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An Impact Assessment of FRDC Investment in 2014-001: Aquatic Animal Health Subprogram: Strategic approaches to identifying pathogens of quarantine concern associated with the importation of ornamental fish

Agtrans Research

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In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

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Joy Becker – Associate Professor in Aquatic Animal Health and Production, University of Sydney
Helen Walker – Director Animal Biosecurity, Aquatics, Department of Agriculture and Water Resources

Abbreviations

ABS	Australian Bureau of Statistics
CEBRA	Centre of Excellence for Biosecurity Risk Analysis
CRRDC	Council of Rural Research and Development Corporations
DAWR	Department of Agriculture and Water Resources
FRDC	Fisheries Research and Development Corporation
ISKNV	Infectious Spleen and Kidney Necrosis Virus
KHV	Koi Herpesvirus
MCV	Megalocytivirus
NNV	Nervous Necrosis Virus
OCS	Office of the Chief Scientist
PCR	Polymerase Chain Reaction
RD&E	Research, Development and Extension
SVCV	Spring Viraemia of Carp Virus
VHSV	Viral Haemorrhagic Septicaemia Virus
WTO	World Trade Organisation

Executive Summary

What the report is about

This report presents the results of an impact assessment of a Fisheries Research and Development Corporation (FRDC) investment in strategies to identify pathogens of concern in imported ornamental fish. FRDC funded the project over the period June 2014 to May 2017.

Methodology

The investment in the project was analysed qualitatively within a logical framework that included activities/outputs, outcomes, and impacts. Identified impacts were then categorised into a triple bottom line framework. Principal impacts from those identified were considered for valuation.

Results/key findings

While the project achieved all four of its objectives but due to World Trade Organisation (WTO) rules and the fact that some parasitic agents are already present in Australia, the recommendations from the project have not been able to be implemented. There were no impacts that could be valued from the findings.

Investment Criteria

Funding for the project over the three years totalled $1.44 million in present value terms. The FRDC investment costs were $0.32 million in present value terms. The investment produced no quantifiable benefits.

Conclusions

Due to international trade rules, Department of Agriculture and Water Resources (DAWR) have not used the outputs of the project to strengthen biosecurity. There may be future impacts if Australia has proved itself free from Megalocytivirus (MCV).

Keywords

Impact assessment, cost-benefit analysis, disease freedom, biosecurity, exotic pathogens, infectious spleen, kidney and necrosis virus, Megalocytivirus, nervous necrosis virus

Introduction

The Fisheries Research and Development Corporation (FRDC) required a series of impact assessments to be carried out annually on a number of investments in the FRDC research, development and extension (RD&E) portfolio. The assessments were required to meet the following FRDC evaluation reporting requirements:

- Reporting against the FRDC 2015-2020 RD&E Plan and the Evaluation Framework associated with FRDC's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to FRDC stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).

The first series of impact assessments, that included 20 randomly selected FRDC investments, was completed in August of 2017. The published reports for the first series of evaluations can be found at: http://frdc.com.au/Research/Benefits-of-research/2017-Portfolio-Assessment

The second series of impact assessments also included 20 randomly selected FRDC investments. The investments were worth a total of approximately $5.62 million (nominal FRDC investment) and were selected from an overall population of 96 FRDC investments worth an estimated $21.32 million (nominal FRDC investment) where a final deliverable had been submitted in the 2016/17 financial year.

The 20 investments were selected through a stratified, random sampling process such that investments chosen spanned all five FRDC Programs (Environment, Industry, Communities, People and Adoption), represented approximately 26% of the total FRDC RD&E investment in the overall population (in nominal terms) and included a selection of small, medium and large FRDC investments.

Project 2014-001: *Aquatic Animal Health Subprogram: Strategic approaches to identifying pathogens of quarantine concern associated with the importation of ornamental fish* was selected as one of the 20 investments and was analysed in this report.

General Method

The impact assessments followed general evaluation guidelines that are now well entrenched within the Australian primary industry research sector including Research and Development Corporations, Cooperative Research Centres, State Departments of Agriculture, and some Universities. The approach includes both qualitative and quantitative descriptions that are in accord with the impact assessment guidelines of the CRRDC (CRRDC, 2014).

