



FINAL REPORT

**An Impact Assessment of Investment
in FRDC Project 2016-053:
the Mareframe - Co-creating Ecosystem-based Fisheries
Management Solutions (EU led project)**

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January 2023

FRDC Project No 2016-134

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ISBN [Insert ISBN/ISSN – researcher to obtain]

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FRDC Project 2016-134

2022

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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.

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Acknowledgments

Agtrans Research and Consulting would like to thank Patrick Hone (Managing Director), Jennifer Marshall (Cross-Functional Facilitator), and Chris Izzo (Senior Research Portfolio 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.

Specific acknowledgments also are made to:

- Beth Fulton, Head of Ecosystem Modelling, CSIRO Oceans & Atmosphere, CSIRO

Abbreviations

CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
EAFM	Ecosystem-based Approach to Fisheries Management
EU	European Union
FRDC	Fisheries Research and Development Corporation
GADGET	Globally applicable Area-Disaggregated General Ecosystem Toolbox
PVC	Present Value of Costs
RD&E	Research, Development and Extension
WP	Work Package

Executive Summary

This report presents an impact assessment of investment in Fisheries Research and Development Corporation (FRDC) investment in Project 2016-053: *the Mareframe - Co-creating Ecosystem-based Fisheries Management Solutions (EU led project)*. 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 investment in Project 2016-053, in collaboration with the CSIRO, facilitated Australian researchers' participation in the EU-led MareFrame project. Australian scientists were able to provide advice on various parts of the MareFrame work and also provided information on experience in Australia and elsewhere, regarding what has been needed to successfully deliver on EAFM and decision support.

The lessons taken from the MareFrame project have been integrated into ongoing FRDC research including "multispecies harvest strategies" (FRDC project 2018-021), "cumulative impact assessments and the review of ERAEF" (FRDC project 2018-020), "adaptation of Australian fisheries management for climate change impacts" (FRDC project 2016-059). Further, recommendations from the project also have been used to inform additional research projects.

The investment achieved its objectives and has contributed to a number of positive potential impacts, including:

- Increased efficiency and/or effectiveness of RD&E resource allocation associated with the ecosystem-based approach to fisheries management.
- Increased scientific knowledge, research capacity, and international research networks for Australian fisheries researchers.
- In the longer-term, improved management of Australian fisheries that is both economically and environmentally sustainable through implementation of the learnings from the EU-led MareFrame project and international research networks.

Total funding for the Project was \$0.41 million (present value terms) with an FRDC component of \$0.14 million (present value terms). Though a number of positive impacts were identified no impacts were valued in monetary terms within the scope of the assessment.

Keywords

Project 2016-053, MAREFRAME, ecosystem-based approach to fisheries management, EAFM, ecosystem modelling, impact assessment, evaluation, 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 2016-053: *the Mareframe - Co-creating Ecosystem-based Fisheries Management Solutions (EU led project)* was randomly selected as one of the 20 RD&E investments completed in 2019/20 for evaluation in the fifth series of annual impact assessments (2019/20 sample). The current report presents the Project 2016-053 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. No impacts were valued for Project 2016-053.

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

Significant investments had been made toward ecosystem-based management in Australia fisheries and in tools to support those efforts. However, many gaps remained, and it was believed that there was much to be learnt from applications in other international jurisdictions, particularly one as data rich as the European Union (EU).

Between 2014 and 2018, a large European Union (EU) project known as MareFrame (<http://www.mareframe-fp7.org/>) was run with the intent of identifying and reducing impediments to the implementation of ecosystem approach to fisheries management. Australian researchers engaged with this effort, both to share Australian experience, but also to benefit from the lessons learnt in this far more data rich context.

The MareFrame framework included both process and technology and consisted of:

- 1) Co-creation process
- 2) Ecosystem models
- 3) Decision support tools (a dashboard and infographics for exploring and communicating management options)
- 4) Educational resources

A significant number of decision support tools were developed over a set of eight case studies (seven from the EU and one from New Zealand).

