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Impact Assessment FRDC Investment in 2010-200: The Innovative Development of the *Octopus tetricus* Fishery in Western Australia

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Impact Assessment

FRDC Investment in 2010-200: The Innovative Development of the Octopus tetricus Fishery in Western Australia
Project 2016-134

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

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Abbreviations

CRRDC	Council of Rural Research and Development Corporations
DAWR	Australian Government Department of Agriculture and Water Resources
DoFWA	Department of Fisheries, Western Australia
FRDC	Fisheries Research and Development Corporation
PVB	Present Value of Benefits
RD&E	Research, Development and Extension
WA	Western Australia

Executive Summary

What the report is about

This report presents the results of an impact assessment of a Fisheries Research and Development Corporation (FRDC) investment in *innovative development of the Octopus tetricus fishery in Western Australia (WA)*. The project was funded by FRDC and the Department of Fisheries, Western Australia (DoFWA) over the period July 2010 to June 2013.

Methodology

The project was analysed qualitatively within a logical framework that included activities/outputs, outcomes and impacts. Impacts were categorised into a triple bottom line framework. The principal impact was then valued. Benefits were estimated for a range of time frames up to 30 years from the year of last investment in the project. Past and future cash flows in 2016/17 dollar terms were discounted to the year 2016/17 using a discount rate of 5% to estimate the investment criteria.

Results/key findings

The major impact identified was of a financial nature. However, some social and environmental impacts were also identified but not valued. It is expected that the Western Australian commercial octopus industry will be the primary beneficiary of the investment.

Investment Criteria

Total funding from all sources for the project was $0.89 million (present value terms). The value of benefits was estimated at $6.44 million (present value terms). This gave an estimated net present value of $5.55 million, and a benefit-cost ratio of 7.2 to 1.

Conclusions

Investment in this project has provided the evidence base for sustainable expansion of the WA *Octopus tetricus* fishery. Commercial fishers have responded to the opportunity and have increased their catches. A new octopus processor has been established in Geraldton WA and Fremantle Octopus has expanded both their value added domestic and export sales.

The analysis provided a good example of how a relatively small FRDC investment can ‘kick-start’ a whole new industry.

Keywords

Impact assessment, innovative development, octopus fishery, Western Australia.

Introduction

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

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

The first series of impact assessments included 20 randomly selected FRDC investments worth a total of approximately $6.31 million (nominal FRDC investment). The investments were selected from an overall population of 136 FRDC investments worth an estimated $24.98 million (nominal FRDC investment) where a final deliverable had been submitted in the 2015/16 financial year.

The 20 investments were selected through a stratified, random sampling process such that investments chosen spanned all five FRDC Programs (Environment, Industry, Communities, People and Adoption), represented approximately 25% of the total FRDC RD&E investment in the overall population (in nominal terms) and included a selection of small, medium and large FRDC investments.

Project 2010-200: *Innovative development of the Octopus tetricus fishery in Western Australia* was selected as one of the 20 investments and was analysed in this report.

General Method

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

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

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

Background and Rationale

Background

In the late 1990s the DoFWA investigated the possibility of developing a commercial octopus fishery. To this end six exemption licences were issued to commercial fishers. Exemption licenses required use of unbaited shelter pots set on a longline with a 20 to 40 day soak time. Unbaited shelter pots were required to prevent the taking of lobsters as by-catch and the imposition of additional pressure on the Western Rock Lobster Fishery.

Since the late 1990s, industry has developed an octopus specific baited trigger trap with a 4 to 8 day soak time and 5 to 10 times higher catch per unit of effort than the unbaited shelter pots. The new technology combined with an increase in octopus price (from $4/kg in 1999 to $12/kg in 2010) provided a surge in interest in commercial octopus fishing. Octopus catch in the developmental fishery increased from a single tonne in 1999 to 119 tonnes in 2010.

Prior to the commencement of this project, DoFWA was already investing in octopus research. DoFWA was supporting two honours projects on octopus biology, had developed a trial octopus logbook, and was initiating trials to develop octopus culture techniques (FRDC 2009-20: Octopus Aquaculture and FRDC 2009-206: Octopus Aquaculture – Rearing, Handling and Systems Design).

Rationale

As a consequence of the surge in interest in commercial octopus fishing in WA resulting from the new technology and the higher commodity prices, there was a need to generate knowledge on the biology and population dynamics of octopus to ensure that any expansion in effort resulted in both an ecologically and economically sustainable fishery.

