Appendix I: 2014-028: Mud cockle (*Katelysia* spp.) stock enhancement/restoration: Practical implementation and policy evaluation

Background

Cockle species inhabit easily accessible intertidal and shallow subtidal regions and can be harvested using simple, economically viable processes. This leaves them vulnerable to overfishing and stocks can collapse due to commercial fishing, environmental change, recruitment failure, and mass mortality events.

The Mud Cockle (*Katelysia* spp.) supports fisheries in South Australia (SA), New South Wales, Victoria, and Tasmania. Section Bank is one of three main Mud Cockle fishing zones in SA. In 2005, the Mud Cockle catch rate decreased from 180t to less than 20t in 2010 resulting in the closure of the Section Bank fishery. In 2014, there were further concerns about Mud Cockle populations declining below the threshold limit for successful recruitment, raising concerns regarding the natural recovery of stock.

Restoration of Mud Cockle stocks is important because in addition to being an important commercial product, Mud Cockles also support an important role in environmental integrity. They stabilise sediment, reduce turbidity, and decrease the occurrence and duration of anoxic episodes in deep waters, allowing for benthic vegetation, invertebrates, fisher and birds species to thrive. Therefore, the industry and government highlighted the need for intervention through a re-seeding program to restore the Mud Cockle fishery at Section Bank.

Description of the project

Table 72 Project summary of project 2014-028

Project code	2014-028
Title	Mud Cockle (*Katelysia* spp.) stock enhancement/ restoration: Practical implementation and policy evaluation
Research organisation	SARDI Food Safety and Innovation
Principal investigator	Xiaoxu Li
FRDC project manager	Chris Izzo
Period of funding	2014-2017
FRDC investment	$250,432
FRDC program allocation	50% environment, 50% industry

Rationale	To improve research to support restoration of Mud Cockle populations at Section Bank in SA to a viable level for natural recruitment by testing the survival and growth of planted Mud Cockle across different seasons and sites. The uncertainty around the commercial viability of a re-seeding program was also considered a significant barrier to adoption of these methods.

Objectives	• Develop methodologies for optimal transporting and planning of hatchery-produced Mud Cockle for stock enhancement and restoration at Section Bank • Evaluate the post-stocking performance of Mud Cockle, *K. scalarina* produced at Section Bank • Optimise stock enhancement and restoration strategies for Mud Cockles on Section Bank • Develop a monitoring program to determine the long-term success of stock enhancement and restoration by incorporating the program within the existing Mud Cockle fishery stock assessment program • Create knowledge transfer amongst stakeholders from Government fisheries, aquaculture managers and policy makers, and cockle fishers in SA
Activities and outputs	• The pilot studies found that transportation measures used for Pacific Oyster spat were the most suitable for Mud Cockles as well • Field trials showed that seasonal water temperatures had a strong influence on the survival and growth of re-seeded Mud Cockle as a positive relationship was observed between water temperature and growth • Higher water temperatures in trial 4 led to lowest recovery of Mud Cockles however, this trial was also affected by the Pacific Oyster Mortality Syndrome (POMS) outbreak • About 50% of re-seeded Mud Cockles were recovered indicating that they were actively or passively moving from the plots • Stocking density did not have significant impacts on growth or mortality and there were no significant difference in survival between large and small stocking sizes • There was no correlation between survival or mortality and the sediment composition depth of the anoxic layer, however, there was a weak positive correlation between the anoxic layer and the final weight of Mud Cockle • The benefit-cost analysis was modestly positive implying that a re-seeding program could be profitable with further optimisations of re-seeding techniques • Re-seeding of Mud Cockles was sensitive to duration from deployment to harvest, survival to harvest, and market prices as indicated by the benefit-cost analysis
Outcomes	• Re-seeding Mud Cockles at Section Bank is potentially viable for restoring the depleted Section Bank fishery, however, this is a long-term prospect • Further optimisation of re-seeded Mud Cockle stocking size, stocking density, and re-seeding infrastructure is still necessary to increase recovery and survival rates • The results and transportation methods from this study can assist in re-establishing the Mud Cockle fishery at Section Bank and other areas
Potential impacts	• Findings from this project on survival and growth estimates can be used to inform current and future policy evaluation for Mud Cockle fishery at Section Bank and other depleted zones • Increase in the value of the Mud Cockles industry value through application of re-seeding practices • Population restoration will also have social and economic benefits as Mud Cockles are an important resource for commercial and recreational fishing • Improved ecological outcomes as Mud Cockles also support the broader ecosystem at Section Bank

Project investment

A breakdown of FRDC investment and contribution by others by financial year is shown in Table 73.

Table 73 Total investment in project 2014-028 from FRDC (nominal dollar terms)

Year ending June 30th	FRDC ($)	Others* ($)
2014/15	$105,405	$65,079
2015/16	$59,647	$72,813
2016/17		$63,492
2018/19	$35,293	
2021/2022	$50,086	
Total	**$250,432**	**$201,384**

Source: Documents provided by FRDC.

