FRDC
FISHERIES RESEARCH & DEVELOPMENT CORPORATION

SUMMARY REPORT

FRDC Annual RD&E Impact Assessment Program 2023: Aggregate Analysis

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FRDC Annual RD&E Impact Assessment Program 2023: Aggregate Analysis, Summary Report
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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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Abbreviations & Acronyms

BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
FRDC	Fisheries Research and Development Corporation
IRR	Internal Rate of Return
M&E	Monitoring and Evaluation
MIRR	Modified Internal Rate of Return
NPV	Net Present Value
NSW	New South Wales
PVB	Present Value of Benefits
PVC	Present Value of Costs
R&D	Research and Development
RD&E	Research, Development, and Extension
RDC	Research and Development Corporation

Introduction

The following summary report presents the evaluation process and findings of an aggregate analysis of six economic evaluations (impact assessments) of research, development, and extension (RD&E) investments carried out for the Fisheries Research and Development Corporation (FRDC) in calendar 2023 for the FRDC 2022/23 Annual Report (FRDC Project 2023-030).

Background

The FRDC undertakes a range of performance reporting across all aspects of its business. FRDC reporting is driven by a range of legislative and mandatory reporting requirements particularly the Primary Industries Research and Development Act 1989 and the Public Governance, Performance and Accountability Act 2013.

Performance reporting also is undertaken at different time intervals ranging from monthly financial statements through to annual whole of agency reporting. FRDC reporting includes:

- Annual Reports
- Investment Impact Assessment (including Cost-Benefit Analysis (CBA)) Reports
- Financial statements
- FRDC Stakeholder Surveys
- Senate Orders
- Reporting under the FRDC's Statutory Funding Agreement with the Commonwealth Government

The FRDC's performance assessment methods aim to:

1. Ensure the FRDC's RD&E investments deliver economic, social and environmental impacts for fishing and aquaculture in Australia.
2. Inform decision making for the FRDC board and other stakeholders when evaluating future RD&E investments.
3. Demonstrate to the Commonwealth Government and investors the benefits of investing in fishing and aquaculture RD&E.
4. Inform the FRDC's extension approach to maximise the adoption by end users.

One key assessment approach undertaken by the FRDC is investment impact assessments (including CBA). Impact assessments typically are commissioned by FRDC annually and encompass evaluation of a number of randomly selected FRDC investments from within the FRDC's RD&E portfolio. ACRE Economics was contracted to complete the annual impact assessments in 2023 under FRDC Project 2023-030.

RDC impact assessment and performance reporting

The annual evaluation program being undertaken by the FRDC also is part of the Council of Rural Research and Development Corporations (CRRDC) work to collaboratively implement a framework of impact assessment and CBA to evaluate RD&E activities.

The FRDC assessment uses the methodology developed by the CRRDCs impact assessment framework which is based on the work of the Department of Finance in *Introduction to Cost-Benefit Analysis and Alternative Evaluation Methodologies* (Commonwealth of Australia, 2006), and subsequent discussions with the Department to refine the methodology.

Generating and documenting evidence of impact and demonstrating performance of the Research and Development Corporations (RDCs) as a collective is also a key objective for the CRRDC (CRRDC, 2018a).

Evaluation Framework

The annual impact assessments of FRDC RD&E investments 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 assessment components that are in accord with the current guidelines for impact assessment published by the CRRDC (CRRDC, 2018b).

The evaluation process utilised an input to impact continuum RD&E project inputs (costs), objectives, activities, and outputs were briefly described and documented. Actual and expected outcomes, and any actual and/or potential future impacts (positive and/or negative) associated with project outcomes then were identified and described. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework and validated through consultation with expert personnel and review of published literature.

Once impacts were identified and validated, an assessment then was made about whether to quantify/value any of the impacts in monetary terms as part of the project-level analysis. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where one or more of the identified impacts were selected for valuation, the impact assessment used CBA as a principal tool. The impacts valued therefore were deemed to represent the principal benefits delivered by the project investment. However, as not all impacts were valued (based on the selection criteria), the investment criteria estimated for the project investment evaluated are likely to represent an underestimate of the true performance of the FRDC project.

The qualitative and quantitative analysis processes, data sources, assumptions, specific valuation frameworks (where applicable), and evaluation results were clearly documented and then integrated into a written report.

Sample Selection

Selection Process

For the 2023 FRDC impact assessments, FRDC selected six RD&E investments (projects) for evaluation. The projects were selected to span the five 'Outcomes' of the FRDC Research and Development (R&D) Plan 2020-2025 (FRDC, 2020a) with an additional project selected for Outcome 1 (Growth for enduring prosperity) where the largest proportion of FRDC investment was allocated. The six selected projects had a total estimated value of $0.69 million (FRDC investment, nominal dollar terms) and were funded over the period 2016/17 to 2020/21.

The sample selected (six projects) comprised a relatively small proportion of the FRDC's total RD&E investment (~5%) in the relevant population and may, therefore, not be fully representative of the entire RD&E Portfolio. However, the projects selected for evaluation provide insight into the activities and outputs associated with each of FRDC's RD&E Programs, and the outcomes and impacts (and benefits) created. In turn, this will enable communication of benefits of FRDC RD&E to the FRDC Board, funding partners including the Commonwealth, industry, and other stakeholders.

The 2023 Evaluation Sample

Table 1 describes the six RD&E projects were selected for evaluation as part of the FRDC evaluation program for 2023.

Table 1: Six FRDC RD&E projects selected for economic evaluation as part of the FRDC's annual evaluation program in 2023 (by Project Code)

Project Code	Project Title	FRDC Investment (nominal $)	Total Investment[(a)] (nominal $)
2016-224	Boosting fisher returns through smart value adding and greater use of underutilised species	95,000	175,000
2016-261	Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry	270,251	295,091
2017-242	Our Pledge: Australian seafood industry response to community values and expectations	153,560	153,560
2018-148	A Stock Assessment Toolbox for Australian Fisheries	84,174	130,193
2018-164	Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved New South Wales (NSW) estuaries	70,000	120,040
2018-205	Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation	20,000	20,000
	Totals	**692,985**	**893,884**

(a) Total cash and in-kind investment from all funding partners, including FRDC investment, presented in nominal dollar terms.

The individual, project-level impact assessments for each of the six selected RD&E projects are presented in Appendix A to F.

Aggregate Results

Overview

The following section presents estimated investment criteria for each of the six FRDC RD&E investments evaluated and for all six investments in aggregate for the 2023 annual FRDC impact assessments. For each set of results, the investment criteria were estimated for the total investment and for the FRDC investment alone. At least one impact was valued in all six of the project-level impact assessment CBAs.

For the purposes of the investment analyses, all past investment cost and benefit cash flows were expressed in 2022/23-dollar terms, inflated using the Implicit Price Deflator for Gross Domestic Product (Australian Bureau of Statistics, 2023). All future benefits and costs also were expressed in 2023/23-dollar terms. All cost and benefit cash flows were discounted to 2022/23 using a discount rate of 5% and using a reinvestment rate of 5% for calculating the Modified Internal Rate of Return (MIRR).

The base analyses used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All individual analyses ran for the length of the project investment period plus 30 years from the last year of investment. The present value of costs (PVC) and present value of benefits (PVB) were used to estimate the investment criteria and include the net present value (NPV), benefit-cost ratio (BCR), internal rate of return (IRR) and MIRR. Definitions for these terms may be found in the Glossary of Economic Terms at the end of this report.

Investment Criteria: Aggregate (all six projects)

Table 2 and Table 3 show the estimated aggregate investment criteria for all six project investments evaluated as part of the 2023 FRDC evaluation program for the total investment and for the FRDC investment respectively.

Table 2: Aggregate investment criteria – total investment (six projects, 5% discount rate)

Aggregate Investment Criteria	Years after last year of aggregate investment						
	0	5	10	15	20	25	30
PVB ($m)	0.13	1.24	3.43	4.96	5.24	5.35	5.43
PVC ($m)	1.52	1.52	1.52	1.52	1.52	1.52	1.52
NPV ($m)	-1.39	-0.28	1.90	3.44	3.71	3.83	3.90
BCR	0.09	0.82	2.25	3.26	3.44	3.51	3.56
IRR (%)	negative	negative	10.3	12.8	13.0	13.1	13.1
MIRR (%)	negative	3.5	9.5	10.3	9.6	9.0	8.5

Note: differences between the aggregate investment criteria reported (Table 2) and the project-level investment criteria (Table 4) are due to small rounding errors.

Table 3: Aggregate investment criteria – FRDC investment (six projects, 5% discount rate)

Aggregate Investment Criteria	Years after last year of aggregate investment						
	0	5	10	15	20	25	30
PVB ($m)	0.13	1.15	3.05	4.36	4.55	4.63	4.67
PVC ($m)	1.22	1.22	1.22	1.22	1.22	1.22	1.22
NPV ($m)	-1.09	-0.08	1.82	3.13	3.33	3.40	3.45
BCR	0.11	0.94	2.49	3.56	3.72	3.78	3.82
IRR (%)	negative	negative	11.9	14.2	14.4	14.4	14.4
MIRR (%)	negative	4.5	10.1	10.7	9.9	9.2	8.7

Note: differences between the aggregate investment criteria reported (Table 3) and the project-level investment criteria (Table 5) are due to small rounding errors.

Investment Criteria: by Project

Table 4 (total investment) and Table 5 (FRDC investment) show the estimated investment criteria by individual project for the 2023 FRDC evaluation program. The individual, project-level impact assessments for each of the six selected RD&E projects are presented in Appendix A to F.

Table 4: Investment criteria by project (total investment, 30 years, 5% discount rate)

Project Code	Project Title	PVB ($m)	PVC ($m)	NPV ($m)	BCR	IRR (%)	MIRR (%)
2016-224	Boosting fisher returns through smart value adding and greater use of underutilised species	0.46	0.31	0.15	1.47	8.2	6.4
2016-261	Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry	3.12	0.54	2.58	5.78	31.9	11.8
2017-242	Our Pledge: Australian seafood industry response to community values and expectations	0.78	0.26	0.52	3.01	35.8	9.2
2018-148	A Stock Assessment Toolbox for Australian Fisheries	0.60	0.20	0.40	3.07	29.0	9.1
2018-164	Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries	0.39	0.18	0.20	2.08	4.0	7.5
2018-205	Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation	0.09	0.03	0.05	2.60	302.8	13.8

Table 5: Investment criteria by project (FRDC investment, 30 years, 5% discount rate)

Project Code	Project Title	PVB ($m)	PVC ($m)	NPV ($m)	BCR	IRR (%)	MIRR (%)
2016-224	Boosting fisher returns through smart value adding and greater use of underutilised species	0.27	0.18	0.09	1.47	8.2	6.4
2016-261	Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry	2.89	0.50	2.39	5.78	31.9	11.8
2017-242	Our Pledge: Australian seafood industry response to community values and expectations	0.78	0.26	0.52	3.01	35.8	9.2
2018-148	A Stock Assessment Toolbox for Australian Fisheries	0.41	0.13	0.28	3.07	29.0	9.1
2018-164	Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries	0.24	0.12	0.12	2.06	3.9	7.5
2018-205	Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation	0.09	0.03	0.05	2.60	302.8	13.8

FRDC RD&E Leverage Ratios

Leverage ratios for the FRDC RD&E investment were estimated at a project-level and aggregate level (all six projects) for the 2023 evaluation program. Leverage was calculated as the ratio non-FRDC investment to FRDC investment in undiscounted, real dollar terms. Table 6 shows the leverage ratios by project and for the aggregate investment.

The aggreagte leverage ratio across all six RD&E projects evaluated for the 2023 evaluation program was estimated to be 0.25. That is, for every dollar that FRDC invested in the six projects, funding partners contributed 0.25 dollars. Leverage ratios for the individual project investments ranged from zero (two projects: 2017-242 and 2018-205, where FRDC was the sole funder) to 0.71 (project 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*).

Table 6: Leverage ratios by project

Project Code	**Project Title**	**Leverage Ratio**
2016-224	Boosting fisher returns through smart value adding and greater use of underutilised species	0.71
2016-261	Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry	0.08
2017-242	Our Pledge: Australian seafood industry response to community values and expectations	0.00
2018-148	A Stock Assessment Toolbox for Australian Fisheries	0.46
2018-164	Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries	0.60
2018-205	Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation	0.00
	Aggregate Leverage Ratio	**0.25**

Discussion

At the individual project level, at least one impact for all six RD&E investments subjected to assessment in the 2023 evaluation program was valued in monetary terms. The total investment across all six individual RD&E projects (from all sources) ranged from $0.03 million (project 2018-205) to $0.54 million (project 2016-261) (present value terms) with FRDC contributions ranging from 58.3% (project 2016-224) to 100% (projects 2017-242 and 2018-205) of the real undiscounted total investment in each project.

Estimated benefits for each project ranged from $0.09 million (project 2018-205) to $3.12 million (project 2016-261) (present value terms). The weighted average BCR across all six projects was approximately 3.56 to 1 and the simple average BCR was approximately 3.00 to 1.

In the aggregate analysis for the 2023 FRDC evaluation program, total funding from all sources across all six RD&E project investments totalled $1.52 million (present value terms) with FRDC funding totalling $1.22 million (present value terms).The aggregate investment produced estimated total expected benefits of $5.43 million (present value terms). This gave an NPV of $3.90 million, a weighted average BCR of 3.56 to 1, an IRR of 13.1%, and an MIRR of 8.5%.

All aggregate investment criteria were positive from a period of ten years after the last year of investment (2020/21) indicating that positive aggregate benefits were delivered from the investments over a relatively moderate timeframe. The aggregate leverage ratio for the six projects evaluated, defined as the ratio of investment from non-FRDC sources to FRDC investment, was estimated to be 0.25. That is, for every dollar that FRDC invested in the six projects, funding partners contributed 0.25 dollars. Leverage ratios for the individual project investments ranged from zero (two projects: 2017-242 and 2018-205, where FRDC was the sole funder) to 0.71 (project 2016-224).

The 2023 aggregate results were generally consistent with similar results from past FRDC evaluations (FRDC project 2016-134) that reported aggregate BCRs between 2.94 and 7.5 to 1. The 2023 FRDC evaluation program aggregate results also were consistent with reported average returns reported for agricultural RD&E of between 3.5 and 5.5 to 1 (Agtrans Research; AgEconPlus; and EconSearch, 2016; Agtrans Research, 2019; CSIRO, 2021).

The positive results for the 2023 FRDC evaluation program should be viewed positively by FRDC, funding partners including the Commonwealth Government, fisheries and aquaculture industries, and other policy personnel responsible for allocation of public funds, and other stakeholders.

Recommendations

The following recommendations were reproduced from the final report of FRDC project 2016-134 (*Evaluation of FRDC RD&E projects completed in years ending June 2016 to June 2020, 2019/20 FRDC Evaluation Sample (Year 5): Aggregate Summary Report*).

As part of a continuous improvement process, the impact assessment project team assess the evaluation process at the end of each year to identify areas for improvement and to make any reasonable recommendations, to be considered by FRDC management personnel, for any subsequent evaluations of FRDC RD&E investments. The following recommendations were made within this context.

Recommendation 1: Develop, integrate, and implement an impact-specific monitoring and evaluation (M&E) framework

The FRDC has adopted the Commonwealth input/output/outcome/impact reporting framework. The Australian Department of Finance has determined that the FRDC's organisational outcome is '*Increased economic, social and environmental benefits for Australian fishing and aquaculture, and the wider community, by investing in knowledge, innovation, and marketing*'. The FRDC's performance is measured against its ability to deliver this outcome. To report organisation-level performance, FRDC maintains a monitoring and evaluation (M&E) framework that supports the current FRDC RD&E Plan[1] (FRDC, 2020b).

The current RD&E Plan and associated M&E framework cover the 2020-25 period. The current M&E framework includes a description of the key processes and tools that FRDC implements to measure the organisations impact and performance of its RD&E investments. Key M&E tools for the evaluation and reporting of FRDC performance are described as (FRDC, 2020):

- Cost-benefit analyses
- Non-market valuation
- Social survey tools

The FRDC M&E Framework further states that FRDC will undertake economic assessment of all project clusters that are funded to deliver the R&D Plan 2020-25. FRDC is required to report the results of its impact assessments in its annual reporting to the Australian Government and other stakeholders. Hence, a performance report (including impact assessment based on completed projects) is required by 30 June each year until 2026.

It is recommended that FRDC commission a suitably qualified economic consultant to develop an impact-specific M&E framework that addresses the measurement and reporting of specific RD&E impact information and data at a project, program, and organisational-level. This impact M&E framework then would be integrated with the M&E tools used to demonstrate FRDC's performance under the broader FRDC M&E Framework.

An impact M&E framework integrated with the current FRDC M&E framework would be designed to ensure that expected and actual RD&E outcomes and impacts were identified, reported, and measured more comprehensively and accurately and would improve implementation of cost-benefit analyses, non-market valuation, and social survey tools used by FRDC to measure and report performance.

Recommendation 2: Improve communication of project-level M&E requirements for impacts

FRDC includes information on its website, and in other researcher communications, that describes the organisation's RD&E project application, evaluation, and approval processes (for example: https://frdc.com.au/project-evaluation).

[1] FRDC RD&E Plan 2020-25: http://rdplan.frdc.com.au/; FRDC 2020-25 M&E Framework: (see: https://www.frdc.com.au/sites/default/files/inline-files/Approved%20Monitoring%20and%20Evaluation%20Framework%202020-25.pdf)

It is recommended that FRDC undertake a review of current RD&E application, approval, and reporting requirements to assess and potentially improve project-level M&E processes that provide information and data used in FRDC impact assessments and other performance reporting.

The potential improvements may include communications items such as (subject to completion of the recommended review):

- A statement about the FRDC's annual impact assessment program on the FRDC website to ensure researchers are aware that their project may be subjected to impact assessment in the future and that they would be requested to provide input to the impact assessment process.
- A statement about the FRDC's annual impact assessment program in RD&E investment Decision Notification Letters to inform the project team of potential future evaluation processes.
- Information about the FRDC's annual impact assessment program and/or project-level outcome and impact measurement and reporting requirements included in RD&E project applications and/or final reporting guidelines to encourage researchers to consider evidence of outcomes and impacts as part of their RD&E project planning and reporting processes.
- Inclusion of new/improved terms in FRDC project agreements that address project personnel providing input to future RD&E evaluation processes associated with their project.

Improving researcher awareness and understanding of the FRDC's annual impact assessment processes and requirements would improve researcher engagement with the impact assessment/evaluation process and support better future estimation of the actual and expected outcomes and impacts of FRDC RD&E investments.

Recommendation 3: Develop an ex-ante impact assessment and CBA framework/ tool

It is recommended that FRDC commission a suitably qualified economic consultant to develop an ex-ante impact assessment and cost-benefit analysis framework and/or tool that could be used internally by FRDC personnel and/or researchers to identify and estimate the potential outcomes and impacts of new RD&E.

Such an ex-ante framework or tool would support:

1. Development of appropriate impact assessment/cost-benefit analysis frameworks for subsequent ex-post evaluations of FRDC RD&E investment(s),
2. Identification of information/ data gaps associated with RD&E pathways to impact/ impact assessment,
3. Improved monitoring, evaluation, reporting and improvement processes,
4. Demonstration and estimation of potential impacts of important/high value RD&E that could:
    a. Facilitate improved effectiveness and/or efficiency of FRDC RD&E resource allocation,
    b. Enable improved prioritisation and decision-making for marginal RD&E investments, and
    c. Encourage co-investment and/or collaboration and increased adoption of key RD&E outputs.
5. Development of a baseline and framework against which future ex-post impact assessments could be conducted and compared.

The ex-ante framework/tool could be designed for various levels of detail, depending on FRDC requirements and resources, to support project, program and/or portfolio level decision making and best management practise from a RD&E resource allocation perspective.

For example, a Microsoft Excel® based ex-ante impact and CBA tool could be developed where RD&E applicants input preliminary estimated impact data (based on evidence or other rationale) according to simple instructions within the tool. The tool then would provide estimated investment criteria that could be included in project applications to demonstrate the potential impacts and value of the project to FRDC decision-makers. The key impact data could then be updated at the end of the project, or several years after the project, to compare actual performance with expected performance.

Similar ex-ante assessment tools currently are used by similar organisations for best practice resource allocation, monitoring, evaluation, and reporting including the Grains RDC, Meat & Livestock Australia, and some Cooperative Research Centres.

Future Evaluation RD&E Opportunities

The following evaluation opportunities were reproduced from the final report of FRDC project 2016-134 (*Evaluation of FRDC RD&E projects completed in years ending June 2016 to June 2020, 2019/20 FRDC Evaluation Sample (Year 5): Aggregate Summary Report*).

In 2018, an independent performance review of FRDC was conducted by Forest Hill Consulting. The review concluded that FRDC is a well-managed, high-performing organisation and that there is good evidence of the delivery of benefits to levy payers, Government, and other investors from FRDC investments. The review also identified several areas where improvements might be made. Ten specific recommendations were listed. One such recommendation was:

> *"10. FRDC should develop and implement with its impact assessment provider a project to assess willingness-to-pay studies of environmental attributes of fishery resources and externalities arising from aquaculture as input into future assessments of the environmental impacts of FRDC's Environment Program. After completion of the review, FRDC committed to commissioning its external provider (currently Agtrans Research) to undertake work to improve the non-market valuation of FRDC RD&E impacts."*

To address this recommendation, in 2020 FRDC commissioned Agtrans Research to undertake Project 2019-091: *Non-Market Impact Valuation for Fisheries RD&E – Phase I: An Investigation and Gap Analysis of Non-Market Impact Valuation Studies for Australian Fisheries and Aquaculture RD&E*. The study was the first stage (assessment of WTP studies) of a process to assess and compile relevant, publicly available, non-market impact valuation studies for potential use in future FRDC RD&E impact assessments. The study also provides an assessment of the major gaps in the available non-market information related to the environmental and social impacts of fisheries RD&E to inform and prioritise potential future WTP studies.

The 2020 study (Thomy, Hardaker, Chudleigh, & Binney, 2020) produced a database[2] of non-market valuation literature applicable to the evaluation of FRDC RD&E and identified key areas where quantification of impacts would be valuable and provided information on the methods that could be used to achieve this. The areas identified included:

- Value of fisher satisfaction,
- Contribution of fish habitat to carbon sequestration and storage,
- Willingness to pay for maintenance of biodiversity and/or ecosystem conservation,
- Willingness to pay for fish welfare, particularly farmed fish,
- Industry stakeholders' WTP for improvements to human health and wellbeing, and
- Social equity and maintained or enhanced social capital for fishers and fishing communities.

FRDC currently is at the mid-point of the organisation's 2020-25 RD&E Plan and will likely have another independent performance review in the future. It would be timely for FRDC to consider funding/co-funding projects to address the fisheries economics and evaluation RD&E opportunities presented for Phase II of Project 2019-091.

[2] The accompanying database from the 2020 study can be found at: https://www.frdc.com.au/project/2019-091

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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Appendices

Appendix A: An Impact Assessment of Investment in FRDC Project 2016-224

Acknowledgments

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Principal investigator Ewan Colquhoun, Ridge Partners was contacted to review the working draft.

Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
DPI	Department of Primary Industries
FRDC	Fisheries Research and Development Corporation
GVP	Gross Value of Production
IRR	Internal Rate of Return
NSW	New South Wales
PVB	Present Value of Benefits
RD&E	Research, Development and Extension
RDC	Research and Development Corporation

Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) Project 2016-224: *Boosting Fisher Returns through Smart Value-Adding and Greater Use of Underutilised Species*. The assessment was completed as part of a cost-benefit analysis for inclusion in the FRDC 2022-23 Annual Report. The assessment was made up of six FRDC projects.

The impact assessment 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 assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations.

