



FINAL

**An Impact Assessment of FRDC  
Investment in 2014-036: First  
Implementation of an  
independent observer program  
for the Charter Boat Industry of  
NSW: data for industry-driven  
resource sustainability**

Agtrans Research

July 2018

FRDC Project No 2016-134

© Year Fisheries Research and Development Corporation.  
All rights reserved.

**An Impact Assessment of FRDC Investment in 2014-036: First Implementation of an independent observer program for the Charter Boat Industry of NSW: data for industry-driven resource sustainability**

**Project 2016-134  
2018**

**Ownership of Intellectual property rights**

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Fisheries Research and Development Corporation

This publication (and any information sourced from it) should be attributed to **Chudleigh, P., Hardaker T. and Abell, J., Agtrans Research, 2018, *An Impact Assessment of FRDC Investment in 2014-036: An Impact Assessment of FRDC Investment in 2014-036: First Implementation of an independent observer program for the Charter Boat Industry of NSW: data for industry-driven resource sustainability*, November 2018. CC BY 3.0**

**Creative Commons licence**

All material in this publication is licensed under a Creative Commons Attribution 3.0 Australia Licence, save for content supplied by third parties, logos and the Commonwealth Coat of Arms.



Creative Commons Attribution 3.0 Australia Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available from [creativecommons.org/licenses/by/3.0/au/deed.en](http://creativecommons.org/licenses/by/3.0/au/deed.en). The full licence terms are available from [creativecommons.org/licenses/by/3.0/au/legalcode](http://creativecommons.org/licenses/by/3.0/au/legalcode).

Inquiries regarding the licence and any use of this document should be sent to: [frdc@frdc.com.au](mailto:frdc@frdc.com.au)

**Disclaimer**

The authors do not warrant that the information in this document is free from errors or omissions. The authors do not accept any form of liability, be it contractual, tortious, or otherwise, for the contents of this document or for any consequences arising from its use or any reliance placed upon it. The information, opinions and advice contained in this document may not relate, or be relevant, to a readers particular circumstances. Opinions expressed by the authors are the individual opinions expressed by those persons and are not necessarily those of the publisher, research provider or the FRDC.

The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a statutory authority within the portfolio of the federal Minister for Agriculture, Fisheries and Forestry, jointly funded by the Australian Government and the fishing industry.

**Researcher Contact Details**

Name: Peter Chudleigh  
Address: Suite 36, Benson House,  
Toowong QLD 4066  
Phone: 07 3870 4047  
Fax: 07 3371 3381  
Email: peter@agtrans.com.au

**FRDC Contact Details**

Address: 25 Geils Court  
Deakin ACT 2600  
Phone: 02 6285 0400  
Fax: 02 6285 0499  
Email: frdc@frdc.com.au  
Web: www.frdc.com.au

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

# Contents

<b>Contents .....</b>	<b>iii</b>
List of Tables .....	iv
List of Figures .....	iv
<b>Acknowledgments .....</b>	<b>v</b>
<b>Abbreviations .....</b>	<b>v</b>
<b>Executive Summary .....</b>	<b>vi</b>
<b>Introduction.....</b>	<b>7</b>
<b>General Method .....</b>	<b>8</b>
<b>Background and Rationale.....</b>	<b>9</b>
Background.....	9
Rationale .....	10
<b>Project Details .....</b>	<b>11</b>
Summary .....	11
Objectives .....	11
Logical Framework.....	11
<b>Project Investment .....</b>	<b>13</b>
Nominal Investment.....	13
Program Management Costs .....	13
Real Investment and Extension Costs.....	13
<b>Impacts.....</b>	<b>14</b>
<b>Valuation of Impacts.....</b>	<b>16</b>
Impact Valued.....	16
Impacts not Valued .....	16
<b>Results.....</b>	<b>18</b>
Investment Criteria.....	18
Sensitivity Analyses.....	19
Pessimistic and Optimistic Scenarios .....	19
Confidence Ratings and other Findings .....	21
<b>Conclusions.....</b>	<b>22</b>
<b>Glossary of Economic Terms .....</b>	<b>23</b>
<b>References.....</b>	<b>24</b>

