Informing the structural reform of South Australia's Marine Scalefish Fishery

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Abbreviations

Acronym	Meaning
B_{msy}	Biomass corresponding to MSY
CBA	Cost benefit analysis
CMSFRAC	Commercial Marine Scalefish Fishery Reform Advisory Committee
cMSY	catch MSY model
CPH	Census of population and housing
CPUE	Catch per unit effort
ESD	Ecological sustainable development
GSP	Gross state product
GST	Goods and services tax
GSV	Gulf St Vincent
GSV/KI	Gulf St Vincent & Kangaroo Island fishing zone
GSVS	Gulf St Vincent stock
GVP	Gross value of production
H	Harvest fraction
H_{msy}	Harvest fraction corresponding to MSY
IAAP	Independent allocation advisory panel
ITE	Individual transferable effort
ITQ	Individual transferable quota
KI	Kangaroo Island
LCF	Lakes and Coorong Fishery
MAC	Management Advisory Committee
MCDA	Multi-criteria decision analysis
MFA	Marine Fishers Association
MFAs	Marine fishing areas
MSF	Marine Scalefish Fishery
MSFMAC	Marine Scalefish Fishery Management Advisory Committee
MSY	Maximum sustainable yield
NER	Net economic return
NGSV	Northern Gulf St Vincent
NSG	Northern Spencer Gulf
PIIMS	Primary industries information management system
RBC	Recommended biological catch
RTRWG	Red tape reduction working group
RWS	Regional wellbeing survey
SA	South Australia
SE	South East
SG	Spencer Gulf
SGSV	Southern Gulf St Vincent
SRWG	Strategic review working group
SSG	Southern Spencer Gulf
TAC	Total allowable catch
TACC	Total allowable commercial catch
TACE	Total allowable commercial effort
TAE	Total allowable effort

TARC	Total allowable recreational catch
TVC	Total variable costs
VLSP	Voluntary licence surrender program
WA	Western Australia
WC	West coast
WV	Western Victoria

Executive Summary

Overview

This study was undertaken by the South Australia Research and Development Institute (SARDI) in collaboration with PIRSA Fisheries and Aquaculture, BDO EconSearch, the Marine Fishers Association (MFA), Fishwell Consulting and University of Canberra. This project guided the reform of South Australia's commercial Marine Scalefish Fishery (MSF) by providing scientific advice and analyses to underpin its implementation. The MSF is a multi-sector, multi-gear and multi-species fishery, making any management reform a complex and difficult process. Both the sustainability of key stocks and commercial fishery's economic performance have been deteriorating over a 20-year period; significantly influenced by fishery overcapitalisation. Simply put, there were too many fishers and not enough fish to support a vibrant and sustainable commercial fishery. This was addressed through the three 'pillars' of the reform: regionalisation, unitisation and rationalisation. These pillars were reflected in the reform with: 1) the creation of four new zones of management; 2) implementation of individual transferable quotas (ITQs) for appropriate 'Tier 1' stocks; and 3) rationalisation of the commercial MSF fleet by removing one third of licences through a voluntary licence surrender program (VLSP). These pillars were supported by research on the biological, economic and social carrying capacity of the fishery. The reform was implemented on 1 July 2021 resulting in a fishery that has regional management with appropriate output controls and a reduced fleet size.

Background

Overcapitalisation and stock depletion have been long-term concerns for the MSF. Over the past 30 years, several attempts have been made to rein back fishing pressure that originated from the fishery's initial open access. This occurred through management interventions that included amalgamating licences, gear restrictions, licensing conditions, spatial and temporal closures, trip catch limits and fish size limits. However, these strategies, while necessary, have generally been ineffective because fish stocks have continued to be over-exploited through progressively increasing fishing efficiency, advancing technology, excess commercial sector capacity, and increasing recreational catch and effort.

More than 60 species can be harvested by the MSF but four primary species account for the majority of the fishery's targeted catch and effort at the State-wide level. These are Snapper (*Chrysophrys auratus*), Southern Garfish (*Hyporhamphus melanchir*), King George Whiting (*Sillaginodes punctatus*) and Southern Calamari (*Sepioteuthis australis*). Except for Southern Calamari, over the past decade, these species have had sustainability concerns and currently one Southern Garfish stock and two Snapper stocks are classified as 'depleted'. In 2019 Snapper fishing was closed in all State waters except for the south east region. These poor stock statuses have occurred despite numerous management interventions using input controls such as trip limits, gear restrictions, and seasonal and spatial closures.

Poor stock status has also led to deteriorating fishery economics and as a result, many fishing businesses have not been profitable. All indicators of fishing profitability—including such measures as boat cash income and rate of return on total capital—are the lowest of all South Australian commercial fisheries. The MSF has not generated any economic rent since economic indicators were first measured by PIRSA in 1998/99, with a calculated value of -$0.6 million in 2019/20. This has occurred as operating costs have increased while fishery production has been declining, partly due to stock depletion.

The need for reform was industry-initiated through a strategic review that commenced in 2014 through a Working Group within the former South Australian Fisheries Council. This Working Group reviewed the management tools in the commercial MSF and recommended strategic options to improve long-term management of the fishery. This review broadly concluded that the management arrangements were complex, inefficient, and ineffectively controlled fishing effort and catch of key species. There was broad recognition within the commercial sector that the structure and management framework of the MSF needed reform in order to ensure the long-term sustainability and economic viability of the fishery.

The Government of South Australia committed to investigate and implement key reforms in the commercial MSF to unlock the industry's potential and provide long-term sustainability. A Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) was established in November 2018 to provide advice to Government on the development of a reform package and new management framework. On 8 May 2020, a $24.5 million MSF reform package was announced by the State Government to increase the profitability of fishing businesses and grow sustainable fish populations. The majority of this package was designated for the voluntary licence surrender program (VLSP) to directly address fishery overcapacity by removing between 100 to 150 MSF licences.

Aims/objectives

1. To review the structure and function of multi-species, multi-gear fisheries around the world.
2. To disentangle the complexities of the South Australian commercial Marine Scalefish Fishery (MSF) to describe the long-term spatio-temporal trends in the composition, dynamics, and socio-economic performance of the fishing fleet.
3. To evaluate the possible strategic management options such as regionalisation, licencing, ITQs and ITEs on the future structure and viability of the MSF.
4. To determine the biological, economic, and social 'carrying capacity' of the MSF across key regions of the fishery.

Regionalisation

Four new zones of management were formed for the MSF: West Coast (WC), Spencer Gulf (SG), Gulf St Vincent and Kangaroo Island (GSV/KI), and South East (SE). These zones were determined based on the stock structure and boundaries of key species across SA and by defining the footprint of fishing activity and fleet dynamics of MSF licence holders. Several species have multiple stocks across SA which predominantly occur within Spencer Gulf and Gulf St Vincent. As a result, each of these regions required clearly defined zones for management and stock assessment processes. Similarly, several species had distinct stocks or distributions associated with areas located to the west and east of the two gulfs, leading to the creation of the WC and SE zones, respectively. The boundaries of these four zones were determined by analysing historical catch and effort data across different spatial scales and identifying zone boundaries that minimised displacement of fishing effort for MSF licence holders. Three of the resulting zones accounted for more than 95% of the spatial effort of fishers that operated in that zone (i.e., 95% of fishing in SG was undertaken by licence holders from SG). The South East zone was the only exception, where approximately 50% of the effort in this zone originated from GSV/KI fishers from Fleurieu peninsula.

Unitisation

The creation of four new zones of management posed a complication for the MSF due to the number of species that require assessment. Approximately twenty species are regularly assessed in the fishery, leading to up to 80 assessments being required at the zonal level. This would have required more resources to assess and manage than are available. This was addressed by developing a "tiered" management framework (TMF) that assigns each stock to one of three management and assessment tiers:

- Tier 1 stocks – managed via a total allowable commercial catch (TACC) which was unitised via ITQs for appropriate stocks.
- Tier 2 stocks – managed without TACCs but require estimates of recommended biological catches (RBCs) to determine whether levels of exploitation are appropriate.
- Tier 3 stocks – assessed using fishery dependent performance indicators.

The TMF included indicators for stock status, management need, level of targeting, and commercial, recreational and Aboriginal/Traditional importance. The Aboriginal/Traditional importance indicator aspect of the project could not be completed due to the COVID-19 pandemic and risk of infection preventing appropriate and meaningful discussions with coastal Indigenous communities. Thus, further discussions and research are required to understand the importance of different fish species to Aboriginal/Traditional communities across SA for sustenance, social/cultural reasons and general management of Sea Country.

Although difficult to integrate in multi-species fisheries, individual transferable quotas (ITQs) were determined to be the most appropriate management measure for the MSF, particularly because units of effort differ across the fishery depending on fishing methods and activities. For example, fishers catch multiple species in a single day of fishing effort, meaning that stock-specific management could not be applied using effort-based units. On the other hand, ITQs allow catch limits to be imposed only when required, directly addressing stock management needs on an individual basis.

The TACCs for each stock first required a recommended biological catch (RBC) that could be apportioned between sectors. These TACCs were determined for Tier 1 stocks in a stepwise approach. Initially, stock assessment models for Southern Garfish, Snapper and King George Whiting were used to determine the RBC for a stock, based on recent estimates of biomass and the target harvest fractions (exploitation rates) listed in the management plan. These RBCs were then used to determine proposed TACCs for Tier 1 stocks by apportioning them based on commercial catch shares at the zone level. For stocks that do not yet have stock assessment models (i.e., Southern Calamari and all Tier 2 stocks), catch MSY (cMSY) models were used to provide preliminary RBCs. The assumptions of cMSY models were only met for two Tier 2 stocks (Blue Crabs in the WC and Yellowfin Whiting in SG) and were not appropriate for the remaining stocks that they were applied to. Therefore, the results of these cMSY models were not provided for management advice. Preliminary levels of appropriate commercial catches for these stocks were determined from estimates of recent annual commercial catches. This highlights that more sophisticated models are required to appropriately assess several important MSF stocks.

Rationalisation

Prior to the development of the VLSP, the financial benefits of rationalisation were examined through a cost benefit analysis (CBA) with three options considered:

- Base Case: No further fishery input control measures, stocks continue to decline.
- Option 1: Ongoing fishery input control measures and no buyout of licences, stocks continue to decline but at a slower rate than under the base case.
- Option 2: Effective catch control and stock recovery including a buyout of licences and introduction of ITQs.

With respect to the commercial sector of the fishery, both Options 1 and 2 were preferable to the Base Case with Option 2 generating the largest net economic return (NER) of $51.4 million over 20 years. Option 2 was also estimated to produce an additional gross state product (GSP) of $277 million above the Base Case over the 20-year period, demonstrating the value that fleet rationalisation would provide to the MSF.

A subsequent economic analysis determined that the State-wide carrying capacity of the MSF was between 107 and 196 commercial licences, depending on the performance of remaining businesses following the VLSP. At the commencement of this project, 307 licences remained in the fishery. Therefore, a target of 150 licence surrenders was set for the VLSP. At the completion of the VLSP, 100 licences had been surrendered. The fishing statistics of the surrendered licence holders demonstrated that most fishers that left the MSF contributed very little to the overall fishery production of the Tier 1 stocks and primarily represented poorer performing businesses. Therefore, many of the fishers that remain in the fishery following the reform are the fishery's more successful operators, who have the greatest chance of adapting their operations to run successful and profitable fishing businesses.

Implications

There are four main outcomes of the MSF reform that were based on the scientific input from this project:

1. Four new zones of management were established across South Australia

2. A Tiered Management Framework was developed to classify stocks to tiers of management based on several biological, management and sectoral indicators.
3. ITQ-based management was implemented for ten Tier 1 stocks.
4. One hundred licences were removed from the fishery through a VLSP.

Keywords

Fishery reform, unitisation, regionalisation, rationalisation, tiered management, South Australia, Marine Scalefish Fishery.

1 Background

1.1 The Need for Reform

At the initiation of this project, overcapitalisation and stock depletion had become a feature of South Australia's Marine Scalefish Fishery (MSF), largely a legacy of the fishery's initial open access. Fisheries managers have attempted to rein back existing fishing pressure over the past 30 years through considerable management interventions including limiting entry, restructures, amalgamating licences, gear restrictions, trip limits, spatial and temporal closures, and size limits. In many ways, the outcomes of these management strategies have not met their initial level of expectation because fishery production continued to decline, fishing efficiency increased, and excess capacity remains. This led to a situation where there were simply too many fishers and not enough fish to sustain a vibrant and profitable industry.

The MSF was South Australia's first commercial fishery, having evolved from the collective knowledge and expertise of the early settlers, who had migrated from a diversity of European countries that had strong fishing industries. From its humble beginnings in the 19th Century, the MSF is now the State's most complex commercial fishery with the highest number of operators. The resource is also shared with an active recreational fishing sector and is culturally significant to the State's Indigenous communities.

The MSF is a multi-species, multi-gear, multi-sector fishery. It currently has a gross value of production (GVP) of $19.1 million (BDO Econsearch 2022), directly employs more than 250 people but involves a largely ageing workforce. Commercial fishers are permitted to take more than 60 marine species that include scalefish, molluscs, crustaceans, annelid worms and sharks. Fishery production is mainly comprised of traditional scalefish species, in particular King George Whiting (*Sillaginodes punctatus*), Snapper (*Chyrsophrys auratus*), Southern Garfish (*Hyporhamphus melanochir*), Southern Calamari (*Sepioteuthis australis*) and Yellowfin Whiting (*Sillago schomburgkii*). Other species such as Australian Herring (*Arripis georgianus*), Sand Crabs (*Ovalipes australiensis*), Blue Swimmer Crab (*Portunus armatus*), Western Australian Salmon (*Arripis truttaceus*) and Leatherjackets (Family Monacanthidae) are also important.

There are 30 types of fishing gear (or devices) permitted for use in the fishery, but their use differs, depending on the location of fishing and the types of species being targeted. With the exception of fishing rods and handlines, all devices must be registered on a licence before they can be used to take fish for trade or business. These devices include longlines, squid jigs, octopus pots, razorfish tongs, bait pumps, and fish traps. A number of licence holders have specific net endorsements and are permitted to use hauling nets and set/gill nets to target certain species.

At the start of this project the MSF involved 307 licences. Approximately 80% of MSF licence holders actively fish and, of these, approximately two-thirds (63%) are considered part-time operators. Thus, there is considerable "latent effort" within the fishery. Most of the State's MSF catch is landed by a small proportion of efficient, 'full-time', fishers. There is also some level of access to MSF species by licence holders from other fisheries including Northern and Southern Zone Rock Lobster fisheries, Lakes and Coorong Fishery, three prawn fisheries, Blue Crab Fishery, and the Miscellaneous Fishery. Access varies from the ability to retain some species as a by-product (prawn fisheries), or for bait-only purposes (Blue Crab Fishery), to targeting species within spatially restricted areas (Lakes and Coorong) and relatively open access (rock lobster fisheries).

The mixture of participants, fishing devices, licence conditions and regulations associated with the MSF, makes the task of managing the level of exploitation of key fish species extremely challenging. This is further compounded by the highly dynamic nature of the commercial fishers who can switch their fishing activity between species and fish throughout State waters. The complex nature of this fishery means that there has always been considerable capacity for it to expand through the realisation of latent effort.

In recent years, the need for reform has been driven by an industry-initiated strategic review that commenced in 2014 with the establishment of a Working Group by the former South Australian Fisheries Council. The terms of reference for the Working Group were to review the overarching structures and management tools in the MSF and to recommend strategic options to improve the long-term management of the fishery. This review broadly concluded that the management arrangements were complex, inefficient, and ineffective in controlling fishing effort and catch of key species (MSF SRWG 2016). There was recognition within the commercial sector that the management of the MSF needed to be reformed and restructured in order to ensure its long-term sustainability and economic viability.

