptome - the complete set of RNA transcripts that are produced by the genome under specific experimental conditions.

- eDNA

Analysis of genetic material obtained from environmental samples (i.e. water or sediment). eDNA can be used for detection of specific targets (e.g. detection of OsHV-1 in plankton samples) or analysis of biodiversity in environmental samples.

CURRENT PRIORITIES

- Improved knowledge about microbiomes and their role in disease outbreaks
- Evaluation, optimisation and validation of analysis pipelines for the detection of WSSV and OsHV-1 in plankton samples.

6.3 The application and evaluation process

A general guide to developing research proposals for submission to FRDC is provided on the FRDC Website (<http://www.frdc.com.au/Research/Apply-for-funding>) and should be followed. In addition, PIs may contact any of the AAHBS committee members to obtain advice of the relevance of any project idea to the AAHBS.

In the sections that require text, it may be useful to draft these using your normal word-processor (e.g. MS Word) so that you can use tools such as spell-check and word-count and then copy and paste the final text into the on-line application. Thus poor presentation will not distract reviewers from the proposal content.

Selection of a successful application is a competitive process, taking into account the following criteria:

- Whether or not the project is of national significance
- Whether or not appropriate collaborations are included and corroborated
- The objectives are clearly defined and address identified AAHBS RD&E priorities
- Evidence of strong stakeholder support such as cash contributions

- Does the project provide value for money, is the budget justified and is the application of the project (to industry or environment) clearly identified?
- Are the methods appropriate to address the objectives to provide a high likelihood of their achievement?
- What is the track record of the PI and research team?
- Has a literature review been undertaken and does the project reflect current knowledge?

7. Current and completed projects within AAHB Subprogram

Projects are listed according to the most relevant key research areas and as such some projects may be listed more than once because they are relevant to more than one key research area. For completed projects the date of the Final Report is included. Final Reports can be found on the FRDC website: <http://www.frdc.com.au/Research/Final-reports>

7.1 Nature of diseases and their epidemiology

- 2002/043: The production of nodavirus-free fish fry and the nodaviruses natural distribution (Ian Anderson, QDPI&F) September 2008.
- 2002/044: Pilchard herpesvirus infection in wild pilchards (Brian Jones, Fisheries WA) October 2006.
- 2004/084: Investigating and managing the *Perkinsus*-related mortality of blacklip abalone in NSW Phase 1 (Geoff Liggins, NSW DPI) June 2010.
- 2006/062: Identification of host interactions in the life-cycle of QX disease (Rob Adlard, Qld Museum) May 2008.
- 2007/225: Metazoan parasite survey of selected macro-inshore fish of southeastern Australia, including species of commercial interest (Kate Hutson, U. Adelaide) February 2011.
- 2008/031: Investigation of Chlamydiales-like organisms in pearl oysters, *Pinctada maxima* (Brian Jones, Fisheries WA) June 2012.
- 2008/041: Tools for investigation of the nodavirus carrier state in marine, euryhaline and freshwater fish and control of NNV through integrated management (Richard Whittington, U. Sydney) November 2012.
- 2009/032: Characterisation of abalone herpes-like virus infections in abalone (Mark Crane, CSIRO) August 2014.
- 2009/075: Determining the susceptibility of remnant populations of abalone previously exposed to AVG (Mark Crane, CSIRO) January 2012.
- 2010/034: Investigation of an emerging bacterial disease in wild Queensland gropers, marine fish and stingrays with production of diagnostic and epidemiological tools to reduce the spread of disease to other states of Australia (Rachel Bowater, DEEDI, Qld) February 2015.
- 2011/003: Investigations into the genetic basis of resistance to infection of abalone by the abalone herpes-like virus (Serge Corbeil, CSIRO) September 2013.
- 2011/043: Understanding and planning for the potential impacts of OHsV1 on the Australian Pacific oyster industry (Tom Lewis, RDS Partners Pty Ltd) September 2012.
- 2011/048: Determining the susceptibility of Australian species of prawns to infectious myonecrosis (Mark Crane, CSIRO) April 2015.
- 2011/053: Pacific oyster mortality syndrome (POMS) - Understanding biotic and abiotic environmental and husbandry effects to reduce economic losses (Richard Whittington, U. Sydney) January 2013.
- 2011/255: Tactical Research Fund: Optimisation of treatment of *Ichthyophthirius multifiliis* in farmed trout (Marty Deveney, SARDI) May 2014.
- 2012/032: Pacific oyster mortality syndrome (POMS) - risk mitigation, epidemiology and OsHV-1 biology (Richard Whittington, U. Sydney) December 2015.
- 2012/052: Development of a laboratory model for infectious challenge of Pacific oysters (*Crassostrea gigas*) with ostreid herpesvirus type-1 (Peter Kirkland, NSW DPI) April 2015.
- 2013/001: Determination of susceptibility of various abalone species and populations to the various AbHV genotypes (Serge Corbeil, CSIRO) May 2016.
- 2013/002: Identifying the cause of Oyster Oedema Disease (OOD) in pearl oysters (*Pinctada maxima*), and developing diagnostic tests for OOD (David Raftos, MacQuarie University) February 2017.

