FINAL REPORT

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

Mark St. J. Crane

August 2012

FRDC Project No. 2008/039

Australian Government
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OBJECTIVES:

1. To administer and co-ordinate the activities of the AAHS
2. To manage a portfolio of R&D projects that are directly concerned with aquatic animal health and are not covered by other FRDC subprograms
3. To facilitate meetings of the AAHS Steering and Scientific Advisory Committees
4. In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for aquatic animal health R&D
5. To disseminate information and results through: a) a biennial scientific conference; b) specialist workshops on topics identified through AAHS business c) *Health Highlights* Newsletter; d) relevant articles in FRDC News *FISH* and e) the FRDC website

NON TECHNICAL SUMMARY

OUTCOMES ACHIEVED TO DATE

The overall outcome of this project has been the successful facilitation, administration and promotion of the FRDC Aquatic Animal Health Subprogram (AAHS) over the period from July 2008 to May 2012. During this period the AAHS has managed a total of 30 projects through which improved diagnostic and health management capability at the local, state and national levels has been delivered. Moreover, aquatic animal disease awareness has been enhanced and disease emergency management capability at industry and government levels has been improved. Thus Australia's capability to be prepared for, and respond to, aquatic animal disease emergencies has been greatly enhanced.

AAHS projects were developed following FRDC procedures, ensuring that research undertaken addressed aquatic animal health issues of highest concern and that duplication of research was avoided. The AAHS' bi-annual newsletter *Health Highlights* reported on progress made in these projects.

The AAHS R&D Plan, "AQUATIC ANIMAL HEALTH SUBPROGRAM Strategic Plan 2002-2008", developed to guide the Subprogram to accomplish its objectives, was reviewed and updated to "AQUATIC ANIMAL HEALTH SUBPROGRAM Strategic Plan 2009-2012". Subsequently, it was reviewed on a regular basis to ensure that it remained current.

The Fourth National FRDC Scientific Conference on Aquatic Animal Health was held in July 2009 (63 registrations). For 2011, the conference (First FRDC Australasian Scientific Conference on Aquatic Animal Health) was opened to international participants (125 registrations). In addition to industry representatives, aquatic animal health specialists, including representatives from governments, universities and other academic institutions, participated in each of the conferences. These conferences play an important role in the communication function of the Subprogram, with a large proportion of its projects discussed. In addition, the conferences are open to all interested parties and non-FRDC-funded research was included in the programs. The 2011 conference was followed by the International Workshop on Ostreid Herpesvirus. Sponsorship of this workshop by FRDC facilitated attendance by international experts, including representatives from international aquatic animal health organisations (OIE and EFSA). The workshop report provides the most up-to-date information on this virus and has been distributed internationally.

In summary, 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

ACKNOWLEDGEMENTS

The author wishes to thank members of the FRDC Aquatic Animal Health Subprogram Steering Committee and Scientific Advisory Committee without whom the subprogram would not exist, and aquatic animal health in Australia would be less well-placed. Furthermore, the Principal Investigators and all the staff involved in the research projects making up the subprogram portfolio deserve mention for the high quality of the research output.

BACKGROUND

Prompted by the federal budget initiative (FBI) - Building a National Approach to Animal and Plant Health and under a joint agreement between DAFF and FRDC, the Aquatic Animal Health Subprogram (AAHS) was established in 2001 and, in consultation with industry, a portfolio of projects was developed. AAHS provided support to, and management of, these projects as well as other, non-FBI-funded, health-related projects within FRDC. Based on the success of AAHS, the continued need for such a structure, and strong stakeholder support, in 2004 the Subprogram was renewed for a further 4 years.

During the period 2001-2004, the subprogram managed 47 projects within the FBI (i) Diagnostics Program; (ii) Manuals and Planning Program; (iii) Training Program, as well as managing FRDC aquatic animal health projects outside the federal budget initiative program. By 2004, forty-five of these projects had been completed and two remained active. During the period 2004-2007, a further 16 projects were initiated, 5 of which were completed and 11 remained active. For the 2008-09 funding cycle 4 full proposals relating to aquatic animal health were submitted.

A major strength of AAHS has been the access to industry and scientific expertise via a Steering Committee, a Scientific Advisory Committee and a core of technical experts (NAAH-TWG now SCAAH) that have provided invaluable input to the Subprogram Leader, supported by a Subprogram Coordinator. Thus all research proposals have been evaluated with respect to their relative priority to industry and government and to their scientific soundness and feasibility. Where appropriate, collaboration between research providers has been encouraged and has resulted not only in enhanced project outputs but also in further development of the professional relationships within the research community which has improved Australia's research capacity in the area of aquatic animal health, not only for the aquaculture sector but also for all other aquatic animal sectors which include the wild-capture, recreational and ornamental sectors.

The AAHS strategic plan was drafted in consultation with industry, governments and research providers in which the strengths of AAHS are recognised. The R&D Plan is reviewed on a regular basis (with the latest revision occurring in 2011). Based on this R&D Plan, the major stakeholders (governments and industry) provided strong support for the continuation of AAHS. Thus the Subprogram was renewed for a further 4 years (July 2008 to May 2012) – FRDC Project No. 2008/039 for which this is the final report.

NEED

When this project was proposed (in 2008), Australia's wild fisheries production was declining from a peak in 2004-5, while aquaculture production was continuing to grow to 30% of total fisheries by volume and to almost 40% of total by value. Table 1 summarises Australian fisheries (wild catch and aquaculture) statistics (derived from *Australian Fisheries Statistics*, an annual report published by ABARE now ABARES) since 1992. This table shows that the wild catch sector production was at its lowest volume in 2009-10 (171.5 kilotonnes per annum from a peak of 231 kilotonnes in 2004-5) while aquaculture production has more than quadrupled in volume and more than trebled in value during this time period. The latest data were sourced from ABARES (2011).

Table 1. Australian Fisheries Production 1992-2010

Year	Wild catch		Aquaculture		Total	
	Volume[1]	Value[2]	Volume	Value	Volume	Value
1992-93	228	1.23	17	0.26	245	1.49
1993-94	199	1.42	20	0.26	219	1.68
1994-95	202	1.46	24	0.35	226	1.81
1995-96	199	1.31	26	0.38	225	1.69
1996-97	193	1.35	27	0.44	220	1.79
1997-98	200	1.37	29	0.51	229	1.88
1998-99	205	1.50	34	0.61	239	2.11
1999-00	185	1.66	37	0.68	222	2.34
2000-01	188	1.73	41	0.71	229	2.44
2001-02	189	1.70	45	0.71	234	2.43
2002-03	210	1.57	44	0.71	254	2.28
2003-04	226	1.49	49	0.72	275	2.21
2004-05	231	1.48	47	0.63	278	2.11
2005-06	187	1.38	54	0.75	241	2.13
2006-07	180	1.39	60	0.79	240	2.18
2007-08	181.6	1.39	64.1	0.87	245.7	2.19
2008-09	173.1	1.40	69.6	0.86	242.7	2.26
2009-10	171.5	1.34	73.5	0.87	245.0	2.21

[1]kilotonnes
[2]AU$billions

It is recognised that disease represents a significant risk to the fisheries and aquaculture sector (for examples see Go and Whittington, 2006; Hooper et al 2007; Hayward et al., 2008; Owens et al., 2009; Moody et al., 2009; Anderson 2011; Frances et al., 2011; Bowater et al., 2012). Nevertheless, Australia's aquatic animal sector is free from many diseases that occur elsewhere in the world, providing us with a competitive advantage in both production and trade. This is one reason why the number of aquatic animal species and the absolute number of aquatic animals farmed in Australia is increasing annually. However, new/emerging infectious diseases continue to threaten the sustainability of significant enterprises and the need for health services to support the aquatic animal sector is growing. Health R&D is required for all segments of the aquatic animal sector (aquaculture, wild-capture, recreational

and ornamental) that share the aquatic environment, interacting with and impinging on each other. Thus aquatic animal health services need to be coordinated across these segments to ensure synergy while avoiding duplication.