In summary, the review identified the following issues facing the industry:

- Excess fishing capacity - too many fishing licences to manage the fishery in a sustainable and economically viable way;
- A highly dynamic fishing fleet - excess latent and active fishing effort, and effort shifting amongst species and regions;
- Constant adjustment to management arrangements to meet sustainability objectives – usually achieved through controls on fishing effort;
- Reactive regulatory adjustments that create uncertainty for fishers in the long-term direction of the fishery, and a cumbersome and complicated regulatory system;
- Restrictions on fishing effort generally resulting in less efficient operators and poor profitability and economic returns; and,
- Increased conflict both within and between the commercial and recreational sectors.

An investment warning was sent to licence holders in December 2017 to advise them of a potential fishery reform and its implications[1].

1.2 Status of Fish Stocks

Although more than 60 species can be harvested within the MSF, four primary species (King George Whiting, Snapper, Southern Garfish, and Southern Calamari) have collectively accounted for more than half of the State-wide total commercial catch over the history of the fishery. Previous stock assessments for King George Whiting, Southern Garfish and Snapper have identified concern regarding the sustainability of some stocks. Consequently, levels of fishing effort and catches for these species have been restricted through a variety of management approaches, that have included spatial closures, closed seasons, netting restrictions, and catch limits.

The current assessment of South Australia's MSF considers 20 species (Drew *et al.* 2021). Collectively, these species were considered across 30 management units (i.e., biological stock or jurisdiction), at a resolution that aligned with either the biological stock, or jurisdictional level. Of these, 23 management units (77%) were classified as 'sustainable', three (10%) were classified as 'depleted', one (3%) was classified as 'recovering', one was classified as 'depleting' and the remaining three (10%) were classified as 'undefined' because there was insufficient information to assign a stock status.

Declines in the fishery productivity of the premium finfish species have contributed to the diversification of the MSF fishing fleet, with many fishers switching their effort from Snapper, King George Whiting and Southern Garfish towards species such as Southern Calamari and Yellowfin Whiting. These changes have most likely been financially driven, when it has become more cost-effective to target these species based on their relative abundance, catchability, low fishing set-up costs and increasing market value. Although the capacity of the

[1] https://pir.sa.gov.au/__data/assets/pdf_file/0011/308981/Notice_to_Fishers-_MSF_Investment_Warning.pdf

fishing fleet to adjust their target fishing species provides considerable flexibility and opportunities, there is a high likelihood that increased fishing pressure on these secondary species may create additional sustainability issues.

Throughout the history of the fishery there have been periods of increased fishing activity for other secondary and tertiary species, such as Ocean Jackets, Western Australian Salmon and Australian Herring which highlights the dynamic capacity of the MSF fishing fleet. Given the declining fishing activity observed for some of the primary species, current fishers may have greater incentive to target a broader diversity of 'under-utilised' species and to synchronise their fishing activity to the species' patterns of seasonal abundance. Spreading fishing effort more broadly across a range of species may contribute to alleviating fishing pressure on the susceptible target species.

1.3 Economic and Social Indicators

In retrospect, too many commercial licences were issued during the early stages of development of the MSF, when fishing technology levels and catching capacity of the fleet were relatively low. After the introduction of limited entry licensing during the 1970s, catching capacity and effectiveness of the fishing fleet have been constantly improving through technological advancements in vessels, electronics and improved fisher knowledge and experience.

Since 1998/99, the total GVP for the MSF has followed a decreasing trend, principally due to a reduction in total commercial catch, from approximately 5,000 tonnes to a current catch of approximately 2,000 tonnes. Over this period, increases in the average costs of catching fish (83% in real terms) has outstripped the average price paid for fish (63% in real terms) (BDO EconSearch 2019). All indicators of fishing profitability—including such measures as boat cash income and rate of return on total capital—are the lowest of all South Australian commercial fisheries. The MSF has not generated any economic rent since economic indicators were first measured by PIRSA in 1998/99, with a calculated value of -$1 million in 2019/20 (BDO EconSearch 2022). However, it should be noted that estimated economic rent has improved progressively from as low as -$13 million in 1999/00, with much of the improvement related to a 50% reduction in the number of licences achieved principally through the licence amalgamation scheme that was adopted in 1994 (Steer & Besley, 2016).

Commercial fishers across Australia – both offshore and onshore – have higher than average levels of psychological distress: in 2018, 22.9% had high psychological distress, compared to 11.7% of Australian adults more generally (King et al. 2021). The key factors found to be contributing to this high level were a combination of 'modern uncertainties' and 'traditional risks'. Modern uncertainties were commonly driven by regulatory conditions in the fishery, with challenges of complex regulation, changes to regulation, and uncertainty about security of future access to fish stocks, all contributing. Traditional risks include variable weather, lack of social contact due to work hours, risk of work injury, and fluctuating market conditions (King et al. 2021). In King et al.'s study, 10% of the sample was South Australia, with many MSF fishers likely to have participated. The social analysis presented in this report suggests that a significant proportion of MSF licence holders experience a high degree of uncertainty, and that work satisfaction has declined for many, as has confidence in future of the fishery. The top sources of stress were related to uncertainty about future in the fishing industry, changes to government regulations particularly relating to the security of access to fishing, and the high level of 'red tape' and complex regulations. Negative media and poor public image were also identified to compound stress levels. In contrast, factors such as isolation, physical danger of fishing, climate change, and succession were not perceived to be associated with stress. While not all licence holders report these experiences, a significant proportion do.

Whilst this situation represents a sub-optimal use of the State's naturally renewable and publicly owned fisheries resources, if the necessary management reforms are introduced and key fish stocks recover to deliver long-term fish stock sustainability, the increased production and yield from these important fish stocks will translate into increased value generated by the fishery that will flow on through the regional and State economies. This will provide benefits for all South Australians for years to come. In addition, these positive outcomes will translate into improved business opportunities for commercial fishers and seafood processors and regional tourism opportunities for South Australian's linked to recreational and charter fishing activities.

1.4 Sharing the Resource

The MSF is a community shared resource, that includes commercial, recreational and Aboriginal/Traditional stakeholders.

Aboriginals have inhabited coastal South Australia for more than 40,000 years. Over the millennia, these inhabitants used a variety of techniques and tools (e.g., mesh nets, woven fish traps, spears, fire, rock traps and canoes) to catch crustaceans, shellfish, fish, mammals (including seals) and sea birds. But the value of Sea Country to Aboriginal peoples is far more than simply access to marine, intertidal and estuarine resources for subsistence; it has value both culturally or spiritually, and includes all living things, beliefs, values, creation spirits and cultural obligations connected to that area. These values vary between the different coastal Aboriginal communities, which includes from west to east the Mirning, Wirangu, Nawu, Banggarla, Nukunu, Narungga, Kaurna, Peramangk, Ngarrindjeri, and Baundig tribal or First Nation groups as represented by the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS). A good example of these values is provided in the Narungga Nation Traditional Fishing Agreement (PIRSA 2021). Aside from the coastal Aboriginal groups, it should be recognised that there is evidence of trading marine resources inland, and that "desert" people also have a connection to coast through cultural, social and economic exchange (Smyth *et al*., 2018[2]).

Most recreational fishing effort occurs in marine waters, including estuaries, with fishers permitted to use a variety of gear types. Given the shared nature of the fishery, the reform of the commercial MSF cannot occur in isolation and will need to consider other stakeholder groups. In 2013/14, the recreational fishery was estimated to have approximately 277,000 participants (Giri and Hall 2015). Prior to this, recreational fishing surveys were undertaken in 2000/01 (Jones and Doonan 2005) and 2007/08 (Jones 2009). A current project, FRDC 2020/056 "Evaluation of a smart-phone application to collect recreational fishing catch estimates, including an assessment against an independent probability-based survey, using South Australia as a case study"[3], is investigating the application of smart phone apps for capturing recreational fishing data as part of the 2021/22 South Australian recreational fishing survey.

Unlike some other Australian fishing jurisdictions, South Australia is in a unique position in having a fisheries management policy (PIRSA 2011) that formally recognises the shared nature of the fishery through the allocation of resource shares for many species. The *Fisheries Management Act 2007* provides that a management plan must specify the share of the fishery to be allocated to each fishing sector. The Policy addresses the question of allocation and access to aquatic resources between extractive user groups, to include the commercial, recreational and Aboriginal/Traditional fishing sectors. Allocations were set based on the best available information in 2009 (PIRSA 2013). They were quantified for a range of species at the State level through analysis of catches. The sources of information included in the analysis were: the 2007/08 South Australian Recreational Fishing Survey (Jones 2009); the South Australian Charter Boat Fishery statistics (Knight 2010); and the SARDI Aquatic Sciences catch and effort database of licensed commercial fishers' logbook returns from 2007/08 (PIRSA 2013). If sectors are subsequently found to have exceeded their resource share, then management arrangements can be implemented to re-establish the original allocations.

[2] https://www.frdc.com.au/project/2015-205
[3] https://www.frdc.com.au/project/2020-056

1.5 Government Commitment

The Government of South Australia is committed to investigating and implementing key reforms in the commercial Marine Scalefish Fishery (MSF) to provide long-term sustainability whilst optimising the commercial industry's full potential. A Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) was established in November 2018 to provide advice to Government on the development of a reform package and new management framework. This committee liaised with an established Marine Fishers Association (MFA) Forum to seek industry input and feedback on reform options as they were developed. The committee also relied on the working group of this FRDC research project to provide technical support, analyse available information about the fishery, evaluate various reform options, and to provide scientific advice. The research direction and content of this report has essentially responded to the needs of the CMSFRAC.

1.6 Three Pillars of Reform

At the commencement of this project, there were too many fishers and not enough fish to support a sustainable fishery. Recognising their industry's need for reform, commercial fishers proposed three pillars (Fig. 1) to ensure the MSF transforms into a vibrant industry that sustainably harvests premium seafood:

1. REGIONALISE – Establish zones that recognise economic, ecological, and social diversity,
2. UNITISE – Determine sustainable catch limits for all who share the resource,
3. RATIONALISE – Improve the economic efficiency of the fishery by reducing capacity.

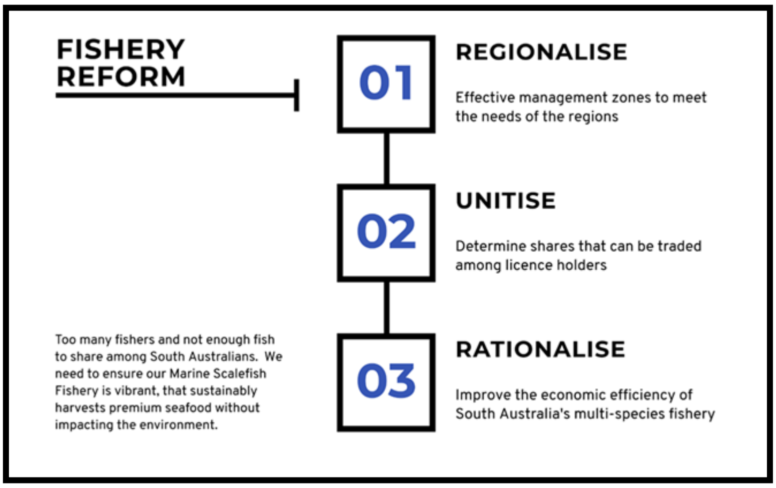

Figure 1. The three pillars of the MSF reform.

1.7 Reform Process

The MSF reform involved multiple steps and input from several stakeholder groups and committees throughout its implementation (Fig. 2). The Department of Primary Industries and Regions (PIRSA) implemented the reform based on the advice from the CMSFRAC and lately from the Marine Scalefish Fishery Management Advisory Committee (MSFMAC), which was preceded by the Snapper MAC. Once the recommendation to implement Individual Transferable Quotas (ITQs) was accepted, an Independent Allocation Advisory Panel (IAAP) provided advice on how ITQs could be allocated to licence holders. Throughout the reform process, there was a need to incorporate industry views and feedback, and underpin the reform with advice on biological, social and economic implications of the reform. Industry advice was provided through the MFA Forum, while the scientific advice was provided by this FRDC project and its associated working group.

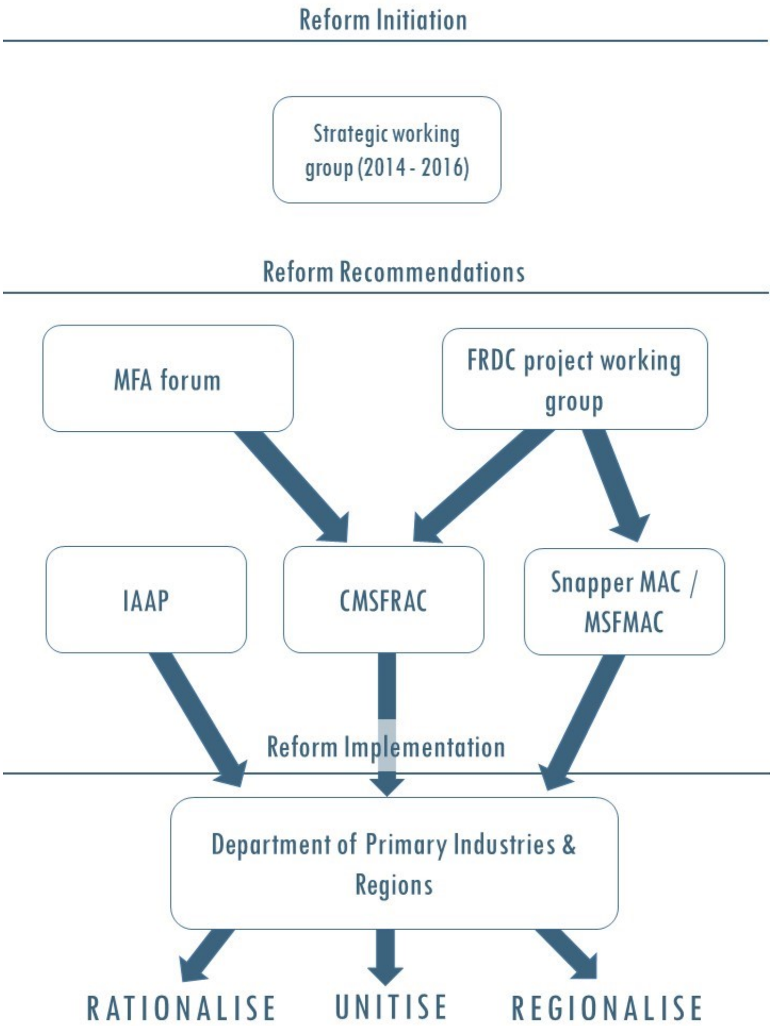

Figure 2. Schematic of the reform process of the MSF from its initiation to its implementation of the 'three pillars'.

1.8 Objectives

1. To review the structure and function of multi-species, multi-gear fisheries around the world.
2. To disentangle the complexities of the South Australian commercial Marine Scalefish Fishery (MSF) to describe the long-term spatio-temporal trends in the composition, dynamics, and socio-economic performance of the fishing fleet.
3. To evaluate the possible strategic management options such as regionalisation, licencing, ITQs and Individual Transferable Effort (ITE) on the future structure and viability of the MSF.
4. To determine the biological, economic, and social 'carrying capacity' of the MSF across key regions of the fishery.

1.9 Structure of the report

Stakeholder engagement throughout the reform has frequently referred to the three pillars of the reform (Fig. 1). Therefore, the chapters of this report have been structured around these pillars. This provides the best overview of this research and conforms with how the MSF reform has been communicated to licence holders, fishery managers and other key stakeholders.

2 Regionalise

2.1 Introduction

The process of fishery regionalisation, common practice throughout the world, is to determine regional boundaries that achieve sustainable and effective management of marine resources to provide substantial economic and social benefits for local communities. The configuration of the boundaries may align with either the biological stock structure of the targeted species, defined jurisdictional boundaries, practical management units, or a combination of these. However, delineating zones may have flow-on consequences that could negatively affect patterns of established fleet dynamics, displace licence holders, or impact regional communities. As such, regionalisation needs to be broadly considered with industry and relevant stakeholders through consultative processes.

Partitioning South Australia's MSF into management zones that recognise economic, ecological, and social diversity was a key pillar of the reform process. Delineating these zones represents an important first step as it forms the spatial basis for subsequent analysis and interrogation. In SA, the most comprehensive information available to help inform the regionalisation of the fishery relates to the population biology of the various species that comprise the fishery and the spatial extent of fishery operations by different gears obtained from logbook data. These initial analyses provide a foundation upon which further economic and social investigations can be made.

