FISHERIES RESEARCH & DEVELOPMENT CORPORATION

FINAL REPORT

An Impact Assessment of Investment in FRDC Project 2016-118:

Using cat DNA to Inform Sustainable Fisheries Management and Ecological Risk Assessments: A Shy Albatross Case Study

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FRDC Project 2016-134

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Abbreviations

ABS	Australian Bureau of Statistics
AFMA	Australian Fisheries Management Authority
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
DAWR	Department of Agriculture and Water Resources
DNA	deoxyribonucleic acid
DPIPWE	Department of Primary Industries Parks, Water & Environment
EPBC	Environment Protection and Biodiversity Act
ERA	Environmental Risk Assessment
FRDC	Fisheries Research and Development Corporation
MIRR	Modified Internal Rate of Return
OCS	Office of the Chief Scientist
PVB	Present Value of Benefits
R&D	Research and Development
RD&E	Research, Development and Extension
WTP	Willingness to Pay

Executive Summary

The Shy Albatross is a seabird endemic to Tasmania. The seabird is listed as 'Endangered' under the Australian Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). There was a recognition that current fishing activities could be interacting negatively with the diet of the Shy Albatross through activities such as fishing by-catch and discards. Fisheries Research and Development (FRDC) project 2016-118 was funded to explore this possibility and was carried out by personnel from the CSIRO Marine Laboratories, Hobart over the period October 2017 to March 2019.

The principal outputs of the project included:

- The compilation of DNA databases addressing the known fish dietary species of the Shy Albatross, as well as fish species associated with the main fishery catch and by-catch in Shy Albatross environments.
- Assembly and DNA sequencing of Shy Albatross scat samples covering breeding and non-breeding seasons and comparison with the main fishery species DNA.
- Identification of spatial overlaps between the Shy Albatross and commercial fisheries, as well as overlaps between species consumed by the Shy Albatross and species caught by fishers in the area.

These outputs provided information that could be used in Shy Albatross environments to improve sustainable fisheries management and ecological risk assessment. The project made a number of recommendations associated with any revision of the next Albatross and Giant Petrel Recovery Plan, the revision of management plans and ecological risk assessment for fisheries operating in the south-east of Australia, and the discouragement of fishers in the Southern Rock Lobster fishery from feeding baits and by-catch to Shy Albatross.

The principal impact of the project investment and its findings was to reduce the threat from fishing activities associated with the Shy Albatross. This contributed to the preservation of the current risk status (Endangered) afforded to the Shy Albatross by the Australian Government.

Funding for the project over the three years totalled $0.53 million (present value terms) and produced estimated total expected benefits of $1.42 million (present value terms). This gave a net present value of $0.89 million, a benefit-cost ratio of 2.67 to 1, an internal rate of return of 19.0% and a modified internal rate of return of 8.9%. Apart from the reduced threat to the future of the Albatross, there were several other potential impacts identified but not valued in monetary terms. This meant that the investment criteria as provided by the evaluation are likely to be an underestimate of the total value of the project investment.

Introduction

The Fisheries Research and Development Corporation (FRDC) required an annual series of impact assessments to be carried out on a sample of completed investments from 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 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 April 2017, FRDC commissioned Agtrans Pty Ltd (Agtrans) to undertake the annual impact assessments for RD&E projects funded under the FRDC 2015-2020 RD&E Plan and completed in the years ended 30 June 2016 to 2020 (FRDC Project 2016-134). Between 2016/17 and 2020/21, four series of annual impact assessments were completed. Each of the four series of assessments included a set of 20 randomly selected FRDC RD&E investments as well as an aggregate analysis across all 20 investments evaluated in each year. Published reports for the annual FRDC evaluations can be found at: https://www.frdc.com.au/frdc-project-impact-assessments-benefits-research.

