



FINAL

**An Impact Assessment of FRDC  
Investment in 2016-057:  
Workshop to identify research  
needs and a future project to  
reduce bycatch and improve  
fuel efficiency via Low Impact  
Fuel Efficient (LIFE) prawn  
trawls**

Agtrans Research

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**An Impact Assessment of FRDC Investment in 2016-057: Workshop to identify research needs and a future project to reduce bycatch and improve fuel efficiency via Low Impact Fuel Efficient (LIFE) prawn trawls**

**FRDC Project No 2016-134**

**2018**

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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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Steve Kennelly, Director, IC Independent Consulting Pty Ltd

# Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
ACPF	Australian Council of Prawn Fishers
BRD	Bycatch Reduction Devices
CRRDC	Council of Rural Research and Development Corporations
DAWR	Department of Agriculture and Water Resources
EU	European Union
FRDC	Fisheries Research and Development Corporation
GDP	Gross Domestic Product
LIFE	Low Impact Fuel Efficient
MIRR	Modified Internal Rate of Return
OCS	Office of the Chief Scientist
PVB	Present Value of Benefits
R&D	Research and Development
RAC	Research Advisory Committee
RD&E	Research, Development and Extension
TED	Turtle Exclusion Devices

# Executive Summary

## What the report is about

This report presents the results of an impact assessment of Fisheries Research and Development Corporation (FRDC) investment in a project to hold a workshop exploring Low Impact Fuel Efficient (LIFE) prawn trawl methods. The project was funded by FRDC, the Australian Council of Prawn Fishers (ACPF) and Commonwealth and State Research Advisory Committee (RAC) groups over the three months from December 2016 to March 2017.

## Methodology

The investment in the project was analysed qualitatively within a logical framework that included activities/outputs, outcomes, and impacts. Identified impacts were then categorised into a triple bottom line framework. Principal impacts from those identified were then valued. Benefits were estimated for a range of time frames up to 30 years from the year of last investment in the project. Past and future cash flows in 2017/18 \$ terms were discounted to the year 2017/18 using a discount rate of 5% to estimate the investment criteria.

## Results/key findings

Several economic, social and environmental impacts/potential impacts were identified. The impact valued as a result of the workshop was the prospect for increased profitability for prawn trawl fishers. Other impacts were identified but not valued in this assessment.

## Investment Criteria

Total funding from all sources for the project was \$0.08 million (present value terms). The value of benefits was estimated at \$0.13 million (present value terms). This gave an estimated net present value of \$0.05 million, a benefit-cost ratio of 1.60 to 1, an internal rate of return of 13.0 % and a modified internal rate of return (MIRR) of 6.7%.

## Conclusions

The valuation of the impact is based on uncertain assumptions. However, the assumptions made in the valuation are conservative, and there may be long-term benefits of the project that are not valued or not realised yet as they will be dependent on another project. The impacts not valued along with these conservative assumptions, make it likely that the investment criteria are underestimated in the evaluation.

## Keywords

Impact assessment, cost-benefit analysis, LIFE, prawn trawl, workshop



# Introduction

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

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

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

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

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

Project 2016-057: *Workshop to identify research needs and a future project to reduce bycatch and improve fuel efficiency via Low Impact Fuel Efficient (LIFE) prawn trawls* was selected as one of the 20 projects and was analysed in this report.

# General Method

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

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

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

# Background and Rationale

## Background

Bycatch remains a critical issue for the social licence of prawn trawl fishers. Despite advances in technology, prawn trawling can still result in large amounts of bycatch, and some trawling can disturb benthic habitats. Prawn trawling methods also contribute to high fuel and energy costs, leading to high operating costs within the industry. There are incentives for the prawn trawl industry to find and adopt new technology for the benefit of their profits and for protecting their access to fisheries through their existing social licence to fish.

## Rationale

The issues of bycatch and fuel efficiency are a major concern to stakeholders in the prawn trawl industry. Stakeholders have different concerns with prawn trawling ranging from industry (e.g. reduction in operational costs including discard handling) to environmental groups (e.g. reduction in bycatch, habitat and ecosystem disturbance) and the general public.

