FINAL REPORT

An Impact Assessment of Investment in FRDC Project 2009-324:

the People Development Program: Nuffield Scholarship for an Aquaculture and/ or Fish Producer

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

Contents

Tables

Figures

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Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ACPF	Australian Council of Prawn Fisheries
AFMA	Australian Fisheries Management Authority
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
EM	Electronic Monitoring
FRDC	Fisheries Research and Development Corporation
GHaT	Gillnet, Hook and Trap Fishery
GVP	Gross Value of Production
IRR	Internal Rate of Return
MMI	Marine Mammal Interaction
NSW	New South Wales
PVB	Present Value of Benefits
RD&E	Research, Development and Extension
RDC	Research and Development Corporation
SA	South Australia
SESSF	Southern and Eastern Scalefish and Shark Fishery
SGPF	Spencer Gulf Prawn Fishery
SLO	Social Licence to Operate
TAS	Tasmania

Executive Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) investment in Project 2009-324: *People Development Program: Nuffield Scholarship for an Aquaculture and/ or Fish Producer*. The assessment was completed as part of a fifth annual series of impact assessments under the FRDC 2015-2020 Research, Development and Extension Plan. The fifth series of assessments included 20 randomly selected FRDC investments worth a total of approximately $5.30 million (nominal FRDC investment) and that 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 impact assessments followed general evaluation guidelines that are now well entrenched within the Australian primary industry research sector including Research and Development Corporations, Cooperative Research Centres, State Departments of Agriculture, and some universities. The approach includes both qualitative and quantitative assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations.

The FRDC Nuffield scholarships funded through Project 2009-324 provided a select group of fishing and aquaculture industry professionals with the opportunity to travel internationally to expand their personal and professional horizons while exploring industry issues and opportunities in a global context. Through the Nuffield scholarship program, the eight fishing and aquaculture professionals that received scholarships between 2012 and 2017 were able to:

- Develop new and improved practical, managerial and commercial capability and capacity,
- Increase both individual and industry understanding of international industry issues and opportunities applicable to Australian fishing and aquaculture, and
- Create domestic and international networks of industry professionals and researchers that continue to promote the exchange of information.

The investment has led to a range of potential direct and indirect economic and social impacts. Importantly, Project 2009-324 contributed to:

- Increased efficiency and/or effectiveness of collaborative RD&E based on learnings from international industry experience and knowledge sharing.
- Increased earning capacity for scholarship recipients through enhanced long-term career opportunities/potential.
- Increased long-term profitability and/or productivity for the broader Australian fishing and aquaculture industries through knowledge sharing and adoption/ implementation of industry level recommendations resulting from the Nuffield scholarship studies.

Total funding for the Project was $0.76 million (present value terms). Three impacts were valued and generated estimated total net benefits of $1.14 million (present value terms). This produced an estimated net present value of $0.38 million, a benefit-cost ratio of 1.5 to 1, an internal rate of return (IRR) of 8.3%, and a modified IRR of 6.2% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2009-324. The positive results should be viewed favourable by FRDC, the Australian Government, industry and other RD&E stakeholders.

Keywords

2009-324, Nuffield, Nuffield Scholarship, People Development Program, Capacity Building, Evaluation, Impact Assessment, Cost-Benefit Analysis

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 2009-324: *People Development Program: Nuffield Scholarship for an Aquaculture and/ or Fish Producer Conference* 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 2009-324 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 Nuffield Farming Scholarship has been awarded in Australia every year since 1950 and is regarded as Australia's foremost agricultural award. Over recent years, the program has increased its industry coverage beyond the traditional agricultural sectors to cover a wider range of Australian primary industries. The aquaculture and fishing industry joined the program through the FRDC's investment in an annual scholarship in 2007.

The scholarship program is a targeted and proven means of investing in industry people and providing opportunities to learn from other sectors, nationally and internationally, and for continued involvement by members of the fishing industry in the international Nuffield network. Scholars are selected for their farming and leadership capabilities, and potential to make a valuable contribution to Australian agriculture. Each new scholarship recipient joins a growing international network of Nuffield scholars, with more than 485 members in Australia and 1,800 members worldwide (Nuffield Australia Farming Scholars, 2021).

Rationale for Project 2009-324

FRDC project 2009-324 follows on from a previous FRDC funded project (2007-315), that saw FRDC invest in an annual Nuffield Australia Farming Scholarship for the aquaculture and fishing sectors over three years. During this period, three members of the fishing sector participated in the Nuffield experience - Lester Marshall of South Australia (SA), Adam Butterworth of SA and Ian Duthie of Tasmania (TAS). Project 2009-324 sought to build on this investment through support for another three years of aquaculture and fishing scholarships.

Project Details

Summary

Project Code: 2009-324

Title: *People Development Program: Nuffield Scholarship for an Aquaculture and/ or Fish Producer*

Research Organisation: Australian Nuffield Farming Scholars Association

Principal Investigator: Jim Geltch, Chief Executive Officer

Period of Funding: April 2010 to April 2014

FRDC Program Allocation: People 100%

Objectives

The specific objective of project 2009-324 was:

1. To build the capacity of the aquaculture/fishing industry to overcome the challenges of a global and internationally competitive environment through the provision of FRDC support for an annual Nuffield Farming Scholarship for an aquaculture or fishing producer for the next three years.

Logical Framework

Table 1: Logical Framework for FRDC Project 2009-324

Activities	The Nuffield Scholarship Program awards primary producers with a scholarship that enables them to pursue travel and study an agricultural topic of their choice. The scholarships are intended to build capacity for individual producers, their businesses and the broader Australian agricultural industry. In general, the scholars program involves: • Selection; • Pre-tour briefing; • Global Focus program; • Individual study program; and • Reporting and debriefing. The Global Focus Programme introduces Scholars to the major influences at a global level of their industries and individual businesses and the global network of Nuffield scholars. The individual study component allows the scholars to study and interest specific to the scholar and their industry. **2011 Scholar: Clinton Scharfe (Prawn and Sardine Manager, Blaslov Fishing Group)** Nuffield Project: Value Adding: The King Prawn • With the 2011 Nuffield scholarship, Clinton Scharfe undertook travel and research with the goal of increasing the value of the SA prawn industry both in terms of license value and product value by researching global prawn industry technology. • The specific goals of Clinton Scharfe's Nuffield project were: 1. Investigate new technologies and how they could be applied in SA. 2. Learn about management practices in other fisheries and identify those that could improve the performance of the Spencer Gulf Prawn Fishery (SGPF) and prawn fisheries in Australia more generally. 3. Identify how product differentiation will improve prawn prices (including the value of an internationally recognised environmental accreditation system, such as the Marine Stewardship Council certification).