The fifth and final series of impact assessments under Project 2016-134 was for a set of FRDC RD&E investments completed in the year ended 30 June 2020, the final year of the FRDC 2015-2020 RD&E Plan. As in previous years, the fifth series of impact assessments included 20 randomly selected FRDC RD&E investments. The 20 investments had a total value of approximately $5.30 million (nominal FRDC investment) and were selected from an overall population of 81 FRDC investments worth an estimated $17.66 million (nominal FRDC investment) where a final deliverable had been submitted in the 2019/20 financial year.

The 20 RD&E 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 30.0% 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 (total nominal FRDC investment of $\leq$ $50.000, $50,001 to $250,000, and > $250,000 respectively).

Project 2016-118: *An Impact Assessment of Investment in Using scat DNA to inform sustainable fisheries management and Ecological Risk assessments: a Shy Albatross case study* was randomly selected as one of the 20 RD&E investments completed in 2019/20 for evaluation in the fifth series of annual impact assessments (2019/20 sample). The current report presents the Project 2016-118 analysis and findings.

Method

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 Shy Albatross is a seabird endemic to Tasmania and is listed as 'Endangered' under the Australian Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The key threatening processes are interactions with commercial fisheries and climate change. There is potential overlap between fishery target species and Shy Albatross prey, and the risk of birds being attracted to vessels through the availability of fishing by-catch and discards.

Rationale for Project 2016-118

A key priority of the Australian Fisheries Management Authority (AFMA) is to ensure Australian fisheries operate sustainably. As there was limited data available on seabird interactions with fisheries management, it was considered that more data on the interactions were required to assess whether fisheries management in south-east Australian waters needed to change to become more sustainable in relation to the diet of the Shy Albatross. Also, as previous dietary analysis applications were of an invasive nature, no recent data on the diet of the bird were available. FRDC Project 2016-118 planned to use recently developed non-invasive DNA methods to determine the diet of the Shy Albatross.

Project Details

Summary

Project Code: 2016-118

Title: *Using scat DNA to inform sustainable fisheries management and ecological risk Assessments: a shy Albatross case study*

Research Organisation: Department of Primary Industries Parks, Water & Environment (DPIPWE)

Principal Investigator: Rachael Alderman, Team Leader, Marine Conservation Program

Period of Funding: October 2017 to March 2019

FRDC Program Allocation: Environment 75%, Industry 25%

Objectives

1. To develop a south-east Australian marine prey DNA database.
2. Characterise the range of prey species consumed by shy albatrosses to high taxonomic resolution (species or genus where possible) and the relative frequency of occurrence of each taxa within the diet.
3. Assess the extent to which the shy albatross group engage with fisheries by quantifying the frequency of target, secondary and bycaught species in the diet.
4. Assess the spatial and temporal variability of both objectives 2 and 3.

Logical Framework

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

Table 1: Logical Framework for FRDC Project 2016-118

Activities	<u>Construction/comparison of existing databases</u> • The first database constructed addressed the known dietary species of the Shy Albatross, as well as fish species associated with the main fishery catch and by-catch. • Comparison of the above dietary database was then made with a genetic database (DNA reference sequences) to identify genetic data gaps. <u>Addressing the data gaps</u> • The identified data gaps were addressed via researchers and fishery observers throughout the project via the following set of activities. <u>Collection and sequencing of Albatross scat samples</u> • Shy Albatross scat samples were collected from an island in Bass Strait from 2013 to 2018. • The scat samples covered the three main breeding stages (incubation, brood, and chick rearing), as well as the non-breeding season. • DNA was extracted from the scat samples. • The DNA samples were sequenced and compared to the reference sequences. <u>Definition of foraging areas</u> • Shy Albatross foraging areas were defined for each breeding stage. • These areas were overlayed with Commonwealth fisheries catch data.

	• This allowed the development of spatial overlaps between the Shy Albatross and commercial fisheries, as well as overlaps between species consumed by the Shy Albatross and species caught by fishers in the area. <u>Identification of potential resource competition</u> • Identification of the source of each fish species was assessed. • Identification of whether each species was a shared resource (naturally consumed by the Shy Albatross as well as being caught by the fishery) or a fishery discard species (not naturally accessible to the Shy Albatross and discarded by the fishery). • The volume consumed for each major food group overall, as well as for the major individual fish species and fishery discards was estimated; this was achieved by using the Shy Albatross metabolic rates, activity patterns, and food proportions. • Information was compiled on the Tasmanian fishers that were operating, their spatial overlap with the albatross, and the gear type used.