The effectiveness of dissemination to industry of findings of past research on bycatch reduction devices has been variable. Also, information exchange on different approaches between fisheries had been lacking. There was a need to assemble information currently available, disseminate it to the industry and identify what further research was required. Also, by describing the existing research and information available to industry, there was an opportunity for the prawn trawl industry members to better formulate business plans and adapt different bycatch technologies for their own individual situations.

Specifically, there was a need to further explore Low Impact Fuel Efficient (LIFE) gears that both reduce bycatch and increase fuel efficiency. By holding a workshop addressing LIFE gears, there was an opportunity to synthesise and disseminate existing knowledge to industry and obtain a greater focus on where applications of existing knowledge and future research should be heading.

# Project Details

## Summary

Project Code: 2016-057

Title: *Workshop to identify research needs and a future project to reduce bycatch and improve fuel efficiency via Low Impact Fuel Efficient (LIFE) prawn trawls*

Research Organisation: IC Independent Consulting Pty Ltd

Principal Investigator: Steve Kennelly

Period of Funding: December 2016 – March 2017

FRDC Project Allocation: Industry (70%), Environment (30%)

## Objectives

The project included three key objectives:

1. Organise and plan a workshop of key stakeholders in Australia’s prawn-trawl fisheries whose goal is to ameliorate bycatch issues and improve fuel efficiency by developing Low Impact Fuel Efficient (LIFE) gears for those fisheries.
2. Hold the above workshop over two days in Sydney.
3. Prepare and finalise a report outlining the conduct and results of the workshop and the staged approach recommended for ongoing research.

## Logical Framework

Table 1 provides a description of the project in a logical framework developed for the evaluation.

Table 1: Logical Framework for Project 2016-057

Activities and Outputs	<ul style="list-style-type: none"> <li>• Twenty-one participants attended the workshop, held over two days on the 7<sup>th</sup> and 8<sup>th</sup> of February 2017. Participants included gear scientists, representatives from all major Australian prawn fisheries, and personnel from the Fisheries Research and Development Corporation (FRDC).</li> <li>• Day one focused on identifying research needs and options for bycatch amelioration whereas day two focused on issues related to the fuel efficiency of Australian prawn trawlers.</li> <li>• A number of potential trawl designs and modifications were discussed throughout the workshop. For example, Bycatch Reduction Devices (BRDs), Turtle Excluder Devices (TEDs), and overall trawl gear designs.</li> <li>• The current European Union (EU) ban on discards of quota species was discussed, with the relevance to the Australian industry explored. It was recognised that Australia could take a ‘wait and see’ approach with future relevant learnings expected from EU fishers having to implement new technologies.</li> <li>• The Principal Investigator of the project, Steve Kennelly, presented the research on bycatch reduction being produced in Europe because of the EU Discard Ban on quota species.</li> <li>• Specific jurisdictional issues were discussed and shared amongst different jurisdictional representatives. Topics included:</li> </ul>
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	<ul style="list-style-type: none"> <li>○ Improvements to existing trawl gear</li> <li>○ Intellectual Property (IP) issues</li> <li>○ Extension of the workshop findings to industry</li> <li>● The workshop demonstrated the value of holding fora of this type due to the useful information exchange that occurred among an array of stakeholders.</li> <li>● The workshop recommended that the best short-term strategy regarding implementing innovations for BRDs was to take the workshop presented in the project “on the road” to as many prawn trawl fisheries, fishers, scientists and managers as possible and so identify the next steps in development that may be appropriate for each fishery’s particular issues. While these workshops were occurring over the next year or so, it was suggested that it would be prudent to monitor any European innovations to take advantage of any additional information and innovations emerging from the European Discard Ban.</li> <li>● A report outlining the discussions and results of the workshop was produced.</li> </ul>
Outcomes	<ul style="list-style-type: none"> <li>● More effective meaningful knowledge integration for lower discard and more energy efficient trawls due to investigations being undertaken in the EU being recognised and evaluated.</li> <li>● There has been an additional FRDC Project (FRDC Project 2017-065) funded because of the recommendations of this project (FRDC Project 2016-057). FRDC Project 2017-065 will conduct 12 workshops around different prawn trawl fisheries, disseminating the knowledge produced in this project.</li> <li>● Because of the FRDC Project 2017-065, some prawn trawl fishers are utilising new prawn trawl gear (Steve Kennelly, pers. comm., 2018).</li> <li>● An extension based around the findings of the project is being considered by Australian Council of Prawn Fisheries (ACPF) to trial different prawn trawl gears across the country.</li> </ul>
Impacts	<ul style="list-style-type: none"> <li>● Improved future profitability of prawn trawl fishers through adoption of new gears.</li> <li>● More effective long-term research and development (R&amp;D) expenditure by industry and FRDC, due to the information presented and exchanged at the workshop.</li> <li>● Reduction in bycatch and benthic impact due to new technology adopted.</li> <li>● Improved social licence to operate due to lower bycatch.</li> <li>● Improved regional incomes from increased profitability of prawn trawl fishers.</li> </ul>