The geographic extent of a species can consist of multiple biological stocks. Biological stocks are relatively discrete populations of a fish species, with similar life history characteristics that are self-reproducing (Hilborn and Walters 1992). Different biological stocks may vary in abundance, growth and natural mortality rates, and may be influenced by contrasting environmental factors. Consequently, the amount of catch that can be sustainably harvested from one biological stock, may differ from another. From a fisheries management perspective, it is important to understand the stock structure of a species, along with its underlying population dynamics, to ensure that harvest rates do not compromise their ecological function and sustainability.

Genetically different populations are usually defined as different stocks, but a stock is not necessarily just a genetic construct. There is a suite of complementary techniques to discriminate stocks that can be made up of multiple sub-populations that comprise a stock-complex, with each having some definable attribute that may be of interest to fishery managers (Stephenson 1999). For example, a homogeneous genetic population may comprise multiple, self-replenishing, components of which some may be susceptible to overfishing and localised depletion. This is emphasised on the understanding that there only needs to be negligible intermixing to homogenise the genetic stock. Integrating a variety of stock discrimination techniques that cover multiple aspects of the fish's biology is likely to help disentangle population structure with a greater level of confidence. Stocks may be discriminated on the basis of different life-history characteristics (i.e., growth rates), movement and migration patterns, morphological variation, or bio-physiological processes. For those species where the biological stock structure remains unresolved, fisheries assessments default to either a 'management unit' or a jurisdictional level.

2.2 Establishing regions

2.2.1 Biological Stocks

An extensive literature review was undertaken to describe the biological stock structure of key MSF species. The current biological stock structure has been determined for a few of the key species targeted in South Australia's MSF (i.e., Snapper, Southern Garfish, Southern Calamari, Western Australian Salmon, Australian Herring) (Steer *et al.* 2018b). Some inferences have been made for other species based on our understanding of their biology and State-wide fishing activity patterns. Stock structures were spatially resolved to Marine Fishing Areas (MFAs).

2.2.1.1 Snapper *(Chrysophrys auratus)*

A recent study used a combination of population-based demographics and physical and chemical characteristics of Snapper otoliths to partition South Australian Snapper into three distinct stocks: the Spencer Gulf/West Coast Stock (SG/WC); the Gulf St. Vincent Stock (GSV); and the Western Victorian Stock (WV) (Fowler 2016) (Fig. 3). Each of these stocks is considered to be self-sustaining and dependent on a significant primary nursery area (Fowler 2016). The northern gulfs are the nursery areas for the SG/WC and GSV stocks, whereas the WV stock extends westward from Port Phillip Bay, Victoria into the south east region of South Australia (Fig. 3). The regional extent of these stocks depends on the emigration of sub-adult and adult fish. There appears to be minimal movement among regional sub-populations. Most recaptures in tagging studies have been within 20 km of the tag site (i.e., residents), relatively few adult Snapper moved distances that would justify them being recognised as 'migrants' (Jones 1981, 1984). However, these few migrants are likely to represent a proportion of the population that undergo considerable movement, such as that seen in the westward extension of the WV and SG/WC stock. This life history model is reflected in the population demography, as there are considerable differences in the size/age structures and growth trajectories among regional sub-populations (Fowler *et al.* 2013).

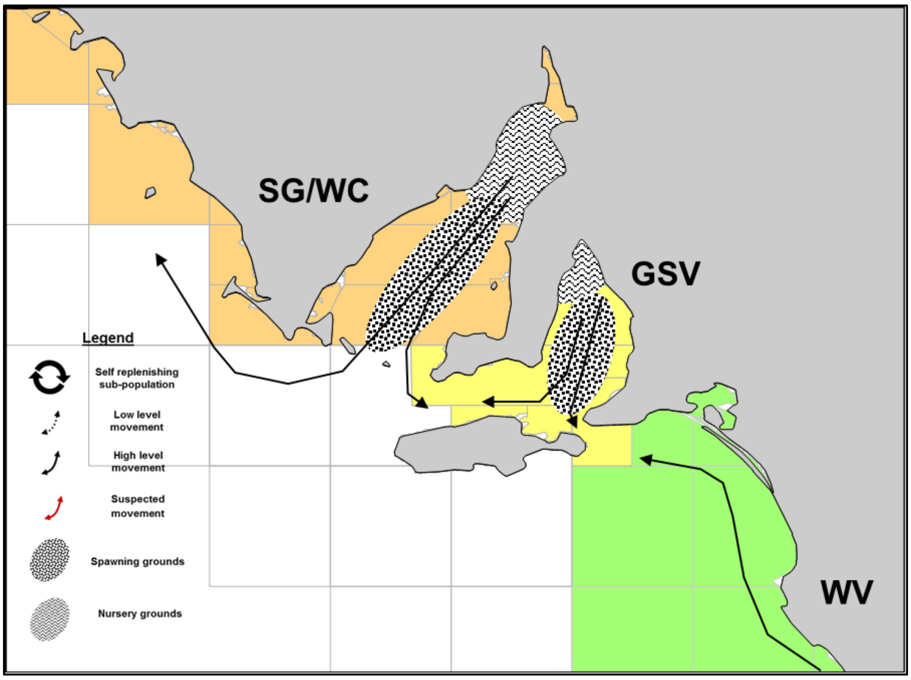

Figure 3. Conceptual biological stock structure for Snapper. Spencer Gulf/West Coast Stock (SG/WC), Gulf St. Vincent Stock (GSV), and Western Victorian Stock (WV).

2.2.1.2 King George Whiting *(Sillaginodes punctatus)*

The stock structure for King George Whiting (KGW) throughout its range in southern Australia remains unresolved due to uncertainty about the connectivity amongst regional populations and the lack of clear phylogeographic genetic structure (Haigh and Donnellan 2000). A recent genetic study indicated that the SA and Victorian populations were genetically similar but were distinct from those in Western Australia and Tasmania (Jenkins *et al.* 2016). The similar genotypes of the South Australian and Victorian populations are consistent with the results from hydrodynamic modelling and otolith chemistry analyses which indicate that the Victorian populations may be replenished from spawning grounds located in SA, through the eastward advection of eggs and larvae (Jenkins *et al.* 2000, 2016). This advection pathway has also been identified in a study that explored key source and sink populations in SA's southern gulfs (Drew *et al.* 2020[4]). The genetic homogeneity of the SA regional populations indicates that there must be at least a small degree of mixing between them. Nevertheless, for stock assessment and management purposes three stocks are recognised based largely on the locations of and connectivity between nursery areas and spawning grounds (Fig. 4; Fowler *et al.* 2000). These stocks are: west coast of Eyre Peninsula (WC); Spencer Gulf (SG); and Gulf St. Vincent / Kangaroo Island (GSV/KI) (Fowler and McGarvey 2000, Steer *et al.* 2018a).

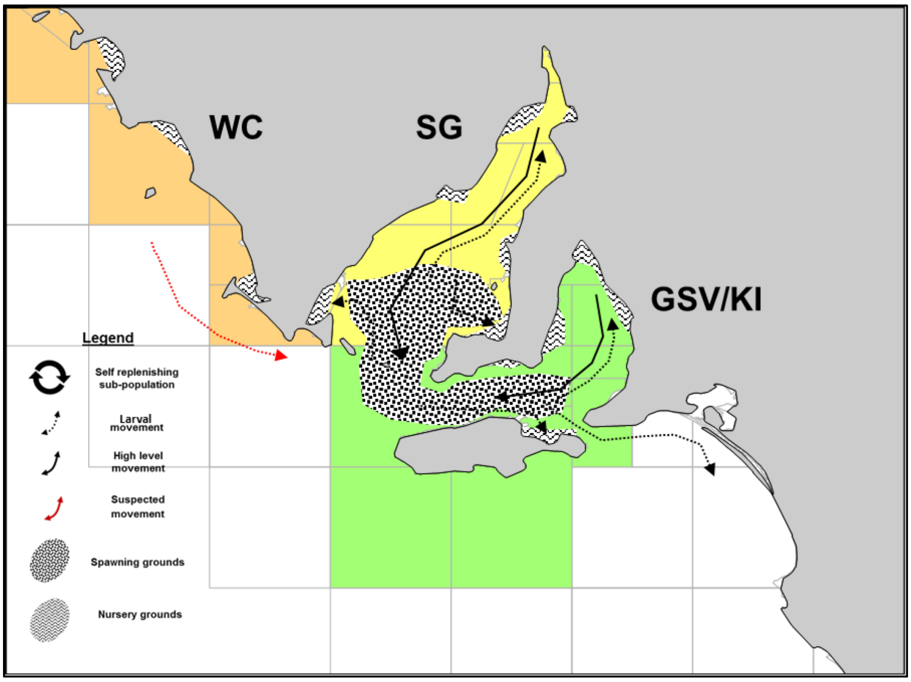

Figure 4. Conceptual biological stock structure for King George Whiting. West Coast Stock (WC), Spencer Gulf Stock (SG), and Gulf St. Vincent / Kangaroo Island Stock (GSV / KI).

2.2.1.3 Southern Garfish *(Hyporhamphus melanochir)*

In 2009, a study adopted a combined approach to delineate potential Southern Garfish sub-populations and determine the extent of mixing within South Australia's coastal waters, through the use of multiple otolith-based techniques (Steer *et al.* 2009a). Spatial differences in otolith chemistry (trace elements and stable isotopes) and morphometrics indicated that there were several groups of Southern Garfish that had spent significant parts of their lives in different environments and that there was some restriction that prevented complete mixing among the regions (Steer *et al.* 2009b, Steer *et al.* 2010; Steer and Fowler 2015). At least five regional divisions were identified. Three of these were clearly defined as they exhibited negligible levels of inter-regional mixing: the West Coast; Northern Spencer Gulf; and South-Western Spencer Gulf (Fig. 5). The remaining two, however, were less distinct: Northern Gulf St. Vincent and Southern Gulf St. Vincent but demonstrated a level of population structuring that would require them to be considered as separate from a precautionary management measure. A concurrent study that examined the spatial variation in parasite abundance in Southern Garfish inferred a similar population structure (Hutson *et al.* 2011). This level of

[4] https://www.frdc.com.au/project/2016-003

population structuring was sufficient to suggest that the historical management framework of two discrete, gulf-specific stocks should be restructured to align with these five smaller, semi-discrete, regional units. A South East biological stock was also assumed based on the level of population sub-structuring evident in the other regions.

Some level of inter-regional mixing must occur based on genetic homogeneity (Donnellan *et al.* 2002). Given the essentially coastal distribution of Southern Garfish and their close association with seagrass habitats, it is likely that gene flow occurs via a one-dimensional 'stepping stone' model in which neighbouring sub-populations exchange genes. The clear sub-division of Spencer Gulf into northern and south-western sub-populations and the fine-scale population structuring in Gulf St. Vincent suggests that there may be additional inter-connecting sub-populations within the gulfs that contribute to homogenising the genetic stock which were not detected in the multi-disciplinary study (Fig 5; Steer *et al.* 2009a). Genetic homogeneity over large scales such as GSV or SG can relate to the scale of larval advection even though adults move over much shorter distances (Fowler 2019[5]).

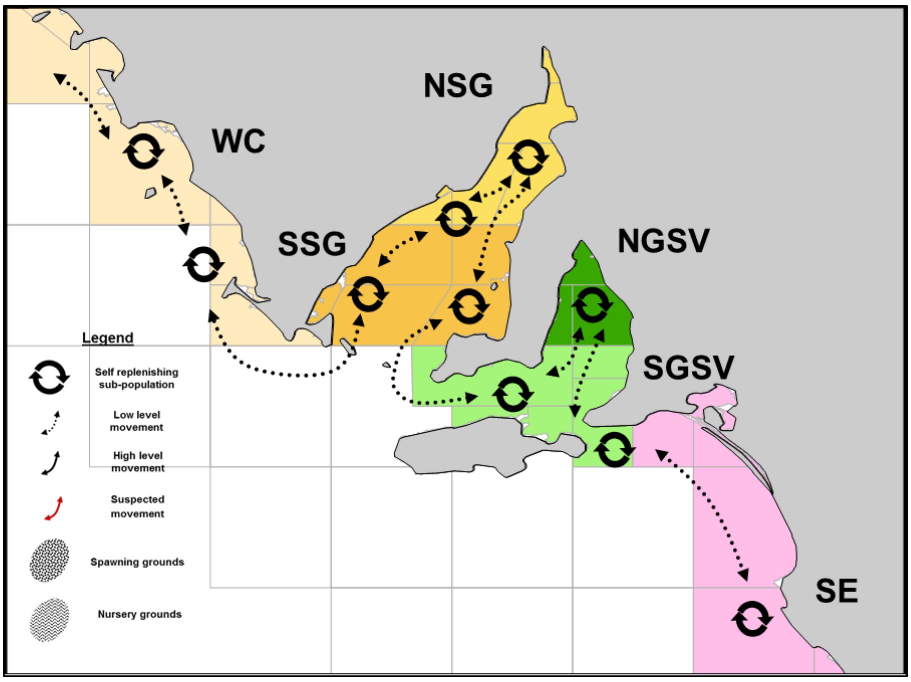

Figure 5. Conceptual biological stock structure for Southern Garfish. West Coast Stock (WC), Northern Spencer Gulf Stock (NSG), Southern Spencer Gulf Stock (SSG), Northern Gulf St. Vincent stock (NGSV), Southern Gulf St. Vincent Stock (SGSV), and South East Stock (SE).

2.2.1.4 Yellowfin Whiting *(Sillago schomburgkii)*

Fishery catches indicate that in SA, Yellowfin Whiting occur in highest abundances in the two northern regions of each gulf, with lower abundances in the southern gulfs and the west coast of Eyre Peninsula. Its life history appears adapted to habitation of relatively protected, shallow, near-shore waters. Adults are generally associated with shallow, tidal creeks and coastal sand flats, and are commonly found in waters of 1 – 10 m depth (Jones 1981). Spawning occurs during the summer months, and then between February and April, post-larvae are found along the shallow, protected, sandy beaches of the northern gulfs. Subsequently, juvenile fish occupy similar habitats as well as tidal creeks (Kailola *et al.* 1993, Ferguson 1999).

[5] https://www.frdc.com.au/project/2015-018

Based on the possible discontinuous distribution between South Australian and Western Australian populations, there is the possibility of separate stocks as well as genetic differentiation. However, even within South Australia, the oceanographic separation of the two gulfs during the spawning season in summer must considerably reduce the opportunity for mixing by egg and larval advection. As such, the populations in the two gulfs may constitute separate stocks (Fig. 6). This remains to be resolved.

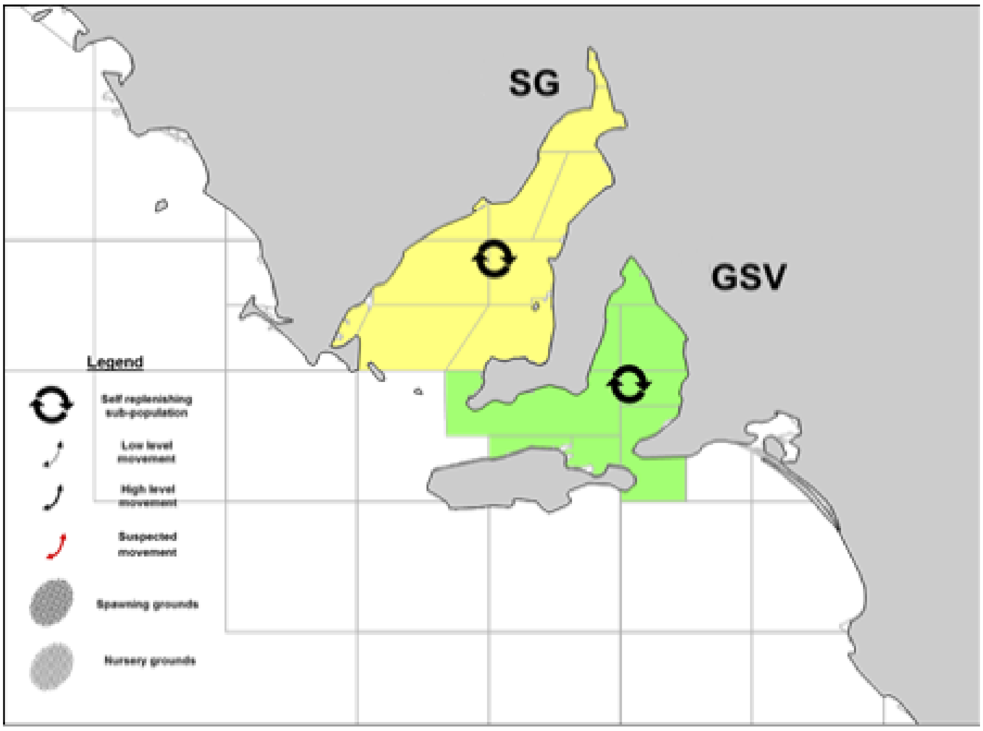

Figure 6. Conceptual biological stock structure for Yellowfin Whiting. Northern Spencer Gulf Stock (NSG) and Northern Gulf St. Vincent Stock (NGSV).

