



Aquatic Animal Health Subprogram: Strategic planning, project management and adoption

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2012-001**

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Abbreviations

AABERA	Aquatic Animal Biosecurity Emergency Response Arrangements
AAHL	Australian Animal Health Laboratory
AAHS	Aquatic Animal Health Subprogram
AbHV	Abalone herpesvirus
AHA	Animal Health Australia
AHC	Animal Health Committee
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry (now Department of Agriculture and Water Resources)
FRAB	Fisheries Research Advisory Board
GAV	Gill-associated virus
KBBE	Knowledge-Based Bio-Economy
NAAHIRG	National Aquatic Animal Health Industry Reference Group
NAC	National Aquaculture Council
OOD	Oyster oedema disease
OsHV-1	Ostreid herpesvirus type 1
OsHV-1 uVar	Ostreid herpesvirus type 1 microvariant
POMS	Pacific oyster mortality syndrome
QDAFF	Queensland Department of Agriculture, Fisheries and Forestry
SAC	Scientific advisory committee
SCAAH	Sub-committee on Aquatic Animal Health
STC	Steering committee
TRF	Tactical research fund
YHV	Yellow head virus

Executive Summary

What the report is about

The Aquatic Animal Health Subprogram (AAHS) is a FRDC national subprogram that was established in 2001 and since then has been renewed on a continual basis. Since 2004, AAHS has been managed by the CSIRO AAHL Fish Diseases Laboratory with input from a steering committee (STC) and a scientific advisory committee (SAC). During the current term (2012-16), AAHS has managed 35 projects concerned with various aquatic animal health issues including pathogen/host interaction, aquatic animal health management, development of diagnostic techniques and various training projects and targeting wild and farmed molluscs, crustaceans and finfish.

Background

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 successor *AQUAPLAN 2005-2010*, and the current *AQUAPLAN 2014-2019*. A common theme within these strategic plans is recognition of the need for research, and the adaptability of the plan to include emerging aquaculture industries. Compared to the terrestrial animal industries, the state of knowledge of aquatic animal health management is limited. 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.

Since its establishment AAHS has managed over 100 projects within 6 key research areas:

- Nature of disease and host-pathogen interaction
- Aquatic animal health management
- Endemic and exotic aquatic animal disease diagnostics
- Surveillance and monitoring
- Aquatic animal disease therapy and prophylaxis
- Training and capacity building

The major stakeholders, the fisheries and aquaculture sectors and state and federal governments, have continued to express strong support for the subprogram and have co-invested in the vast majority of the projects within its portfolio, demonstrating the subprogram's importance to the aquatic animal health community.

Aims/objectives

The mission of AAHS is stated in the R&D Plan:

“To provide leadership to aquatic animal health R&D and its adoption in Australia”.

To achieve this the current project had three objectives:

1. To manage a portfolio of R&D projects that are directly concerned with aquatic animal health and are not covered by other FRDC subprograms.
2. In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for R&D.

3. Facilitate the dissemination of information and results

Methodology

AAHS is led by a Subprogram Leader who is assisted by a Subprogram Coordinator and guided by a STC which is advised by a SAC. The Subprogram Leader, along with these committees, conducted AAHS business through either face-to-face meetings or by teleconference. The schedule of meetings is aligned with the normal FRDC funding cycle to ensure that project preproposals are canvassed and evaluated, full proposals are invited and evaluated, and recommendations are submitted to the FRDC Board, as required.

The Subprogram consults on aquatic animal health R&D priorities and strategies with Animal Health Committee (AHC) - Australia's primary government advisory committee for policy, communication and awareness related to animal health. Consultation is primarily through AHC's Sub-committee on Aquatic Animal Health (SCAAH) and the National Industry Reference Group for Aquatic Animal Health (NAAHIRG). In addition, communication with industry peak bodies, e.g. Australian Abalone Growers' Association, Australian Prawn Farmers' Association, Oysters Australia, is maintained on a regular basis.

The dissemination of information and results was achieved through:

- *Health Highlights*, the Subprogram's newsletter
- Scientific workshops
- Scientific Conferences
- FRDC Website
- Formal and informal communication with industry peak bodies, other Subprograms, FRABs, SCAAH, as needed
- Use of developed databases

Results/key findings

In the period 2012-16, AAHS has managed 35 projects concerned with aquatic animal health.

AAHS reviewed, in-house, the R&D Plan on an annual basis which included consultation with major stakeholders (industry and governments). The revisions accounted for the changing aquatic animal health R&D needs at the state and national levels.

Consultation with State Government aquatic animal health specialists included formal face-to-face meetings, e.g. at the annual face-to-face meetings of SCAAH. During these meetings R&D priorities were discussed and taken to AAHS March meeting of the same year for discussion by the STC and SAC. The AAHS R&D was then up-dated in time for the annual call for expressions of interest issued the same year.

During the period 2012-16, there were six issues of the Subprogram newsletter, *Health Highlights*, which has a broad distribution list (>300 subscribers) that includes industry associations, research providers and regulators both domestically and internationally. *Health Highlights* includes information about scientific conferences and workshops, progress reports on active and completed research projects and notices submitted by subscribers.

FRDC AAHS has conducted scientific workshops and conferences on various aquatic animal health issues, as needed. In 2013, FRDC provided funds in support of an international KBBE Workshop on Mollusc Disease Diagnosis (FRDC Project 2009-315-24: People development program: Aquatic Animal Health Training Scheme – KBBE workshop on diagnostics for mollusc diseases) coordinated by the Subprogram Leader. In addition, during the 2012-16 period two

FRDC Australasian Scientific Conferences on Aquatic Animal Health were convened (in 2013 and 2015) attracting 125 (112 from Australia and New Zealand and 13 from other countries) 75 (71 registrations from Australia and New Zealand and 4 from other countries), respectively. Workshop and conference proceedings are produced and distributed electronically.

Implications for relevant stakeholders

The overall planned outcome of the FRDC Aquatic Animal Health Subprogram was an increased ability to manage aquatic animal disease in the commercial, recreational and traditional fishing industry sectors and thus assist Australia's aquaculture and fisheries industries become more competitive, profitable and sustainable. In addition, there is a broader responsibility towards the Australian community to ensure the sustainability of Australian aquatic natural resources.

This overall outcome was achieved through improved diagnostic capability and/or disease management for a number of aquatic animal pathogens; development of enhanced awareness of emergency aquatic animal disease response arrangements and other training to improve the disease emergency management capability of industry and government personnel.

The AAHS has been able to enhance aquatic animal health R&D outputs, strengthen the network of aquatic animal health experts and research providers, and provide training opportunities for young scientists interested in aquatic animal health. Furthermore, AAHS has maintained its linkages to Animal Health Committee, through the Sub-committee on Aquatic Animal Health as well as peak industry groups to ensure that the strategic direction for investment in aquatic animal health is maintained.

KEYWORDS: Aquatic animal health; disease; diagnostics; training and capacity building

Introduction

The FRDC Aquatic Animal Health Subprogram (AAHS) was established in 2001 under a joint agreement between the then Federal Government Department of Agriculture, Fisheries and Forestry (currently the Department of Agriculture and Water Resources) and FRDC to provide a cohesive and national approach to aquatic animal health research and development in Australia, and in particular to address the research and development components of *AQUAPLAN* (Australia's national strategic plan for aquatic animal health). AAHS mission is “*To provide leadership to aquatic animal health R&D and its adoption in Australia*”.

AAHS provides a cohesive national approach to aquatic animal health R&D in Australia by providing leadership, direction and focus for health R&D and other related non-R&D activities. AAHS was renewed in 2004, again in 2008 and again in 2012, based on national need, previous performance and strong stakeholder support. Key strengths include its strategic focus and the establishment of a network of aquatic animal health experts and research providers. Continuation of AAHS on the basis of a shared financial commitment by stakeholders from industry and governments is highly desirable.