- Clinton visited over ten countries including: India, Bahrain, France, England, Scotland, Denmark, Norway, Ukraine, Turkey, the United States of America, the Netherlands, Thailand and Belgium.
- Visits also were made to various prawn fisheries across Australia.
- Desktop study also was undertaken on the current Australian prawn market, prawn production and the possibility of exporting live product from Australia.
- Based on the findings of his travels and research, Clinton made seven key recommendations for the SGPF where he is directly involved in the prawn supply chain:
    1. Investigate options for advertising stringent food safety standards in overseas markets. This could be managed through the Australian Council of Prawn Fisheries (ACPF), liaising with government bodies and its membership to ensure that needs of all prawn fisheries are met and that the advertising is targeted to the most prominent markets/where opportunities are greatest in terms of potential product sales.
    2. Request the ACPF to pursue appropriate product labelling of species, country of origin and sustainability. This needs to be addressed in Australia first and then flow through to working with other countries, particularly where our product is exported: work with government bodies to introduce this in other countries.
    3. Conduct further research on methods and technologies to export live product; use existing work as basis and review recommendations from that research.
    4. Investigate options for export of live product such as:
       i) the country where live product would be purchased,
       ii) transportation methods and times (to input into recommendation 3 above),
       iii) demonstrate and cost benefits of processing live product.
    5. Investigate options for buy-back of seven licenses in the SGPF, and work with government and license holders to determine appropriate mechanisms (i.e. interest rates, loans and method of license purchase).
    6. Investigate options for license amalgamation: terms for each 'group'; fishery management changes (i.e. additional nights, catch rates, etc.); how groups will be formed; governance of groups.
    7. Investigate new technologies to support processing on board vessels.
- Overall, Clinton Scharfe's Nuffield project identified a number of options and avenues to be further investigated for product presentation and processing at both a business and wholesale level that could potentially improve profitability for the Australian prawn industry.
- The results of Clinton's research were shared with industry at a presentation at the Spencer Gulf and West Coast Prawn Fisherman's Association Annual General Meeting in October 2012. Further, the findings were published in a 2013 FRDC article titled "*Scholarships reveal new shellfish opportunities*".

2012 Scholar (1): Ewan McAsh (General Manager, McAsh Oysters)

Nuffield Project: Can strategic planning be used to revitalise the New South Wales (NSW) Oyster Industry?

- 2012 Nuffield scholar Ewan McAsh undertook travel and research to investigate the role strategic planning could take to revive the declining NSW oyster industry and identify the initial steps to develop a strategic vision and plan.
- The specific objectives of Ewan McAsh's Nuffield project were to investigate:
    1. If strategic planning could be used to revitalise the NSW oyster industry; and
    2. What the key steps are to developing a strategic plan for the industry.
- During the course of the study, Ewan found that widely held industry perceptions of strategic planning were that it:
  a) would be purely academic
  b) would not result in any new outcomes

c) would not be acted upon
d) would be expensive to implement

- A case study on the Australian Wine industry was conducted to understand the critical role strategic planning played in revitalising the once struggling industry in the late 1990s. The case study identified three key aspects that successful strategic plans include:
  1. An ambitious and engaging vision for the future;
  2. Industry ownership of the strategic plan; and
  3. Strong leadership with a whole of industry approach.
- Travel undertaken through the Nuffield scholarship included visits to China, the United States of America, Belgium, Spain, Ukraine and Indian.
- The international visits were used to learn more about different agricultural systems, marketing and export potential for oysters in the international marketplace.
- Ewan's key observation from his Nuffield travel was that farming operations do not need to be big to produce positive results. However, collaboration and partnerships are vital to achieve and sustain successful farming businesses and/or industries.
- Based on the findings of Ewan's Nuffield research, five key recommendations were made:
  1. The NSW oyster industry adopts a 'Big Hairy Audacious Goal' (as described in Collins & Porras (2011), *Building Your Companies* Vision) as a strategic vision – something the industry, government and investors can rally behind.
  2. The NSW Farmers' Association Oyster Committee, in collaboration with other industry leaders (NSW Shellfish Committee), develops a short, concise strategic plan to achieve this strategic vision.
  3. The NSW Farmers' Association Oyster Committee takes ownership of the development, implementation and review of the strategic plan in collaboration with government and other stakeholders.
  4. The strategic vision should be broken down into smaller goals so that it can be demonstrated to be achievable.
  5. In developing the NSW oyster industry's strategic plan, the success and strengths of the SA and TAS pacific oyster industry should be taken into account.

2012 Scholar (2): Rhys Arangio (Senior Manager Environment and Policy, Austral Fisheries)
Nuffield Project: Minimising whale depredation on longline fishing – Australian Toothfish fisheries (Nuffield scholarship co-funded by Woolworths)

- 2012 Nuffield scholar Rhys Arangio undertook travel and research to see if any whale depredation mitigation techniques currently used around the world would be both efficient and effective in Australia's toothfish fisheries.
- There are two companies that own the rights to fish for toothfish in Australian waters, Austral Fisheries (who hold around 74% of quota) and Australian Longline (who hold around 26%).
- Austral Fisheries operate two toothfish vessels, a longline/trap vessel and a trawler. The company aimed to replace the trawler with an additional longline vessel in 2013 to increase the amount of longline caught fish taken from the fishery.
- Longline and trap caught fish are considered to be of a premium quality over trawl caught fish, and longline/trap fishing methods also reduce the impact on the fish stock and the potential impact on the seabed.
- However, with an increased portion of longline caught fish there is also an increased risk of production being affected by marine mammal depredation.
- In other toothfish fisheries such as the French Crozet Islands fishery, Orca whales and Sperm whales have been shown to take up to 75% of the fish from the line when they are present which has a serious detrimental effect to fishery's profits (Roche, Guinet, Gasco, & Duhamel, 2007).

- As part of the Nuffield project, Rhys undertook a study tour across Chile, Norway, Belgium, France, Canada and the United States of America to meet fishermen, gear suppliers and scientists to gain their perspectives and ideas on the topic.
- A detailed review of the published literature also was completed.
- Rhys's Nuffield project found that there were many potential mitigation options for whale depredation, but that results vary depending on the depredating species, the fishery involved, and the fishing gear being used.
- Potential mitigation options identified included:
    1. Trap fishing is a solution for depredation; however, commercial catch rates for trap fishing for toothfish (1-2t/day) are far below that of longlines (5-6t/day), so while this method has potential, until either depredation rates or trapping catch rates increase, trapping likely not to be a cost-effective option.
    2. Passive acoustic listening through hydrophones to map where and when whales frequent the fishery.
    3. Active decoys – a 'fake' longline attached with a hydrophone and acoustic playback device emitting propeller cavitation sounds that attract whales to a decoy location.
    4. Cachalotera – a manual longline method with fish protection through a 'net sleeve'. This requires a change in gear and vessel setup. It also means less hooks can be used per day.
    5. Acoustic deterrents (e.g. OrcaSaver). However, results are not conclusive but there is potential scope in navy sonar.
    6. Other mitigation methods/ technologies in development include:
       a) 'SAGO' – a combined longline and trap gear.
       b) Poly bead on each snood emitting the same 'ping' as sablefish to a whale's sonar; decreasing the perceived depredation success rate and potentially dissuading the whales because of this.
       c) Jamming frequencies and water bubbles to confuse whales.
- Rhys's study also provided several key recommendations applicable to Australian toothfish fisheries:
    1. Develop a whale depredation best practice handbook for Australian toothfish vessels;
    2. Develop a Heard Island and McDonald Islands fishery whale sighting catalogue and compare with nearby French fisheries;
    3. When whales may be in the area, decrease longline length and depth fished; and increase hauling speed without risking breakage of line;
    4. Buoy off gear and steam at least 40 nautical miles away when whales sighted. Do not give whales a chance to develop depredation skill further; and
    5. Continue to develop toothfish trap fishery.

Note: a full FRDC sponsored Nuffield scholarship was not awarded in 2013 due to a lack of suitable applicants.