Project 2016-224 was to boost the returns to commercial wild-catch fishers on Australia's east coast by:

- Increasing the legal harvest and use of underutilised species; and
- Increasing fishers' margins and returns through selective value-adding.

The investment has led to a range of potential economic and social impacts. Importantly, Project 2016-224 contributed to:

- A potential increase in commercial fisher profit from Group A species – Royal Red Prawns, Australian Sardine, and Gould's Squid.
- A potential increase in supply chain profit from adding value to Group A species.
- A potential increase in regional employment in east coast fisheries.
- Increased industry and researcher capacity in relation to underutilised seafood species.
- Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and value-adding businesses.
- Potentially, some contribution to maintained food security with respect to the access to, availability of, and use of seafood resources

Total funding for the Project was $0.31 million (present value terms) and produced total expected net benefits of $0.46 million (present value terms). This produced an estimated net present value of $0.15 million, a benefit-cost ratio of 1.5 to 1, an internal rate of return (IRR) of 8.2%, and a modified IRR of 6.4% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2016-224. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

Introduction

The Fisheries Research and Development Corporation (FRDC) required a series of cost-benefit analyses of selected RD&E investments (projects) for inclusion in the FRDC 2022/23 Annual Report. The assessments were completed to contribute to the following FRDC evaluation reporting requirements:

- Reporting against the FRDC 2020-2025 RD&E Plan and the Evaluation Framework associated with FRDC's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to FRDC funding partners and other stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).
- Reporting RD&E impact and performance to FRDC levy payers and other fisheries and aquaculture stakeholders as well as the broader Australian community.

In August 2023, FRDC commissioned ACRE Economics Pty Ltd and associates to undertake cost-benefit analyses (CBAs) of six RD&E projects. The projects were selected to span the five 'Outcomes' of the FRDC Research and Development (R&D) Plan 2020-2025 with an additional project selected for Outcome 1 (Growth for enduring prosperity) where the largest proportion of FRDC investment was allocated. The six selected projects had a total estimated value of $0.69 million (FRDC investment, nominal dollar terms) and were funded over the period 2016/17 to 2020/21.

The sample selected (six projects) comprises a relatively small proportion of the FRDC's total RD&E investment (~5%) of the relevant population and may, therefore, not be fully representative of the entire RD&E Portfolio. However, the projects evaluated provide insight into the activities and outputs associated with each of FRDC's RD&E Programs, and the outcomes and impacts (and benefits) created. In turn, this will enable communication of benefits of FRDC RD&E to the FRDC Board, funding partners including the Commonwealth, industry, and other stakeholders.

The six projects selected by FRDC for evaluation in calendar 2023 were:

1. 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*
2. 2016-261: *Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry*
3. 2017-242: *Our Pledge: Australian seafood industry response to community values and expectations*
4. 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*
5. 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*
6. 2018-205: *Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*

This report presents the assessment process and findings for Project 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*.

Evaluation Framework

The annual impact assessments of FRDC RD&E investments 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 assessment components that are in accord with the current guidelines for impact assessment published by the CRRDC (CRRDC, 2018).

The evaluation process utilised an input to impact continuum RD&E project inputs (costs), objectives, activities, and outputs were briefly described and documented. Actual and expected outcomes, and any actual and/or potential future impacts (positive and/or negative) associated with project outcomes then were identified and described. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework and validated through consultation with expert personnel and review of published literature.

Once impacts were identified and validated, an assessment then was made about whether to quantify/value any of the impacts in monetary terms as part of the project-level analysis. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where one or more of the identified impacts were selected for valuation, the impact assessment used cost-benefit analysis (CBA) as a principal tool. The impacts valued therefore were deemed to represent the principal benefits delivered by the project investment. However, as not all impacts were valued (based on the selection criteria), the investment criteria estimated for the project investment evaluated are likely to represent an underestimate of the true performance of the FRDC project.

The qualitative and quantitative analysis processes, data sources, assumptions, specific valuation frameworks (where applicable), and evaluation results were clearly documented and then integrated into a written report.

Project Background

Background

Greater use of Australia's underutilised commercial fisheries will benefit the Australian seafood industry by increasing commercial fisher productivity and profit as well as employment in regional areas. It will also reduce Australia's reliance on imported seafood.

Rationale for Project 2016-224

The FRDC RD&E Strategy notes that there is potential to increase the productivity and profitability of commercial fisheries by reducing or finding new ways of using waste; capitalising on under-valued, under-utilised or bycatch species; making harvest strategies more effective; rebuilding stocks; value adding and by improving market access and accreditation. Under-utilised species are present in both east coast Commonwealth and state fishery waters.

In 2001, the Queensland Department of Primary Industries (DPI) completed a study (FRDC 1999/347) identifying under-utilised seafood species suitable for export to growing consumer markets in Asia. Many species and markets identified in the DPI study remain under supplied. This project was to address these opportunities with a strong focus on boosting economic and competitive circumstances.

Project Details

Summary

Project Code: 2016-224
Title: *Boosting Fisher Returns through Smart Value-Adding and Greater Use of Underutilised Species*
Research Organisation: Ridge Partners
Principal Investigator: Ewan Colquhoun
Period of Funding: July 2016 to June 2020
FRDC Program Allocation: Adoption 50%, Industry 50%

Objectives

The specific objectives of project 2016-224 were to provide:

1. A demonstration to Australian fishers and enterprises of the increase in the harvest of underutilised yield in selected Australian fisheries.
2. A demonstration to Australian fishers of significant and sustainable increase in the returns to selected Australian fishermen from fishery yield growth and innovative value-adding.
3. A demonstration to Australian fishers of increased utilisation, yield, and margin of seafood product into value-added formats for new consumer markets.

Logical Framework

Table A1: Logical Framework for FRDC Project 2016-224

Activities	• Scoping of the research project with Sydney Fish Market, seafood processor Pacific West, the NSW Professional Fishers' Association, and the Australian Fisheries Management Authority. • Review of an initial list of 132 underutilised wild caught commercial species and the selection of 11 representative east coast Target Utilisation Species for in-depth investigation. All 11 species were currently harvested on a commercial basis. • Completion of project consultation with fishers, cooperatives, wholesalers, and related parties to collate knowledge and test stakeholder motivation to invest in change. • For each Target Utilisation Species desktop research was completed to document the relevant species, its attributes as a seafood, market drivers, processing procedures, product formats, value-adding research requirements, market prices and returns, export and import trade, drivers of underutilisation, and opportunities for increased utilisation. • Analysis revealed gaps in both critical knowledge and industry capacity. • Three species (Royal Red Prawn, Australian Sardines, and Gould's Squid – Group A) were found to offer potential for volume and value gains for fishers. Trials were developed to improve (i) landed product quality, (ii) product upgrades, (iii) transition from bait to consumer markets, and (iv) transition from bulk commodity seafood into consumer seafood products with supporting packaging, presentation, and promotion. • Six species (Silver Trevally, Blue Mackerel, Yellowtail Scad, Luderick, Ocean Jacket, and Sea Mullet – Group B) offer attractive commercial returns from both volume and value gains. However, at the end of the project these species had not attracted sufficient support to advance a demonstration trial. • Two species (Ribbon Fish, and Catfish/Cobbler – Group C) have not been fully assessed for volume or value-adding potential. There is insufficient information available on these species to test their commercial worth. • Commercial proponents for the Group A species were engaged by the project team to develop trials that integrated a range of market leverage objectives.

Outputs	• Commercial entities willing to trial the repositioning of Group A species (Royal Red Prawn, Australian Sardines, and Gould's Squid).
Outcomes	• A potential increase in the value of Group A species. • Increased awareness of opportunities in relation to underutilised seafood species.
Impacts (potential)	• A potential increase in commercial fisher profit from Group A species. • A potential increase in supply chain profit from adding value to Group A species. • A potential increase in regional employment in east coast fisheries. • Increased industry and researcher capacity in relation to underutilised seafood species. • Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and value-adding businesses. • Potentially, some contribution to maintained food security with respect to the access to, availability of, and use of seafood resources.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2016-224 by FRDC and other contributors. Other investors included Pacific West and Sydney Fish Market.

Table A2: Total Investment in FRDC Project 2016-224
(nominal dollar terms)

Year ended 30 June	FRDC ($)	Others ($)	Total ($)
2017	50,000	40,000	90,000
2018	45,000	40,000	85,000
Totals	**95,000**	**80,000**	**175,000**

Source: FRDC project 2016-224 documentation

Management and Administration 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 (x1.179). This multiplier was estimated based on a five-year average of the ratio of total FRDC cash expenditure to project expenditure reported in the FRDC's Cash Flow Statement (FRDC Annual Reports, 2018-2022). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of 1.00 was used for administration and management costs for other contributors.

Real Investment and Extension Costs

For the purposes of the impact analysis, the investment costs of all parties were expressed in 2022/23-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2023).

The cost of trials to reposition Group A species plus investment in supporting packaging, presentation, and promotion are required to realise potential project impacts.

Impacts

Table 3 provides a summary of the principal types of potential impacts from project 2016-224. Impacts have been taken from those listed in Table 1 and categorised using a triple bottom line framework into economic, environmental, and social impact types.

Table A3: Principal Potential Impact Types from Investment in FRDC Project 2016-224

Economic	• A potential increase in commercial fisher profit from Group A species. • A potential increase in supply chain profit from adding value to Group A species.
Environmental	• Nil
Social	• A potential increase in regional employment in east coast fisheries. • Increased industry and researcher capacity in relation to underutilised seafood species. • Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and value-adding businesses. • Potentially, some contribution to maintained food security with respect to the access to, availability of, and use of seafood resources.

Public versus Private Impacts

Both public and private potential impacts were identified for the project. Private impacts may be delivered through a potential increase in commercial fisher and supply chain profit from underutilised Group A species. Public impacts are likely to be delivered through increased industry and researcher capacity and spillover benefits from more profitable fishing and supply chain businesses.

Distribution of Private Impacts

Private impacts from the investment in project 2016-224 will accrue to commercial fishers and the supply chain. Supply chain beneficiaries will include fish cooperatives, wholesalers, fish processors, exporters, retailers, and consumers. The share of benefit retained by each member of the supply chain will depend on both short- and long-term supply and demand elasticities.

Impacts on Other Australian Industries

No direct impacts to other Australian industries beyond fishing and the seafood supply chain were identified.

Impacts Overseas

Trade may be impacted by the adoption of project research, with greater utilisation of Group A species, there may be a displacement of seafood imports and increased sales of Australian seafood to other countries.

In addition, the principle and approaches used for better utilisation of under-valued seafood species may be applicable to the fishing industries of other countries. This information on improved utilisation might be exchanged between fishing industries through the literature and participation in international conferences.

Match with National Priorities

Australian Agriculture, Science, and Research Priorities

The Australian Government's National Science and Research Priorities and Agricultural Innovation Priorities are reproduced in Table 4. Project 2016-224 contributed to National Science and Research Priorities 1 and 2. The project also contributed to Agricultural Innovation Priority 1.

Table A4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities[3]	**National Agricultural Innovation Priorities[4]**
1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. **2. Soil and Water** – improving the use of soils and water resources, both terrestrial and marine. **3. Transport** – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. **4. Cybersecurity** – improving cybersecurity for individuals, businesses, government, and national infrastructure. **5. Energy and Resources** – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia's resources industries. **6. Manufacturing** – supporting the development of high value and innovative manufacturing industries in Australia. **7. Environmental Change** – mitigating, managing, or adapting to changes in the environment. **8. Health** – improving the health outcomes for all Australians.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia's agricultural innovation system to address by 2030. These priorities replace the Australian Government's Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. **1.** Australia is a trusted exporter of premium food and agricultural products by 2030. **2.** Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. **3.** Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. **4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

FRDC National RD&E Priorities

Through extensive consultation, the FRDC 2020-2025 RD&E Plan identified five key outcome areas. The five outcome areas were:

1. Growth for enduring prosperity.
2. Best practices and production systems.
3. A culture that is inclusive and forward thinking.
4. Fair and secure access to aquatic resources.
5. Community trust, respect, and value.

Project 2016-224 addressed outcome areas 1 and 2.

[3] Source: 2015 Australian Government *Science and Research Priorities*. https://www.industry.gov.au/data-and-publications/science-and-research-priorities.

[4] Source: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment.

Valuation of Impacts

The decision to value an impact identified in Table 3 was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Impacts Valued

A single potential impact of investment in project 2016-224 was valued – increase in commercial fisher profit from Group A species.

Valuation of Impact 1: Increase in commercial fisher profit from Group A species

Project research has identified an opportunity to reposition Group A species – Royal Red Prawn, Australian Sardine, and Gould's Squid as consumer products rather than bait. The final project report identifies potential volumes and values of these species that are available for the creation of new consumer products. Using this information, the potential increase in gross returns to commercial fishers has been estimated – Table 5.

Table A5: Potential Gain in Commercial Fisher Gross Returns for Underutilised Group A Species

Underutilised Group A species	**Beach price as consumer product ($/kg) (A)**	**Beach price as bait ($/kg) (B)**	**Net increase in beach price ($/kg) (A-B)**	**Additional volume available (tonnes)**	**Potential increase in gross returns ($).**
Royal Red Prawn	$20.00	$10.00	$10.00	300	$3.00 million
Australian Sardine	$3.40	$2.00	$1.40	5,000	$7.00 million
Gould's Squid	$3.50	$2.00	$1.50	700	$1.05 million
Total					**$11.05 million**

Source: Adapted from Colquhoun 2020. NB: beach price as bait estimated by impact assessment analyst.

The potential gain in gross returns for underutilised Group A species represents an upper bound for quantification of impact 1. It is unlikely that all of the additional volume available will be caught and fishers will incur additional costs in catching and managing Group A species for human consumption.

Additional assumptions for the valuation of the impact are reported in Table 6.

Impacts Not Valued

The impacts not valued included:

- A potential increase in supply chain profit from adding value to Group A species. Data on supply chain business costs and returns pre and post the addition of new products was not available to the impact assessment.
- A potential increase in regional employment in east coast fisheries. Estimation requires Input-Output modelling that was not part of this impact assessment.
- Increased industry and researcher capacity in relation to underutilised seafood species. Detailed study of both industry and research knowledge changes and their application is needed to estimate this benefit.
- Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and value-adding businesses. Estimation requires Input-Output modelling that was not part of this impact assessment.
- Potentially, some contribution to maintained food security with respect to the access to, availability of, and use of seafood resources

Summary of Assumptions

Table 6 describes the specific assumptions used in the valuation of impacts.

Table A6: Summary of Assumptions for the Valuation of Impact 1

Impact 1: Increase in commercial fisher profit from Group A species		
Variable	**Assumption**	**Source**
Potential increase in gross returns for commercial fishers from repositioning Group A species if all additional catch is taken and value-added.	$11.05 million/year.	Table 5 above.
Share of additional Group A catch that is taken by commercial fishers and value-added.	50%.	Analyst assumption – not all the available resource will be targeted and caught.
Profit on additional Group A catch that is taken by commercial fishers and subsequently value-added for human consumption.	40%.	Analyst assumption – additional costs will be incurred by commercial fishers managing Group A species for human consumption including catch technique, labour, and post-harvest care.
First year value-added Group A products are available to Australian and Asian consumers.	2024/25.	Project completed 2019/20, product development trials completed 2023/24, and supply chain commercial adoption commences 2024/25.
Period of impact – that is thenumber of years the new value-added products remain in the market.	20 years (2043/44 is last year of impact)	Analyst assumption – consumer tastes change, and new products are required.
Attribution of impact to this project.	20%.	Analyst assumption – other studies have reviewed value-adding potential.
Risk Factors		
Probability of output	100%	Group A species identified, and commercial trials agreed.
Probability of outcome	50%	Product trials based on Group A species are incomplete.
Probability of impact	50%	Market acceptance of potential new value-added products is unknown.
Counterfactual		
It is assumed that the benefits attributable to this investment are 50% likely to have occurred in the absence of FRDC investment. This may have occurred via seafood processor investment in value-adding underutilised Group A species.		

Results

All past costs and benefits were expressed in 2022/23-dollar terms. All costs and benefits were discounted to 2022/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2017/18) to the final year of benefits assumed.

Investment Criteria

Tables 7 and 8 show the investment criteria estimated for different periods of benefits for the total investment and FRDC investment respectively. The present value of benefits (PVB) for the FRDC investment was estimated by multiplying the total PVB cash flow by the proportion of FRDC investment in real, undiscounted dollar terms (58.3%).

Table A7: Investment Criteria for Total Investment in Project 2016-224

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.00	0.00	0.06	0.24	0.38	0.46	0.46
Present value of costs ($m)	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Net present value ($m)	-0.31	-0.31	-0.25	-0.07	0.07	0.14	0.15
Benefit-cost ratio	0.00	0.00	0.19	0.76	1.24	1.46	1.47
Internal rate of return (%)	negative	negative	negative	1.0	6.7	8.1	8.2
MIRR (%)	negative	negative	negative	2.0	6.1	6.7	6.4

Table A8: Investment Criteria for FRDC Investment in Project 2016-224

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.00	0.00	0.03	0.14	0.22	0.27	0.27
Present value of costs ($m)	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Net present value ($m)	-0.18	-0.18	-0.15	-0.04	0.04	0.08	0.09
Benefit-cost ratio	0.00	0.00	0.19	0.76	1.24	1.46	1.47
Internal rate of return (%)	negative	negative	negative	1.0	6.7	8.1	8.2
MIRR (%)	negative	negative	negative	2.0	6.1	6.7	6.4

The annual undiscounted benefit and cost cash flows for the total investment for the duration of investment period plus 30 years from the last year of investment are shown in Figure 1.

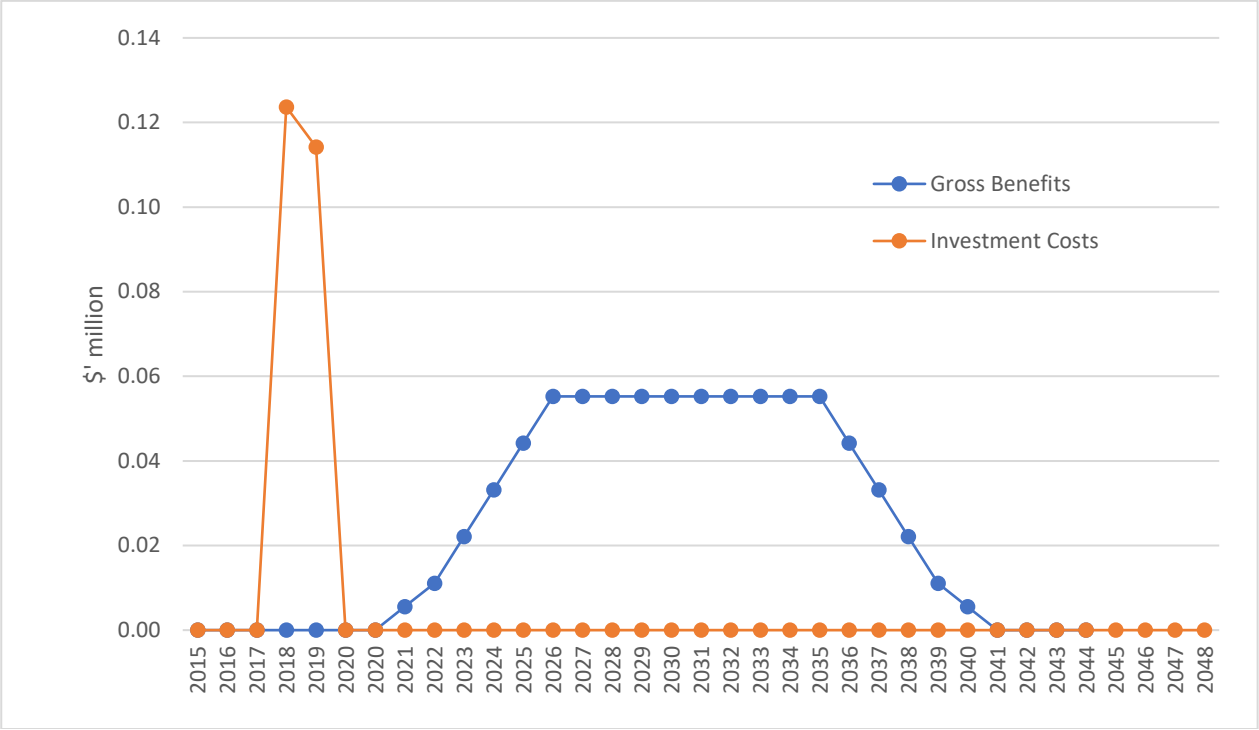

Figure A1: Annual Cash Flow of Undiscounted Total Benefits and Total Costs

Sensitivity Analyses

Sensitivity analyses were performed for variables that were considered (a) key drivers of the investment criteria, and/or (b) uncertain. Each sensitivity analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

A sensitivity analysis was carried out on the discount rate. The results, shown in Table 9, showed sensitivity to the discount rate. This was largely due to the benefit cash flows occurring well into the future and therefore being subject to relatively more severe discounting. At the 10% discount rate project costs exceed project benefits.

Table A9: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	**Discount rate**		
	0%	**5% (base)**	**10%**
Present value of benefits ($m)	0.78	0.46	0.29
Present value of costs ($m)	0.24	0.31	0.40
Net present value ($m)	0.55	0.15	-0.12
Benefit-cost ratio	3.30	1.47	0.71

A sensitivity analysis then was carried out on the assumed share of additional Group A catch taken by commercial fishers for value-adding. Table 10 shows the results. The investment criteria are sensitive to changes in this assumption. If only 25% of available catch is value added with higher prices received by fishers, then project costs exceed project benefits.

Table A10: Sensitivity to the Share of Additional Catch Taken for Value-Adding
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Share of Additional Catch Taken for Value-Adding		
	25%	50% (base)	100%
Present value of benefits ($m)	0.23	0.46	0.92
Present value of costs ($m)	0.31	0.31	0.31
Net present value ($m)	-0.08	0.15	0.60
Benefit-cost ratio	0.74	1.47	2.94

A final sensitivity analysis was undertaken on the increase in commercial fisher profit needed for project investment to breakeven. The results, presented in Table 11, show that commercial fisher profit would need to be at least 27% on catch destined for value-adding if project benefits were to exceed project costs.

Table A11: Sensitivity to the Increase in Profit Realised by Fishers for Catch Taken for Value-Adding
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Commercial Fisher Profit on Catch for Value-Adding		
	27%	40% (base)	60%
Present value of benefits ($m)	0.31	0.46	0.69
Present value of costs ($m)	0.31	0.31	0.31
Net present value ($m)	0.00	0.15	0.38
Benefit-cost ratio	0.99	1.47	2.21

Confidence Rating and Other Findings

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 12). The rating categories used are High, Medium, and Low, where:

- High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
- Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
- Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table A12: Confidence in Analysis of Investment

Coverage of Benefits	Confidence in Assumptions
Medium	Medium

The coverage of benefits was assessed as Medium. The impact valued was deemed to be the most important from the investment.

Confidence in assumptions was rated as Medium. Many of the valuation assumptions were underpinned by credible data. However, because the investment was only recently completed, there was no evidence of actual outcomes and impacts. This meant that a number of the assumptions used in the valuation were uncertain.

Conclusions

Documenting underutilised species' attributes and value-added opportunities builds shared knowledge but does not catch more fish (Colquhoun 2020). There are multiple reasons why shifting Group A species product position from bait to human consumption may not work. However, a valuable foundation has been laid by Project 2016-224 investment.