# Project Investment

## Nominal Investment

Table 2 shows the nominal annual investment made in Project 2016-057 by FRDC, ACPF, and the different Commonwealth and State Research Advisory Committee (RAC) groups.

Table 2: Annual Investment in Project 2016-057 (nominal \$)

<b>Year ended 30<sup>th</sup> June</b>	<b>FRDC (\$)</b>	<b>ACPF (\$)</b>	<b>RAC (\$)</b>	<b>TOTAL (\$)</b>
2017	35,000	9,000	26,000	70,000
<b>Totals</b>	<b>35,000</b>	<b>9,000</b>	<b>26,000</b>	<b>70,000</b>

## Program Management Costs

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

## Real Investment and Extension Costs

For purposes of the investment analysis, the investment costs of all parties were expressed in 2017/18 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2018). There are additional extension costs associated with the project as the impacts are dependent on FRDC Project 2017-065. These costs are taken into account in the valuation.

# Impacts

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

Table 3: Triple Bottom Line Categories of Principal Impacts from the Workshop

Economic	<ul style="list-style-type: none"> <li>• Improved profitability of prawn trawl fishers through adoption of new gears, improving fuel efficiency.</li> <li>• More effective long-term research and development (R&amp;D) expenditure by industry and FRDC, due to the information presented and exchanged at the workshop.</li> <li>• Maintenance access to fisheries and an improved social licence to operate due to lower bycatch.</li> </ul>
Environmental	<ul style="list-style-type: none"> <li>• Reduction in bycatch due to new trawl technology adopted and reduction in damage to sea floor.</li> </ul>
Social	<ul style="list-style-type: none"> <li>• Increased regional incomes through increased profitability and reduced costs for the prawn trawl sector.</li> </ul>

## Public versus Private Impacts

The benefits identified in this analysis are both private and public impacts. The main public impact is the reduced bycatch and reduction in seafloor damage from improved uptake of gears and nets that were presented at the workshops. There are also some public impacts from increased regional incomes.

## Distribution of Private Impacts

The majority of the private impacts will initially flow to the Australian prawn trawl sector. However, these impacts are likely to eventually be shared along the input and product supply chains.

## Impacts on other Australian industries

Other Australian industries outside of the prawn trawl sector are not expected to benefit directly from the project, but some impacts could be captured by other towed gear sectors such as fish trawl.

## Impacts Overseas

Some impacts could be captured in future internationally via knowledge exchange with international partners such as those in the European Union.

### Match with National Priorities

The Australian Government's Science and Research Priorities and Rural Research, Development and Extension (RD&E) priorities are reproduced in Table 4. The project will contribute primarily to Rural RD&E Priorities 1, 3 and 4, and Science and Research Priorities 5 and 7.

Table 4: Australian Government Research Priorities

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

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

# Valuation of Impacts

## Impacts Valued

Analyses were undertaken for total benefits that included future expected benefits. A degree of conservatism was used when finalising assumptions, particularly when some uncertainty was involved.

One impact was valued. The improved profitability of prawn trawl fishers through increased fuel efficiency.

## Impacts not Valued

Not all impacts identified in Table 3 could be valued in the assessment.

The economic, environmental and social impacts not valued are:

- More effective long-term research and development (R&D) expenditure by industry and FRDC, due to the information presented and exchanged at the workshop.
- Maintaining access to fisheries through improved social licence to operate due to lower bycatch and concern for the environment.
- Reduction in bycatch due to new trawl technology adopted and reduced damage to the sea floor.
- Increased regional incomes through reduced costs and higher profitability for the prawn trawl sector.