2.2.1.5 Southern Calamari *(Sepioteuthis australis)*

Southern Calamari is endemic to southern Australian and northern New Zealand waters. In southern Australia, it ranges from Dampier in Western Australia to Moreton Bay in Queensland, including Tasmania. It inhabits coastal waters and bays, usually in depths of less than 70 m (Winstanley *et al.* 1983). The biological stock structure across the distribution is complex and potentially dynamic. One study used allozyme markers to identify three genetic types with overlapping distributions and possible stocks off WA, SA, NSW and Tasmania (data are not available for Victoria) (Triantafillos 2004). In contrast, another study that used microsatellite markers found little genetic differentiation between seven study sites in WA, SA, Victoria and Tasmania (Smith *et al.* 2015). That study also identified Tasmania as a possible important site for gene flow. Life history dynamics, and studies of movement and statolith microchemistry in Tasmania also suggest some localised biological stock structuring (Pecl *et al.* 2011). Therefore, Southern Calamari in SA does not have separate stocks within the State (Fig. 7).

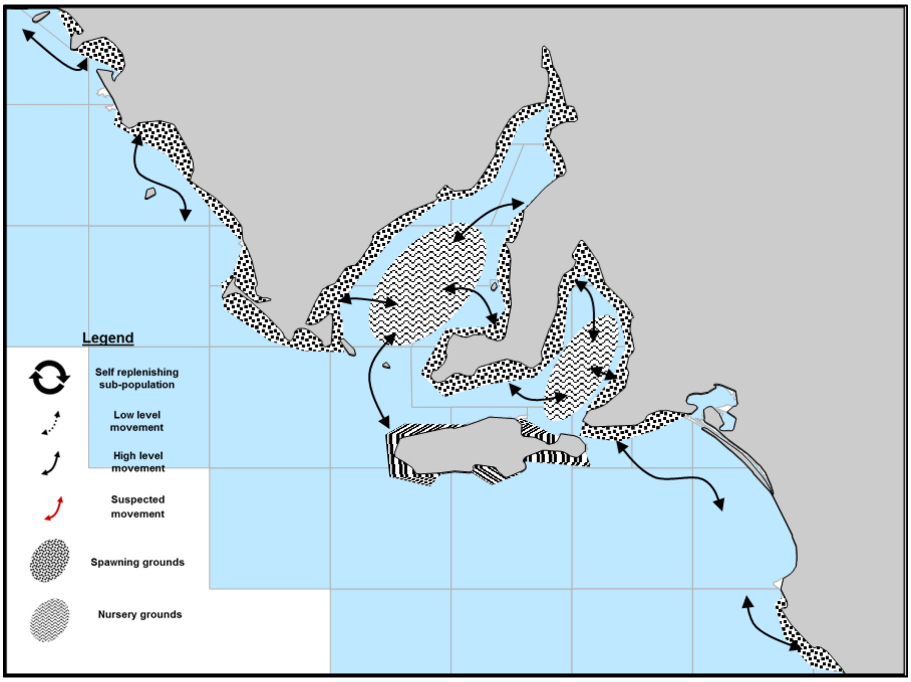

Figure 7. Conceptual biological stock structure for Southern Calamari, State-wide.

2.2.1.6 **Western Australian Salmon *(Arripis truttaceus)***

The biological stock of Western Australian Salmon extends from southern WA to the east coast of Tasmania (Cappo 1987; Jones and Westlake 2003). The fishery of each State jurisdiction harvests different life-history stages. The species intermixes with Eastern Australian Salmon (*Arripis trutta*) in eastern Victorian waters and around Tasmania. The Western Australian fishery typically targets mature spawning fish that aggregate around the south-western tip of the State, whereas the South Australian, Victorian and Tasmanian fisheries predominantly harvest juveniles and sub-adults in coastal waters as they migrate along the southern coast of Australia (Cappo 1987; Jones and Westlake 2003).

Spawning typically occurs in large schools in the coastal waters between Cape Leeuwin and Busselton, WA, during late autumn and early winter when the eastward flow of the Leeuwin current is strongest. The developing larvae settle along the entire southern coastline of Australia, with the main nursery grounds located along the south-eastern coast. Juvenile fish remain in coastal nursery areas for approximately three years where they feed on epibenthic crustaceans and small fish associated with seagrass beds (Hoedt and Dimmlich 1995). As they mature and begin to migrate back to the spawning grounds their diet shifts to small pelagic fish, predominantly Australian Sardines (*Sardinops sagax*). The biological stock exceeds the jurisdictional extent of SA (Fig. 8). A current FRDC project "Fisheries biology of Western Australian Salmon: improving our understanding of population dynamics in South Australia to enable quantitative stock assessments and improved fisheries management" (FRDC 2018/035[6]) will provide further information on stock structure.

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[6] https://www.frdc.com.au/project/2018-035

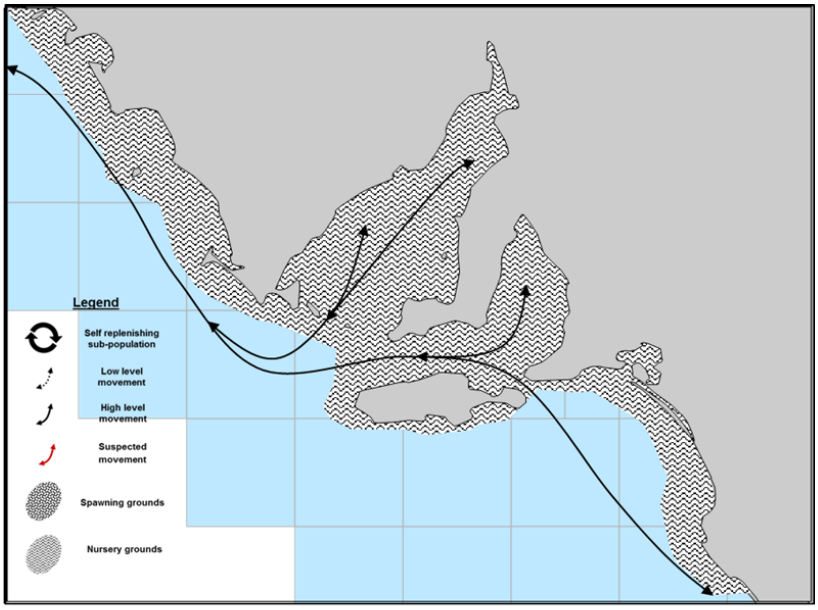


Figure 8. Conceptual State-wide biological stock structure for Western Australian Salmon.

2.2.1.7 Australian Herring *(Arripis georgiana)*

Australian Herring is an abundant pelagic fish species that occurs along the west and south coasts of Australia. They are distributed in coastal marine and estuarine waters between Shark Bay, WA, and Port Phillip Bay, Victoria, and are considered to constitute a single biological stock (Ayvazian *et al.* 2000). Australian Herring share a similar life-history to Western Australian Salmon whereby they spawn around reefs off the lower west coast of Australia from late May to early June and the developing eggs and larvae are advected eastwards. The extent of their distribution depends on the relative strength of the Leeuwin Current which transports warm tropical water along Australia's southern coastline. Juveniles settle in inshore waters throughout this eastward distribution, some in close proximity to the spawning grounds, whereas others extend as far as Victoria. The biological stock exceeds the jurisdictional extent of South Australia (Fig. 9). Juveniles prey upon small epibenthic crustaceans associated with shallow seagrass beds, and as they mature, switch their diet to include small fish, larger crustaceans and surface insects.

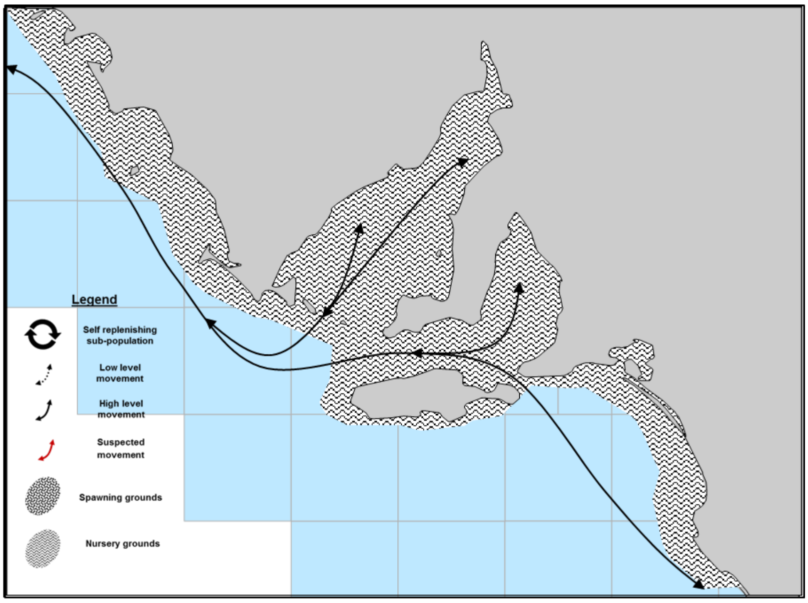


Figure 9. Conceptual State-wide biological stock structure for Australian Herring..

2.2.2 Fishery dynamics

2.2.2.1 Methods

2.2.2.1.1 Data Sources

South Australia's MSF is divided into 58 MFAs for the purpose of statistical reporting and monitoring of commercial fishing activity (Fig. 10). All licenced fishers are required to log their fishing activities, recording specific details such as MFA fished, number of fishers on board, species targeted, species caught, weight of catch, and method of capture. This level of detail was initially recorded on a monthly basis, but since 2003 fishers have been required to provide a daily log of fishing activity. These records are submitted monthly to SARDI where they are entered into a database that is routinely validated and cross-checked as per quality assurance protocols (Vainickis 2010). The current database is a compilation of catch and effort data collected from 1983/84 to the present (2019/20 at the time of this report). This is the primary source of data that are used for determination of stock status for MSF species (Drew et al 2021).

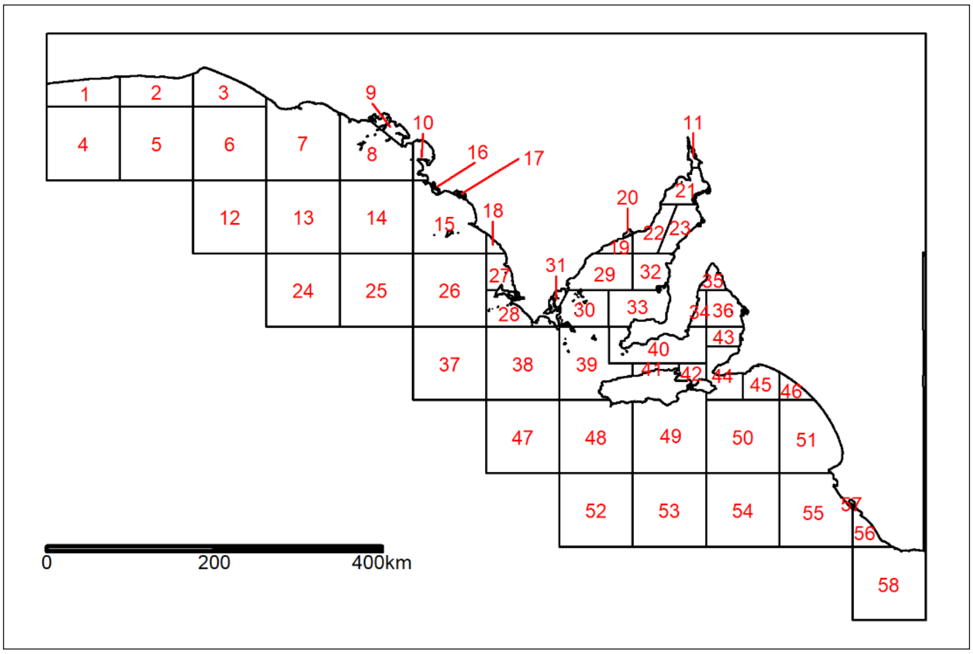


Figure 10. Marine Fishing Areas (MFAs) of South Australia's Marine Scalefish Fishery.

PIRSA's 'Primary Industries Information Management System' (PIIMS) which contains commercial licencing and leasing data was used to detail the composition of the fleet, including the types of licences; associated entitlements, conditions and gear endorsements; relative activity; and point value.

2.2.2.1.2 Analysis

The purpose of the 'Regionalise' pillar of the MSF reform was to determine new zones of management. This was achieved through a two-step process: 1) determining the number of regions required; followed by 2) refining the boundaries of regions to encapsulate the biological stocks of the key species and to differentiate regional fishery dynamics (e.g., catch, effort and species targeting). To undertake this, analyses examined regional species catch compositions by gradually dividing the MSF into an increasing number of regions. The purpose of this was to determine the minimum number of regions that would be required to effectively manage the fishery at a finer scale. Too few regions would result in broad management rules that may not meet the goal of improved local management, while too many regions would unnecessarily stretch assessment and management resources. Each regional option was based on the existing MFA blocks (Fig. 10), as zone boundaries that split existing blocks would prevent catch histories from those areas being assigned to the correct zone.

Once the appropriate number of regions was determined, further refinement of their boundaries was undertaken using the key target species stock structures (Figs. 3 to 9), examination of key ecosystem boundaries and identifying boundaries that minimised fisher displacement. Consideration of these factors resulted in the specific regional options that were included in stakeholder consultation with commercial MSF fishers.

2.2.2.2 Results

2.2.2.2.1 One zone – current MSF arrangements

The first scenario considered the entire State as a unique zone, which matched the biological stock structure of a few species like the Southern Calamari, Western Australian Salmon or Australian Herring. The species that accounted for most of the catch over the last 10 years (2010/11 – 2019/20) were the current primary species in the MSF: Snapper, Southern Calamari, King George Whiting and Southern Garfish, as well as Western Australian Salmon (Fig. 11).