The investment has led to a range of potential economic and social impacts. Importantly, Project 2016-224 contributed to:

- A potential increase in commercial fisher profit from Group A species.
- A potential increase in supply chain profit from adding value to Group A species.
- A potential increase in regional employment in east coast fisheries.
- Increased industry and researcher capacity in relation to underutilised seafood species.
- Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and value-adding businesses.
- Potentially, some contribution to maintained food security with respect to the access to, availability of, and use of seafood resources

Total funding for the Project was $0.31 million (present value terms) and produced total expected net benefits of $0.46 million (present value terms). This produced an estimated net present value of $0.15 million, a benefit-cost ratio of 1.5 to 1, an internal rate of return (IRR) of 8.2%, and a modified IRR of 6.4% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2016-224. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

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Appendix B: An Impact Assessment of Investment in FRDC Project 2016-261

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Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ACPF	Australian Council of Prawn Fishers
APFA	Australian Prawn Farmers Association
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
FRDC	Fisheries Research and Development Corporation
GVP	Gross Value of Production
IRR	Internal Rate of Return
MSC	Marine Stewardship Council
NSW	New South Wales
PVB	Present Value of Benefits
RD&E	Research, Development and Extension
RDC	Research and Development Corporation

Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) Project 2016-261: *Investigating the Use of Trace Element Profiles to Substantiate Provenance for the Australian Prawn Industry*. The assessment was completed as part of a cost benefit analysis for inclusion in the FRDC 2022/23 Annual Report. The assessment was made up of six FRDC RD&E projects.

The impact assessment 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 assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations.

Project 2016-261 research has delivered a scientifically robust, legislatively supported method of establishing the provenance of Australian prawns. With this technology in place, prawn fishers and farmers will have access to a tool to deter substitution and protect the price premium Australian product enjoys in both domestic and export markets.

The investment has led to a range of potential economic and social impacts. Importantly, Project 2016-261 contributed to:

- Protection of the price premium realised by Australian prawn fishers and farmers for their product (i.e., avoided income loss).
- Increased researcher capacity in relation to trace element profiling and its application to food provenance.
- Improved regional community wellbeing through spillover benefits from more productive and profitable prawn fishing and farming businesses.
- Potential increase in consumer trust for Australian prawn products.

Total funding for the Project was $0.54 million (present value terms) and produced total expected net benefits of $3.12 million (present value terms). This produced an estimated net present value of $2.58 million, a benefit-cost ratio of 5.8 to 1, an internal rate of return (IRR) of 31.9%, and a modified IRR of 11.8% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2016-261. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

Introduction

The Fisheries Research and Development Corporation (FRDC) required a series of cost benefit analyses of selected RD&E investments (projects) for inclusion in the FRDC 2022/23 Annual Report. The assessments were completed to contribute to the following FRDC evaluation reporting requirements:

- Reporting against the FRDC 2020-2025 RD&E Plan and the Evaluation Framework associated with FRDC's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to FRDC funding partners and other stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).
- Reporting RD&E impact and performance to FRDC levy payers and other fisheries and aquaculture stakeholders as well as the broader Australian community.

In August 2023, FRDC commissioned ACRE Economics Pty Ltd and associates to undertake cost-benefit analyses (CBAs) of six RD&E projects. The projects were selected to span the five 'Outcomes' of the FRDC Research and Development (R&D) Plan 2020-2025 with an additional project selected for Outcome 1 (Growth for enduring prosperity) where the largest proportion of FRDC investment was allocated. The six selected projects had a total estimated value of $0.69 million (FRDC investment, nominal dollar terms) and were funded over the period 2016/17 to 2020/21.

The sample selected (six projects) comprises a relatively small proportion of the FRDC's total RD&E investment (~5%) of the relevant population and may, therefore, not be fully representative of the entire RD&E Portfolio. However, the projects evaluated provide insight into the activities and outputs associated with each of FRDC's RD&E Programs, and the outcomes and impacts (and benefits) created. In turn, this will enable communication of benefits of FRDC RD&E to the FRDC Board, funding partners including the Commonwealth, industry, and other stakeholders.

The six projects selected by FRDC for evaluation in calendar 2023 were:

1. 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*
2. 2016-261: *Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry*
3. 2017-242: *Our Pledge: Australian seafood industry response to community values and expectations*
4. 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*
5. 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*
6. 2018-205: *Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*

This report presents the assessment process and findings for Project 2016-261: *Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry.*

Evaluation Framework

The annual impact assessments of FRDC RD&E investments 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 assessment components that are in accord with the current guidelines for impact assessment published by the CRRDC (CRRDC, 2018).

The evaluation process utilised an input to impact continuum RD&E project inputs (costs), objectives, activities, and outputs were briefly described and documented. Actual and expected outcomes, and any actual and/or potential future impacts (positive and/or negative) associated with project outcomes then were identified and described. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework and validated through consultation with expert personnel and review of published literature.

Once impacts were identified and validated, an assessment then was made about whether to quantify/value any of the impacts in monetary terms as part of the project-level analysis. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where one or more of the identified impacts were selected for valuation, the impact assessment used cost-benefit analysis (CBA) as a principal tool. The impacts valued therefore were deemed to represent the principal benefits delivered by the project investment. However, as not all impacts were valued (based on the selection criteria), the investment criteria estimated for the project investment evaluated are likely to represent an underestimate of the true performance of the FRDC project.

The qualitative and quantitative analysis processes, data sources, assumptions, specific valuation frameworks (where applicable), and evaluation results were clearly documented and then integrated into a written report.

Project Background

Background

In 2015 industry stakeholders from the Australian Council of Prawn Fishers (ACPF) and the Australian Prawn Farmers Association (APFA) identified the potential for the “Love Australian Prawns” campaign to be undermined by the practice of unscrupulous operators substituting Australian prawns with lower value product.

Rationale for Project 2016-261

Therefore, it was proposed that, to support the national marketing strategy, a rapid and robust scientific method should be developed to verify geographical provenance.

The trace metal authentication methods used by other primary production industries represented a possible opportunity to prove provenance. Should the technology prove suitable, a detailed and effective communication strategy (aligned with the “Love Australian Prawns” distribution channels) was considered mandatory to ensure whole of chain knowledge of the capability as well as demonstrate how the knowledge could be applied to manage product integrity issues.

A project to investigate this technology, funded as FRDC 2016-261 (Investigating the Use of Trace Element Profiles to Substantiate Provenance for the Australian Prawn Industry) was subsequently supported.

Project Details

Summary

Project Code: 2016-261
Title: *Investigating the Use of Trace Element Profiles to Substantiate Provenance for the Australian Prawn Industry*
Research Organisation: Curtin University of Technology
Principal Investigator: Dr Janet Howieson
Period of Funding: September 2019 to January 2021
FRDC Program Allocation: Communities 25%, Industry 75%

Objectives

The specific objectives of project 2016-261 were to:

1. Investigate and pilot a cost-effective, legally enforceable method to establish the provenance of prawns and ensure robust identification of source harvest areas for the Australian prawn industry.
2. Investigate and confirm with stakeholders how the method can be used as a basis for preventing / discouraging the substitution currently impacting the "Love Australian Prawns" national strategy and other accreditation/branding initiatives (e.g., MSC Certification).
3. Communicate the outcomes of project results to supply chain partners and regulators and evaluate such that it can be shown that they are aware that such a method exists and how it can be used to manage product integrity.

Logical Framework

Table B1: Logical Framework for FRDC Project 2016-261

Activities	Stage 1: Proof of concept: • A steering committee was formed that included FRDC, ACPF and APFA. • The steering committee sought legal advice to underpin the project including definitions around different types of food substitution/misrepresentation, the regulatory implications of food substitution in each Australian jurisdiction, frameworks needed for enforcement, and the standard of evidence required to support the scientific method. • Face-to-face consultation was completed with industry, distributors, retailers, and enforcement agencies to determine the level of support for the proposed approach and support was secured from these stakeholders. • A prawn sampling program was trialled based on a "chain of custody" protocol and aligned documentation was developed by a forensic laboratory. • In 2016/17, 120 prawn samples were collected, collated, and stored under the protocol. • An expression of interest process was executed in 2018 to select a suitable laboratory for Stage 2 analytical work and Source Certain International was selected. • The final report for Stage 1 of the project was reviewed by the ACPF and APFA Boards who subsequently agreed to take the project to Stage 2. Stage 2: Database construction and extension: • An assessment of ACPF and APFA production areas resulted in the delineation of 35 wild harvest sources and 19 farmed prawn sources for the project.

	• Between 2016 and 2019, 273 wild harvest and 136 farmed prawn samples were collected and forwarded to Source Certain International for analysis and inclusion in the project database. • Prawn sample analysis resulted in a statistically robust ability to separate prawns by fishery and by farm. • The ability of the test protocol and prawn sample database to establish provenance was established via an in-market exercise in mid-2019. • Project partners have subsequently worked together on commercialisation and extension of the tools. • Commercial wild-catch and farmed prawn businesses, retailers, and third-party certification bodies have expressed interest in accessing the technology and the database. Final decisions on commercialisation and extension will be guided by the project's overarching goal of protecting the provenance of Australian prawns. • Throughout the project, information on progress and ultimate project success was communicated via industry fora and media channels. This communication activity culminated with the announcement of proven capacity to establish Australian prawn provenance by the Federal Assistant Minister for Forestry and Fisheries, Jonathon Durham at an event attended by more than 80 prawn industry stakeholders in Melbourne in October 2019.
Outputs	• A scientifically robust, legislatively supported method of establishing the provenance of Australian prawns. This method has been widely communicated to industry and potential unscrupulous operators who may otherwise be tempted to substitute low-cost alternatives for Australian prawns. Project researchers won a national seafood R&D award for this project.
Outcomes	• Protection of the reputation and associated price premium for Australian prawns.
Impacts (potential)	• Protection of the price premium realised by Australian prawn fishers and farmers for their product (i.e., marketing advantage, consumer confidence, and avoided income loss). • Increased researcher capacity in relation to trace element profiling and its application to food provenance. • Improved regional community wellbeing through spillover benefits from more productive and profitable prawn fishing and farming businesses. • Potential increase in consumer trust in Australian prawn products.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2016-261 by FRDC and other contributors.

Table B2: Total Investment in FRDC Project 2016-261
(nominal dollar terms)

Year ended 30 June	FRDC ($)	Others ($)	Total ($)
2017	55,000	4,800	59,800
2018	171,800	20,000	191,800
2019	43,451	0	43,451
Totals	**270,251**	**24,800**	**295,051**

Source: FRDC project 2016-261 documentation

Management and Administration 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 (x1.179). This multiplier was estimated based on a five-year average of the ratio of total FRDC cash expenditure to project expenditure reported in the FRDC's Cash Flow Statement (FRDC Annual Reports, 2018-2022). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of 1.00 was used for administration and management costs for other contributors.

Real Investment and Extension Costs

For the purposes of the impact analysis, the investment costs of all parties were expressed in 2022/23-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2023).

The cost of extension to maintain stakeholder awareness of the tool along with ongoing update of the provenance database is required to secure potential project impacts over the long term.

Impacts

Table 3 provides a summary of the principal types of potential impacts from project 2016-261. Impacts have been taken from those listed in Table 1 and categorised using a triple bottom line framework into economic, environmental, and social impact types.

Table B3: Principal Potential Impact Types from Investment in FRDC Project 2016-261

Economic	• Protection of the price premium realised by Australian prawn fishers and farmers for their product (i.e., marketing advantage, consumer confidence, and avoided income loss).
Environmental	• Nil
Social	• Increased researcher capacity in relation to trace element profiling and its application to food provenance. • Improved regional community wellbeing through spillover benefits from more productive and profitable prawn fishing and farming businesses. • Potential increase in consumer trust for Australian prawn products.

Public versus Private Impacts

Both public and private potential impacts were identified for the project. Private impacts may be delivered through protection of the price premium received by Australian prawn fishers and farmers. Public impacts are likely to be delivered through increased researcher capacity and spillover benefits from more profitable fishing and farming businesses.

Distribution of Private Impacts

Private impacts from the investment in project 2016-261 will accrue to prawn fishers, prawn farmers and their associated supply chains. Supply chain beneficiaries will include fish cooperatives, wholesalers, processors, exporters, retailers, and consumers. The share of benefit retained by each member of the supply chain will depend on both short- and long-term supply and demand elasticities.

Impacts on Other Australian Industries

No direct impacts to other Australian industries beyond prawn fishing, prawn farming and their associated supply chains were identified. However, it is possible that capacity developed as part of the project may be used to develop systems to establish provenance in other Australian primary industries. There is also potential for increased overall trust in Australian seafood product provenance.

Impacts Overseas

Implementation of a system that proves the provenance of Australian prawns will provide overseas consumers with confidence in the quality of the product they are buying and consuming.

Match with National Priorities

Australian Agriculture, Science, and Research Priorities

The Australian Government's National Science and Research Priorities and Agricultural Innovation Priorities are reproduced in Table 4. Project 2016-261 contributed to National Science and Research Priority 1. The project also contributed to Agricultural Innovation Priorities 1 and 3.

Table B4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities[5]	**National Agricultural Innovation Priorities**[6]
1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. **2. Soil and Water** – improving the use of soils and water resources, both terrestrial and marine. **3. Transport** – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. **4. Cybersecurity** – improving cybersecurity for individuals, businesses, government, and national infrastructure. **5. Energy and Resources** – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia's resources industries. **6. Manufacturing** – supporting the development of high value and innovative manufacturing industries in Australia. **7. Environmental Change** – mitigating, managing, or adapting to changes in the environment. **8. Health** – improving the health outcomes for all Australians.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia's agricultural innovation system to address by 2030. These priorities replace the Australian Government's Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. **1.** Australia is a trusted exporter of premium food and agricultural products by 2030. **2.** Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. **3.** Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. **4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

[5] Source: 2015 Australian Government *Science and Research Priorities*. https://www.industry.gov.au/data-and-publications/science-and-research-priorities.

[6] Source: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment.

FRDC National RD&E Priorities

Through extensive consultation, the FRDC 2020-2025 RD&E Plan identified five key outcome areas. The five outcome areas were:

1. Growth for enduring prosperity.
2. Best practices and production systems.
3. A culture that is inclusive and forward thinking.
4. Fair and secure access to aquatic resources.
5. Community trust, respect, and value.

Project 2016-261 addressed outcome areas 1, 2, 3 and 5.

Valuation of Impacts

The decision to value an impact identified in Table 3 was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Impacts Valued

A single potential impact of investment in project 2016-261 was valued – protection of Australian prawn price premiums with proven provenance.

Valuation of Impact 1: Protection of Australian prawn price premium

Project research has delivered a scientifically robust, legislatively supported method of establishing the provenance of Australian prawns. With this technology in place, prawn fishers and farmers have access to a tool that will deter substitution and protect the premium Australian product enjoys in both domestic and export markets.

Specific assumptions used to value this impact are reported in Table 5.

Impacts Not Valued

The impacts not valued included:

- Increased researcher capacity in relation to trace element profiling and its application to food provenance. Detailed study of changes in researcher knowledge and their application would be needed to make an estimate this benefit.
- Improved regional community wellbeing through spillover benefits from more productive and profitable prawn fishing and farming businesses. Estimation requires Input-Output modelling that was not part of this impact assessment.

Summary of Assumptions

Table 5 describes the specific assumptions used in the valuation of impacts.

Table B5: Summary of Assumptions for the Valuation of Impact 1

Impact 1: Protection of Australian prawn price premium		
Variable	**Assumption**	**Source**
Australian wild-catch and farmed prawn value.	$506 million/year.	ABARES 2021.
Price premium available to prawn fishers and farmers for Australian provenance.	10%.	Analyst assumption including premiums available in export markets.
Risk in price premium loss with substitution of low-cost product for Australian prawns pre-project.	10% (A)	Analyst assumption.
Risk of price premium loss post-project.	5% (B)	Analyst assumption.
Reduction in risk attributable to the project.	5%	(A) minus (B).
First year of impact.	2023/24.	Commercial partners and active testing program in place 5 years after project completion.
Period of impact.	15 years (2037/38 is last year of impact).	Analyst assumption – trace element testing to substantiate provenance replaced with new technology after this time.
Attribution of impact to this project.	50%.	Analyst assumption – a previous study (a MSc completed by Charlene Tan, Uni WA, 2013) had already determined prawn trace element profiling was feasible.
Risk Factors		
Probability of output.	100%	Project has delivered a testing regime and supporting database.
Probability of outcome.	60%	Commercialisation of technology not yet in place.
Probability of impact.	60%	Other factors may erode price premium e.g., Australian prawn contamination incident.
Counterfactual		
It is assumed that the benefits estimated and attributable to the investment in FRDC Project 2016-261 would not have occurred without the investment.		

Results

All past costs and benefits were expressed in 2022/23-dollar terms. All costs and benefits were discounted to 2022/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2018/19) to the final year of benefits assumed.

Investment Criteria

Tables 6 and 7 show the investment criteria estimated for different periods of benefits for the total investment and FRDC investment respectively. The present value of benefits (PVB) for the FRDC investment was estimated by multiplying the total PVB cash flow by the proportion of FRDC investment in real, undiscounted dollar terms (92.7%).

Table B6: Investment Criteria for Total Investment in Project 2016-261

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.04	1.28	2.75	3.12	3.12	3.12
Present value of costs ($m)	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Net present value ($m)	-0.54	-0.50	0.74	2.21	2.58	2.58	2.58
Benefit-cost ratio	0.00	0.08	2.37	5.10	5.78	5.78	5.78
Internal rate of return (%)	negative	negative	22.4	31.3	31.9	31.9	31.9
MIRR (%)	negative	negative	18.0	19.8	16.1	13.5	11.8

Table B7: Investment Criteria for FRDC Investment in Project 2016-261

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.04	1.19	2.55	2.89	2.89	2.89
Present value of costs ($m)	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Net present value ($m)	-0.50	-0.46	0.69	2.05	2.39	2.39	2.39
Benefit-cost ratio	0.00	0.08	2.37	5.10	5.78	5.78	5.78
Internal rate of return (%)	negative	negative	22.4	31.3	31.9	31.9	31.9
MIRR (%)	negative	negative	18.0	19.8	16.1	13.5	11.8

The annual undiscounted benefit and cost cash flows for the total investment for the duration of investment period plus 30 years from the last year of investment are shown in Figure 1.

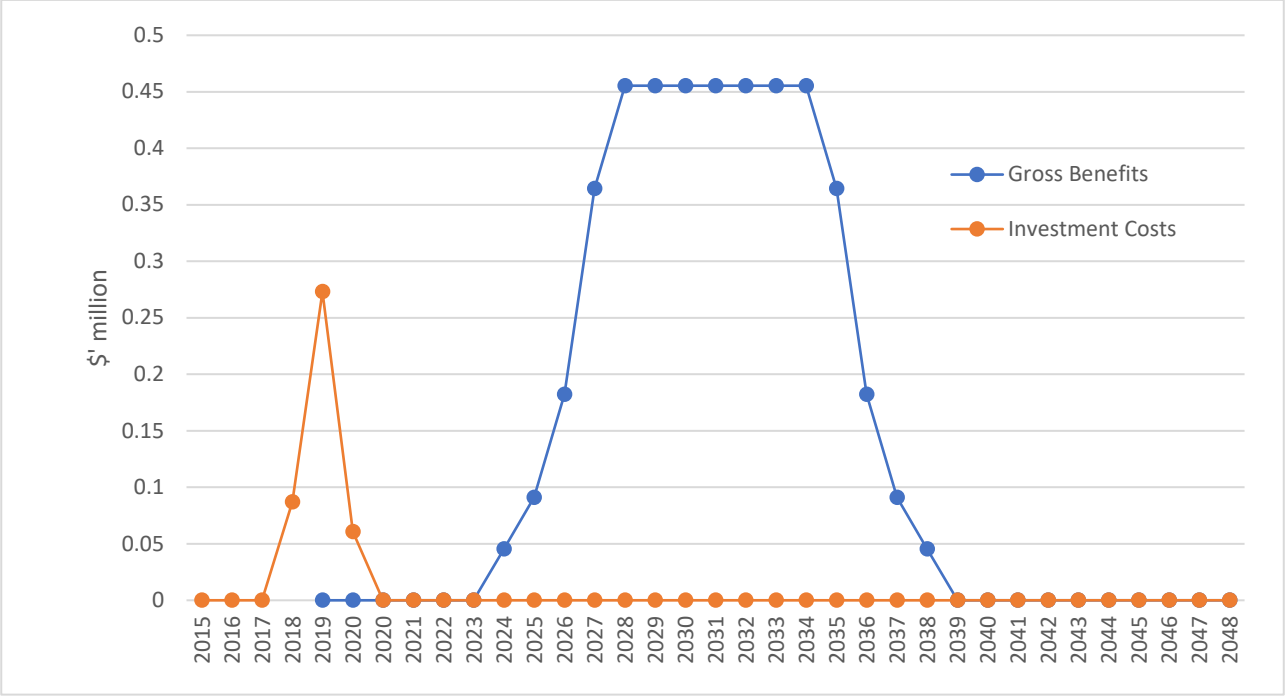

Figure B1: Annual Cash Flow of Undiscounted Total Benefits and Total Costs

Sensitivity Analyses

Sensitivity analyses were performed for variables that were considered (a) key drivers of the investment criteria, and/or (b) uncertain. Each sensitivity analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

A sensitivity analysis was carried out on the discount rate. The results, shown in Table 8, showed moderate sensitivity to the discount rate. This was largely due to the benefit cash flows occurring well into the future and therefore being subject to relatively more severe discounting. At all three discount rates the investment criteria show a favourable return on investment.

Table B8: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	**Discount rate**		
	0%	**5% (base)**	**10%**
Present value of benefits ($m)	4.55	3.12	2.22
Present value of costs ($m)	0.42	0.54	0.68
Net present value ($m)	4.13	2.58	1.54
Benefit-cost ratio	10.82	5.78	3.25

A sensitivity analysis then was carried out on the assumed price premium available to prawn fishers and farmers for Australian provenance. Table 9 shows the results. The premium on Australian prawns would have to be less than 2% (base case 10%) before project costs equal project benefits.

Table B9: Sensitivity to Price Premium Available to Prawn Fishers/Farmers for Australian Provenance
(Total investment, 5% discount rate, 30 years)

Investment Criteria	**Price Premium for Australian Prawns**		
	1.75%	**5%**	**10% (base)**
Present value of benefits ($m)	0.55	1.56	3.12
Present value of costs ($m)	0.54	0.54	0.54
Net present value ($m)	0.01	1.02	2.58
Benefit-cost ratio	1.01	2.89	5.78

Reduction in risk of premium loss attributable to the project

A final sensitivity analysis was undertaken on the reduction in risk of premium loss attributable to the project. The results, presented in Table 10, show that even if risk of premium loss for Australian prawns was reduced by only 1% as a result of the project, project benefits would continue to exceed project costs.

Table B10: Sensitivity to Reduction in Risk of Premium loss Attributable to the Project
(Total investment, 5% discount rate, 30 years)

Investment Criteria	**Reduction in Risk of Premium loss Attributable to the Project**		
	1%	**5% (base)**	**10%**
Present value of benefits ($m)	0.62	3.12	6.24
Present value of costs ($m)	0.54	0.54	0.54
Net present value ($m)	0.08	2.58	5.70
Benefit-cost ratio	1.16	5.78	11.57

Confidence Rating and Other Findings

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 11). The rating categories used are High, Medium, and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table B11: Confidence in Analysis of Investment

Coverage of Benefits	Confidence in Assumptions
High	Medium

The coverage of benefits was assessed as High. The impact valued was deemed to be the most important from the investment. Confidence in assumptions was rated as Medium. Many of the valuation assumptions were underpinned by credible data (e.g., ABARES estimates of wild catch and farmed prawn industry value). However, because the investment was only recently completed, there was limited evidence of actual outcomes and impacts. This meant that a number of the assumptions used in the valuation were uncertain.

Conclusions

Project 2016-261 research has delivered a scientifically robust, legislatively supported method of establishing the provenance of Australian prawns. With this technology in place, prawn fishers and farmers will have access to a tool to deter substitution and protect the price premium Australian product enjoys in both domestic and export markets.