The other economic, environmental and social impacts, while significant, could not be valued due to the difficulty of assigning a reasonable monetary value to non-market impacts, a lack of useable data for benefit transfer, lack of evidence linking outcomes to potential impacts and time and resource constraints.

## Improved profitability through updated gears

Through adopting new gears, there is scope for reducing costs to prawn trawl fishers through adopting more fuel-efficient gears identified and presented in the workshop.

These impacts are dependent on the subsequent FRDC Project 2017-065, as this project further extended the outputs of FRDC Project 2016-057. This is explained further in the attribution section below.

The value of Australian wild-catch prawns is \$301.5 million as of 2015/16 (ABARES, 2017). It is assumed that 10% of the industry would adopt some changes from the workshop that would not have done so otherwise. Assuming variable costs are 55% of gross value and fuel costs are 22.5% of variable costs, fuel costs are estimated at \$37.3 million per annum. It is assumed that adoption of the new gears will accrue to 10% of prawn trawls and will lead to a 5% reduction in fuel costs for these trawls. The cost of adopting the new gears is embedded in the 5% cost reduction. There is a probability of 70% that the adoption will be successful in reducing costs.

The impact is assumed to persist for ten years from when first adopted. Seventy per cent are assumed to adopt in 2019, and a further 10% commence adopting in each of the years 2020, 2021 and 2020. Hence the benefits will commence tapering off in 2029 and reduce to zero by 2031.

Specific assumptions for valuing the impact are provided in Table 5.

## Counterfactual

If the project had not been funded, it is assumed that the workshop would not have taken place. The additional FRDC project (2017-065) also would not have taken place. Some of the technology discussed in the workshops may have been used in the future without investment in the workshop, but not as widely as it is now.

## Attribution

As a result of the project, further workshops have been held around Australia, increasing the total investment of the initiative. An attribution factor is made for the contribution of the FRDC Project 2016-057 to the impacts, as the impacts would not have been realised without the subsequent project. The attribution is based on the proportion of investment by FRDC Project 2016-057 to the total cost of the two projects. The total cost for the second projects was \$452,900, compared to \$70,000 for Project 2016-057.

## Summary of Assumptions

A summary of the key assumptions made for the valuation of the impacts is shown in Table 5.

Table 5: Summary of Assumptions

Variable	Assumption	Source
<b>Benefit one: Avoided reduction in social licence for commercial wild catch fishing</b>		
Gross value of wild caught prawn trawl sector	\$301.5 million per annum	ABARES, 2017
Variable costs as % gross value	55%	Agtrans Research based on prawn fisheries reported by EconSearch (2018)
Total variable costs of wildcatch prawn trawl sector	\$165.83 million p.a.	\$301.5 m * 55%
Fuel as a percentage of variable costs	22.5%	Ward (2015)
Fuel costs	\$37.31 million p.a.	\$165.83 * 22.5
Percentage of prawn fishers affected	10%	Agtrans Research
Fuel cost saving of those changing	\$3.73 million p.a.	\$37.31 m * 10%
Cost savings due to projects	5%	Agtrans Research
Cost savings	\$0.186 million p.a.	\$3.73 m * 5%
First year of impact	2019	Agtrans Research
First year of full benefit	2022	Agtrans Research
Last year of full benefit	2028	Agtrans Research
Last year of benefit	2031	Agtrans Research
Probability of adoption	70%	Agtrans Research
Attribution factor	13.39%	\$70,000/ (\$452,900 + \$70,000)
<b>FRDC Program Allocation</b>		
FRDC Program Allocation – Industry	70%	FRDC
FRDC Program Allocation – Environment	30%	FRDC

# Results

All benefits after 2017/18 were expressed in 2017/18 dollar terms. All costs and benefits were discounted to 2017/18 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 (2016/17) 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 the FRDC investment respectively. The present value of benefits (PVB) attributable to FRDC investment only, shown in Table 7, has been estimated by multiplying the total PVB by the FRDC proportion of real investment (50.71%).

