Appendix P: 2019-013: Modelling environment changes and effects on wild-caught species in Queensland

Background

In QLD and NSW fisheries, Spanner Crabs, Snapper, and Pearl Perch are species at higher risk of depletion, are of commercial significance, and may be experiencing range shifts because of environmental change. Recent assessments of Pearl Perch and Snapper populations of both species are between 10-40% of virgin biomass, which is well below the 60% unfished biomass by 2027 target of the Sustainable Fisheries Strategy. Moreover, the national Status of Australian Fish Stocks Reporting (SAFS, 2018) categorises these species as 'depleting' or 'depleted'.

The sustainable management of these species depends on quantitative assessments of stock. However, these assessments typically do not account for fluctuating environmental factors - such as sea surface temperature, abundance of nutrients, and surface currents – that can affect marine populations. With evidence that environmental factors are changing rapidly in the marine environment, it is particularly important to understand how these changes may impact abundance of fish stocks. Moreover, there is yet to be a rigorous and comprehensive approach to incorporating abiotic influences into QLD and NSW stock assessments.

Understanding the influence of environmental factors can provide greater certainty that the risk of overfishing (under adverse environmental conditions) or under-harvesting (under favourable conditions) are accounted for by resource managers.

Description of the project

Table 122 Project summary of project 2019-013

Project code	2019-013
Title	Modelling environment changes and effects on wild-caught species in Queensland
Research Organisation	University of Queensland
Principal investigator	Jerzy Filar
FRDC project manager	Adrianne Laird
Period of funding	November 2019 - May 2021
FRDC investment	$285,708
FRDC program allocation	20% Adoption, 30% Environment, 30% Industry, 20% People

Rationale	This project aimed to identify the environmental factors which may be influencing the recruitment, catchability or productivity of Snapper, Pearl Perch, and Spanner Crab stocks in Queensland.

Objectives	• To find indices of association between measures of abundance and key environmental drivers • To improve stock assessment models, for targeted species, by incorporating environmental drivers • To enable forecasting of environmentally driven fluctuations in species' abundance, including enhancing Management Strategy Evaluations (MSEs) for targeted species, with the help of a Rapid Adaptive Projections Tools (RAPT)
Activities and outputs	• Environmental variables influencing the abundance of the three species were identified, quantified, and incorporated into stock assessment models • The environmental variables of GSLA and Chl-a were found to have strong associations with either abundance or catchability across the three target species • Incorporating environmental variables (GSLA, Chl-a, and SST) into stock assessment models, under some TACC scenarios, led to the re-building timeframes/stock recovery to sustainable levels • A rapid adaptive projections tool (RAPT) was developed to enable forecasting of environmentally driven fluctuations in species' abundance
Outcomes	• Continued shifts in environmental conditions may have consequences (near term and long term) on rebuilding stocks. Historical levels of harvest of these three species are unlikely to be achievable in the future • The results indicate that environmental variables can be used to inform future harvest strategy development and should be considered for incorporation into performance measures that are used to set harvest limits via harvest strategies
Potential impacts	• Potential application of adaptive management with consideration of environmental variables to optimise economic and environmental outcomes • Improved stock recovery strategies, lower overfishing and greater accuracy in sustainable harvest rates • Greater resilience of fisheries through an informed understanding of how long term climate trends may be influencing fish populations • Greater efficiencies in future projects due to the developed methodologies, tools and capacity building

Project investment

A breakdown of FRDC investment and contribution by others by financial year is shown in Table 123.

Table 123 Total investment project 2019-013 from FRDC (nominal dollar terms)

Year ending June 30th	FRDC ($)	Others* ($)
2019/20	$94,096	$221,251
2020/21	$191,612	$117,103
Total	**$285,708**	**$338,354**

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

Table 124 Triple bottom line impacts, including those valued as part of this evaluation (in bold)

Economic	• **Increased accuracy of stock assessment for the three species, avoiding potential losses through management that is less responsive to volatility** • **Efficiency gains in application to other projects of the developed modelling, methodology and capacity of incorporating climate change factors into stock assessments** • **Preservation of the assessed species' fishery social license**
	• Avoided overfishing through more restrictive management practices for Snapper and Pearl • Improved fish population's health through more responsive and informed stock management
Social	• Improved ability to communicate with fishers on the need for certain management restrictions leading to better compliance amongst fishers • Sustainable fish populations for recreational fishers

Public versus private impacts

The potential impacts identified from the project will accrue to both public and private beneficiaries. Adaptive management that is considerate of environmental factors is key to avoiding harm to the populations assessed and broader environment. The public is further expected to benefit through greater information supplied, specifically to recreational fishers and the local communities, building trust in management techniques and avoiding conflict.