From previous experience overseas (e.g. infectious salmon anaemia, see http://www.thefishsite.com/articles/763/the-impact-of-the-isa-virus-in-chile), as well as in Australia (e.g. abalone herpesvirus), it is clear that disease can cause significant damage to fisheries and aquaculture production threatening resource sustainability and industry profitability (http://www.thefishsite.com/articles/896/aquatic-animal-diseases-and-their-economic-impact). Thus, of further concern is the ever-increasing number of new and emerging diseases of aquatic animals both domestically (e.g. abalone herpesvirus, ostreid herpesvirus) and overseas (i.e. exotic diseases, e.g. viral diseases of prawns such as white spot disease, viral diseases of finfish such as infectious salmon anaemia, red sea bream iridovirus, koi herpesvirus, and viral diseases of molluscs such as ostreid herpesvirus) that have had devastating socio-economic impacts in the affected countries (see http://www.daff.gov.au/animal-plant-health/aquatic/reporting/reportable-diseases and http://www.oie.int/en/international-standard-setting/aquatic-manual), and continue to have significant negative impacts.

Aquatic animal health management includes a risk-based approach to disease prevention, as well as reacting to, and mitigating the affects of, new and existing diseases. Research of this type is often given a low priority as it is not seen as an immediate need. To overcome this deficiency there is a need for a process that takes a national and future (i.e. strategic) view of investment in aquatic animal health. AAHS, through leadership, direction and focus, provides a national approach to aquatic animal health R&D and other related non-R&D activities. Through the Subprogram's Committee membership, AAHS has linkages to NAAH-TWG (now SCAAH), AHC, NAC, DAFF, industry, State Governments and universities. Thus, AAHS provides an industry/government-based structure through which to develop and maintain strategic direction for investment in aquatic animal health. FRDC, through AAHS, plays a major role in addressing research and training needs in the aquatic animal health sector. AAHS is able to direct this support to the most pressing areas. Thus continuation of AAHS on the basis of a shared financial commitment by stakeholders from industry and governments is considered highly desirable.

OBJECTIVES

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2. To manage a portfolio of R&D projects that are directly concerned with aquatic animal health and are not covered by other FRDC subprograms
3. To facilitate meetings of the AAHS Steering and Scientific Advisory Committees
4. In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for aquatic animal health R&D
5. To disseminate information and results through: a) A biennial scientific conference; b) specialist workshops on topics identified through AAHS business c) *Health Highlights* Newsletter; d) relevant articles in FRDC News *FISH* and e) the FRDC website

METHODS

The Aquatic Animal Health Subprogram was led by a Subprogram Leader, assisted by a Subprogram Coordinator. These two part-time positions ensured that all Subprogram business, management of a portfolio of R&D projects, development of strategic directions for R&D, dissemination of information and results, was achieved.

Subprogram business was progressed with advice from a Steering Committee chaired by the Executive Officer, NAC (Simon Bennison until April 2009, then Justin Fromm until October 2010; subsequently. The steering committee was chaired by Mark Crane, Subprogram Leader) and consisting of industry representatives (Pheroze Jungalwalla, NAAHIRG, and TSGA until February 2011, and NAC as of November 2010; Jonas Bryce Woolford, Abalone Industry Association of SA/Abalone Management SA Ltd/Wild Catch Fisheries SA), a Commonwealth Government representative (Ingo Ernst, DAFF), a State Government representative (Brian Jones, WA Fisheries, NAAH-TWG/SCAAH and a representative from the FRDC (Crispian Ashby). The Steering Committee was supported by a Scientific Advisory Committee (SAC) consisting of Barbara Nowak (Aquafin CRC and U. Tasmania), Nick Moody (CSIRO-AAHL) and Richard Whittington (U. Sydney). This Subprogram Executive functioned as detailed in the attached AQUATIC ANIMAL HEALTH SUBPROGRAM Strategic Research and Development Plan 2009–2012 (updated 2011).

Objective 1: To administer and co-ordinate the activities of the AAHS.

All Subprogram business was conducted according to FRDC policies and procedures. The Subprogram Steering and Scientific Advisory Committees met (either face-to-face or by teleconference) up to three times per year to conduct Subprogram business. The Subprogram Coordinator was responsible for organizing business meetings and drafting meeting minutes for review and endorsement by the Subprogram Executive. The schedule of meetings was aligned with the normal FRDC funding cycle to ensure that project preproposals/EoIs were canvassed and evaluated, full proposals were invited and evaluated, and recommendations were submitted to the FRDC Board.

Apart from executive meetings (both face-to-face and teleconference), the AAHS Leader and Coordinator were responsible for:

- *Health Highlights* Newsletters (production and distribution)
- Biennial Scientific Conferences (all aspects)
- FRDC Aquatic Animal Health Technical Workshops (all aspects)
- Linkage between FRDC, AAHS, research providers and stakeholders

Objective 2: To manage a portfolio of R&D projects that are directly concerned with aquatic animal health and are not covered by other FRDC subprograms.

All projects within the R&D portfolio were managed to ensure that milestones were achieved, scheduled payments were paid on approval of milestone reports and Final Reports were completed according to FRDC contracts.

Linkages to AHC/NAAH-TWG/SCAAH, AG-DAFF, Aquafin CRC and industry were maintained through the membership of the STC/SAC and facilitated the coordination, management and planning for aquatic animal health R&D. All preproposals/EoIs and draft full proposals were evaluated with respect to industry and national priorities, scientific quality and technical feasibility.

Review of aquatic animal health related projects within other FRDC subprograms was undertaken and advice provided, as required.

Objective 3: To facilitate meetings of the AAHS Steering and Scientific Advisory Committees

The Subprogram Coordinator was responsible for organising teleconferences and meeting venues including arranging accommodation and catering for Subprogram meetings. The Subprogram Leader drafted meeting agendas and papers addressing meeting agenda items. The Subprogram Leader and coordinator were responsible for ensuring efficient communication between FRDC, AAHS, and stakeholders concerning AAHS business.

Objective 4: In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for aquatic animal health R&D

Consultation during the initial 3-year period of the Subprogram has led to the development of six key research areas. These are detailed in the Strategic R&D Plan 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

These strategic directions underwent a review process on a regular basis, in consultation with key stakeholders. For example, “aquatic animal health R&D priorities” is a standing agenda item for the annual face-to-face SCAAH meeting. R&D priorities discussed at this meeting are communicated to AAHS and, in turn, are considered at the annual FRDC FRAB workshops.

Objective 5: To disseminate information and results through: a) A biennial scientific conference; b) specialist workshops on topics identified through AAHS business c) Health Highlights *Newsletter; d) relevant articles in FRDC News* FISH *and e) the FRDC website*

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

- A Subprogram Newsletter (*Health Highlights*)
- Scientific workshops
- Scientific Conferences
- Website
- Formal and informal communication with other Subprograms, FRABs, as needed
- Use of developed databases

RESULTS AND DISCUSSION

Objective 1: To administer and co-ordinate the activities of the AAHS.