Australia's fisheries/aquaculture continues to be a major sector of our primary industries in terms of both job creation and value of production. The sector's capacity to contribute through export earnings and job creation especially in regional Australia is a vital part of our future prosperity. 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 nervous necrosis virus in finfish, gill associated virus (GAV; yellow head virus (YHV) genotype 2) and other YHV genotypes in prawns, *Bonamia* in edible oysters, oedema oyster disease in pearl oysters, ostreid herpesvirus type 1 microvariant (OsHV-1 uVar) in Pacific oysters, *Edwardsiella ictaluri* in catfish, *Streptococcus agalactiae* in grouper, and abalone viral ganglioneuritis caused by abalone herpesvirus (AbHV). This concern over endemic diseases and the lack of adequate surveillance and diagnostic services compromises Australia's attempts to export aquatic animal products e.g. live shellfish. Such trade barriers, based on our lack of understanding of our own diseases, will continue to be imposed and provide an incentive to Australia to not only improve basic knowledge on endemic disease agents but also, and more critically, to improve the quality control and thus international acceptance of our diagnostic and surveillance capacity. 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, molluscs and amphibians) from all environments, i.e. tropical or temperate, marine, brackish or freshwater environments, is required.

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. Compared to the terrestrial animal industries, the state of knowledge of aquatic animal health management is limited. 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.

Moreover, the importance of biosecurity to the fisheries/aquaculture sector has gained increased recognition by state and Federal governments recently, and in line with national priorities FRDC has recommended expanding the scope of the AAH Subprogram to include aspects of biosecurity. With this in mind, the future subprogram will be named the Aquatic Animal Health and Biosecurity Subprogram (AAHBS).

During the course of this project FRDC commissioned a review of the AAH Subprogram. The review was undertaken by Ian Anderson, Principal Veterinary Pathologist (Aquatic), Queensland Biosecurity, Queensland Department of Agriculture and Fisheries. This review was completed in September 2015 and, following consultation with the major stakeholders, made a series of recommendations concerning Subprogram operations, R&D priority setting, assessment of applications, and adoption of research outputs.

Objectives

1. To manage a portfolio of R&D projects that are directly concerned with aquatic animal health and are not covered by other FRDC subprograms.
2. In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for R&D.
3. Facilitate the dissemination of information and results.

Method

AAHS is led by a Subprogram Leader (currently Dr. Mark Crane, CSIRO AAHL Fish Diseases Laboratory) who is assisted by a Subprogram Coordinator (currently Joanne Slater, CSIRO AAHL Fish Diseases Laboratory), and guided by a Steering Committee which is advised by a Scientific Advisory Committee.

Steering Committee members (2012-16)

Pheroze Jungalwalla (Chair, National Aquaculture Council)
David Ellis (Australian Southern Bluefin Tuna Industry Association; 2013-14)
David Mills (Paspaley Pearling Company; 2014-present)
Dr. Ingo Ernst (Federal Government Department of Agriculture; until 2015)
Dr. Brett Herbert (Federal Government Department of Agriculture and Water Resources; 2015-present)
Crispian Ashby (Fisheries Research and Development Corporation; until 2014)
Jo-Anne Ruscoe (FRDC; 2014-present)
Dr. Brian Jones (Fisheries Western Australia, representing the Sub-committee on Aquatic Animal Health; until 2013)
Dr. Tracey Bradley (Victorian Department of Economic Development, Jobs, Transport and Resources, representing the SCAAH; 2013-present)

Scientific Advisory Committee members (2012-16)

Dr. Barbara Nowak (University of Tasmania; until 2013)
Dr. Nick Moody (CSIRO AAHL Fish Diseases Laboratory)
Dr. Stephen Pycroft (University of Adelaide Veterinary Medical School; 2013-present)
Prof. Richard Whittington (University of Sydney Veterinary Medical School)

In consultation with stakeholders, the Subprogram has developed six key research areas. These are detailed in the R&D Plan (see Appendix 2) and are:

- Nature of infectious disease and host-pathogen interaction
- Aquatic animal health management
- Endemic and exotic aquatic animal disease diagnostics
- Surveillance and monitoring
- Best practice/national and international quality assurance
- Training and capacity building

While these strategic directions undergo a review process on a regular basis, in consultation with key stakeholders, R&D activities are aligned with these key research areas.

Objective 1. *To manage a portfolio of R&D projects that are directly concerned with aquatic animal health and are not covered by other FRDC subprograms.*

The Subprogram Steering and Scientific Advisory Committees meet (either face-to-face or by teleconference) up to four times per year to conduct Subprogram business. The schedule of meetings is aligned with the normal FRDC funding cycle to ensure that project preproposals are canvassed and evaluated, full proposals are invited and

evaluated, and recommendations are submitted to the FRDC Board, as required. All projects within the R&D portfolio are managed to ensure that milestones are achieved, scheduled payments are paid on approval of milestone reports and Final Reports are completed according to FRDC contracts.

Objective 2. *In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for R&D.*

Following the establishment of the AAH Subprogram in 2001, one of the first activities was to develop the Subprogram's R&D Plan (see Appendix 2 for the latest version). This was expected to be a living document to be reviewed and up-dated on a regular basis, usually annually prior to the annual call for research applications. In preparation for the R&D Plan review, the Subprogram consults on aquatic animal health R&D priorities and strategies with Animal Health Committee (AHC) - Australia's primary government advisory committee for policy, communication and awareness related to animal health. Consultation is primarily through AHC's Subcommittee on Aquatic Animal Health (SCAAH) and its Working Groups, e.g. Pacific Oyster Mortality Syndrome Working Group, and the National Industry Reference Group for Aquatic Animal Health (NAAHIRG). In addition, communication with industry peak bodies, e.g. Australian Abalone Growers' Association, Australian Prawn Farmers' Association, Oysters Australia, is maintained on a regular basis.

Objective 3. *Facilitate the dissemination of information and results*

The current communication plan for AAHS includes:

- Biannual AAHS newsletter, *Health Highlights*
- Scientific workshops
- Scientific Conferences
- FRDC Website
- Formal and informal communication with industry peak bodies, other Subprograms, FRABs, SCAAH, as needed
- Use of developed databases e.g. FRDC database of final reports

Results and Discussion

Objective 1. To manage a portfolio of R&D projects that are directly concerned with aquatic animal health and are not covered by other FRDC subprograms.

In the period 2012-16, AAHS has managed 35 projects concerned with aquatic animal health (Table 1). A few of these were continuation of active projects from the previous subprogram (2008-12). Others are relatively new and will continue past the completion date of the current AAHS. In addition, AAHS provided advice on other aquatic animal health-related projects that were part of other FRDC programs, as requested. For example, AAHS has a specific role in the People Development Program's "DAFF FRDC Aquatic Animal Health Training Scheme" (FRDC Project 2009/315). AAHS also provided comment, as requested, on projects submitted to industry peak bodies, e.g. Oysters Australia as part of its IPA, and the New and Emerging Aquaculture Species Subprogram.

Table 1. FRDC Aquatic Animal Health Subprogram – Projects 2012-16

Project	Project Title	Date of final Report
2009/032	Characterisation of abalone herpes-like virus infections in abalone	Aug 2014
2008/041	Tools for investigation of the nodavirus carrier state in marine, euryhaline and freshwater fish and control of NNV through integrated management	Nov 2012
2009/044	Surveys of ornamental fish for pathogens of quarantine significance	Jun 2013
2010/034	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	Feb 2015
2010/036	Improved fish health management for integrated inland aquaculture through Better Management Practices (BMPs)	Feb 2014
2011/003	Investigations into the genetic basis of resistance to infection of abalone by the abalone herpes-like virus	Sep 2013
2011/004	Development of Improved Molecular Diagnostic Tests for <i>Perkinsus olseni</i> in Australian molluscs	Due Jun 2016
2011/005	Investigation of inclusions in Australian prawns	N.A.*
2011/043	Understanding and planning for the potential impacts of OsHV1 on the Australian Pacific oyster industry	Sep 2012
2011/046	Tactical Research Fund: Disease risk assessment for abalone stock enhancement program	Dec 2012
2011/048	Tactical Research Fund: determining the susceptibility of Australian species of prawns to infectious myonecrosis	Apr 2015
2011/053	Pacific oyster mortality syndrome (POMS) - understanding biotic and abiotic environmental and husbandry effects to reduce economic losses	Jan 2013
2011/245	Tactical Research Fund: Research methods to manage pathogenic microbiological and biological organism within a redclaw (<i>Cherax quadricarinatus</i>) egg incubator hatchery to improve survival and reliability	Jun 2013