- 2015/001: Bonamiasis in farmed Native Oysters (*Ostrea angasi*) (Tracey Bradley, DEDJTR, Victoria) July 2019.
- 2015/005: Determining the susceptibility of Australian *Penaeus monodon* and *P. merguensis* to newly identified enzootic (YHV7) and exotic (YHV8 and YHV10) Yellow head virus (YHV) genotypes (Nick Moody, CSIRO) TBA.
- 2016/013: Comparative pathogenicity of exotic AHPND and the presumptive bacterial hepatopancreatitis detected in farmed *Penaeus monodon* in Queensland (Nick Moody, CSIRO) TBA.
- 2016/064: Field observations and assessment of the response to an outbreak of White Spot Disease (WSD) in Black Tiger Prawns (*Penaeus monodon*) farmed on the Logan River in November 2016 (Ben Diggles, DigsFish Services) February 2017.
- 2017/117: Identification of differentially expressed innate immune genes in the New Zealand paua (*Haliotis iris*) and the Australian hybrid abalone (*H. laevigata* X *H. rubra*) upon immersion challenge with the abalone herpesvirus-1 (HaHV) (Serge Corbeil, CSIRO) February 2020.

7.2 Biosecurity

- 2001/214: Development of a disease zoning policy for maritelliosis to support sustainable production, health certification and trade in Sydney rock oyster (Rob Adlard, Qld Museum) November 2005.
- 2001/660: Enhancement of Emergency Disease Management Capability in the Queensland Department of Primary Industries and the Redclaw Crayfish (*Cherax quadricarinatus*) industry (Iain East, DAFF) March 2002.
- 2002/600: Facilitating the establishment of the Aquatic Animal Health Consultative Committee (AAHCC) as the primary industry/government interface for aquatic animal health (Eva-Maria Bernoth, DAFF) June 2004.
- 2002/640: Viral Haemorrhagic Septicaemia (VHS) – A Disease Strategy Manual (Paul Hardy-Smith, Panaquatic Health Solutions) June 2004.
- 2002/641: Crayfish plague - disease strategy manual (Fran Stephens, Aquatila Healthcare) March 2004.
- 2002/643: Viral encephalopathy and retinopathy – disease strategy manual (Barry Munday, IDEXX) December 2003.
- 2002/647: Development of the AQUAVETPLAN disease strategy manual for white spot disease of prawns (Chris Baldock, AusVet Services) March 2004.
- 2002/651: Whirling Disease – A Disease Strategy Manual (Paul Hardy-Smith, Panaquatic Health Solutions) June 2004.
- 2002/652: Victoria's arrangements for the management of aquatic animal disease emergencies (Anthony Forster, DPI Vic) December 2003.
- 2002/653: AQUAVETPLAN aquatic disease disinfection manual (Kevin Ellard, Livestock & Aquaculture Veterinary Consulting Services) March 2006.
- 2002/661: Enhancing the emergency disease response capability of NSW and Qld Government agencies and industry bodies associated with oyster culture (Matt Landos, NSW Fisheries) March 2004.
- 2002/665: Enhancement of the emergency disease management capability in Victoria – adapting Victoria's arrangements for the management of aquatic animal disease emergencies (Anthony Forster, Fisheries Victoria) June 2004.
- 2002/668: Enhancing the emergency disease response capability of the Western Australian Department of Fisheries and industry bodies associated with non-maxima oyster culture (Brian Jones, Fisheries WA) March 2004.