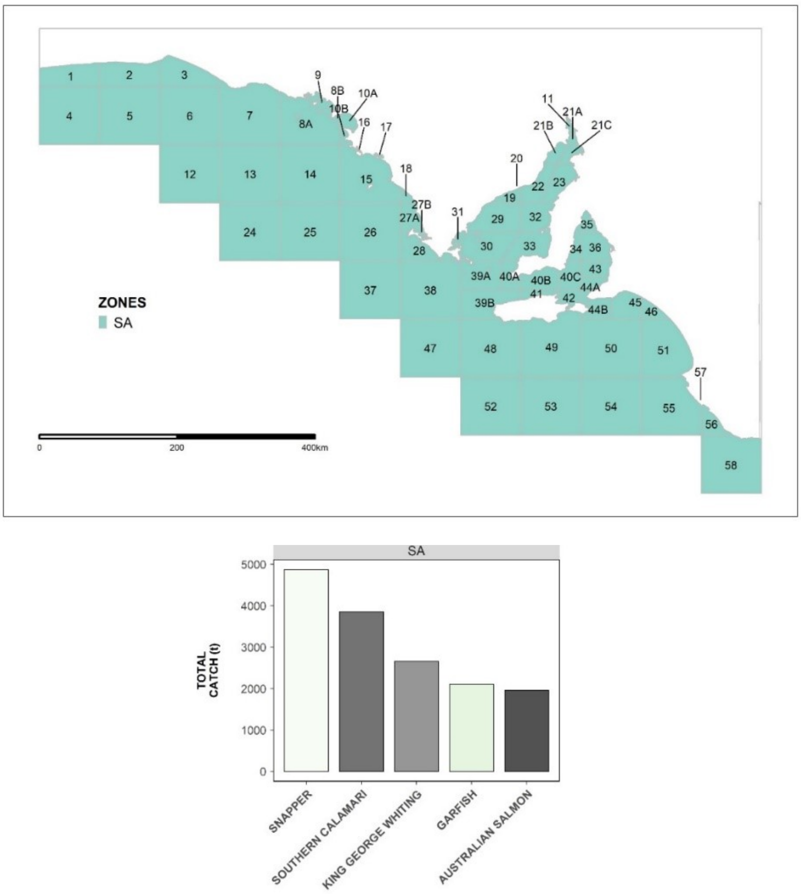
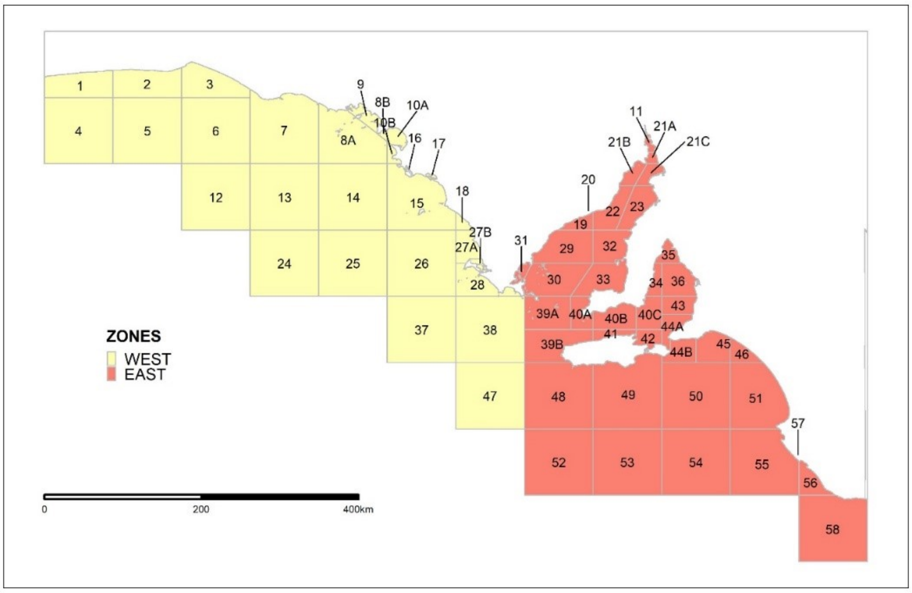


Figure 11. Map showing the entire State as one zone for the first scenario (top) and plot of total catch over 10 years (2010/11 – 2019/20) for the top five species (bottom).

2.2.2.2.2 *Two zones*

For a two-zone scenario, two zones of approximately equal size, east and west, were considered. This revealed considerable differences in the species composition and the relative catches between the eastern and western sides of the State. The species that accounted for most of the catch in the east were Snapper, Southern Calamari, Southern Garfish, Western Australian Salmon and King George whiting. The species that accounted for most of the catch in the west were Ocean Jacket, King George whiting, Mud Cockle, Gummy Shark and Blue Crab. The total catch in these two regions also indicated much greater catches in the east over the last ten years, as both Spencer Gulf and Gulf St Vincent were in this zone.



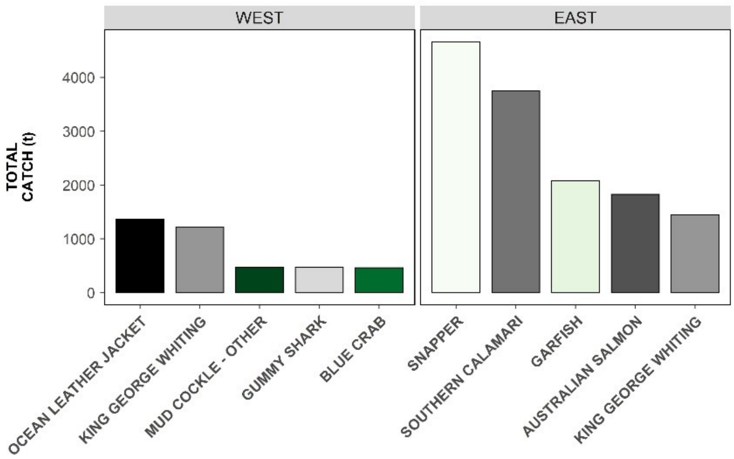


Figure 12. Map showing the boundary setting for the second scenario (top) and plot of total catch over 10 years (2010/11 – 2019/20) for the species that accounted for most of the catch in each zone (bottom).

2.2.2.2.3 Three zones

The third scenario considered a central zone separated by an eastern and western zone. Compared to the second scenario, there was still a significant difference between the species that accounted for most of the catch in the east and in the west. Except for Snapper, which was mainly fished in the east, the dominant species were similar between the central and the east zones, which included Spencer Gulf and Gulf St Vincent, respectively.

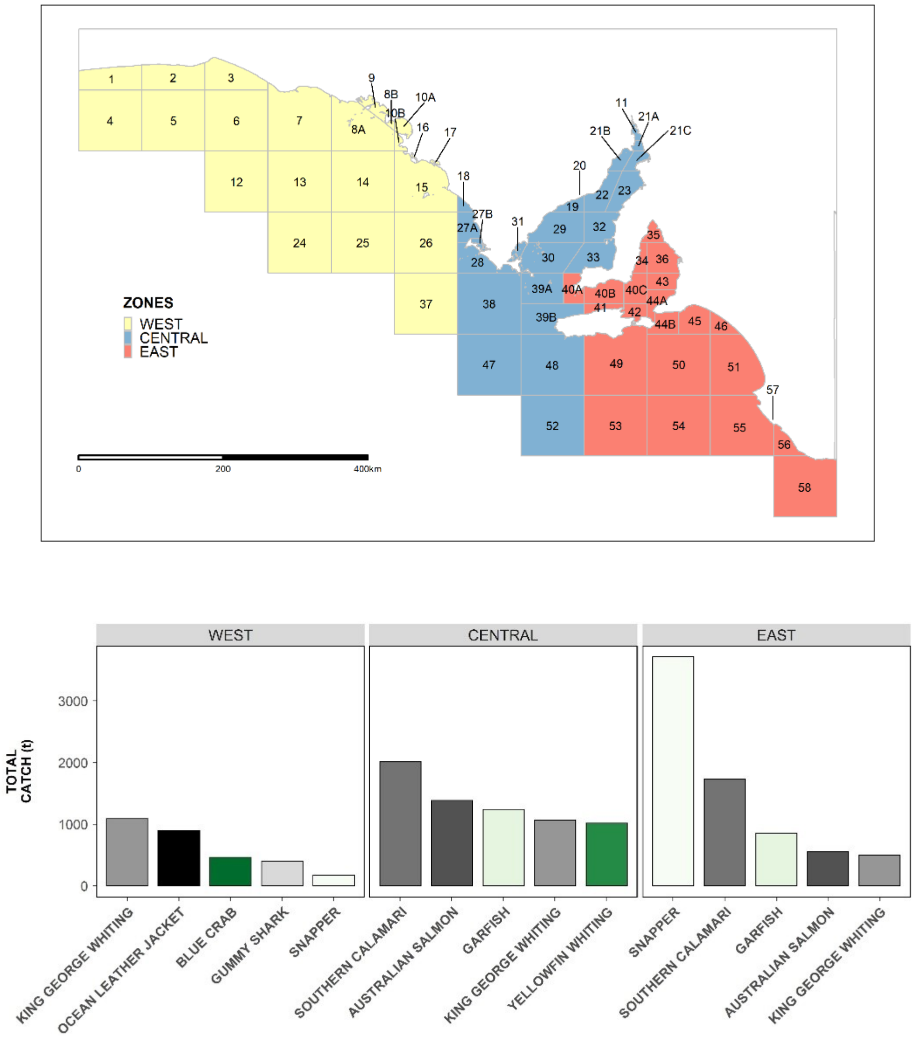
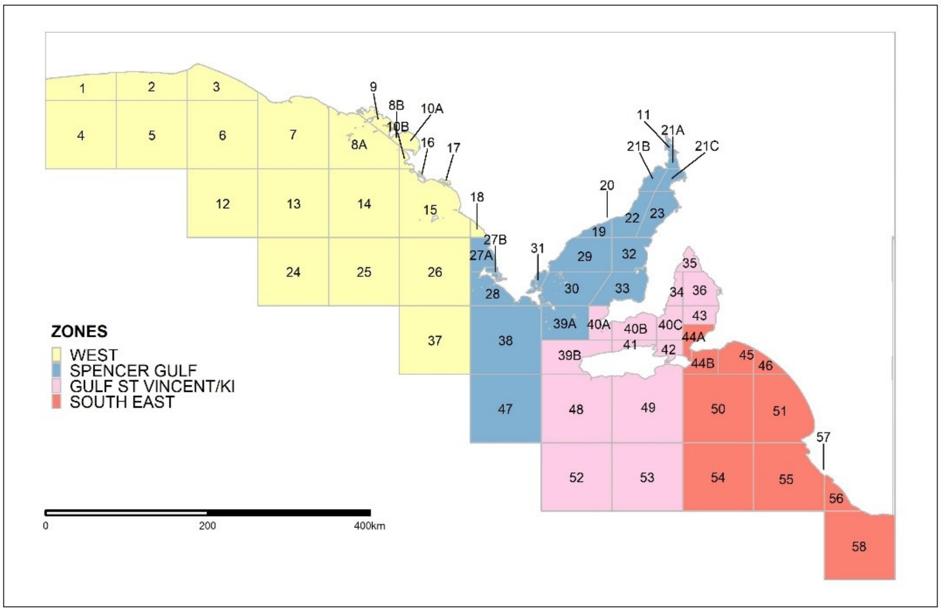


Figure 13. Map showing the boundaries setting for the third scenario (top) and plot of total catch over 10 (2010/11 – 2019/20) years for the top five species in each zone (bottom).

2.2.2.2.4 Four zones

A four-zone scenario included a separate zone for each gulf as well as a west zone and south east zone. Catches were highest in the gulfs although those greater than 500 t still occurred for some species in the south east and west zones (Fig. 14). A primary MSF species comprised the largest catch in each zone and every zone had large catches from at least two primary MSF species (Fig. 14).



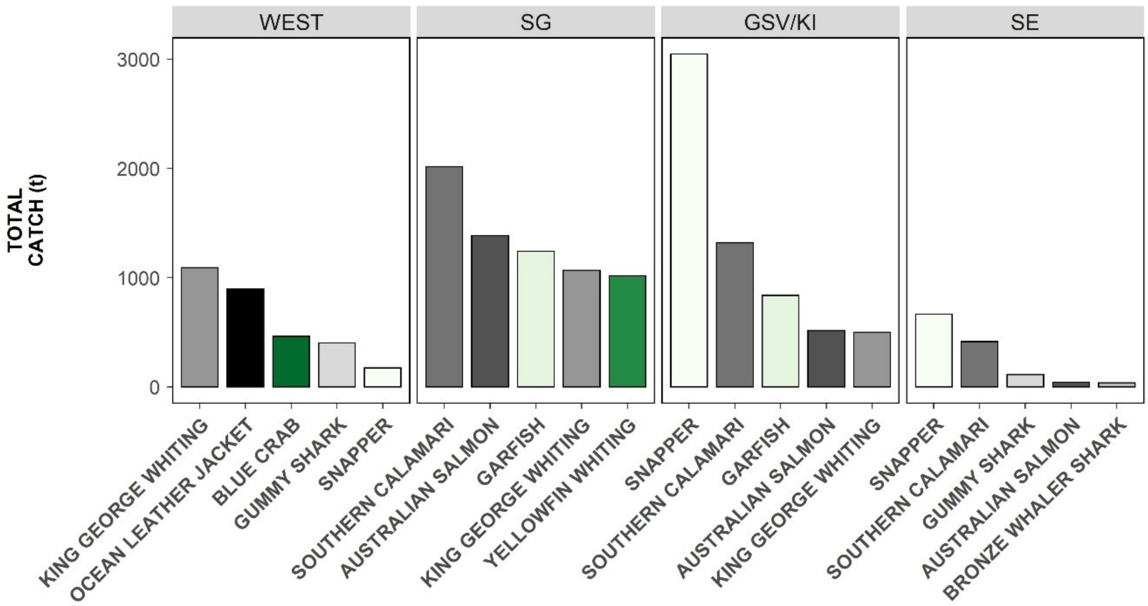


Figure 14. Map showing the boundaries setting for the fourth scenario (top) and plot of total catch over 10 years (2010/11 – 2019/20) for the top five species in each zone delineated (bottom).

2.2.2.2.5 *Five zones*

A five-zone scenario added an additional zone around Kangaroo Island (KI) and the southern gulfs. This zone resulted in lower catches for the KI and SE zones than the previous four zone option as catches for most species in the southern gulfs were lower than in the northern gulfs. Therefore, the creation of a fifth zone in this scenario divided a smaller volume of catch between the KI and SE zones (Fig. 15).

