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Informing the BSCZSF Harvest Strategy and TAC-setting with MEY calculations

AFMA Project 2019/0836

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Executive Summary

The Bass Strait Central Zone Scallop Fishery (BSCZSF) targets the Commercial Scallop (*Pecten fumatus*). Management of the BSCZSF falls under the Australian Fisheries Management Authority (AFMA) and is guided by the Commonwealth Harvest Strategy Policy, which aims to keep key commercial species at a biomass that produces maximum economic yield (B_{MEY}). However, scallops are relatively short-lived species with highly-variable recruitment and population dynamics that result in extremely patchy abundance on relatively small spatial and temporal scales. These population characteristics affect estimates of stock biomass and B_{MEY} which remain difficult to determine. Thus, where biomass depletion is unknown, as is the case for scallops in the BSCZSF, alternative target proxies can be applied provided they are consistent with the Policy objective.

The BSCZSF harvest strategy adopts a tiered approach with only minimal catches allowed unless pre-season surveys of known fishing grounds are undertaken. Under a risk-cost-catch framework, the survey results determine areas that will be closed to fishing and which annual total allowable catch (TAC) is applied outside these closures. Since 2015, the TACs have ranged between 2,500 and 4,000 t. Although higher TACs during this period would have been biologically sustainable, industry has recognised that large quantities of scallops landed within a relatively brief fishing season can overload processing capacity and flood markets with scallops, potentially depressing prices and impacting the maximum economic yield from the fishery. However, the actual relationship between TAC and economic yield from the fishery has not been evaluated.

In this project, a fishery gross margin (FGM) model (which presents the greatest difference in the gross value of production equivalent to market revenue minus variable costs) was developed for the BSCZSF and used to evaluate optimal TACs. Maximising FGM is used in this analysis as a proxy for MEY in estimating an optimal TAC for the BSCZSF.

Catch and effort data were obtained from the Australian Fisheries Management Authority and economic information gained from industry surveys was used in the FGM model. Results were produced with three different assumed price flexibilities. The results show that under each price flexibility, the fishery gross margin is maximised at a different level of TAC. At a -0.3 price flexibility, the FGM is maximised at 4,000 t of TAC. At this price flexibility, there is very little change in price, so the marginal costs of fishing are lower than the increase in gross value of production (GVP), meaning that it is profitable to continue fishing at 4,000 t. At a -0.8 price flexibility, there is a significant change in price, and the marginal costs of fishing become greater than the increase in GVP at 3,000 t. Therefore, the fishery gross margin is maximised at 2,500 t of TAC.

There is uncertainty associated with the FGM model estimates. First, the economic survey was only completed by three of the fifteen active licence holders. Although the catches by these operators accounted for 37% of the average total catch over the last five years, there is concern that a low participation rate could have biased the results of the economic analyses and may yield results that are not representative of the broader industry. Second, the uncertainty in price flexibility meant this analysis produced a broad range of optimal TACs. Improving the quality of the price flexibility estimate will require collection of additional data from fishing businesses and buyers.

The FGM model accounts for changes in prices and variable costs but not fixed costs. Therefore, the model is most appropriate for short-term (i.e. annual) decision making and relatively small

adjustments that do not affect the structure of a fishery (e.g. number of boats). Because the BSCZSF is an opportunistic fishery and responsive to large variations in biomass and seasonal yields, it requires year-to-year consideration of optimal harvest strategies for which the FGM model can be a useful tool.

If the FGM model approach is to be improved and incorporated into the BSCZSF harvest strategy, a greater level of consistent economic data collection from across industry is required together with improved estimates of the price flexibility.

Key words: Scallop, MEY, Harvest Strategy

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Acknowledgements

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1 Introduction

The Bass Strait Central Zone Scallop Fishery (BSCZSF) targets *Pecten fumatus*, a species with highly-variable population distribution and abundance, seemingly independent of management intervention (Haddon *et al.,* 2006). Furthermore, for mature individuals, yields vary seasonally according to their reproductive cycle (Young et al. 1999). Thus, the BSCZSF harvest strategy (AFMA 2015) must be flexible and spatially and temporally adapted to current scallop populations. The harvest strategy has two primary objectives:

1. To keep stocks within the BSCZSF at ecologically sustainable levels and, within that context, maximise the economic returns to the Australian community; and,
2. To pursue efficient and cost-effective management in attaining (1) above.

The harvest strategy adopts a tiered approach with different levels of management and research depending on the state of the resource. At the commencement of the season, a 150 t total allowable catch (TAC) may be set to provide concession holders with the capacity to search for, locate and conduct a fishery-independent survey of commercially-viable scallop beds. Based on minimum survey outcome requirements, the TAC can be increased in line with the following Tiers:

- Tier 1. A TAC of 1,000 ≤ 2,000 t with the identification and closure of a scallop bed/s containing at least 1,500 tonnes of scallops of a minimum size limit of 85 mm (shell width) at high density; and,
- Tier 2. A TAC > 2,000 t with the identification and closure of a scallop bed/s containing at least 3000 tonnes of scallops of a minimum size limit of 85 mm (shell width) at high density.