Project Details

Summary

Project Code: 2010-200

Title: *Innovative development of the Octopus tetricus fishery in Western Australia*

Research Organisation: Department of Fisheries, Western Australia.

Principal Investigator: Anthony Hart.

Period of funding: July 2010 to June 2013.

Objectives

The objectives of the project were:

1. To describe the general life history of *Octopus tetricus* in WA, including age, growth and reproductive biology.
2. To determine the fishing efficiency of octopus trigger traps.
3. To estimate potential harvest from octopus fisheries.
4. To calculate the effects of fishing closures on octopus predation rates on rock lobsters.

Logical Framework

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

Table 1: Logical Framework for Project 2010-200

Activities and Outputs	• Establishment of a project reference group that included DoFWA, environmental managers and commercial fishers. • Detailed project design including data collection and modelling requirements. • Engagement with commercial fishers to collect data on octopus catch and the fishing efficiency of trigger traps including effort, catch and fishing location. • Determination of potential harvest from three WA *Octopus tetricus* fishing zones (Greenhead, Perth and Esperance), using a range of methods including direct survey of octopus stocks and octopus habitat. • Estimation of the biologically sustainable *Octopus tetricus* catch using reference point analysis and biological data on age-composition, maximum age, growth, length, weight, sex, fecundity and octopus mortality. • Preparation of size-structure population models and testing of these models against catch history. • Linking of data sets and models to changes in the marine environment to develop relationships between environment conditions (e.g. Southern Oscillation Index) and octopus abundance to further inform estimates of sustainable catch. • Modelling determined that the population of *Octopus tetricus* is strongly influenced by environmental variables, especially water temperature, and is likely to experience significant fluctuation in abundance from year to year.

	• Working with lobster fishers to analyse catch records, dead lobsters/empty shells in lobster pots and the number of octopus found in lobster pots to determine octopus predation rates on Western Rock Lobster. • Formulation of spatial and temporal catch targets for *Octopus tetricus*. The study was the first of its kind to age a wild population of octopus using a combination of direct and indirect aging methods. The study linked age profile to gear type used and showed that trigger pots captured mature males while shelter pots were more likely to capture immature males and females. This finding was important as mature males can be removed from the population without impacting on its sustainability. • Furthermore, research showed that trigger pots (average catch of 1.46 kg of octopus per pot lift) are more efficient than shelter pots (0.17 kg of octopus per pot lift). • The study was able to conclude that the Developmental Octopus Fishery should be able to maintain landings of approximately 1,000 tonnes per year. This indicated there was considerable room for expansion in the fishery. • Recommendations to form an expert group and prepare a plan to manage an expanded fishery. • Preparation of scientific papers detailing research methods employed, the findings that were produced, and a plain-English report to communicate research outputs.
Outcomes	• Convening of an octopus expert group with skills required to manage the fishery, implement project recommendations and monitor octopus stocks. • Preparation of a management plan detailing octopus stocks, sustainable catch levels, the viability and scale of the fishery and fishery management strategies including licence limits, and effort and catch controls. • An expanded fishery that catches additional octopus. • A sustainable catch of octopus which will minimise risk to the fishery and the fishers who rely on it. • Reduced octopus predation and potential additional Western Rock Lobster catch. • Development of a significant new octopus-based industry for WA. • Product value adding including a new octopus processing facility in Geraldton and an expanded operation in Fremantle.
Potential Impacts	• Increased profit due to larger octopus catch. • Improved beach prices as a result of a more consistent catch. • Cost savings from the matching of gear and boat operation to a more consistent catch. • Improved resource management with more accurate data used to set sustainable octopus catch. • Increased lobster catch due to reduced octopus predation. • Increased regional income on the WA south and west coasts. • Additional revenue for the WA Government from licence fees in the new octopus fishery. • Increased octopus research capacity and research techniques that can be applied in other Australian and overseas cephalopod fisheries.

Project Investment

Nominal Investment

Table 2 shows the annual investment for the project funded by FRDC, DoFWA and a single other investor. The other investor was Occotechnologies Pty Ltd a major player in the WA octopus industry.

Table 2: Annual Investment in the Project (nominal $)

Year ended 30 June	FRDC ($)	DoFWA ($)	OTHER ($)	TOTAL ($)
2011	161,818	90,198	10,000	262,016
2012	81,682	83,746	10,000	175,428
2013	127,965	52,411	10,000	190,376
Totals	371,465	226,355	30,000	627,820

Program Management Costs

For the FRDC investment the cost of managing the FRDC funding was added to the FRDC contributions in Table 2 via a management cost multiplier (1.115); this was estimated based on the share of 'employee benefits' and 'supplier' expenses' in total FRDC expenditure reported in the FRDC Cash Flow Statement (FRDC 2016).