*Contributions to the project cost not sourced from FRDC e.g. in-kind contributions

For the BCA, the cost of managing the FRDC funding was added to the FRDC contribution for the project using a management cost multiplier of 1.157. As per impact assessments in previous years, this multiplier was estimated based on a five-year average of the ratio of total FRDC non-project cash expenditure to project expenditure as reported in FRDC's Cash Flow Statement (FRDC Annual Reports, 2019-2023). No multiplier was applied to the investment by other contributors, as it was assumed that project management and administration were included in the value of funding provided.

In undertaking the impact assessment, all past costs were expressed in 2023/24-dollar terms using the Implicit Price Deflator for GDP.

Summary of impacts

Table 74 below provides a summary of the expected triple bottom line impacts (economic, environmental, and social) from the project.

Table 74 Triple bottom line impacts, including those valued as part of this evaluation (in bold)

Economic	• **Increased likelihood of the economically and commercially viable restoration of Mud Cockle and other viable species** • Supports policymakers and addresses research needs of the industry
Environmental	• Improved overall ecosystem health due to the important contribution of Mud Cockle and other similar species • Improved understanding of re-seeding as a fisheries management tool to recover depleted shellfish populations
Social	• Maintained or improved social license to operate for Section Bank fishery • Support recreational fishing in the area again • Support Indigenous methods of Pipi and Cockles harvesting and knowledge transfer through generations as a result of an active fishery • Informed a PhD study on Mud Cockle translocation mechanisms • Developed fisheries and aquaculture science capacity by supporting a PhD candidate

Public versus private impacts

The potential impacts identified from the project are seen to accrue to both public and private beneficiaries. Public benefits will be seen as co-benefits of re-seeding Mud Cockles, including improved ecosystem health, social and recreational benefits arising from the revival of the fisheries.

Distribution of private impacts

Private impacts realised from this project may be distributed amongst Pipis, Vongole (Mud Cockles), and Cockles fisheries in South Australia, NSW, Victoria, and Tasmania that decide to utilise the learnings to re-seed populations (as is the case in Ceduna South Australia). Further benefits may be realised by other fishing industries that use Cockles as bait. Cockles constituted 51% of bait sales in South Australian bait shop sales in 2008, however concerns at the time identified price increases as a significant determinant of usage (Davies et al, 2008).

Impacts on other Australian industries

No direct impacts to other Australian primary industries were identified.

Impacts overseas

Although there may be environmental, along with species, differences across countries, findings from this project could inform best practice in re-seeding efforts of Cockles and other similar species internationally.

Quantification of impacts

For the BCA, quantification of the impact assumes that this project will help achieve previously seen levels of harvest in a more sustainable manner. The adoption of re-seeding efforts has been shown to be commercially viable, hence, is a valid way to re-build populations over time. A specific example of how this benefit is assumed to occur is there are ongoing trials in the translocation of Mud Cockles in another SA fishery in an effort to promote Mud Cockle growth and increase profitability.

Estimated benefits

Table 75 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Maximum harvest of Pipis, Vongole, and Cockles in previous ten years across SA, NSW, Vic, Tas	986.3 tonnes	Ferguson et al, 2023a Ferguson et al, 2023b
b) 2022 harvest of Pipis, Vongole, and cockles across SA, NSW, Vic, Tas	585.2 tonnes	Ferguson et al, 2023a Ferguson et al, 2023b
c) Difference in harvest assumed to be the potential tonnes that are able to be regained	401.1 tonnes	a – b
d) Value of 1 kg	$14	ABARES Fisheries and Aquaculture production 2021-22. Per comms, this

		is likely to be conservative based on recent price increases.
e) Profit	10%	Analyst assumption
f) Increased production per year attributable to project	6.25%	Analyst assumption, chosen under the assumption that c) can be achieved in 15 years
g) Annual benefit	$35,000	c x d x e x f, assumed to accumulate every year until c) is achieved

Adoption costs

Considering that the project's BCA was positive, the adoption costs are expected to be reflected in the increased value of the industry, hence, have not explicitly been included for simplicity.

Counterfactual

The counterfactual considers a similar outcome would have occurred with a 10 year delay. Although this project was unique in its approach, a rebuilding of biomass can be influenced by other management techniques or environmental factors, hence, the benefits are expected to only be unique until the medium term.

Attribution

The attribution of benefits - summarised in Table 76 – considers all benefits to be attributable to this project, of which 58% is FRDC and 42% is other parties.

Table 76 Attribution of benefits for project 2014-028

Variable	Assumptions
FRDC costs	58%
Other project party costs	42%
Total	100%

Adoption

Considering circumstances that have led Section Bank to not be of a high likelihood in focussed re-seeding efforts, a broader approach to adoption has been considered. It will be up to individual businesses to determine a region's suitability to re-seeding, hence it is difficult to make any specific assumptions on where or who will carry it out. However, this assessment assumes that there will be some level of adoption due to the identified net benefit of conducting re-seeding under suitable conditions.

Results

Table 77 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2023/24-dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2023/24 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The 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 (2023/24) to the final year of benefits assumed.