Distribution of private impacts

Private impacts realised from this project will be distributed amongst fishers of these species, in the form of more optimally managed management and in turn a reduced risk to their social license.

Impacts on other Australian industries

No direct impacts to other Australian primary industries were identified.

Impacts overseas

The tools and methodologies developed through this project are likely to be of high relevance to other countries. Although useful in general application of environmental changes, the body of research that this project is contributing to is likely to become increasingly important for management agencies to adopt to avoid the consequences of inaccurate management which is becoming increasingly challenging.

Quantification of impacts

For the BCA, three benefits have been deemed suitable for quantification. Firstly, the target species of the research are likely to face increasingly difficult management decisions in coming years, especially Snapper and Pearl Perch. This project is likely to contribute significantly to the successful navigation of these decisions through a more informed modelling approach and understanding of trends. Similarly, under the counterfactual of less informed management, there would be a higher risk of impacts to the social license of these fisheries. Further, the methodologies, tools and additional capabilities developed through this project are likely to create significant efficiencies and benefits to other similar projects.

Estimated benefits

Table 125 Benefit assumptions

Variable	Assumption	Source/ Explanation
Impact 1: Avoidance of potential losses to value of species due to improved management		
a) Value of 3 species across NSW and QLD in both recreational and commercial GVP	$15.5M	Based on *Economic and social indicators for the QLD rocky reef fishery* (BDO, 2020), *Snapper 2023* (FRDC), *Pearl Perch 2023* (FRDC) and *Spanner Crab 2023* (2023)
b) Decrease over 30 years without project	25%	Analyst assumption
c) Decrease over 30 years with project	10%	Analyst assumption
d) Profit margin	10%	Analyst assumption
e) Marginal value mitigated	$232,500	(a x b x d) – (a x c x d)
Impact 2: Decreased risk to social license		
f) Risk to social license through management that is less informed	10%	Analyst assumption,
g) Annual benefit to social license	$155,000	a x d x f
Impact 3: Efficiencies realised through the tools, methodologies and capacity developed		
h) Expected efficiencies on future projects	10%	Analyst assumption
i) Number of projects per year	0.5	Per comms, applicable projects are likely to occur every 2 years

j) Cost of project	$500,000	Analyst assumption, expected to be $170,000 less than this project
k) Annual benefit 2	$25,000	h x i x j, assumed to last 15 years

Adoption costs

There are no significant adoption costs expected, the outputs of the project are ready to be incorporated into current practices without significant difficulty or cost.

Counterfactual

The counterfactual considered is that there would be a continuance in current management practices, for the target species, that are not inclusive of environmental variables. This would likely lead to poorer outcomes commercially and to increase the risk to the social license to operate. However, due to the increased focus on this area of research, the counterfactual also considers there to be a similar impact slowly come into effect after 20 years. Further, increased costs/inaccuracies are expected of future similar research without the significant contribution of the methodologies, tools and capacity created by this project.

Attribution

The attribution of benefits from the project - summarised in Table 126 – considers any past inputs and expected future development costs required to realise beneficial outcomes. The attribution of benefits from this project are estimated to be approximately 90%, of which 44% is attributable to FRDC's investment.

Table 126 Attribution of benefits for project 2019-013

Variable	Assumptions
FRDC costs	44%
Other project party costs	46%
Future development	10%
Total	100%

Adoption

The findings of this project are expected to be reflected into ongoing management decisions for the target species. Hence, benefits are expected to accrue from the year of evaluation. As outlined under the counterfactual, adoption of similar management practices would be expected after a significant delay, estimated to be 25 years before adoption could begin, with the benefits of this project decreasing from year 25 to 30.

Results

Table 127 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 $4.94 million and a favourable BCR of 7.2. Table 128 shows FRDC investment returning a NPV of $2.43 million.