- 2003/216: Detection and management of yellowtail kingfish (*Seriola lalandi*) health issues (Mark Shepperd, Sakana Vet Services) October 2005.
- 2003/640: Subprogram conference “emergency disease response planning and management” (Mark Crane, CSIRO) May 2004.
- 2003/641: Development of the Control Centres Manual for managing aquatic animal disease emergencies in Queensland (Tiina Hawkesford, QDPI&F) January 2004.
- 2003/644: NSW aquatic animal diseases Control Centres Manual (Damian Ogburn, NSW Fisheries) June 2004.
- 2003/648: The revision of the Tasmanian fish health plan and incorporation into the Tasmanian control centre manual (Mary Lou Conway, DPIWE Tas) March 2004.
- 2003/649: Industry's emergency preparedness and response to mass mortality of yellowtail kingfish *Seriola lalandi*: development of plans and protocols (Mark Shepperd, Sakana Vet Services) August 2008.
- 2003/650: Update of the AQUAVETPLAN Enterprise Manual (semi-open systems) (Jo Sadler) December 2003.
- 2003/670: Emergency response microalgal identification for the finfish aquaculture industry (Judith-Anne Marshall, U. Tasmania) May 2004.
- 2003/671: Enhancing the emergency disease response capability of the Western Australian Department of Fisheries and industry bodies associated with freshwater crayfish (Fran Stephens, Fisheries WA) May 2004.
- 2004/080: Development of a national translocation policy using abalone and prawns as templates for other aquatic species (Brian Jones, Fisheries WA) October 2006.
- 2005/620: Development of national investigation and reporting protocols for fish kills in recreational and capture fisheries (Barbara Nowak, U. Tasmania) June 2005.
- 2005/640: Technical guidelines for the translocation of live aquatic animals (Brian Jones, Fisheries WA) December 2005.
- 2006/243: Development of management strategies for herpes-like virus infection of abalone (Mehdi Doroudi, DPI Victoria) May 2009.
- 2009/072: Risk analysis - aquatic animal diseases associated with bait translocation (Ben Diggles, DigsFish) July 2011.
- 2010/036: Improved fish health management for integrated inland aquaculture through Better Management Practices (BMPs) (Tracey Bradley, DPI Victoria) February 2014.
- 2012/001: Strategic planning, project management and adoption (Mark Crane, CSIRO) June 2016.
- 2013/036: Tactical Research Fund: Viral presence, prevalence and disease management in wild populations of the Australian Black Tiger prawn (*Penaeus monodon*) (Jeff Cowley, CSIRO) June 2015.
- 2015/001: Bonamiasis in farmed native oysters (*Ostrea angasi*) (Tracey Bradley, Department of Economic Development, Jobs, Transport and Resources, Victoria) July 2019.
- 2016/011: Disinfection measures to support biosecurity for ISKNV at aquaculture facilities (Joy Becker, U. Sydney) January 2019.
- 2016/066: Assessing compliance and efficacy of import conditions for uncooked prawn in relation to White Spot Syndrome Virus (WSSV) through testing retail commodities and comparison of stringency of import measures with other imported commodities into Australia (Matt Landos, Future Fisheries Veterinary Services Pty Ltd) April 2017.
- 2016/266: Prawn White Spot Disease Response Plan (Len Stephens) March 2017.
- 2016/245: Development of sector-specific biosecurity plan templates and guidance documents for the abalone and oyster aquaculture industries (Elise Matthews, PIRSA) November 2017.
- 2017/190: Assessment of gamma irradiation as a feasible method for treating prawns to inactivate White Spot Syndrome Virus (Stephen Wesche, Biosecurity Queensland) TBA