Apart from executive meetings (both face-to-face and teleconference), the AAHS Leader and Coordinator were responsible for:

- Health Highlights Newsletters (production and distribution)
- Biannual Scientific Conferences (all aspects)
- FRDC Aquatic Animal Health Technical Workshops (all aspects)
- Linkage between FRDC, AAHS, research providers and stakeholders

Each of these activities are discussed below.

1.1 Health Highlights Newsletters

During the period 2008-2012 the AAHS newsletter, *Health Highlights*, was produced and published on a bi-annual basis and distributed widely to stakeholders via hard copies, electronic mail, and placing onto FRDC's Website. Feedback on *Health Highlights* has been extremely encouraging and the distribution list has increased to over 300 contacts in Australia and overseas.

1.2 Biennial Scientific Conferences

During the period 2008-12, there has been two scientific conferences (2009 and 2011), both held in Cairns.

In 2009, there were 63 registrations for the Fourth FRDC National Scientific Conference on Aquatic Animal Health, compared with 48 registrations for the Third FRDC National Scientific Conference on Aquatic Animal Health held in 2007. All logistical issues (registrations, venue, keynote speaker, abstract booklet, production and distribution of proceedings etc.) were managed by the AAHS Coordinator. Development of the program was managed by the AAHS Leader.

Dr Steve Feist, Aquatic Animal Disease Leader, Centre for Environment, Fisheries and Aquaculture Sciences, Weymouth Laboratory, UK as the conference Keynote Speaker who made presentations on:

1) The application of fish health parameters in marine environmental monitoring programmes

2) Histopathology of fish parasite infections

3) Crustacean disease and the EU Fish Health Directive (2006/88/EC)

Steve made a significant contribution to the conference with these presentations as well as through informal discussions with many of the conferees throughout the three days.

In 2011, the AAHS executive (STC and SAC) made a decision to open up the conference internationally. This decision was made quite late and the conference was probably not marketed as well as it could have been. Nevertheless, the number of registrations for the First FRDC Australasian Scientific Conference on Aquatic Animal Health (Cairns, 2011) was 125 (essentially 100% increase over the 2009 conference). This increase in

registrations was assisted by (i) an *Emergency Disease Response* conference session sponsored by DAFF and (ii) the international ostreid herpesvirus workshop sponsored by FRDC and held back-to-back with the conference. Further sponsorship for the conference was obtained from ABIN (Aquatic Animal Health Project NEPTUNE launch) and it was pleasing that Schering-Plough/Intervet continued with their support (conference bags) of the conference.

The number of overseas participants was relatively small (15) but included internationally recognised experts:

Prof. Teruo Miyazaki (Graduate School of Bioresources, Mie University, Dept. Life Science, Fish Pathology, Mie, JAPAN) was the conference Keynote Speaker and made presentations on each of the 3 days of the conference:

1. Impact of Megalocytivirus disease on fish farming.
2. Megalocytivirus disease: Histopathology, electron microscopy and molecular studies.
3. Control of Megalocytivirus disease.
4. Morphogenesis of *Alloherpesvirinae*.

Dr. Niels Olesen (National Veterinary Institute, Technical University of Denmark (DTU), European Union Reference Laboratory for Fish Diseases, OIE Reference Laboratory for VHS, DENMARK) presented in *Emergency Disease Response* session:

Emergency response to aquatic animal diseases in Europe.

Dr. Isabelle Arzul (IFREMER, Laboratoire de Genetique et Pathologie, OIE Reference Laboratory for Marteiliosis and Bonamiosis, EU Reference Laboratory for Diseases of Molluscs, FRANCE) presented in *Emergency Disease Response* session:

Increased mortality outbreaks of French Pacific oysters Crassotrea gigas *since 2008 in Europe: Detection of pathogens and emergency response*.

Dr. Ed Peeler, Cefas, Barrack Road, Weymouth, Dorset, DT4 8UB ENGLAND, UK presented in *Emergency Disease Response* session:

Detecting and responding to new and emerging aquatic animal disease threats.

Proceedings of each of the conferences were produced (on CD-Rom) and distributed to conference registrants. Copies of these proceedings have also been made available to other interested parties, on request.

1.3 Ostreid herpesvirus International Workshop

Following the 2010 outbreaks of Ostreid herpesvirus in New Zealand and NSW, an international workshop was convened back-to-back with the 2011 Australasian Scientific Conference on Aquatic Animal Health. This workshop proved to be very popular attracting over 30 participants from Australia, New Zealand, Asia and Europe.

The workshop focused on Ostreid herpesvirus-1 microvariant (OsHV-1 µVar) which has caused high mortalities amongst Pacific oyster (*Crassostrea gigas*)

populations, whether farmed or wild, in several oyster growing countries around the world.

The objectives of the workshop were to:

- Review current knowledge about OsHV-1 µVar, in particular in relation to its detection, epidemiology and current global distribution;
- Assess current practices for surveillance, prevention and control of the associated disease and provide recommendation to national, regional and global authorities for their improvement;
- Identify priorities for further research, and plan and coordinate research activities between international partners.

The workshop was facilitated by Drs. Angus Cameron (Director, AusVet Animal Health Services) and Mark Crane (FRDC Aquatic Animal Health Subprogram Leader and Research Team Leader, AAHL Fish Diseases Laboratory, CSIRO Livestock Industries).

International participants included:

Dr. Isabelle Arzul (IFREMER, Laboratoire de Genetique et Pathologie, OIE Reference Laboratory for Marteiliosis and Bonamiosis, EU Reference Laboratory for Diseases of Molluscs, FRANCE)

Dr. Ed Peeler, Cefas, Barrack Road, Weymouth, Dorset, DT4 8UB ENGLAND, UK

In addition, Drs. Ana Afonso and Franck Berthe (EFSA - Animal Health and Welfare), joined for part of the workshop by Skype.

A report from this workshop was prepared and has been made available world-wide (see http://ebookbrowse.com/oyster-herpes-virus-workshop-final-report-pdf-d290410869; http://www.oysterstasmania.org/news/cairns-2011-final-report-oshv-1-var-international-workshop; http://wwz.ifremer.fr/crlmollusc/layout/set/print/content/download/52616/747032/file/OYSTER%20HERPES%20VIRUS%20WORKSHOP%20final%20REPORT.pdf). Therefore the details of the workshop outputs will not be included in this report.

1.4 Communication

Apart from using *Health Highlights* newsletter, scientific conferences and workshops, the AAHS Leader and Coordinator provided Subprogram information and advice to FRDC, research providers and major stakeholders via email and telephone and by participation in industry workshops and conferences (see below in section on Objective 5).

Objective 2: 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 2008-12, AAHS has managed 30 projects concerned with aquatic animal health (Table 2). A few of these were continuation of active projects from the previous subprogram (2004-07). 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).