2014 Scholar (1): Ben Ralston (Owner, Ralston Bros Oysters)
Nuffield Project: Educating to change Australia's oyster culture

- The overall aim of Ben Ralston's Nuffield scholarship project was to contribute to re-modelling the Australian oyster supply chain.
- The majority of the worlds' oyster supply sees oysters being sold live where oysters then are shucked, either to order at restaurants and markets, or taken home and shucked in household kitchens. The reason behind this is that the oyster remains alive until it has been shucked and then it will be served in its own natural juice.
- In fact, in some countries it is against the law to serve or handle oysters the same way Australians do. In Australia, oysters typically are sold live in bulk to processors who shuck the oyster and rinse the oyster meat under a freshwater shower.

- Educating the consumer is about teaching them how to handle, shuck and serve live oysters and future opportunities for farmers are associated with the ability to sell live oysters with higher value or profit margins.
- The purpose of Ben's Nuffield study was to compare Australian oysters and the Australian oyster industry with the most respected and highly valued oysters in the world, the French oyster. The specific objective of the research was to see how Australian oyster farmers can add value through the supply chain by:
    1. Building stronger and better relationships between government departments and oyster farms.
    2. Exploring opportunities for export and the challenges ahead.
    3. Improving handling, packaging and oyster presentation.
    4. Turning the supply chain into the value chain.
    5. Selling a good experience.
- The travel and research undertaken by Ben Ralston through the Nuffield scholarship led to the following project recommendations:
    1. Have a government paid oyster advisory role where the job description is work for 40 days per year on farm work on 40 different farms per year. The advisory role could explain to farmers, as they work, what is happening within the government. Then once back in their government office the advisory officer can update the government.
    2. To add value, pack oysters in smaller quantities in small branded boxes.
    3. Type up an action plan for how your business supply chain works. See what changes could be made to change the supply chain to the value chain.
    4. Extend the use of technology to help add value and keep track of the value chain. For example, temperature loggers placed in oyster boxes to see what temperature the oysters are travelling at. There is also potential to explore the use of GPS trackers on oysters showing time from harvest to the customers' door.
    5. Wholesalers and retailers sell live oysters. The idea of buying live oysters and shucking them oneself needs to be promoted.
    6. Each farm and company needs to brand their oysters. It needs to be passed through to the consumer so they can start to find the farms from where they prefer to buy their oysters.
    7. Farms embrace the idea of selling live oysters and packing smaller amounts (and price accordingly).
    8. Every house in Australia owns a good quality oyster knife (e.g. Dexter Russell New Haven Oyster Knife).
    9. Consumers learn how to shuck oysters without losing the natural juice of the oyster.

2014 Scholar (2): Wayne Dredge (Managing Director, Piscari Industries)
Nuffield Project: Innovation and accountability in commercial fisheries: the case for reform of harvest and management practices for Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) and related fisheries (Nuffield scholarship co-funded by Woolworths)

- In recent years the Gillnet, Hook and Trap (GHaT) fishery underwent significant spatial closures in Commonwealth fishing grounds off SA resulting from Marine Mammal Interactions (MMIs) between shark gillnet boats, Australian Sea Lions and Common Dolphins. These closures imposed significant restrictions on gillnet fishers as it meant that up to 70% of available waters were closed to fishing in the area off SA (Knuckey, Ciconte, Koopman, & Rogers, 2014).
- Given that closure of available fishing grounds generally corresponds with decreased catches of the same magnitude the original aim Wayne Dredge's Nuffield scholarship research was to identify other fishing techniques that could be implemented that would reduce MMIs; allow previously closed areas to be reopened to fishing; and improve the economic efficiency of the industry.
- Specific objectives of the research were to:

	1. Identify fishing methods being used or developed internationally and assess their viability within Australia's SESSF and GHaT fisheries for targeting Gummy shark and/or other species. 2. Research ways in which other fisheries are managed with regard to conflict issues that exist between fishing sectors and management jurisdictions. 3. Identify the regulatory and legislative factors in Australia that are inhibiting industry from adopting new technology and discouraging investment in fisheries production. • As part of Wayne's study, he visited a number of international fisheries including in Argentina, Chile, the United States of America, Canada, Belgium, the Netherlands, Denmark, Sweden, Norway, France, Spain, the United Kingdom, Ireland, Belgium, and Portugal. • Wayne also consulted widely with industry and fisheries management in Australia and reviewed published works from the Australian and international literature. • In undertaking the research, it became apparent that longline methods and other fishing techniques could be utilised in the SESSF and GHaT fisheries but that current management or regulatory arrangements in Australia prohibit them; make entry into the fishery extremely difficult; or that using different fishing methods would cause conflict with other fishing sectors. • Wayne's research showed that, due to complicated regulatory and jurisdictional arrangements amongst Australian fisheries, any shift in technology regarding fishing practices has significant potential to cause conflict between fishing sectors harvesting from the same resource under different licensing arrangements or, amongst management authorities. • As such, capital investment in Australian fisheries production is inherently risky and lack of resolution regarding these management arrangements is causing a loss of confidence within the industry; comes at an economic cost to fishers; reduces consumer choices for Australian seafood; and decreases the current production potential of Australia's marine resources. • Proactive reform driven by industry that seeks to increase individual accountability and responsibility; improve data auditing processes through Electronic Monitoring (EM); as well as the ability to transfer fishing rights between State and Commonwealth fishers, would have the potential to open the door for greater innovation in fishing practices; improve industry productivity; and decrease compliance costs across the sector. • Any attempt at these reforms without concurrently addressing management and jurisdictional conflicts would only result in increased costs to industry without productivity gains and more burdensome regulation. • As a result of the research, several key recommendations were made as follows: 1. All management authorities and industry stakeholders should undertake a thorough and comprehensive review of the management structure of Australian fisheries to identify: i) Areas of conflict between fishing sectors; ii) Jurisdictional conflict between management authorities; iii) Regulatory provisions that inhibit innovation without clearly defined objectives; and iv) Industry practices that inhibit the ability of managers to make the most informed decisions possible. 2. The Australian Fisheries Management Authority (AFMA) and State management authorities must resolve jurisdictional conflict by creating a more innovative strategy for fisheries management that centralises policy and management under a single authority but is administered by regional structures. 3. Implement a standard platform for data collection across all fisheries to reduce costs, increases efficiency and better monitors ecosystem impacts of fishing. 4. Introduce 100% EM requirements across all multi-species fisheries or fisheries that experience high bycatch, or marine mammal or seabird mortalities, which would

enhance accountability and individual responsibility. The implementation of EM must be industry driven and innovative in ways that reduces costs to fishers and provides a productivity dividend to the industry.

5. Removal of sector, input, spatial or technological restrictions that do not serve a specific biological purpose in order to promote a greater culture of innovation within industry and allow fishers to be more adaptive to changing circumstances and consumer markets.
6. Significantly greater onus must be placed on industry to be the driver of regulatory reform rather than being the victim or reactionaries of it.

Note: An FRDC Nuffield scholarship was awarded in 2014/15 to Stacey Loftus. However, Stacey was unable to complete her Nuffield research and travel due to maternity leave and withdrew in 2016.