For the DoFWA and other investment, the management and administration costs for the project are already built into the nominal amounts shown in Table 2.

Real Investment and Extension Costs

For the purposes of the investment analysis, the investment costs of all parties were expressed in 2016/17 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2016).

Report recommendations were used by DoFWA to prepare a Management Plan for the Octopus Interim Managed Fishery in Western Australia (Hart et al 2016) at an estimated cost of $100,000. (Michelle Yerman, Aquatic Manager – South West Bioregion, DoFWA pers. comm., June 2017).

Additional costs for 'extension' were incurred and these covered stock monitoring and compliance completed by DoFWA, an estimated cost of $200,000 per year (Michelle Yerman, Aquatic Manager – South West Bioregion, DoFWA pers. comm., June 2017).

Impacts

Table 3 provides a summary of possible project impacts categorised across the triple bottom line i.e. economic, environmental and social impacts.

Table 3: Triple Bottom Line Categories of Impacts from *Octopus tetricus* Research

Economic	• Increased profit due to larger octopus catch. • Improved beach prices as a result of consistent catch. • Cost savings from the matching of gear and boat operation to a more consistent catch. • Increased lobster catch due to reduced octopus predation.
Environmental	• Improved resource management with more accurate data used to set sustainable octopus catch.
Social	• Increased regional income - WA south and west coasts. • Additional revenue for the WA Government from licence fees in the new octopus fishery. • Increased octopus research capacity and research techniques that can be applied in other Australian and overseas cephalopod fisheries.

Public versus Private Impacts

The majority of benefits identified in this evaluation will be captured by octopus licence holders and therefore are considered private benefits. Public benefits have also been delivered, including environmental benefits and social benefits.

Environmental and social impacts were reported in Table 3. The principal environmental benefit was improved resource management with more accurate data on sustainable octopus catch. Social benefits delivered by the research included increased regional income – WA south and west coasts, additional revenue for the WA Government from licence fees in the new octopus fishery and increased octopus research capacity.

Distribution of Private Impacts

The benefits to the octopus fishing industry from investment in this project will be shared along the supply chain with WA octopus licence holders, commercial fishers, processors (Fremantle Octopus and the new octopus processing plant established at Geraldton), fish wholesalers and exporters all sharing impacts produced by the project.

Impacts on other Australian Industries

The potential to increase lobster catch due to reduced octopus predation was noted in the research report and in Table 3.

Impacts on industries other than the octopus fishing industry and its associated sectors may also include potential gains to other industries via any spillovers from the increases in research capacity and the application of research techniques developed through the project to other cephalopod fisheries.

Impacts Overseas

Will include potential adoption of research techniques developed as part of this project.

Match with National and Priorities

The Australian Government's Science and Research Priorities and Rural Research, Development and Extension (RD&E) priorities are reproduced in Table 4. Investment in *innovative development of the Octopus tetricus fishery in WA* contributes to Rural RD&E Priorities 1 and 3 and to Science and Research Priority 1 and 6.

Table 4: Australian Government Research Priorities

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

Sources: DAWR (2015) and OCS (2015)

Valuation of Impacts

Impacts Valued

Analyses were undertaken for total benefits that included future expected benefits. A degree of conservatism was used when finalising assumptions, particularly when some uncertainty was involved. Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria.

A single impact was valued – increased profit due to the larger octopus catch.

Impacts Not Valued

The economic impacts identified but not valued included:

- Improved beach prices as a result of a consistent catch – time series data on prices before and after the fishery expansion to quantify this benefit were not available to the analyst; also, any quality impact estimated may have been confounded by the supply change.
- Cost savings from the matching of gear and boat operation to a more consistent catch – fishers contacted noted this benefit but were not able to provide data for its quantification.
- Potential for increased lobster catch due to reduced octopus predation - advice from fishers is that the number of traps licenced is too small to affect a change. However, the potential remains and the number of traps licenced may be revised upward in the future.

The environmental impact identified but not valued was improved natural resource management with more accurate data on the sustainable octopus catch; this impact was difficult to value due to the uncertainty of the extent of conservatism that may have been applied in the counterfactual scenario.