The decision to move to either Tier 1 or 2 from the default opening of the fishery is made by the AFMA Commission following advice from the scallop resource assessment group (ScallopRAG) and the scallop management advisory committee (ScallopMAC). Since 2015, surveys have revealed a high scallop biomass (see Koopman *et al.* 2021), prompting Tier 2 management in recent years. Accordingly, the season can begin with a > 2,000 t TAC (for commercial scallops) as recommended by ScallopRAG and ScallopMAC. The time-series of recent TACs, catch and gross value of production (GVP) is shown in Table 1 and Figure 1.

Management of the BSCZSF falls under the Commonwealth Harvest Strategy Policy (Department of Agriculture and Water Resources, 2018). The Policy states the target reference point for key commercial species is the stock biomass that produces maximum economic yield from the fishery (B_{MEY}) or, if this is not known, a proxy of 0.48 times the unfished biomass, or 1.2 times the biomass at maximum sustainable yield (B_{MSY}). Where biomass depletion is poorly estimated or unknown, as is the case for commercial scallops in the BSCZSF, alternative target proxies may be applied provided that they can be demonstrated to be compliant with Policy objectives.

The biomass of scallops within the entire spatial extent of the BSCZSF is not known. Their variable recruitment, sedentary nature and relatively short life-cycle combined with extremely patchy abundance over relatively small spatial and temporal scales, determines that estimates of stock biomass and B_{MEY} remain elusive. Estimates of biomass obtained from the annual surveys derive from isolated patches of high-density scallops that are known or discovered by industry. Based on the survey results obtained since 2015, the TAC for the BSCZSF has been set in a very biologically precautionary manner compared with biomass estimates (< 10%). This has not only been for sustainability reasons. In a fishery that has witnessed boom and bust in the past (Figure

1), industry are wary about investing in infrastructure and supply chains that depend on high volumes of catch. They recognise that large quantities of scallops landed within a relatively brief fishing season can overload processing capacity and flood markets, potentially depressing prices (often referred to economically as price flexibility). Although this is reasonably intuitive, and has been reported anecdotally by fishers in recent years when there has been potential to take higher catches, the actual relationship between TAC and economic returns from the fishery has not been evaluated.

Table 1. BSCZSF TAC, catch and GVP for Commercial Scallop (from Patterson *et al.* 2017, 2019, 2020, 2021).

	2015	2016	2017	2018	2019	2020
TAC (t)	2,542	3,060	3,120	4,000	4,100	3,100
Catch (t)	2,260	2,885	2,964	3,253	2,946	2,732
GVP (million)	$2.8	$4.6	$6.7	$6.7	$6.3	$5.3

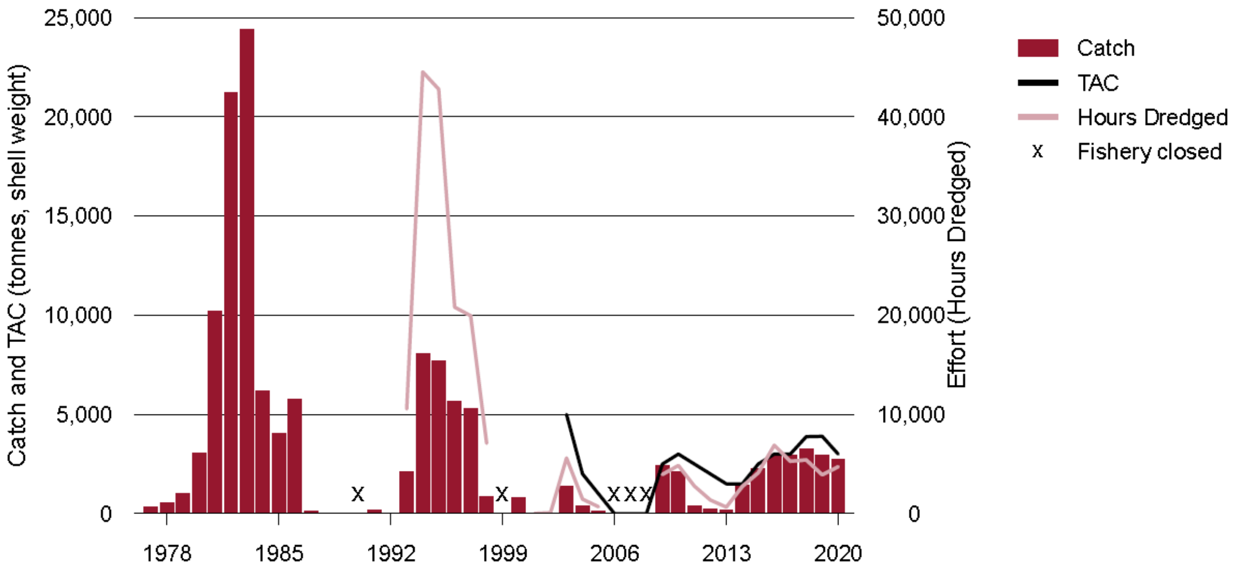

Figure 1. Catch and TAC of commercial scallop in the BSCZSF, 1977 to 2020 (Patterson *et al.* 2021).