2011/255	Tactical Research Fund: Optimisation of treatment of <i>Ichthyophthirius multifiliis</i> in farmed freshwater fish	Apr 2014
2012/001	Strategic planning, project management and adoption	Jun 2016
2012/002	Aquatic Animal Health Technical Forum	May 2016
2012/030	Prawn Superpowers Summit – enhancing awareness of emergency aquatic animal disease response arrangements for the Australian prawn farming industry	Mar 2013
2012/032	Pacific oyster mortality syndrome (POMS) – risk mitigation, epidemiology and OsHV-1 biology	Dec 2015
2012/044	Exercise Sea Fox: Testing aquatic animal disease emergency response capabilities within aquaculture	Oct 2012
2012/050	A survey of <i>Edwardsiella ictaluri</i> in wild catfish populations in Australia	Jul 2015
2012/052	Development of a laboratory model for infectious challenge of Pacific Oysters (<i>Crassostrea gigas</i>) with ostreid herpesvirus type-1	Apr 2015
2013/001	Determination of susceptibility of various abalone species and populations to the various known AbHV genotypes	May 2016
2013/002	Identifying the cause of Oyster Oedema Disease (OOD) in pearl oysters (<i>Pinctada maxima</i>), and developing diagnostic tests for OOD	Due Feb 2017
2013/004	The Neptune project	Sep 2014
2013/036	Tactical Research Fund: Viral presence, prevalence and disease management in wild populations of the Australian Black Tiger prawn (<i>Penaeus monodon</i>)	Jun 2015
2013/414	A Review of Vocational Education and Training Aquatic Animal Health Programs Within Australia	Mar 2014
2014/001	Strategic approaches to identifying pathogens of quarantine concern associated with the importation of ornamental fish	Due Nov 2016
2014/002	Development of stable positive control material and development of internal controls for molecular tests for detection of important endemic and exotic pathogens.	Due Jul 2016
2014/403	Development of a national aquatic animal health curriculum (NAAHC) for delivery by tertiary institutions	May 2016
2015/001	Bonamiasis in farmed Native Oysters	Due Aug 2017
2015/003	Development of standard methods for the production of marine molluscan cell cultures	Due Jul 2017
2015/005	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	Due Jun 2017
2016/009	<i>Perkinsus olseni</i> in abalone: Development of fit-for-purpose tools to support its understanding and management	TBA
2016/011	Aquatic Animal Health and Biosecurity Subprogram: Quarantine risks and disease preparedness for iridoviruses for Australia	TBA
2016/013	Comparative pathogenicity of exotic AHPND and the presumptive bacterial hepatopancreatitis detected in farmed <i>Penaeus monodon</i> in Queensland	TBA

*Project terminated due to PI leaving host research organisation

To manage the AAHS R&D portfolio of projects, the AAHS committees met either face-to-face or by teleconference, as organised by the AAHS Coordinator. Table 2 provides the

schedule of meetings convened to progress AAHS business. Most face-to-face meetings were convened in Melbourne which is central for all committee members (four committee members are Victorian residents), and allows for direct air flights.

Table 2. FRDC Aquatic Animal Health Subprogram – Schedule of meetings 2012-16

Meeting	Date	Venue	Main purpose
45	18-19/07/12	Melbourne	Review 7 Eols and 2 TRF proposals received and to discuss planning for the 2013 Scientific Conference
46	23/10/12	Melbourne	Review the finalised Eols and agree on comments to be forwarded to FRDC
47	26/03/13	Melbourne	Review the draft final applications, one TRF and to discuss R&D priorities for 2014/15
48	08/07/13	Cairns	Review 4 Eols and 4 TRF proposals
49	17-18/09/13	Melbourne	Review 2 Eols and the aquatic animal health training program applications
50	12/03/14	Brisbane	Review 2 revised Eols and to discuss R&D priorities for the next funding cycle. Recommendations to be forwarded to FRDC (including visit to Bribie Island)
51	26/07/14	Hobart	Review draft Eols and to discuss planning for the 2015 Scientific Conference (including visit to salmon hatchery)
52	18/09/14	Melbourne	Review revised Eols and provide advice back to FRDC
53	22/10/14	Teleconference	Scientific review revised Eol submitted by Richard Whittington after consultation with various oyster stakeholders
54	03/03/15	Melbourne	Review three full applications and provide advice to FRDC and to determine R&D priorities for the 2016 competitive round
55	23/03/15	Teleconference	Confirm R&D priorities for 2016 competitive round
56	06/07/15	Cairns	Review priorities for the upcoming year, discuss OOD project 2013/002 and to update the AAHS R&D Plan
57	07/10/15	Melbourne	Review expressions of interest (Eols) submitted for the 2016 funding round
58	15/03/16	Melbourne	Review 4 full applications submitted for the 2016 funding round, and expressions of interest (Eols) not previously seen (including visit to barramundi farm)

Meetings in Cairns were convened in conjunction with the FRDC Scientific Conference on Aquatic Animal Health. The meeting in Brisbane provided an opportunity for Dr Ian Anderson (QDAFF) to be an observer at the meeting which would assist him in his review of AAHS, commissioned by FRDC.

Objective 2. *In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for R&D.*

To address this objective, AAHS reviewed, in-house, the Subprogram R&D Plan on an annual basis which included consultation with major stakeholders (industry and governments). The revisions accounted for the changing aquatic animal health R&D needs at the state and national levels.

Consultation with State Government aquatic animal health specialists included formal face-to-face meetings, e.g. “FRDC AAHS” is a standing agenda item at the annual face-to-face meetings of SCAAH. It was during these meetings that R&D priorities were discussed and taken to AAHS March meeting for discussion by the STC and SAC. The AAHS R&D was then up-dated in time for the annual call for expressions of interest for that year.

The most recent version of the R&D Plan is attached (Appendix 2).

Objective 3. *Facilitate the dissemination of information and results*

A communication strategy was developed in the first 3 years of the Subprogram existence. This communication plan has continued and includes:

- Production of the Subprogram Newsletter - *Health Highlights*
- Scientific workshops
- Scientific Conferences
- Formal and informal communication with other Subprograms, FRABs, as needed (see Table 3)
- Website http://frdc.com.au/research/aquatic_animal_health/Pages/default.aspx
- Use of developed databases <http://frdc.com.au/research/final-reports/Pages/default.aspx>

Health Highlights

During the period 2012-16, there were six issues of the Subprogram newsletter, *Health Highlights*, which has a broad distribution list (>300 subscribers) that includes industry associations, research providers and regulators both domestically and internationally. *Health Highlights* includes information about scientific conferences and workshops, progress reports on active and completed research projects and notices submitted by subscribers, e.g., an article, contributed by the Australian Government Department of Agriculture, Fisheries and Forestry’s Aquatic Animal Health Program, concerning Animal Health Committee (AHC) protocols for sending aquatic animal health samples overseas, “Sending aquatic animal samples overseas – What are the risks and procedures?” Past issues of *Health Highlights* are available on the Aquatic Animal Health page of the FRDC website (http://frdc.com.au/research/aquatic_animal_health/Pages/default.aspx).

Scientific Workshops

In the past, AAHS has coordinated workshops on priority issues, e.g. 2002 National Workshop on *Pfiesteria*, 2007 National Workshop on *Nodavirus* and 2011 International Workshop on Ostreid Herpesvirus. In 2013, FRDC provided funds in support of an international KBBE Workshop on Mollusc Disease Diagnosis (FRDC Project 2009-315-24: People development program: Aquatic Animal Health Training Scheme – KBBE workshop on diagnostics for mollusc diseases) coordinated by the Subprogram Leader and facilitated by Dr. Ingo Ernst (DAFF representative on the AAHS Steering Committee). This workshop brought together international experts on mollusc disease diagnosis from Europe, New Zealand and Australia to discuss priority disease issues of common interest and facilitated further development of an international network of research and diagnostic laboratories for the exchange of information and resources.