The investment has led to a range of potential economic and social impacts. Importantly, Project 2016-261 contributed to:

- Protection of the price premium realised by Australian prawn fishers and farmers for their product (i.e., avoided income loss).
- Increased researcher capacity in relation to trace element profiling and its application to food provenance.
- Improved regional community wellbeing through spillover benefits from more productive and profitable prawn fishing and farming businesses.
- Potential increase in consumer trust for Australian prawn products.

Total funding for the Project was $0.54 million (present value terms) and produced total expected net benefits of $3.12 million (present value terms). This produced an estimated net present value of $2.58 million, a benefit-cost ratio of 5.8 to 1, an internal rate of return (IRR) of 31.9%, and a modified IRR of 11.8% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2016-261. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

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Appendix C: An Impact Assessment of Investment in FRDC Project 2017-242

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Jane D. Lovell, Chief Executive Officer, Seafood Industry Australia (SIA)

Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ACPF	Australian Council of Prawn Fishers
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
FRDC	Fisheries Research and Development Corporation
GVP	Gross Value of Production
NSW	New South Wales
PVB	Present Value of Benefits
QLD	Queensland
RD&E	Research, Development and Extension
SIA	Seafood Industry Australia

Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) Project 2017-242: *Our Pledge - Australian seafood industry response to community values and expectations*. The assessment was completed as part of a cost-benefit analysis for inclusion in the FRDC 2022-23 Annual Report. The assessment was made up of six FRDC RD&E projects.

The impact assessment 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 assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations.

The investment has led to a range of potential economic and social impacts. Importantly, Project 2017-242 contributed to:

- Maintained or improved social license to operate for the Australian seafood industry through uptake of ''Our Pledge'' as an improved mechanism for industry stakeholders to clearly understand and respond to community concerns and values and to enable the industry's growth, prosperity, and contribution to society on a continued basis.
- Increased regional community wellbeing from spill over benefits to regional communities from more economically and/or environmentally sustainable Australian seafood industry.
- Potentially improved security of resource access, regulatory certainty and trust, and positively impact mental health and safety within Australian Seafood Industry through improved decision makings by the industry about investing resources in undertaking specific engagement activities and strategies, which are informed by knowledge of their own as well as community values, and those industry behaviours that support or detract from levels of community trust and acceptance of their activities.

Total funding for the Project was $0.26 million (present value terms) and produced total expected net benefits of $0.78 million (present value terms). This produced an estimated net present value of $0.52 million, a benefit-cost ratio of 3.0 to 1, an internal rate of return (IRR) of 35.8%, and a modified IRR of 9.2% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made (including exclusion of aquaculture from the impact valuation) and the fact that two impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2017-242 and the positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

Introduction

The Fisheries Research and Development Corporation (FRDC) required a series of cost-benefit analyses of selected RD&E investments (projects) for inclusion in the FRDC 2022/23 Annual Report. The assessments were completed to contribute to the following FRDC evaluation reporting requirements:

- Reporting against the FRDC 2020-2025 RD&E Plan and the Evaluation Framework associated with FRDC's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to FRDC funding partners and other stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).
- Reporting RD&E impact and performance to FRDC levy payers and other fisheries and aquaculture stakeholders as well as the broader Australian community.

In August 2023, FRDC commissioned ACRE Economics Pty Ltd and associates to undertake cost-benefit analyses (CBAs) of six RD&E projects. The projects were selected to span the five 'Outcomes' of the FRDC Research and Development (R&D) Plan 2020-2025 with an additional project selected for Outcome 1 (Growth for enduring prosperity) where the largest proportion of FRDC investment was allocated. The six selected projects had a total estimated value of $0.69 million (FRDC investment, nominal dollar terms) and were funded over the period 2016/17 to 2020/21.

The sample selected (six projects) comprises a relatively small proportion of the FRDC's total RD&E investment (~5%) of the relevant population and may, therefore, not be fully representative of the entire RD&E Portfolio. However, the projects evaluated provide insight into the activities and outputs associated with each of FRDC's RD&E Programs, and the outcomes and impacts (and benefits) created. In turn, this will enable communication of benefits of FRDC RD&E to the FRDC Board, funding partners including the Commonwealth, industry, and other stakeholders.

The six projects selected by FRDC for evaluation in calendar 2023 were:

1. 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*
2. 2016-261: *Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry*
3. 2017-242: *Our Pledge: Australian seafood industry response to community values and expectations*
4. 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*
5. 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*
6. 2018-205: *Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*

This report presents the assessment process and findings for Project 2017-242: *Our Pledge: Australian seafood industry response to community values and expectations*.

Evaluation Framework

The annual impact assessments of FRDC RD&E investments 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 assessment components that are in accord with the current guidelines for impact assessment published by the CRRDC (CRRDC, 2018).

The evaluation process utilised an input to impact continuum RD&E project inputs (costs), objectives, activities, and outputs were briefly described and documented. Actual and expected outcomes, and any actual and/or potential future impacts (positive and/or negative) associated with project outcomes then were identified and described. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework and validated through consultation with expert personnel and review of published literature.

Once impacts were identified and validated, an assessment then was made about whether to quantify/value any of the impacts in monetary terms as part of the project-level analysis. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where one or more of the identified impacts were selected for valuation, the impact assessment used cost-benefit analysis (CBA) as a principal tool. The impacts valued therefore were deemed to represent the principal benefits delivered by the project investment. However, as not all impacts were valued (based on the selection criteria), the investment criteria estimated for the project investment evaluated are likely to represent an underestimate of the true performance of the FRDC project.

The qualitative and quantitative analysis processes, data sources, assumptions, specific valuation frameworks (where applicable), and evaluation results were clearly documented and then integrated into a written report.

Project Background

Background

Social license and community perceptions are critical issues for the ongoing viability and prosperity of the Australian Seafood Industry (represented by national peak-body Seafood Industry Australia (SIA)). To improve the industry's social license to operate and achieve high levels of support from immediate stakeholders and the Australian public, SIA desired to identify measures and benchmarks of industry behaviours that are consistent with industry values, behaviours, and values that the community shares and deems important regarding how industry acts.

Rationale for Project 2017-242

FRDC Project 2017-242 was funded to establish a mechanism for SIA to clearly understand and respond to community concerns and values and improve and maintain social license at an industry scale. The mechanism was required to have capacity to enable the seafood industry's growth, prosperity, and contribution to society into the future.

Project Details

Summary

Project Code: 2017-242

Title: *Our Pledge - Australian seafood industry response to community values and expectations*

Research Organisation: Fisheries Research and Development Corporation (FRDC)

Principal Investigator: Jane D. Lovell, Chief Executive Officer, Seafood Industry Australia (SIA)

Period of Funding: August 2018 to September 2019

FRDC Program Allocation: Adoption 50%, Industry 50%

Objectives

The specific objectives of the project were to:

1. Identify values of major segments of the Australian community for fisheries resources and seafood industries, and expectations of industry behaviours that support those values.
2. Identify values of the Australian seafood industry that are common across the industry at national and sector/regional scales.
3. Establish industry response to community values and expectations, including measurable benchmarks of industry behaviours and performance that demonstrate commitment.
4. Demonstrate and evaluate the effectiveness of a community engagement and communication strategy that is built on recognised shared values and commitment to supporting industry behaviours (Extension proof of concept – Australian Council of Prawn Fishers).
5. Increase capacity of industry's current and emerging leaders to engage in values and behaviours conversations with community leaders on an ongoing basis.

Logical Framework

Table C1: Logical Framework for FRDC Project 2017-242

Activities	**Identifying community values and perceptions of desirable industry practices:** • SIA commissioned Futureye Pty Ltd, a community engagement and research consultancy, to review existing research into community attitudes to understand society's current values and expectations about the industry. • This review included other market research with a focus on primary data collected through population-wide surveys on community values undertaken since 2014. • Based on the review of this information, recommendations were provided to inform a highly effective charter or promise. • To validate results of this review, the findings were reviewed against similar research Futureye that had undertaken for individual industry participants and the Northern Territory Seafood Council. **Review of industry values and practices:** • A rapid analysis of the most common Australian industry values and underpinning behaviours (practices) was undertaken by Sea Change Consulting Australia by reviewing values statements and recorded practices of 52 seafood organisations. • Using the organisation's website text, strategic documents, newsletters and media releases, 'Values Statements' were extracted. • In total, 1014 Values Statements and Practices were analysed (571 Values Statements, 443 Practices).

	• Each Values Statement and Practice was coded using a grounded theory approach (Strauss & Corbin, 1997) given the research was exploratory. • Each value statement and practice were given a code (category) name and then were amalgamated into broader codes. • The iterative coding approach was repeated and refined until there were as few codes as possible, without losing important detail (a total of 43 codes for all the Values Statements and Practices). • The percentage of organizations, who made the coded Values Statement and showed evidence of practicing the Stated Value, were calculated. • The data were categorized by industry type (Wildcatch and/or Aquaculture) and by organization type (Industry Association or Business) and examined for differences. **Determining industry response to community values and expectations:** • A draft industry 'charter or promise' to demonstrate the industry's intent to earn its social license to operate or strawman "Our Pledge", along with evidence of both alignment and misalignment in practices, was drafted for testing at industry workshops. • At a Technical workshop (19 September 2018, Canberra), the collected data was used to develop a first draft of "Our Pledge". • At the workshop, the identified values were examined and compared to identify clusters of themes of values and then were simplified to single statements to capture the cluster of values. • The draft "Our Pledge" was reviewed at an SIA Members' Forum (27 September, Brisbane). • Feedback from the Members' Forum was analysed and reviewed with Kate Brooks (KAL Analysis). • The results of the analysis were used to develop an updated version of "Our • Pledge" that encapsulated industry values and its response to community values and expectations. • The revised version of "Our Pledge" was subsequently tested at a series of workshops held across Australia. **Increase capacity of industry's current and emerging leaders to engage in values and behaviours conversations with community leaders on an ongoing basis:** • Industry workshops were organised by representative organisations in each State/Territory to review and refine draft values and supporting practices as relevant for national, regional and sector scales. • Collaborations were coordinated with National Seafood Industry Leadership Program members of the first 2018 intake to review and refine draft values and supporting practices within their sectors. • Meetings with SIA members were organised to review and refine draft values and supporting practices.
Outputs	**Identification of values of major segments of the Australian community for fisheries resources and seafood industries, and expectations of industry behaviours that support those values:** • A short report to present the findings from the review and synthesis into society's values and expectations of SIA. • The review identified that primary concerns about the fishing industry raised by the community relate to environmental sustainability and industry and government accountability.

- The synthesis of previous research concluded that the most critical issues affecting the community's views of and concerns about SIA should be the focus of the charter or promise.
- It was therefore recommended that the charter should reflect the industry's commitment to sustainability - fishing stocks and habitat - as the primary focus of the promise or charter.
- It was additionally recommended that the charter should reflect the industry's commitment to accountability for industry participants who 'break the rules' as a major element of the charter.
- The findings indicated that community believes strong government action and a strict regulatory environment are critical to ensure genuine industry focus on improved stock and environmental sustainability.
- The literature review also highlighted community awareness about the sustainability of fish stocks globally and to ensure that community engagement becomes an important element of strategy formation and execution.
- While addressing the potential of aquaculture and fish farming to reduce reliance on wild harvest and overfishing, the industry must acknowledge environmental concerns and commit to transparently investigate them and provide solutions to mitigate the adverse effects.

Identification of values of the Australian seafood industry that are common across the industry at national and sector/regional scales:

- Comparisons of industry values and practices undertaken by Sea Change Consulting Australia highlighted several differences and similarities between what seafood organisations valued versus practiced.
- The result of an analysis of the alignment between societal values and expectations based on the similarities in the values and practices of organisations were as follows.
- The key values that were common regardless of the type of organisation or sector were:
    - The sustainability of the environment and its natural resources is paramount, and our seafood is sourced from a pristine environment.
    - The industry is committed to responsible practices and stewardship and will continue to improve.
    - The industry provides high quality, fresh and delicious seafood.
- Key Practices that were common regardless of the type of organisation or sector were:
    - The sustainability of the environment and its natural resources is paramount, and our seafood is sourced from a pristine environment.
    - The industry is undertaking responsible practices and stewardship and is committed to improving.
    - The industry strives to connect to and meet the expectations of seafood consumers and customers.
    - The industry values collaboration, engagement and their relationships with stakeholders, government, businesses, and communities.
    - The industry is committed to sharing information about the industry, business, and products.
    - Building industry and organisational capacity and provide professional development.

Determination of industry response to community values and expectations:

- Based on the research results, the following values and practices were highlighted ubiquitously important:
    - environmental sustainability.
    - responsible practices and stewardship.

- quality product.
- striving to connect and meet expectations of seafood consumers, customers, and communities.
- desire to collaborate, engage and have positive relationships with stakeholders, government, businesses, and community.
- commitment to sharing information about the industry, businesses, and products.
- Given the many similarities between community concerns and stated industry values and practices, it was assumed that areas of potential misalignment were minimal and likely related to semantics.

- The research by Essence Communications identified 16 key findings in relation to community sentiment towards Australia's Seafood Industry and in evaluating the opportunity for 'Our Pledge':
  1. There appears to be a good understanding of ethical practice and what this means.
  2. There is low awareness of the Australian seafood industry and how it operates.
  3. There are mixed perceptions of the seafood industry and its focus on ethical and sustainable practice.
  4. Those who know more about the seafood industry, who buy Australian seafood and who consume seafood regularly are more positive.
  5. "Our Pledge" offers a good opportunity to further enhance perceptions and community understanding of the seafood industry.
  6. The commitment made in "Our Pledge" must be clear and concise.
  7. There are high expectations when it comes to caring for the environment.
  8. Participants agree that primary producers and workers should be looked after, and their sense is that they are.
  9. Having regard for animal welfare is viewed positively.
  10. The opportunity is to promote transparency and accountability when it comes to complying with the law.
  11. Participants value a level of responsiveness to community concern about how the industry is behaving.
  12. Continuous improvement is viewed as being essential to identifying ways to do and be better.
  13. Stories about the industry, its people and how it works would be highly regarded.
  14. Expectations of proof that the industry is living "Our Pledge" reflects the areas of importance: environment, respecting animals and sustainability.
  15. The role of Marine Parks is relatively unknown.
  16. "Our Pledge" has the potential to positively influence seafood buying behaviour.
- Based on the community sentiment survey research, it was concluded that 'Our Pledge' has the potential to provide a strong and engaging message about the Australian seafood industry and the work it is doing as responsible and environmentally focussed primary producers.
- Creation and lunch of a final digital version of 'Our Pledge' to industry in late October to provide an effective mechanism in assisting industry responses to stakeholder and community interests in a consolidated and targeted manner.
- Annual community sentiment survey with the intent of repeating the survey process to track changes in community support for industry over time.
- Recommendations and templates for future monitoring and tracking of:
  - changes in industry values,
  - changes in values and preferences of major segments of the Australian community, and
  - changes in acceptance of and trust in industry practices by major segments of the Australian community.
- Recommendations for consideration by industry when seeking to engage with
- the Australian community including:
  - Commit to and prioritise transparency and accountability,

	○ Develop goals before evaluating performance, ○ Ensure evidence supporting Our Pledge (and other demonstrations of shared values/behavioural norms) is easy to understand, ○ Engage in regular outreach and engagement, and ○ Be responsive and open to change. • Improved mechanism for building social license at an industry scale via representation of values relevant to the entire diverse national seafood industry, validated via community survey as effective in relating and responding to stakeholder and community concerns to build trust and ultimately support for the seafood industry.
Outcomes	• Uptake of ''Our Pledge'' as is a tool by the Australian seafood industry and broader community to improve the industry's social license to operate and contribute to the industry's growth, prosperity and contribution to society into the future. • Improved communications and engagement activities among SIA members, Australian Council of Prawn Fishers (ACPF), and other industry representative organisations to help industry respond to community values and expectations and increase commitment to supporting industry practices. • Improved decision makings by members of Australian fisheries and aquaculture industries, SIA members, and other industry representatives/ organisations about investing resources in undertaking specific engagement activities and strategies, which are informed by knowledge of their own as well as community values, and those industry behaviours that support or detract from levels of community trust and acceptance of their activities. • Potentially improved adoption of R&D, fisheries management, health and safety practices by Australian seafood industry.
Impacts (Potential)	• Maintained or improved social license to operate for the Australian seafood industry through uptake of ''Our Pledge'' as an improved mechanism for industry stakeholders to clearly understand and respond to community concerns and values and to enable the industry's growth, prosperity, and contribution to society on a continued basis. • Increased regional community wellbeing from spill over benefits to regional communities from more economically and/or environmentally sustainable Australian seafood industry. • Potentially improved security of resource access, regulatory certainty and trust, and enhanced mental health and safety within the Australian Seafood Industry through improved decision making by the industry about investing resources in undertaking specific engagement activities and strategies, which are informed by knowledge of their own as well as community values, and those industry behaviours that support or detract from levels of community trust and acceptance of their activities.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2017-242 by FRDC and other contributors.

Table C2: Total Investment in FRDC Project 2017-242
(nominal dollar terms)

Year ended 30 June	FRDC ($)	Others ($)	Total ($)
2019	121,100	0	121,100
2020	32,460	0	32,460
Totals	**153,560**	**0**	**153,560**

Source: FRDC project 2017-242 documentation.

Management and Administration 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 (x1.179). This multiplier was estimated based on a five-year average of the ratio of total FRDC cash expenditure to project expenditure reported in the FRDC's Cash Flow Statement (FRDC Annual Reports, 2018-2022). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of 1.00 was used for administration and management costs for other contributors.

Real Investment and Extension Costs

For the purposes of the impact analysis, the investment costs of all parties were expressed in 2022/23-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2023).

No additional costs of extension were included as the activities undertaken during Project 2017-242 were focused on stakeholder engagement, direct extension to end-users, and other communication and extension resources and activities.

Impacts

Table 3 provides a summary of the principal types of potential impacts from Project 2017-242. Impacts have been taken, and potentially expanded, from those listed in Table 1 and categorised using a triple bottom line framework into economic, environmental and social impact types.

Table C3: Principal Potential Impact Types from Investment in FRDC Project 2017-242

Economic	• Nil.
Environmental	• Nil.
Social	• Maintained or improved social license to operate for the Australian seafood industry through uptake of ''Our Pledge'' as an improved mechanism for industry stakeholders to clearly understand and respond to community concerns and values and to enable the industry's growth, prosperity, and contribution to society on a continued basis. • Increased regional community wellbeing from spill over benefits to regional communities from more economically and/or environmentally sustainable Australian seafood industry. • Potentially improved security of resource access, regulatory certainty and trust, and enhanced mental health and safety within the Australian Seafood Industry through improved decision making by the industry about investing resources in undertaking specific engagement activities and strategies, which are informed by knowledge of their own as well as community values, and those industry behaviours that support or detract from levels of community trust and acceptance of their activities.

Public versus Private Impacts

The key impacts from Project 2017-242 were public impacts. Public impacts were delivered through maintained social license to operate for the Australian seafood industry, spill over benefits to regional communities from a more economically and/or environmentally sustainable Australian seafood industry, and potentially improved security of resource access, regulatory certainty and trust, and enhanced mental health and safety within the Australian Seafood Industry.

Some private impacts also may be delivered in the longer-term. Private impacts are likely to be delivered through maintained or improved productivity/profitability for Australian Seafood Industry in the future from increased interest in fisheries and aquaculture careers.

Distribution of Private Impacts

Any private impacts from the investment in Project 2017-242 will primarily accrue to Australian Seafood Industry supply chains, and particularly producers in the short term. Over the longer term, any private benefits will be distributed along seafood supply chains according to relevant supply and demand elasticities.

Impacts on Other Australian Industries

No direct impacts to other Australian industries beyond the Australian Seafood Industry were identified.

Impacts Overseas

No direct impacts to overseas parties were identified.

Match with National Priorities

Australian Agriculture, Science, and Research Priorities

The Australian Government's National Science and Research Priorities and Agricultural Innovation Priorities are reproduced in Table 4. Project 2017-242 indirectly contributed to National Science and Research Priority 1. Further, the RD&E investment may contribute indirectly to all four Agricultural Innovation Priorities because of maintained or improved social license to operate for the Australian seafood industry through uptake of improved mechanism for industry stakeholders to clearly understand and respond to community concerns and values and to enable the industry's growth, prosperity, and contribution to society on a continued basis.

Table C4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities[7]	**National Agricultural Innovation Priorities**[8]
1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. **2. Soil and Water** – improving the use of soils and water resources, both terrestrial and marine. **3. Transport** – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. **4. Cybersecurity** – improving cybersecurity for individuals, businesses, government, and national infrastructure.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia's agricultural innovation system to address by 2030. These priorities replace the Australian Government's Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. **1.** Australia is a trusted exporter of premium food and agricultural products by 2030. **2.** Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030.

[7] Source: 2015 Australian Government *Science and Research Priorities*. https://www.industry.gov.au/data-and-publications/science-and-research-priorities.

[8] Source: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment.

Australian Government	
National Science and Research Priorities[7]	**National Agricultural Innovation Priorities[8]**
5. Energy and Resources – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia's resources industries. **6. Manufacturing** – supporting the development of high value and innovative manufacturing industries in Australia. **7. Environmental Change** – mitigating, managing, or adapting to changes in the environment. **8. Health** – improving the health outcomes for all Australians.	**3.** Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. **4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

FRDC National RD&E Priorities

Through extensive consultation, the FRDC 2020-2025 RD&E Plan identified five key outcome areas. The five outcome areas were:

1. Growth for enduring prosperity.
2. Best practices and production systems.
3. A culture that is inclusive and forward thinking.
4. Fair and secure access to aquatic resources.
5. Community trust, respect, and value.

Project 2017-242 addressed all outcome areas, with particular emphasis on outcomes 4 and 5.

Valuation of Impacts

The valuation of impacts generally focused on the most important and direct impacts of the investment in project 2017-242. The decision to value any of the impacts identified in Table 3 was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Impacts Valued

One impact was valued for the assessment of Project 2017-242. The impact valued was:

- Maintained or improved social license to operate for the Australian seafood industry.

Valuation of Impact 1: Maintained social license to operate for some Australian fisheries

The average annual total gross value of production (GVP) for Australian State and Commonwealth wild-catch fisheries was estimated at $1.66 billion (five-year average) (Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2023). The investment in Project 2017-242 has contributed to the uptake of ''Our Pledge'' as an improved mechanism for industry stakeholders to clearly understand and respond to community concerns and values and to enable the industry's growth, prosperity, and contribution to society on a continued basis and therefore contributed to a reduced risk of the loss of the social license to operate for a proportion of the Australian fisheries sector an therefore a reduced risk of loss of profits.

Specific assumptions for the valuation of Impact 1 are reported in Table 5.

Attribution

The specific assumptions used to value Impact 1 were such that 100% of the estimated benefits were assumed to be attributable to the investment in Project 2017-242.

Counterfactual

It was assumed that, without the investment in FRDC Project 2017-242, community pressure, individual industry or enterprise practice change, and/or related RD&E would have contributed to a continued move toward more socially conscious and economically and environmentally sustainable industry values and activities. However, such changes would not be coordinated at a whole of industry level and would be approached ad hoc and therefore less effective and/or efficient. Thus, it was assumed that approximately 60% of the estimated total expected net benefits would still have occurred without the Project 2017-242 investment.

Impacts Not Valued

The impacts not valued included:

- Increased regional community wellbeing from spill over benefits to regional communities from more economically and/or environmentally sustainable Australian seafood industry.
- Potentially improved security of resource access, regulatory certainty and trust, and positively impact mental health and safety within Australian Seafood Industry through improved decision makings by the industry about investing resources in undertaking specific engagement activities and strategies, which are informed by knowledge of their own as well as community values, and those industry behaviours that support or detract from levels of community trust and acceptance of their activities.