In line with the Commonwealth Harvest Strategy Policy, this report considers the economic performance of the BSCZSF consistent with the Australian Fisheries Management Authority's (AFMA) legislative objective to manage fisheries to achieve maximum economic yield (MEY). Here we apply a simple Fishery Gross Margin (FGM) framework to evaluate MEY against TAC for the BSCZSF.

1.1 Project Objectives

1. Collect relevant economic and market data for Bass Strait scallops.
2. Develop a practical approach to estimate MEY for the fishery to inform the harvest strategy/TAC-setting process.
3. Report results to AFMA, ScallopRAG and ScallopMAC.

2 Methods

2.1 Data collection

Fishery catch and effort data is routinely collected by AFMA in all fisheries through mandatory logbooks. However, the collection of fishery-level economic data is not collected consistently or routinely in the various AFMA-managed fisheries. AFMA doesn't collect any specific economic data from the BSCZSF, but have recently begun to keep records of lease and transfer prices.

Recent catch and effort information was obtained from AFMA under a confidentiality agreement. The lack of economic information on the BSCZCF prompted the gaining of additional information from confidential industry surveys. Accordingly, economic data were obtained either through individual operators completing a survey or by project team members interviewing operators (according to the survey) and recording relevant economic information. Details of the survey are provided in Appendix 1. The survey focused on six main areas:

PART A – FISHING REVENUE AND EXPENDITURE

- catch and effort;
- price;
- direct costs;
- administrative costs.

PART B – EMPLOYMENT

- Paid;
- Unpaid.

PART C – QUOTA SFRs

- Quota SFRs – number owned and value;…
- Quota SFRs – number leased and price.…

PART D – CAPITAL

- Fishing boats.

PART E – UNEXPECTED EVENTS OF 2020 AND THEIR EFFECTS

PART G – FURTHER COMMENTS

2.2 FGM modelling

The maximum economic yield (MEY) model used in the South Australian pipi fishery (EconSearch 2012) was adapted to the BSCZSF. This model uses a fishery gross margin (FGM) approach as an alternative to more complex bio-economic models that require large data sets and are not as suited to highly variable fisheries such as the BSCZSF.

FGM is calculated as total fishery income less total variable costs, where variable costs are assumed to be proportional to fishing effort. Advantages of using FGM for the BSCZSF include:

- simple data input: price, price elasticity of demand, variable costs, and nominal TAC;
- FGM can be evaluated against harvest strategy targets;

- the TAC can be set to provide for optimal economic outcomes while minimising the risk of overexploitation; and,
- The FGM can be used as a proxy for MEY.

Phone interviews with fishers and processors were undertaken to obtain values for variable costs (including unpaid labour); revenue data for the past 3 years (total sales, average price, days fished); monthly prices and size grades. These interviews were also be used to assess operational supply / capacity bottle necks and market dynamics. The FGM was run over a range of TACs drom 2000 t to 4000 t (Table 2).

An average price of $15/kg was used with three assumed price flexibilities to show how changes in quantity of scallops supplied are expected to affect prices, and hence GVP and FGM outcomes. A price flexibility is the percentage change in market price given a percentage change in quantity supplied. There have been relatively few studies completed on the price flexibility of scallops and none in Australia. One study from the United States found that scallop prices were relatively robust to changes in the quantity landed, ranging from -0.46 to -0.65 (Altobello *et al.*1977). An Australian study on own-price flexibilities for wild-caught Australian seafood reported short-run own-price flexibilities of -0.45 for wild prawns, -0.80 for Sydney rock oysters and -0.26 for Pacific oysters (Pascoe *et al.* 2021). Given these estimates the price flexibility for scallops was assumed to vary between -0.3 and -0.8.

Data on variable costs were collected in the survey of fishing businesses. Business-level fishery logbook data on catch and effort was used to adjust the survey responses to reflect the whole fishery. Average variable costs were estimated to be $7.34/kg and are shown in Table 3. This assumes no change in CPUE and therefore costs at differing TAC levels. Data on expected changes in CPUE at the various TAC levels could be incorporated to vary costs at differing TAC levels.