The results show the total investment returning a net present value (NPV) of $2.61 million and a favourable BCR of 5.1. Table 78 shows FRDC investment returning a NPV of $1.52 million and a BCR of 5.1

Table 77 Investment criteria for total investment in Project 2014-028 ($M)

Year	0	5	10	15	20	25	30
PV Benefits	$0.10	$0.81	$1.87	$2.74	$3.17	$3.24	$3.24
PV Costs	$0.63	$0.63	$0.63	$0.63	$0.63	$0.63	$0.63
NPV	-$0.53	$0.18	$1.24	$2.11	$2.54	$2.61	$2.61
BCR	0.2	1.3	3.0	4.3	5.0	5.1	5.1
IRR	-19%	6%	13%	14%	15%	15%	15%
MIRR	-3%	6%	8%	9%	9%	8%	8%

Table 78 Investment criteria for FRDC investment in Project 2014-028 ($M)

Year	0	5	10	15	20	25	30
PV Benefits	$0.06	$0.47	$1.09	$1.60	$1.84	$1.88	$1.88
PV Costs	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37
NPV	-$0.31	$0.10	$0.72	$1.23	$1.48	$1.52	$1.52
BCR	0.2	1.3	3.0	4.3	5.0	5.1	5.1
IRR	-21%	6%	13%	15%	15%	15%	15%
MIRR	-3%	6%	8%	9%	9%	8%	8%

The flow of total undiscounted costs and benefits from the project is presented in Figure 9 below.

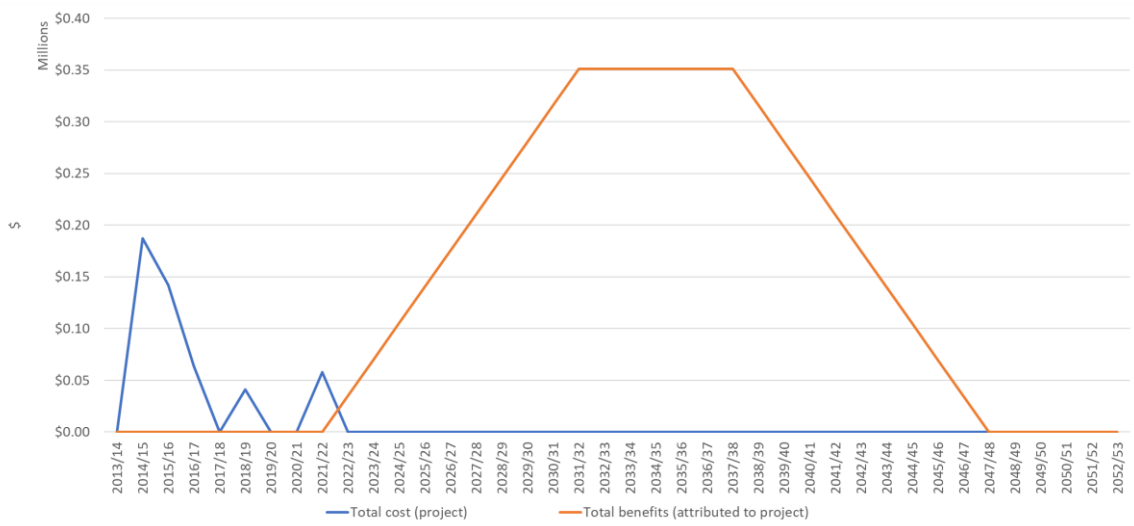

Figure 9 Flow of undiscounted costs and benefits from the project.

Sensitivity Analysis

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented in Table 79 below and show that the project will deliver a positive NPV ($M) across all modelled scenarios.

Table 79 Sensitivity analysis

Changes to key variables	NPV ($M)	BCR	MIRR
Standard assumption	2.61	5.1	8%
Discount rate			
4%	2.96	5.7	7%
6%	2.30	4.6	9%
Increased production per year attributable to project			
4.25%	1.57	3.5	7%
8.25%	3.64	6.8	17%

Confidence ratings

The accuracy of the assessment is highly dependent on:

- The extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and
- The level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions).

An assessment of coverage and confidence ratings for this project is presented below in Table 80.

Table 80 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	Although difficult to quantify, benefits are expected through the contribution to recreational and cultural values, along with the scientific knowledge of Mud Cockles.
Confidence in assumptions	Low	There is a low degree of certainty in underlying assumptions for adoption and attribution to the project considering the broader approach in quantification.

Conclusions

*Project 2014-028: Mud Cockle (*Katelysia *spp.) Stock Enhancement/ Restoration: Practical Implementation and Policy Evaluation* ran a re-seeding trial at Section Bank that was viable for restoring depleted Mud Cockle populations over the long term. Further research is required to optimise stocking size and density and increase recovery and survival rates. Based on the adopted assumptions, the total FRDC investment is expected to provide a positive economic return (BCR of 5.1), which remains positive across all modelled scenarios. Some project delays, such as obtaining a transport permit from the Department of Planning, Infrastructure and Transport, South Australia for the transport of Mud Cockles and a change in project investigators led to inflated project costs due to conversion to present-day values.

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