2016 Scholar (1): Dennis Holder (Owner, Two Gulf's Crab)
Nuffield Project: Old Men: Older Boats – Electric drive, power storage and power generation in commercial fishing vessels

- The majority of Australia's fishing fleet uses combustion engines as the typical form of power generation. As power generation technology has superseded traditional diesel engines in the last three decades, there is room and requirement for improvement.
- Dennis Holder's Nuffield scholarship research examined the prospect of building a modern fishing vessel using the latest technology of propulsion, power storage and power generation.
- The specific objectives of the research were to:
  1. Investigate the latest hull designs.
  2. Investigate electric drives.
  3. Investigate power storage options.
  4. Investigate power generation options.
- As part of the study, Dennis visited 19 countries including the Netherlands, Iceland, Ireland, the United States of America, Brussels and Norway.
- During the study tour, Dennis was able to experience an electric fishing boat for a full day, met with ship designers, factory tank test hulls, and visited battery and fishing manufacturers.
- The research showed that electric and hybrid power generation systems have been successfully utilised in Scandinavia and other parts of mainland Europe. Electric motors provide more power and vessels can utilise smaller engine units and conserve space for additional cargo, catch or crew.
- Further, the added efficiencies associated with electric motors like thermal waste re-use, allow for further reductions in required power on board fishing vessels.
- In addition, hull design enhances the efficiency of power conversion of electric motors and battery storage solutions are able to capitalise on commercial fishing conditions.
- Overall, Dennis's research indicated that, with new technology, it is possible to reduce fuel costs by up to 80%, reduce maintenance costs by up to 50% and positively address occupational health and safety fatigue management and reduce the overall carbon footprint of the fishing industry.
- However, the study also found evidence of significant barriers associated with regulations that may reduce uptake of newer technology.
- Based on the findings of the research, the following recommendations were made:
  1. The fishing industry should work with the Federal Government and infrastructure teams with the aim of revamping current boat building facilities. The objective should be to enable boat builders to utilise modern technology in all newly built vessels.
  2. The fishing industry should adopt new 'green' technologies to add environmental value to its image and products.

3. "Clean-Green" Loan Scheme. Fiscal incentives should be offered by Government bodies and safety authorities to have modern power generators fitted in all new boats. Loans to commercial fishing enterprises that renew their fleet with clean and green technology can be repaid by savings made on fuel and maintenance.
4. The fishing industry needs to attract young participants with modern boats that are technologically advanced, with an improved working environment with less noise and vibration and a lower environmental impact.
5. The fishing industry should work with the FRDC to investigate a professional cost benefit analysis for the technologies investigated in this report.
6. The fishing industry should work with Governments and financial institutions to create an environment to stimulate investment in new boats and career paths for young people.

2016 Scholar (2): Steven Davies (Chief Executive Officer, Aquatic Life Industries)
Nuffield Project: The Australian Seafood Industry and the Social Licence to Operate: Fishmongering and fearmongering in the modern market

- In an age of social media and 24-hour news cycles, it may be argued the Australian seafood industry and its general social licence to operate (SLO) finds itself under increasing levels of attack. It is vital that the industry takes effective and collaborative steps to ensure that public perceptions pertaining to the industry are in line with the reality of the generally responsible way in which it operates.
- The aim of Steven Davies Nuffield scholarship research was to understand the importance of maintenance of an industry's social licence to operate, whilst considering consumer confidence, modern markets, investor confidence, key motivators, brand development, politically motivated policy settings and general public perception
- Specific objectives of the research were to:
  1. Understand perceptions orbiting the sustainability of the Australian seafood industry.
  2. Define the social licence to operate.
  3. Explore issues which arise due to the complexity and fragmentation of industry.
  4. Iterate the importance of stakeholder engagement.
  5. Consider the economic and other benefits of socially responsible operations.
  6. Consider the impact of third-party certification.
  7. Deliver sound and reasonable recommendations to industry based on global observations.
- Steven visited nine countries as part of the research, including commercial fishing operations, aquaculture ventures, general agribusinesses, peak representative bodies, wholesalers, retailers, third-party certifiers and financial institutions in both developing and developed nations.
- Based on the findings of the Nuffield study, the following recommendations were made:
  1. The Australian seafood industry works to further identify key indicators which impact on its SLO.
  2. Australian consumers are provided with a foodservice retail environment within which they can make an informed choice to support (or otherwise) Australian seafood products via the legislated national implementation of country of origin labelling.
  3. Industry and regulators alike understand that development and maintenance of social licence is key to maintaining resource access rights.
  4. Respective industry harvest strategies consider social licence as a standard included chapter.
  5. Proactive, positive and consistent messaging based upon independent science delivered in chorus by peak bodies of representation, including via social media.
  6. Regulatory bodies, including government departments, publicly and proactively back the Australian seafood industry.

7. All vested interests work to explore ways to better connect producers with consumers.
8. The Australian seafood industry identifies key improvement areas which may impact on its ongoing SLO, including workplace health and safety.
9. Access to fishing wharves and fishers is encouraged, maintained and/or reinstated.
10. Australia considers its own independent third-party certification schemes which provide non-replicable global market differentiation.

2017 Scholar: Jonas Woolford (President, Abalone Industry Association of SA)
Nuffield Project: World Abalone Fisheries and Stock Enhancement

- Wild abalone fisheries production has been declining while abalone aquaculture production has been increasing.
- In Australia, despite large spawning biomass and controlled fishing pressure, wild abalone production has decreased at an alarming rate.
- The specific objectives of Jonas Woolford's Nuffield research were to:
  1. Gain an understanding of the world's major wild harvest abalone producing countries.
  2. Explore the fundamentals of fishery stock enhancement with a focus on abalone.
  3. Determine if and how successful abalone stock enhancement can occur.
  4. Consider the implications of abalone stock enhancement (including to the market).
- As part of the Nuffield study, Jonas toured a number of domestic and international Abalone fisheries across Australia, New Zealand, Japan, USA and the Republic of South Africa. Hong Kong and The Peoples Republic of China also were visited to explore the market for abalone and customers' perceptions of hatchery spawned but wild raised abalone.
- Through the Nuffield research and travel, the project found that, in general, abalone stock enhancement is in its infancy, except for in Japan where 30 plus years of stock enhancement sees 30% of their total annual harvest consisting of seeded abalone that achieves a survival rate of 10-15% of what is released.
- Further research, particularly around the ecology of release areas, and large-scale projects are needed to determine key constraints and improve stock enhancement success rates. This will require significant long-term investment and resources. Thus, it is crucial that there is confidence in government to provide protection to the reseeded abalone from any external factors which may interfere with the abalones' survival.
- Further, not all locations will be conducive to successful stock enhancement and keeping the handling of the juvenile abalone to a minimum is important for survival.
- No release method stood out as the most successful.
- The ideal release size was approximately 30 millimetres shell length. This size is the best because of genetic fitness. The juvenile abalone is strong enough to not succumb to the environmental factors inhibiting recruitment in the first place and is small enough not to be too domesticated from being raised in a hatchery.
- Stock enhancement, combined with resting areas, will be the best way to rebuild the biomass of abalone on the reefs and therefore commercial production. Utilising technology in a fully transparent commercial fishery will be the way to monitor and manage harvesting pressure to find optimum efficiency, quality and reef production.
- Jonas Woolford's Nuffield research also produced the following recommendations:
  1. Form professional relationships with colleagues in the world's abalone countries to share knowledge about issues and challenges faced.
  2. Form a working group of expert skill sets to explore and steer a commercial stock enhancement project.
  3. Work with the abalone aquaculture industry as they understand the early life cycle of abalone.
  4. Ensure governance arrangements are sufficient to provide the security necessary to undertake an investment in commercial stock enhancement.