The evaluation process involved identifying and briefly describing project objectives, activities and outputs, outcomes, and impacts. The principal economic, environmental and social impacts were then summarised in a triple bottom line framework.

Some, but not all, of the impacts identified, were then valued in monetary terms. Where impact valuation was exercised, the impact assessment uses Cost-Benefit Analysis as its principal tool. The decision not to value certain impacts was due either to a shortage of necessary evidence/data, a high degree of uncertainty surrounding the potential impact, or the likely low relative significance of the impact compared to those that were valued. The impacts valued are therefore deemed to represent the principal benefits delivered by the project. However, as not all impacts were valued, the investment criteria reported for individual investments potentially represent an underestimate of the performance of that investment.

Background and Rationale

Background

Ornamental fish imported into Australia are known to carry exotic pathogens. There is the potential for ornamental fish to be released into the environment and be a risk to Australia's water ecosystem and aquaculture production. Aquatic pathogens from imported ornamental fish have been discovered in wild and farmed fish populations. These diseases included Cyprinid herpesvirus 2, *Aeromonas salmonicida*, and *Infectious spleen and kidney necrosis virus*. Determination of the range of infectious agents carried by imported fish is required so that appropriate regulation can be put in place to manage the risk. There has been prior research into exotic pathogens carried by ornamental fish by FRDC. The prior research includes research into imported ornamental fish with the Megalocytivirus (MCV), and infectious spleen and kidney necrosis virus (ISKNV). FRDC Project 2009/044 showed that pre-export and post-arrival quarantine measures were not effective to detect and prevent exotic MCV from entering Australia.

Rationale

This project (2014-001) was developed from the need to acquire new knowledge to support policy reform as the ornamental fish industry advances and known and new pathogens emerge. There was a need to study ornamental fish being imported into Australia to see what exotic pathogens were entering. By analysing ornamental fish imports at quarantine, knowledge gaps would be filled regarding the types of pathogens that enter Australia through ornamental fish and where updates and improvements need to be made.

Project Details

Summary

Project Code: 2014-001

Title: *Aquatic Animal Health Subprogram: Strategic approaches to identifying pathogens of quarantine concern associated with the importation of ornamental fish*

Research Organisation: University of Sydney

Principal Investigator: Joy Becker

Period of Funding: June 2014 – May 2017

FRDC Program Allocation: Environment (100%)

Objectives

The project included four key objectives:

1. Determine if pathogens of potential biosecurity concern on the national list are entering quarantine approved premises in Australia through the trade in ornamental fish
2. Determine if current import conditions for goldfish requiring freedom from specific pathogens are being met
3. Document parasites of potential biosecurity concern that are associated with imported ornamental fish
4. Develop efficient pooled sample strategies for testing imported fish

Logical Framework

Table 1 provides a detailed description of the project in a logical framework.

Table 1: Logical Framework for Project 2014-001

Activities and Outputs	• The project bought 12 large consignments of ornamental fish from nine commercial exporters from five countries with populations defined as a single fish species received from an exporter on a specific day. • Fish were ordered based on the history of known pathogens, current volume of imports, and potential for hosting pathogens. • Twelve consignments of eight marine and 12 freshwater ornamental fish species, were received at the University of Sydney. In total, sixty-two populations of fish were collected. • The fish were tested under quarantine (pre-import) in a biosecure laboratory. • Sampling and testing of the imported fish took place in January, May, and October 2015. • Tissue samples collected from the ornamental fish received were tested for viral pathogens by nucleic acid detection (e.g. polymerase chain reaction (PCR)). • ISKNV was detected in 11 out of the 12 consignments tested with positive results for 24 out of 46 populations of fish tested for MCV. • Nervous Necrosis Virus (NNV) was detected in three of the 23 populations of marine fish that were received. Banggai cardinal fish and Threadfin cardinal fish were the only two species that tested positive. • Seven populations of goldfish tested negative for koi herpesvirus (KHV), spring viraemia of carp virus (SVCV), viral haemorrhagic septicaemia virus (VHSV), and *Aeromonas salmonicida*