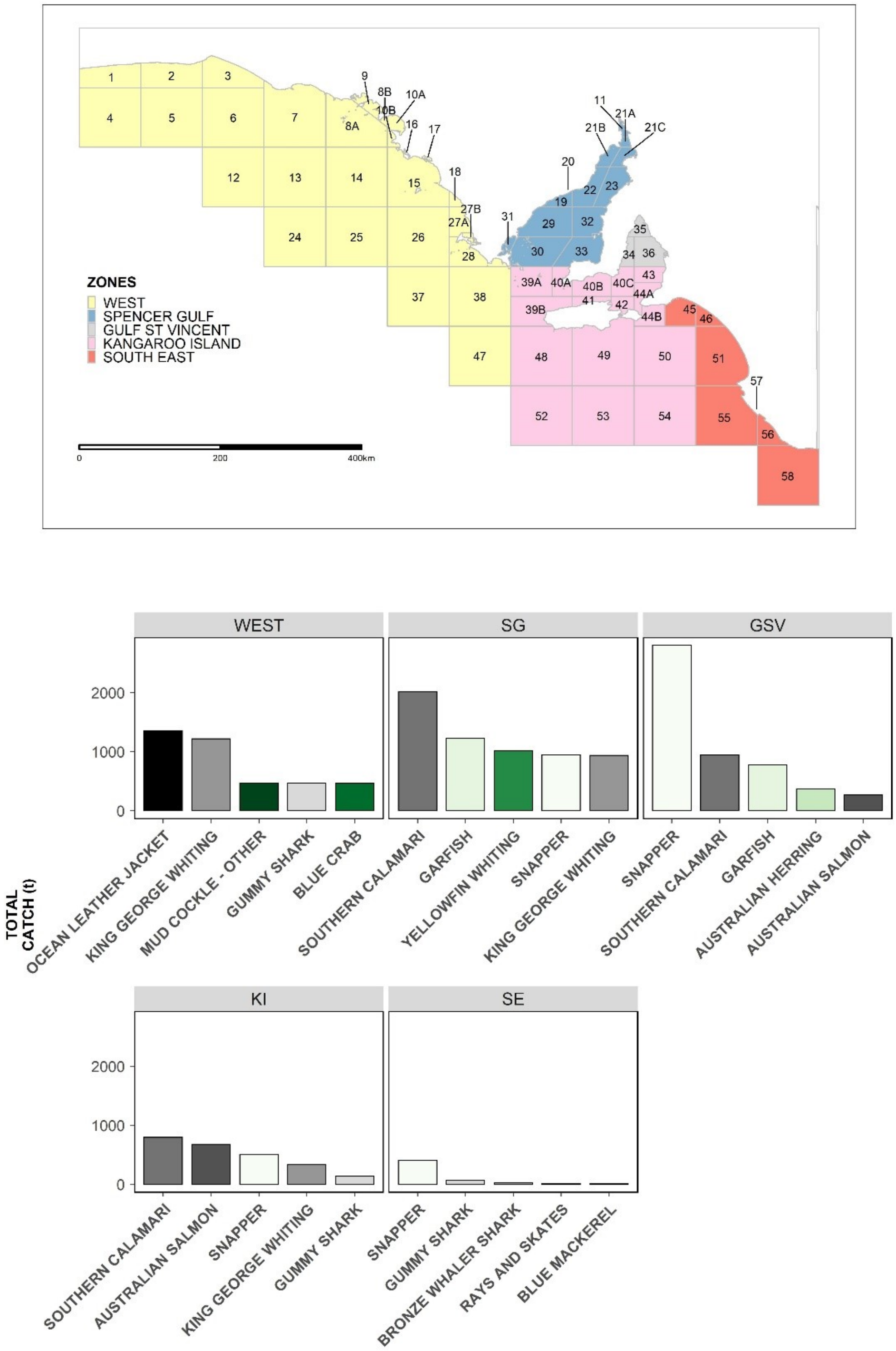
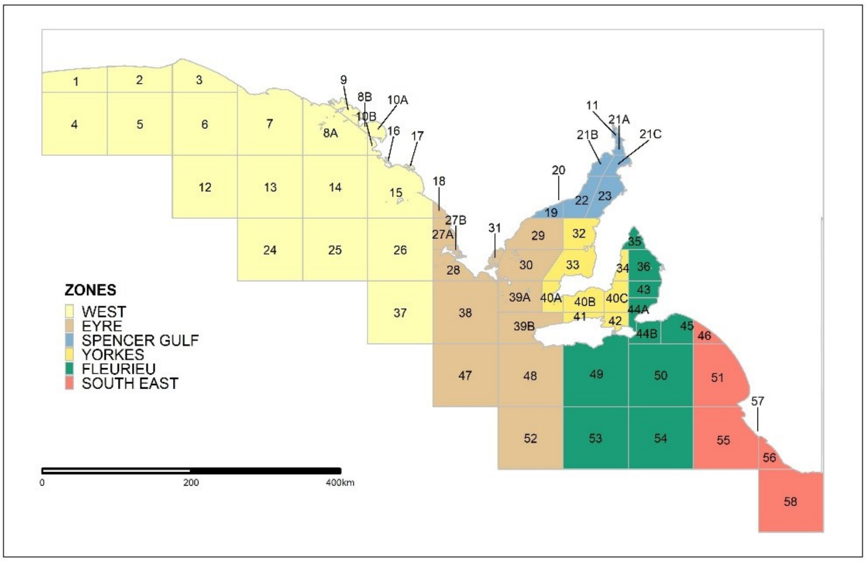


Figure 15. Map showing the boundaries setting for the fifth scenario (top) and plot of total catch over 10 years (2010/11 – 2019/20) for the top five species in each zone delineated (bottom).

2.2.2.2.6 Six zones

A sixth zone was added that created a separate zone for Yorke Peninsula. This was included because many MSF fishers are based on Yorke Peninsula and regularly fish in both Spencer and Gulf St Vincent. This option removed King George Whiting as a species that accounted for most of the catch from the Spencer Gulf and Fleurieu regions (which included eastern Gulf St Vincent) as catches in each gulf mostly occur around Yorke Peninsula (Fig. 16).



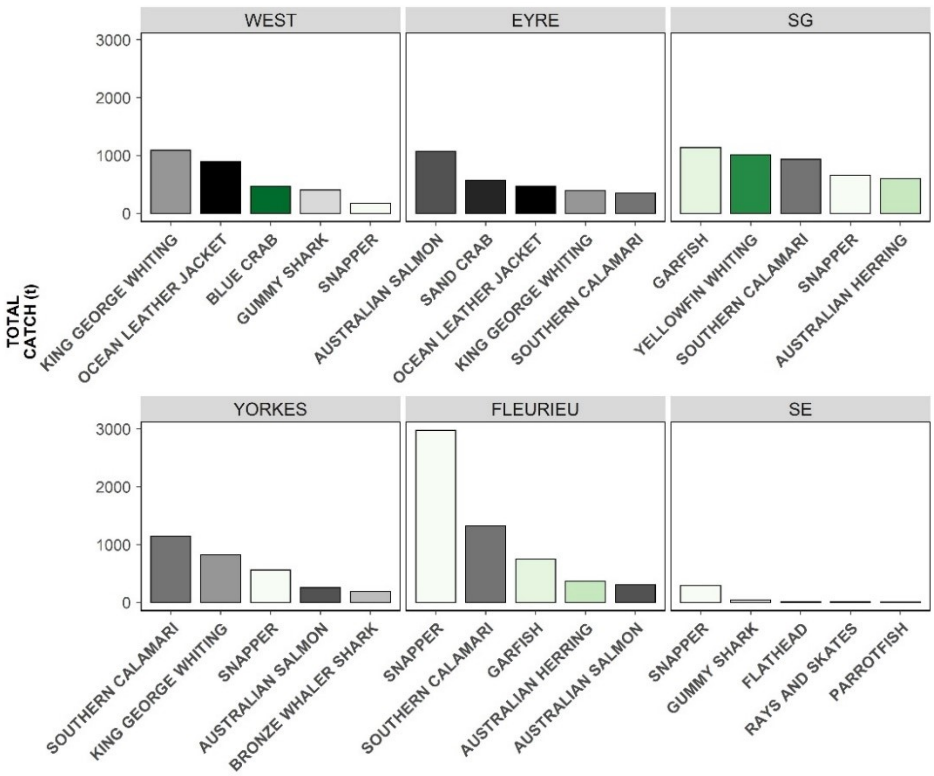


Figure 16. Map showing the boundaries setting for the sixth scenario (top) and plot of total catch over 10 years (2010/11 – 2019/20) for the top five species in each zone (bottom).

2.2.2.2.7 *Seven zones*

A scenario with seven zones provided additional areas on the west coast by creating the Bight zone. However, this region had minimal catches in comparison to the other options (Fig. 17).

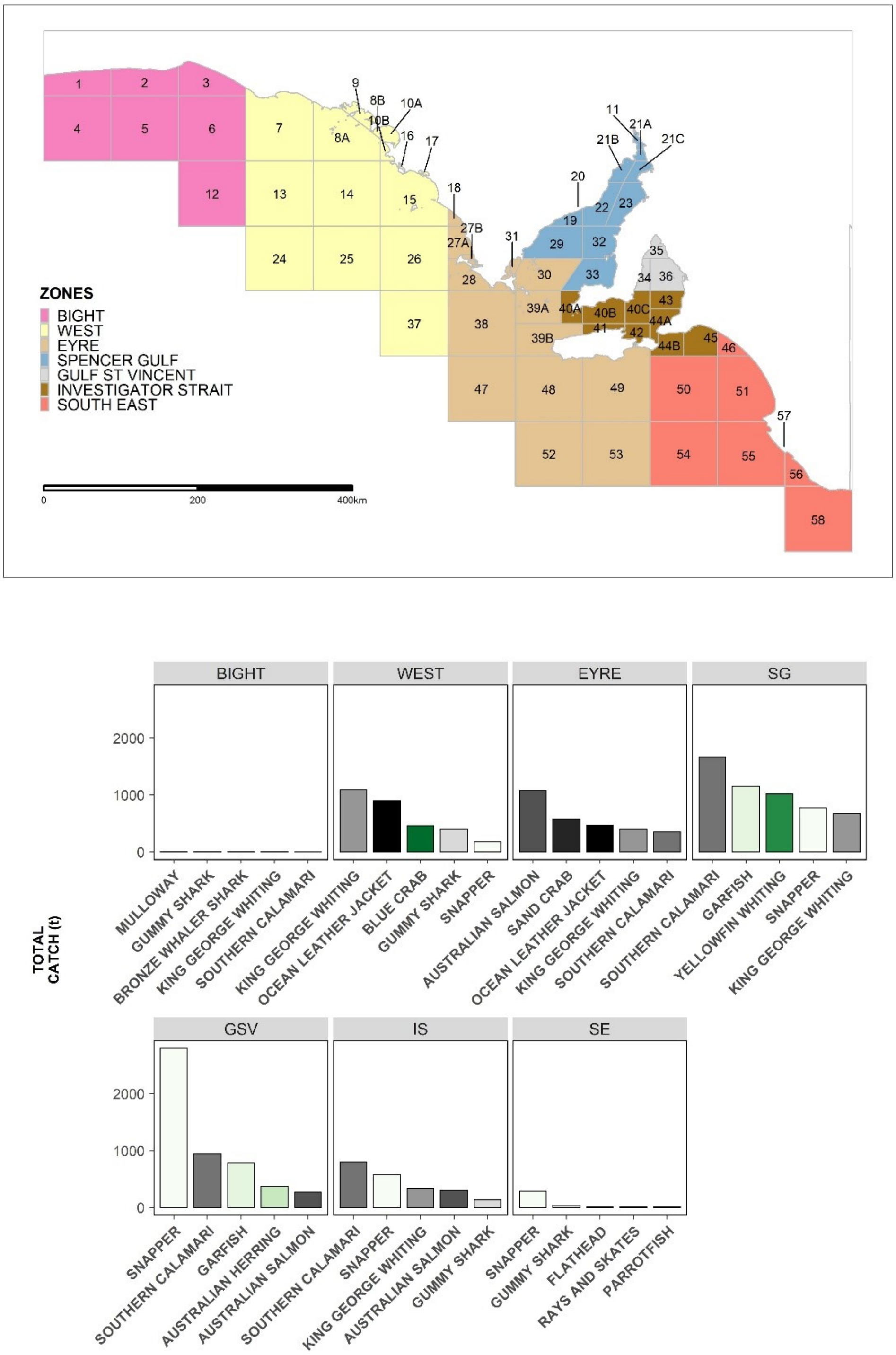


Figure 17. Map showing the boundaries setting for the seventh scenario (top) and plot of total catch over 10 years (2010/11 – 2019/20) for the top five species in each zone (bottom).

2.2.2.3 Broad regional structure

The seven zoning options identified that the MSF catches differed greatly across SA in terms of both size and diversity. This strengthened the argument that some level of regional management would be beneficial to the fishery as it could be tailored to meet the needs of local fishery management. However, these seven options also identified that there is a point of diminishing returns with regards to how many zones should be implemented. Several zones of management that covered broad regions contained negligible catches (e.g., SE and Bight regions in the seven-zone option, and the SE in the six-zone option), which would not merit the resources needed for their own management arrangements.

Consideration of the overlay of the different regional options and the stock structures of the various species that accounted for most of a zone's catch was critical in the decision about regionalisation. First, species such as Southern Calamari, Australian Herring and Western Australian Salmon had stocks that were State-wide and would be inter-regional, regardless of how many regions of management were implemented. Second, several distinct fish stocks occur in each gulf such as King George Whiting, Southern Garfish and Yellowfin Whiting. This suggested that the gulfs needed to be assessed and managed separately. Third, Snapper also have a different stock in each gulf: one which covers the Spencer Gulf and West Coast region; one in Gulf St Vincent; and the Western Victorian stock. One option may have been to combine Spencer Gulf and West Coast region that encapsulated this entire stock. However, this would then combine two different King George Whiting stocks, one of which (the WC stock) is considerably larger than the Spencer Gulf Stock (Steer *et al.* 2018). This would complicate any catch limits imposed for King George Whiting stocks as unsustainable levels of catch could occur for the Spencer Gulf stock through quota displacement from the West Coast stock. Therefore, a more risk-averse option would be to set a catch limit for the Spencer Gulf and West Coast snapper stock and apportion this across those regions of management.

In addition to stock structure, the levels of catch of key species varied greatly across SA and were influenced by species presence and abundance, and/or by differences in fishery dynamics across the State. The regional catch analysis revealed that increasing the number of regions did not necessarily lead to more diverse regions, but rather lead to regions with increasingly lower catch levels.

Overall, based on the biological stock structure of key MSF species and the regional analysis of fishery catches, four regional zones of management would be the most pragmatic option for the MSF. This would include zones for Spencer Gulf, Gulf St Vincent/Kangaroo Island, the West Coast and the South East. However, further work was conducted to determine exactly where the boundaries to those zones should be placed.

2.3 Refining Regional Boundaries

2.3.1 Boundary options for the final zones of management

While four zones of management were selected for regionalising the fishery, the placement of zone boundaries required further consideration. To achieve this, two regional options were provided for broader stakeholder consultation (Appendix A). Both regional options for consideration included the West Coast (WC), Spencer Gulf (SG), Gulf St. Vincent and Kangaroo Island (GSV/KI), and the South East (SE) regions. The area south of Kangaroo Island (KI) area was associated with the GSV in Option I and SE in Option II (Fig. 18). These regions were designed to support the application of strategic management arrangements.

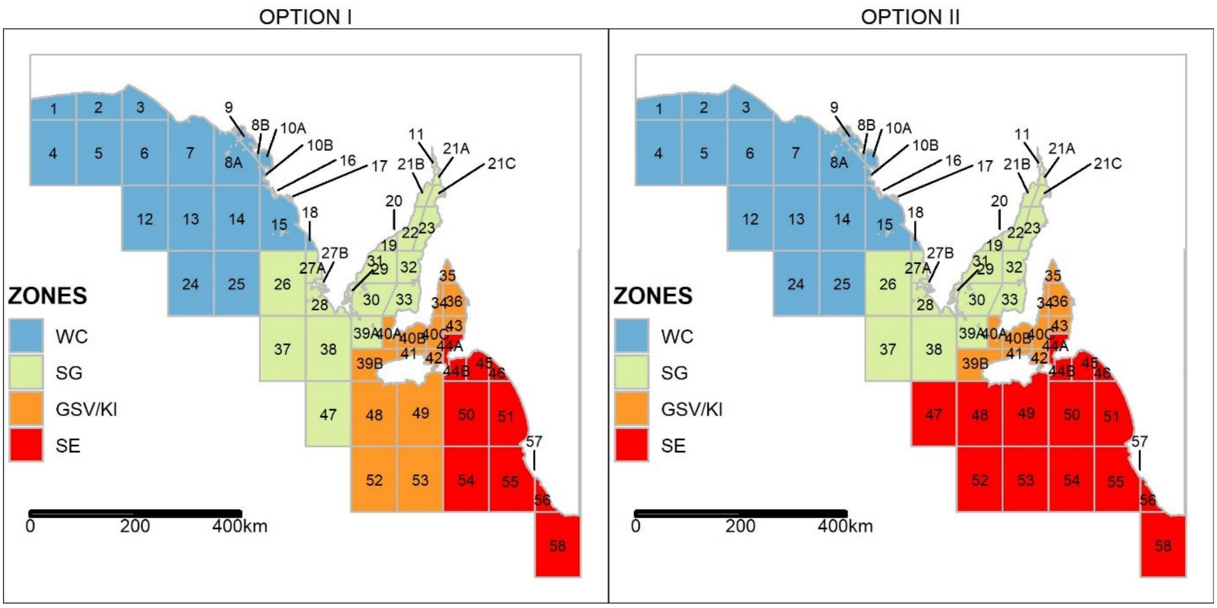


Figure 18. Maps showing the two regional options suggested for consideration as part of stakeholder consultation.

2.3.2 Alignment with ecosystem boundaries

Ecosystem habitats and their connectivity were also considered in addition to key target species stock structures and regional fishery dynamics. This was particularly important for the boundary of the GSV/KI and SE zones as Option I includes the southern coast of KI in the GSV/KI zone whereas Option II includes this area in the SE zone (Fig. 19). Ideally, the boundaries of the management zones would align with natural breaks in habitats and connectivity. In Option I, the GSV/KI Zone effectively represents two discrete ecosystems north (Gulf/Strait) and south (continental shelf) of KI, with the only connectivity being to the west of KI. To the east, the SE zone truncates connectivity between these two ecosystems in the Backstairs Passage. Therefore, Option II represented a preferred option as it retained the entire Lacepede Shelf (south and east of KI) in one zone, rather than dissecting it (Option I).