## List of Tables

Table 1: Logical Framework for Project 2014-036 .....	11
Table 2: Annual Investment in Project 2014-036 (nominal \$).....	13
Table 3: Triple Bottom Line Categories of Principal Impacts from Project 2014-036.....	14
Table 4: Australian Government Research Priorities.....	15
Table 5: Summary of Assumptions.....	17
Table 6: Investment Criteria for Total Investment in Project 2014-036.....	18
Table 7: Investment Criteria for FRDC Investment in Project 2014-036 .....	18
Table 8: Sensitivity to Discount Rate .....	19
Table 9: Sensitivity to Key Assumptions with High Uncertainty .....	20
Table 10: Confidence in Analysis of Project .....	21

## List of Figures

Figure 1: Annual Cash Flow of Undiscounted Total Benefits and Total Costs.....	19
--	----

# Acknowledgments

Agrans Research and Consulting would like to thank Patrick Hone (Executive Director) and Nicole Stubing (Project Manager) of the Fisheries Research and Development Corporation for facilitating contact with relevant project personnel and for their guidance and feedback throughout the Impact Assessment process.

Charles Gray, Principal Investigator, WildFish Research

# Abbreviations

CBA	Cost-Benefit Analysis
CRRDC	Council of Research and Development Corporations
FRDC	Fisheries Research and Development Corporation
IRR	Internal Rate of Return
MERCMAC	Marine and Estuarine Recreational Charter Management Advisory Committee
MIRR	Modified Internal Rate of Return
OTLF	Ocean Trap and Line Fishery
PVB	Present Value of Benefits
RD&E	Research, Development and Extension

# Executive Summary

## What the report is about

This report presents the results of an impact assessment of the Fisheries Research and Development Corporation (FRDC) investment in a project to develop and implement an independent observer program for the Charter Boat Industry of NSW in order to enhance industry-driven resource sustainability. The project was funded by FRDC in the years ending 30<sup>th</sup> June 2014, and 2015.

## 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

The major impact identified and valued was a contribution to maintenance and/or improvement in the long-term economic sustainability and recreational value of the NSW Charter Boat Industry. The project led also to increased confidence in the industry logbook data and its use in NSW fisheries management.

## Investment Criteria

Funding for the project over the two years totalled \$0.46 million (present value terms) and produced estimated total expected benefits of \$2.02 million (present value terms). This gave a net present value of \$1.56 million, a benefit-cost ratio of 4.4 to 1, an internal rate of return of 16.8% and a modified internal rate of return of 10.2%.

## Conclusions

The investment in this project has resulted in improvements in the long-term management of the NSW Charter Boat Industry and the NSW saltwater recreational fishery industry.

## Keywords

**Impact assessment, cost-benefit analysis, fisheries sustainability, recreational fishing, logbook data**

# Introduction

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

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

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

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

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

Project 2014-036: *First Implementation of an independent observer program for the Charter Boat Industry of NSW: data for industry-driven resource sustainability* was selected as one of the 20 investments and was analysed in this report.

# General Method

The impact assessments followed general evaluation guidelines that are now well entrenched within the Australian primary industry research sector including Research and Development Corporations (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 that investment.

# Background and Rationale

## Background

The NSW charter boat fishery is managed as part of the wider Recreational Fishery in NSW. Charter boat operators need a licence to operate their business and are required to maintain comprehensive records of catches and effort in order to protect fisheries resources for the future. Licensing was introduced as an effort to manage fishing pressure on fish stocks, enabling sustainable fish stock management. The recreational charter fishing boat sector is managed as part of the overall management of NSW fish stocks as management needs to account for all human induced fishing mortality when determining the catch allocation. There was a need to ensure that the charter fishing boat sector, along with the wider recreational and commercial fishing sectors, is included in management arrangements for the conservation and sustainable utilisation of fish stocks.

The NSW charter boat fishery is recognised as a valuable and unique service industry for recreational anglers and the general public. However, the continued viability of the charter boat industry relies on a sustainable fisheries resource and its appropriate management. This requires a knowledge base of the species diversity, levels of retained and released catches and their size compositions across the fishery and over time. Such information had been poorly documented and was currently unavailable for the NSW charter boat fishery. While recreational fishery log books can provide some data for fisheries management, the data had not been independently validated.

A reliable source of data regarding the sustainability of a fishery is an observer-based research approach. This involves scientifically-trained observers accompanying fishers on fishing trips as part of normal fishing operations. Specific data recorded during fishing trips include their fishing activities and any interactions with non-target species. The data from an observer-based approach can be used by those responsible for fisheries management and the associated ecological and economic sustainability of the fishery.