The social impacts identified but not valued included:

- Increased regional income on the WA South and West coasts.
- Increased octopus research capacity and research techniques that can be applied in other Australian and overseas cephalopod fisheries.
- The increased WA government revenue from licencing; this was relatively small and considered a transfer payment made by fishers and only affecting the distribution of project benefits.

Valuation of Benefit: Increased Profit due to Larger Octopus Catch

At the commencement of this project in 2011 the WA Development Octopus Fishery had provision for six exemption licences which generated an annual catch of 119 tonnes. In the absence of scientific data on sustainable catch, a conservative approach to licenced catch was maintained.

Project 2010-200 *'Innovative Development of the Octopus tetricus fishery in WA'* generated data on the life history of *Octopus tetricus* (age, growth and reproductive biology), the fishing efficiency of octopus trigger traps, the impact of octopus predation on lobster and the estimated sustainable octopus catch. The project provided the scientific rationale for increasing the octopus catch from 119 tonnes pa to 630 tonnes pa under the Octopus Fishery Interim Management Plan (Shane O'Donoghue, Manager Northern Bioregions, DoFWA, http://frdc.com.au/knowledge/publications/fish/Pages/24-1_articles/22-25_Growth-opportunity.aspx).

The increase in catch is net of any octopus by-catch associated with the Western Rock Lobster Fishery, the Cockburn Sound (Line and Pot) Managed Fishery and recreational octopus fishing. The increase in

catch started to occur in 2016 following research completion in 2013, the subsequent management plan development and a legal challenge to proposed resource allocation in 2014 and 2015.

Total trap licencing permitting a catch of up to 630 tonnes has been allocated by the DoFWA to commercial fishers and industry anticipates that it will be geared up to harvest this total volume in 2019 (Ross Camilleri, Fremantle Octopus, pers. comm., May 2017).

Furthermore, the fishery biomass has been assessed at between 8,000 and 12,000 tonnes and research points to a sustainable catch of between 1,000 and 2,000 tonnes per annum (Shane O'Donoghue, Manager Northern Bioregions, DoFWA, http://frdc.com.au/knowledge/publications/fish/Pages/24-1_articles/22-25_Growth-opportunity.aspx). Given that the sustainable catch is estimated to be higher than the current total licenced catch, this analysis assumes that total licenced catch is reviewed in 2026 and increased to 1,000 tonnes per annum in 2027.

"The capacity of the new fishery under the new management plan is based on 630 tonnes for the fishery and there is the capacity for further expansion over time based on continuous positive research results" (Shane O'Donoghue, Manager Northern Bioregions, DoFWA, http://frdc.com.au/knowledge/publications/fish/Pages/24-1_articles/22-25_Growth-opportunity.aspx).

Profit on increased catch was estimated following discussions with Ross Camilleri of Fremantle Octopus. Fremantle Octopus is the major purchaser of octopus caught by commercial fishers operating in the Interim Octopus Fishery and will commence fishing itself in 2018. Fremantle Octopus presently pays fishers a beach price of $12.40/kg and estimates production cost at $7.90/kg (Ross Camilleri, Fremantle Octopus, pers. comm., May 2017).

Counterfactual

If this project had not been funded incremental progress with the increase in total licenced catch would have been made. However, DoFWA did not have the resources to fund potential harvest research and therefore incremental increases in total licenced catch would have occurred in a much slower and more precautionary way. In the absence of FRDC investment in innovative development of the *Octopus tetricus* fishery, it is assumed that only 75% of the increase in licenced catch would have been realised during the analysis period.

Attribution

Research supported by DoFWA and FRDC prior to this project contributed to project impacts. Prior research included work on octopus biology, logbooks and culture techniques. Attribution of quantified benefits to the project being assessed has been assumed at 60%.