	5. Undertake inclusive and transparent trials including all stakeholders in the process. 6. A recommendation from the market is to tell the story of successful stock enhancement whereby the sustainability of abalone stocks is being ensured. **Other Activities** • A breakfast seminar was held for FRDC Nuffield scholars on 4 March 2014. • The FRDC Nuffield scholars presented their research findings to industry and other stakeholders over the course of project 2009-324 through a range of industry meetings, conferences, and published media.
Outputs	• Through FRDC project 2009-324, eight Nuffield scholarships were awarded to fishing/aquaculture industry professionals: 1. 2011 scholar: Clinton Scharfe (prawns, wild-catch) 2. 2012 scholar: Ewan McAsh (oysters, aquaculture) 3. 2012 scholar: Rhys Arangio (co-funded by Woolworths) (toothfish, wild-catch) 4. 2014 scholar: Ben Ralston (oysters, aquaculture) 5. 2014 scholar: Wayne Dredge (co-funded by Woolworths) (scalefish/shark, wild-catch) 6. 2016 scholar: Dennis Holder (boat technology, wild-catch and aquaculture) 7. 2016 scholar: Steven Davies (SLO, wild-catch and aquaculture) 8. 2017 scholar: Jonas Woolford (half-scholarship) (abalone, wild-catch) • Each scholar produced a written final report detailing the findings of their Nuffield travel and research program. • Based on the findings of the Nuffield scholarship travel and research, a range of industry recommendations were made by each of the scholars. • Project findings for each scholar were communicated to industry through various Nuffield and FRDC extension activities including field-days, industry meetings, conferences and published media.
Outcomes	The FRDC Nuffield scholarships funded through project 2009-324 provided a select group of fishing and aquaculture industry professionals with the opportunity to travel internationally to expand their personal and professional horizons while exploring industry issues and opportunities in a global context. Through the Nuffield scholarship program, the eight fishing and aquaculture professionals that received scholarships between 2012 and 2017 were able to: • Develop new and improved practical, managerial and commercial capability and capacity, • Increase both individual and industry understanding of international industry issues and opportunities applicable to Australian fishing and aquaculture, and • Create domestic and international networks of industry professionals and researchers that continue to promote the exchange of information. • Other outcomes include adoption/ implementation of key recommendations made by each of the FRDC Nuffield scholars at an individual business and/or industry level.
Impacts	Potential direct impacts of the investment in project 2009-324 include: • Increased personal and professional capability and capacity for each of the eight FRDC Nuffield scholarship recipients. • Enhanced industry knowledge and leadership skills for each scholarship recipient. • Increased profitability and/or productivity at an individual business level for those fishing and aquaculture businesses adopting/ implementing learnings and recommendations achieved through each of the FRDC Nuffield scholarship studies. • Increased efficiency and/or effectiveness of collaborative RD&E based on learnings from international industry experience and knowledge sharing.

Impacts	Potential secondary or indirect impacts of the investment include: • Increased earning capacity for scholarship recipients through enhanced long-term career opportunities/potential. • Increased profitability and/or productivity for the broader Australian fishing and aquaculture industries through knowledge sharing and adoption/ implementation of industry level recommendations resulting from the Nuffield scholarship studies. • Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and aquaculture businesses.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2009-324 by FRDC and other contributors.

Table 2: Total Investment in FRDC Project 2009-324
(nominal dollar terms)

Year ended 30 June	FRDC ($)	Others[(a)] ($)	Total ($)
2011	45,000	0	45,000
2012	70,000	25,000	95,000
2013	0	0	0
2014	75,543	25,000	100,543
2015	46,000	0	46,000
2016	100,000	0	100,000
Totals	**336,543**	**50,000**	**386,543**

Source: FRDC project 2009-324 financial acquittal
(a) Assumed contribution from Woolworths Australia as co-contributor to the Nuffield scholarships for Rhys Arangio and Wayne Dredge.

Management and Administration Costs

For the FRDC investment, the cost of managing the FRDC funding was added to the FRDC contribution for the project via a management cost multiplier (x1.179). This multiplier was estimated based on a five-year average of the ratio of total FRDC cash expenditure to project expenditure reported in the FRDC's Cash Flow Statement (FRDC Annual Reports, 2017-2021). This multiplier then was applied to the nominal investment by FRDC shown in Table 2. A multiplier of 1.00 was used for administration and management costs for other contributors.

Real Investment and Extension Costs

For the purposes of the impact analysis, the investment costs of all parties were expressed in 2020/21-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2020).

No additional costs of extension were included. The findings from each of the Nuffield scholarship studies funded under project 2009-324 were communicated directly to industry by the scholars through their various industry roles and through presentations at industry field-days, meetings, and conferences, as well as other published materials.

Impacts

Table 3 provides a summary of the principal types of potential impacts from project 2009-324. Impacts have been taken and potentially expanded from those listed in Table 1 and categorised using a triple bottom line framework into economic, environmental, and social impact types.

Table 3: Principal Potential Impact Types from Investment in FRDC Project 2009-324

Economic	• [Direct] Increased profitability and/or productivity at an individual business level for those fishing and aquaculture businesses adopting/ implementing learnings and recommendations achieved through each of the FRDC Nuffield scholarship studies. • [Direct] Increased efficiency and/or effectiveness of collaborative RD&E based on learnings from international industry experience and knowledge sharing. • [Secondary/Indirect] Increased earning capacity for scholarship recipients through enhanced long-term career opportunities/potential. • [Secondary/Indirect] Increased profitability and/or productivity for the broader Australian fishing and aquaculture industries through knowledge sharing and adoption/ implementation of industry level recommendations resulting from the Nuffield scholarship studies.
Environmental	• Nil
Social	• [Direct] Increased personal and professional capability and capacity for each of the eight FRDC Nuffield scholarship recipients. • [Direct] Enhanced industry knowledge and leadership skills for each scholarship recipient. • [Secondary/Indirect] Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and aquaculture businesses.

Public versus Private Impacts

Both public and private potential impacts were identified for the project. Private impacts may be delivered through increased profitability/productivity for individual fishing and aquaculture businesses adopting the recommendations from the specific Nuffield scholarship studies, increased efficiency/effectiveness of industry research and development, and increased earning capacity for FRDC Nuffield scholarship recipients. Other private impacts may include increased personal and professional capability and enhanced knowledge and leadership skills for the eight FRDC Nuffield scholarship recipients.

Public impacts are likely to be delivered through spillover benefits from more productive and profitable fishing and aquaculture businesses.

Distribution of Private Impacts

Private impacts from the investment in project 2009-324 will primarily accrue to the eight individual FRDC Nuffield scholarship recipients and to the fishing and aquaculture businesses they represent. Over the longer-term, private impacts may also extend to other fishing and aquaculture stakeholders along the supply chains such as input providers, producers, processors, wholesalers, retailers and consumers. Such impacts would be distributed according to associated short- and long-term supply and demand elasticities.

Impacts on Other Australian Industries

The eight Nuffield scholarships supported by project 2009-324 covered a range of fishing and aquaculture industries. Two of the eight FRDC Nuffield studies addressed cross-industry issues of social licence to operate and boating technology.

No direct impacts to other Australian industries beyond fishing and aquaculture were identified.

Impacts Overseas

No significant or direct impacts to overseas parties are expected. However, there may be some future benefits to overseas fishing and aquaculture industries as a result of ongoing knowledge exchange through the international industry networks created by the Nuffield scholarship program.

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 2009-324 indirectly contributed to National Science and Research Priorities 1 and 2. Further, the RD&E investment is likely to contribute indirectly to all four Agricultural Innovation Priorities because of research and industry capacity and capability developed for each scholarship recipient.