Table 2. FRDC Aquatic Animal Health Subprogram – Projects 2008-12

Project	Project Title	Date of Final Report
2002/043	AAH Subprogram: the production of nodavirus-free fish fry and the nodaviruses natural distribution	Sep 2008
2003/649	AAH Subprogram: Industry's emergency preparedness and response to mass mortality of yellowtail kingfish *Seriola lalandi*: development of plans and protocols	Aug 2008
2004/079	AAH Subprogram: Strategic planning, project management and adoption	Nov 2008
2004/084	AAH Subprogram: Investigating and managing the *Perkinsus*-related mortality of blacklip abalone in NSW Phase 1	Jun 2010
2004/086	AAH Subprogram: Identification and distribution of an intracellular ciliate in pearl oysters	Feb 2009
2006/064	AAH Subprogram: Development of diagnostic tests to assess the impact of *Haplosporidium* infections in pearl oysters	Sep 2008
2006/243	AAH Subprogram: Development of management strategies for herpes-like virus infection of abalone	May 2009
2007/006	AAH Subprogram: Development of molecular diagnostic procedures for the detection and identification of herpes-like virus of abalone (*Haliotis* spp.)	Nov 2009
2007/007	AAH Subprogram: Validation of PCR tests for diagnosis of megalocytivirus (gourami iridovirus)	May 2009
2007/225	AAH Subprogram: Metazoan parasite survey of selected macro-inshore fish of southeastern Australia, including species of commercial interest	Feb 2011
2007/226	AAH Subprogram: Rapid strain identification of the bacterial fish pathogen *Streptococcus iniae* and development of an effective polyvalent vaccine for Australian barramundi	Feb 2010
2008/030	AAH Subprogram: Development of a DNA microarray to identify markers of disease in pearl oysters (*Pinctada maxima*) and to assess overall oyster health	Due May 2012
2008/30.20	AAH Subprogram: Development of a DNA microarray to identify markers of disease in pearl oysters (*Pinctada maxima*) and to assess overall oyster health	Due May 2012
2008/031	AAH Subprogram: Investigation of Chlamydiales-like organisms in pearl oysters, *Pinctada maxima*	Due May 2012
2008/039	AAH Subprogram: Strategic planning, project management and adoption	Due May 2012
2008/041	AAH Subprogram: Tools for investigation of the nodavirus carrier state in marine, euryhaline and freshwater fish and control of NNV through integrated management	Due Nov 2012
2008/317	AAH Subprogram: Intensive pathology training workshop for laboratory diagnosticians	Jul 2010
2008/354	Tactical Response Fund: Investigating the establishment of a national aquatic animal health industry reference group	Sep 2009
2009/032	AAH Subprogram: Characterisation of abalone herpes-like virus infections in abalone	Due Oct 2012
2009/044	AAH Subprogram: Surveys of ornamental fish for pathogens of quarantine significance	Due Mar 2013
2009/072	AAH Subprogram: Risk analysis – Aquatic animal diseases associated with bait translocation	Due Jun 2011
2010/034	AAH Subprogram: Investigation of an emerging bacterial disease in wild Queensland gropers, marine fish and stingrays with production of diagnostic tools to reduce the	Due Jul 2013

	spread of disease to other states of Australia	
2010/036	AAH Subprogram: Improved fish health management for integrated inland aquaculture through Better Management Practices (BMPs)	Due Feb 2013
2011/003	AAH Subprogram: Investigations into the genetic basis of resistance to infection of abalone by the abalone herpes-like virus	Due Nov 2012
2011/004	AAH Subprogram: Development of Improved Molecular Diagnostic Tests for *Perkinsus olseni* in Australian molluscs	Due Aug 2014
2011/005	AAH Subprogram: Investigation of inclusions in Australian prawns	Due Jan 2015
2011/043	AAH Subprogram: Understanding and planning for the potential impacts of OsHV1 on the Australian Pacific oyster industry	Due Jul 2012
2011/046	Tactical Research Fund - Aquatic Animal Health Subprogram: Disease risk assessment for abalone stock enhancement program	Due Jul 2012
2011/048	Tactical Research Fund - Aquatic Animal Health Subprogram: determining the susceptibility of Australian species of prawns to infectious myonecrosis	Due Oct 2012
2011/053	AAH Subprogram: Pacific oyster mortality syndrome (POMS) - understanding biotic and abiotic environmental and husbandry effects to reduce economic losses	Due Dec 2012

Objective 3: To facilitate meetings of the AAHS Steering and Scientific Advisory Committees

The AAHS Coordinator and Leader convened executive (AAHS STC/SAC) meetings by either face-to-face or teleconference format. For the most part, meetings were convened to coincide with the FRDC funding cycle, thus ensuring that business was managed efficiently. On occasion, and usually by teleconference, extra meetings were required to consider extraordinary business (Table 3).

Most face-to-face meetings were convened in Melbourne – most committee members are located on the east coast with direct flights to Melbourne. The only face-to-face meetings that convene outside of Melbourne are those associated with the scientific conferences in Cairns.

There was a flurry of (extraordinary) meetings (mostly teleconferences) at the beginning of 2012 in response to aquatic animal health research needs following the ostreid herpesvirus outbreaks.

Table 3. Subprogram meetings

Meeting # and Date	**Face-to-face / teleconference**	**Location (if face-to-face meeting)**	**In conjunction with**
STC/SAC-28 01.07.2008	Face-to-face	Melbourne	
STC/SAC-29 27.10.2008	Teleconference		
STC/SAC-30 20.01.2009	Face-to-face	Melbourne	
STC/SAC-31 21.07.2009	Face-to-face	Cairns	Fourth FRDC National Aquatic Animal Health

			Scientific Conference
STC/SAC-32 02.09.2009	Teleconference		
STC/SAC-33 08.12.2009	Face-to-face	Melbourne	
STC/SAC-34 13.05.2010	Face-to-face	Melbourne	
STC/SAC-35 21.07.2010	Face-to-face	Melbourne	
STC/SAC-36 08.09.2010	Teleconference		
STC/SAC-37 09.12.2010	Face-to-face	Melbourne	
STC/SAC-38 16.03.2011	Face-to-face	Melbourne	
STC/SAC-39 05.07.2011	Face-to-face	Cairns	♦First FRDC Australasian Aquatic Animal Health Scientific Conference ♦International ostreid herpesvirus workshop
STC/SAC-40 28.07.2011	Teleconference		
STC/SAC-41 18.10.2010	Teleconference		
STC/SAC-42 16.02.2012	Teleconference		
STC/SAC-43 20.03.2012	Face-to-face	Melbourne	
STC/SAC-44 02.04.2012	Teleconference		

Objective 4: In consultation with key stakeholders (industry and aquatic animal health specialists) develop strategic directions for aquatic animal health R&D

To address this objective, AAHS reviewed, in-house, the R&D Plan on an annual basis with major reviews undertaken in 2009 and 2011 including consultation with major stakeholders (industry and governments). The revisions accounted for 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 NAAH-TWG/SCAAH. Moreover, in conjunction with the 2011 SCAAH Annual Meeting held in Perth, an in-depth workshop was convened to discuss aquatic animal health R&D priorities.

The most recent version of the R&D Plan is attached (Appendix 4).

Objective 5: To disseminate information and results through: a) A biennial scientific conference; b) specialist workshops on topics identified through AAHS business c) Health Highlights Newsletter; d) relevant articles in FRDC News FISH and e) the FRDC website

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

- A Subprogram Newsletter - *Health Highlights* (see Section 1.1)
- Scientific workshops (see Section 1.3)
- Scientific Conferences (see Section 1.2)
- Website (see: http://www.frdc.com.au/research/Animal-Health)
- Formal and informal communication with other Subprograms, FRABs, as needed (see Table 4)
- Use of developed databases (see: http://www.frdc.com.au/research/Animal-Health)

Use was also made of *FRDC R&D News*.

The Subprogram leader (or delegate) represented the AAHS at many meetings, workshops and conferences (see Table 4).