The primary aim of the study was to identify and quantify the species composition of retained and discarded catches for the main line-fishing methods used charter boat fishery. Apart from rates of retention and discards, other relevant information collected addressed the rates of interaction with rare and threatened species.

An estimate of stock size is a fundamental requirement in predicting both a species' and a fishery's production potential and subsequently in developing ecologically sustainable management practices. Knowledge that underpins stock assessment and sustainability includes understanding taxonomy, age structure and longevity, reproduction, habitats, feeding preferences, history of the fishery, catch rate, and species interactions. Assessment has become more and more ecosystem-based with environmental drivers being of importance (e.g. climate variability, river changes), together with the interconnectedness of species, by-product catches and the interactions between different fisheries management regimes.

Improvement of assessment methods and improved monitoring information is an important priority for FRDC. However, routine monitoring, assessment and management of the relevant NSW fisheries are generally the responsibility of the NSW Department of Primary Industries. This project was expected to promote the sustainability and viability of the charter boat industry in NSW and was deemed a high priority of the NSW DPI Resource Assessment workshops in 2011, 2012 and 2013.

## **Rationale**

The rationale for this investment is that wild catch fisheries need to be managed to avoid the tragedy of the commons. Management to ensure a sustainable catch usually takes the form of input and output controls. Output controls focus on the 'take' whereas input controls focus on the catch rate and gear type. Without government control, it is likely that the industry and the public would be worse off through an increased frequency of fisheries collapses, unsustainable resource use and industry becoming unprofitable.

# Project Details

## Summary

Project Code: 2014-036

Title: *First Implementation of an independent observer program for the Charter Boat Industry of NSW: data for industry-driven resource sustainability*

Research Organisation: WildFish Research

Principal Investigator: Charles Gray

Period of Funding: July 2014 to June 2016

FRDC Program Allocation: Environment (100%)

## Objectives

The objectives of the project were:

1. Deliver independent quantitative observer-based information on the diversity, rates of capture and length compositions of species retained and released from coastal charter boats in NSW.
2. Obtain quantitative information and report on the ages and age compositions of catches of key fish species harvested by the coastal charter boat fishery in NSW.
3. Provide summaries of analyses of data across appropriate spatial and temporal scales.
4. Deliver summary profiles of charter boat cliental to industry.
5. Compare on-board observer estimates of species retained and their rates of capture with industry logbooks.
6. Provide feedback to industry and management on project objectives.

## Logical Framework

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

Table 1: Logical Framework for Project 2014-036

Activities and outputs	<ul style="list-style-type: none"> <li>• A Project Advisory Committee was established and briefed regularly.</li> <li>• Consultation was carried out with the charter boat industry representatives including the Marine and Estuarine Recreational Charter Management Advisory Committee (MERCMAC).</li> <li>• The initial observer-based survey was restricted to traditional coastal charter boat operations.</li> <li>• Observations of up to 15 fishing charters in each season were targeted</li> <li>• The project addressed three NSW regions (North, Central and South) to determine the feasibility of observer-based monitoring of charter boat catches for resource management of sustainability purposes.</li> <li>• Experienced observers were employed to collect catch and effort data from normal charter trips selected randomly from the pool of operators in each region; observers and operators were paid a standard fee.</li> <li>• Observers (and charter operators) were paid from the project budget</li> <li>• A sampling plan involving catch recording and otolith collection and processing was developed and approved. A total of 180 fishing trips over one year were targeted.</li> </ul>
------------------------	--