Table 2. Modelled TAC levels

	Large Decrease	Small Decrease	Base TAC	Small Increase	Large Increase
TAC	2,000 t	2,500 t	3,000 t	3,500 t	4,000 t

Table 3. BSCZSF variable costs

Variable Costs	$/kg	Share of Total
Skipper fees	2.46	33.6%
Crew wages	2.54	34.6%
Vessel fuel and lubricants	1.41	19.2%
Provisions	0.16	2.2%
Repairs and Maintenance to Boat	0.76	10.4%
Protective clothing	0.00	0.1%

Total	7.34	100.0%

A cost-effective framework for ongoing annual data collection to inform the MEY estimates was also developed.

Other applicable assumptions include:

- The FGM model is static i.e. the harvest strategy that generates the best return in one year may not be the best strategy for future returns.
- For scallop harvests, variable costs are proportional to fishing effort.
- Fixed costs are not considered in the model e.g. investment in vessels, plant and equipment; permanent labour and business overheads.

2.3 Quality Assurance

Confidential interviews were undertaken with stakeholders in the fishery and results cross-checked across respondents. Data were not directly associated with respondents who remain anonymous in the collated data. Results and their interpretations and conclusions were discussed amongst the research team, and draft reports were reviewed by co-authors and by AFMA managers. Where required, comments were addressed in preparation of the final report.

3 Results and Discussion

3.1 Survey participation and representativeness

At the outset, the major risk to the success of this project was ability to access economic information that could be considered to be representative of the broader industry. Fishwell Consulting has a history of good working relationships with the scallop fishing industry but the project proposal highlighted:

> *"…there are presently considerable differences of opinion within industry about the application of MEY principles within the harvest strategy and subsequently there is no guarantee that we will be able to collect an unbiased economic information from the fleet / processors. This is a significant risk to the acceptance of economic data that is output from the project and its inclusion in the harvest strategy. The project team will do all in its powers to minimise and overcome this risk, but we can not take responsibility if some industry members refuse to provide economic information for the project."*

Concerns about the risk of industry representativeness were well-founded. Very few industry members provided their economic information to the project team, despite assurances of its confidentiality. A total of three responses to the survey was recorded despite 15 fishers being active in the fishery over the last five years of which six (40%) caught 81% of the catch. Catches taken by the three survey respondents accounted for 37% of the total catch. Although this is a reasonable percentage of the catch, the low level of survey participation may have biased the results of the economic analysis and therefore yield results that are not representative of the broader industry. Greater representation of the scallop industry in obtaining relevant economic data may be achieved in future years.

Poor representation of fishers in the economic survey reflected concerns about the utility of the MEY goal, its application to the fishery as a whole, and its implications for their own business in particular. Despite many similarities, BSCZSF operators can have substantially different business situations with respect to access to quota (whether they mainly own it or have to lease it), relationships with processors, and access to markets and opportunities to expand market opportunities. Since 2015 inclusive, catches have ranged from about 2,300 to 3,200 t. Operators consulted were concerned whether, based on the outcome of this project, adoption of a MEY goal in the harvest strategy would result in a significant change in the TAC (either up or down) and whether such a change could negatively affect their individual businesses. Given this uncertainty, it appeared that some operators preferred not to provide their economic data for the economic analyses.

Recognising the shortfalls noted above, including the sensitivity to key assumptions, the FGM model results are presented and discussed. The results are presented in a format that can be easily understood by stakeholders and potentially used to inform harvest decisions.

3.2 FGM modelling results

The results from the fishery gross margin analysis are presented for three alternative price flexibility assumptions (-0.3, -0.5 and -0.8) (Table 4). Within each section of the table, the modelled price, GVP and gross margin is presented for each level of TAC.

The results show that when a -0.3 price flexibility occurs to the price of $15 per kilogram, the fishery is profitable at all listed levels of TAC, and both the GVP and gross margin are highest at 4,000 t of TAC (Table 4). These values decrease gradually as TAC decreases. At this price flexibility, there is very little change in price, so the marginal costs of fishing are lower than the increase in GVP, meaning that it is profitable to continue fishing at 4,000 t.

At a -0.5 price flexibility, the gross margin is highest at 3,000 t of TAC then decreases gradually as TAC decreases. Although GVP is higher at 3,500 t ($6.3m) and 4,000 t ($6.7m) than at 3,000 t ($5.6m), the gross margin at 3,000 t ($3.2m), is higher than at 3,500 t ($3.1m) and 4,000 t ($2.9m). This is due to variable costs increasing more significantly than GVP at higher levels of TAC (Table 4).

At a -0.8 price flexibility, the gross margin is highest at 2,500 t of TAC then decreases gradually as TAC increases. Although GVP is higher at 3,000 t ($6.3m) than at 2,500 t ($5.9m), the gross margin at 2,500 t ($3.4m), is higher than at 3,000 t ($3.2m). This is due to variable costs increasing more significantly than GVP at higher levels of TAC (Table 4).