	• Four populations of zebrafish tested negative for SVCV and VHSV
	• Three populations of zebra fish and four populations of rosy barb tested negative for *Edwaedsiella ictalurid*.
	• Thirty goldfish from Singapore, Malaysia, and Thailand were examined per consignment, with 210 goldfish tested in total.
	• Goldfish were found to be infested with gill flukes (*Dactylogyrus vastator*). Current import conditions were found not to be effective for the elimination of *Dactylogyrus vastator* in fish imported. Therefore, chemical treatment before importation was not effective in eliminating *Dactylogyrus* species. The project team suggested three reasons why this may be the case. Chemical treatment may not be effective, the appropriate chemical dose was not applied, and/or adult parasite or eggs are resistant to chemical treatment.
	• During three sampling periods in 2015, 990 fish representing 18 species from 33 populations were surveyed for protozoan and metazoan parasites. All 33 populations contained at least one parasite taxon (prevalence was above 10%).
	• Five parasites were found and categorised as a potential risk to Australian aquaculture and native fish due to potential transmission. The high-risk parasites included *Argulus japonicus, Gyrodactylus spp., Trichodina spp., Morphologically distinct myxozoans, Centrocestus formosanus*., and *Trematode metacercaria*.
	• Pool testing was carried out to determine the sensitivity of a quantitative PCR test for MCV. Each pool involved five or ten fish to be tested, with the test of one fish within the pool to be representative of that pool. The pool testing was to enable the researchers to compare individual fish tests to pool testing and to determine effective strategies for testing imported fish for MCV.
	• The project determined that pool testing was only deemed to be feasible if the sample size was above 150 fish. Therefore, pool testing was recommended as a testing procedure on a case by case basis, with pool testing not being suitable for certifying "freedom from infection".
	• The project discovered that the Australian biosecurity regulations for MCV and NNV were not being met. The biosecurity regulations for KHV, SVCV, and VHSV were being met, with no evidence of ornamental fish with these pathogens being imported into Australia.
	• Visual inspection was found not to be effective for screening ornamental fish for parasites and exotic pathogens as there were numerous instances of misidentification by biosecurity personnel.
	• There were several recommendations made because of the project. The main recommendations were:
	  ○ A revision of biosecurity policy, with the revision being aimed at preventing incursions of MCV from marine ornamental fish. This required the application of effective parasite treatment of all ornamental fish being exported to Australia, health certification for ornamental fish to be free from *Argulus japonicus* and *Lernaea cyprinacea* and included import conditions to improve labelling of ornamental fish.
	  ○ Australian ornamental importers should treat transport water and fish for external and internal parasite infections.
	  ○ Factors additional to prevalence and viral load affect the pooled diagnostic sensitivity and need to be explored further as pooled testing cannot be applied empirically for surveillance using PCR assays.
	• The work from this project aided in two university theses and produced six conference abstracts. "The Conversation" article about the dangers of not disposing of pet fish properly mentioned the project.

Outcomes	• There has been no additional batch testing to date by the DAWR, and no additional training of biosecurity staff has taken place. • Due to World Trade Organisation (WTO) rules, DAWR, to date, has not used the recommendations from the project. There may be potential for future use of the

	outputs of the project to improve testing and screening of exotic pathogens in ornamental fish. • To date, there have not been any significant changes because of the project, despite the project successfully achieving the original objectives. There may be changes in biosecurity policy and ornamental fish testing procedures to increase the probability of detecting pests and diseases during importation providing the recommendations are adopted in the future. • If Australia is declared free from MCV, there may be additional import conditions on ornamental fish entering Australia. • There may be a reduced probability of viral outbreak in aquaculture or ornamental fish industries from imported viruses and pathogens from ornamental fish.
Impacts	• Possible reduction in the probability of ornamental fish diseases entering Australia due to better management. • Potential avoided potential losses to ornamental fish businesses and/or hobbyists in Australia through improved biosecurity/quarantine protocols. • Maintained biosecurity reputation for Australia.