Outputs	• Compilation of DNA databases addressing the known dietary species of the Shy Albatross, as well as fish species associated with the main fishery catch and by-catch in Shy Albatross environments.
	• Assembly and DNA sequencing of Shy Albatross scat samples covering breeding and non-breeding seasons and comparison with the main fishery species DNA.
	• Identification of spatial overlaps between the Shy Albatross and commercial fisheries, as well as overlaps between species consumed by the Shy Albatross and species caught by fishers in the area.
	• Associated recommendations included:
	  ○ That the Department of Environment consider the findings of the project when revising the next Albatross and Giant Petrel Recovery Plan
	  ○ That AFMA consider the findings of the project when revising management plans and ecological risk assessments for the fisheries operating in the south-east of Australia.
	  ○ That fishers in the Southern Rock Lobster fishery should be discouraged from feeding baits and by-catch to Shy Albatross as such behaviour can encourage birds to approach vessels.

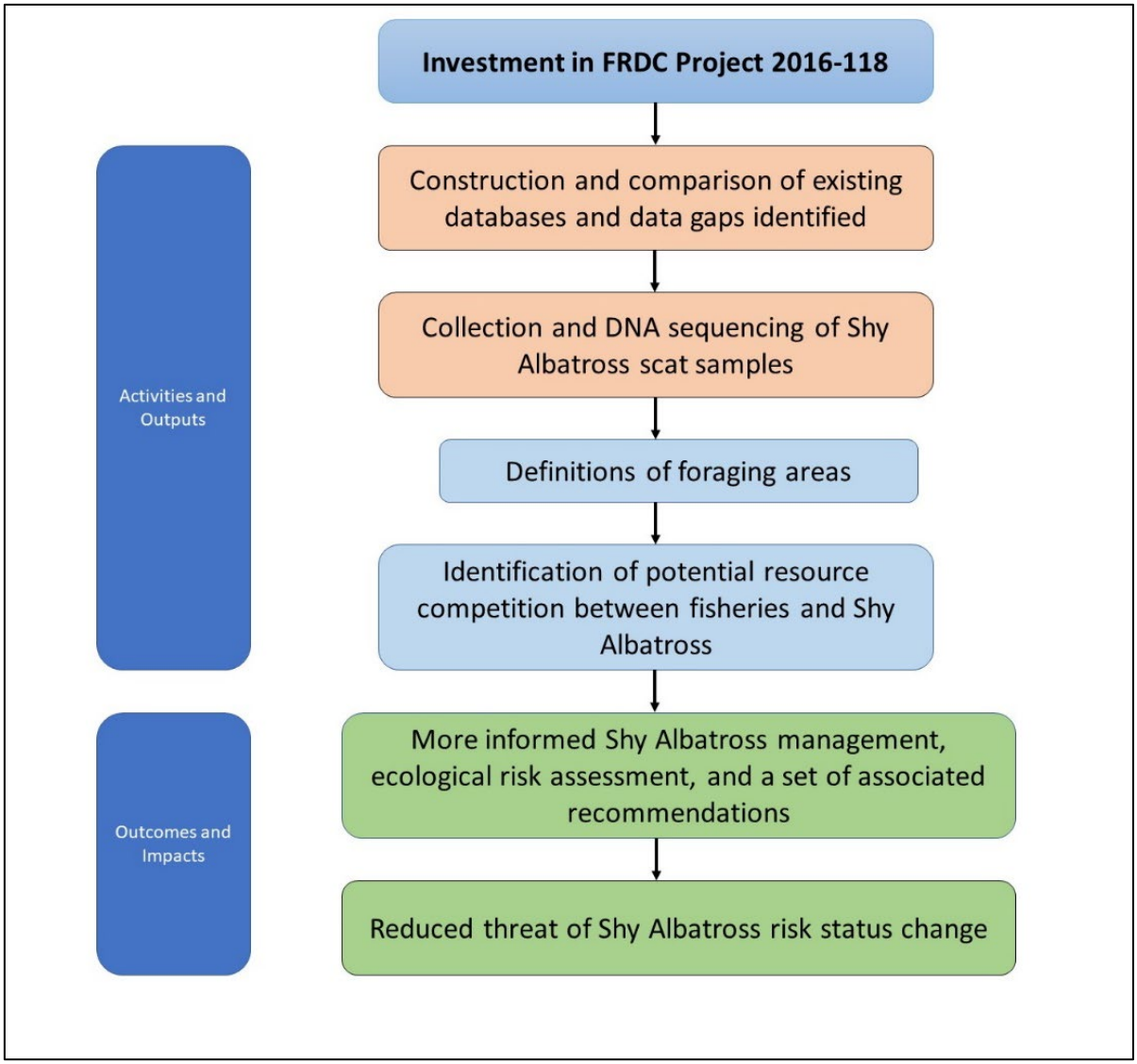
Outcomes	• Information that is being used in Shy Albatross environments to improve sustainable fisheries management and ecological risk assessment. • During the project, AFMA introduced the management action that trawl vessels were not allowed to discard offal while fishing gear dangerous to seabirds was in the water (Julie McInnes, pers. comm., 2022). • information developed during the project has been included in the updated Albatross and Giant Petrel recovery plan, highlighting the diet of albatross and the high proportion of birds that engage with fisheries. • Also, it has been acknowledged that the data from this report will be useful for future environmental risk assessment (ERA). However, there has not been any updated ERA online since the project was completed (Julie McInnes, pers. comm., 2022). • The findings from the report were disseminated to State Government and also researchers working with and evaluating the Southern Rock Lobster (SRL) fishery catch. • An EPBC nomination to list the Shy Albatross as Endangered was submitted in 2016; this was prior to the project conclusion. The nomination included population modelling that highlighted the impacts of fishery by-catch on population trends but noted the lack of robust data on fishery engagement (Julie McInnes, pers. comm., 2022). • Since 2016, the FRDC project has quantified the proportion of the Shy Albatross population engaging with fisheries and provided an insight into which fisheries and gear type these engagements likely occurred.