The gross margin produced under each price flexibility assumption is illustrated in Figure 2 using curves that show gross margin as a function of TAC. A dot is placed at the optional TAC (where gross margin is maximised) for each price flexibility assumption. At this point, an increase or decrease in TAC would decrease gross margin.

Table 4. BSCZSF Price, GVP and Gross Margin at -0.3, -0.5 and -0.8 Price Flexibility for defined TAC levels.

	2,000t	2,500t	3,000t	3,500t	4,000t
-0.3 Price Flexibility					
Price ($/kg)	$16.5	$15.8	$15.0	$14.3	$13.5
GVP ($m)	$4.6m	$5.5m	$6.3m	$6.9m	$7.5m
Gross Margin ($m)	$2.5m	$2.9m	$3.2m	$3.4m	$3.4m
-0.5 Price Flexibility					
Price ($/kg)	$17.5	$16.3	$15.0	$13.8	$12.5
GVP ($m)	$4.9m	$5.6m	$6.3m	$6.7m	$6.9m
Gross Margin ($m)	$2.8m	$3.1m	$3.2m	$3.1m	$2.9m
-0.8 Price Flexibility					
Price ($/kg)	$19.0	$17.0	$15.0	$13.0	$11.0
GVP ($m)	$5.3m	$5.9m	$6.3m	$6.3m	$6.1m
Gross Margin ($m)	$3.2m	$3.4m	$3.2m	$2.8m	$2.0m

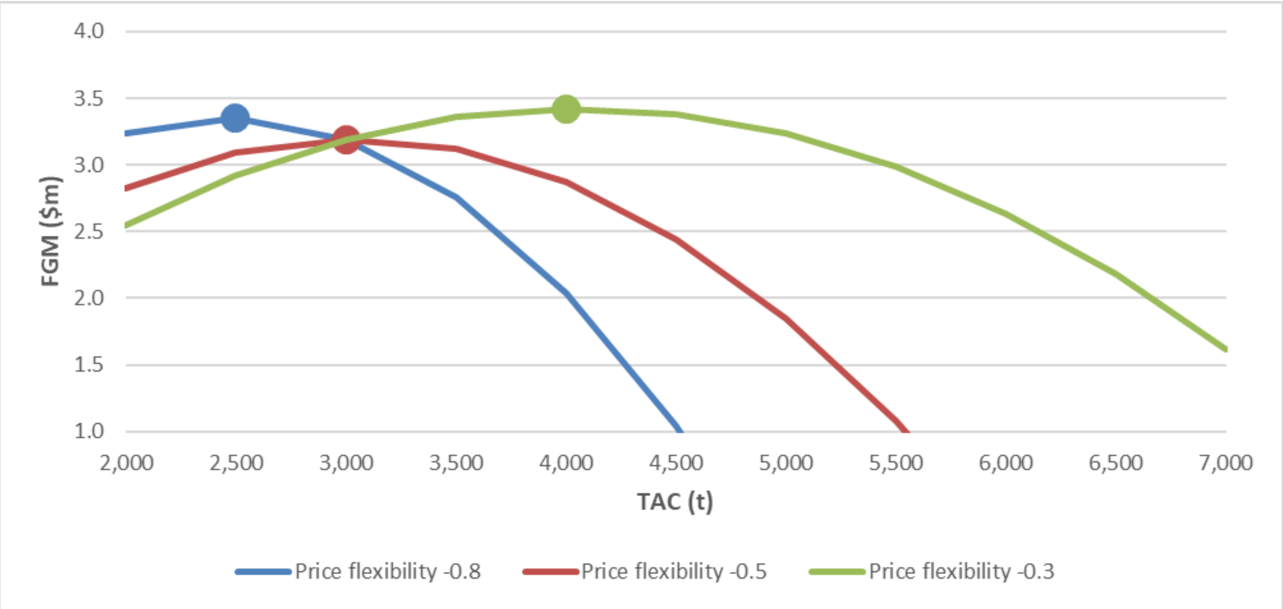

Figure 2. FGM-maximising TAC (large dots) under alternative price flexibility assumptions (curves).

3.3 FGM modelling discussion

Analysis of gross value of production based on five indicative TACs showed variation in the gross margin of the Bass Strait Central Zone Scallop Fishery.

The results in Table 4 show the price, GVP and fishery gross margin for the five indicative TACs at three different price flexibilities. The fishery gross margin is calculated as the difference between the GVP and variable costs at each scenario. The GVP is reliant on the TAC and price, which vary across scenarios to reflect the effects of changes to these variables on the gross margin. Total variable costs are calculated using the cost per kilogram shown in Table 3, multiplied by the TAC of the scenario.