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.	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.

[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.

Australian Government	
National Science and Research Priorities[1]	**National Agricultural Innovation Priorities**[2]
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.	**4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

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 2009-324 indirectly addressed all three FRDC national RD&E priorities through research and industry capacity and capability developed for each scholarship recipient.

Valuation of Impacts

The valuation of impacts generally focused on direct impacts of the investment in project 2009-324. The decision to value an impact identified in Table 3 was based on:

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

Impacts Valued

Three of the seven impacts of investment in project 2009-324 were selected for valuation. The three impacts are:

1. [Direct] Increased efficiency and/or effectiveness of collaborative RD&E based on learnings from international industry experience and knowledge sharing.
2. [Indirect] Increased earning capacity for scholarship recipients through enhanced long-term career opportunities/potential.
3. [Indirect] Increased profitability and/or productivity for the broader Australian fishing and aquaculture industries through knowledge sharing and adoption/ implementation of industry level recommendations resulting from the Nuffield scholarship studies.

Valuation of Impact 1: Increased efficiency and/or effectiveness of RD&E

The travel and research undertaken by the eight FRDC Nuffield scholarship recipients funded by project 2009-324 has contributed to increased industry knowledge and research capacity for a range of fishing and aquaculture industries. Each of the FRDC Nuffield scholars made recommendations and identified additional areas of work and/or research and development that would further benefit the fishing and aquaculture sectors. Further, the FRDC Nuffield support for industry research and capacity building is likely to have increased industry engagement with RD&E processes.

Such increases to industry knowledge and research capacity are likely to underpin maintained or increased returns to future research. The total average annual investment in fisheries and aquaculture RD&E funded through the FRDC was estimated at $30.07 million (five-year average, 2016/17 to 2020/21, nominal dollar terms) (FRDC Annual Reports, 2017 to 2021). However, other fisheries and aquaculture RD&E is funded by state and territory governments and privately by industry. Thus, the estimated figure of $30.07 million for Australia expenditure on fisheries and aquaculture RD&E is highly conservative and likely an underestimate of total expenditure on such RD&E.

Aggregate analyses of the performance of Australian RD&E investments funded by the Australian Rural Research and Development Corporations (RDCs) found that the weighted average benefit-cost ratio (BCR) for rural research was approximately 4.5 to 5.5 to 1 (Agtrans Research; AgEconPlus; and EconSearch, 2016; Agtrans Research, 2019). It was assumed that the FRDC project 2009-324 investment in the Nuffield scholarship program contributed to the maintenance of the return on investment to fisheries and aquaculture RD&E.

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

Valuation of Impact 2: Increased earning capacity for scholarship recipients

The opportunities afforded to the eight FRDC Nuffield scholarship recipients supported through project 2009-324 contributed to many career and earning/income enhancing factors such as increased industry knowledge, improved personal and professional capacity, enhanced leadership skills, and professional networking.

Key benefits of such investments include upskilling individuals and enhancing industry capacity to exploit opportunities as they arise. While these benefits are apparent, measuring them in monetary terms is challenging. Previous research on return on investment in capacity building/education indicates that there are several benefits from research training and education. These include benefits to the scholarship recipients, their employer and society at large. Benefits for individuals can be measured through higher salaries (Holbrook, Wixted, Chee, Klingbeil, & Shaw-Garlock, 2009). While there is a scarcity of studies on the return to tertiary education and training, Mariotti and Meinecke (2011) estimated that the return to education in Australia was 8.1% for Australian school graduates. Further, various international literature supports the existence of an income premium for higher levels of tertiary qualifications, training and education.

The Australian agriculture, forestry and fisheries industries employs approximately 313,700 persons with the median weekly earnings for the sector estimated at $932 per week (Australian Government, 2022). It was assumed that, over the medium to long-term, each FRDC Nuffield scholarship recipient would benefit through an increase in average salary over what they would have received had they not participated in the Nuffield scholarship program.

Specific assumptions for the valuation of Impact 2 are reported in Table 6.

Valuation of Impact 3: Increased profitability and/or productivity for the broader Australian fishing and aquaculture industries

Each of the eight FRDC Nuffield scholars that undertook travel and research funded under project 2009-324 completed the program with new industry knowledge and an international perspective on key industry issues and opportunities. As described in Table 1, through the Nuffield scholarship program, the eight fishing and aquaculture professionals that received scholarships between 2012 and 2017 were able to:

- Develop new and improved practical, managerial and commercial capability and capacity,
- Increase both individual and industry understanding of international industry issues and opportunities applicable to Australian fishing and aquaculture, and
- Create domestic and international networks of industry professionals and researchers that continue to promote the exchange of information.

These positive capacity and capability outcomes from the scholarship investment have contributed to improvements in productivity/profitability. These improvements are likely to have occurred both directly, for the individual organisations represented by the Nuffield scholars where changes and recommendations have been implemented, and indirectly, for the broader fishing and aquaculture industries through industry level changes and knowledge sharing.

The average annual gross value of production (GVP) for the Australian fisheries and aquaculture industries is estimated to be $2.78 billion (10-year average) (Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2021). For the project 2009-324 evaluation, it was assumed that net profit makes up approximately 10% of total GVP for the fisheries and aquaculture industries.

Specific assumptions for the valuation of Impact 3 are reported in Table 7.

Impacts Not Valued

The impacts not valued included:

- [Direct] Increased personal and professional capability and capacity for each of the eight FRDC Nuffield scholarship recipients. However, this impact may be partially captured by the valuation of increased earning capacity for scholarship holders as the increase in personal and professional capability and capacity is associated with enhanced career opportunities/potential.
- [Direct] Enhanced industry knowledge and leadership skills for each scholarship recipient. As for the capacity impact above, this impact also may be partially captured by the valuation of increased earning capacity for scholarship holders as enhanced industry knowledge and leadership skills is associated with improved career opportunities/potential.

- [Direct] Increased profitability and/or productivity at an individual business level for those fishing and aquaculture businesses adopting/ implementing learnings and recommendations achieved through each of the FRDC Nuffield scholarship studies. This impact was not valued due to a lack of specific data on the productivity/profitability changes experienced by the businesses represented by the FRDC Nuffield scholarship recipients. However, this impact may be captured by the valuation of the more general increase in fishing and aquaculture industry productivity and profitability.
- [Indirect] Improved regional community wellbeing through spillover benefits from more productive and profitable fishing and aquaculture businesses.

Summary of Assumptions

The following tables present the specific assumptions used in the valuation of Impacts 1 to 3.