Scientific Conferences

During 2012-16 two FRDC Australasian Scientific Conferences on Aquatic Animal Health were convened (in 2013 and 2015). Following the 2011 initiative to open the FRDC-sponsored conference to overseas participation, the 2013 and 2015 conferences attracted 125 (112 from Australia and New Zealand and 13 from other countries) 75 (71 registrations from Australia and New Zealand and 4 from other countries), respectively. It is noteworthy that the first conference held in 2003 attracted approximately 30 participants, with the conference participation rate increasing steadily to 125 in 2013. It is suspected that the downturn in the global economy is responsible for the reversal in the trend with a reduction in 50 registrations for the 2015 conference. Conference proceedings are produced and distributed electronically.

Other Meetings/Workshops/Conferences

The Subprogram leader (or delegate) represented AAHS at many other meetings, workshops and conferences (Table 3).

Table 3. Face-to-face meetings attended by the AAH Subprogram Leader

Date	Forum
14 August 2012	AHA Workshop 1 on National Animal Biosecurity RD&E Strategy, Canberra
19-20 August 2012	National Workshop on Aquatic Animal Biosecurity Emergency Response Arrangements (AABERA), Melbourne
26 September 2012	AHA Workshop 2 on National Animal Biosecurity RD&E Strategy, Canberra
5-6 February 2013	Annual meeting of the Sub-committee on Aquatic Animal Health (SCAAH), Geelong
7 February 2013	SCAAH Workshop on Development of a new AQUAPLAN, Geelong
4-5 April 2013	FRDC Annual FRAB/Subprogram Workshop, Canberra
12 April 2013	Research Providers Network Biosecurity Hub teleconference
18 April 2013	Research Providers Network meeting, Melbourne
22-24 October 2013	KBBE Workshop on Mollusc Disease Diagnosis, Geelong
11-12 February 2014	SCAAH Annual Meeting, Adelaide

13-14 February 2014	FRDC National Curriculum Workshop, Adelaide
17 February 2014	Neptune meeting with DAFF and CSIRO, Canberra
9-10 April 2014	FRDC FRAB stakeholder workshop, Canberra
5 June 2014	Research Providers Network Biosecurity Hub teleconference
7-11 June 2014	World Aquaculture Society Conference, Adelaide
19 June 2014	Research Providers Network meeting, Melbourne
14-15 July 2014	FRDC RD&E Workshop, Adelaide
19 September 2014	Tasmanian Bio-secure Fish Facility Management Committee meeting, Hobart
25 February 2015	AHA National Animal Biosecurity RD&E Forum, Melbourne
11-13 Mar 2015	SCAAH Annual Meeting, Wellington New Zealand
31 March-1 April 2015	FRDC FRAB stakeholder workshop, Canberra
13-14 August 2015	Australian Abalone Growers Association Workshop, Adelaide
11-12 November 2015	FRDC Workshop on New and Emerging Aquaculture Species, Melbourne
1-2 March 2016	SCAAH Annual Meeting, Brisbane
2-3 March 2016	National Workshop on Emergency Aquatic Animal Disease Response Arrangements, Brisbane
9 June 2016	Research Providers Network meeting, Melbourne

FRDC Website and databases

There is a dedicated page to Aquatic Animal Health on the FRDC website (http://frdc.com.au/research/aquatic_animal_health/Pages/default.aspx) that provides information on the Subprogram. In addition, as with all FRDC projects, aquatic animal health final reports are available from the FRDC database (<http://frdc.com.au/research/final-reports/Pages/default.aspx>).

Other

In addition to the above methods of information dissemination, it is noteworthy that aquatic animal health and biosecurity matters make a regular appearance in the FRDC News magazine *FISH*:

“POMS strikes another Australian estuary” *FISH* Vol 21 (2) 20-21 2013.

“The darker side of exotic ornamental fish” *FISH* Vol 21 (4) 26-27 2013.

“Biosecurity ‘seatbelt’ for salmon producers” *FISH* 21 (4) 32-33 2013.

“Oyster growers invest in genetic POMS resistance” *FISH* 23 (2) 26-27 2015.

Subprogram Review

In 2015, FRDC commissioned a review of the Aquatic Animal Health Subprogram which was undertaken by Ian Anderson, Principal Veterinary Pathologist (Aquatic), Queensland Biosecurity, Queensland Department of Agriculture and Fisheries. This review was completed in September 2015. Following consultation with the major government and industry stakeholders (fifteen of which submitted responses by either telephone or in writing) a series of recommendations concerning Subprogram operations, R&D priority setting, assessment of applications, and adoption of research

outputs was reported in the review. The scope (objectives) and findings of the review are summarised below.

Scope

1. From a technical and communication standpoint, determine if the AAHS is contributing to:
 - Reduced risk of disease impact on Australia's resources
 - Improved fisheries productivity/profitability
 - Market access/biosecurity/meeting international obligations
 - Improved standard/productivity of research and analysis
 - Increased awareness of aquatic animal health issues
 - Identifying priority areas for AAH research
 - Generating applications against the identified priority areas
2. Identify ways to improve the performance of the subprogram and to improve the R&D Plan.

Findings of the review

There was a general comment of strong support for the AAHS from the government and industry stakeholders. Additionally, some identified the need for AAHS to have increased funding so that more critical aquatic animal health issues could be progressed through new R&D projects.

Industry stakeholders all highlighted their sectors' high priority for surveillance and biosecurity to prevent or manage disease to avoid disease impacts. Thus industry directly, or indirectly, endorses the leadership and coordination provided by AAHS. Some recognised a general weakness throughout Australia in aquatic animal health resources and experience. In several responses the need to understand the biosecurity risks of imported seafood products and major pandemic exotic diseases was highlighted as their priority. The expectation was that this information would inform Australian risk analyses and mitigation requirements to remove any risk to the Australian industry and environment from imports.

Other, specific comments are covered in the following recommendations.

Recommendations

Some of the responses to the request for inputs on how the performance of the AAHS could be improved suggested no changes and expressed satisfaction in the way the subprogram operated. The overall tone of the responses received by the review were positive.

Other responses to the review raised matters and some of these are addressed by the following recommendations; some relate to new processes that could improve the performance, or perceptions, of the subprogram; others are for clarification by FRDC or AAHS.

Aquatic Animal Health Subprogram Operations

1. AAHS publish (as an appendix in the R&D Plan) the process and criteria used to identify new members of Steering Committee and Scientific Advisory Committee,

the appointment procedure, the terms and conditions of appointed members and the duration of membership.

2. Changes made to the R&D Plan at each review be listed in an appendix in the new R&D Plan for easy reference, for example the new “Current Priorities”.
3. FRDC and AAHS consider further measures that demonstrate effective management of any perceived conflicts of interest in AAHS operations.

Priority setting

4. FRDC advise all jurisdictional FRABs they need to consider aquatic animal health priorities in their annual consultations, including seeking input from their relevant SCAAH member as required.
5. The subprogram do a formal review of the process used to establish national (and minor/emerging industry) aquatic animal health R&D priorities with the aim to identify possible options to improve the quality of the contributions from all fisheries and aquaculture sectors. This review could consider:
 - Effectiveness of the current broadcast of request for input to the priority setting process
 - Formal contact directly with FRABs
 - Options to engage effectively with different industry sectors that have limited national representation
 - Use a more deliberate process where key individuals throughout Australia are interviewed
 - Better guidelines/training of SCAAH members
 - Use of a short-term consultancy to identify and evaluate national strategic priorities and the feasibility of solutions
6. FRDC consider and confirm/clarify the scope of AAHS responsibility for coordination of aquatic animal health research projects funded by FRDC throughout Australia.