Table 4. Face-to-face meetings attended by the AAH Subprogram Leader

Date	Forum
3-6 August 2008	Australasian Aquaculture 2008, Brisbane, QLD
4-5 March 2009	FRDC Salmon Aquaculture Program Meeting, Launceston, TAS
25 March 2009	Industry Reference Group Meeting, Melbourne, VIC
1-2 April 2009	NAAH-TWG Annual Meeting, Canberra, ACT
11 June 2009	FRDC Board meeting, AAHL, Geelong, VIC
21-24 July 2009	FRDC National Scientific Conference, Cairns, QLD
10-11 March 2010	SCAAH Annual Meeting, Hobart, TAS
6-7 April 2010	FRDC FRAB stakeholder workshop, Canberra, ACT
24-26 May 2010	Australasian Aquaculture 2010, Hobart, TAS
6-8 April 2011	SCAAH Annual Meeting, Perth, WA
5-8 July 2011	FRDC Australasian Scientific Conference, Cairns, QLD
9-10 July 2011	FRDC International OsHV-1 Workshop, Cairns, QLD
29 Feb-2 Mar 2012	SCAAH Annual Meeting, Darwin, NT
29-30 March 2012	FRDC FRAB stakeholder workshop, Canberra, ACT
1-5 May 2012	Australasian Aquaculture 2012, Melbourne, VIC
6-11 May 2012	International Abalone Symposium, Hobart, TAS
15 May 2012	AABERA Workshop planning meeting, Canberra, ACT

In addition, two articles were published in the FRDC News magazine *FISH*:

- "FRDC project team wins Victorian DPI Science Award" FISH December 2010, pg31.
- "Lab leads national disease-detection efforts" FISH December 2011, Pp 34-36.

BENEFITS AND ADOPTION

The AAHS has delivered improved diagnostic capability for a number of priority aquatic animal diseases including nervous necrosis virus, gourami iridovirus, *Streptococcus iniae* and *S. agalactiae* in finfish, *Haplosporidium* infections in pearl oysters, abalone herpesvirus; other AAHS projects addressing other priority aquatic animal diseases, for example *Perkinsus* spp. in mollusks, and infectious myonecrosis in prawns, are on-going (Table 2). Other AAHS projects have been instrumental in providing tools that will enhance aquatic animal disease preparedness and management, for example development of plans and protocols for YTK industry (FRDC Project 2003/649 AAH Subprogram: Industry's emergency preparedness and response to mass mortality of yellowtail kingfish *Seriola lalandi*: Development of plans and protocols) and other training resources (FRDC Project 2008/317: AAH Subprogram: Intensive pathology training workshop for laboratory diagnosticians). AAHS projects have also developed the basis for improving aquatic animal health policy in Australia (e.g. FRDC Project 2006/243 AAH Subprogram: Development of management strategies for herpes-like virus infection of abalone; FRDC Project 2009/072 AAH Subprogram: Risk analysis – Aquatic animal diseases associated with bait translocation).

It is likely that many of the diagnostic tests developed/established during the course of research projects within the AAHS portfolio will form the basis for Australian and New Zealand Standard Diagnostic Procedures (ANZSDPs) to be submitted to Australia's Sub-Committee on Animal Health Laboratory Standards (SCAHLS) for review and publication. ANZSDPs concerned with other aquatic animal diseases and developed following the completion of AAHS projects in previous years are available on the SCAHLS website (http://www.scahls.org.au/procedures/anzsdps2). Furthermore, the research outputs from the abalone herpesvirus projects have gained international attention with the Australian Animal Health Laboratory (AAHL) being established as the OIE Reference Laboratory for "Infection with Abalone Herpesvirus" (http://www.oie.int/fileadmin/Home/eng/Health_standards/aahm/2010/2.4.01_INF_ABALONE.pdf). While AAHL is the nominated reference laboratory, it is recognized that the collaborative team involving research providers from Victoria, Tasmania and South Australia make significant contributions to reference laboratory activities.

The FRDC Aquatic Animal Health Scientific Conferences held on a biennial basis 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 role 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. In 2011, the conference "went international" which was perceived as the next natural step in the evolution of the "Cairns Conference". The international participants truly added value to the 2011 conference and it is anticipated that international participation will increase in the future. Thus, the Cairns Conference is increasing in significance with respect to its standing at the

national, and now international, level as a scientific conference. It is likely that with improved marketing, this conference will grow into one of the major international conferences on aquatic animal health alongside the International Meeting of the European Association of Fish Pathologists (http://eafp.org/) and the International Symposium on Aquatic Animal Health (e.g. http://aquaticpath.phhp.ufl.edu/isaah6/).

The International Workshop on Ostreid herpesvirus, held in Cairns following on from the 2011 AAH Scientific Conference, and made possible with funding from FRDC, brought together industry representatives, research providers and national and international experts to discuss this emerging problem, and to develop plans to address the various issues associated with this virus. The outcome of this workshop was a report that has been made available publicly and is used as the basis for development of future national/international research on the Ostreid herpesvirus (http://www.oysterstasmania.org/news/cairns-2011-final-report-oshv-1-var-international-workshop).

FURTHER DEVELOPMENT

To date, while Australia has been relatively disease-free and suffered few major national emergencies, there are indications that with the anticipated growth in the aquaculture sector the number of new and emerging diseases is likely to increase 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 (AVG) in wild abalone in processing plants (Tasmania)

2008: Mortalities (*Streptococcus* sp.) in (wild) grouper (Queensland)

2008: Kingfish mortalities (Western Australia)

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

2010: Barramundi herpesvirus (Victoria)

2010: AVG in farmed abalone (Tasmania)

2010: Aquabirnavirus in trout (Victoria)

2010/11: Ostreid herpesvirus in Pacific oysters (NSW)

2012: Kingfish mortalities (South Australia)

Moreover, established diseases such as amoebic gill disease and RLO in farmed Atlantic salmon, viral encephalopathy and retinopathy in several finfish species, cyprinid herpesvirus in ornamental fish, and infection with *Perkinsus* in abalone continue to reduce the profitability of the fisheries and aquaculture sector. Viruses that have been present in Tasmanian salmonids (aquabirnavirus and aquareovirus) for over a decade are drawing industry's attention such that projects on vaccine development have been initiated in the FRDC Salmon Aquaculture Program.

In the face of climate change, it is likely that increased temperature stress on farmed temperate species will increase their susceptibility to other infectious agents. Normally non-pathogenic agents may become pathogenic for some host species at the higher temperatures and under conditions of intensive culture (Douglas-Helders et al., 2001; Mitchell and Rodger, 2011).

The presence of these diseases/agents reduces profitability 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. An understanding of the epidemiology of these diseases/agents is required before appropriate management and control measures can be implemented. In the absence of this understanding the implementation of inappropriate control measures can be costly and ineffective. Thus it is important that when new diseases/agents emerge their significance should not be underestimated and basic research should be implemented in an effort to provide an understanding of the biology of these diseases/infectious agents. Thus an AAH Subprogram will be needed even more so in the future to ensure the coordinated delivery and extension of relevant aquatic animal health R&D at the national level.

PLANNED OUTCOMES

The overall planned outcome of the AAH 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 for a number of aquatic animal pathogens including nervous necrosis virus, gourami iridovirus, *Streptococcus iniae* and *S. agalactiae* in finfish, *Haplosporidium* infections in pearl oysters, abalone herpesvirus and other priority aquatic animal diseases on which research is continuing; through development of further resources to enhance the disease emergency management capability of industry and government personnel. Achievement of outcomes addressing AAH priorities identified by industry 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 AAHS STC and SAC structure and their linkages to other bodies involved in aquatic animal health, such as AAHC/AHC, its technical working group NAAH-TWG/Sub-committee on Aquatic Animal Health (SCAAH) and NAAHIRG.

Extension of R&D results was achieved through a proactive communication strategy, with the Subprogram newsletter *Health Highlights* and the FRDC AAHS national and international conferences being the two most effective mechanisms. Preventing duplication of aquatic animal health research is an important reason for the existence of an AAH 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 AAHS is also made aware of some non-FRDC funded research through their networks. The development of a nationally agreed 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 AAH issues included is also attached to calls for pre-research proposals/EoIs each May, and to the May issue of the Subprogram newsletter *Health Highlights*.