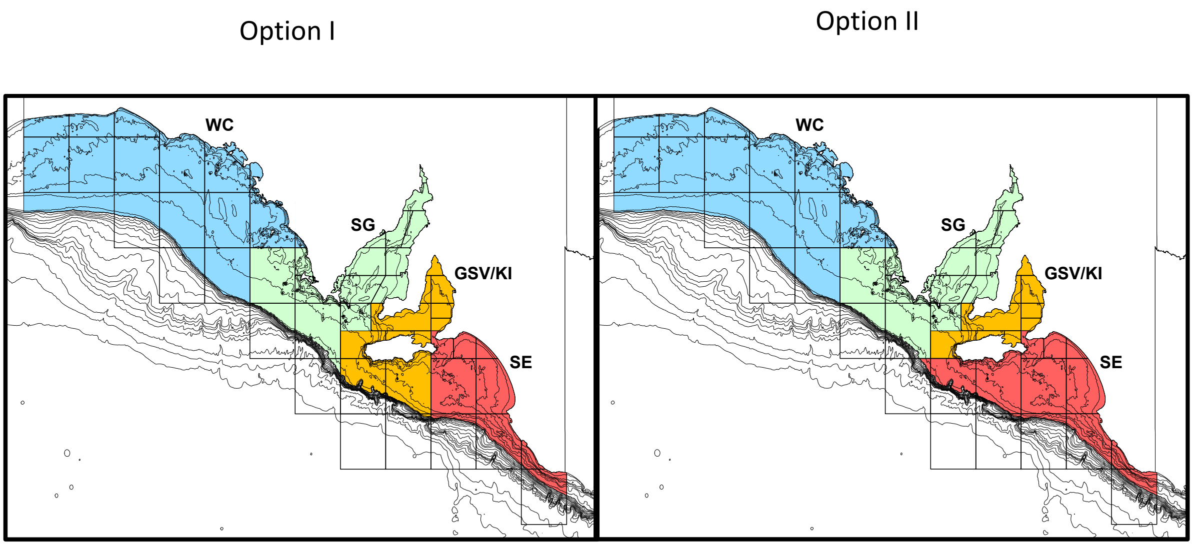


Figure 19. Maps of the two regional options overlaid with ocean bathymetries. Zones are only shaded for depths that are less than 200 meters.

2.3.3 Fishery dynamics and potential effort displacement

2.3.3.1 Fishery dynamics of final zone options

These two proposed options (Fig. 18) were provided to commercial MSF fishers in September 2019 as part of an industry consultation paper (Appendix A). Following their feedback, a final refinement of zone boundaries was made based on a modification to Option II (Fig 20). Two changes were made that included incorporating MFA 47 into the SG zone (as per Option I) and splitting MFA 44 by its subblocks so that 44A was included in GSV/KI zone and 44B was included in the SE zone. This last modification was made as it was clear that the subblocks of MFA 44 form the natural boundary of these two zones (Fig. 19).

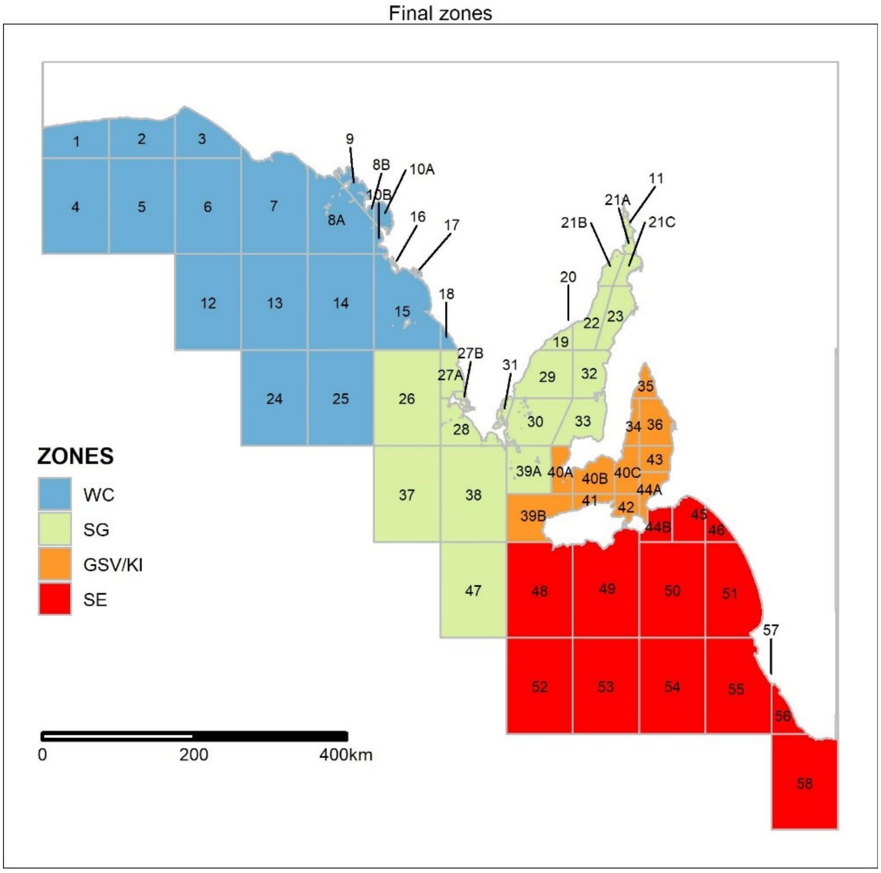


Figure 20. Map of the final zone boundaries determined following industry consultation.

Further analyses that focused on fishery dynamics were undertaken to determine the functional differences in regional fisheries that would occur for both original options and the final zones. This included examinations of the number of active licences in each zone under the three scenarios, and changes in regional catch and effort of the four priority species across the three scenarios.

The number of active licences differed over time within each zone but did not differ amongst scenarios for the GSV/KI, SG and WC zones (Fig. 21). Catch and effort differed very little between Option I and Option II, although they did differ from the final zone boundaries (Figs. 22; 23). This occurred as a reasonable level of calamari catch and effort occurred in MFA 44a. The assignment of this sub block to GSV/KI in the final zones removed catch and effort from the SE zone. A small amount of Snapper catch and effort was also re-assigned from the SE to the GSV/KI zone for the same reasons (Fig 22; 23).

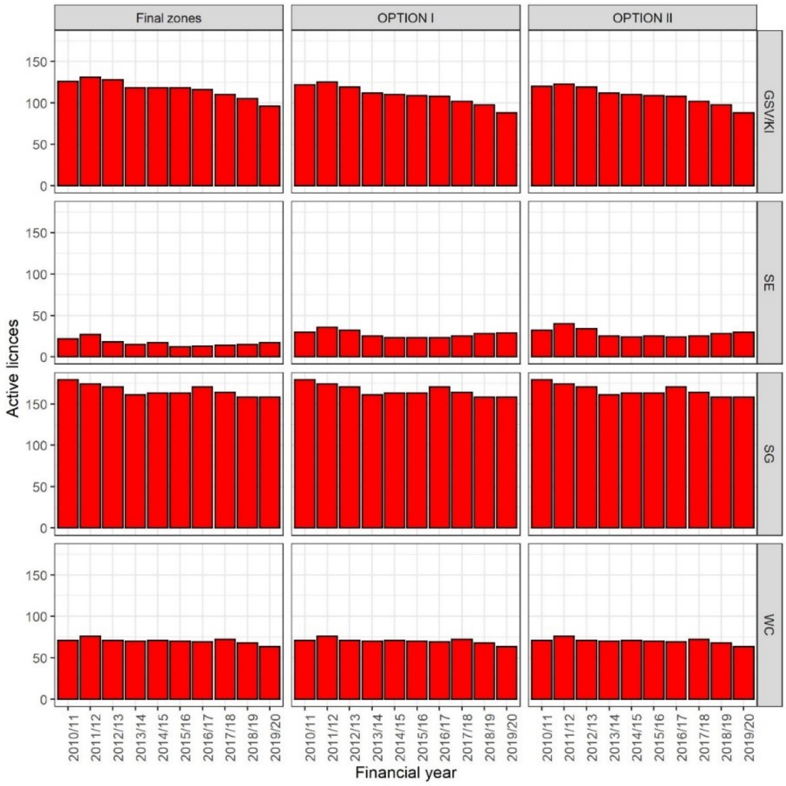


Figure 21. Number of active licences calculated per zone for each of the options considered.

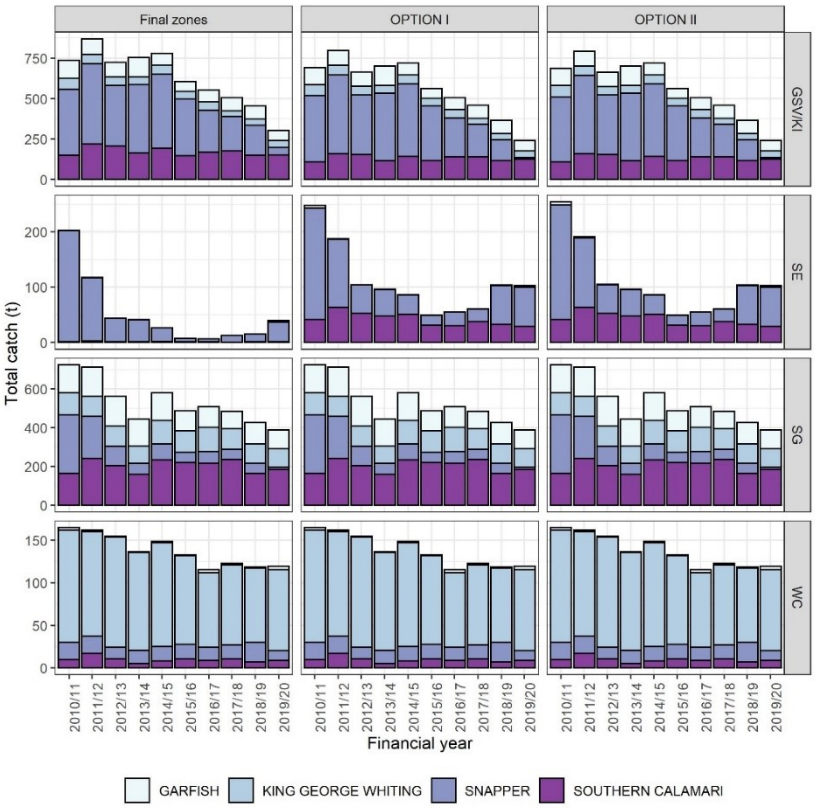


Figure 22. Total catch over 10 years calculated per zone for the four primary species and for the options considered. Note that y axes have individual scales for each zone.

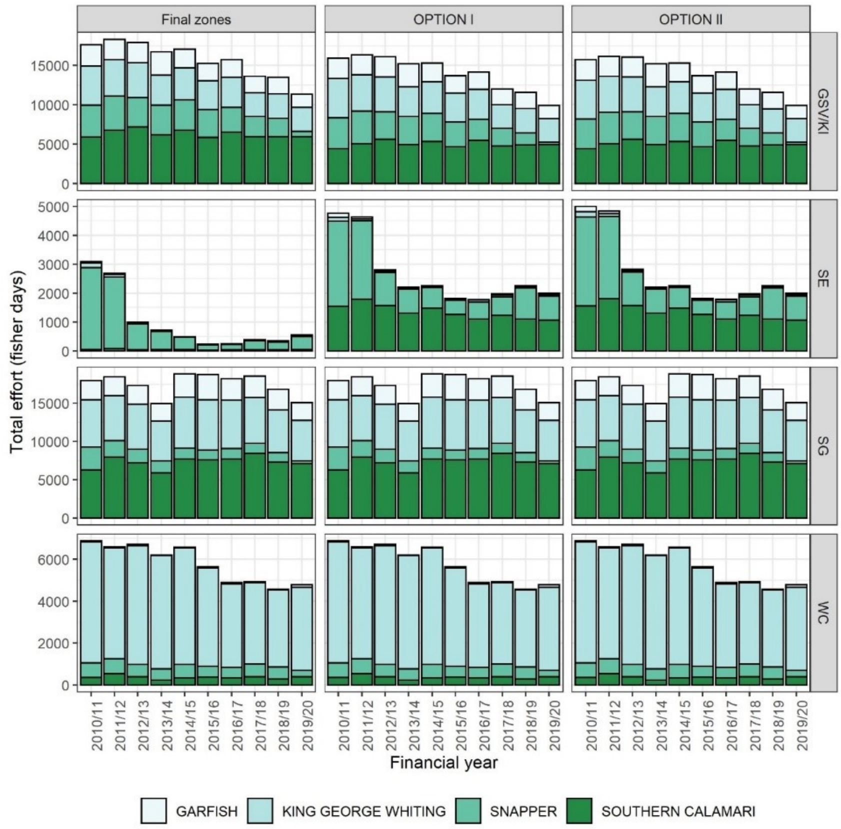


Figure 23. Total effort over 10 years calculated per zone for the four primary species and for the options considered. Note that y axes have individual scales for each zone.

2.3.3.2 Potential effort displacements of zone options

An important aspect of regional management is to understand how the creation of several zones may impact the fishers. As different zones may have different management measures such as gear restrictions and catch limits, fishers who fish between zones may have to alter their operations accordingly. The potential impacts of regionalisation on fishers were examined by assigning every licence holder to a 'home region' based on where they had spent the greatest number of boat days between 2015 and 2019. The quantum of fishing effort that then occurred in each fishing zone could then be calculated based on the home regions of the fishers that fished there. This analysis revealed that most of the fishing effort within each zone was undertaken by fishers from that home region (Fig. 24). This was regardless of zone and the three potential zone boundaries outlined previously (Option I and II, and the final boundaries). A small amount of fishing effort by fishers from a different fishing zone did occur in each scenario, typically with fishers from an adjacent zone (Fig 24). The greatest level of inter-regional fishing in Options I and II occurred with GSV/KI fishers who accounted for approximately 5% of boat days in the SG zone between 2015 and 2019 (Fig. 24). However, the final zone boundaries revealed that GSV/KI fishers accounted for approximately 45% of boat days in the SE zone (Fig. 24). This was caused by MFA 44a being assigned to GSV/KI rather than the SE zone in the final zone boundaries. Therefore, several fishers were assigned to GSV/KI as home region. As several of these fishers had operated in both MFA 44a and 44b, a greater level of inter-regional fishing occurred.

Figure 24. The level of total fishing effort (left hand panels) and proportion of total fishing effort (right hand panels) that occurred within and outside of fisher's home regions based on the boundaries of the regional three options. The coloured arrows originating in the home regions (bottom section of each circle) indicate where effort was expended by fishers from that region. An arrow that goes from a home region to the same fishing zone (e.g., SG to SG) indicates effort by fishers that remained within their home zone. Arrows that go from a home region to a different fishing zone indicate the level of effort that fishers from that home region spent in that fishing zone. All effort was calculated as total boat days from 2015-2019. Purple arrows represent fishing effort of GSV/KI fishers, blue arrows represent fishing effort of SE fishers, green arrows represent fishing effort of SG fishers and yellow arrows represent fishing effort of WC fishers.

2.4 Discussion

The MSF was the only remaining SA commercial fishery that had State-wide management. However, the results presented in this chapter demonstrate substantial benefit from regionalisation. First, stock structure of key species differed across the State. In some cases, these require individual assessment and management. The boundaries of these stocks often aligned with ecosystem boundaries, and we demonstrated that forming four new zones of management (SG, GSV/KI, WC, SE) would be an appropriate option. There are discrete stocks of several key species in SG and GSV/KI that warrant distinct zones of management. The WC and SE zones are distinct from the gulfs due to natural ecosystem boundaries that occur at Backstairs Passage and the western coast of the Eyre Peninsula. Therefore, four distinct regions that encapsulate these distinct ecosystems and their fish stocks is justified. This was further supported by the catch compositions of the four-zone scenario which demonstrated that sufficient catches occurred within these zones to justify their individual management. Scenarios with more zones produced catch compositions where the benefits of zonal management began to decrease and could have resulted in unjustifiable increases in management costs.