Assessment of applications

7. The STC/SAC introduce a procedure where they teleconference with the Principal Investigator, or their representative, of every short listed EoI and application so the proponent has the opportunity to advocate the merits of their project, and STC/SAC members can clarify any issues or gaps in the application, before the overall priority of the applications is finalised.
8. AAHS consider formally identifying a pool of scientific reviewers who are willing to comment on the feasibility and merit of EoIs and full applications on an out-of-session/remote basis.
9. AAHS establish a procedure where an additional reviewer (or reviewers) is always co-opted to assess the scientific merit of an EoI or full application when the proponent of the project is a STC/SAC member and has withdrawn from the assessment or when a specific scientific expertise is required.
10. AAHS consider providing the PI of each EoI and application a written assessment, with a high, medium or low attributed to each of the categories; fit to criteria, the

need, feasibility and scientific merit, as well as the overall assessment, for the proposed project.

Adoption

11. AAHS consider a formal review of selected projects once the final report is submitted. Any review of a project's merit and success should involve the use of objective tools to measure meaningful adoption of research outputs or measure/identify changes to policy, practise or husbandry.
12. Add "extension" to the scope of the key research area "Training and capacity building" to allow the subprogram to identify current priorities for extension projects to provide a specific, stand-alone project option to address gaps in adoption of critical aquatic animal health information, greater than just facilitation.

Responses to recommendations

The report of the reviewer has been forwarded to FRDC Aquatic Animal Health & Biosecurity Subprogram (AAHSB) committee members for review and consideration. The report will be discussed at the next meeting of AAHSB for a formal response to the recommendations.

Conclusion

The AAH Subprogram (AAHS) was established by the FRDC in mid-2001 to provide a cohesive and national approach to aquatic animal health research and development in Australia and has been an integral part of FRDC's business ever since. The continued support from the Federal Government, FRDC and other stakeholders is evidence of AAHS relevance to the Australian aquatic animal health community. Within FRDC's operations, AAHS is a national subprogram with a dedicated budget which provides a continuity of research funds for national priorities.

The AAHS Steering Committee and Scientific Advisory Committee, with input from SCAAH and NAC, have directed the relatively small amount of funding to the most pressing priorities such as Pacific oyster mortality syndrome (Projects 2012/032 and 2012/052), oyster oedema disease (Project 2013/002), abalone viral ganglioneuritis (Project 2013/001) and various issues concerned with exotic disease risks (Projects 2014/001, 2014/002, 2015/005, 2016/011 and 2016/013). The project portfolio is balanced with, in addition to those projects on pathogen/host interaction, projects addressing more strategic issues (Project 2015/003), training and professional development (Projects 2012/002, 2012/030, 2012/044, 2013/414 and 2014/403) and cross-jurisdictional initiatives (Projects 2012/050, 2013/036, 2015/001 and 2016/009).

Wherever there is aquaculture activities there will be new and emerging diseases of the aquatic animals under culture. One of the strengths of AAHS is the capability to provide extra funding for research on these diseases when they arise. Thus the AAHS R&D Plan is up-dated on a regular basis (at least annually) to incorporate R&D on newly emerging diseases.

Consultation with stakeholders is an on-going activity via both formal and informal mechanisms. In recent years, there have been a number of workshops on development of RD&E strategies, in particular RD&E strategy for biosecurity which is a concern for industry, government policy makers and regulators, and research providers. It is interesting to note that the FRDC Board has recognised this national priority and "biosecurity" is further emphasized with a change in the subprogram name from Aquatic Animal Health Subprogram (AAHS) to Aquatic Animal Health and Biosecurity Subprogram (AAHBS).

Dissemination of information and results is a major activity undertaken by AAHS and is achieved through various means. The biennial FRDC Aquatic Animal Health Scientific Conferences provide an important forum for Australian (and other) aquatic animal health specialists to meet and discuss current R&D and newly emerging health issues for the fisheries and aquaculture sector. The conferences are open to aquatic animal health specialists and research providers, including representatives from industry, the Australian Government, State governments, universities and other academic institutions and private laboratories, as well as overseas participation. The conferences play an important part in the communication function of the Subprogram. Not only is a large proportion of the AAHS research portfolio presented and discussed but also the conferences are open to all aquatic animal health specialists and they are invited to present results from other, non-FRDC-funded, projects. In this way, linkages to other research providers were enhanced. Furthermore, the conferences

provide an opportunity for the younger aquatic animal health specialists, the newcomers in the field, to develop their networks.

In summary, major stakeholders acknowledge the key role the AAH Subprogram plays in ensuring that the strategic direction for R&D investment in aquatic animal health, at the national and state levels, is maintained.

Implications

The overall planned outcome of the FRDC Aquatic Animal Health Subprogram was an increased ability to manage aquatic animal disease in the commercial, recreational and traditional fishing industry sectors and thus assist Australia's aquaculture and fisheries industries become more competitive, profitable and sustainable. In addition, there is a broader responsibility towards the Australian community to ensure the sustainability of Australian aquatic natural resources.

This overall outcome was achieved through improved diagnostic capability and/or disease management for a number of aquatic animal pathogens including abalone herpesvirus, nervous necrosis virus, *Streptococcus agalactiae*, Pacific oyster mortality syndrome (caused by OsHV-1 uVar), various prawn pathogens, *Ichthyophthirius multifiliis*, *Edwardsiella ictaluri*, *Perkinsus olseni* and other priority aquatic animal diseases on which research is continuing (e.g., *Bonamia* spp., yellow head virus genotypes); development of enhanced awareness of emergency aquatic animal disease response arrangements and other training to enhance the disease emergency management capability of industry and government personnel. Achievement of outcomes addressing aquatic animal health priorities identified by industries and governments was ensured through the structure of a Subprogram Steering Committee which had a balance of industry and government representatives and was supported by a Scientific Advisory Committee.

Efficiency and effectiveness in R&D prioritisation as well as delivery and extension of R&D results have been achieved through the Aquatic Animal Health Subprogram's STC and SAC structure and their linkages to other organisations involved in aquatic animal health, such as National Aquaculture Council, state and federal governments and Animal Health Committee's SCAAH and its working groups.

Extension of R&D results was further achieved through a proactive communication strategy, with the Subprogram newsletter *Health Highlights* and the FRDC Scientific Conferences on Aquatic Animal Health being the two most effective mechanisms for information dissemination. Preventing duplication of aquatic animal health research is an important reason for the existence of the FRDC Aquatic Animal Health Subprogram. By ensuring that all health-related proposals are reviewed by the Subprogram STC and SAC we are confident that FRDC-funded research at least is not duplicated. Several members of the STC and SAC are also involved with other funding bodies and therefore the subprogram is also made aware of some non-FRDC funded research. The development of a nationally agreed FRDC AAHS R&D plan with regular review by the major stakeholders and its placement on the FRDC website also assists in this respect. The up-dated R&D Plan with the FRDC research projects relevant to aquatic animal health issues included is also attached to calls for expressions of interest. In addition, all final reports are available from the FRDC website (<http://frdc.com.au/research/final-reports/Pages/default.aspx>).

Recommendations

During the course of this project the FRDC Scientific Conference on Aquatic Animal Health has continued as a biennial event which receives extremely positive feedback demonstrating its importance to the aquatic animal health community. The conferences provide a forum for discussion of advances in aquatic animal health including those provided by research results of AAHS projects. Thus these conferences play an important part ensuring that AAHS research is adopted by the major stakeholders. The conferences also provide a forum for discussion of current health issues facing the Australian fisheries and aquaculture sector. Such discussions often lead to the development of potential collaborative proposals for submission to FRDC for funding. An important development was the expansion of the conference to include overseas participation which is seen as a beneficial change that not only promotes Australian aquatic animal health but also provides an opportunity to interact with international experts. To capitalize on this development and to attract increased international participation, the scientific conferences should be marketed overseas more effectively through established networks.

In addition, AQUAPLAN is Australia's national strategic plan for aquatic animal health which was developed in consultation with governments and industry. As such it is important for the FRDC Aquatic Animal Health and biosecurity Subprogram to support research to expedite implementation of the plan. Currently, there are some research projects within the subprogram's portfolio (e.g. FRDC Projects 2013/403, 2014/002 and 2015/005) but it is likely that there could be other projects developed that would assist in addressing AQUAPLAN objectives.