	<ul style="list-style-type: none"> <li>• Data on retained and discarded catches, species number and length etc including otolith removal (otoliths can reveal a fish's age and growth rate), were recorded.</li> <li>• At least 200 otoliths for four fish species were collected and their ages estimated.</li> <li>• Data on charter boat operations such as vessel type, fishing gear, fished areas, water depth and temperature, weather conditions etc were recorded for each trip.</li> <li>• All data relating to 12 months of catch, including otolith data and charter boat information, were recorded on excel data sheets and transferred to WildFish Research and NSW DPI (Recreational Management).</li> <li>• Data on catches and discards were successfully collected and analysed as was information on charter boat clientele.</li> <li>• The independent observer data were compared with commercial logbook data.</li> <li>• The comparison showed that the mean catch rate for most species were the same and suggested that the industry log book data could potentially be used for monitoring the catch rate for key species; this was not the case for fish length data or for released species.</li> <li>• The observer sampling obtained additional detail on catch, location, depth and habitat, important for interpreting spatio-temporal variability in catches.</li> <li>• It was concluded that it would not be realistic for charter boat operators to report the additional information provided by the observer program.</li> <li>• In conclusion, it was suggested that a future monitoring and assessment strategy could include a combination of both industry log book data and periodically collected independent observer data.</li> <li>• An extension and adoption plan was executed during the project; this included ongoing discussions with NSW DPI personnel and charter boat operators and other mechanisms (e.g. an overview of the project in the NSW DPI charter boat newsletter).</li> </ul>
Outcomes	<ul style="list-style-type: none"> <li>• The project has, at least in the short term validated, to some extent, the industry logbook data and its use in fisheries management.</li> <li>• The data were used by the resource assessment team in their deliberations (Charles Gray, pers. comm., 2018).</li> <li>• Information in the report could help determination of changes in the way that management imposes catch restrictions for individual species (e.g. bag and size limits, discarding rules) in the fishery, and also monitoring methods to assist better resource assessment and management (Charles Gray, pers. comm., 2018).</li> <li>• As far as can be ascertained a similar observer program for charter boat fishing has not been implemented in other states, but the methods and logistic constraints determined in the project could assist the development of other projects (Charles Gray, pers. comm., 2018).</li> </ul>
Impacts and potential impacts	<ul style="list-style-type: none"> <li>• Increased confidence in the industry logbook data and its use in NSW fisheries management.</li> <li>• Contribution to improved resource and ecosystem sustainability of the NSW Charter Boat Industry and the wider Recreational Fishery in NSW.</li> <li>• Potential for methodology developed to be used in fishery management projects in NSW and in other States.</li> </ul>

# Project Investment

## Nominal Investment

Table 2 shows the annual investment made in Project 2014-036 by FRDC and others including the NSW Department of Primary Industries and Wildfish Research.

Table 2: Annual Investment in Project 2014-036 (nominal \$)

<b>Year ended 30 June</b>	<b>FRDC (\$)</b>	<b>OTHER<sup>(a)</sup> (\$)</b>	<b>TOTAL (\$)</b>
2014	80,000	93,800	173,800
2015	100,000	80,500	180,500
<b>Totals</b>	<b>180,000</b>	<b>174,300</b>	<b>354,300</b>

(a) 91.4% of total for other funding was contributed by the NSW Department of Primary Industries and 8.6% by the applicant WildFish Research.

## 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 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). No additional costs of extension were included as the project itself maintained communication channels with NSW DPI personnel and MERCMAC and updates of the project were included in the NSW DPI charter boat newsletter.

# 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 2014-036

Economic	<ul style="list-style-type: none"><li>• Maintenance of, or improvement, in the long-term economic sustainability and recreational value of the NSW Charter Boat Industry</li></ul>
Environmental	<ul style="list-style-type: none"><li>• Contribution to maintenance of, or improvement in, the biological and ecological sustainability of the NSW Charter Boat Fishery, including a reduced risk of endangered fish species extinctions</li></ul>
Social	<ul style="list-style-type: none"><li>• Maintenance of spillover benefits to Australian coastal communities via fishing activity based in those communities</li></ul>

## Public versus Private Impacts

Most impacts identified in this evaluation are related to fisheries management and therefore the principal private long-term impacts are considered both economic and environmental. Some additional long-term private benefits will accrue to individuals and businesses operating charter boats and there are likely to be some spillover benefits maintained to NSW coastal communities.

Public benefits will be in the form of improved fisheries management that maintain ecological sustainability and reduces the risk of extinction of species via overfishing.

## Distribution of Private Impacts

Long-term private benefits will be captured by both individual charter businesses and the charter boat industry as a whole.

## Impacts on other Australian industries

It is assumed that project impacts will be confined to the NSW Charter Boat Industry. There also is the prospect of the project methods and findings having some potential use in other fisheries management areas.

## Impacts Overseas

No significant benefits to overseas parties are expected.

## 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 improved ecological sustainability impacts will contribute primarily to Rural RD&E Priority 3 and to Science and Research Priorities 1 and 2.