Project Investment

Nominal Investment

Table 2 shows the annual investment (cash and in-kind) in project 2014-001 by FRDC, the University of Sydney, and the Centre of Excellence for Biosecurity Risk Analysis (CEBRA).

Table 2: Annual Investment in the Project 2014-001 (nominal $)

Year ended 30 June	FRDC ($)	University of Sydney ($)	CEBRA ($)	TOTAL ($)
2014	49,996	0	0	49,996
2015	36,932	459,510	10,000	506,442
2016	74,941	481,692	0	556,633
2017	87,897	0	0	87,897
Totals	249,766	941,202	10,000	1,200,968

Program Management Costs

For the FRDC investment, the cost of managing the FRDC funding was added to the FRDC contribution for the project via a management cost multiplier (1.122). This multiplier was estimated based on the share of 'employee benefits' and 'supplier' expenses' in total FRDC expenditure (5-year average) reported in the FRDC's Cash Flow Statement (FRDC, 2013-2017). This multiplier then was applied to the nominal investment by FRDC shown in Table 2.

For the University of Sydney and CEBRA investments, it was assumed that program management and administration costs were already included in the nominal amounts shown in Table 2.

Real Investment and Extension Costs

For the purposes of the investment analysis, the investment costs of all parties were expressed in 2017/18 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2018). There are no additional costs of extension, as extension was through published project findings.

There may be additional costs if the recommendations of the project are implemented.

Impacts

Table 3 provides a summary of the principal types of impacts from Table 1 categorised into economic, environmental and social impacts.

Table 3: Triple Bottom Line Categories of Principal Impacts from Project 2014-001

Economic	• Potential avoided potential losses to ornamental fish businesses, hobbyists, and aquaculture in Australia through improved biosecurity/quarantine protocols.
Environmental	• Possible reduction in the probability of ornamental fish diseases entering Australia due to better management.
Social	• Maintained biosecurity reputation for Australia.

Public versus Private Impacts

The impacts valued are both private and public impacts. The primary private impact is a contribution to potentially avoided losses to ornamental fish businesses and aquaculturists through reduction of diseases entering Australia. The primary public impact is the reduction of disease entering Australia infecting native fish and the wider environment.

Distribution of Private Impacts

Any potential private impacts will be distributed to the ornamental fish industry (both businesses and consumers) and aquaculture operators.

Impacts on other Australian industries

There is expected to be no significant impacts to other Australian industries as a result of this project.

Impacts Overseas

No significant impacts to overseas parties are expected.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 4. The project findings and related impacts will contribute primarily to Rural RD&E Priority 2, and to Science and Research Priorities 1 and 2.

Table 4: Australian Government Research Priorities

Australian Government	
Rural RD&E Priorities (est. 2015)	**Science and Research Priorities (est. 2015)**
1. Advanced technology 2. Biosecurity 3. Soil, water and managing natural resources 4. Adoption of R&D	1. Food 2. Soil and Water 3. Transport 4. Cybersecurity 5. Energy and Resources 6. Manufacturing 7. Environmental Change 8. Health

Sources: (DAWR, 2015) and (OCS, 2015)

Valuation of Impacts

Impacts Valued

The project did not produce any quantifiable impacts, so no quantitative evaluation processes were applied to estimate benefits.

Impacts not Valued

The impacts identified in Table 3 were not valued for the following reasons (Table 5):

Table 5: Reasons for Not Valuing Impacts

Impact/Potential Impact	**Reason why Impact Not Valued**
Reduction in the probability of ornamental fish diseases entering Australia due to better management.	DAWR have not used the outputs from the project (Helen Walker, pers. comm., 2018). It is unknown whether Australia will be declared MCV free.
Avoided potential losses to ornamental fish businesses and/or hobbyists in Australia through improved biosecurity/quarantine protocols.	DAWR have not used the outputs from the project (Helen Walker, pers. comm., 2018). There is uncertainty around the outputs being used by DAWR as it is dependent on a number of conditions such as DAWR demonstrating freedom from MCV and ornamental fish imported being free of MCV.
Maintained biosecurity reputation for Australia.	The difficulty of placing a financial value on any contribution

Results

All past costs were discounted to 2017/18 using a discount rate of 5%. All analyses ran for the length of the project investment period plus 30 years from the last year of investment in Project 2014-001 (2015/16).All past costs were discounted to 2017/18 using a discount rate of 5%. All analyses ran for the length of the project investment period plus 30 years from the last year of investment in Project 2014-001 (2016/17).