FRDC has a strong record in supporting workshops on priority aquatic animal health issues (e.g. the national workshop on nervous necrosis virus, the international workshops on Ostreid herpesvirus type 1 microvariant and on mollusc disease diagnosis) and brought together industry representatives, research providers and national and international experts to discuss issues of national and international importance. These workshops provide rare opportunities for these experts to meet and focus on very specific topics, and lead to development of research plans for future consideration. It is recommended that workshop support be continued, perhaps through the Aquatic Animal Health Training Scheme.

Further development

To date, while Australia has been relatively disease-free and suffered few major national emergencies, there are indications that with the growth in the aquaculture sector the number of new and emerging diseases appears to be growing in parallel. For example, in the period since 2008 the following incidences have occurred:

2008: White tail disease in the giant freshwater prawn (Queensland)

2008: Infectious hypodermal and haematopoietic necrosis virus (Queensland)

2008: Abalone viral ganglioneuritis in wild-caught abalone (Tasmania)

2010: Ostreid herpesvirus-1 μ Var in Pacific oysters (New South Wales)

2010: *Edwardsiella ictaluri* in catfish (Northern Territory)

-
- 2011: Abalone herpesvirus in farmed abalone (Tasmania)
- 2012: *Megalocytivirus* in farmed ornamental fish (Queensland)
- 2012: Pilchard Orthomyxovirus in farmed Atlantic salmon (Tasmania)
- 2013: New yellow head virus genotype in farmed prawns (Queensland)
- 2014: *Edwardsiella ictaluri* in catfish (Queensland)
- 2015: *Penaeus monodon* hepatopancreatitis (Queensland)
- 2015: *Bonamia exitiosa* in native oysters (Victoria)
- 2015: *Bonamia exitiosa* in native oysters (South Australia)
- 2016: Ostreid herpesvirus-1 μ Var in Pacific oysters (Tasmania)

The presence of these diseases/agents has had significant negative impacts on profitability and sustainability of industry sectors through direct effects such as mass mortality, reduced growth of animals, as well as more indirect effects such as increased expenditure on control and management measures. Moreover, an understanding of the epidemiology is required before appropriate management and control measures can be implemented. Thus when new diseases/agents emerge it is critical not to underestimate their significance and to implement basic research in an effort to provide an understanding of their biology/epidemiology. The AAH Subprogram is one conduit that can ensure coordinated delivery and extension of relevant aquatic animal health R&D.

In addition, with the occurrence of global warming, it is likely that increased temperature stress on farmed species will increase their susceptibility to infectious agents; agents that are normally non-pathogenic may become pathogenic for some host species at the higher temperatures and under conditions of intensive culture. In addition, geographical ranges of disease agents may be expanded as warmer water temperatures allow host ranges to expand southward.

In response to the increased awareness around biosecurity, the AAH Subprogram will, in the future, be re-named the Aquatic Animal Health and Biosecurity Subprogram and will include in its portfolio of projects research to enhance Australia's capability to prevent disease outbreaks (through stronger quarantine and biosecurity), to detect diseases when they occur (through diagnostics and surveillance), and to reduce their impacts (through genetics, vaccines and approved veterinary medicines).

To date, AAHS has been concerned mainly with aquatic animal health i.e. the health of the animal *per se* and the resources and procedures to maintain aquatic animal health (for the subprogram this relates to infectious diseases). In contrast, aquatic animal biosecurity is all the resources and procedures in place to prevent new pests and diseases from entering our country/state/farms and becoming established. So, relevant for the subprogram would be research and training activities that support this. It is interesting to note that when developing AQUAPLAN 2014-2019, the industry sectors were advocating development of more on-farm biosecurity tools. In this context it is also worth noting that the R&D Plan for the new AAHBS is likely to align with the five objectives of the current AQUAPLAN 2014-2019 (<http://www.agriculture.gov.au/SiteCollectionDocuments/animal-plant-health/aquatic/aquaplan-2014-2019.pdf>):

-
1. Improving regional and enterprise-level biosecurity
 2. Strengthening emergency disease preparedness and response capability
 3. Enhancing surveillance and diagnostic services
 4. Improving availability of appropriate veterinary medicines
 5. Improved education, training and awareness

Extension and Adoption

The major output from this project includes all the knowledge, processes and technology that is developed from research projects within the AAHS project portfolio. Thus AAHS encourages that the outputs from each research project are published, widely disseminated and promoted, particularly at the project development stage; extension and adoption strategies for each project are part of project development.

With respect to AAHS communication, extension and adoption of results has been (and will continue to be) achieved through various means, including:

- The Subprogram Newsletter, *Health Highlights*
- Scientific workshops/conferences
- FRDC Website
- Databases
- Provision of advice to other FRDC Subprograms and FRABs regarding aquatic animal health research

Milestone Progress Reports for this project have been submitted to the STC/SAC for approval prior to submission to FRDC approximately every 6 months.

Project materials developed

The latest version of the FRDC Aquatic Animal Health Subprogram R&D Plan is attached.

Conference and workshop proceedings have been produced and distributed. Copies of these proceedings remain available, on request:

2012 AABERA Workshop: Outcomes Report

2013 Second FRDC Australasian Scientific Conference on Aquatic Animal Health

2013 International Knowledge-Based Bio-Economy (KBBE) Forum Report from the Workshop on “Mollusc Disease Diagnosis”

2015 Third FRDC Australasian Scientific Conference on Aquatic Animal Health

Appendices

Appendix 1: Project Staff

Mark Crane, Aquatic Animal Health Subprogram Leader

Joanne Slater, Aquatic Animal Health Subprogram Coordinator

Steering Committee Members:

Pheroze Jungalwalla, National Aquaculture Council

Ingo Ernst, Department of Agriculture, Fisheries and Forestry (until 2015)

Brett Herbert, Department of Agriculture and Water Resources (2015-present)

Crispian Ashby, FRDC (until 2014)

Jo-Anne Ruscoe, FRDC (2014-present)

David Ellis, Australian Southern Bluefin Tuna Industry Association (2013-2014)

David Mills, Paspaley Pearling Company (2014-present)

Brian Jones, Fisheries - Western Australia (until 2013)

Tracey Bradley, Department of Economic Development, Jobs, Transport and Resources, Victoria (2013-present)

Scientific Advisory Committee Members:

Richard Whittington, University of Sydney

Nick Moody, CSIRO AAHL Fish Diseases Laboratory

Barbara Nowak, University of Tasmania (until 2013)

Stephen Pyecroft, University of Adelaide (2013-present)

Appendix 2: Aquatic Animal Health Subprogram R&D Plan



Aquatic Animal Health Subprogram Research and Development Plan 2012-2016 (2015 ver 1.0)

Prepared by:

FRDC Aquatic Animal Health Subprogram

Edited by:

Dr Mark Crane, Aquatic Animal Health Subprogram Leader

Joanne Slater, Aquatic Animal Health Subprogram Coordinator

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1 Introduction

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

This strategic R&D plan is a revision of the 2002-2008 Plan and is a 'working document'. It has been developed for a four-year period (2012-2016) after which a full review will be conducted.

However, the Plan will also be reviewed annually and amended accordingly.

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 project applications;
- Lists current R&D 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. The sector's capacity to contribute through export earnings and job creation especially in regional Australia is a vital part of our future prosperity. 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 nervous necrosis virus in finfish, gill associated virus (GAV) in prawns, *Bonamia* sp. in edible oysters, oedema oyster disease in pearl oysters, OsHV-1 in Pacific oysters, *Edwardsiella ictaluri* in catfish, and abalone viral ganglioneuritis. This concern over endemic diseases and the lack of adequate surveillance and diagnostic services compromises Australia's attempts to export aquatic animal products e.g. live shellfish. Such trade barriers, based on our lack of understanding of our own diseases, will continue to be imposed and provide an incentive to Australia to not only improve basic knowledge on endemic disease agents but also, and more critically, to improve the quality control and thus international acceptance of our diagnostic and surveillance capacity. 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, molluscs and amphibians) from all environments, i.e. tropical or temperate, marine, brackish or freshwater environments, is required.