Australian researchers were invited to be advisers on (and participants in) the European MareFrame project that aimed to significantly progress ecosystem-based approach to fisheries management (EAFM) in the EU. However, constraints on the access of non-EU members to the funding prevented full Australian participation (i.e. Australians could not support work on a full case study, as New Zealand did).

Rationale for Project 2016-053

FRDC Project 2016-053 was funded to support Australian researchers' involvement. Australian participants provided software and experience support to the project and were able to access and learn from the MareFrame project.

Project Details

Summary

Project Code: 2016-053

Title: *the Mareframe - Co-creating Ecosystem-based Fisheries Management Solutions (EU led project)*

Research Organisation: CSIRO Oceans & Atmosphere

Principal Investigator: Beth Fulton, Head of Ecosystem Modelling

Period of Funding: July 2017 to June 2019

FRDC Program Allocation: Environment 100%

Objectives

Project 2016-053 had two main objectives:

1. To contribute to the EU funded MareFrame Project – supplying modelling expertise and software support so as to allow the use of Atlantis in the intermodal comparison (thereby supporting understanding and development of appropriate ecosystem-based management tools)
2. Summarise the findings of MareFrame and describe how these could be adapted for Australian use.

Logical Framework

Table 1: Logical Framework for FRDC Project 2016-053

Activities	<p>Objective 1: Contributing to the EU funded MareFrame project</p> <ul style="list-style-type: none">• FRDC and the CSIRO supported Australian researcher involvement in MareFrame because EU funding could not be used outside the EU.• Australian researchers Cathy Dichmont, Eva Plagányi and Beth Fulton all advised on various parts of the MareFrame work.• CSIRO had an advisory role for MareFrame Work Package (WP) 1 ‘Co-creation & pathways for implementation’ and WP 6 ‘Develop a decision support framework’.• CSIRO also provided information on experience in Australia and elsewhere, regarding what has been needed to successfully deliver on EAFM and decision support, with the majority of CSIRO’s participation going into WP 4 ‘Ecosystem models & assessment models’ and WP 7 ‘Synthesis & training development’.• The CSIROs Atlantis modelling team also contributed through support for the development of Icelandic and Sicily Atlantis EAFM models.• This involved hosting Erla Sturludóttir (who implemented the Icelandic Atlantis model) and instructing Christopher Desjardins and Matteo Sinerchia on how to use Atlantis.• CSIRO personnel provided instruction and support (via Skype and email and one-on-one support during visits to Hobart) around implementing the model, defining the model maps, calculating oceanographic/hydrodynamic forcing of the model and parameterisation of the ecological and fisheries sub-models.• CSIRO also provided support around software updates, calibration advice, time series fitting to improve model and forecast skill. This involved adjusting Atlantis software code to allow for reproduction of the form of management used/trialled in the Icelandic and Sicily ecosystems.• Instructions also were provided on demand (via Skype and email) on how to calculate the ecological, economic and social indicators from the existing model output (adjusting the format where possible to make this easier).
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	<ul style="list-style-type: none"> • The modelling work also supported performance comparison across model frameworks (e.g. with Ecopath with Ecosim (ecosystem modelling platform) and GADGET models (Globally applicable Area-Disaggregated General Ecosystem Toolbox) developed for the same area). • Beth Fulton also contributed to the drafting of the document “D7.2 MAREFRAME Analysed case studies” that laid out model intercomparison protocols, useful indicators to use for EAFM and model comparisons and key considerations for the use and communication of models. • Together the work delivered through Project 2016-053 contributed to MareFrame tasks: <ul style="list-style-type: none"> 4.2: Incorporate GES indicators 4.3: Incorporate economic and social indicators 4.5: Forecasting 4.6: Performance comparison. <p>Objective 2: Documenting learnings and how they could be applied in Australia</p> <ul style="list-style-type: none"> • Learnings from the MareFrame project were documented and evaluated to provide information on how the processes and technologies could be implemented in Australia.
Outputs	<ul style="list-style-type: none"> • The project team reported that Australia is arguably further down the EAFM road than the EU. However, Australia is far from having a complete or comfortable implementation of EAFM, especially at tactical levels. • The following points outline what aspects of the MareFrame work were identified as being applicable to be transported to Australia – addressing each of MareFrame's four core principles. <ol style="list-style-type: none"> 1) Co-creation processes: <p>There has been growing appreciation that co-creation processes are important iterative processes that can utilise stakeholders’ local knowledge to improve transparency, the reliability of outcomes and increase uptake. Co-creation and participation are already at the heart of the Australian Fisheries Management Authority’s management and scientific committees. Co-creation is less clear at the state level, but at the federal level it is well established.</p> <p>There is likely a need to interact with an even broader audience if Australian fisheries are to remain an evidence-based undertaking. Such broad engagement by the research and management community would likely need to involve online and other media avenues and would require the authentic building of trust around the content. It will not be an easy or necessarily rapid process, but the level of connection and cross validation of options across all parties will be required for Australian fisheries and coastal communities to navigate the issues of sustainability and adaptation necessary in the currently rapidly changing conditions.</p> <p>The MareFrame work and other research indicated that one means of anchoring stakeholder expectations in practical (feasible) and evidence-based bounds is to firmly ground co-design activities in the context of governance and policy.</p> 2) Ecosystem models: <p>Australia remains amongst the world leaders in the development and implementation of ecosystem models. Australia still has areas for improvement, however. There are few implementations of multi-species assessment models – such as GADGET – in Australia, with the Northern Prawn Fishery models being a notable exception. This is likely to be important going forward, especially in the context of multi-species harvest strategies.</p> <p>One area where Australia can benefit from a MareFrame like approach is the improved adoption of database technologies in support of fisheries and EAFM. Australia fisheries scientists, managers and other interested parties are in need of easily accessible information repositories for rapid reporting of the state of stocks and environmental conditions and for parameterising multi-species and ecosystem tools used in support of fisheries management. While MareFrame opted for a distributed</p>