Summary of Assumptions

The following tables present the specific assumptions used in the valuation of Impact 1.

Table C5: Summary of Assumptions for the Valuation of Impact 1

Variable	Assumption	Source
WITHOUT investment in Project 2016-417		
Average annual total GVP of Australian State and Commonwealth wild-catch fisheries	$1.66 billion	Five-year average, derived from ABARES (2023) – Gross value of fisheries and aquaculture production, Australia (time series) – Australian fisheries and aquaculture statistics 2021 (excluding aquaculture because the wild catch sector was the considered the sector most subject to the social license issues)
Fisheries net profit as a proportion of GVP	10%	Estimate of average economic profit for Australian industries - Analyst assumption
Average annual net profit of Australian fisheries	$166 million	10% x $1.66 billion p.a.
Proportion of fisheries profit at risk from a loss of social license in any given year	20%	Analyst assumption – conservative estimate based on expert knowledge of the RD&E and socially conscious industry strategies and plans underpinning the Australian seafood industry

Variable	Assumption	Source
Net profit at risk of loss	$33.2 million p.a.	20% x $166 million p.a.
WITH investment in Project 2017-242		
Reduction in risk of loss of social license attributable to uptake of ''Our Pledge'' as an improved mechanism for industry stakeholders to clearly understand and respond to community concerns and values and to enable the industry's growth and prosperity delivered through Project 2017-242	1% risk reduction in any given year	Analyst assumption
Maximum annual value of net profits saved through reduced risk of loss of social license	$0.332 million	1% x $33.2 million p.a.
First year of impact	2019/20	The first year after the completion of project in 2019.
Year of maximum impact	2021/22	Allows for three years of uptake and extension of "Our Pledge" after completion of the project in 2019.
Period of impact	5 years (2021/22 to 2025/26) then declining over another 3 years to 5% residual benefit value from 2028/29 onward	Assumes no further specific investment like Project 2017-242 and therefore gradual decline in the relevance and use (dis-adoption) of ''Our Pledge''
Risk Factors		
Probability of output	100%	Based on successful completion of Project 2017-242.
Probability of outcome	90%	The probability of outcome refers to the likelihood that the project outputs are adopted/ implemented at the level assumed.
Probability of impact	90%	Refers to the probability that, given adoption (outcome), the impact as estimated will be realised. This allows for exogenous factors that may affect the estimated benefits being achieved.
Attribution of benefits to investment in Project 2017-242	100%	See valuation of impact 1 description reported previously.
Counterfactual	60% of the estimated benefits would have occurred without the Project 2017-242 investment.	

Results

All past costs and benefits were expressed in 2022/23-dollar terms. All costs and benefits were discounted to 2022/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2019/20) to the final year of benefits assumed.

Investment Criteria

Tables 6 and 7 show the investment criteria estimated for different periods of benefits for the total investment and FRDC investment respectively. The present value of benefits (PVB) for the FRDC investment was estimated by multiplying the total PVB cash flow by the proportion of FRDC investment in real, undiscounted dollar terms (100%). The investment criteria are the same in both Table 6 and Table 7 because FRDC contributed 100% of the investment costs for Project 2017-242.

Table C6: Investment Criteria for Total Investment in Project 2017-242

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.04	0.54	0.73	0.75	0.76	0.77	0.78
Present value of costs ($m)	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Net present value ($m)	-0.22	0.28	0.47	0.49	0.50	0.51	0.52
Benefit-cost ratio	0.16	2.10	2.83	2.89	2.94	2.98	3.01
Internal rate of return (%)	negative	30.8	35.7	35.8	35.8	35.8	35.8
MIRR (%)	negative	20.7	16.6	13.0	11.2	10.0	9.2

Table C7: Investment Criteria for FRDC Investment in Project 2017-242

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.04	0.54	0.73	0.75	0.76	0.77	0.78
Present value of costs ($m)	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Net present value ($m)	-0.22	0.28	0.47	0.49	0.50	0.51	0.52
Benefit-cost ratio	0.16	2.10	2.83	2.89	2.94	2.98	3.01
Internal rate of return (%)	negative	30.8	35.7	35.8	35.8	35.8	35.8
MIRR (%)	negative	20.7	16.6	13.0	11.2	10.0	9.2

The annual undiscounted benefit and cost cash flows for the total investment for the duration of investment period plus 30 years from the last year of investment are shown in Figure 1.

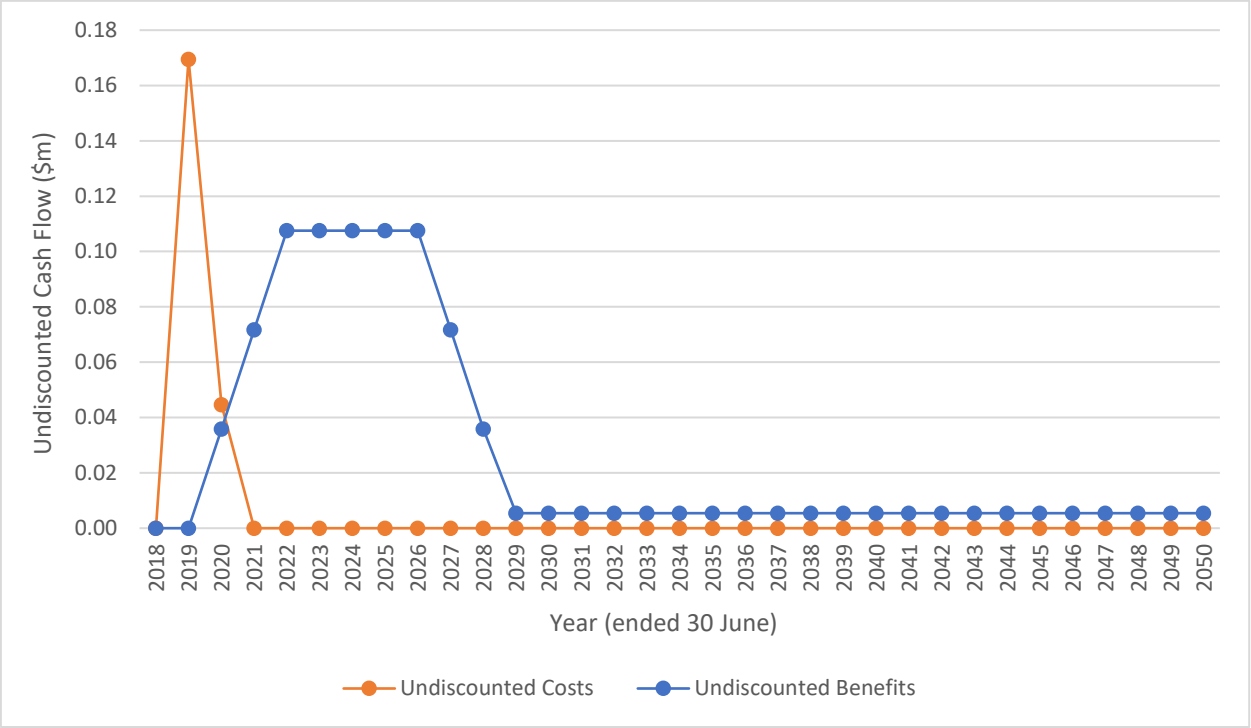

Figure C1: Annual Cash Flow of Undiscounted Total Benefits and Total Costs

Sensitivity Analyses

Sensitivity analyses were performed for variable that were considered (a) key drivers of the investment criteria, and/or (b) uncertain. Each sensitivity analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

A sensitivity analysis was carried out on the discount rate. The results, shown in Table 8, showed a low to medium sensitivity to the discount rate. This was largely due to the benefit cash flows occurring over the short-term after the last year of investment in the project and therefore being subject to relatively less severe discounting.

Table C8: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	**Discount rate**		
	0%	**5% (base)**	**10%**
Present value of benefits ($m)	0.87	0.78	0.73
Present value of costs ($m)	0.21	0.26	0.31
Net present value ($m)	0.66	0.52	0.42
Benefit-cost ratio	4.06	3.01	2.37

A sensitivity analysis then was carried out on proportion of fisheries net profits assumed to be at risk from a loss of social license as this was uncertain. Table 9 shows the results. The investment criteria showed a moderate sensitivity to the proportion of fisheries net profits at risk. A break-even analysis indicated that the proportion of fisheries net profits at risk of loss of social license could decline to 6.6% and the investment criteria would remain positive (benefit-cost ratio of at least 1 to 1) with all other assumptions held at their base values.

Table C9: Sensitivity to the Proportion of Fisheries Net Profits at Risk from Loss of Social License
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Proportion of Fisheries Net Profits at Risk from Loss of Social License		
	5%	20% (base)	35%
Present value of benefits ($m)	0.19	0.78	1.36
Present value of costs ($m)	0.26	0.26	0.26
Net present value ($m)	-0.06	0.52	1.10
Benefit-cost ratio	0.75	3.01	5.27

A sensitivity analysis was undertaken on the reduction in the risk of loss of social license attributable to the investment. The results, presented in Table 10, showed a high to moderate sensitivity to assumed reduction in risk of a loss of social license for Australian fisheries. This was expected as the change in risk was a key driver in the estimation of the impact valued. A break-even analysis showed that, with all other assumptions at base values, the investment criteria remained positive with a 0.3% reduction in risk attributable to the Project 2017-242 investment.

Table C10: Sensitivity to the Reduction in Risk of Loss of Social License
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Reduction in Risk of Loss of Social License		
	0.5%	1% (base)	2%
Present value of benefits ($m)	0.39	0.78	1.55
Present value of costs ($m)	0.26	0.26	0.26
Net present value ($m)	0.13	0.52	1.29
Benefit-cost ratio	1.51	3.01	6.02

A final sensitivity analysis was undertaken on the counterfactual factor, the likelihood that the estimated benefits would have occurred without the Project 2017-242. The results, presented in Table 11, showed a high to moderate sensitivity to the assumed counterfactual factor. A break-even analysis showed that, with all other assumptions at base values, the investment criteria remained positive where it was assumed that 87% of the estimated total expected net benefits still would have occurred without the Project 2017-242.

Table C11. Sensitivity to the Counterfactual Factor
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Counterfactual Factor		
	30%	60% (base)	90%
Present value of benefits ($m)	1.36	0.78	0.19
Present value of costs ($m)	0.26	0.26	0.26
Net present value ($m)	1.10	0.52	-0.06
Benefit-cost ratio	5.27	3.01	0.75

Confidence Rating and Other Findings

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 12). The rating categories used are High, Medium and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table C12: Confidence in Analysis of Investment

Coverage of Benefits	Confidence in Assumptions
Medium-High	Low

The coverage of benefits was assessed as Medium to High. One of three impacts was valued and the impact valued was considered an important and direct benefit of the investment.

Confidence in assumptions was rated as Low. Changes to social license are very difficult to measure and, though evidence of change through education was apparent from project data, many of the assumptions used in the valuation framework were uncertain. However, sensitivity analyses showed that, even at more conservative values, the investment criteria were positive.

Conclusions

FRDC Project 2017-242 was funded to establish a mechanism for SIA to clearly understand and respond to community concerns and values and improve and maintain social license at an industry scale. The mechanism was required to have capacity to enable the seafood industry's growth, prosperity, and contribution to society into the future.

The investment is likely to have generated positive impacts, including:

- Maintained or improved social license to operate for the Australian seafood industry through uptake of ''Our Pledge'' as an improved mechanism for industry stakeholders to clearly understand and respond to community concerns and values and to enable the industry's growth, prosperity, and contribution to society on a continued basis.
- Increased regional community wellbeing from spill over benefits to regional communities from more economically and/or environmentally sustainable Australian seafood industry.
- Potentially improved security of resource access, regulatory certainty and trust, and positively impact mental health and safety within Australian Seafood Industry through improved decision makings by the industry about investing resources in undertaking specific engagement activities and strategies, which are informed by knowledge of their own as well as community values, and those industry behaviours that support or detract from levels of community trust and acceptance of their activities.

Total funding for the Project was $0.26 million (present value terms) and produced total expected net benefits of $0.78 million (present value terms). This produced an estimated net present value of $0.52 million, a benefit-cost ratio of 3.0 to 1, an internal rate of return (IRR) of 35.8%, and a modified IRR of 9.2% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made (including exclusion of aquaculture from the impact valuation) and the fact that two impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2017-242 and the positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

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Appendix D: An Impact Assessment of Investment in FRDC Project 2018-148

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Principal Investigator Dr Cathy Dichmont, Cathy Dichmont Consulting was contacted to provide review of the working draft.

Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
FAO	Food and Agriculture Organisation of the United Nations
FRDC	Fisheries Research and Development Corporation
IRR	Internal Rate of Return
NOAA	National Oceanic and Atmospheric Administration
NSW	New South Wales
PVB	Present Value of Benefits
RD&E	Research, Development and Extension
US	United States of America

Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) Project 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*. The assessment was completed as part of a cost benefit analysis for inclusion in the FRDC 2022-23 Annual Report. The assessment was made up of six FRDC RD&E projects.

The impact assessment 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 assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations.

Project 2018-148 has delivered a single platform that summarises the features of 67 current stock assessment packages in a consistent manner. Packages have been placed into ten classes, worked examples provided and state-of-the-art approaches noted. Use of the stock assessment toolbox to assess Australian fish stocks has the potential to increase the efficiency and consistency of fish and crustacean assessments. Project 2018-148 has contributed to:

- A potential cost saving in fishery stock assessments.
- More accurate stock assessments with greater confidence in resource sharing decisions.
- More sustainable commercial, recreational, and Indigenous fishing.
- Reduced risk of over-fishing and associated environmental damage.
- Increased researcher capacity in understanding and working with stock assessment models.
- Continued Australian support for the current social licence to fish and continued sustainable commercial access to Australian fisheries, as well as for recreational and Indigenous purposes.
- Contribution/endorsement of Australia's image world-wide as being an effective fisheries manager.

Total funding for the Project was $0.2 million (present value terms) and produced total expected net benefits of $0.6 million (present value terms). This produced an estimated net present value of $0.4 million, a benefit-cost ratio of 3.1 to 1, an internal rate of return (IRR) of 29%, and a modified IRR of 9.1% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2018-148. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

Introduction

The Fisheries Research and Development Corporation (FRDC) required a series of cost benefit analyses of selected RD&E investments (projects) for inclusion in the FRDC 2022/23 Annual Report. The assessments were completed to contribute to the following FRDC evaluation reporting requirements:

- Reporting against the FRDC 2020-2025 RD&E Plan and the Evaluation Framework associated with FRDC's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to FRDC funding partners and other stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).
- Reporting RD&E impact and performance to FRDC levy payers and other fisheries and aquaculture stakeholders as well as the broader Australian community.

In August 2023, FRDC commissioned ACRE Economics Pty Ltd and associates to undertake cost-benefit analyses (CBAs) of six RD&E projects. The projects were selected to span the five 'Outcomes' of the FRDC Research and Development (R&D) Plan 2020-2025 with an additional project selected for Outcome 1 (Growth for enduring prosperity) where the largest proportion of FRDC investment was allocated. The six selected projects had a total estimated value of $0.69 million (FRDC investment, nominal dollar terms) and were funded over the period 2016/17 to 2020/21.

The sample selected (six projects) comprises a relatively small proportion of the FRDC's total RD&E investment (~5%) of the relevant population and may, therefore, not be fully representative of the entire RD&E Portfolio. However, the projects evaluated provide insight into the activities and outputs associated with each of FRDC's RD&E Programs, and the outcomes and impacts (and benefits) created. In turn, this will enable communication of benefits of FRDC RD&E to the FRDC Board, funding partners including the Commonwealth, industry, and other stakeholders.

The six projects selected by FRDC for evaluation in calendar 2023 were:

1. 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*
2. 2016-261: *Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry*
3. 2017-242: *Our Pledge: Australian seafood industry response to community values and expectations*
4. 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*
5. 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*
6. 2018-205: *Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*

This report presents the assessment process and findings for Project 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*.

Evaluation Framework

The annual impact assessments of FRDC RD&E investments 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 assessment components that are in accord with the current guidelines for impact assessment published by the CRRDC (CRRDC, 2018).

The evaluation process utilised an input to impact continuum RD&E project inputs (costs), objectives, activities, and outputs were briefly described and documented. Actual and expected outcomes, and any actual and/or potential future impacts (positive and/or negative) associated with project outcomes then were identified and described. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework and validated through consultation with expert personnel and review of published literature.

Once impacts were identified and validated, an assessment then was made about whether to quantify/value any of the impacts in monetary terms as part of the project-level analysis. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where one or more of the identified impacts were selected for valuation, the impact assessment used cost-benefit analysis (CBA) as a principal tool. The impacts valued therefore were deemed to represent the principal benefits delivered by the project investment. However, as not all impacts were valued (based on the selection criteria), the investment criteria estimated for the project investment evaluated are likely to represent an underestimate of the true performance of the FRDC project.

The qualitative and quantitative analysis processes, data sources, assumptions, specific valuation frameworks (where applicable), and evaluation results were clearly documented and then integrated into a written report.

Project Background

Background

Stock assessments are integral to fisheries management, and the demand for stock assessments based on population dynamics models continues to increase. Historically, stock assessments have been based on bespoke methods and software.

There is now a trend towards the use of flexible, documented, tested, and maintained software packages because use of such packages increases efficiency and consistency in assessments and should lead to more reliable and repeatable assessment outcomes.

Rationale for Project 2018-148

Project 2018-148 builds on a previous FRDC investment (2014-039 – Stock Assessment Integration: A Review). Project 2014-039 reviewed the range of packages used to conduct assessments of fish and invertebrate stocks in the United States (US). US stock assessments have similar goals to those completed in Australia. Project 2014-039 also reviewed all model-based assessments undertaken in Australia, specifically to evaluate how many assessments could have been conducted using the publicly available stock assessment packages used in the US and New Zealand. It was found that only 18 of 76 stock assessments could have been conducted using US and New Zealand packages.

Stock assessment is severely capacity limited in the present climate as demand for assessments, especially those that are data-limited, increases. Impediments to the uptake of packages was found to include lack of time to transition, lack of knowledge of what is available, and where, lack of sharing within the stock assessment communities, and lack of investment in training.

Project Details

Summary

Project Code: 2018-148

Title: *A Stock Assessment Toolbox for Australian Fisheries*

Research Organisation: CSIRO and Cathy Dichmont Consulting

Principal Investigator: Dr Cathy Dichmont

Period of Funding: March 2019 to January 2021

FRDC Program Allocation: Environment 50%, People 50%

Objectives

The specific objectives of project 2018-148 were to:

1. Link all freely available international stock assessment packages into a single framework within FRDC's web system.
2. Provide guidance as to which package is more appropriate for what kind of situation.
3. Link resources created by the authors of packages such as test data and models.

Logical Framework

Table D1: Logical Framework for FRDC Project 2018-148

Activities	• Define what constitutes a stock assessment package, search the web, and consult internationally with scientists to identify a list of relevant products. • Categorise packages into classes and remove those that are no longer supported by the developer or do not align with the definition developed for this project. • For suitable stock assessment packages, contact the developer and obtain detailed specifications for each package. • Develop test data, installation, and use instructions for two examples of a data-limited package and a data-moderate package. • Develop data, installation, and use instructions using a data simulation feature within the package Stock Synthesis. • Create a facility for scientists to add their stock assessment reports to the website. • Communicate development of the toolbox to potential users via the Fisheries Research Providers Network. • Post completion of the project the Toolbox was extended to users through the scientific literature and relevant fisheries management conferences.
Outputs	• In total, 64 of 130 identified packages were included on the website. • Over 70 model specifications were listed. • Packages were placed into 10 classes: Catch curves, Catch only, Delay difference, Depletion model, Integrated approach, Length only, Mean length, Size-structure, Surplus production, and Virtual population analysis. • Some 67 Australian stock assessment reports were linked to the website. • The project delivered a single platform that summarises the features of current stock assessment packages in a consistent manner. State of the art packages were identified.

Outcomes	• Use of the Toolbox by fisheries managers will increase the efficiency and consistency of fish and crustacean stock assessments.
Impacts (potential)	• A potential cost saving in fishery stock assessments. • More accurate stock assessments with greater confidence in resource sharing decisions. • More sustainable commercial, recreational, and Indigenous fisheries. • Reduced risk of over-fishing and associated environmental damage. • Increased researcher capacity in understanding and working with stock assessment models. • Continued Australian support for the current social licence to fish and continued sustainable commercial access to Australian fisheries, as well as for recreational and Indigenous purposes. • Contribution/endorsement of Australia's image world-wide as being an effective fisheries manager.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2018-148 by FRDC and other contributors.

Table D2: Total Investment in FRDC Project 2018-148
(nominal dollar terms)

Year ended 30 June	FRDC ($)	Others ($)	Total ($)
2019	21,044	11,505	32,549
2020	42,086	23,009	65,095
2021	21,044	11,505	32,549
Totals	**84,174**	**46,019**	**130,193**

Source: FRDC project 2018-148 documentation

Management and Administration 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 (x1.179). This multiplier was estimated based on a five-year average of the ratio of total FRDC cash expenditure to project expenditure reported in the FRDC's Cash Flow Statement (FRDC Annual Reports, 2018-2022). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of 1.00 was used for administration and management costs for other contributors.

Real Investment and Extension Costs

For the purposes of the impact analysis, the investment costs of all parties were expressed in 2022/23-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2023).

The cost of raising awareness of the "one-stop-shop" for stock assessment packages created as part of the project was included as part of Project 2018-148 investment costs. However, the assessment of stock assessment packages will require update at regular intervals to ensure the ongoing relevance of the Toolbox.

Impacts

Table 3 provides a summary of the principal types of potential impacts from project 2018-148. Impacts have been taken from those listed in Table 1 and categorised using a triple bottom line framework into economic, environmental, and social impact types.

Table D3: Principal Potential Impact Types from Investment in FRDC Project 2018-148

Economic	• A potential cost saving in fishery stock assessments. • More accurate stock assessments with greater confidence in resource sharing decisions. • More sustainable commercial, recreational, and Indigenous fisheries.
Environmental	• Reduced risk of over-fishing and associated environmental damage.
Social	• Increased researcher capacity in understanding and working with stock assessment models. • Continued Australian support for the current social licence to fish and continued sustainable commercial access to Australian fisheries, as well as for recreational and Indigenous purposes. • Contribution/endorsement of Australia's image world-wide as being an effective fisheries manager.

Public versus Private Impacts

Both public and private potential impacts were identified for the project. Private impacts may be delivered via more sustainable commercial, recreational, and Indigenous fisheries along with protection of the commercial fishing industry's continued fair and secure resource access to operating areas and markets (domestic and international), and social licence to operate. Public impacts are likely to be delivered through potential cost saving in fishery stock assessments, greater confidence in resource sharing decisions, reduced risk of environmental damage, increased researcher capacity, and a contribution to Australia's image as an effective fisheries manager.

Distribution of Private Impacts

Private impacts from the investment in project 2018-148 will accrue to commercial fishers and the supply chain. Supply chain beneficiaries will include fish cooperatives, wholesalers, fish processors, exporters, retailers, and consumers. The share of benefit retained by each member of the supply chain will depend on both short- and long-term supply and demand elasticities.

Impacts on Other Australian Industries

No direct impacts to other Australian industries beyond the commercial, recreational, and Indigenous fishing sectors were identified.

Impacts Overseas

The stock assessment Toolbox will be accessible to fisheries scientists and managers overseas, as well as organisations that seek to evaluate the maturity of Australian stock assessment capabilities. The website will allow access to best practice models and examples which have the potential to create the same types of impact identified in Table 1 in other countries. This will be particularly relevant to the US and New Zealand which share similar goals and approaches to stock management.

Match with National Priorities

Australian Agriculture, Science, and Research Priorities

The Australian Government's National Science and Research Priorities and Agricultural Innovation Priorities are reproduced in Table 4. Project 2018-148 contributed to National Science and Research Priorities 1 and 2. The project also contributed to Agricultural Innovation Priorities 2 and 4.