Table 6: Investment Criteria for Total Investment in the Project

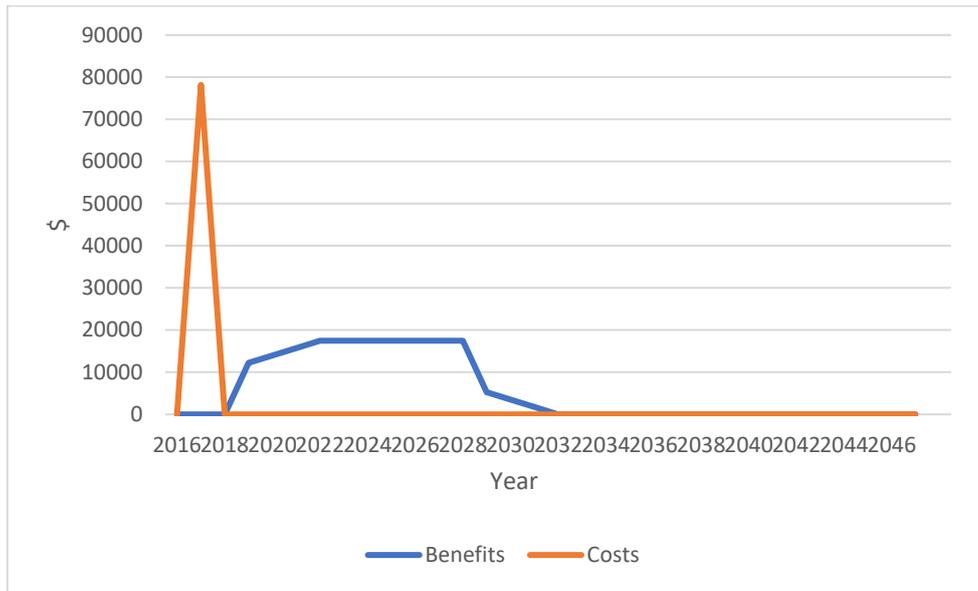
Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits (\$m)	0.00	0.05	0.11	0.13	0.13	0.13	0.13
Present value of costs (\$m)	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Net present value (\$m)	-0.08	-0.03	0.03	0.05	0.05	0.05	0.05
Benefit-cost ratio (BCR)	0.00	0.64	1.40	1.60	1.60	1.60	1.60
Internal rate of return (%)	negative	negative	11.2	13.0	13.0	13.0	13.0
MIRR (%)	negative	negative	8.9	8.5	7.6	7.1	6.7

Table 7: Investment Criteria for FRDC Investment in the Project

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits (\$m)	0.00	0.03	0.06	0.07	0.07	0.07	0.07
Present value of costs (\$m)	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Net present value (\$m)	-0.04	-0.02	0.02	0.02	0.02	0.02	0.02
Benefit-cost ratio (BCR)	0.00	0.64	1.40	1.60	1.60	1.60	1.60
Internal rate of return (%)	negative	negative	10.9	13.0	13.0	13.0	13.0
MIRR (%)	negative	negative	9.0	8.6	7.6	7.1	6.7

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the 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

A sensitivity analysis was carried out on the discount rate. The 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. Table 8 presents the results. The results showed a moderately low sensitivity to the discount rate.

Table 8: Sensitivity to Discount Rate  
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits (\$m)	0.17	0.13	0.10
Present value of costs (\$m)	0.08	0.08	0.09
Net present value (\$m)	0.10	0.05	0.02
Benefit-cost ratio	2.24	1.60	1.18

## Pessimistic and Optimistic Scenarios

Sensitivity analyses were undertaken for pessimistic and optimistic levels of the variables with the highest level of uncertainty: the percentage of prawn trawl fishers who adopted new technology and the probability of successful adoption. Results are reported in Table 9 and Table 10.

Table 9: Sensitivity to the Percentage of the Prawn Trawl Affected  
(Total Investment, 30 years)

Investment Criteria	Sensitivity to the Percentage of Prawn Trawl Affected		
	5%	10%	15%
Present value of benefits (\$m)	0.07	0.13	0.20
Present value of costs (\$m)	0.08	0.08	0.08
Net present value (\$m)	-0.02	0.05	1.11
Benefit-cost ratio	0.80	1.60	2.40

The results presented in Table 9 show that the investment criteria are sensitive to the proportion of the industry that benefit. In the pessimistic scenario, the BCR is below 1, while in the optimistic scenario the BCR is above 2.