Table 5: Summary of Assumptions for the Valuation of Impact 1

Impact 1: Increased efficiency/effectiveness of fisheries RD&E		
Variable	**Assumption**	**Source**
Estimated total annual expenditure on Australianfisheries and aquaculture RD&E	$30.07 million	Conservative estimated based on average annual RD&E expenditure by FRDC
BCR for Australian rural RD&E **with** the FRDC Nuffield scholarship investment	5.0 to 1 (over 30 years, 5%discount rate)	Average return based on estimated average BCR of 4.5to 5.5 to 1 for the aggregate investment in the rural RDCs (Agtrans Research; AgEconPlus; EconSearch, 2016; Agtrans Research, 2019)
BCR for Australian ruralRD&E **without** the FRDC Nuffield scholarship investment (counterfactual)	4.9 to 1 (over 30 years, 5% discount rate)	Analyst assumption: reflects that investment in project 2009-324 has contributed to the maintenanceof returns on RD&E investments
Proportion of total annual fisheries RD&E investment benefiting from enhanced knowledge and research capacity	1.0%	Analyst assumption: conservative estimate
First year of affected RD&E expenditure that will benefit from enhanced capacity	2013/14	Based on the first scholar (Clinton Scharfe) submitting a final report in 2012/13
Period of impact – that is thenumber of years of new RD&E investment benefiting from enhanced capacity	10 years (2022/23 is last year of impact)	Analyst assumption
Risk Factors		
Probability of output	100%	Based on successful completion of eight FRDC Nuffield scholarships under project 2009-324
Probability of outcome	90%	The probability of outcome refers to the likelihood that theindividuals that received the FRDC Nuffield scholarships have utilised their learnings etc. to enhance knowledge and research capacity

Impact 1: Increased efficiency/effectiveness of fisheries RD&E		
Variable	**Assumption**	**Source**
Probability of impact	90%	Allows for exogenous factors that may affect the estimated future benefits being achieved(e.g. reduced government support for RD&E)

Table 6: Summary of Assumptions for the Valuation of Impact 2

Impact 2: Increased future earning capacity for scholarship recipients		
Variable	**Assumption**	**Source**
Number of FRDC Nuffield scholarship recipients funded under project 2009-324	8	FRDC project documentation
Median weekly earnings for individuals involved in the Australian agriculture, forestry and fishing sector	$932 per week	Australian Government (2022)
Average increase in net income for scholarship recipients	10% increase over themedian income	Conservative estimate based on estimated returns to education and training in Australian and international literature (see 'Valuation of Impact 2' above)
First year of impact	2015/16	Three years after the first scholar (Clinton Scharfe) submitted a final report (2012/13) – allows for time taken to realise advantages of professional development in career advancement
Year of maximum impact	2021/22	Three years after the last scholar funded by project 2009-324 submitted a final report (2018/19)
Risk Factors		
Probability of output	100%	Based on successful completion of eight FRDC Nuffield scholarships under project 2009-324
Probability of outcome	75%	The probability of outcome refers to the likelihood that theindividuals that received the FRDC Nuffield scholarships have utilised the professional development to further their careers
Probability of impact	90%	Allows for exogenous factors that may affect the estimated future benefits being achieved (e.g. recession)
Counterfactual		
It was assumed that the benefits estimated and attributable to the investment in FRDC project 2009-324 for impact 2 would not have occurred without the investment.		

Table 7: Summary of Assumptions for the Valuation of Impact 3

Impact 3: Increased long-term productivity for Australian fisheries and aquaculture industries		
Variable	**Assumption**	**Source**
Average total annual GVP for the Australian fisheries and aquaculture sector	$2.78 billion	Based on ABARES fisheries and aquaculture statistics (10-year average)
Proportion of fisheries and aquaculture sector benefiting	0.5%	Analyst estimate (based on completion of eight FRDC Nuffield scholarships across a range of fisheries and aquaculture industries)
Proportion of GVP assumed to be industry net profits	10.0%	Analyst estimate
Increase in average net profits for beneficiaries of the FRDC investment	5.0%	
First year of impact	2017/18	Five years after the first scholar (Clinton Scharfe) submitted a final report (2012/13) – allows for time taken to realise benefits of implementing scholarship recommendations etc.t
Year of maximum impact	2026/27	Analyst assumption: 10-years after the first year of impact. Allows for adoption/ implementing of Nuffield scholar recommendations across relevant industries
Last year of impact	Level of impact decreasing linearly to zero by 2036/37 (10 years after year of maximum impact)	Analyst assumption
Risk Factors		
Probability of output	100%	Based on successful completion of eight FRDC Nuffield scholarships under project 2009-324
Probability of outcome	90%	The probability of outcome refers to the likelihood that theindividuals that received the FRDC Nuffield scholarships have utilised the professional development to further their careers
Probability of impact	90%	Allows for exogenous factors that may affect the estimated future benefits being achieved (e.g. climate change)
Counterfactual		
It was assumed that the benefits estimated and attributable to the investment in FRDC project 2009-324 for impact 3 would not have occurred without the investment.		

Results

All past costs and 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 (2015/16) to the final year of benefits assumed.

Investment Criteria

Tables 8 and 9 show the investment criteria estimated for different periods of benefits for the total investment and FRDC investment respectively. The present value of benefits (PVB) for the FRDC investment was estimated by multiplying the total PVB cash flow by the proportion of FRDC investment in real, undiscounted dollar terms (88.9%).

Table 8: Investment Criteria for Total Investment in Project 2018-207

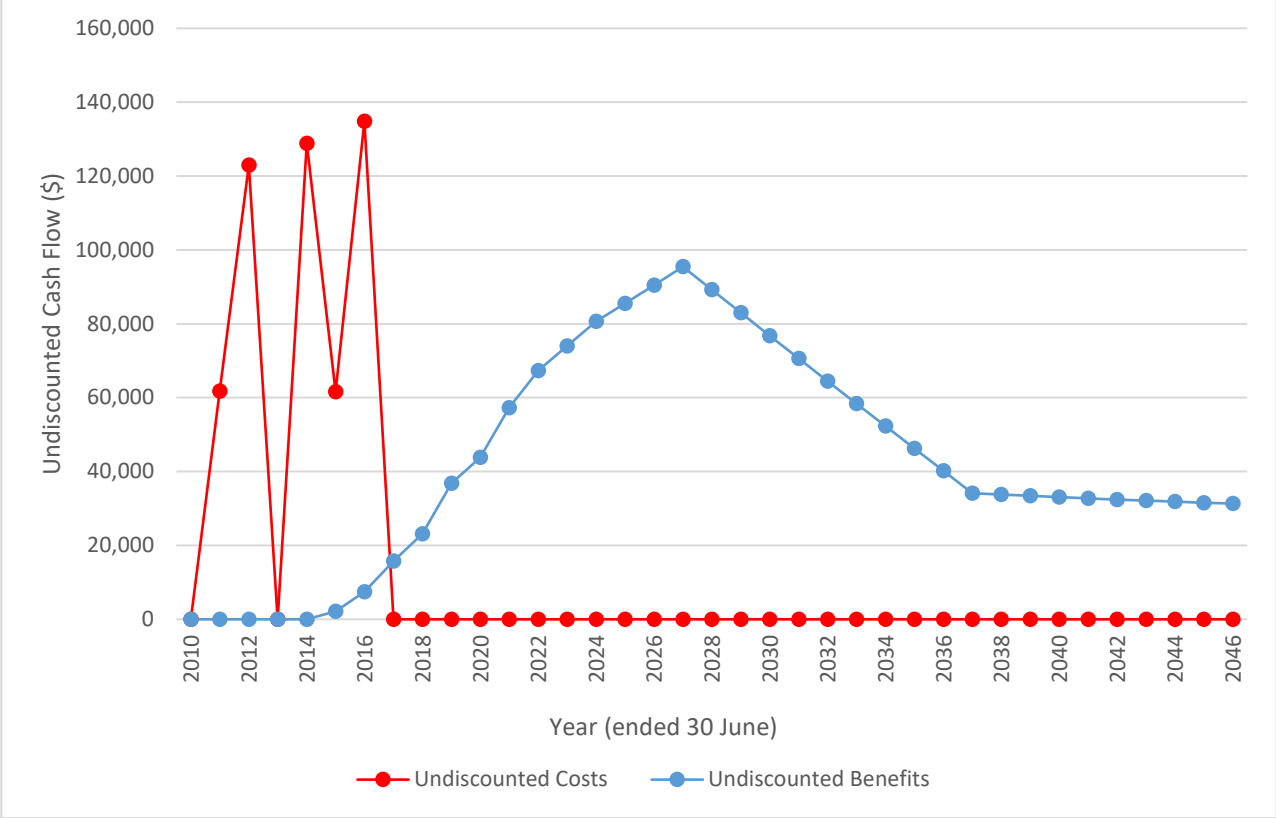
Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.01	0.21	0.57	0.87	1.02	1.09	1.14
Present value of costs ($m)	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Net present value ($m)	-0.75	-0.55	-0.19	0.11	0.25	0.33	0.38
Benefit-cost ratio	0.02	0.28	0.75	1.14	1.33	1.43	1.50
Internal rate of return (%)	negative	negative	1.6	6.3	7.6	8.0	8.3
MIRR (%)	negative	negative	3.1	5.7	6.2	6.2	6.2