- 2018/180: Benchmarking for health and productivity in abalone aquaculture (Tracey Bradley, Agriculture Victoria) TBA
- 2019/005: Risk analysis to identify and minimise biosecurity risks arising from recycling bivalve mollusc shell waste during shellfish reef restoration projects in Australia (Ben Diggles, DigsFish Services) TBA

7.3 Diagnostics

- 1999/226: Generation of diagnostic reagents for pilchard herpes virus (Bryan Eaton, CSIRO) June 2002.
- 2001/620: Development of improved procedures for the identification of aquatic birnaviruses (Mark Crane, CSIRO) April 2004.
- 2001/621: Molecular diagnostic tests to detect epizootic ulcerative syndrome (*Aphanomyces invadans*) and crayfish plague (*Aphanomyces astaci*) (Nicky Buller, Agriculture WA) June 2004.
- 2001/624: Development of diagnostic procedures for the detection and identification of *Piscirickettsia salmonis* (Mark Crane, CSIRO) April 2004.
- 2001/625: Development of diagnostic capability for priority aquatic animal diseases of national significance: Spawner-isolated mortality virus (Leigh Owens, JCU) April 2004.
- 2001/626: Development of diagnostic tests for the detection of nodavirus (Nick Moody, QDPI&F) August 2004.
- 2001/628: Vibrios of aquatic animals: Development of a national standard diagnostic technology (Jeremy Carson, DPIWE Tas) December 2006.
- 2001/630: Validation of DNA-based (PCR) diagnostic tests suitable for use in surveillance programs for QX disease of Sydney rock oysters (*Saccostrea glomerata*) in Australia (Rob Adlard, Qld Museum) June 2003.
- 2003/620: Establishment of diagnostic expertise for detection and identification of red sea bream iridovirus (RSIV) (Mark Crane, CSIRO) June 2006.
- 2003/621: Development of diagnostic and reference reagents for epizootic haematopoietic necrosis virus of finfish (Richard Whittington, U. Sydney) June 2004.
- 2003/622: Development of molecular diagnostic expertise for the mollusc pathogen *Bonamia* sp. (Serge Corbeil, CSIRO) June 2004.
- 2004/091: Further research and laboratory trials for diagnostic tests for the detection of *A. invadans* (EUS) and *A. astaci* (crayfish plague) (Nicky Buller, Agriculture WA) June 2007.
- 2006/064: Development of diagnostic tests to assess the impact of *Haplosporidium* infections in pearl oysters (Philip Nicholls, Murdoch U.) November 2009.
- 2007/006: Development of molecular diagnostic procedures for the detection and identification of herpes-like virus of abalone (*Haliotis* spp.) (Mark Crane, CSIRO) November 2009.
- 2007/007: Validation of PCR tests for diagnosis of megalocytivirus (gourami iridovirus) (Richard Whittington, U. Sydney) May 2009.
- 2008/030: Development of a DNA microarray to identify markers of disease in pearl oysters (*Pinctada maxima*) and to assess overall oyster health (Brian Jones, Fisheries WA) June 2012.
- 2011/004: Development of improved molecular diagnostic tests for *Perkinsus olseni* in Australian molluscs (Nick Gudkovs, CSIRO) June 2016.
- 2013/002: Identifying the causes of Oyster Oedema Disease (OOD) in pearl oysters (*Pinctada maxima*) (David Raftos, Macquarie U.) February 2017.
- 2014/002: Development of stable positive control material and development of internal controls for molecular tests for detection of important endemic and exotic pathogens (Nick Moody, CSIRO) TBA.