CONCLUSION

The AAH Subprogram was established by the FRDC in mid 2001 to provide a cohesive and national approach to aquatic animal health research and development in Australia. The initial term of AAH Subprogram (2001-2004) was partly supported through the Australian Government's Budget Initiative *Building a National Approach to Animal and Plant Health*. This injection of funds supported some fifty collaborative projects in the areas of diagnosis, AQUAVETPLAN manuals and emergency disease planning, and aquatic animal health training. These projects established the AAHS and significantly enhanced Australia's capability to be prepared for, and respond to, aquatic animal disease emergencies.

With this as a background, the AAH Subprogram was renewed for a second (2004-2008) and third (2008-2012) term with a similar remit to the initial term. Thus projects were developed following a consultation process, ensuring relevance while avoiding duplication of the research conducted. The AAH Subprogram's bi-annual newsletter *Health Highlights* reported on progress made in these projects.

The AAH Subprogram R&D Plan 2002-2008 was up-dated and a 2009 version was produced to 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 2009 R&D Plan identified short-term and long-term aquatic animal health R&D priorities and maintains a listing of AAHS projects including both finalised and currently active projects.

The biennial FRDC AAHS Scientific Conferences provide an important forum for Australian (and international) aquatic animal health specialists to meet and discuss current R&D and newly emerging health issues for the fisheries and aquaculture sector (e.g. ostreid herpesvirus). The conferences are open to aquatic animal health specialists, including representatives from industry, governments, universities and other academic institutions and private laboratories whether they are participants in FRDC AAHS projects or not. The conferences play an important part in the communication function of the Subprogram. Not only is a large proportion of the AAHS research portfolio discussed but also the conferences are open to all aquatic animal health specialists and they are invited to present results from non-FRDC funded projects. In this way, linkages to other interested parties such as DAFF, the Aquafin CRC, the university network, commercial companies, and overseas participants with an interest in aquatic animal health were strengthened. 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 is maintained.

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APPENDIX 1: INTELLECTUAL PROPERTY

This project has not developed any intellectual property that requires legal protection.

APPENDIX 2: STAFF

A range of professionals have served the AAHS in various capacities and some have changed their affiliation over the years. The following personnel have made significant contributions to the FRDC AAHS.

Crispian Ashby, Programs Manager, FRDC, Deakin West, ACT

Simon Bennison, Executive Officer, National Aquaculture Council

Gemma Carlile, AAHL Fish Diseases Laboratory, Australian Animal Health Laboratory, CSIRO Livestock Industries, Geelong, VIC

Mark Crane, AAHL Fish Diseases Laboratory, Australian Animal Health Laboratory, CSIRO Livestock Industries, Geelong, VIC 3220

Ingo Ernst, Aquatic Animal Health Unit, DAFF, Canberra, ACT

Justin Fromm, Projects Manager (Research), FRDC, Deakin West, ACT/ Executive Officer, National Aquaculture Council

Brian Jones, Fish Health Unit, WA Fisheries, Perth, WA

Pheroze Jungalwalla, Executive Officer, Tasmanian Salmonid Growers Association, Hobart, TAS/Executive Officer, National Aquaculture Council

Nick Moody, AAHL Fish Diseases Laboratory, Australian Animal Health Laboratory, CSIRO Livestock Industries, Geelong, VIC

Barbara Nowak, Aquafin CRC and University of Tasmania, Launceston, TAS

Joanne Slater, AAHL Fish Diseases Laboratory, Australian Animal Health Laboratory, CSIRO Livestock Industries, Geelong, VIC

Richard Whittington, University of Sydney, Camden, NSW

Nette Williams, AAHL Fish Diseases Laboratory, Australian Animal Health Laboratory, CSIRO Livestock Industries, Geelong, VIC

Jonas Bryce Woolford, Abalone Industry Association of SA/Abalone Management SA Ltd/Wild Catch Fisheries SA

APPENDIX 3: ACRONYMS AND ABBREVIATIONS

AAH	Aquatic animal health
AAHL	Australian Animal Health Laboratory
AAHC	Aquatic Animal Health Committee
AAHS	[FRDC] Aquatic Animal Health Subprogram
ABARE	Australian Bureau of Agricultural and Resource Economics
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AFDL	AAHL Fish Diseases Laboratory
AG-DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
AAHC	Aquatic Animal Health Committee
AHC	Animal Health Committee
ANZSDP	Australian and New Zealand Standard Diagnostic Procedure
APFA	Australian Prawn Farmers Association
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EUS	Epizootic Ulcerative Syndrome
FBI	Federal Budget Initiative *Building a National Approach to Animal and Plant Health*
FRAB	Fisheries Research Advisory Body
FRDC	Fisheries Research and Development Corporation
NAAH-TWG	National Aquatic Animal Health Technical Working Group
NAC	National Aquaculture Council
NNV	Nervous necrosis virus
PI(s)	Principal investigator(s)
R&D	Research and Development
RLO	Rickettsia-like organism
SAC	[AAH Subprogram] Scientific Advisory Committee
SCAAH	[Animal Health Committee] Sub-committee for Aquatic Animal Health
SCAHLS	[Animal Health Committee] Sub-committee for Animal Health Laboratory Standards
STC	[AAH Subprogram] Steering Committee
TSGA	Tasmanian Salmonid Growers Association

APPENDIX 4: R&D PLAN 2009-2012 (UPDATED April 2011)

Australian Government
Fisheries Research and Development Corporation

Aquatic Animal Health Subprogram Research and Development Plan 2009 – 2012 (2011 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

TABLE OF CONTENTS

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 (2009-2012) 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 gill associated virus (GAV) in prawns, infectious hypodermal and haematopoietic necrosis virus (IHHNV) in prawns, *Bonamia* sp. in edible oysters, oedema oyster disease in pearl oysters, and abalone viral ganglioneuritis. This concern over endemic diseases and the lack of surveillance and diagnostic services has already compromised attempts to export live shellfish to the European Union. 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 research 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 about 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 types of 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*. *AQUAPLAN 1998-2003* was a comprehensive document describing initiatives ranging from border controls and import certification through to enhanced veterinary education and improved capacity to manage incursions of exotic diseases. The eight programs described in that plan represented a world first in proactive management of aquatic animal health. *AQUAPLAN 2005-2010* was developed on the basis of stakeholder prioritisation of more specific issues that our aquatic industries were to face during that five year period; it consists of seven discrete strategies:

- Enhanced Integration and Scope of Aquatic Animal Health Surveillance in Australia
- Harmonisation of Approaches to Aquatic Animal Health in Australia
- Enhancement of Aquatic Animal Emergency Disease Preparedness and Response Framework
- Education and Training in the Aquatic Animal Health Sector
- Welfare Standards for Aquaculture
- Appropriate Use of Therapeutics for Aquatic Animal Health Management
- Aquatic Animal Health Management as Part of Ecologically Sustainable Development

Whilst *AQUAPLAN 2005-2010* features seven discrete strategies, there are several themes that are common to all of them, including 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. During the *AQUAPLAN 1998-2003* and *2005-2010* tenures, responsibility for strategic research was embedded within the Aquatic Animal Health Subprogram.

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.

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. Set and review national priorities of aquatic animal health research; and
3. Oversee the communication, extension and adoption of results of 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 species-specific aquaculture subprogram exists[1], these subprograms are responsible for the prioritisation and management of any health

[1]E.g. Atlantic Salmon Aquaculture

related projects involving those specific species. The Subprogram provides advice on these health related projects where necessary.