	<p>approach – providing a database structure that could be deployed locally/regionally, rather than having a single centralised database – the much smaller researcher population, the smaller quantities of available data and the greater geographic extent in Australia argues for a more centralised approach.</p> <p>3) Decision support tools: A number of decision support tools inspired by the MareFrame experience could be of value in Australia, such tools include:</p> <p>a) centralized information sources on Australian fisheries - the kernel of which likely already exists in the Status of Australian Fish Stocks website (www.fish.gov.au/Reports), the prototype Australian Fisheries Health check portal, and the WhichFish webpage (http://whichfish.com.au/).</p> <p>b) visualization platforms that provide a dashboard and infographics for exploring and communicating management options – seaview (http://www.csiro.au/seaview/index.html) is an early example</p> <p>c) interactive tools – similar to the MareFrame multi-criteria decision analysis and Bayesian belief network plug-ins to the decision support framework (https://mareframe.github.io/dsf/)</p> <p>d) expansion of the socioeconomic tools available to Australian fisheries – for example, the Socio-Economic Impact Assessment procedures developed by MareFrame may be usefully adapted for Australia.</p> <p>4) Education resources: There is still significant scope for improving the general education levels of resource managers and industry members and consultants in Australia around EAFM. The kind of ‘masterclass’ developed by MareFrame provides an excellent template that could be applied in Australia in collaboration with Australian universities.</p>
Outcomes	<ul style="list-style-type: none"> • The lessons are from MareFrame through Project 2016-053 have been integrated into appropriate ongoing FRDC projects including “multispecies harvest strategies” (FRDC project 2018-021), “cumulative impact assessments and the review of ERAEF” (FRDC project 2018-020), “adaptation of Australian fisheries management for climate change impacts” (FRDC project 2016-059). • Recommendations from the project also have been used to inform additional research projects.
Impacts	<ul style="list-style-type: none"> • Increased efficiency and/or effectiveness of RD&E resource allocation associated with the ecosystem-based approach to fisheries management. • Increased scientific knowledge, research capacity, and international research networks for Australian fisheries researchers. • In the longer-term, improved management of Australian fisheries that is both economically and environmentally sustainable through implementation of the learnings from the EU-led MareFrame project and international research networks. • Some contribution to improved fisheries management around the EU through Australian researchers’ contributions to the MareFrame project.