The price flexibility is used to determine the significance of the change in price at each level of TAC. The price is calculated as the total change in TAC from 3,000,t multiplied by the price flexibility and then the base price of $15/kg.

The optimal TAC from an economic efficiency perspective is where gross margin is maximised and ranges from 2,500 t (price flexibility of -0.8) to 4,000 t (price flexibility of -0.3) given different price flexibilities. This range of TAC values highlights the need to improve the data upon which price flexibility is estimated to improve the precision of the model.

The impact of price flexibility on FGM at various TAC levels is illustrated in Table 5. The highlighted cells show the gross margin maximising TAC for each assumed level of price flexibility. The current price flexibility range used (-0.3 to -0.8) produces an optimal TAC range that is 1,500 t wide. Refining the price flexibility range with improved economic data (for example to -0.4 to -0.6) may reduce this range to 1,000 t or 500 t, increasing the precision of the model.

Table 5. Gross margin ($m) at various TAC levels and price flexibilities, maximum of each column (price flexibility) highlighted

Gross Margin ($m)		Price flexibility																				
		0	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8	-0.9	-1.0	-1.1	-1.2	-1.3	-1.4	-1.5	-1.6	-1.7	-1.8	-1.9	-2.0
TAC (t)	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	500	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3
	1,000	1.1	1.2	1.3	1.5	1.6	1.8	1.9	2.0	2.2	2.3	2.5	2.6	2.7	2.9	3.0	3.1	3.3	3.4	3.6	3.7	3.8
	1,500	1.6	1.8	1.9	2.1	2.2	2.4	2.5	2.7	2.8	3.0	3.2	3.3	3.5	3.6	3.8	3.9	4.1	4.3	4.4	4.6	4.7
	2,000	2.1	2.3	2.4	2.5	2.7	2.8	3.0	3.1	3.2	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.5	4.6	4.8	4.9
	2,500	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.0	4.1	4.2	4.3	4.4
	3,000	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
	3,500	3.7	3.6	3.5	3.4	3.2	3.1	3.0	2.9	2.8	2.6	2.5	2.4	2.3	2.1	2.0	1.9	1.8	1.7	1.5	1.4	1.3
	4,000	4.3	4.0	3.7	3.4	3.1	2.9	2.6	2.3	2.0	1.8	1.5	1.2	0.9	0.6	0.4	0.1	-0.2	-0.5	-0.7	-1.0	-1.3
	4,500	4.8	4.3	3.9	3.4	2.9	2.4	2.0	1.5	1.0	0.6	0.1	-0.4	-0.8	-1.3	-1.8	-2.2	-2.7	-3.2	-3.6	-4.1	-4.6
	5,000	5.3	4.6	3.9	3.2	2.5	1.8	1.2	0.5	-0.2	-0.9	-1.6	-2.3	-3.0	-3.7	-4.4	-5.1	-5.8	-6.5	-7.2	-7.9	-8.6
	5,500	5.9	4.9	3.9	3.0	2.0	1.1	0.1	-0.8	-1.8	-2.7	-3.7	-4.7	-5.6	-6.6	-7.5	-8.5	-9.4	-10.4	-11.3	-12.3	-13.2
	6,000	6.4	5.1	3.9	2.6	1.4	0.1	-1.1	-2.4	-3.6	-4.9	-6.1	-7.4	-8.6	-9.9	-11.1	-12.4	-13.6	-14.9	-16.1	-17.4	-18.6
	6,500	6.9	5.3	3.8	2.2	0.6	-1.0	-2.6	-4.1	-5.7	-7.3	-8.9	-10.5	-12.0	-13.6	-15.2	-16.8	-18.4	-19.9	-21.5	-23.1	-24.7
	7,000	7.4	5.5	3.6	1.6	-0.3	-2.3	-4.2	-6.2	-8.1	-10.1	-12.0	-13.9	-15.9	-17.8	-19.8	-21.7	-23.7	-25.6	-27.6	-29.5	-31.4
	7,500	8.0	5.6	3.3	1.0	-1.4	-3.7	-6.1	-8.4	-10.8	-13.1	-15.5	-17.8	-20.1	-22.5	-24.8	-27.2	-29.5	-31.9	-34.2	-36.5	-38.9
	8,000	8.5	5.7	3.0	0.2	-2.6	-5.4	-8.2	-10.9	-13.7	-16.5	-19.3	-22.0	-24.8	-27.6	-30.4	-33.2	-35.9	-38.7	-41.5	-44.3	-47.0
	8,500	9.0	5.8	2.6	-0.7	-3.9	-7.2	-10.4	-13.7	-16.9	-20.2	-23.4	-26.7	-29.9	-33.2	-36.4	-39.7	-42.9	-46.1	-49.4	-52.6	-55.9
	9,000	9.6	5.8	2.1	-1.7	-5.4	-9.2	-12.9	-16.7	-20.4	-24.2	-27.9	-31.7	-35.4	-39.2	-42.9	-46.7	-50.4	-54.2	-57.9	-61.7	-65.4
	9,500	10.1	5.8	1.5	-2.8	-7.0	-11.3	-15.6	-19.9	-24.2	-28.5	-32.8	-37.1	-41.3	-45.6	-49.9	-54.2	-58.5	-62.8	-67.1	-71.4	-75.7
	10,000	10.6	5.8	0.9	-3.9	-8.8	-13.7	-18.5	-23.4	-28.2	-33.1	-38.0	-42.8	-47.7	-52.6	-57.4	-62.3	-67.1	-72.0	-76.9	-81.7	-86.6