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>
<ol style="list-style-type: none"> <li>1. Advanced technology</li> <li>2. Biosecurity</li> <li>3. Soil, water and managing natural resources</li> <li>4. Adoption of R&amp;D</li> </ol>	<ol style="list-style-type: none"> <li>1. Food</li> <li>2. Soil and Water</li> <li>3. Transport</li> <li>4. Cybersecurity</li> <li>5. Energy and Resources</li> <li>6. Manufacturing</li> <li>7. Environmental Change</li> <li>8. Health</li> </ol>

Sources: DAWR (2015) and OCS (2015)

# Valuation of Impacts

## Impact Valued

The principal impact valued is the improvement in the sustainability of the saltwater NSW Recreational Fishery, specifically via a contribution to improved management of the NSW recreational fishery via a reduction in risk of species extinction associated with existing vulnerable species.

## Impacts not Valued

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

- Maintenance of, or improvement in, the long-term economic sustainability and recreational value of the NSW Charter Boat Industry
- Maintenance of spillover benefits to Australian coastal communities via fishing activity associated with in those communities.

Any improvement in the long-term economic sustainability of the NSW Charter Boat Industry was not valued due to the difficulty of developing credible assumptions and relationships between management of the fishery and the industry value. Likewise, credible assumptions required for valuation of the spillover benefits to NSW coastal communities from improvements in fisheries management were difficult due to lack of information.

## Reduction of Risk of Species Extinction

This improvement has been assumed due to the investment leading to improved stock assessments and hence improved resource management. This valuation is achieved by assuming a change in the probability of a shift in the status of the vulnerability of several species due to the information provided by the observer program and its use in management of the fishery.

## Species Status

NSW Fisheries resources are periodically assessed and reported by NSW DPI. Among the species reported as Overfished, Fully Fished or Growth Overfished in any one year or more from 2012-13 to 2014-15 included: Angel Sharks, Australian Bonito, Blue-eye Trevalla, Bluespotted Flathead, Dogfish, Eastern Australian Salmon, Eastern Pigfish, Eastern Sea Garfish, Gemfish, Grey Morwong, Gummy Shark, Jackass Morwong, John Dory, Luderick, Mulloway, Ocean Perch, Redfish, Sand Whiting, School Shark, Silver Trevally, Snapper, Tailor, Tiger Flathead, Yellow Bream, Yellow Tail Kingfish, Yellow Tail Scad, Bluespot Flathead and Redfish (NSW DPI, 2015).

A number of these species were reported caught or caught and released from the NSW Charter Boat survey (e.g. Bluespot Flathead, Grey Morwong, Redfish, Tiger Flathead, Ocean Perch, Snapper, Yellowtail Scad). The recreational catch of many of these species is already restricted by size or by bag limits (See, NSW DPI, 2018).

It was assumed that the project information contributed to improvements to the management of three unspecified species; this contribution was assumed from the direct catch data as well as the increased confidence by fisheries management of the past and future records kept by the NSW Charter Boat Industry.

## Assumptions Regarding the Contribution of Project Information to Future Risk of Extinction

The management improvements would be only marginal as other information from the wider recreational fishing sector as well as the commercial sector would be major information contributors. Assumptions for the Project contribution are provided in Table 5.

### Willingness to Pay (WTP)

The value society places on the existence of species is difficult to elicit due to the absence of a market for this environmental good. Consequently, non-market values can be estimated by inferring how much money people are willing to pay (or accept) if a market for them did exist. There are several methods that have been developed to estimate non-market values and are broadly classified as either stated preference or revealed preference methods. Contingent valuation and choice modelling are examples of the stated preference method which involves a range of survey techniques that elicit respondent preferences.

A review by Lai (2012) identified two particular studies that made willingness to pay estimates of the value of protecting Australian species from extinction. Both studies were published in *The Australian Journal of Agricultural and Resource Economics*, an internationally recognised A-grade journal, and are therefore considered with high regard. Both studies also used the preferred choice modelling method to derive the corresponding willingness to pay estimates.

Lai summarised the results of the two studies to estimate the willingness to pay to protect a species from extinction by Australian households in 2012/13 as \$16.00 per household in 2010/11 \$ terms. This value was for the protection of an endangered species from extinction. In 2017/18 \$ terms this would be equivalent to \$17 per household.