Table 127 Investment criteria for total investment in Project 2019-013 ($M)

Year	0	5	10	15	20	25	30
PV Benefits	$0.37	$1.99	$3.26	$4.25	$4.98	$5.63	$5.74
PV Costs	$0.80	$0.80	$0.80	$0.80	$0.80	$0.80	$0.80
NPV	-$0.43	$1.19	$2.46	$3.45	$4.18	$4.83	$4.94
BCR	0.5	2.5	4.1	5.3	6.2	7.0	7.2
IRR	NA	24%	28%	29%	29%	29%	29%
MIRR	1%	9%	10%	10%	10%	9%	9%

Table 128 Investment criteria for FRDC investment in Project 2019-013 ($M)

Year	0	5	10	15	20	25	30
PV Benefits	$0.18	$0.98	$1.71	$2.17	$2.51	$2.73	$2.83
PV Costs	$0.39	$0.39	$0.39	$0.39	$0.39	$0.39	$0.39
NPV	-$0.21	$0.59	$1.32	$1.78	$2.12	$2.34	$2.43
BCR	0.5	2.5	4.3	5.5	6.4	6.9	7.2
IRR	-16%	24%	29%	30%	30%	30%	30%
MIRR	1%	9%	10%	10%	10%	9%	9%

The flow of total undiscounted costs and benefits from the project is presented in Figure 15 below.

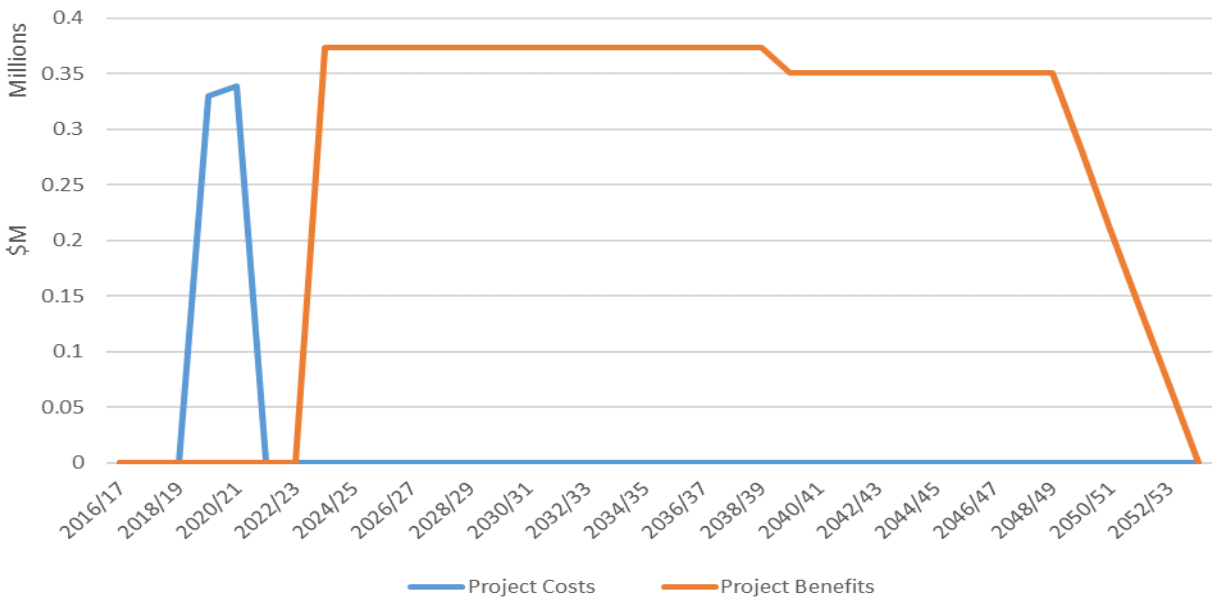

Figure 15 Flow of undiscounted costs and benefits from the project.

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 129 below and shows that NPV ($M) remains positive across all scenarios

Table 129 Sensitivity analysis

Changes to key variables	NPV ($M)	BCR	MIRR
Standard assumption	4.94	7.2	9%
Discount rate			
4%	5.55	7.9	8%
6%	4.42	6.5	10%
Annual risk of loss of social license through management that is less informed			
5%	3.84	5.8	9%
15%	6.04	8.55	9%

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 130.

Table 130 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	High	The included benefits are considered broad and to cover the most likely to occur, although conservative values have been utilised to reflect the uncertainty in assumptions.
Confidence in assumptions	Medium	As outlined in the sensitivity analysis, the modelling is highly sensitive to some uncertain variables utilised.

Conclusions

This project successfully identified the environmental factors which influence the recruitment, catchability and productivity of Snapper, Pearl Perch, and Spanner Crab stocks in Queensland. Based on the adopted assumptions this analysis has estimated the project investment will likely deliver a positive economic benefit (BCR 7.2), which remained positive across all modelled scenarios. This significantly large benefit is reflective of the likely positive impacts in optimised management within the assessed fisheries and the contribution of tools, methodologies and capacity to future projects. The importance of this project will increase as environmental fluctuations are occurring more often and extreme under climate change.

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