- 2015/003: Development of standard methods for the production of marine molluscan cell cultures (Andrew Reid, EMAI) November 2019.
- 2016/009: *Perkinsus olseni* in abalone – development of fit-for-purpose tools to support its management (Cecile Dang, Fisheries WA) TBA.
- 2017/206: Assessment of the Inflamark method as a sensitive and cost-effective measure of oxidative stress in cultured fish (Gavin Partridge, DPIRD WA) TBA
- 2018/147: Diagnostic detection of aquatic pathogens using real-time next generation sequencing (David Cummins, CSIRO-AAHL) TBA

7.4 Strategic surveillance

- 2001/630: Validation of DNA-based (PCR) diagnostic tests suitable for use in surveillance programs for QX disease of Sydney rock oysters (*Saccostrea glomerata*) in Australia (Rob Adlard, Qld Museum) June 2003.
- 2003/622: Development of molecular diagnostic expertise for the mollusc pathogen *Bonamia* sp. (Serge Corbeil, CSIRO) June 2004.
- 2006/064: Development of diagnostic tests to assess the impact of *Haplosporidium* infections in pearl oysters (Philip Nicholls, Murdoch U.) November 2009.
- 2007/225: Metazoan parasite survey of selected macro-inshore fish of southeastern Australia, including species of commercial interest (Kate Hutson, U. Adelaide) February 2011.
- 2008/030: Development of a DNA microarray to identify markers of disease in pearl oysters (*Pinctada maxima*) and to assess overall oyster health (Brian Jones, Fisheries WA) June 2012.
- 2008/031: Investigation of Chlamydiales-like organisms in pearl oysters, *Pinctada maxima* (Brian Jones, Fisheries WA) June 2012.
- 2009/044: Surveys of ornamental fish for pathogens of quarantine significance (Joy Becker, U. Sydney) June 2013.
- 2014/001: Strategic approaches to identifying pathogens of quarantine concern associated with the importation of ornamental fish (Joy Becker, U. Sydney) May 2017.

7.5 Disease Mitigation

- 2007/226: Rapid strain identification of the bacterial fish pathogen *Streptococcus iniae* and development of an effective polyvalent vaccine for Australian barramundi (Andy Barnes, U. Queensland) February 2010.
- 2011/255: Tactical Research Fund: Optimisation of treatment of *Ichthyophthirius multifiliis* in farmed trout (Marty Deveney, SARDI) May 2014.

7.6 Training and capacity building

- 2001/093: Strategic planning, project management and adoption (Eva-Maria Bernoth, DAFF) June 2004.
- 2002/645: Aquatic animal health exotic diseases training manual (Shane Raidal, Murdoch U.) June 2004.
- 2002/654: Development of a training course on exotic diseases of aquatic animals (Ken McColl, CSIRO) June 2004.
- 2002/655: Design and organisation of a multi-state disease emergency simulation exercise (Iain East, DAFF) January 2004.
- 2002/660: Enhancement of emergency disease management through the education and training of the CCEAD participants on the CCEAD process (Lynda Walker, DAFF) February 2004.
- 2002/664: Aquatic animal health emergency management training and incident simulation (Melanie Ryan, Seafood Training SA) June 2004.
- 2002/666: Training course on exotic diseases of aquatic animals (Mark Crane, CSIRO) June 2004.