### Expected value of benefits

The expected values of potential species status changes in the NSW Recreational Fishery with and without the project were estimated through the marginal change in future value from the lowered risk of one or more of the vulnerable species becoming extinct through improved management. The expected value of losing a species to extinction was estimated by subtracting one value loss stream (with the project) from the other loss stream (without the project).

A summary of key assumptions made for the valuation of the impact is provided in Table 5. A degree of conservatism was used when finalising assumptions, particularly when some uncertainty was involved.

Table 5: Summary of Assumptions

Variable	Assumption	Source
<b>Species Status</b>		
Number of species assumed affected in the long-term via Project information and increased confidence	2	Based on overlap between vulnerable species and Charter Boat catch, Agrans Research
<b>Project Information and Risk Assessment Changes</b>		
Without Project 2014-036: Probability of extinction for any one of the three vulnerable species	2% per annum in any one future year	Agrans Research
With Project 2014-036: Probability of extinction for anyone of the three vulnerable species	1.95% per annum in any one future year	
Year in which possibility of extinction could first occur	2020/21	
<b>Willingness to Pay (WTP) for Avoidance of Single Species Extinction</b>		
WTP per Australian household	\$16 (one off payment) in 2010-11 \$ terms	Lai (2013)
WTP per Australian household	\$17 (one off payment) in 2017-18 \$ terms	GDP Implicit Price Deflator (2018)
Number of Australian households in 2016	9.3 million	ABS (2015)

# Results

All benefits after 2017/18 were expressed in 2017/18 \$ 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 (2014/15) 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 (51.8%).

Table 6: Investment Criteria for Total Investment in Project 2014-036

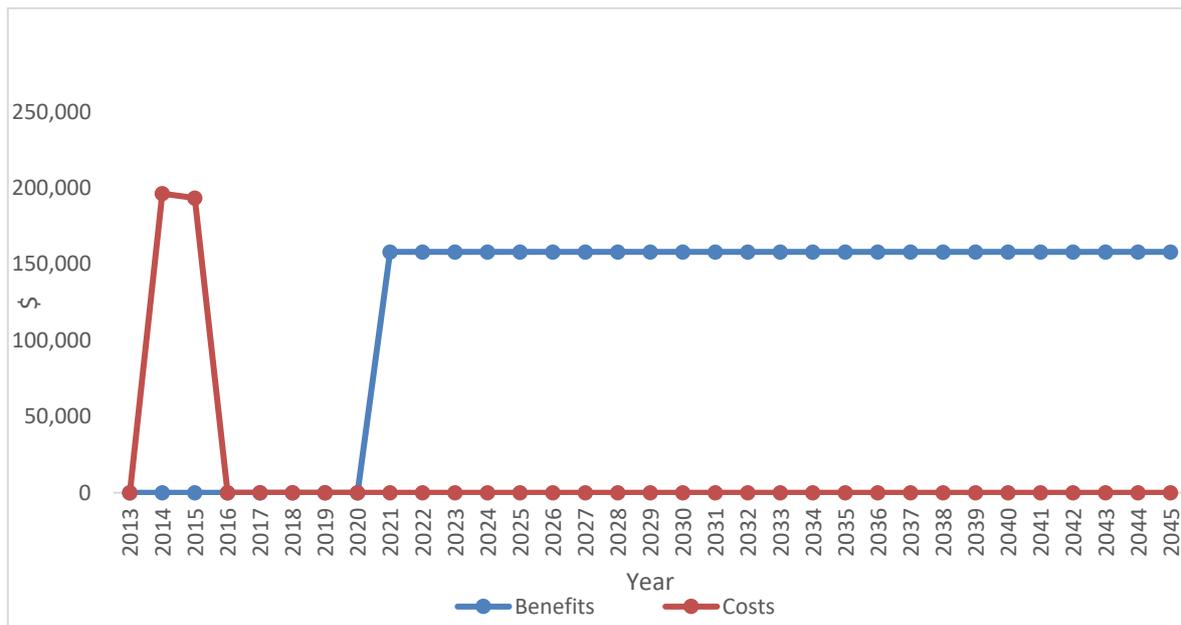
Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits (\$m)	0.00	0.00	0.62	1.11	1.49	1.79	2.02
Present value of costs (\$m)	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Net present value (\$m)	-0.46	-0.46	0.16	0.64	1.03	1.32	1.56
Benefit-cost ratio	0.00	0.00	1.34	2.39	3.22	3.86	4.37
Internal rate of return (%)	negative	negative	8.8	14.3	16.0	16.6	16.8
MIRR (%)	negative	negative	6.8	11.3	11.3	10.8	10.2