Table D4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities[9]	**National Agricultural Innovation Priorities**[10]
1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. **2. Soil and Water** – improving the use of soils and water resources, both terrestrial and marine. **3. Transport** – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. **4. Cybersecurity** – improving cybersecurity for individuals, businesses, government, and national infrastructure. **5. Energy and Resources** – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia's resources industries. **6. Manufacturing** – supporting the development of high value and innovative manufacturing industries in Australia. **7. Environmental Change** – mitigating, managing, or adapting to changes in the environment. **8. Health** – improving the health outcomes for all Australians.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia's agricultural innovation system to address by 2030. These priorities replace the Australian Government's Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. **1.** Australia is a trusted exporter of premium food and agricultural products by 2030. **2.** Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. **3.** Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. **4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

FRDC National RD&E Priorities

Through extensive consultation, the FRDC 2020-2025 RD&E Plan identified five key outcome areas. The five outcome areas were:

1. Growth for enduring prosperity.
2. Best practices and production systems.
3. A culture that is inclusive and forward thinking.
4. Fair and secure access to aquatic resources.
5. Community trust, respect, and value.

Project 2018-148 addressed outcome areas 2, 4 and 5.

[9] Source: 2015 Australian Government *Science and Research Priorities*. https://www.industry.gov.au/data-and-publications/science-and-research-priorities.

[10] Source: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment.

Valuation of Impacts

The decision to value an impact identified in Table 3 was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Impacts Valued

A single potential impact of investment in project 2018-148 was valued – cost saving in fishery stock assessments.

Valuation of Impact 1: Cost saving in fishery stock assessments

Project research has delivered a Toolbox that has the potential to increase the efficiency and consistency of fish and crustacean stock assessments. Fish stock assessments are resource intensive exercises with costs ranging widely depending on the complexity of the exercise. Estimates available from the literature suggest that cost can be less than $100,000 for a simple exercise to more than $2 million for more complex assessments. An average cost of $1.2 million has been used in this assessment.

Additional assumptions for the valuation of the impact are reported in Table 5.

Impacts Not Valued

The impacts not valued included:

- More accurate stock assessments with greater confidence in resource sharing decisions. Translating increased confidence in monetary values would require interviews with fisheries managers to better understand practical decision making in a representative sample of fisheries.
- More sustainable commercial, recreational, and Indigenous fishing. Long-term forecasts of stocks with and without use of the Toolbox would be required and these are not available to the analyst.
- Reduced risk of over-fishing and associated environmental damage. The extent of risk reduction was not known to the analyst.
- Increased researcher capacity in understanding and working with stock assessment models. Detailed study of changes in researcher knowledge and their application to projects is needed to estimate this benefit.
- Continued Australian support for the current social licence to fish and continued sustainable commercial access to Australian fisheries, as well as for recreational and Indigenous purposes. Changes in the value of social licence, especially for recreational and Indigenous fishers are difficult to estimate.
- Contribution/endorsement of Australia's image world-wide as being an effective fisheries manager. Estimation of this benefit would need survey information or reporting from agencies such as the United Nations and this data was not available to the assessment.

Summary of Assumptions

Table 5 describes the specific assumptions used in the valuation of impacts.

Table D5: Summary of Assumptions for the Valuation of Impact 1

Impact 1: Cost saving in the completion of fish stock assessments		
Variable	**Assumption**	**Source**
Pre-project cost of fish stock assessment.	$1,200,000 each.	FAO 2007 estimate for Marine Stewardship Certification $US10,000 to $US500,000. NOAA 2016 estimate of cost per stock assessment of $US1.7 million.
Cost saving associated with use of models and analyses compiled in project Toolbox.	2.5%	Analyst assumption.
Number of fish stock assessments making use of project Toolbox.	7 per year.	Analyst estimate after considering there are 477 separate stocks in Australia.
First year of project Toolbox use.	2021/22.	One year after project completion in 2020/21.
Period of impact – that is the number of years the tools in the Toolbox are updated and remain relevant.	15 years (2035/36 is last year of impact).	Analyst assumption – alternative technology is likely to be available after this time.
Attribution of impact to this project.	50%.	Analyst assumption – after considering contribution made by previous research (e.g., 2014-039 – Stock Assessment Integration: A Review).
Risk Factors		
Probability of output	100%	Toolbox website is live.
Probability of outcome	80%	Toolbox widely communicated to potential users.
Probability of impact	80%	There is some risk that cost saving will not occur.
Counterfactual		
It is assumed that the benefits estimated and attributable to the investment in FRDC Project 2018-148 would not have occurred without the investment.		

Results

All past costs and benefits were expressed in 2022/23-dollar terms. All costs and benefits were discounted to 2022/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2020/21) to the final year of benefits assumed.

Investment Criteria

Tables 6 and 7 show the investment criteria estimated for different periods of benefits for the total investment and FRDC investment respectively. The present value of benefits (PVB) for the FRDC investment was estimated by multiplying the total PVB cash flow by the proportion of FRDC investment in real, undiscounted dollar terms (68.3%).

Table D6: Investment Criteria for Total Investment in Project 2018-148

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.21	0.46	0.60	0.60	0.60	0.60
Present value of costs ($m)	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Net present value ($m)	-0.20	0.02	0.27	0.40	0.40	0.40	0.40
Benefit-cost ratio	0.00	1.08	2.36	3.07	3.07	3.07	3.07
Internal rate of return (%)	negative	6.1	26.5	29.0	29.0	29.0	29.0
MIRR (%)	negative	5.7	15.4	13.7	11.4	10.0	9.1

Table D7: Investment Criteria for FRDC Investment in Project 2018-148

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.14	0.32	0.41	0.41	0.41	0.41
Present value of costs ($m)	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Net present value ($m)	-0.13	0.01	0.18	0.28	0.28	0.28	0.28
Benefit-cost ratio	0.00	1.08	2.36	3.07	3.07	3.07	3.07
Internal rate of return (%)	negative	6.1	26.5	29.0	29.0	29.0	29.0
MIRR (%)	negative	5.7	15.4	13.7	11.4	10.0	9.1

The annual undiscounted benefit and cost cash flows for the total investment for the duration of investment period plus 30 years from the last year of investment are shown in Figure 1.

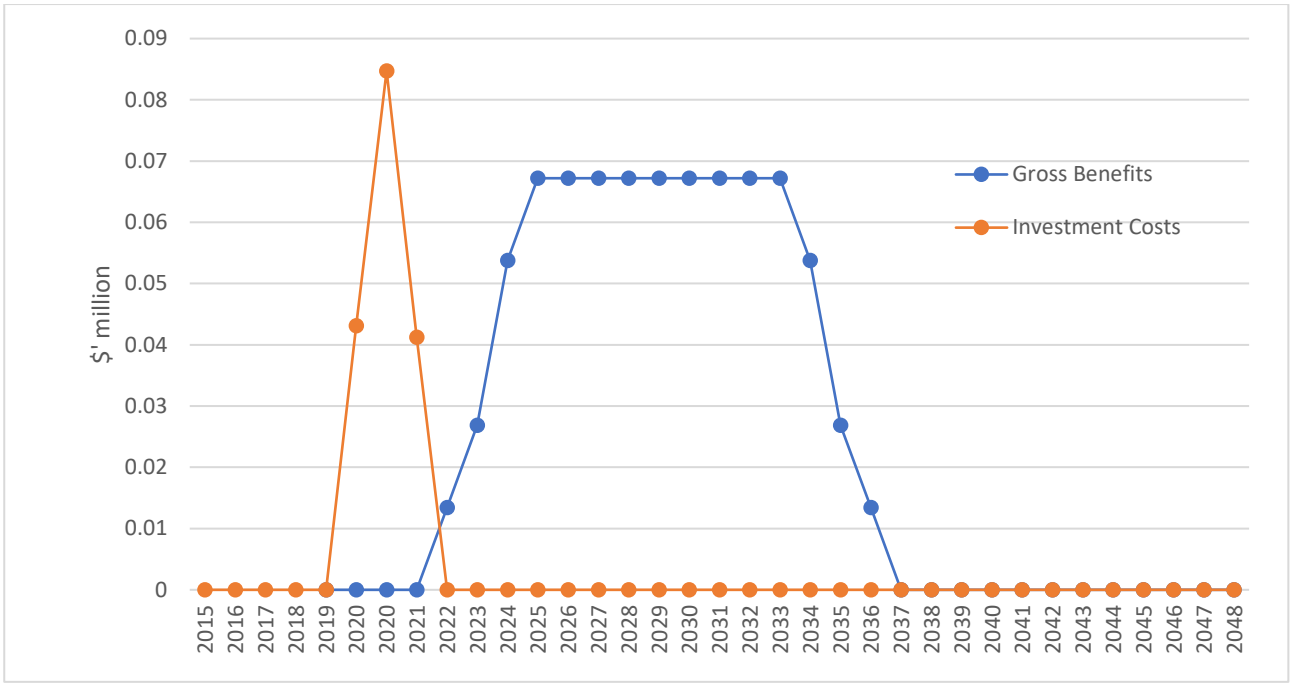

Figure D1: Annual Cash Flow of Undiscounted Total Benefits and Total Costs

Sensitivity Analyses

Sensitivity analyses were performed for variables that were considered (a) key drivers of the investment criteria, and/or (b) uncertain. Each sensitivity analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

A sensitivity analysis was carried out on the discount rate. The results, shown in Table 8, showed limited sensitivity to the discount rate. At the 10% discount rate project costs continue to exceed project benefits and show a favourable return on investment.

Table D8: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	**Discount rate**		
	0%	**5% (base)**	**10%**
Present value of benefits ($m)	0.79	0.60	0.47
Present value of costs ($m)	0.17	0.20	0.23
Net present value ($m)	0.62	0.40	0.25
Benefit-cost ratio	4.69	3.07	2.10

A sensitivity analysis then was carried out on the assumed number of fish stock assessments completed using the Toolbox each year. Table 9 shows the results. Project benefits continue to exceed project costs if only 3 fish stock assessments are completed using the Toolbox each year.

Table D9: Sensitivity to Number of Fish Stock Assessments Completed Using Toolbox
(Total investment, 5% discount rate, 30 years)

Investment Criteria	**Number of Stock Assessments using Toolbox**		
	3	**7 (base)**	**10**
Present value of benefits ($m)	0.26	0.60	0.86
Present value of costs ($m)	0.20	0.20	0.20
Net present value ($m)	0.06	0.40	0.66
Benefit-cost ratio	1.31	3.07	4.38

A final sensitivity analysis was undertaken on the cost saving associated with use of the Toolbox. The results, presented in Table 10, show that project benefits continue to exceed project costs if cost saving per assessment is only 1%.

Table D10: Sensitivity to Cost Saving Associated with Use of Toolbox
(Total investment, 5% discount rate, 30 years)

Investment Criteria	**Cost Saving Associated with Toolbox**		
	1%	**2.5% (base)**	**5%**
Present value of benefits ($m)	0.24	0.60	1.20
Present value of costs ($m)	0.20	0.20	0.20
Net present value ($m)	0.04	0.40	1.01
Benefit-cost ratio	1.23	3.07	6.13

Confidence Rating and Other Findings

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 11). The rating categories used are High, Medium, and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table D11: Confidence in Analysis of Investment

Coverage of Benefits	Confidence in Assumptions
Medium	Medium

The coverage of benefits was assessed as Medium. The impact valued was deemed to be the most important from the investment.

Confidence in assumptions was rated as Medium. Many of the valuation assumptions were underpinned by credible data. However, because the investment was only recently completed, there was no evidence of actual outcomes and impacts. This meant that a number of the assumptions used in the valuation were uncertain.

Conclusions

Project 2018-148 has delivered a single platform that summarises the features of 67 current stock assessment packages in a consistent manner. Packages have been placed into ten classes, worked examples provided and state-of-the-art approaches noted. Use of the stock assessment toolbox to assess Australian fish stocks has the potential to increase the efficiency and consistency of fish and crustacean assessments. Project 2018-148 has contributed to:

- A potential cost saving in fishery stock assessments.
- More accurate stock assessments with greater confidence in resource sharing decisions.
- More sustainable commercial, recreational, and Indigenous fishing.
- Reduced risk of over-fishing and associated environmental damage.
- Increased researcher capacity in understanding and working with stock assessment models.
- Continued Australian support for the current social licence to fish and continued sustainable commercial access to Australian fisheries, as well as for recreational and Indigenous purposes.
- Contribution/endorsement of Australia's image world-wide as being an effective fisheries manager.

Total funding for the Project was $0.2 million (present value terms) and produced total expected net benefits of $0.6 million (present value terms). This produced an estimated net present value of $0.4 million, a benefit-cost ratio of 3.1 to 1, an internal rate of return (IRR) of 29%, and a modified IRR of 9.1% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2018-148. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

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Appendix E: An Impact Assessment of Investment in FRDC Project 2018-164

Acknowledgments

ACRE Economics would like to thank Patrick Hone (Managing Director), and Jennifer Marshall (Cross-Functional Facilitator) of the Fisheries Research and Development Corporation for facilitating contact with relevant project personnel and for their guidance and feedback throughout the impact assessment process.

Project leader Matthew Cunningham, General Manager, Australian Seafood Industries Pty Ltd was contacted to review the working draft.

Abbreviations

2n	Diploid
3n	Triploid
4n	Tetraploidy
ABS	Australian Bureau of Statistics
ASI	Australian Seafood Industries Pty Ltd
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EBV	Estimated Breeding Value
FRDC	Fisheries Research and Development Corporation
MIRR	Modified Internal Rate of Return
NSW	New South Wales
NSW DPI	New South Wales Department of Primary Industries
OsHV-1	Ostreid Herpesvirus-1
POMS	Pacific Oyster Mortality Syndrome
PVB	Present Value of Benefits
RD&E	Research, Development, and Extension

Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*. The assessment was completed as part of a cost-benefit analysis for inclusion in the FRDC 2022-23 Annual Report. The assessment was made up of six FRDC RD&E projects.

The impact assessment 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 assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations.

FRDC Project 2018-164 was funded to support and investigate an innovative program where highly POMS resistant triploid Pacific oyster spat were produced directly via induction in Tasmania and then shipped utilising the export/import protocols in place between Tasmania and Hawkesbury River NSW for Hawkesbury River farmers to evaluate, under large scale protocols, and test the commercial viability of the new POMS resistant genetics.

Despite some challenges due to flooding during the project period, the investment produced useful knowledge and other outputs and has contributed to positive impacts, including:

- Increased rate of recovery of Pacific oyster production in affected regions. This impact is driven by increased producer awareness of and confidence in the availability of POMS resistant spat, improving interstate import/export processes for spat, and improved data on commercial performance of POMS resistant family lines in POMS affected areas to enhance breeding program outcomes.
- Increased knowledge and scientific capacity associated with the movement and commercial trial of disease resistant oyster spat.
- Improved community well-being through the regional spill-over benefits of the recovery and maintenance of the Australian Pacific oyster industry in POMS affected areas.

Total funding for the Project was $0.18 million (present value terms), with an FRDC contribution of $0.12 million (present value terms). The investment produced total expected net benefits of $0.39 million (present value terms). This gave an estimated net present value of $0.20 million, a benefit-cost ratio of 2.1 to 1, an internal rate of return (IRR) of 4.0%, and a modified IRR of 7.5% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made, the fact that two impacts were not valued in monetary terms, and that sensitivity analyses showed that the results remained positive even when more pessimistic/ conservative assumptions were tested, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2018-164 and the positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

Introduction

The Fisheries Research and Development Corporation (FRDC) required a series of cost-benefit analyses of selected research, development, and extension (RD&E) investments (projects) for inclusion in the FRDC 2022/23 Annual Report. The assessments were completed to contribute to the following FRDC evaluation reporting requirements:

- Reporting against the FRDC 2020-2025 RD&E Plan and the Evaluation Framework associated with FRDC's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to FRDC funding partners and other stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).
- Reporting RD&E impact and performance to FRDC levy payers and other fisheries and aquaculture stakeholders as well as the broader Australian community.

In August 2023, FRDC commissioned ACRE Economics Pty Ltd and associates to undertake cost-benefit analyses (CBAs) of six RD&E projects. The projects were selected to span the five 'Outcomes' of the FRDC Research and Development (R&D) Plan 2020-2025 with an additional project selected for Outcome 1 (Growth for enduring prosperity) where the largest proportion of FRDC investment was allocated. The six selected projects had a total estimated value of $0.69 million (FRDC investment, nominal dollar terms) and were funded over the period 2016/17 to 2020/21.

The sample selected (six projects) comprises a relatively small proportion of the FRDC's total RD&E investment (~5%) of the relevant population and may, therefore, not be fully representative of the entire RD&E Portfolio. However, the projects evaluated provide insight into the activities and outputs associated with each of FRDC's RD&E Programs, and the outcomes and impacts (and benefits) created. In turn, this will enable communication of benefits of FRDC RD&E to the FRDC Board, funding partners including the Commonwealth, industry, and other stakeholders.

The six projects selected by FRDC for evaluation in calendar 2023 were:

1. 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*
2. 2016-261: *Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry*
3. 2018-164: *Our Pledge: Australian seafood industry response to community values and expectations*
4. 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*
5. 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*
6. 2018-205: *Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*

This report presents the assessment process and findings for 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*.

Evaluation Framework

The annual impact assessments of FRDC RD&E investments 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 assessment components that are in accord with the current guidelines for impact assessment published by the CRRDC (CRRDC, 2018).

The evaluation process utilised an input to impact continuum RD&E project inputs (costs), objectives, activities, and outputs were briefly described and documented. Actual and expected outcomes, and any actual and/or potential future impacts (positive and/or negative) associated with project outcomes then were identified and described. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework and validated through consultation with expert personnel and review of published literature.

Once impacts were identified and validated, an assessment then was made about whether to quantify/value any of the impacts in monetary terms as part of the project-level analysis. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where one or more of the identified impacts were selected for valuation, the impact assessment used CBA as a principal tool. The impacts valued therefore were deemed to represent the principal benefits delivered by the project investment. However, as not all impacts were valued (based on the selection criteria), the investment criteria estimated for the project investment evaluated are likely to represent an underestimate of the true performance of the FRDC project.

The qualitative and quantitative analysis processes, data sources, assumptions, specific valuation frameworks (where applicable), and evaluation results were clearly documented and then integrated into a written report.

Project Background

Background

The viral disease known as Pacific Oyster Mortality Syndrome (POMS), caused by infection with a microvariant genotype of ostreid herpesvirus-1 (OsHV-1), was first diagnosed in Australia in the Georges River in New South Wales (NSW) in 2011 and then in the Hawkesbury River in NSW in 2013 and Tasmania in February 2016. The disease had significant negative impacts on the Australian Pacific oyster industry, particularly in the Hawkesbury River where losses of up to 98% of oyster stock occurred and POMS losses were compounded by farmers' inability to access QX[11] resistant Sydney Rock Oysters for the next two seasons. Ongoing monitoring has confirmed that the POMS virus (and QX) persists in the wild stocks in the river systems.

The hatcheries that produce most of the Pacific oyster spat for Australia and that supply the Hawkesbury River triploid (3n) Pacific oysters are based in Tasmania. Since POMS was first diagnosed in Australia, Hawkesbury River growers have collaborated with Australian Seafood Industries Pty Ltd (ASI), leader of the Australian-wide Pacific oyster selective breeding program, and other research institutes (including NSW Department of Primary Industries (NSW DPI), Sydney University, Macquarie University) for the development and selection of POMS resistant Pacific oysters.

[11] QX is a seasonally occurring disease of Sydney Rock Oysters (*Saccostreaglomerata*) that has impacted a number of estuaries in NSW. QX stands for "Queensland Unknown" and the term has been in use since the 1960s when mortalities were first observed in cultivated oysters in southeast Queensland prior to the cause being identified (NSW Department of Industry, n.d.(a)).

However, Hawkesbury River grower access to the high-level POMS resistance genetics was difficult because the research and Pacific oyster breeding program for NSW were based in Port Stephens (NSW) where POMS was not present. Importation of resistant parent lines into Port Stephens was not possible because of existing biosecurity import/export restrictions between NSW and Tasmania. Access to POMS resistant triploid pacific oysters was made even more challenging for NSW farmers due to the extensive timelines and complexities associated with producing suitable 4n (tetraploidy) and 2n (diploid) parent lines under prevailing spat import protocols to supply triploid spat to the Hawkesbury River. Thus, by 2018/19, triploid Pacific oysters incorporating the highly resistant parent lines had not been commercially evaluated anywhere in Australia.

Rationale for Project 2018-164

FRDC Project 2018-154 was funded to support and investigate an innovative program proposed by Hawkesbury River farmers utilising relatively new triploid induction technology available via Cameron's Nursery[12] in Tasmania. Cameron's was to produce highly resistant triploid Pacific oyster spat directly via induction and utilising the export/import protocols in place between Tasmania and Hawkesbury River NSW for Hawkesbury River farmers to evaluate, under large scale protocols, and test the commercial viability of the new POMS resistant genetics. Further, the project funding would enable Hawkesbury River growers to access, import, and fairly assess and record survival and performance data and to provide meaningful feedback to ASI on the ability of the selected POMS resistant family lines to withstand environmental infection of POMS under commercial growing conditions.

Project Details

Summary

Project Code: 2018-164

Title: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*

Research Organisation: ASI

Principal Investigator: Matthew Cunningham, General Manager, ASI

Period of Funding: March 2019 to April 2020

FRDC Program Allocation: Industry (100%)

Objectives

The specific objectives of the project were to:

1. Determine if POMS resistant triploid ASI oysters can improve the commercial viability of POMS affected NSW oyster farms, especially the Hawkesbury River.
2. Develop with ASI/CSIRO a recording and reporting format to assess the performance of triploid POMS resistant ASI Pacific Oyster spat cultured in the Hawkesbury River under commercial growing conditions.
3. Data collected from farms will determine performance and survival of predicted high POMS resistant triploid ASI Pacific Oysters cultured in POMS affected NSW oyster farms.
4. Develop protocols to test/sample for OsHV-u1, that are incorporated into regular assessment processes, to ensure that results can be reflected against a known challenge to POMS.

[12] Cameron of Tasmania is a hatchery and nursery that is a major producer and supplier of seed oysters to Tasmania and South Australia. For more information see: http://www.cameronsoysters.com/html/history.html

Logical Framework

Table E1: Logical Framework for FRDC Project 2018-164

Activities	• A commercial production trial with high POMS tolerant triploid Pacific oysters in approved NSW estuaries was undertaken between April 2019 and July 2020. • Triploid Pacific oyster spat was successfully produced through direct induction techniques by Cameron of Tasmania at their bio-secure hatchery in Tasmania. • Highly resistant ASI family lines using YC15 families with estimated breeding values[13] (EBVs) for POMS resistance between 80% and 90% were used in the production of the triploid spat in January 2019. • The project team worked with the Tasmanian and NSW authorities to extend the existing NSW import protocol for oyster spat to allow Cameron of Tasmania to ship the trial batch to the Hawkesbury River growers. • The triploid spat then was subjected to, and passed, the biosecurity requirements for shipment to NSW. • Spat were received by ten participating growers from the Hawkesbury River estuary on the 17th or 18th of April 2019. Each grower received approximately 200,000 spats, divided over two size classes; 1.6 mm (~60,000 spat) and 2 mm (~140,000 spat). The number of spat allocated to each grower was estimated by weight. • The spat received by each participating grower were farmed on their own oyster farming leases and maintained at a commercial density and in units typically used by each grower to effectively capture a 'proof of product' test and assess the commercial viability of the spat. • A data reporting template was developed and provided to each grower to record the data that was required to understand individual farming practices, stock management and survivorship and growth of the triploid spat. • POMS activity was documented by growers throughout the trial.
Outputs	• Over the project trial period (April 2019 to April 2020), the first reported oyster mortality event occurred in late November 2019 with five percent mortality of 6mm stock held in intertidal baskets. No other mortality was noted until late December 2019. • A separate grower noted up to 30% mortality in 12 mm stock unrelated to the ASI trial. Tissue samples were collected but not immediately tested for OsHV-1 as the laboratory was closed for the Christmas period. • A third grower reported between 30% and 40% mortality of 6mm stock from the ASI trial that were held in floating baskets in early January 2020. Samples were collected and returned a negative result for OsHV-1. • On February 7th, 2020, the Hawkesbury River catchment received 340mm of rainfall over a four-day period. The Hawkesbury River and its estuaries were subjected to extensive flooding with freshwater. • Salinity levels were monitored by growers and were found to have decreased to zero at the mouth of the Hawkesbury River. Stock was submerged for excessive periods of time during the flood event. Further, the Hawkesbury River catchment received a further 230 mm of rainfall over the following two months which prolonged the effects of the flood event. The estuary was not reopened for commercial harvest and stock sales until May 1st, 2020.