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 successor *AQUAPLAN 2005-2010*. A new *AQUAPLAN (2014-2019)* has recently been endorsed by Australian Governments. 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. Compared to the terrestrial animal industries, the state of knowledge of aquatic animal health management is limited. 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 Subprogram

The Subprogram 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, consistent with international obligations and continues to address Australia's aquatic animal health R&D needs.

3.1 Mission

“To provide leadership to aquatic animal health R&D and its adoption in Australia”

3.2 Objectives

The Subprogram's key objectives are to:

1. Provide leadership, coordination, management and planning for aquatic animal health R&D;
2. With other stakeholders, set and review national priorities of aquatic animal health research; and
3. Oversee the communication, extension and adoption of results of FRDC aquatic animal health research projects

3.3 Role

The role of the Subprogram is to:

- Implement the Subprogram strategic R&D Plan;
- Set R&D priorities to maximise investment in aquatic animal health, avoid duplication and achieve the greatest potential return;
- Invite R&D applications to address those priorities;
- Maximise collaboration between researchers, and between researchers, fisheries managers and fishing industry interests;
- Attract other R&D funding and influence the way in which other funding entities apply their investments in that field;
- Standardise on the best scientific methods;
- Communicate regularly with potential beneficiaries; and
- Influence the adoption of R&D results.

3.4 Outcomes

The Subprogram's activities will contribute to:

1. Reduced risk of a major disease impact on Australia's fisheries resources
2. Improved productivity and profitability of the fishing and aquaculture sectors
3. Market access/biosecurity/meeting international obligations
4. Improved standard/productivity of research and analysis
5. Cost-effective research and analysis
6. Increased awareness of aquatic animal health issues

3.5 Scope within FRDC

The scope of the Subprogram is 'health' with a focus on infectious diseases of aquatic animals. Thus the Subprogram is responsible for coordinating research projects that are funded by FRDC, that are aimed at addressing priorities within the field of aquatic animal health, and exclude issues concerning food safety or toxicology.

The Subprogram adopts a special responsibility for health-related research applications originating in industry sectors for which there is no other specific subprogram. In particular the Subprogram manages health-related projects on new or emerging aquatic animal species ('orphan species') for aquaculture.

In situations where a sector-specific subprogram/industry partnership agreement (IPA) exists¹, these entities are responsible for the prioritisation and management of any health related projects involving those specific species. The Subprogram provides advice on these health related projects on request.

The preferred process for submission and assessment of such applications is as follows:

1. Following consultation with the species-specific subprogram/IPA an EoI or full application is submitted to the species-specific subprogram/IPA which assesses its need and priority.
2. If supported by the species-specific subprogram/IPA, the EoI or full application is forwarded to the Aquatic Animal Health Subprogram for advice on technical feasibility and merit.
3. The full application should gain support from both subprograms/IPA before submission to the FRDC Board for final assessment.
4. If approved, the project is then managed by the species-specific subprogram/IPA; the AAH Subprogram provides advice on milestone reports and the final report as required.

3.6 Scope and links with other bodies

The Subprogram consults on aquatic animal health R&D priorities and strategies with Animal Health Committee (AHC) - Australia's primary government advisory committee for policy, communication and awareness related to animal health. Consultation is primarily through AHC's Sub-committee on Aquatic Animal Health (SCAAH) and the National Industry Reference Group for Aquatic Animal Health (NAAHIRG).

3.7 AAHS Steering Committee

The Steering Committee (STC) comprises both government and industry representatives.

Amongst the key tasks of the STC are:

- To develop a Strategic R&D Plan which is reviewed on a regular basis.
- 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 facilitate industry extension and technology transfer.

STC members

Industry members:	National Aquaculture Council (Pheroze Jungalwalla, Executive Chair) Capture fisheries (David Mills, Paspaley Pearling)
Government members:	AGDoA (Ingo Ernst, Director - Aquatic Pest and Health Policy) SCAAH Representative (Tracey Bradley, DEPI Victoria)
FRDC member:	Jo-Anne Ruscoe (Programs Manager – People Development)
Subprogram Leader:	Mark Crane (Research Group Leader, CSIRO AFDL)
Subprogram Coordinator:	Joanne Slater (Senior Technical Officer, CSIRO AFDL)

3.8 Scientific Advisory Committee

The Scientific Advisory Committee (SAC) consists of a small core group of specialists that may co-opt additional expert scientists as needed. The SAC members were chosen to encompass a broad range of knowledge and expertise.

Amongst the key tasks of the SAC are:

¹E.g. Atlantic Salmon Aquaculture, Southern Rock Lobster, Australian Southern Bluefin Tuna Industry Association, Australian Prawn Farmers Association, Abalone Council of Australia, Oysters Australia, Pearl Producers Association

-
- To scientifically assess new research proposals, *inter alia* to ensure that the research proposed is scientifically feasible, and to advise the STC on new funding applications.
 - 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 facilitate research extension and technology transfer.
 - To co-opt, as required, additional aquatic animal health experts to assist in the provision of advice.

Current SAC members

Prof Richard Whittington (University of Sydney)

Dr Nick Moody (CSIRO AAHL Fish Diseases Laboratory)

Dr Stephen Pyecroft (University of Adelaide)

Thus, while full representation is not possible, within the current Steering Committee and Scientific Advisory Committee structure many of the major stakeholders are represented.

4 Stakeholders

The key stakeholders in the Subprogram, i.e. those beneficiaries that have the greatest stake in the success of the Subprogram and with whom the Subprogram consults to identify aquatic animal health R&D needs, are (in alphabetical order):

- Australian Government Department of Agriculture
- Animal Health Committee (AHC) and its Subcommittee on Aquatic Animal Health (SCAAH)
- Capture fisheries
- FRDC
- Major aquaculture industries (salmon, tuna, edible oysters, pearls, prawns)
- National Aquaculture Council
- Research providers
- State/Territory Departments of Fisheries/Natural Resources/Agriculture

It is acknowledged that the list of beneficiaries is much longer, 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 Methods

The Subprogram fulfils its role by:

- Being accountable for actions outlined in this strategic plan;
- Adopting a proactive approach to aquatic animal health;
- Adopting a holistic approach to aquatic animal health;
- Adopting clear directions and processes;
- Providing a focal point for research;
- Promoting a collaborative/cooperative R&D environment;
- Advocating the importance of aquatic animal health; and
- Communicating with Fisheries Research Advisory Bodies (FRABs) and other FRDC subprograms/IPAs on:
 - ⇒ Research EoIs and full project applications received by the Subprogram – informing and seeking comment by FRABs/subprograms/IPAs;
 - ⇒ Subprogram assessment of research EoIs and full applications; and
 - ⇒ Advice sought on health related EoIs and full applications submitted to FRABs or other subprograms/IPAs.

The STC and SAC assist the Subprogram in fulfilling its role and managing its projects.

5.1 FRDC R&D projects

The Subprogram follows the FRDC's standard operating procedures for project approval and management, especially regarding communication with other subprograms and FRABs.

5.2 Meeting Objectives

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

Objective 1: Provide leadership, coordination, management and planning for aquatic animal health R&D

A) Planning

- Establishment and annual review of strategic R&D plan (update; identify gaps)

B) Development of applications

Project applications submitted to the Subprogram:

- Commissioned, unsolicited or forwarded (by FRDC, FRABs or other subprograms/IPAs, or by AHC and SCAAH)

C) Assessment of applications

- Determine whether application fits criteria² (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) Project management facilitation

- Assessment and execution of projects
- Communication/extension of results
- Encourage/facilitate adoption of results

F) Governance

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

H) Linkages

- Establish strategic alliances

Objective 2: Set and review national priorities of aquatic animal health research

- Establish current R&D issues in consultation with stakeholders, e.g. through the annual meetings of SCAAH
- Annual update of strategic R&D plan
- Full review of strategic R&D plan every 5 years

Objective 3: Oversee the communication, extension and adoption of results of aquatic animal health research projects

Develop a communication strategy that may include:

- *Health Highlights* (AAH Subprogram newsletter)
- Scientific workshops (there have been several of these, convened to prioritise and facilitate a national approach to specific R&D problems, for example, most recently the national workshop on “Development of a national aquatic animal health curriculum for delivery by tertiary institutions”, Adelaide 13-14 February 2014); in addition the subprogram has sponsored four biennial National FRDC Aquatic Animal Health Conferences (2003, 2005, 2007, 2009) and two Australasian Scientific

² See 6.1 below

Conference on Aquatic Animal Health (2011, 2013) at which researchers have been able to present their work.