Table 7: Investment Criteria for FRDC Investment in Project 2014-036

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of benefits (\$m)	0.00	0.00	0.32	0.58	0.77	0.93	1.05
Present value of costs (\$m)	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Net present value (\$m)	-0.24	-0.24	0.08	0.34	0.53	0.69	0.81
Benefit-cost ratio	0.00	0.00	1.34	2.40	3.22	3.87	4.38
Internal rate of return (%)	negative	negative	8.8	14.4	16.0	16.7	16.9
MIRR (%)	negative	negative	9.5	12.9	12.5	11.7	10.9

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

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)	3.95	2.02	1.19
Present value of costs (\$m)	0.39	0.46	0.54
Net present value (\$m)	3.56	1.56	0.64
Benefit-cost ratio	10.14	4.37	2.18

## Pessimistic and Optimistic Scenarios

A sensitivity analysis was undertaken for pessimistic and optimistic levels of the variables with the highest level of uncertainty: the reduced risk level, and the number of vulnerable fish species assumed affected.

Results are reported in Table 9. Results show that the investment criteria for the pessimistic scenario are barely positive.

Table 9: Sensitivity to Key Assumptions with High Uncertainty  
(Total Investment, 30 years)

Investment Criteria	Sensitivity to Reduction in Risk Level and Species Number		
	Pessimistic (Risk reduction due to project halved; no of species 1)	Most likely (Base)	Optimistic (Risk reduction due to project doubled; no of species 3)
Present value of benefits (\$m)	0.51	2.02	6.06
Present value of costs (\$m)	0.46	0.46	0.46
Net present value (\$m)	0.04	1.56	5.60
Benefit-cost ratio	1.09	4.37	13.11

## 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

<b>Coverage of Benefits</b>	<b>Confidence in Assumptions</b>
Medium-Low	Low

The coverage of benefits was assessed as medium. On the one hand the environmental sustainability benefit was one of the other key drivers of the project but, on the other hand, the other major benefit pertaining to the economic sustainability of the Charter Boat Industry was not valued. For the benefit valued, many of the assumption used were supported, the critical assumption of how the risk might change due to the improved information for management was necessarily subjective. Hence, the overall rating of confidence in the assumptions was considered low.

# Conclusions

The investment in this project has resulted in improvements in the long-term management of the NSW saltwater recreational fishery industry.

Funding for the project over the two years totalled \$0.46 million (present value terms) and produced estimated total expected benefits of \$2.02 million (present value terms). This gave a net present value of \$1.56 million, a benefit-cost ratio of 4.4 to 1, an internal rate of return of 16.8% and a modified internal rate of return of 10.2%.

As some of the impacts identified were not valued, and conservative assumptions used for the impacts valued, the investment criteria as provided by the valued benefit are likely to be underestimates of the investment performance. On the other hand, confidence in the assumptions for the benefit valued were considered to be low.

# 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

- ABS. (2015). *Household and Family Projections, Australia, 2011 to 2036*. Retrieved from <http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/3236.0Main%20Features42011%20to%202036>
- ABS. (2018). *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>
- 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>
- Lai J (2013) *Willingness to pay to prevent the extinction of vertebrate species in Australia and New Zealand*. Retrieved from: <https://www.scribd.com/document/98360169/Willingness-to-Pay-to-Prevent-the-Extinction-of-Vertebrate-Species-in-Australia-and-NZ>
- 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)
- NSW DPI (2015) *Status of Fisheries Resources in NSW 2014-15*. Summary. Retrieved from: [https://www.dpi.nsw.gov.au/\\_\\_data/assets/pdf\\_file/0006/692646/INT16-161027-DRAFT-Status-fisheries-resources-NSW-2014-152-Summary.pdf](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/692646/INT16-161027-DRAFT-Status-fisheries-resources-NSW-2014-152-Summary.pdf)
- NSW DPI (2018) *Saltwater bag and size limits*, Retrieved from <https://www.dpi.nsw.gov.au/fishing/recreational/fishing-rules-and-regs/saltwater-bag-and-size-limits>