	• In 2020 the Shy Albatross was upgraded on the Federal Government's threatened species list from Vulnerable to Endangered. This change was likely related to information assembled in Project 2016-188.
Impacts	Potential impacts include: • A reduced threat from fishing activities resulting in the preservation of the current risk status afforded to the Shy Albatross by the Australian Government. • Potentially, increased costs for some Australian fisheries because of management changes required to protect the Endangered Shy Albatross. • Enhanced capacity and capability of Australian scientists with regard to linking the DNA of bird scat data to fish species. • Contribution/endorsement of Australia's image world-wide as being an effective fisheries science provider and fisheries manager.

Pathway to Impact

A diagram describing the simplified pathways to impact for the investment in Project 2016-118 is provided in Figure 1.

Figure 1: Pathway to Impact for Project 2016-118



Nominal Investment

Table 2 shows the annual investment made in Project 2016-118 by FRDC, DPIPWE and Others

Table 2: Annual Investment in Project 2016-118 (nominal $)

Year ended 30 June	FRDC ($)	DPIPWE ($)	OTHERS ($)	TOTAL ($)
2015	0	60,710	2,000 (a)	62,710
2016	0	60,710	2,000 (a)	62,710
2017	0	60,710	0	60,710
2018	59,500	60,710	24,500 (b)	144,710
2019	33,000	0	0	33,000
Totals	92,500	242,840	28,500	363,840

Source: FRDC Project Agreement and FRDC Financial Acquittal

(a) Winfred Violet Scott Charitable Trust

(b) Winfred Violet Scott Charitable Trust ($17,0000) plus CSIRO-staff time ($7,500)

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 (x1.179). 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, 2017-2021). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of x1.00 was applied to the nominal investment by DPIPWE and the other funders.