3.4 FGM modelling limitations

There are a few limitations of the model to note:

1. Optimal TAC is quite sensitive to assumed price flexibility. More information on price response from fishers, processors and others knowledgeable of the scallop market is needed to improve model output. The uncertainty in price sensitivity meant this analysis produced a broad range for optimal TAC. Improving the quality of the price sensitivity estimate will require collection of additional data from fishing businesses and buyers. This should be a focus of future development of this model.
2. Catch per unit effort (CPUE) is assumed to be constant. It may decrease if boats need to travel further or fish for longer to take additional catch. The model could easily be extended to incorporate more information on the likely relationship between CPUE and TAC.
3. The costs of variable inputs (e.g. fuel, labour) are assumed to be constant. Some costs may increase if there are constrained inputs although this is unlikely given the relatively small size of the scallop fishery.
4. As noted in Section 6.1, maximising FGM is used in this analysis as a proxy for MEY in estimating optimal TAC. The FGM model accounts for changes in prices and variable costs but not fixed costs. Accordingly, it is most appropriate for short-term (i.e. annual) decision making about relatively small adjustments that do not affect the structure of a fishery (e.g. number of boats). Because the Bass Strait scallop fishery is an opportunistic fishery and responsive to large variations in biomass and seasonal yields, it requires year to year consideration of optimal harvest strategies for which the FGM model can be a useful tool.

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5 Appendix 1 – Economic survey

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AFMA PROJECT 2019-0836
Informing the Bass Strait Central Zone Scallop Fishery (BSCZSF) Harvest Strategy and TAC setting process with economic data 2018 to 2020

Please read this first:

- Fishwell Consulting has a strict contractual obligation to ensure the confidentiality of all data collected. The data collected from this questionnaire will only be analysed by Fishwell and project partners, BDO EconSearch and Oceanomics, and will only be presented in a form that ensures anonymity of licence holders.
- Please only include the amounts that can be attributed to your Bass Strait Central Zone Scallop fishing business.
- If exact figures are not available, please provide careful estimates.

The BSCZSF Harvest Strategy has two primary objectives. To: 1) keep stocks within the BSCZSF at ecologically sustainable levels and, within that context, maximise the economic returns to the Australian community; and, 2) pursue efficient and cost-effective management in attaining (1) above.

Application of the harvest strategy is under-pinned by annual biomass surveys to determine spatial closures and provide information on the density, biomass and size of scallops in surveyed beds. The harvest strategy also sets out conditions that need to be met in order that the TAC may be opened at either Tier 1 (1,000 t) or Tier 2 (above 2000 t).

In recent years, conditions to open the fishery have aligned with a Tier 2 TAC. Within sustainability requirements, the amount above 2000t at which the TAC was set, was influenced by industry conversations, basically about fishery economics. The views of industry were often contradictory, some putting forward the case for higher TACs, some for lower. Concerns about a higher TAC relate to the effect on demand, beach prices and bottle neck at processing facilities potentially impacting on the net economic return of the fishery.

To better inform the TAC setting process, the RAG and MAC recommended the collection of economic data and MEY analysis be undertaken. This questionnaire aims to collect that information.

Direct Costs…

3. Please provide estimates of your direct costs associated with fishing in the BSCZ Scallop fishery for the three years 2018 to 2020. Only include the amount that can be attributed to BSCZ Scallop fishing (please provide values *exclusive* of GST).

Direct Costs	**Direct Fishing Costs $ (excl. GST)**		
	2018	**2019**	**2020**
Skipper share (either a wage or % of catch)			
Crew share (as either a wage or % of catch)			
Boat fuel & lubricants			
Ice			
Provisions			
Repairs & maintenance to boat			
Repairs & maintenance to gear & equipment			
Slipping			
Mooring			
Boat survey			
PPE and equipment			
Freight, unloading fees and marketing			
AFMA levies			
Quota leasing			
Other fishing costs (provide details)			

Administrative Costs…

4. Please provide estimates of your administrative costs associated with fishing in the BSCZ Scallop fishery for the three years 2018 to 2020. Only include the amount that can be attributed to BSCZ Scallop fishing (please provide values exclusive of GST).

