FINAL REPORT

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

A Stock Assessment Toolbox for Australian Fisheries

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

Contents

Tables

Figures

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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

Executive 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.

Keywords

2018-148, Stock Assessment, Packages, Specifications, Toolbox, Website, Evaluation, Impact Assessment, Cost-Benefit Analysis

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 funded under the FRDC 2020-2025 RD&E Plan and completed in the years ended 30 June 2017 to 2021. The projects were selected by FRDC and spanned the organisation's current RD&E Programs and Strategic Outcomes. 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 1: 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 2: 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 3: 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 4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities[1]	**National Agricultural Innovation Priorities**[2]
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.

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

[2] 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 5: 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 6: Investment Criteria for Total Investment in Project 2018-148

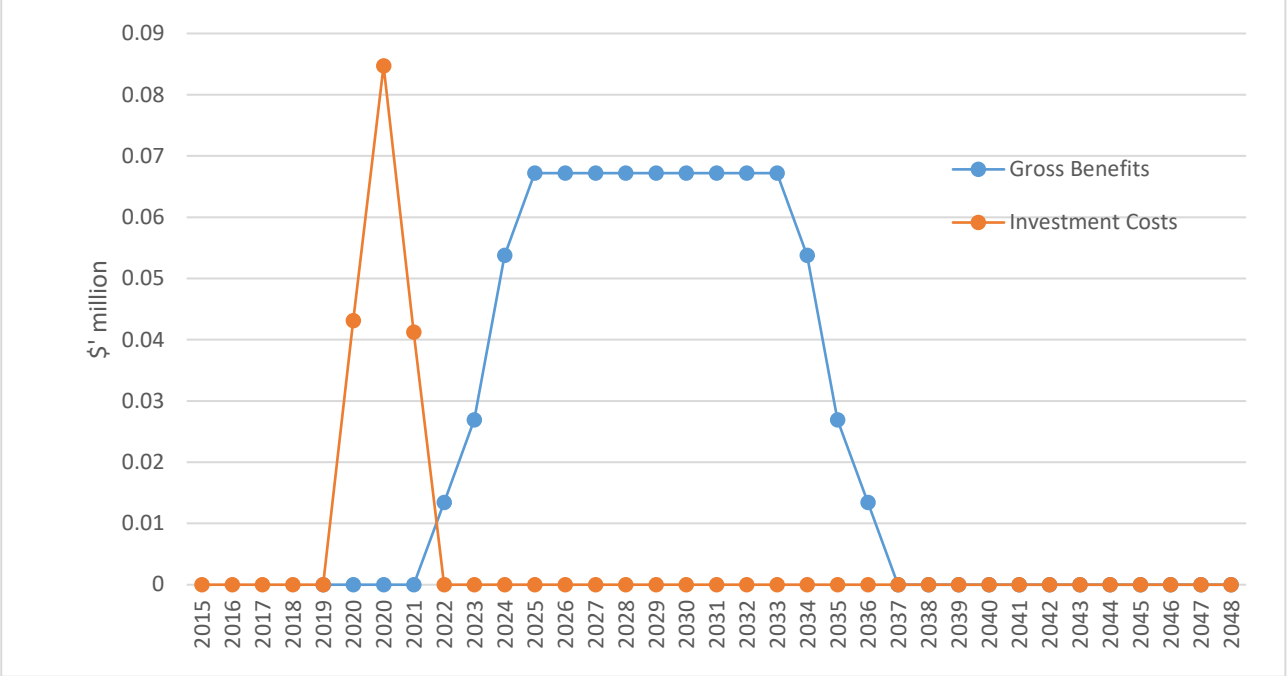
Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.00	0.21	0.46	0.60	0.60	0.60	0.60
Present value of costs ($m)	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Net present value ($m)	-0.20	0.02	0.27	0.40	0.40	0.40	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 7: 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 1: 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 8: 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 9: 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 10: 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 11: 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.
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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.

Glossary of Economics 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.

References

Australian Bureau of Agricultural and Resource Economics and Sciences. (2021, October 6). *Fisheries and Aquaculture Statistics 2020.* Retrieved from Australian Government - Department of Agriculture, Water and the Environment ABARES: https://www.awe.gov.au/abares/research-topics/fisheries/fisheries-and-aquaculture-statistics#download-full-report

Australian Bureau of Statistics. (2023, June 7). *Australian National Accounts: National Income, Expenditure and Product Quarterly estimates of key economic flows in Australia, including gross domestic product (GDP), consumption, investment, income and saving*. Table 5. Expenditure on Gross Domestic Product (GDP), Implicit price deflators (XLSX). Retrieved from Australian Bureau of Statistics: https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-national-income-expenditure-and-product/latest-release#data-downloads

Australian Government. (2015, May). Science and Research Priorities. *Science*. Department of Industry, Science, Energy and Resources. Retrieved from https://www.industry.gov.au/data-and-publications/science-and-research-priorities

Council of Rural Research and Development Corporations. (2018). *Cross-RDC Impact Assessment Program: Guidelines.* Canberra ACT: Council of Rural Research and Development Corporations. Retrieved January 2022, from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf

Department of Agriculture, Water and the Environment. (2019, November 4). *Rural Research, Development and Extension Priorities*. Retrieved from Australian Government - Department of Agriculture, Water and the Environment: https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/priorities

Dichmont, CM, Deng, RA, Dowling, N, Punt, AE, and Tsang, A (2021) A Stock Assessment Toolbox for Australian Fisheries. Final FRDC Report.

FAO (2007) Cost of MSC Certification. Accessed at https://www.fao.org/3/ai002e/AI002E05.htm

Fisheries Research and Development Corporation. (2018). *Annual Report 2017-18.* Canberra ACT: Fisheries Research and Development Corporation. Retrieved from https://www.frdc.com.au/annual-reports

Fisheries Research and Development Corporation. (2019). *Annual Report 2018-19.* Canberra ACT: Fisheries Research and Development Corporation. Retrieved from https://www.frdc.com.au/annual-reports

Fisheries Research and Development Corporation. (2020). *Imagining the Future of Fishing and Aquaculture, The FRDC RD&E Plan 2020-2025*.

Fisheries Research and Development Corporation. (2020). *Annual Report 2019-20.* Canberra ACT: Fisheries Research and Development Corporation. Retrieved from https://www.frdc.com.au/annual-reports

Fisheries Research and Development Corporation. (2021). *Annual Report 2020-21.* Canberra ACT: Fisheries Research and Development Corporation. Retrieved from https://www.frdc.com.au/annual-reports

Fisheries Research and Development Corporation. (2022). *Annual Report 2020-21.* Canberra ACT: Fisheries Research and Development Corporation. Retrieved from https://www.frdc.com.au/annual-reports

QLD DAF Stock Assessment Program. Retrieved online at https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-research/data/stock-assessment-program

National Oceanic and Atmospheric Administration (NOAA) (2016) NOAA's Cost of Fish Stock Assessments.