- 2003/642: Revision and expansion of the *Australian Aquatic Animal Disease Identification Field Guide* for publishing to CD-Rom (Alistair Herfort, DAFF) November 2004.
- 2003/645: The development of media tools to increase the awareness of aquatic animal diseases (Wayne Tindall, Big Time Solutions) August 2005.
- 2003/646: Database of diseases and pathogens of Australian aquatic animals (Gustad Boman, F1 Solutions) July 2004.
- 2003/647: Development of a database for Australian laboratory diagnostic expertise for diseases of aquatic organisms (Iain East, DAFF) March 2004.
- 2003/669: Conduct of a multi-jurisdictional simulation exercise focused on health management in Australian aquaculture (Iain East, DAFF) April 2004.
- 2004/079: Strategic planning, project management and adoption (Mark Crane, CSIRO) November 2008.
- 2005/621: Establishment of a national aquatic animal health diagnostic network (Richard Whittington, U. Sydney) December 2006.
- 2005/641: Current and future needs for aquatic animal health training and for systems for merit-based accreditation and competency assessments (Brian Jones, Fisheries WA) March 2007.
- 2008/039: Strategic planning, project management and adoption (Mark Crane, CSIRO) August 2012.
- 2009/315: People development program: scholarship program for enhancing the skills of aquatic animal health professionals in Australia (Jo-Anne Ruscoe, FRDC) March 2016.
- 2009/315.02: People development program: Aquatic animal health training scheme – Aquatic Animal Health Technical forum and Skills Training Workshop (Lynette Williams, CSIRO) February 2012.
- 2009/315.11: People development program: Aquatic animal health training scheme – Nick Moody (Nick Moody, CSIRO) February 2012.
- 2009/315.12: People development program: Aquatic animal health training scheme – Cassandra Ypelaan (Cassandra Ypelaan, Panaquatic Health Solutions) September 2012.
- 2009/315.13: People development program: Aquatic animal health training scheme – Richmond Loh (Richmond Loh, The Fish Vet) July 2012.
- 2009/315.16: People development program: Aquatic animal health training scheme – Boosting Biosecurity Capability in Western Australia (Susan Gibson-Kueh, ACWA) July 2013.
- 2009/315.21: People development program: Aquatic animal health training scheme – Jo Bannister (Jo Bannister, Western Australia) June 2013.
- 2009/315.22: People development program: Aquatic animal health training scheme – Teruo Miyazaki visit (Richard Whittington, U. Sydney) June 2013.
- 2009/315.23: People development program: Aquatic animal health training scheme – Jo Bannister (Jo Bannister, Western Australia) June 2013.
- 2009/315.24: People development program: Aquatic animal health training scheme - KBBE workshop on diagnostics for mollusc diseases (Mark Crane, CSIRO) May 2014.
- 2009/315.25: People development program: Aquatic animal health training scheme – Aquavet II Comparative Pathology Training Course, Cornell University, 2014 (Ben Diggles, DigsFish) June 2014.
- 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 (Rachel Bowater, QDAF) February 2016.
- 2009/315.29: FRDC People Development Program: Aquatic animal health training scheme – fish kill investigation (Shane Roberts, PIRSA) June 2014.

- 2009/315.31: People development program: Aquatic Animal Health Training Scheme: Introductory training workshop in surveillance for aquatic animal diseases (Evan Sargeant, AusVet Services) December 2014.
- 2012/001: Strategic planning, project management and adoption (Mark Crane, CSIRO) July 2016.
- 2012/002: Aquatic Animal Health Technical Forum (Lynette Williams, CSIRO) May 2016.
- 2013/004: The Neptune Project - a comprehensive database of Australian aquatic animal pathogens and diseases (Marissa McNamara, Qld Museum) September 2014.
- 2013/414: Review of vocational education courses on aquatic animal health available to fisheries and aquaculture sectors in Australia for the FRDC Aquatic Animal Health Subprogram (AAHS) (Mark Oliver, Aquaculture Support Services) March 2014.
- 2014/403: Development of a national aquatic animal health curriculum for delivery by tertiary institutions (Stephen Pyecroft, U. Adelaide) February 2014.
- 2016/404: Strategic planning, project management and adoption (Mark Crane, CSIRO) TBA.
- 2018/144: Aquatic Animal Health Technical Forum and Training workshops (Lynette Williams, CSIRO) TBA.

8. Further information

- **Aquatic Animal Health & Biosecurity Subprogram website:**

Go to the FRDC website: <http://www.frdc.com.au/en/Partners/National-Priorities-and-Subprograms/Aquatic-Health-and-Biosecurity>

- **Department of Agriculture, Water and the Environment website:**

<https://www.agriculture.gov.au/animal/aquatic>

- **Contact Aquatic Animal Health & Biosecurity Subprogram:**

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