Real Investment and Extension Costs

For purposes of the investment analysis, the investment costs of all parties were expressed in 2020/21-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2021). No additional costs of extension were included as the outcomes and impacts were largely driven by project activities.

Impacts

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

Table 3: Triple Bottom Line Categories of Principal Impacts from Project 2016-118

Economic	• Increased costs for some Australian fisheries due to management changes required to protect the threatened Shy Albatross.
Environmental	• A reduction in threat from fishing activities resulting in the preservation of the current 'Endangered' risk status afforded to the Shy Albatross by the Australian Government.
Social	• Enhanced capacity and capability of Australian scientists with regard to linking the DNA of bird scat data to fish species. • Contribution/endorsement of Australia's image world-wide as being an effective fisheries science provider and fisheries manager.

Public versus Private Impacts

The impacts identified in this evaluation are related to improvements in effective management of some Australian fisheries. Both private and public impacts have been delivered by investment in Project 2016-188. The public impacts will include improved management of some Australian fisheries resulting in reduced threats to the Shy Albatross, an enhanced image of Australian science and fisheries management, and an increase in the capacity of Australian scientists. The private impacts potentially may include some increased costs to Australian fisheries.

Distribution of Private Impacts

Australian fishers will bear any potential long-term private costs. Any such costs will be shared with the supply chains with which fishers interact. Such costs will be shared by members of the various fishery supply chains according to associated supply and demand elasticities.

Impacts on Other Australian Industries

It is expected that there would be negligible impacts on other Australian primary industries.

Impacts Overseas

The impacts overseas will be largely associated with a stronger image world-wide of Australia being an effective fisheries science provider and fisheries manager.

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 2016-118 indirectly contributed to National Science and Research Priorities 1 and 2. Further, the RD&E investment is likely to contribute indirectly to Agricultural Innovation Priority 1 through the project's contribution to increased environmental sustainability credentials for Australia's wild-catch fisheries.

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.

[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.

FRDC National RD&E Priorities

Through extensive consultation, the FRDC 2015-2020 RD&E Plan identified three national RD&E priorities to focus and direct FRDC investments. The three FRDC national RD&E priorities were:

1. Ensuring that Australian fishing and aquaculture products are sustainable and acknowledged to be so.
2. Improving productivity and profitability of fishing and aquaculture.
3. Developing new and emerging aquaculture growth opportunities.

Project 2016-118 directly addressed FRDC national RD&E Priority 1 through the project's contribution to improved environmental sustainability credentials for Australia's wild-catch fisheries because of enhanced understanding of Shy Albatross behaviour and minimising threats from fishing practices.

Valuation of Impacts

Impacts Valued

The principal impact valued in assessment of the investment in FRDC Project 2016-118 is the preservation of the current risk status (Endangered, as of 2020) afforded to the Shy Albatross by the Australian Government. However, the value of this impact may be partially offset by any potential additional costs or loss of benefits incurred by Australian fishers; these additional impacts to fishers are already accounted for in the valuation of the preservation impact.

A degree of conservatism was used when finalising assumptions for valuing both positive and negative impacts, particularly as some significant uncertainty was involved in many of the estimates. A summary of the assumptions made in the impact valuations is provided in Table 5.

Impacts Not Valued

Not all impacts identified in Table 3 could be valued in the assessment. The impacts identified but not valued were social impacts and included:

- The enhanced capacity and capability of Australian scientists with regard to linking the DNA of bird scat data to fish species.
- Contribution/endorsement of Australia's image world-wide as being an effective fisheries science provider and fisheries manager.

These two impacts were not valued in monetary terms due to the difficulty of developing credible assumptions and relationships between the project and the capability and capacity built or how the world-wide image of Australia being an effective fisheries manager could be valued.