Administrative Costs	Administrative Fishing Costs $ (excl. GST)		
Wages – land-based personnel			
Insurance – vessels			
Insurances – other			
Legal & accounting			
Communication – telephone, internet			
Utilities and water			
Repairs and maintenance to buildings/plant			
Repairs and maintenance to motor vehicles			
Rates (e.g. Emergency Services Levy, Council Rates, etc.)			
Rents (i.e. berth or sheds/building)			
Leasing charges and costs (other than quota and boat SFR leasing costs – Part C below)			
Interest and borrowing costs			
Travel, accommodation			
Membership, association expenses			
Other expenses (specify)			

PART B – EMPLOYMENT

Paid…

5. How many people worked in your Scallop fishing operation in 2020? **Only include people paid a wage or a crew share.** Scallop fishing operation means at-sea and on-shore activities (e.g. Repairs and maintenance, bookkeeping, attending meetings. Full time is 8 hours/day.

Full-Time	Part Time	
	No of Persons	Full Time Equivalent

Unpaid…

6. Please estimate the **number of days** in 2020 that were spent on Scallop fishing activities by people who were **not paid a wage** (assuming an average of 8 hours per business day).

	Fishing (boat time) (days)	Repairs & Maintenance (days)	Management & Admin (days)
You			
Family (unpaid)			
Other unpaid labour			

PART C – QUOTA SFRs

Quota SFRs – number owned and value…

7. How many commercial scallop quota SFRs do you own, and what is your estimate of their value?

	31 December 2020
Total number of quota SFRs owned	
Value of SFR ($)	

Quota SFRs – number leased and price…

8. How many units of Scallop quota statutory fishing rights (SFRs) did you lease (in or out) for the three years 2018 to 2020? Please include the average price you paid/received for each category of leased quota SFRs.

	2018		2019		2020	
	Quota SFRs (no.)	Average price ($/SFR)	Quota SFRs (no.)	Average price ($/SFR)	Quota SFRs (no.)	Average price ($/SFR)
Leased out						
Leased in						

PART D – CAPITAL

11. In the following sections, please describe the boat(s) that you operated in the Scallop fishery in 2020.
    - If exact figures are not available, please provide careful estimates.
    - **Age** may be an average.
    - **Current value** is the value that you imagine someone may pay to buy it from you.
    - **Replacement value** is the cost of replacing it 'for new' today, excluding GST.

BOAT 1

Length (m): ___________

Engine power (total HP): _________

Percentage used in Scallop fishery (based on number of days fished): ______%

Hull:	Age:_____	Current value: $___________	Replacement value: $___________
Engine:	Age:_____	Current value: $___________	Replacement value: $___________
Gear:	Age:_____	Current value: $___________	Replacement value: $___________
Electronics:	Age:_____	Current value: $___________	Replacement value: $___________

BOAT 2

Length (m): ___________

Engine power (total HP): _________

Percentage used in Scallop fishery (based on number of days fished): ______%

Hull:	Age:_____	Current value: $___________	Replacement value: $___________
Engine:	Age:_____	Current value: $___________	Replacement value: $___________
Gear:	Age:_____	Current value: $___________	Replacement value: $___________
Electronics:	Age:_____	Current value: $___________	Replacement value: $___________

12. Please estimate the average age, current value and replacement cost of all non-boat capital in your Bass Strait Scallop business (i.e. everything not included above). Please also estimate the percentage of your capital used for your business:

Item	**Average age (years)**	**Current Value ($)**	**Replacement value ($)**	**Percent of capital used for Scallop fishery (%)**
Buildings				
Motor Vehicles				
Other (specify): ______________				
Other (specify): ______________				
Other (specify): ______________				

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PART E – UNEXPECTED EVENTS OF 2020 AND THEIR EFFECTS

The purpose of this questions is to find out how your fishing business was impacted by the unexpected and unusual events that occurred during 2020 (that is, up to 31 December 2020), such as bush fires, COVID-19 and access to international markets. Please provide your best estimate of the effect these combined events have had on your business compared to a 'normal' year.

1. For each of the following items, please estimate the impact that the unexpected and unusual events had on your business across the whole of 2020.

	The events decreased this by…						No Effect	The events increased this by…						More than 100% (specify)	Unsure
	100%	80%	60%	40%	20%	10%		10%	20%	40%	60%	80%	100%		
Price received for products	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	__%	☐
Volume of catch	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	__%	☐
Business revenue	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	__%	☐
Cost of a day of fishing (wages only)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	__%	☐
Cost of a day of fishing (non-wage costs)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	__%	☐

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PART G – FURTHER COMMENTS

Please provide any additional comments.

Thank you for completing this survey.