[13] Estimated Breeding Values (EBVs) allow primary producers to evaluate an animal's genetic potential for a range of traits that directly impact on the profitability of the production enterprise. EBVs typically are calculated based on the lineage and performance data of a parental line's progeny and family in relation to a range of genetic traits.

	• According to normal practices, stock was not handled during or after the flood event for a period of time deemed suitable for recovery. Handling time-points varied between growers. Consequently, it was not possible for some growers to count the mortality of the triploid stock directly following the flood event. • A similar approach was taken by the growers not to handle their stock following the first POMS event. Most farmers hadn't worked their oysters after the mortality event in January 2020 or before the flood event. Thus, it was difficult to get figures on whether the mortality recorded in the data sheets was due to the POMS event or the flood event for that time period. • Growers had reported growth, including a volume explosion and excellent winter growth prior to both events (POMS and flooding). • A second POMS event was reported by a number of growers in late April 2020. • Growers received spat, unrelated to the ASI trial, in the first week of April. Growers recorded close to 100% mortality of the spat by the end of the month. • Tissue samples were collected and returned a positive result for OsHV-1 when tested by NSW DPI. • There were no reports of mortality in the ASI trial, though this may have been due to a reduction in the number of growers maintaining observations and reporting data. • The project team observed that that the Cameron of Tasmania trial stock (10 months old at the time of the second POMS event) showed high resistance for the second POMS event with very few losses compared to nearby younger stock (weeks old) from others exhibiting 90 percent mortality. • Although the trial was affected by an unforeseen and major flood event that impacted data collection, there was evidence of ASI spat survival following a POMS outbreak. • Growers recorded between 50% to 70% survival of spat following the first POMS event, which was predominantly restricted to smaller size classes. • Four growers continued to monitor their trial oysters in to 2020, following the second POMS event. These four growers recorded between 10% and 45% of the original allocation of spat had survived to at least April when stock was last checked. • Other growers did not continue to monitor stock following the flood event and consequently, had no record of mortality following the second POMS outbreak. The majority of these growers recorded major mortalities (in excess of 50%) following the flood event. • Some growers did not sample between the POMS and flood events which restricted the data available to the project. • Growers overall were happy with the survival of the spat given the disease and environmental stress events experienced during the trial. • Though the trial indicated potential for predicted high POMS resistant triploid ASI Pacific oysters in the Hawkesbury River estuary, it also highlighted the importance of farm management practices.
Outcomes	• Pacific oyster farmers in NSW have increased confidence that they will have a future growing triploid Pacific oyster with high POMS resistant spat that have demonstrated only 50% mortality (due to POMS). • Further, the trial increased NSW producer awareness of and confidence in the continued improvement each year in the family lines of high POMS resistant Pacific oyster spat available to them. • In conjunction with advances in QX resistance in Sydney Rock Oysters in the Hawkesbury region, in particular, the findings of Project 2018-164 increased confidence that the NSW industry can be reinvigorated in terms of oyster farming activity.

Impacts (Potential)	• Increased rate of recovery of Pacific oyster production in affected regions. This impact is driven by increased producer awareness of and confidence in the availability of POMS resistant spat, improving interstate import/export processes for spat, and improved data on commercial performance of POMS resistant family lines in POMS affected areas to enhance breeding program outcomes. • Increased knowledge and scientific capacity associated with the movement and commercial trial of disease resistant oyster spat. • Contribution to improved community well-being through the regional spill-over benefits of the recovery and maintenance of the Australian Pacific oyster industry in POMS affected areas.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2018-164 by FRDC and other contributors. Other contributors included ASI and Cameron of Tasmania.

Table E2: Total Investment in FRDC Project 2018-164
(nominal dollar terms)

Year ended 30 June	FRDC ($)	Others ($)	Total ($)
2019	50,000	5,040	55,040
2020	20,000	45,000	65,000
Totals	**70,000**	**50,040**	**120,040**

Source: FRDC project 2018-164 documentation.

Management and Administration 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 (x1.179). This multiplier was estimated based on a five-year average of the ratio of total FRDC cash expenditure to project expenditure reported in the FRDC's Cash Flow Statement (FRDC Annual Reports, 2018-2022). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of 1.00 was used for administration and management costs for other contributors.

Real Investment and Extension Costs

For the purposes of the impact analysis, the investment costs of all parties were expressed in 2022/23-dollar terms using the Implicit Price Deflator for Gross Domestic Product (Australian Bureau of Statistics (ABS), 2023).

No additional costs of extension were included as the outputs and outcomes of Project 2018-164 were extended through regular updates to project participants who were ultimately the beneficiaries of the project.

Impacts

Table 3 provides a summary of the principal types of potential impacts from Project 2018-164. Impacts have been taken, and potentially expanded, from those listed in Table 1 and categorised using a triple bottom line framework into economic, environmental, and social impact types.

Table E3: Principal Potential Impact Types from Investment in FRDC Project 2018-164

Economic	• Increased rate of recovery of Pacific oyster production in affected regions. This impact is driven by increased producer awareness of and confidence in the availability of POMS resistant spat, improving interstate import/export processes for spat, and improved data on commercial performance of POMS resistant family lines in POMS affected areas to enhance breeding program outcomes.
Environmental	• Nil.
Social	• Increased knowledge and scientific capacity associated with the movement and commercial trial of disease resistant oyster spat. • Contribution to improved community well-being through the regional spill-over benefits of the recovery and maintenance of the Australian Pacific oyster industry in POMS affected areas.

Public versus Private Impacts

The impacts identified from Project 2018-164 were both private and public impacts. Private impacts will be delivered through improved productivity and profitability for the Australian Pacific oyster industry through increased rate of recovery for regions devastated by POMS.

Public impacts are expected to be achieved through increase knowledge and capacity and, potentially, spill over benefits to regional communities from the recovery and maintenance of the Pacific oyster industry.

Distribution of Private Impacts

In the short-term, private impacts from the investment in Project 2018-164 accrue to Pacific oyster farmers in POMS affected regions, particularly in NSW, and their direct supply chains. Over the longer term, private benefits will be distributed along Pacific oyster supply chains more broadly according to relevant supply and demand elasticities.

Impacts on Other Australian Industries

No direct impacts to other Australian industries beyond the Pacific oyster industry were identified. However, there may be knowledge spill overs or other synergies associated oyster breeding programs and movement and trial of advanced spat that could benefit other farmed oyster sectors, such as Syndey Rock Oysters, in the longer term.

Impacts Overseas

No direct impacts to overseas parties were identified.

Match with National Priorities

Australian Agriculture, Science, and Research Priorities

The Australian Government's National Science and Research Priorities and Agricultural Innovation Priorities are reproduced in Table 4. Project 2018-164 contributed to National Science and Research Priority 1. Further, the RD&E investment contributes indirectly to Agricultural Innovation Priorities 1 and 3.

Table E4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities[14]	**National Agricultural Innovation Priorities**[15]
1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. **2. Soil and Water** – improving the use of soils and water resources, both terrestrial and marine. **3. Transport** – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. **4. Cybersecurity** – improving cybersecurity for individuals, businesses, government, and national infrastructure. **5. Energy and Resources** – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia's resources industries. **6. Manufacturing** – supporting the development of high value and innovative manufacturing industries in Australia. **7. Environmental Change** – mitigating, managing, or adapting to changes in the environment. **8. Health** – improving the health outcomes for all Australians.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia's agricultural innovation system to address by 2030. These priorities replace the Australian Government's Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. **1.** Australia is a trusted exporter of premium food and agricultural products by 2030. **2.** Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. **3.** Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. **4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

FRDC National RD&E Priorities

Through extensive consultation, the FRDC 2020-2025 RD&E Plan identified five key outcome areas. The five outcome areas were:

1. Growth for enduring prosperity.
2. Best practices and production systems.
3. A culture that is inclusive and forward thinking.
4. Fair and secure access to aquatic resources.
5. Community trust, respect, and value.

Project 2018-164 addressed outcome areas 1 and 2, with some contribution to outcome 4.

[14] Source: 2015 Australian Government *Science and Research Priorities*. https://www.industry.gov.au/data-and-publications/science-and-research-priorities.

[15] Source: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment.

Valuation of Impacts

The valuation of impacts generally focused on the most important and direct impacts of the investment in project 2018-164. The decision to value any of the impacts identified in Table 3 was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Impacts Valued

One impact was valued for the assessment of Project 2018-164. The impact valued was:

- The investment's contribution to an increased rate of recovery of Pacific oyster production in POMS affected regions.

Valuation of Impact 1: Increased rate of recovery of oyster production

In NSW, POMS has been confirmed in three Pacific oyster producing estuary systems, Botany Bay/Georges River, Hawkesbury River, and Brisbane Water. POMS also has been confirmed in wild Pacific oysters in Sydney Harbour/Paramatta River, where oyster farming does not occur (NSW Department of Industry , n.d.(b)).

The valuation of an increased rate of recovery for Pacific oyster production focused on production in the Hawkesbury River and was underpinned by the current and expected future production of Pacific oysters taking into account Project 2018-164 contribution to increased producer awareness of and confidence in the availability of POMS resistant spat, improving interstate import/export processes for spat, and improved data on commercial performance of POMS resistant family lines in POMS affected areas to enhance breeding program outcomes.

Figure 1 shows the historical trend in Pacific oyster production for the Hawkesbury River from 2010 to 2022. Specific assumptions for valuing the impact are provided in Table 5.

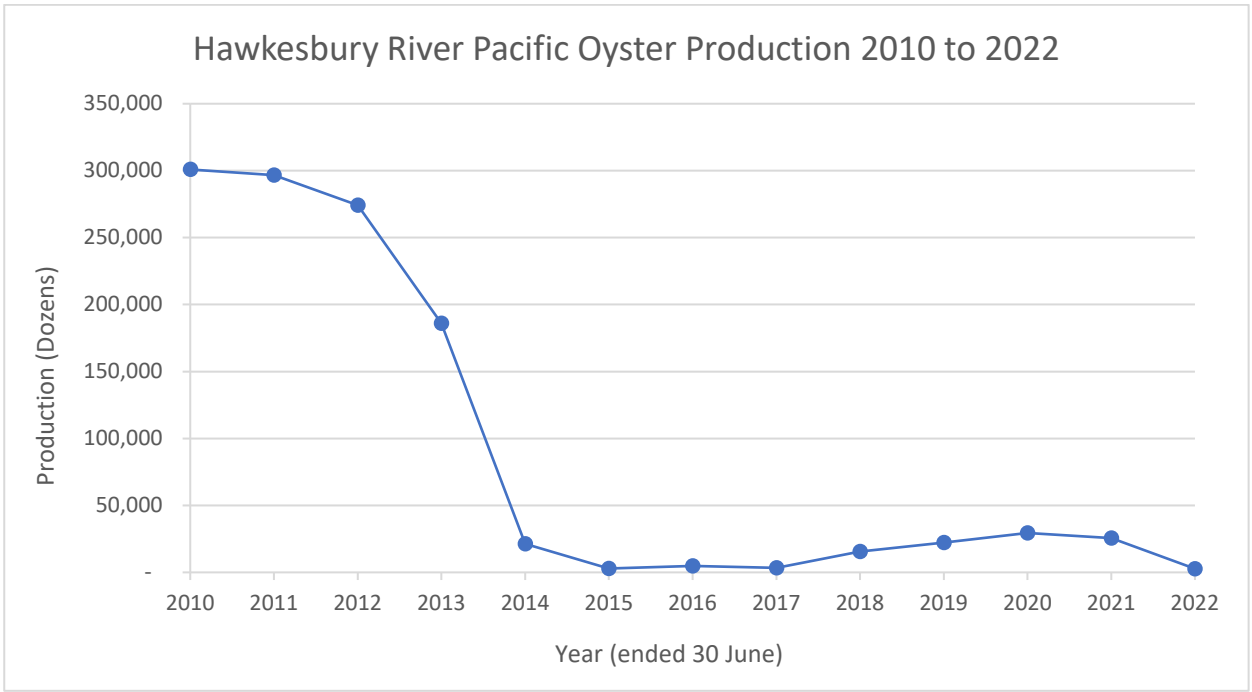

Figure E1: Hawkesbury River Pacific Oyster Production Over Time (2010 to 2022)
Source: Derived from NSW aquaculture production data 2010-2022 (NSW Department of Industry, n.d.(c))

Impacts Not Valued

The impacts not valued included:

- Increased knowledge and scientific capacity associated with the movement and commercial trial of disease resistant oyster spat.
- Contribution to improved community well-being through the regional spill-over benefits of the recovery and maintenance of the Australian Pacific oyster industry in POMS affected areas.

Summary of Assumptions

The following tables present the specific assumptions used in the valuation of Impact 1.

Table E5: Summary of Assumptions for the Valuation of Impact 1

Variable	Assumption	Source
BASELINE DATA (STATUS QUO – WITHOUT PROJECT 2018-164)		
Historic Pacific oyster production for the Hawkesbury River by year (dozens)		
2010	300,875	NSW DPI, Aquaculture Production Reports 2009-10 to 2021-22 (see Figure 1)
2011	296,620	
2012	274,181	
2013	186,093	
2014	21,221	
2015	2,855	
2016	4,745	
2017	3,373	
2018	15,492	
2019	22,264	
2020	29,390	
2021	25,665	
2022	2,745	
Production recovery trend equation (rate of recovery)	y = 2245.9x + 3209.7 where x = 1 for 2014/15 y = production (dozens) Rate of recovery = 2,246 dozen per annum	Based on recovering production trend in the Hawkesbury over the period 2015 to 2022 (see Figure 1) following peak losses after POMS was first diagnosed in NSW (2011/12 to 2013/14).
Average farm-gate price of Hawkesbury Pacific oysters	$13.00 per dozen	NSW DPI, Aquaculture Production Report 2022, average price of small and medium Pacific Oysters from Hawkesbury River (constituting approximatley 95% of sales)
WITH PROJECT 2018-164		
First year of impact	2021/22	Year after the last year of investment in project 2018-164 and publication of project report and findings.
Increased rate of recovery from project outputs and outcomes	1.5x the base rate of recovery (3,369 dozen per annum production increase)	Analyst assumption – 1.5 x est. base production recovery trend of 2,246 dozen per annum (see sensitivity analyses for further investigation).
Maximum level of production recovery for Hawkesbury Pacific oyster industry (production ceiling given presence of POMS)	80% of average, pre-POMS outbreak production	Analyst assumption - based on a 80% resistance target for new diploid varieties of Pacific oysters through the ASI breeding program (ASI, 2023)

Variable	Assumption	Source
Maximum potential future production for Hawkesbury River	172,638 dozen	80% x 215,798 dozen (2010 to 2014 average Hawkesbury River Pacific oyster production – prior to POMS diagnosis in NSW)
Other Economic Factors		
Attribution of benefits to specific investment in Project 2018-164	There have been multiple investments associated with POMS and aiding the recovery and economic sustainability of the NSW and broader Pacific oyster industry. Thus, given the specific assumptions used to value Impact 1, it was assumed that **20%** of the estimated benefits were directly attributable to the investment in Project 2018-164.	
Counterfactual – without investment in Project 2018-164	Due to the size of the Australian Pacific oyster industry and nature of funding for Pacific oyster RD&E, it was assumed that, without the investment in FRDC Project 2018-164, the estimated total expected net benefits would **not** have occurred.	
Probability of output.	100%	Based on completion of Project 2018-164 and the creation of useful RD&E outputs.
Probability of outcome.	90%	Refers to the likelihood that outputs of the project are adopted/used as estimated. Based on active producer engagement in Project 2018-164 and evidence of superior performance of POMS resistant spat in commercial settings in the Hawkesbury River.
Probability of impact.	90%	Allows for exogenous factors that may affect the realisation impacts as estimated (e.g., climate change, extreme weather events, other biosecurity incursions, etc.).

Results

All past costs and benefits were expressed in 2022/23-dollar terms. All costs and benefits were discounted to 2022/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2019/20) to the final year of benefits assumed.

Investment Criteria

Tables 6 and 7 show the investment criteria estimated for different periods of benefits for the total investment and FRDC investment respectively. The present value of benefits (PVB) for the FRDC investment was estimated by multiplying the total PVB cash flow by the proportion of FRDC investment in real, undiscounted dollar terms (62.5%).

Table E6: Investment Criteria for Total Investment in Project 2018-164

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.01	0.05	0.12	0.21	0.30	0.39
Present value of costs ($m)	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Net present value ($m)	-0.18	-0.18	-0.13	-0.06	0.02	0.11	0.20
Benefit-cost ratio	0.00	0.04	0.28	0.67	1.13	1.61	2.08
Internal rate of return (%)	negative	negative	negative	negative	0.9	2.9	4.0
MIRR (%)	negative	negative	negative	2.4	5.6	6.9	7.5

Table E7: Investment Criteria for FRDC Investment in Project 2018-164

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.00	0.03	0.08	0.13	0.19	0.24
Present value of costs ($m)	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Net present value ($m)	-0.12	-0.11	-0.08	-0.04	0.01	0.07	0.12
Benefit-cost ratio	0.00	0.03	0.28	0.66	1.12	1.59	2.06
Internal rate of return (%)	negative	negative	negative	negative	0.8	2.8	3.9
MIRR (%)	negative	negative	negative	2.3	5.6	6.9	7.5

The annual undiscounted benefit and cost cash flows for the total investment for the duration of investment period plus 30 years from the last year of investment are shown in Figure 2.

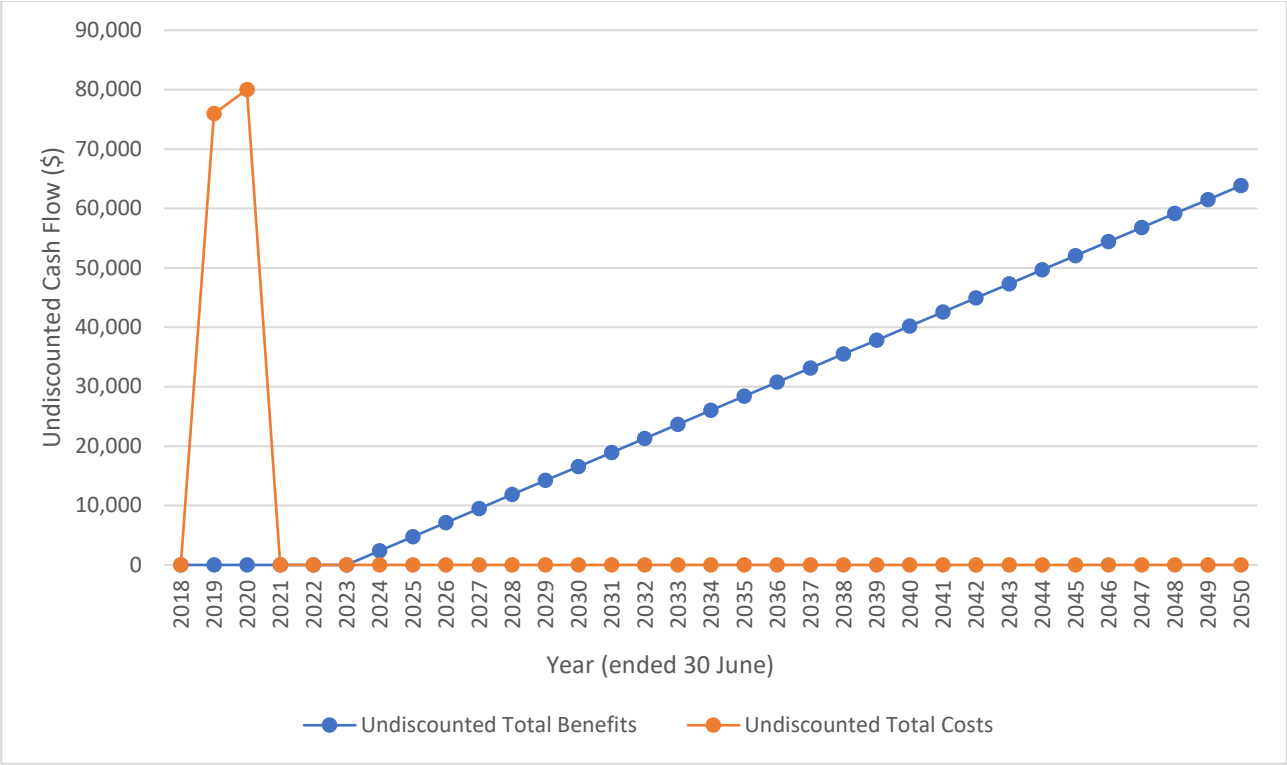

Figure E2: Annual Cash Flow of Undiscounted Total Benefits and Total Costs

Sensitivity Analyses

Sensitivity analyses were performed for variable that were considered (a) key drivers of the investment criteria, and/or (b) uncertain. Each sensitivity analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

A sensitivity analysis was carried out on the discount rate. The results, shown in Table 8, showed a moderate to high sensitivity to the discount rate. This was largely due to the benefit cash flows occurring into the future and therefore being subject to relatively more severe discounting.

Table E8: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	**Discount rate**		
	0%	**5% (base)**	**10%**
Present value of benefits ($m)	0.89	0.39	0.19
Present value of costs ($m)	0.16	0.18	0.22
Net present value ($m)	0.74	0.20	-0.03
Benefit-cost ratio	5.73	2.08	0.88

A sensitivity analysis then was carried out on the increase in the rate of recover for Pacific oyster production in the Hawkesbury River as this was uncertain and a key driver of the investment criteria. Table 9 shows the results. The investment criteria showed a moderate sensitivity to the assumed increase to the rate of recovery for Pacific oyster production. A break-even analysis indicated that the assumed increase in the rate of recovery (base of x1.5) could decline to x1.24 and the investment criteria would remain positive (benefit-cost ratio of at least 1 to 1) with all other assumptions held at their base values.

Table E9: Sensitivity to the Increase in the Rate of Recover for Pacific Oyster Production
(Total investment, 5% discount rate, 30 years)

Investment Criteria	**Increase in the Rate of Recover for Pacific Oyster Production**		
	1.2x	**1.5x (base)**	**1.8x**
Present value of benefits ($m)	0.15	0.39	0.62
Present value of costs ($m)	0.18	0.18	0.18
Net present value ($m)	-0.03	0.20	0.43
Benefit-cost ratio	0.83	2.08	3.33

Confidence Rating and Other Findings

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 10). The rating categories used are High, Medium, and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made

Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made

Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table E10: Confidence in Analysis of Investment

Coverage of Benefits	Confidence in Assumptions
Medium-High	Medium

The coverage of benefits was assessed as Medium to High. One of three impacts was valued and the impact valued was considered the most direct and important benefit of the investment in Project 2018-164.