- Website
- Provide scientific advice and communication to other subprograms/IPAs and FRABs regarding aquatic animal health research pre-proposals, applications, projects and results
- Databases

6 Research and Development

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 Criteria

The following criteria are used to define a project under 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 contributes to the future understanding of 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 R&D needs identified in *AQUAPLAN 2014-2019*.

6.2 Key research areas

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 AAHS in the next funding cycle are listed under pertinent areas.

6.2.1 Nature of disease and host-pathogen interaction

SCOPE

- Improved knowledge of the biology of disease agents (including epizootiology, 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
- Knowledge about disease translocation risk factors.

CURRENT PRIORITIES

- Immunology of aquatic invertebrates
- Bonamiosis in oysters

6.2.2 Aquatic animal health management

SCOPE

- R&D to inform risk analyses (including disease risk minimisation procedures for exported and imported aquatic animals and products)

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- R&D to facilitate inter-jurisdictional harmonisation of domestic and international approaches (common tests, common protocols (e.g. translocation), common certification)
 - Development of protocols, methods and operational instruments to manage routine biosecurity and also emergency aquatic animal disease outbreaks
 - Methods of aquatic animal product treatments to prevent spread of disease (sterilisation, disinfection and decontamination)

CURRENT PRIORITIES

- Research on safety of imported species/products
- Develop generic response/key strategies to manage an outbreak of a new (previously unknown) disease, including epidemiology and a guideline for undertaking initial investigation. Develop recommendations for research addressing newly emerging diseases.
- Development of robust methodologies for investigation of mollusc disease outbreaks.
- Integrated health management for commercial molluscs.

6.2.3 Endemic and exotic aquatic animal disease diagnostics

SCOPE

- Review and assessment of existing screening and diagnostic tests, and those under development
- Development of sampling methodology to detect sub-clinical infections at low levels of prevalence
- Development of case definitions and diagnostic criteria
- Development and validation of screening tests and diagnostic tests
- Facilitate transfer of knowledge and technology in aquatic animal diagnostics
- R&D to support QA for diagnostic services

CURRENT PRIORITIES

- Development, improvement and standardisation of generic procedures (tissue sampling, tissue processing, nucleic acid extraction, result interpretation) for molecular tests
- Develop highly sensitive/specific and validated diagnostic tests for significant enzootic, exotic, new and emerging diseases of aquatic animals in Australia.

6.2.4 Surveillance and monitoring

SCOPE

- Support projects to enhance existing surveillance and monitoring programs and those under development
- Research into aquatic animal disease surveillance methodology
- Strategic R&D to inform disease control programs, translocation, zoning, surveillance and monitoring, and risk analyses in relation to disease organisms

CURRENT PRIORITIES

- Development/establishment of cell culture systems for the isolation of viruses from finfish and aquatic invertebrates
- 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.
- 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 Aquatic animal disease therapy and prophylaxis

SCOPE

- R&D (microbiology/immunology) that underpins development of autogenous vaccines for aquatic animals

CURRENT PRIORITIES

- Research on immune response to viral, bacterial and parasitic diseases of Australian aquaculture species that supports development and assessment of alternative therapeutics/vaccines.

6.2.6 Training and capacity building

SCOPE

- Human capital development
- Facilitate the development of training and extension tools
- Sustain and further develop technical skill-base in aquatic animal health
- Facilitate R&D knowledge transfer in aquatic animal health

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).
- Development of a national aquatic animal health curriculum.

6.3 The application process

A general guide to developing research proposals for submission to FRDC is provided on the FRDC Website (http://frdc.com.au/research/applying_funding/Pages/default.aspx) and should be followed. The following guide is specific for submissions directed at the FRDC Aquatic Animal Health Subprogram during the normal funding cycle (and not the Tactical Research Funding proposals) and aligns with the FRDC generic process. In addition, PIs may contact any of the AAHS committee members to obtain advice of the relevance of any project idea to the AAHS.

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.

6.3.1 The time-line

The project development and review process for new proposals will normally take up to 12 months, according to the following schedule:

March: AAHS R&D Plan 2012-2016 reviewed and priorities set.

April: FRDC to review priorities.

May: FRDC to send out general call for Expression of Interest (EoIs).

June: EoIs submitted by PIs to FRDC. Aquatic animal health EoIs forwarded to AAHS for review and comment.

July: AAHS meet to review EoIs. Feedback on EoIs forwarded to PIs.

By 1 September: PIs to submit finalised EoIs to FRDC.

October: Finalised AAH EoIs forwarded to AAHS for comment back to FRDC Board.

November: FRDC Board evaluates EoIs and forwards assessment to PIs.

December-February: Full proposal developed for successful EoIs in consultation with stakeholders.

March: Full proposal assessed.

April-July: Successful projects would normally commence at the start of the next financial year unless approval for an early start has been obtained.

Thus in May 2015 a general call for EoIs for projects that address current priorities (and to commence in 2016 - usually after 1 July 2016) will be sent out by FRDC. In this notice, research providers will be instructed to submit the EoI by a specific closing date. *As part of EoI, AAHS proposals should include, in an attachment, proposed methodology in sufficient detail that will allow AAHS to assess the likelihood of*

achieving the project objectives. The EoIs will be reviewed by the AAHS at its July 2015 meeting. The PI will be informed of the results of this review, including recommendations concerning submission of a revised (if required) EoI to FRDC by 1 September 2015. If the project is considered a priority by AAHS, this will be clearly stated together with feedback to assist the PI in preparing a full proposal. FRDC will forward all finalised AAH EoIs to AAHS for comment back to FRDC by October. The FRDC Board will assess EoIs at the November Board meeting. The PIs of approved EoIs will be notified that they will need to develop a full proposal in consultation with stakeholders. The full proposal will be developed during the December-February period and contracting completed prior to project commencement.

7 Current and completed projects within the Aquatic Animal Health 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.

7.1 Nature of disease and host-pathogen interaction

- 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 groppers, 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: Aquatic Animal Health Subprogram: 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: Aquatic Animal Health Subprogram: 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: Aquatic Animal Health Subprogram: 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: Aquatic Animal Health Subprogram: Determination of susceptibility of various abalone species and populations to the various AbHV genotypes (Serge Corbeil, CSIRO) May 2016.

7.2 Aquatic animal health management

2001/214: Development of a disease zoning policy for marteiliosis 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.

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- 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: Aquatic Animal Health Subprogram: Strategic planning, project management and adoption (Mark Crane, CSIRO) June 2016.

7.3 Endemic and exotic aquatic animal disease 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*) (Nick 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.

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- 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) TBA.
- 2013/002: Aquatic Animal Health Subprogram: Identifying the causes of Oyster Oedema Disease (OOD) in pearl oysters (*Pinctada maxima*) (David Raftos, Macquarie U.) TBA.
- 2014/001: Aquatic Animal Health Subprogram: Strategic approaches to identifying pathogens of quarantine concern associated with the importation of ornamental fish (Joy Becker, U. Sydney) TBA.

7.4 Surveillance and monitoring

- 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.

7.5 Aquatic animal disease therapy and prophylaxis

- 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.

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- 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) TBA.
- 2012/001: Aquatic Animal Health Subprogram: Strategic planning, project management and adoption (Mark Crane, CSIRO) June 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) (Oliver, Aquaculture Support Services) TBA.
- 2014/403: Aquatic Animal Health Subprogram: Development of a national aquatic animal health curriculum for delivery by tertiary institutions (Pycroft, U. Adelaide) TBA
- 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.

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- 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 TBA.
- 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.
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8 Further information

Aquatic Animal Health Subprogram website:

Go to the FRDC website www.frdc.com.au and follow the links: Research/Aquatic Animal Health

Department of Agriculture website: <http://www.daff.gov.au/animal-plant-health/aquatic>

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