Table 5: Summary of Assumptions

Variable	Assumption	Source
Impact 1: Reduced Probability of a Conservation Status Change		
Willingness to pay (WTP) estimate per species extinction	$0.67 per household per annum (2004 $ terms)	Derived from van Bueren and Bennett, 2004
	$1.08 per household per annum (2021 $ terms)	0.67 x 1.61 (implicit GDP deflator for 2021 vs 2004)
WTP for avoiding status change from endangered to critically endangered	$1.08/4 = $0.26 per household per annum	Distributing the $1.08 per household equally across the four classification stages related to endangerment status (Agtrans Research)
Number of households in Australia	10.1 million	Australian Institute of Family Studies (2020)
Proportion of WTP benefit achieved considering any potential additional cost to fisheries	50%	Agtrans Research
Year of first impact	2023	Assumed first year of avoided status change from Endangered to Critically Endangered (Agtrans Research)
Last year of impact	2027	Assumed last year of avoided status change from Endangered to Critically Endangered (Agtrans Research)

Variable	Assumption	Source
Risk Factors and Counterfactual		
Probability of output	100%	Agtrans Research
Probability of outcome	50%	
Probability of impact	50%	
Counterfactual: Impact would not have been achieved in the absence of the project		

Results

All benefits were expressed in 2020/21-dollar terms. All costs and benefits were discounted to 2021/22 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) attributable to the FRDC investment only, shown in Table 7, has been estimated by multiplying the total PVB by the FRDC proportion of real investment before discounting (28.2%).

Table 6: Investment Criteria for Total Investment in Project 2016-118

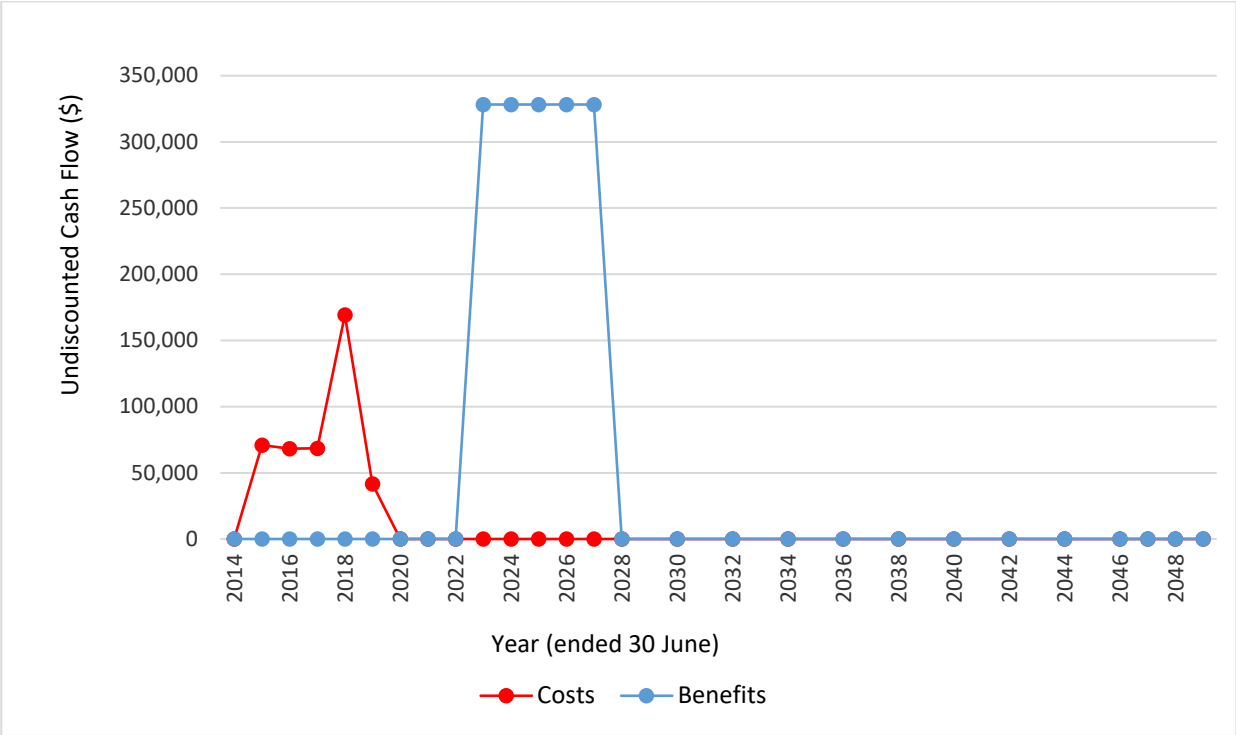
Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.00	0.61	1.42	1.42	1.42	1.42	1.42
Present value of costs ($m)	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Net present value ($m)	-0.53	0.08	0.89	0.89	0.89	0.89	0.89
Benefit-cost ratio	0.00	1.15	2.67	2.67	2.67	2.67	2.67
Internal rate of return (%)	negative	7.2	19.0	19.0	19.0	19.0	19.0
MIRR (%)	negative	12.4	20.8	14.0	11.2	9.8	8.9