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

1. Following consultation with the species-specific subprogram an EoI or full application is submitted to the species-specific subprogram which assesses its need and priority.
2. If supported by the species-specific subprogram, the pre-proposal or full application is forwarded to the Subprogram for advice on technical feasibility and merit.
3. The full application should gain support from both subprograms before submission to the FRDC Board for final assessment.
4. If approved, the project is then managed by the species-specific subprogram; the 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 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:* RecFish vacancy
  Pheroze Jungalwalla[2]
  Wild capture vacancy[3]
- *Government Members:* Ingo Ernst[4]
  Brian Jones[5]

[2] National Aquaculture Council
[3] Wild catch fisheries
[4] Aquatic Animal Health Unit, Australian Government Department of Agriculture, Fisheries and Forestry
[5] SCAAH representative, Fish Pathologist, Department of Fisheries, Government of Western Australia

- *FRDC member:* Crispian Ashby
- *Subprogram Leader:* Mark Crane[6]
- *Subprogram Coordinator:* Joanne Slater[6]

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 so that a veterinary perspective, an aquaculture perspective, as well as a government laboratory perspective is obtained.

Amongst the key tasks of the SAC are:

- 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.

SAC members

- Richard Whittington[7]
- Nick Moody[6]
- Barbara Nowak[8]

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):

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

[6] CSIRO Livestock Industries, Australian Animal Health Laboratory, Geelong
[7] Department of Farm Animal Health, Faculty of Veterinary Science, University of Sydney
[8] National Centre for Marine Conservation and Resource Sustainability, University of Tasmania

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 on:
  - ⇒ Research pre-proposals and full project applications received by the Subprogram – informing and seeking comment by FRABs/subprograms;
  - ⇒ Subprogram assessment of research pre-proposals and full applications; and
  - ⇒ Advice sought on health related pre-proposals and full applications submitted to FRABs or other subprograms.

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, or by AHC and SCAAH as a result of *AQUAPLAN 2005-2010*)

C) Assessment of applications

- Determine whether application fits criteria[9] (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* (Subprogram newsletter)
- Scientific workshops (there have been several of these, convened to prioritise and facilitate a national approach to specific R&D problems); in addition the subprogram has sponsored four biennial National FRDC Aquatic Animal Health Conferences at which researchers have been able to present their work.
- Website
- Provide scientific advice and communication to other subprograms and FRABs regarding aquatic animal health research pre-proposals, applications, projects and results
- Databases

[9] See 6.1 below

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 potential 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 stakeholders)
- Addresses R&D needs identified in *AQUAPLAN 2005-2010* or a successor strategy

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

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)
- 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.

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

- Diagnostics for agents of national/international significance including test selection, effects of sample pooling, processing, and (for nucleic acid based tests) effects of nucleic acid extraction and presence of non-target nucleic acid on test results.
- Development of stable, positive control material for use in diagnostic tests

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

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 to support the development of autogenous vaccines for significant production diseases

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

- Support continuing education with particular reference to practising aquatic animal health professionals (through FRDC/DAFF Scholarship Program)
- Support development of national information systems with training functionality (e.g. ABIN), including by capturing training materials in digital form with appropriate instructional design
- Continued support for the Scientific Conference on Aquatic Animal Health and for the Aquatic Animal Health Technical Forum

6.3 The new application (EoI) process

A general guide to developing research proposals for submission to FRDC is provided on the FRDC Website (http://www.frdc.com.au/research/applying-for-funding) 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). 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 2009-2012 reviewed and priorities set.

April: FRDC to review priorities.

May: FRDC to send out general call for EoIs.

30 June: EoIs submitted by PIs to FRDC. AAH 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-June: Full proposal developed for successful EoIs in consultation with stakeholders. 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 2011 a general call for EoIs for projects to commence in 2012 (usually after 1 July 2012) will be sent out by FRDC. In this notice, research providers will be instructed to submit the EoI using FishNET (http://www.frdc.com.au/research/fishnet-for-applicants) by a specific closing date – for AAHS projects this is likely to be 30 June 2011. 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 2011 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 2011. If the AAHS does consider the project a priority it will be clearly stated in the letter together with feedback to assist the PI in preparing a full proposal. FRDC will forward all AAH EoIs to AAHS for comment 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-June 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) Sep 2008.

2002/044: Pilchard herpesvirus infection in wild pilchards (Brian Jones, Fisheries WA) Oct 2006.

2004/084: Investigating and managing the *Perkinsus*-related mortality of blacklip abalone in NSW Phase 1 (Geoff Liggins, NSW DPI) June 2010.

2004/086: Identification and distribution of an intracellular ciliate in pearl oysters (Brian Jones, WA Fisheries) Feb 2009.

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) TBA.

2008/031: Investigation of Chlamydiales-like organisms in pearl oysters, *Pinctada maxima* (Brian Jones, Fisheries WA) TBA.

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) TBA.

2009/032: Characterisation of abalone herpes-like virus infections in abalone (Mark Crane, AFDL) TBA.

2009/075: Determining the susceptibility of remnant populations of abalone previously exposed to AVG (Mark Crane, AFDL) Jan 2012.

2010/034: Investigation of an emerging bacterial disease in wild Queensland gropers, marine fish and stingrays with production of diagnostic and epidemiological tools to reduce the spread of disease to other states of Australia (Rachel Bowater, DEEDI, Qld) TBA.

2011/003: Investigations into the genetic basis of resistance to infection of abalone by the abalone herpes-like virus (Serge Corbeil, AFDL) TBA.

2011/005: Investigation of inclusions in Australian prawns (Melanie Crockford, Fisheries WA) TBA.

2011/053: Pacific oyster mortality syndrome (POMS) – understanding biotic and abiotic environmental and husbandry effects to reduce economic losses (Richard Whittington, U. Sydney) TBA.

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) Nov 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) Mar 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) Jun 2004.

2002/640: Viral Haemorrhagic Septicaemia (VHS) – A Disease Strategy Manual (Paul Hardy-Smith, Panaquatic Health Solutions) Jun 2004.

2002/641: Crayfish plague - disease strategy manual (Fran Stephens, Aquatila Healthcare) Mar 2004.

2002/643: Viral encephalopathy and retinopathy – disease strategy manual (Barry Munday, IDEXX) Dec 2003.

2002/647: Development of the AQUAVETPLAN disease strategy manual for white spot disease of prawns (Chris Baldock, AusVet Services) Mar 2004.

2002/651: Whirling Disease – A Disease Strategy Manual (Paul Hardy-Smith, Panaquatic Health Solutions) Jun 2004.

2002/652: Victoria's arrangements for the management of aquatic animal disease emergencies (Anthony Forster, DPI Vic) Dec 2003.

2002/653: AQUAVETPLAN aquatic disease disinfection manual (Kevin Ellard, Livestock & Aquaculture Veterinary Consulting Services) Mar 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) Mar 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) Jun 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) Mar 2004.

2003/216: Detection and management of yellowtail kingfish (*Seriola lalandi*) health issues (Mark Shepperd, Sakana Vet Services) Oct 2005.

2003/640: Subprogram conference "emergency disease response planning and management" (Mark Crane, AFDL, CSIRO LI) May 2004.

2003/641: Development of the Control Centres Manual for managing aquatic animal disease emergencies in Queensland (Tiina Hawkesford, QDPI&F) Jan 2004.

2003/644: NSW aquatic animal diseases Control Centres Manual (Damian Ogburn, NSW Fisheries) Jun 2004.