Source: FRDC project documentation

Nominal Investment

Table 2 shows the total annual investment made in project 2016-053 by FRDC and the CSIRO.

Table 2: Total Investment in FRDC Project 2016-053
(nominal dollar terms)

Year ended 30 June	FRDC (\$)	CSIRO (\$)	Total (\$)
2017	60,000	140,000	200,000
2018	0	50,000	50,000
2019	21,151	0	21,151
Totals	81,151	190,000	271,151

Source: FRDC project 2016-045 project agreement and financial acquittal

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.

For the other contributors to project 2016-053 (CSIRO), it was assumed that any management and administration costs were already included in the cost data presented in Table 2. A multiplier of 1.0 was applied to the nominal investment by CSIRO shown in Table 2.

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 as the learnings from Project 2016-053 were communicated directly to relevant fisheries research funders, researchers, and fisheries managers and has been incorporated into existing and new EAFM RD&E.

Impacts

Table 3 provides a summary of the principal types of potential impacts from Project 2016-053. 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 2016-053

Economic	<ul style="list-style-type: none">Increased efficiency and/or effectiveness of RD&E resource allocation associated with the ecosystem-based approach to fisheries management.
Environmental	<ul style="list-style-type: none">In the longer-term, improved management of Australian fisheries that is environmentally sustainable through implementation of the learnings from the EU-led MareFrame project and international research networks. This impact will also likely maintain or improve the long-term economic sustainability of Australian fisheries.Some contribution to improved fisheries management around the EU through Australian researchers' contributions to the MareFrame project.
Social	<ul style="list-style-type: none">Increased scientific knowledge, research capacity, and international research networks for Australian fisheries researchers.

Public versus Private Impacts

The impacts from the investment in Project 2016-053 are predominantly public impacts. Public impacts will be delivered through improved efficiency/effectiveness of public resource allocation in EAFM RD&E, increased knowledge and research capacity, and, in the longer-term, improved environmentally sustainable management of Australian fisheries.

Some private impacts also may be delivered. Private impacts are likely to be delivered through increased efficiency/effectiveness of private resource allocation in EAFM RD&E (e.g. industry investment in RD&E through the FRDC), and long-term improved fisheries management leading to maintained or improved economic sustainability for Australian fisheries.

Distribution of Private Impacts

Any private impacts from the investment in Project 2016-053 will primarily accrue to Australian wild-catch fishers that benefit from Australian fisheries that are being better managed.

Impacts on other Australian industries

The Australian fisheries industry is very broad and no direct impacts to other Australian industries were identified. However, over the longer-term, some indirect impacts may accrue to Australian aquaculture industries or other industries utilising ecosystem modelling through spillover benefits from increased scientific knowledge and research capacity in the EAFM space.

Impacts Overseas

Funding for Project 2016-053 enabled a two-way exchange of knowledge and expertise between the EU and Australia. Australian scientists actively contributed to the MareFrame project that will, in turn, improve fisheries management in the EU.

Match with National Priorities

Australian Agriculture, Science, and Research Priorities

The Australian Government’s National Science and Research Priorities and Agricultural Innovation Priorities are reproduced in Table 4. Project 2016-053 indirectly contributed to National Science and Research Priorities 1 and 2. Further, the RD&E investment may contribute indirectly to all four Agricultural Innovation Priorities because of the strengthening of international scientific and industry relationships as well as potentially improved effectiveness/efficiency of RD&E.

Table 4: Australian R&D Priorities

Australian Government	
National Science and Research Priorities ¹	National Agricultural Innovation Priorities ²
<ol style="list-style-type: none"> 1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. 2. Soil and Water – improving the use of soils and water resources, both terrestrial and marine. 3. Transport – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. 4. Cybersecurity – improving cybersecurity for individuals, businesses, government, and national infrastructure. 5. Energy and Resources – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia’s resources industries. 6. Manufacturing – supporting the development of high value and innovative manufacturing industries in Australia. 7. Environmental Change – mitigating, managing, or adapting to changes in the environment. 8. Health – improving the health outcomes for all Australians. 	<p>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.</p> <ol style="list-style-type: none"> 1. Australia is a trusted exporter of premium food and agricultural products by 2030. 2. Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. 3. Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. 4. Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

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

² Source: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment.