Table 10: Sensitivity to the Probability of Adoption  
(Total Investment, 30 years)

Investment Criteria	Sensitivity to the probability of adoption		
	50%	70%	90%
Present value of benefits (\$m)	0.09	0.13	0.17
Present value of costs (\$m)	0.08	0.08	0.08
Net present value (\$m)	0.01	0.05	0.09
Benefit-cost ratio	1.14	1.60	2.06

The results presented in Table 10 show that given the range of adoption levels assumed, the investment criteria are positive in both the pessimistic and optimistic scenarios.

## Confidence Ratings 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 Project

Coverage of Benefits	Confidence in Assumptions
Low	Low

The coverage of benefits was assessed as Low as the benefit valued was only one of a whole range of benefits identified. The confidence in assumptions is rated as Low as while the assumptions made are logical and indicative, they are not well supported by the available evidence, and there is little information available on adoption levels or cost impacts.

# Conclusions

Overall, the project achieved its objectives of conducting a workshop of key stakeholders in Australia's prawn-trawl fisheries, with subsequent workshops now being held around Australia's multiple prawn trawl fisheries.

Total funding for the project over the four months totalled \$0.08 million (present value terms) and produced estimated total expected benefits of \$0.13 million (present value terms). This gave a net present value of \$0.05 million, a benefit-cost ratio of 1.60 to 1, an internal rate of return of 13.0% and a MIRR of 6.7%.

The valuation of the impact is based on uncertain assumptions. However, the assumptions made in the valuation are conservative, and there were several benefits identified that were not valued. Also, there may be long-term impacts of the project that are not valued. The impacts not valued along with the conservative assumptions, make it likely that the investment criteria have been underestimated.

# 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.

# References

- Australian Bureau of Agricultural and Resource Economics and Sciences. (2017) *Australian fisheries and aquaculture statistics 2016* Retrieved July 2018 from [http://data.daff.gov.au/data/warehouse/9aam/afstad9aamd003/2016/AustFishAquacStats\\_2016\\_v1.0.0.pdf](http://data.daff.gov.au/data/warehouse/9aam/afstad9aamd003/2016/AustFishAquacStats_2016_v1.0.0.pdf)
- Australian Bureau of Statistics. (2018, January 31). 5204.0 - Australian System of National Accounts, 2016-17. Retrieved from Australian Bureau of Statistics: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5204.02016-17?OpenDocument>
- Council of Rural Research and Development Corporations. (2014). *Impact Assessment Guidelines*. Canberra: Council of Rural Research and Development Corporations. Retrieved from <http://www.ruralrdc.com.au/wp-content/uploads/2016/04/CRRDC-Impact-Assessment-Guidelines-V.1-070514.pdf>
- Department of Agriculture and Water Resources. (2015). *Agricultural Competitiveness White Paper*. Canberra: Commonwealth of Australia. Retrieved from <http://agwhitepaper.agriculture.gov.au/SiteCollectionDocuments/ag-competitiveness-white-paper.pdf>
- EconSearch. (2018). *Project: Economic Indicators for the Commercial Fisheries of South Australia. 1998 – 2017*. Retrieved from <http://www.econsearch.com.au/pages/completed-projects/fishing-aquaculture/fish10.php>
- Fisheries Research and Development Corporation. (2013-2017). *Annual Report*. Canberra: Fisheries Research and Development Corporation. Retrieved from <http://www.frdc.com.au/en/About-us/Corporate-documents/Annual-reports>
- Office of the Chief Scientist. (2015). *Strategic Science and Research Priorities*. Canberra: Commonwealth of Australia. Retrieved from [http://www.chiefscientist.gov.au/wp-content/uploads/STRATEGIC-SCIENCE-AND-RESEARCH-PRIORITIES\\_181214web.pdf](http://www.chiefscientist.gov.au/wp-content/uploads/STRATEGIC-SCIENCE-AND-RESEARCH-PRIORITIES_181214web.pdf)