2003/648: The revision of the Tasmanian fish health plan and incorporation into the Tasmanian control centre manual (Mary Lou Conway, DPIWE Tas) Mar 2004.

2003/649: Industry's emergency preparedness and response to mass mortality of yellowtail kingfish *Seriola lalandi*: development of plans and protocols (Mark Shepperd, Sakana Vet Services) August 2008.

2003/650: Update of the AQUAVETPLAN Enterprise Manual (semi-open systems) (Jo Sadler) Dec 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) Oct 2006.

2005/620: Development of national investigation and reporting protocols for fish kills in recreational and capture fisheries (Barbara Nowak, U. Tasmania) Jun 2005.

2005/640: Technical guidelines for the translocation of live aquatic animals (Brian Jones, Fisheries WA) Dec 2005.

2006/243: Development of management strategies for herpes-like virus infection of abalone (Mehdi Doroudi, DPI Victoria) May 2009.

2008/354: Tactical Response Fund: Investigating the establishment of a national aquatic animal health industry reference group (Pheroze Jungalwalla, TSGA) Sep 2009.

2009/072: Risk analysis - aquatic animal diseases associated with bait translocation (Ben Diggles, DigsFish) Sep 2011.

2010/036: Improved fish health management for integrated inland aquaculture through Better Management Practices (BMPs) (Tracey Bradley, DPI Victoria) TBA.

2011/046: Tactical Research Fund: Disease risk assessment for abalone stock enhancement program (Richard Stevens, WAFIC) TBA.

7.3 Endemic and exotic aquatic animal disease diagnostics

1999/226: Generation of diagnostic reagents for pilchard herpes virus (Bryan Eaton, AAHL, CSIRO) Jun 2002.

2001/620: Development of improved procedures for the identification of aquatic birnaviruses (Mark Crane, AFDL, CSIRO LI) Apr 2004.

2001/621: Molecular diagnostic tests to detect epizootic ulcerative syndrome (*Aphanomyces invadans*) and crayfish plague (*Aphanomyces astaci*) (Nicky Buller, Agriculture WA) Jun 2004.

2001/624: Development of diagnostic procedures for the detection and identification of *Piscirickettsia salmonis* (Mark Crane (AFDL, CSIRO LI) Apr 2004.

2001/625: Development of diagnostic capability for priority aquatic animal diseases of national significance: Spawner-isolated mortality virus (Leigh Owens, JCU) Apr 2004.

2001/626: Development of diagnostic tests for the detection of nodavirus (Nick Moody, QDPI&F) Aug 2004.

2001/628: Vibrios of aquatic animals: Development of a national standard diagnostic technology (Jeremy Carson, DPIWE Tas) Dec 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) Jun 2003.

2003/620: Establishment of diagnostic expertise for detection and identification of red sea bream iridovirus (RSIV) (Mark Crane, AFDL, CSIRO LI) Jun 2006.

2003/621: Development of diagnostic and reference reagents for epizootic haematopoietic necrosis virus of finfish (Richard Whittington, U. Sydney) Jun 2004.

2003/622: Development of molecular diagnostic expertise for the mollusc pathogen *Bonamia* sp. (Serge Corbeil, AFDL, CSIRO LI) Jun 2004.

2004/086: Identification and distribution of an intracellular ciliate in pearl oysters (Brian Jones, WA Fisheries) Feb 2009.

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) Jun 2007.

2006/064: Development of diagnostic tests to assess the impact of *Haplosporidium* infections in pearl oysters (Philip Nicholls, Murdoch U.) Nov 2009.

2007/006: Development of molecular diagnostic procedures for the detection and identification of herpes-like virus of abalone (*Haliotis* spp.) (Mark Crane, AFDL, CSIRO LI) Nov 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) TBA.

2011/004: Development of improved molecular diagnostic tests for *Perkinsus olseni* in Australian molluscs (Nick Gudkovs, AFDL, CSIRO LI) TBA.

2011/048: Tactical Research Fund: Determining the susceptibility of Australian species of prawns to infectious myonecrosis (Mark Crane, AFDL, CSIRO LI) 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) Jun 2003.

2003/622: Development of molecular diagnostic expertise for the mollusc pathogen *Bonamia* sp. (Serge Corbeil, AFDL, CSIRO LI) Jun 2004.

2006/064: Development of diagnostic tests to assess the impact of *Haplosporidium* infections in pearl oysters (Philip Nicholls, Murdoch U.) Nov 2009.

2007/225: Metazoan parasite survey of selected macro-inshore fish of southeastern Australia, including species of commercial interest (Kate Hutson, U. Adelaide) TBA.

2008/031: Investigation of Chlamydiales-like organisms in pearl oysters, *Pinctada maxima* (Brian Jones, Fisheries WA) TBA.

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) TBA.

2009/044: Surveys of ornamental fish for pathogens of quarantine significance (Joy Becker, U. Sydney) TBA.

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) Feb 2010.

7.6 Training and capacity building

2001/093: Strategic planning, project management and adoption (Eva-Maria Bernoth, DAFF) Jun 2004.

2002/645: Aquatic animal health exotic diseases training manual (Shane Raidal, Murdoch U.) Jun 2004.

2002/654: Development of a training course on exotic diseases of aquatic animals (Ken McColl, AFDL, CSIRO LI) Jun 2004.

2002/655: Design and organisation of a multi-state disease emergency simulation exercise (Iain East, DAFF) Jan 2004.

2002/660: Enhancement of emergency disease management through the education and training of the CCEAD participants on the CCEAD process (Lynda Walker, DAFF) Feb 2004.

2002/664: Aquatic animal health emergency management training and incident simulation (Melanie Ryan, Seafood Training SA) Jun 2004.

2002/666: Training course on exotic diseases of aquatic animals (Mark Crane, AFDL, CSIRO LI) Jun 2004.

2003/642: Revision and expansion of the *Australian Aquatic Animal Disease Identification Field Guide* for publishing to CD-Rom (Alistair Herfort, DAFF) Nov 2004.

2003/645: The development of media tools to increase the awareness of aquatic animal diseases (Wayne Tindall, Big Time Solutions) Aug 2005.

2003/646: Database of diseases and pathogens of Australian aquatic animals (Gustad Boman, F1 Solutions) Jul 2004.

2003/647: Development of a database for Australian laboratory diagnostic expertise for diseases of aquatic organisms (Iain East, DAFF) Mar 2004.

2003/669: Conduct of a multi-jurisdictional simulation exercise focused on health management in Australian aquaculture (Iain East, DAFF) Apr 2004.
2004/079: Strategic planning, project management and adoption (Mark Crane, AFDL, CSIRO LI) Nov 2008.
2005/621: Establishment of a national aquatic animal health diagnostic network (Richard Whittington, U. Sydney) Dec 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) Mar 2007.
2008/039: Strategic planning, project management and adoption (Mark Crane, AFDL, CSIRO LI) TBA.
2008/317: Intensive pathology training wokshop for laboratory diagnosticians (Les Gabor, DPI Victoria) Jul 2010.
2009/315: People development program: scholarship program for enhancing the skills of aquatic animal health professionals in Australia (Jo-Anne Ruscoe, FRDC) TBA.

8 Further information

- **Aquatic Animal Health Subprogram website:**

Go to the FRDC website www.frdc.com.au and follow the links:

Research and Development/Subprograms/Aquatic Animal Health Subprogram

- **Department of Agriculture, Fisheries and Forestry website:** www.daff.gov.au/aquaticanimalhealth
- **Contact Aquatic Animal Health Subprogram:**

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