Confidence in assumptions was rated as Medium. Much of the data and assumptions used in the CBA were developed using credible, published sources and expert opinion. However, as the project ended in 2019/20 there was scarce evidence/data on actual outcomes and impacts. Despite some uncertainty, sensitivity analyses showed that, even at more conservative values, the investment criteria were positive.

Conclusions

FRDC Project 2018-164 was funded to support and investigate an innovative program where highly POMS resistant triploid Pacific oyster spat were produced directly via induction in Tasmania and then shipped utilising the export/import protocols in place between Tasmania and Hawkesbury River NSW for Hawkesbury River farmers to evaluate, under large scale protocols, and test the commercial viability of the new POMS resistant genetics.

Despite some challenges due to flooding during the project period, the investment produced useful knowledge and other outputs and has contributed to positive impacts, including:

- Increased rate of recovery of Pacific oyster production in affected regions. This impact is driven by increased producer awareness of and confidence in the availability of POMS resistant spat, improving interstate import/export processes for spat, and improved data on commercial performance of POMS resistant family lines in POMS affected areas to enhance breeding program outcomes.
- Increased knowledge and scientific capacity associated with the movement and commercial trial of disease resistant oyster spat.
- Improved community well-being through the regional spill-over benefits of the recovery and maintenance of the Australian Pacific oyster industry in POMS affected areas.

Total funding for the Project was $0.18 million (present value terms), with an FRDC contribution of $0.12 million (present value terms). The investment produced total expected net benefits of $0.39 million (present value terms). This gave an estimated net present value of $0.20 million, a benefit-cost ratio of 2.1 to 1, an internal rate of return (IRR) of 4.0%, and a modified IRR of 7.5% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made, the fact that two impacts were not valued in monetary terms, and that sensitivity analyses showed that the results remained positive even when more pessimistic/ conservative assumptions were tested, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2018-164 and the positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

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Appendix F: An Impact Assessment of Investment in FRDC Project 2018-205

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Abbreviations

CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
FRDC	Fisheries Research and Development Corporation
IRR	Internal Rate of Return
ITQ	Individual Transferable Quota
MIRR	Modified Internal Rate of Return
NSW	New South Wales
RD&E	Research, Development and Extension
SFU	Simon Fraser University, Canada
SRL	Southern Rocklobster Limited

Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) Project 2018-205: *Informing strategies, policies, and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*. The assessment was completed as part of a cost benefit analysis for inclusion in the FRDC 2022-23 Annual Report. The assessment was made up of six FRDC RD&E projects.

The impact assessment 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 assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations.

Project 2018-205 research has delivered knowledge to the southern rock lobster (SRL) industry on fisheries management that will help inform future policy making. More informed stakeholders are likely to make better decisions and avoid outcomes that erode the value of the fishery. In 2021/22 the SRL fishery was valued at $200 million per annum. Project 2018-205 has contributed to:

- Avoided loss of southern rock lobster economic value as a result of poor policy decisions.
- Better educated industry stakeholders with additional decision-making capacity.
- Avoided adverse environmental impacts associated with adoption of poor policy options.

Total funding for the Project was $0.03 million (present value terms) and produced total expected net benefits of $0.09 million (present value terms). This produced an estimated net present value of $0.05 million, a benefit-cost ratio of 2.6 to 1, an internal rate of return (IRR) of 302.8%, and a modified IRR of 13.8% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that two impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2018-205. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

Introduction

The Fisheries Research and Development Corporation (FRDC) required a series of cost benefit analyses of selected RD&E investments (projects) for inclusion in the FRDC 2022/23 Annual Report. The assessments were completed to contribute to the following FRDC evaluation reporting requirements:

- Reporting against the FRDC 2020-2025 RD&E Plan and the Evaluation Framework associated with FRDC's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to FRDC funding partners and other stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).
- Reporting RD&E impact and performance to FRDC levy payers and other fisheries and aquaculture stakeholders as well as the broader Australian community.

In August 2023, FRDC commissioned ACRE Economics Pty Ltd and associates to undertake cost-benefit analyses (CBAs) of six RD&E projects. The projects were selected to span the five 'Outcomes' of the FRDC Research and Development (R&D) Plan 2020-2025 with an additional project selected for Outcome 1 (Growth for enduring prosperity) where the largest proportion of FRDC investment was allocated. The six selected projects had a total estimated value of $0.69 million (FRDC investment, nominal dollar terms) and were funded over the period 2016/17 to 2020/21.

The sample selected (six projects) comprises a relatively small proportion of the FRDC's total RD&E investment (~5%) of the relevant population and may, therefore, not be fully representative of the entire RD&E Portfolio. However, the projects evaluated provide insight into the activities and outputs associated with each of FRDC's RD&E Programs, and the outcomes and impacts (and benefits) created. In turn, this will enable communication of benefits of FRDC RD&E to the FRDC Board, funding partners including the Commonwealth, industry, and other stakeholders.

The six projects selected by FRDC for evaluation in calendar 2023 were:

1. 2016-224: *Boosting fisher returns through smart value adding and greater use of underutilised species*
2. 2016-261: *Investigating the use of trace element profiles to substantiate provenance for the Australian prawn industry*
3. 2017-242: *Our Pledge: Australian seafood industry response to community values and expectations*
4. 2018-148: *A Stock Assessment Toolbox for Australian Fisheries*
5. 2018-164: *Commercial production trial with high POMS tolerant triploid Pacific Oysters in approved NSW estuaries*
6. 2018-205: *Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*

This report presents the assessment process and findings for Project 2018-205: *Informing strategies, policies and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation.*

Evaluation Framework

The annual impact assessments of FRDC RD&E investments 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 assessment components that are in accord with the current guidelines for impact assessment published by the CRRDC (CRRDC, 2018).

The evaluation process utilised an input to impact continuum RD&E project inputs (costs), objectives, activities, and outputs were briefly described and documented. Actual and expected outcomes, and any actual and/or potential future impacts (positive and/or negative) associated with project outcomes then were identified and described. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework and validated through consultation with expert personnel and review of published literature.

Once impacts were identified and validated, an assessment then was made about whether to quantify/value any of the impacts in monetary terms as part of the project-level analysis. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where one or more of the identified impacts were selected for valuation, the impact assessment used cost-benefit analysis (CBA) as a principal tool. The impacts valued therefore were deemed to represent the principal benefits delivered by the project investment. However, as not all impacts were valued (based on the selection criteria), the investment criteria estimated for the project investment evaluated are likely to represent an underestimate of the true performance of the FRDC project.

The qualitative and quantitative analysis processes, data sources, assumptions, specific valuation frameworks (where applicable), and evaluation results were clearly documented and then integrated into a written report.

Project Background

Background

The Australian wild-caught southern rock lobster industry operates in the south eastern part of Australia and spans three jurisdictional areas – South Australia, Victoria, and Tasmania. The industry comprises a fleet of vessels run by a mix of family owned and operated businesses and vertically integrated export businesses.

Some industry participants consider that the ownership structure of the fishery has an impact on the culture of the industry, which extends to benefits to regional communities, employment, and job satisfaction.

Rationale for Project 2018-205

Southern Rocklobster Limited (SRL), the national peak body representing the interests of the Australian southern rock lobster industry, recognised that there is a diversity in the composition of the industry's structure and the receipt of benefits from the fishery varies between user types. With this in mind, SRL secured FRDC project funding to investigate strategies, policies, and options to support owner operated fishing businesses. FRDC Project 2018-205 was delivered as a workshop to identify examples of other fisheries successfully negotiating corporatisation along with management options that might be applicable to the southern rock lobster industry.

Project Details

Summary

Project Code: 2018-205

Title: *Informing strategies, policies, and options supporting owner-operated fishing businesses in fisheries experiencing corporatisation*

Research Organisation: Southern Rocklobster Ltd

Principal Investigator: Thomas Cosentino

Period of Funding: June 2019 to December 2019

FRDC Program Allocation: Communities 100%

Objectives

The specific objectives of project 2018-205 were to:

1. Plan for and adapt to corporatisation in the southern rock lobster fishery and summarise concerns and identify possible solutions.
2. Identify ways that fishers can become better organised and better able to protect their interests.
3. Identify comparisons with fisheries that exist within Individual Transferable Quota (ITQ) managed systems.

Logical Framework

Table F1: Logical Framework for FRDC Project 2018-205

Activities	• Delivery of a strategy, policy, and option development workshop in Melbourne 7 October 2019. The workshop was attended by southern rock lobster industry leaders and fisheries management. The workshop was facilitated by Professor Caleb Gardner, Institute for Marine and Arctic Studies, University of Tasmania. • Keynote speakers included Dr Nick Rayns independent fisheries consultant and former second in command Australian Fisheries Management Authority, Dr Evelyn Pinkerton a marine anthropologist and professor of Resource and Environmental Management SFU Canada, Dr Joshua Stoll, a researcher in ocean governance and the resilience of coastal communities, Stephen Xiao KPMG, and Mike Barron a lobster fisher from Nova Scotia. • The objective of the workshop was to identify management options to address consolidation of ownership in the southern rock lobster industry. • The workshop agenda included: 1) The economic fundamentals of ITQ management, 2) How does the community benefit from ITQs, 3) Where are we headed with current targets for southern rock lobster fisheries, 4) Who is responsible for retrieving the bolted horse (i.e., reduced employment and a contraction in regional benefit from the fishery)? 5) Could we put the horse back in the stable even if we wanted to? • Keynote speakers presented information of ITQs, their history in Australia and case studies from North America. • Dr Rayns provided information on the benefits that Total Allowable Catch ITQs offer fishers. These included integration with macro changes in global economies and followed trends in capitalism and the enhancement of free trade. • The workshop discussed the various aspects of the characterisation of 'rights' including flexibility, exclusivity, quality of title, transferability, divisibility, and duration.

	• The workshop considered whether individual transferable quotas constitute rights. In Australia there has been a push to equate ITQs as rights which increase exclusivity and reduce investor's exposure to the risk of a change in government policy. • There are alternative business arrangements that have not been considered in Australian fisheries management and speakers outlined options for curbing the rate at which a fishery becomes more exclusive. • For alternative business arrangements to work, stakeholders in a fishery must first decide on their goals. Goals might include the prevalence of owner operator businesses, low entry costs for young fishers, support for regional communities, and return on investment. • The workshop identified but did not assess options to deliver fishery management goals. These options ranged from legislative and regulatory instruments to voluntary local agreements.
Outputs	The workshop did not target realisable solutions for industry. Instead, it delivered: • A succinct summary and discussion on current direction of the SRL fishery, and options for changing course gleaned from overseas fisheries. • A synthesis of alternative business/deed/corporate models that can be used to deliver different objectives. These included ITQs, Total Allowable Catch, Individually Transferable Effort, or Input Controls. For each option the synthesis addressed 1) a succinct overview, 2) a conceptual framework for informing decisions, 3) case studies, and 4) further resource material. • Increased knowledge and debate/discussion opportunities for attendees at the workshop. • Draft and final workshop reports.
Outcomes	• Better informed decision-making that will protect the value of the southern rock lobster fishery. • Knowledge to inform further R&D projects including FRDC Project 2020-029 Improving performance of ITQ fisheries.
Impacts (potential)	• Avoided loss of southern rock lobster economic value as a result of poor policy decisions. • Better educated industry stakeholders with additional decision-making capacity. • Avoided adverse environmental impacts associated with adoption of poor policy options.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2018-205 by FRDC. There were no other contributors.

Table F2: Total Investment in FRDC Project 2018-205
(nominal dollar terms)

Year ended 30 June	FRDC ($)	Others ($)	Total ($)
2019	18,000	0	18,000
2020	2,000	0	2,000
Totals	**20,000**	**0**	**20,000**

Source: FRDC project 2018-205 documentation

Management and Administration 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 (x1.179). This multiplier was estimated based on a five-year average of the ratio of total FRDC cash expenditure to project expenditure reported in the FRDC's Cash Flow Statement (FRDC Annual Reports, 2018-2022). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of 1.00 was used for administration and management costs for other contributors.

Real Investment and Extension Costs

For the purposes of the impact analysis, the investment costs of all parties were expressed in 2022/23-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2023).

There were no additional extension costs associated with this project.

Impacts

Table 3 provides a summary of the principal types of potential impacts from project 2018-205. Impacts have been taken from those listed in Table 1 and categorised using a triple bottom line framework into economic, environmental, and social impact types.

Table F3: Principal Potential Impact Types from Investment in FRDC Project 2018-205

Economic	• Avoided loss of southern rock lobster economic value as a result of poor policy decisions.
Environmental	• Avoided adverse environmental impacts associated with adoption of poor policy options.
Social	• Better educated industry stakeholders with additional decision-making capacity.

Public versus Private Impacts

Both public and private potential impacts were identified for the project. Private impacts may be delivered via avoiding loss of southern rock lobster economic value as a result of poor policy decisions. Public impacts are likely to be delivered through avoided adverse environmental impacts associated with adoption of poor policy decisions and better educated industry stakeholders with additional decision-making capacity.

Distribution of Private Impacts

Private impacts from the investment in project 2018-205 will accrue to southern rock lobster fishers and their supply chains. Supply chain beneficiaries will include wholesalers, exporters, retailers, and consumers. The share of benefit retained by each member of the supply chain will depend on both short- and long-term supply and demand elasticities.

Impacts on Other Australian Industries

The principles communicated to southern rock lobster stakeholders regarding the merits of ITQ and its alternatives will be applicable to other Australian fishing industries managed on the same basis.

Impacts Overseas

An appropriately managed southern rock lobster fishery will ensure a sustainable supply of quality Australian lobster to export markets.

Match with National Priorities

Australian Agriculture, Science, and Research Priorities

The Australian Government's National Science and Research Priorities and Agricultural Innovation Priorities are reproduced in Table 4. Project 2018-205 contributed to National Science and Research Priorities 1 and 2. The project also contributed to Agricultural Innovation Priority 1.

Table F4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities[16]	**National Agricultural Innovation Priorities**[17]
1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. **2. Soil and Water** – improving the use of soils and water resources, both terrestrial and marine. **3. Transport** – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. **4. Cybersecurity** – improving cybersecurity for individuals, businesses, government, and national infrastructure. **5. Energy and Resources** – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia's resources industries. **6. Manufacturing** – supporting the development of high value and innovative manufacturing industries in Australia. **7. Environmental Change** – mitigating, managing, or adapting to changes in the environment. **8. Health** – improving the health outcomes for all Australians.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia's agricultural innovation system to address by 2030. These priorities replace the Australian Government's Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. **1.** Australia is a trusted exporter of premium food and agricultural products by 2030. **2.** Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. **3.** Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. **4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

[16] Source: 2015 Australian Government *Science and Research Priorities*. https://www.industry.gov.au/data-and-publications/science-and-research-priorities.

[17] Source: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment.

FRDC National RD&E Priorities

Through extensive consultation, the FRDC 2020-2025 RD&E Plan identified five key outcome areas. The five outcome areas were:

1. Growth for enduring prosperity.
2. Best practices and production systems.
3. A culture that is inclusive and forward thinking.
4. Fair and secure access to aquatic resources.
5. Community trust, respect, and value.

Project 2018-205 addressed outcome area 2, 3 and 4.

Valuation of Impacts

The decision to value an impact identified in Table 3 was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Impacts Valued

A single potential impact of investment in project 2018-205 was valued – avoided loss of industry value due to poor policy decisions.

Valuation of Impact 1: Avoided loss of industry value due to poor policy decisions

Project research has delivered knowledge to the SRL industry on fisheries management that will help inform future policy making. More informed stakeholders are likely to make better decisions and avoid outcomes that erode the value of the fishery. In 2021/22 the SRL fishery was valued at $200 million per annum.

Assumptions made for the valuation of this impact are reported in Table 5.

Impacts Not Valued

The impacts not valued included:

- Better educated industry stakeholders with additional decision-making capacity. Additional insight on the types of issues beyond SRL fishery management is needed to quantify this impact.
- Avoided adverse environmental impacts associated with adoption of poor policy options. Additional insight on the type and timing of environmental damage is needed to quantify this impact.

Summary of Assumptions

Table 5 describes the specific assumptions used in the valuation of impacts.

Table F5: Summary of Assumptions for the Valuation of Impact 1

Impact 1: Avoided loss of industry value due to poor policy decisions		
Variable	**Assumption**	**Source**
Beach value of southern rock lobster.	$200 million.	Southern Rock Lobster Strategy 2022.
Impact of poor policy on SRL beach value.	10% annual loss in value.	Analyst assumption.
Risk of poor policy pre-project 2018-205.	5%.	
Reduction in risk of poor policy after-project 2018-205.	5%.	
First year of project Toolbox use.	2020/21.	Analyst assumption – outcomes of project informing decision-making in the first year after workshop completion.
Period of impact – that is the number of years findings from the project workshop inform decision-making.	6 years (2025/26 is last year of impact).	Analyst assumption – alternative information informs decision making after this time e.g., findings from FRDC Project 2020- 029 Improving performance of ITQ fisheries.
Attribution of impact to this project.	100%.	Analyst assumption – the project was the start of research to inform ITQ review and refinement.
Risk Factors		
Probability of output	100%	Workshop has been held and relevant stakeholders were in attendance.
Probability of outcome	60%	There is some risk that workshop messages will not translate into informed policy decisions.
Probability of impact	60%	Other exogenous factors determine SRL value e.g., demand for Australian lobsters.
Counterfactual		
It is assumed that the benefits estimated and attributable to the investment in FRDC Project 2018-205 would not have occurred without the investment.		

Results

All past costs and benefits were expressed in 2022/23-dollar terms. All costs and benefits were discounted to 2022/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2019/20) to the final year of benefits assumed.

Investment Criteria

Table 6 shows the investment criteria estimated for different periods of benefits for the total investment. FRDC was the only investor in the project.

Table F6: Investment Criteria for Total Investment in Project 2018-205

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.08	0.09	0.09	0.09	0.09	0.09
Present value of costs ($m)	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Net present value ($m)	-0.03	0.05	0.05	0.05	0.05	0.05	0.05
Benefit-cost ratio	0.00	2.37	2.60	2.60	2.60	2.60	2.60
Internal rate of return (%)	negative	301.0	302.8	302.8	302.8	302.8	302.8
MIRR (%)	negative	112.8	39.3	24.9	19.0	15.8	13.8

The annual undiscounted benefit and cost cash flows for the total investment for the duration of investment period plus 30 years from the last year of investment are shown in Figure 1.

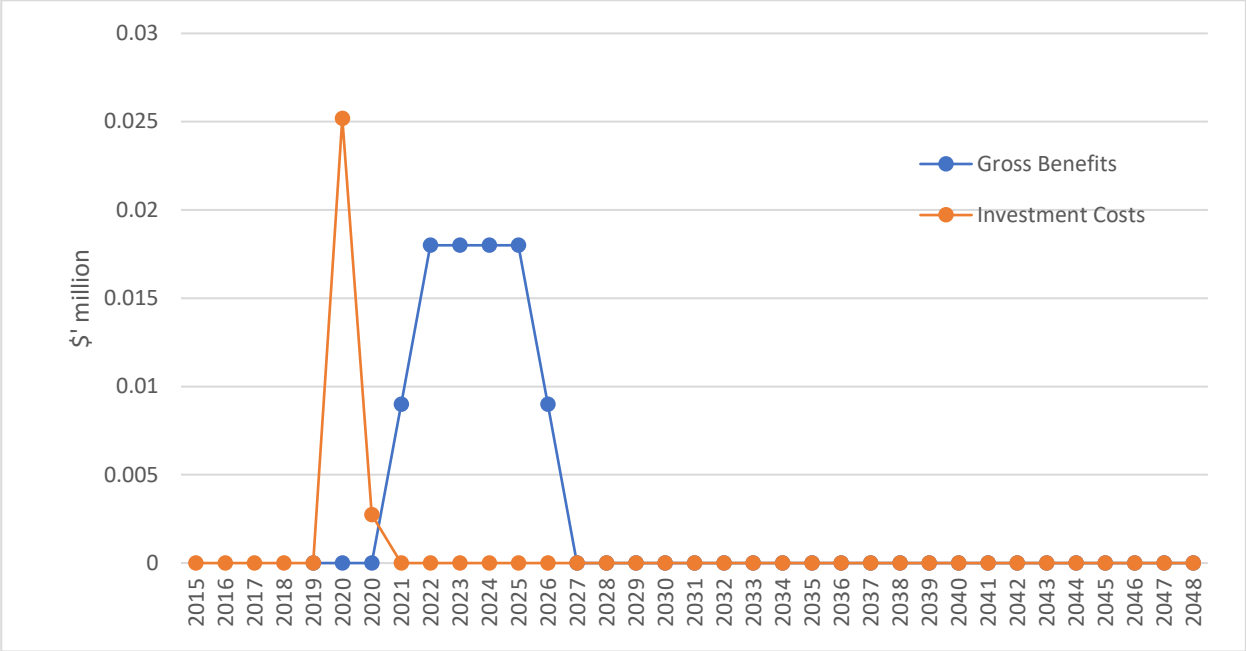

Figure F1: Annual Cash Flow of Undiscounted Total Benefits and Total Costs

Sensitivity Analyses

Sensitivity analyses were performed for variables that were considered (a) key drivers of the investment criteria, and/or (b) uncertain. Each sensitivity analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

A sensitivity analysis was carried out on the discount rate. The results, shown in Table 7, showed limited sensitivity to the discount rate. At the 10% discount rate project costs continue to exceed project benefits and show a favourable return on investment.

Table F7: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	0.09	0.09	0.09
Present value of costs ($m)	0.03	0.03	0.04
Net present value ($m)	0.06	0.05	0.05
Benefit-cost ratio	3.22	2.60	2.14

A sensitivity analysis then was carried out on the assumed reduction in southern rock lobster fishery value due to poor policy decisions. Project benefits continue to exceed project costs if the reduction in fishery value from poor policy decisions is only 5% - Table 8.

Table F8: Sensitivity to the Impact of Poor Policy on SRL Fishery Value
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Reduction in Fishery Value Due to Poor Policy		
	5%	10% (base)	15%
Present value of benefits ($m)	0.04	0.09	0.13
Present value of costs ($m)	0.03	0.03	0.03
Net present value ($m)	0.01	0.05	0.10
Benefit-cost ratio	1.30	2.60	3.91

A final sensitivity analysis was undertaken on the reduction in poor policy risk attributable to the project. The results, presented in Table 9, show that project benefits continue to exceed project costs if the reduction in risk is only 2%.

Table F9: Sensitivity to Reduction in Poor Policy Risk Attributable to Project
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Reduction in Poor Policy Risk Attributable to Project		
	2%	5% (base)	7.5%
Present value of benefits ($m)	0.04	0.09	0.13
Present value of costs ($m)	0.03	0.03	0.03
Net present value ($m)	0.00	0.05	0.10
Benefit-cost ratio	1.04	2.60	3.91

Confidence Rating and Other Findings

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 10). The rating categories used are High, Medium, and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table F10: Confidence in Analysis of Investment

Coverage of Benefits	Confidence in Assumptions
High	Medium

The coverage of benefits was assessed as High. The impact valued was deemed to be the most important from the investment and there were only two other, relatively minor potential impacts.

Confidence in assumptions was rated as Medium. Many of the valuation assumptions were underpinned by credible data (e.g., value of SRL fishery). However, because the investment was only recently completed, there was no evidence of actual outcomes and impacts. This meant that a number of the assumptions used in the valuation were uncertain.

Conclusions

Project 2018-205 research has delivered knowledge to the SRL industry on fisheries management that will help inform future policy making. More informed stakeholders are likely to make better decisions and avoid outcomes that erode the value of the fishery.

Total funding for the Project was $0.03 million (present value terms) and produced total expected net benefits of $0.09 million (present value terms). This produced an estimated net present value of $0.05 million, a benefit-cost ratio of 2.6 to 1, an internal rate of return (IRR) of 302.8%, and a modified IRR of 13.8% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that two impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2018-205. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

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