Summary of Assumptions

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

Table 5: Summary of Assumptions

Variable	Assumption	Source
COUNTERFACTUAL: In the absence of FRDC investment in innovative development of the *Octopus tetricus* fishery, 75% of the increase in licenced catch would have been realised during the analysis period.		
Benefit: Increased Profit Due to Larger Octopus Catch		
Octopus tetricus catch pre-project research.	119 tonnes per annum	Hart et al 2016.
Maximum total licenced catch as a result of project research.	630 tonnes	O'Donoghue 2016.
Year in which maximum total licenced catch is first caught.	2019	Ross Camilleri, Fremantle Octopus, pers. comm., May 2017. Note it has been assumed that the increase in catch between 2016 and 2019 is 'linear' i.e. the increase occurs in equal intervals.
Year in which total licenced catch is revised to 1,000 tonnes.	2026	Consultant estimate after considering project literature.
Year in which revised total licenced catch of 1,000 tonnes is first caught.	2027	Consultant estimate after considering project literature.
Octopus beach price.	$12.40/kg	Ross Camilleri, Fremantle Octopus, pers. comm., May 2017.
Octopus catch cost (including an allowance for capital equipment).	$7.90/kg	Ross Camilleri, Fremantle Octopus, pers. comm., May 2017.
Profit on the additional *Octopus tetricus* catch.	$4.50/kg	$12.40/kg less $7.90/kg.
Attribution of project benefits to this project.	60%	Consultant estimate after considering research supported by DoFWA prior to this project i.e. work on octopus biology, logbooks and culture techniques.
Cost to prepare a Management Plan for the Octopus Interim Managed Fishery	$100,000 in 2014.	Michelle Yerman, Aquatic Manager – South West Bioregion, DoFWA pers. comm., June 2017.
Cost of Octopus Interim Managed Fishery stock monitoring and compliance	$200,000 per annum from 2016.	Michelle Yerman, Aquatic Manager – South West Bioregion, DoFWA pers. comm., June 2017.

Results

All benefits after 2016/17 were expressed in 2016/17 dollar terms. All costs and benefits were discounted to 2016/17 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the Modified Internal Rate of Return. 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 project investment period plus 30 years from the last year of Project 2010-200 investment (2012/13) to the final year of benefits assumed.

Investment Criteria

Tables 6 and 7 show the investment criteria estimated for different periods of benefits for the total investment and the FRDC investment. The present value of benefits (PVB) attributable to FRDC investment only, shown in Table 7, has been estimated by multiplying the total PVB by the FRDC proportion of real investment (62%). The balance of benefits is attributable to DoFWA and the other project contributor (i.e. Occotechnologies Pty Ltd).

Table 6: Investment Criteria for Total Investment in Project 2010-200

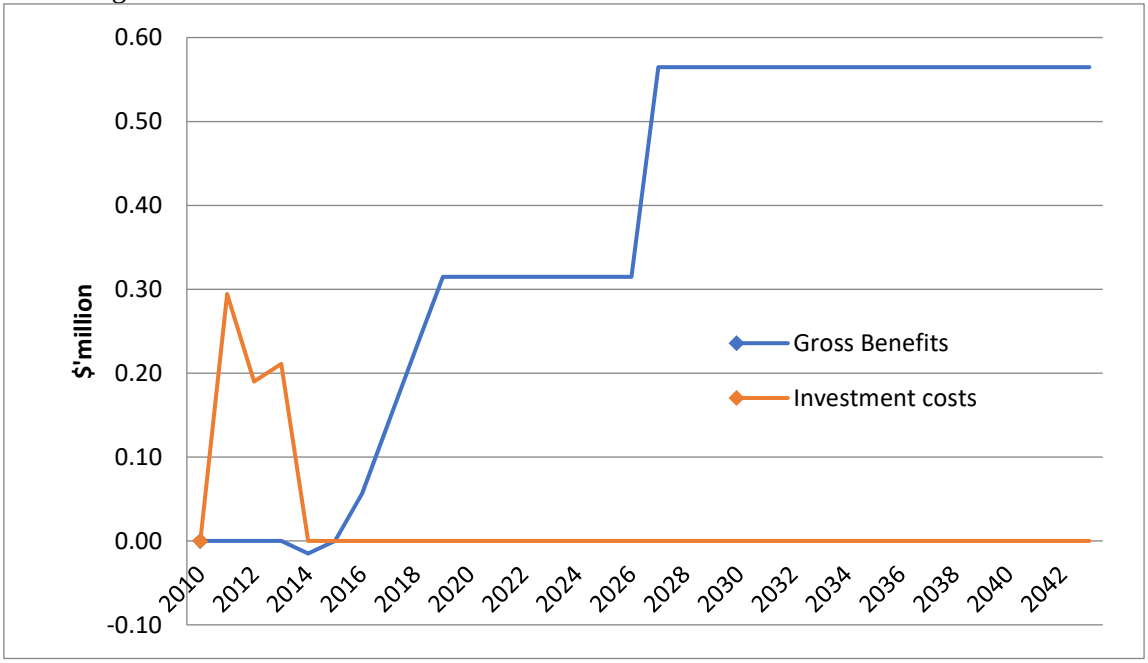
Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.00	0.40	1.70	3.02	4.45	5.57	6.44
Present value of costs ($m)	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Net present value ($m)	-0.89	-0.49	0.81	2.12	3.55	4.67	5.55
Benefit-cost ratio	0.00	0.45	1.90	3.38	4.98	6.23	7.21
Internal Rate of Return (IRR) (%)	negative	negative	13.64	18.20	19.92	20.46	20.65
Modified IRR (%)	negative	negative	19.18	19.09	17.46	15.64	14.17