Investment Criteria

Tables 6 and 7 show the investment criteria estimated for different periods of costs for the total investment and FRDC investment respectively. Note that, as no impacts were valued, the investment criteria reporting is restricted to the Present Value of Costs.

In the interests of consistency with other project analyses and reporting, the Present Value of Costs was reported for the length of the investment period plus for different periods up to 30 years from the last year of investment (2016/17).

Table 6: Investment Criteria for Total Investment in Project 2014-001

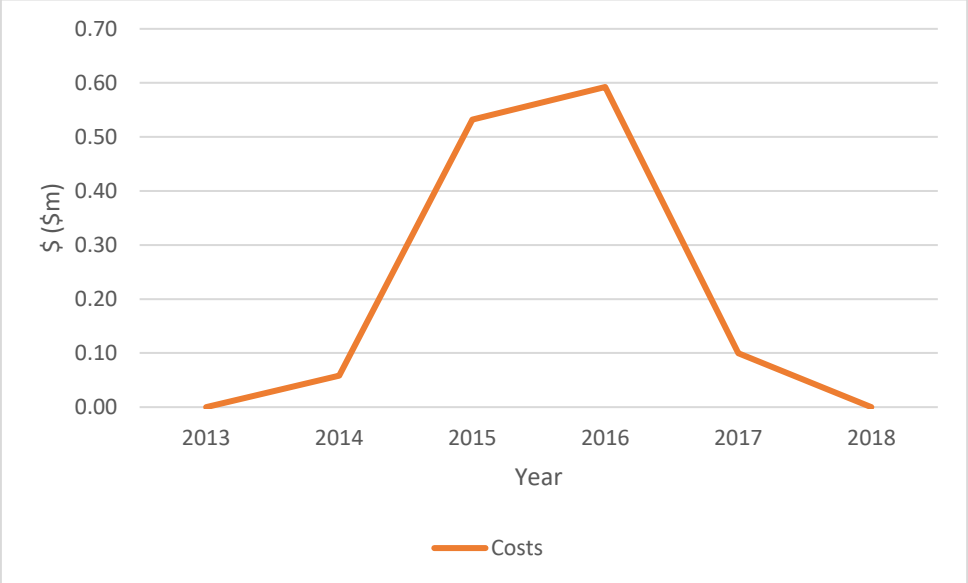
Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Costs ($m)	1.44	1.44	1.44	1.44	1.44	1.44	1.44

Table 7: Investment Criteria for FRDC Investment in the Project Group

Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Costs ($m)	0.32	0.32	0.32	0.32	0.32	0.32	0.32

The annual undiscounted cost cash flow for the total investment for the duration of the investment period is shown in Figure 1.

Figure 1: Annual Cash Flow of Undiscounted Total Investment Costs



Conclusions

Total funding for the investment over the five years totalled $1.44 million in present value terms. The FRDC investment costs were $0.32 million in present value terms.

Due to international trade rules, DAWR have not used the outputs of the project to strengthen biosecurity. There may be future impacts if Australia has proved itself free from MCV.

Glossary of Economic Terms

Cost-benefit analysis:	A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.
Benefit-cost ratio:	The ratio of the present value of investment benefits to the present value of investment costs.
Discounting:	The process of relating the costs and benefits of an investment to a base year using a stated discount rate.
Internal rate of return:	The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.
Investment criteria:	Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.
Modified internal rate of return:	The internal rate of return of an investment that is modified so that the cash inflows from an investment are re-invested at the rate of the cost of capital (the re-investment rate).
Net present value:	The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.
Present value of benefits:	The discounted value of benefits.
Present value of costs:	The discounted value of investment costs.

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