Table 9: Investment Criteria for FRDC Investment in Project 2018-207

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.01	0.19	0.51	0.77	0.90	0.97	1.02
Present value of costs ($m)	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Net present value ($m)	-0.66	-0.49	-0.17	0.10	0.23	0.29	0.34
Benefit-cost ratio	0.02	0.28	0.75	1.14	1.34	1.43	1.51
Internal rate of return (%)	negative	negative	1.6	6.3	7.6	8.1	8.3
MIRR (%)	negative	negative	3.1	5.7	6.2	6.2	6.2

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

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



Sources of Benefits

Three impacts were valued in the quantitative analysis of the investment in Project 2009-324. Table 10 shows the contribution of each benefit (impact valued) to the total expected net benefits estimated (PVB).

Table 10: Investment Criteria for FRDC Investment in Project 2018-207

Impact Valued/Benefit	PVB ($m)	% of Total PVB
Impact 1: Increased efficiency/effectiveness of fisheries RD&E	0.22	19.0%
Impact 2: Increased future earning capacity for scholarship recipients	0.48	41.7%
Impact 3: Increased long-term productivity for Australian fisheries and aquaculture industries	0.45	39.3%
Totals	**1.14**	**100.0%**

Sensitivity Analyses

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

A sensitivity analysis was carried out on the discount rate. The results, shown in Table 11, showed a moderate sensitivity to the discount rate. This was largely due to the benefit cash flows occurring well into the future and therefore being subject to relatively more severe discounting.

Table 11: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	1.59	1.14	0.93
Present value of costs ($m)	0.51	0.76	1.13
Net present value ($m)	1.08	0.38	-0.20
Benefit-cost ratio	3.11	1.50	0.82

A sensitivity analysis then was carried out on the assumed increase in net income for scholarship recipients (Impact 2). Table 12 shows the results. The investment criteria showed a moderate to low sensitivity to the assumed increase in net income. This was likely because Impact 2 contributed approximately 42% of the total benefits and therefore was not the only driver of the investment criteria.

Table 12: Sensitivity to the Increase in Net Income for Scholarship Participants
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Increase in Net Income for Scholarship Participants		
	5%	10% (base)	20%
Present value of benefits ($m)	0.91	1.14	1.62
Present value of costs ($m)	0.76	0.76	0.76
Net present value ($m)	0.14	0.38	0.86
Benefit-cost ratio	1.19	1.50	2.12

A final sensitivity analysis was undertaken for the proportion of the fisheries and aquaculture sector benefiting from long-term productivity and/or profitability increases attributable to practice changes implemented by scholarship recipients and their respective businesses or industries (Impact 3). The results, presented in Table 13, showed a moderate to low sensitivity to the proportion of the industry benefiting from long-any term increase in productivity/profitability. This was likely because Impact 3 contributed approximately 39.3% of the total benefits and the benefit cash flows were assumed to end in 2036/37 (see Table 7).

Table 13: Sensitivity to the Proportion of the Industry Benefiting from Increased Long-Term Productivity/Profitability
(Total investment, 5% discount rate, 30 years)

Investment Criteria	Proportion of the Industry Benefiting from Increased Long-Term Productivity/Profitability		
	0.25%	0.5% (base)	1.0%
Present value of benefits ($m)	0.92	1.14	1.59
Present value of costs ($m)	0.76	0.76	0.76
Net present value ($m)	0.16	0.38	0.83
Benefit-cost ratio	1.21	1.50	2.09

Confidence Rating and Other Findings

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

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 14). 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 14: Confidence in Analysis of Investment

Coverage of Benefits	**Confidence in Assumptions**
Medium	Medium-Low

The coverage of benefits was assessed as Medium. The three impacts valued were deemed to be the most important and direct impacts of the investment.

Confidence in assumptions was rated as Medium-Low. Many of the valuation assumptions were underpinned by credible data, published research and/or expert opinion. However, because the investment was only recently completed, there was little to no evidence of actual outcomes and impacts. This meant that a number of the assumptions used in the valuation were uncertain.

Conclusions

The FRDC Nuffield scholarships funded through Project 2009-324 provided a select group of fishing and aquaculture industry professionals with the opportunity to travel internationally to expand their personal and professional horizons while exploring industry issues and opportunities in a global context.

Through the Nuffield scholarship program, the eight fishing and aquaculture professionals that received scholarships between 2012 and 2017 were able to:

- Develop new and improved practical, managerial and commercial capability and capacity,
- Increase both individual and industry understanding of international industry issues and opportunities applicable to Australian fishing and aquaculture, and
- Create domestic and international networks of industry professionals and researchers that continue to promote the exchange of information.

The investment has led to a range of potential direct and indirect economic and social impacts. Importantly, Project 2009-324 contributed to:

- Increased efficiency and/or effectiveness of collaborative RD&E based on learnings from international industry experience and knowledge sharing.
- Increased earning capacity for scholarship recipients through enhanced long-term career opportunities/potential.
- Increased long-term profitability and/or productivity for the broader Australian fishing and aquaculture industries through knowledge sharing and adoption/ implementation of industry level recommendations resulting from the Nuffield scholarship studies.

Total funding for the Project was $0.76 million (present value terms). Three impacts were valued and generated estimated total net benefits of $1.14 million (present value terms). This produced an estimated net present value of $0.38 million, a benefit-cost ratio of 1.5 to 1, an internal rate of return of 8.3%, and a m IRR of 6.2% (over 30 years, using a 5% discount rate and 5% finance rate).

Given the conservative assumptions made and the fact that a number of impacts were not valued in monetary terms, the investment criteria reported are likely to be an underestimate of the true performance of the investment in Project 2009-324. The positive results should be viewed favourable by FRDC, the Australian Government, industry, and other RD&E stakeholders.

Glossary of Economics Terms

Cost-benefit analysis:	A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.
Benefit-cost ratio:	The ratio of the present value of investment benefits to the present value of investment costs.
Discounting:	The process of relating the costs and benefits of an investment to a base year using a stated discount rate.
Internal rate of return:	The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.
Investment criteria:	Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.
Modified internal rate of return:	The internal rate of return of an investment that is modified so that the cash inflows from an investment are re-invested at the rate of the cost of capital (the re-investment rate).
Net present value:	The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.
Present value of benefits:	The discounted value of benefits.
Present value of costs:	The discounted value of investment costs.

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