Table 7: Investment Criteria for FRDC Investment in Project 2016-118

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.00	0.17	0.40	0.40	0.40	0.40	0.40
Present value of costs ($m)	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Net present value ($m)	-0.14	0.03	0.26	0.26	0.26	0.26	0.26
Benefit-cost ratio	0.00	1.22	2.84	2.84	2.84	2.84	2.84
Internal rate of return (%)	negative	9.1	23.5	23.5	23.5	23.5	23.5
MIRR (%)	negative	16.7	22.1	14.7	11.7	10.2	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 2.

Figure 2: 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 moderate 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 ($m)	1.64	1.42	1.24
Present value of costs ($m)	0.42	0.53	0.67
Net present value ($m)	1.22	0.89	0.57
Benefit-cost ratio	3.92	2.67	1.85

A sensitivity analysis was undertaken on the potential additional costs to the fisheries sector due to action taken that has assumed to reduce the endangerment status of the Shy Albatross. Results are shown in Table 9.

Table 9 shows the investment criteria achieved after accounting for the varied assumptions for the additional costs to fisheries. The break-even proportion of benefits actually achieved after any additional costs to Fisheries were included was estimated at 18.7%, compared to the base assumption of 50%.

Table 9: Sensitivity to Assumption of Cost to Fisheries

Investment Criteria	Proportion of WTP Benefits Actually Achieved after Accounting for Additional Costs to Fisheries		
	75% (optimistic)	50% (base)	25% (pessimistic)
Present value of benefits ($m)	2.13	1.42	0.71
Present value of costs ($m)	0.53	0.53	0.53
Net present value ($m)	1.60	0.89	0.18
Benefit-cost ratio	4.00	2.67	1.33

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 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 10: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium-High	Low

The coverage of benefits was assessed as Medium-High. Of the four impacts identified in Table 3, two were addressed in the valuation (the preservation of the existing status of the Shy Albatross, and the cost to fisheries). The two impacts not valued were considered minor relative to the two main impacts valued.

For the impacts valued, the critical assumption associated with the willingness to pay by the Australian public for reduced endangerment of the Shy Albatross was somewhat uncertain. Hence, the overall rating of confidence in the assumptions was considered Low.

Conclusions

The principal contribution of the project investment was to reduce the threat from fishing activities associated with the Shy Albatross. This reduction in threat is assumed to have contributed to the preservation of the current risk status afforded to the Shy Albatross by the Australian Government.

Funding for the project over the three years totalled $0.53 million (present value terms) and produced estimated total expected benefits of $1.42 million (present value terms). This gave a net present value of $0.89 million, a benefit-cost ratio of 2.67 to 1, an internal rate of return of 19.0% and a modified internal rate of return of 8.9%. Apart from the reduced threat to the future of the Albatross, there were several other potential impacts identified but not valued in monetary terms. This meant that the investment criteria as provided by the evaluation are likely to be an underestimate of the total value of the project investment.

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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