Table 7: Investment Criteria for FRDC Investment in Project 2010-200

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.00	0.25	1.05	1.86	2.75	3.44	3.98
Present value of costs ($m)	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Net present value ($m)	-0.55	-0.30	0.50	1.31	2.20	2.89	3.43
Benefit-cost ratio	0.00	0.45	1.90	3.38	4.98	6.23	7.22
Internal Rate of Return (IRR) (%)	negative	negative	13.67	18.24	19.95	20.49	20.68
Modified IRR (%)	negative	negative	19.19	19.10	17.46	15.64	14.18

The annual undiscounted benefit and R&D cost cash flows for the total investment for the duration of Project 2010-200 investment plus 30 years from the last year of Project 2010-200 investment are shown in Figure 1.

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



Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment in Project 2010-200. All other parameters were held at their base values. Table 8 presents the results. Results are moderately sensitive to the discount rate.

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

Investment Criteria	**Discount rate**		
	0%	**5% (base)**	**10%**
Present value of benefits ($m)	12.53	6.44	3.84
Present value of costs ($m)	0.70	0.89	1.14
Net present value ($m)	11.84	5.55	2.70
Benefit-cost ratio	18.02	7.21	3.38

The project benefit is dependent on price received and quantity of octopus caught by fishers. Price changes after allowing for catch costs are tested in the second sensitivity test (Table 9). Even at a price of $1.13/kg greater than catch cost, investment in the project delivers a positive benefit-cost ratio.

Table 9: Sensitivity to Price Above Catch Cost
(Total investment, 30 years)

Investment Criteria	**Price Above Catch Cost**		
	($1.13/kg) 25% of base	**($2.25/kg) 50% of base**	**($4.50/kg) Base**
Present value of benefits ($m)	1.24	2.97	6.44
Present value of costs ($m)	0.89	0.89	0.89
Net present value ($m)	0.34	2.07	5.55
Benefit-cost ratio	1.38	3.32	7.21

A third analysis was conducted on the sensitivity to the increase in total licenced catch attributable to the project (Table 10). Even if 90% of the licenced catch increase would have occurred without the project, the investment delivers a positive benefit-cost ratio.

Table 10: Sensitivity to Counterfactual Assumption for Project
(Total investment, 30 years)

Investment Criteria	**% Increase in Licenced Catch Attained Without the Project**		
	90%	**75%** **Base**	**50%**
Present value of benefits ($m)	2.58	6.44	12.89
Present value of costs ($m)	0.89	0.89	0.89
Net present value ($m)	1.68	5.55	12.00
Benefit-cost ratio	2.89	7.21	14.43

Confidence Ratings and other Findings

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

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 11). The rating categories used are High, Medium and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 11: Confidence in Analysis of Project

Coverage of Benefits	**Confidence in Assumptions**
Medium	High

Coverage of benefits was assessed as medium. While the most important benefit (profit from additional catch) was valued, other secondary impacts were not valued in the analysis (e.g. more stable beach prices because data were not available).

Confidence in assumptions was rated as high. Principal assumptions around additional catch and the value of the catch were tested with and confirmed by personnel in the commercial octopus sector in WA.

Conclusions

Investment in this project has provided the evidence base for sustainable expansion of the WA *Octopus tetricus* fishery. Commercial fishers have responded to the opportunity and have increased their catches. A new octopus processor has been established in Geraldton WA and Fremantle Octopus has expanded both their value added domestic and export sales.

Investment in this project totalled $0.89 million (present value terms) and produced aggregate total expected benefits of $6.44 million (present value terms). This gave a net present value of $5.55 million, a benefit-cost ratio of 7.2 to 1, an internal rate of return of 21% and a modified internal rate of return of 14%.

The analysis provided a good example of how a relatively small FRDC investment can ‘kick-start’ a whole new industry.

Glossary of Economic Terms

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

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