FRDC National RD&E Priorities

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

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

Project 2016-053 indirectly addressed FRDC national RD&E priorities 1 and 2 by strengthening international scientific and industry relationships, building capacity and capability, and increasing the effectiveness and/or efficiency of fisheries RD&E in Australia.

Valuation of Impacts

Impacts Not Valued

Based on the scope of the assessment of the investment in Project 2016-053 none of the impacts identified were valued in monetary terms. Table 5 describes the reasoning for non-valuation of each of the impacts identified (Table 3).

Table 5: Reasons for Non-Valuation of Impacts

Impact Identified	Reason(s) for Non-Valuation
Increased efficiency and/or effectiveness of RD&E resource allocation associated with the ecosystem-based approach to fisheries management.	Data on the total value of Australian public and private investment in EAFM RD&E were not available. Further, the change in efficiency and/or effectiveness of RD&E directly attributable to the learnings from Project 2016-053 were uncertain.
Increased scientific knowledge, research capacity, and international research networks for Australian fisheries researchers.	The current and likely change in capacity of Australian researchers as it related to the investment were highly uncertain. Further, it is difficult to put monetary values on capacity and capability.
In the longer-term, improved management of Australian fisheries that is both economically and environmentally sustainable through implementation of the learnings from the EU-led MareFrame project and international research networks.	The pathways to impact were uncertain and require the learnings from Project 2016-053 to be integrated into successful future RD&E to achieve long-term impacts.
Some contribution to improved fisheries management around the EU through Australian researchers' contributions to the MareFrame project.	The pathways to impact were uncertain. Also, the incremental improvement in the MareFrame project because of the Australian investment as well as the counterfactual also were uncertain.

Results

All costs were expressed in 2020/21-dollar terms and were discounted to 2021/22 using a discount rate of 5%. Though no impacts were valued, in the interests of consistency with other project analyses and reporting, the Present Value of Costs (PVC) was reported for the length of the investment period plus for different periods up to 30 years from the last year of investment (2018/19).

Investment Criteria

Tables 6 and 7 show the investment criteria estimated for different periods of costs for the total investment and FRDC investment respectively. As no impacts were valued, the investment criteria reporting is restricted to the PVC.

Table 6: Investment Criteria for Total Investment in Project 2016-053

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of costs (\$m)	0.41	0.41	0.41	0.41	0.41	0.41	0.41

Table 7: Investment Criteria for FRDC Investment in Project 2016-053

Investment criteria	Number of years from year of last investment						
	0	5	10	15	20	25	30
Present value of costs (\$m)	0.14	0.14	0.14	0.14	0.14	0.14	0.14

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 Costs

Conclusions

The FRDC investment in Project 2016-053, in collaboration with the CSIRO, facilitated Australian researchers' participation in the EU-led MareFrame project. Australian scientists were able to provide advice on various parts of the MareFrame work and also provided information on experience in Australia and elsewhere, regarding what has been needed to successfully deliver on EAFM and decision support.

The lessons taken from the MareFrame project have been integrated into ongoing FRDC research including "multispecies harvest strategies" (FRDC project 2018-021), "cumulative impact assessments and the review of ERAEF" (FRDC project 2018-020), "adaptation of Australian fisheries management for climate change impacts" (FRDC project 2016-059). Further, recommendations from the project also have been used to inform additional research projects.

The investment achieved its objectives and has contributed to a number of positive potential impacts, including:

- Increased efficiency and/or effectiveness of RD&E resource allocation associated with the ecosystem-based approach to fisheries management.
- Increased scientific knowledge, research capacity, and international research networks for Australian fisheries researchers.
- In the longer-term, improved management of Australian fisheries that is both economically and environmentally sustainable through implementation of the learnings from the EU-led MareFrame project and international research networks.

Total funding for the Project was \$0.41 million (present value terms) with an FRDC component of \$0.14 million (present value terms). Though a number of positive impacts were identified no impacts were valued in monetary terms within the scope of the assessment.

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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