The placement of boundaries for the four fishing zones was further refined based on the needs of the fishery by examining fishery dynamics such as catch and effort of key species, and fisher activities across zones. Catch and effort statistics revealed that the different zone boundary options had few implications for current and recent fishery fleet dynamics. The one exception was the SE and GSV/KI boundary at Backstairs Passage along MFA 44a and 44b, which had some catch and effort of Southern Calamari and Snapper displaced between the two zones. However, this boundary better aligns with stock structures and natural ecosystems breaks. Therefore, it was retained in the final zone boundaries.

Extensive industry consultation occurred throughout the regionalisation process. This initially occurred via the CMSFRAC and the MFA Forum, with perspectives from fishers in attendance considered as part of the original options. Consultation with all licence holders occurred via the industry consultation paper that was circulated in September 2019. Considerable feedback was received from industry members which mostly focused on whether or not licences would also be regionalised and allocated to a single zone. As regional licences were not implemented as part of the reform, most of the industry concern was addressed as licences remained State-wide. The industry feedback that was not linked to licencing led to the further refinement of zone boundaries for MFA's 44 and 47. These final zone boundaries were communicated to industry as part of a 'Stage 1' information pack in June 2020[7].

The only boundary in the final zones that requires additional context is the WC and SG boundary which currently includes the south eastern coast of the Eyre Peninsula in the SG zone. This occurs despite fish in areas such as Coffin Bay belonging to WC stocks rather SG stocks. King George Whiting is the most important example of this. This boundary was located here due to stakeholder consultation that revealed fishers that operated in Coffin Bay were mostly based in Port Lincoln and therefore also fished within SG. This was supported by the effort displacement analysis (Fig. 24) which demonstrates that very little fishing effort from fishers associated with the WC zone occurred in the SG zone. Therefore, a natural boundary between the WC and SG fishing fleets warranted a zone boundary occurring at this location despite the inclusion of Coffin Bay in SG.

[7] https://www.pir.sa.gov.au/__data/assets/pdf_file/0006/364605/MSF_reform_-_Stage_1_information.pdf

3 Unitise

3.1 Introduction

Setting a sustainable catch for fish stocks is a core instrument in fisheries management. It effectively determines how much of the resource can be landed to maintain, or restore, stocks to levels corresponding to Maximum Sustainable Yield (MSY - the largest average annual catch that can be sustained over time). The MSY for a given fish stock represents the balance between levels of exploitation and population productivity. A 'precautionary approach' to fisheries management is often adopted to cope with uncertainty, where regulators set target fishing levels that have a low risk of exceeding MSY reference points (Cadrin 1999, Villasante *et al.* 2011). The Maximum Economic Yield (MEY) is an alternative to MSY that can be used depending on the management objectives. The MEY for a given fish stock indicates the level of catch that provides the maximum profits over an indefinite period. Depending on the management objective, total allowable catches (TACs) can be a proportion of MSY in order to be conservative. As the MEY is often less than MSY, this is often used as a more conservative management objective. Determining the MSY (or MEY), and subsequent sustainable catches of a single species is challenging enough, with systemic issues relating to data reliability, biological uncertainty, and incorrect assumptions (Guillen *et al.* 2013). Determining MSY and sustainable catches for multi-species fisheries is far more difficult due to ecological interactions between species (Farcas and Rossberg 2016) and technical interactions between fishing gears and multiple species (e.g., Cardoso et al. (2015). Nevertheless, there are two main ways that management can ensure sustainable catches: ***input controls*** that limit the amount of effort commercial fishers put into their fishing activities through Total Allowable Effort (TAE); or ***output controls*** that directly limit the amount of fish which can be taken through a TAC.

Sophisticated fisheries models are commonly relied upon to support the development of fisheries harvest strategies and performance indicators. The level of sophistication is generally proportional to the quality and quantity of data available for a managed stock. In many cases, fisheries are considered data-poor where there is a limited time series of catch and effort data, or distinct information gaps in the species' life-history processes and population dynamics. This is typical of low value, small-scale fisheries, and although this lack of information may present additional management challenges, it is not considered a reason to avoid developing harvest strategies (Dowling *et al.* 2015). Fisheries management relies on the best scientific information available at the time and will subsequently need to be responsive when new information arises. There are a range of simple, pragmatic, empirical options that can be applied to data-poor fisheries (Carruthers *et al.* 2014). These approaches are generally enhanced by positive stakeholder engagement, embracing the precautionary principle and adaptive management (Dowling *et al.* 2015).

The multi-species MSF clearly demonstrates the variation in available information that can be used to support the development of harvest strategies and estimate sustainable catches. The assessments of three of the primary species — King George Whiting, Southern Garfish and Snapper — are supported by sophisticated fisheries models that integrate multiple fishery-dependent and fishery-independent data sources and population biology metrics across different spatial scales. Fishery-independent methods are also used to estimate spawning biomass for Snapper and King George Whiting, which can contribute to fishery assessments (Steer *et al.* 2017, Drew *et al.* 2020). Assessments for the remaining species predominantly relies on the interpretation of commercial catch and effort data (Drew *et al.* 2021). Given the diversity of information, identifying sustainable catch levels for each species should adopt a cascading approach driven by the availability of supporting empirical data. When sophisticated models exist, estimates of key parameters including fishable biomass, fishing mortality, recruitment, and exploitation rates can be used to determine the MSY of the stock and to set precautionary catch levels. In the absence of such information there are various second tier 'catch-only' or catch per unit effort (CPUE) models that can be used to estimate MSY on the basis of historical trends in total catch or CPUE and an understanding of the species resilience (Martell and Froese

2013). These models are often limited in their application as they do not account for biological parameters (i.e., age, length and growth), recruitment measures, or broad-scale population dynamics (i.e., movement) that influence fish stocks. Using average catch history over a prescribed reference period can also be used to set sustainable catch levels, however, these present a relative base-case approach and are best supported by expert judgement. Determining sustainable catches from average catches in isolation in an already depleted fishery is only going to perpetuate stock decline, so it is important that all available information is considered when determining catch limits (Carruthers *et al.* 2014).

3.1.1 Catch or Effort Management?

Pope (2009) has reviewed the pros and cons of input and output controls in responsible fisheries management. This review states that a major problem with effort management is defining a reasonable measure of fishing effort that has a constant ability to exploit fish, regardless of the type of gear (static or mobile) or improvements in technical efficiency. It can also be problematic where fishing can focus on schooling species or aggregations. Problems with catch management can occur if it causes a race to fish, however, this can be mitigated through quota-based management.

In an output-controlled fishery, catch of a stock is generally managed by setting a TAC that is managed through a system of Individual Transferable Quotas (ITQs) where a proportion of the TAC is provided as catch units to fishers. Catch units are typically easier to apportion amongst licence holders compared to effort units, because a kilogram of a particular species is stable through time, whereas a unit of effort is not consistent between fishing methods and can improve in efficiency as a function of advancing technology, changing fishing practices, and fisher behaviour. TAE constraints have been applied to a number of European fisheries and generally operate by restricting vessel days or the number of gear units (i.e., pots, traps, hooks) (Mulazzani *et al.* 2018). Once a TAE is established, effort units can be apportioned and transferred in the same way as catch shares are distributed as part of an ITQ system but referred to as an Individual Transferable Effort (ITE) system. The difficulty with this system arises when effort units need to be regulated for different gear types, vessel classes, and areas fished. This is because effort units are not equal across fishing fleets, as a day fished with one particular gear type can be different in its effectiveness compared with another gear type, or even a different vessel using the same gear (Squires *et al.* 2017). There have been attempts to capture these differences by adjusting effort units. For example, a unit of longline effort in the Faroe Island Demersal Fishery was considered to be equivalent to two jigging units (Baudron *et al.* 2010). If effort units are to be used, then careful consideration and analysis needs to be undertaken to determine the relative efficiency of the various gear types and fishing methods that currently exist within the fishery and their potential to change.

The use of effort-based management systems can be applied to mixed-species fisheries, where TACs often struggle due to the interactive nature of the stocks and a gear's ability to catch multiple species, however, effort controls need to be inherently flexible, adaptable to natural fluctuations in stock abundance and the initial effort levels need to be conservatively set to account for potential 'effort creep' (Baudron *et al.* 2010). A Total Allowable Commercial Effort (TACE) based system is currently used to manage the finfish sector of South Australia's multi-species Lakes and Coorong Fishery (LCF) (PIRSA 2016). This TACE is based on net units and links to a suite of environmental performance indicators that provide a surrogate metric for population abundance (biomass). This fishery, however, is relatively unique as its productivity is intrinsically linked to freshwater flows and variable estuarine conditions (Knuckey *et al.* 2015). The choice of effort or catch-constrained management systems subsequently depends on the specific fishery. Establishing an ITQ system does not preclude the incorporation of effort-based controls. Hybrid programs can be established that combine features of a catch constrained system with effort-based limitations. For example, a TAC can be set but still have restrictions on gear types and spatial and/or temporal closures. These arrangements may also be augmented depending on the regional structure of the fishery, where some zones or regions are managed using different tools that are tailored more-specifically to the local stocks.

3.1.2 TACs and quota allocation

TACs and ITQ systems have been suggested as the 'default' management technique for commercial, wild-caught fisheries by Australia's Productivity Commission Inquiry Report (Productivity Commission 2016). This report suggests that this system will provide greater confidence in stock sustainability, more scope for innovation and efficient fishing practices, and facilitate structural adjustment. ITQs are commonly incorporated into fisheries management strategies throughout the world, but their implementation and utility remain controversial (Chu 2009, Pascoe et al. 2019).

ITQs essentially give fishers their own exclusive right to a proportion of the TAC. TACs are established by a regulatory authority for a given species which is then apportioned amongst the licence holders in the form of individual catch quotas, usually as a percentage, or share, of the TAC. These shares can be transferred through buying and selling in an open market. The principle behind this system is to remove the 'race-to-fish', but instead create greater flexibility for fishers to adjust their business practices and derive economic benefits over the longer term (Squires *et al.* 1998). Although ITQs provide an instrument to promote economic efficiency, the system should also reduce the tendency of fishers to over-exploit the resource, provided the TAC is set at an appropriate level. It is this economic focus that has challenged the value of ITQ management systems around the world, as it diminishes the emphasis of other important factors such as: conserving the resource; preserving ecosystem function; and ensuring equity and social justice amongst those who share the resource (Sumaila 2018). Issues of equality and social justice become increasingly important in fisheries that are shared by the greater community to include recreational fishers, Indigenous communities, seafood consumers, who all derive some tangible, or intangible, value from the resource.

One of the main criticisms of ITQs arises from how the initial catch shares are allocated and the associated flow-on social ramifications that can result as a consequence. These allocations are typically based on catch histories and/or vessel characteristics in order to ensure that relative economic positions are maintained for each licence holder. In the absence of quota capping, this process inherently favours the most productive and efficient licence holders, which may promote social inequality amongst the fishers. When ITQs are established, quotas are typically purchased by the most efficient licence holders while the least efficient fishers either reduce their activities or leave the industry all together (Pascoe *et al.* 2019). This results in the same catch being shared by fewer licences, increased catch rates, greater fishing efficiency within the remaining fleet, fewer owners, increased profits, and a reduction in over-capitalisation (Vieira *et al.* 2010). All of this can occur at no cost to the government, as the industry may adjust autonomously. Although this level of consolidation may be appropriate for some large-scale fisheries in industrialised countries, it is less appealing for small-scale artisanal or subsistence fisheries. Such smaller-scale fisheries can be susceptible to altered employment structures, either through reducing full-time equivalent jobs, impacting fishing crews, or encouraging part-time operators to transition into full-time work (Pascoe *et al* 2019). However, the employment structure of the MSF is likely to be more stable than other small-scale fisheries as it is an owner-operator fishery and will remain so following the reform.

ITQs have been adopted for many reasons: stock depletion induced by overfishing and overcapitalisation in the fishery; safety concerns for fishers; political change; economic stimulation; or a combination of these (Chu 2009). It is generally accepted that on their own, ITQs cannot be a panacea for solving fisheries management problems. For example, they do not necessarily manage bycatch levels, ecosystem impacts or interactions with threatened species. Numerous reviews of ITQ management systems around the world have provided mixed results regarding their effectiveness in promoting sustainability. Nevertheless, in an assessment of 11,135 global fisheries, those that were managed using catch shares were half as likely to collapse compared with those that were not managed using ITQs (Costello *et al.* 2008). A similar study, that explored biomass trends in 20 fish stocks, determined that 12 of these exhibited improvement after the implementation of ITQs, whereas the remaining eight stocks continued to decline (Chu 2009).

If ITQs are to work, they need to be applied at the right scale and be part of a broad management system that safeguards the sustainable and equitable use of the fishery resources and ecosystems that support them (Sumaila 2018). How they are to be implemented is thought to underpin their success and, in most cases, cannot be considered in the absence of other control measures (i.e., seasonal closures, gear restrictions). Setting an appropriate and precautionary TAC, within which sectorial allocations and commercial ITQs are apportioned, is fundamentally the governing factor that underpins successful resource management. An absence of robust estimates of stock biomass and the determination of sustainable harvest limits, coupled with insufficient monitoring and compliance, can compromise the effectiveness of ITQ systems. A decline of a stock with an ITQ suggests that the TAC may be too high, or harvest compliance is too low, but also demonstrates the complexity of managing dynamic resources in a changing environment (Chu 2009).

Acquiring the level of information described above can be challenging, particularly in multi-species, multi-sector, community-shared fisheries, like South Australia's MSF, where many targeted species are data-limited. In these situations, designing and implementing an ITQ system is best considered through a sensible co-management approach, with the appropriate mix of stakeholder representation and broad consultation. Through this approach, systems can be designed to meet specific ecological, economic, and social objectives. Quota holdings can be capped to guard against the dominance of larger corporate entities or restricted to those who actually fish (i.e., owner operators); resource shares can be cautiously determined within the context of the broader ecosystem; or management decision processes can be refined to enhance the development of environmental stewardship amongst the fishing community.

Applying an ITQ system to a multi-species fishery can further complicate management, due to the complexity of species interactions, technical interactions with gears and multiple species, intermixing of stocks, species-specific input controls, and potential for fishers to land non-targeted by-product species. The management challenge is to provide the best available option. It has been stated that the key issue is not that ITQs fail to give the best outcome, but whether they lead to an improvement over current fishery management practices, or possible alternatives (Squires *et al.* 1998).

3.1.3 How do we share the resource among the sectors?

The MSF stocks are a common property resource, owned by the community, who has empowered the government of the day, to manage it on their behalf (PIRSA 1999). Consequently, the fishing industry is regularly subjected to public scrutiny on matters such as fishing intensity, stock sustainability, resource sharing and access. The commercial sector strives for a social licence to operate, whereby fishers have a level of approval from the community to utilise a shared resource to provide fresh, local, seafood to consumers. It is, therefore, important for the community to understand the social and economic value derived from commercial fisheries. Similarly, the recreational fishing sector, which includes charter boat operators, represents a significant proportion of the community that also derive value from the State's fisheries resources. A recent definition of recreational fishing is "fishing activities undertaken either for personal consumption or for fun, sport, thrill of the catch or social bonding" (Arlinghaus *et al.* 2010). This definition highlights the social shift whereby increasing numbers of recreational fishers seek to enjoy the total fishing experience in addition to harvesting fish. There are diverse flow-on economic ramifications from recreational fishing that relate to tourism, retail, and employment. However, quantifying the economic value is challenging due to the difficulties in collecting and comparing data about activities which occur in a relatively informal way, and across a fragmented industry (Deloitte Access Economics 2017). The forthcoming report of the National Recreational Fishing Survey (NRFS) (FRDC 2018-161)[8] will provide estimates of the economic value of recreational fishing in South Australia: however, the NRFS project has highlighted that in many cases it is likely that economic activity arising from commercial and recreational activity are not direct substitutes for each other, because of the different nature of each activity – whereas commercial fishing economic activity is highly

[8] https://www.frdc.com.au/project/2018-161

dependent on catch rates and value adding to catch, the value of recreational fishing to the economy depends on whether there is a positive fishing experience overall, rather than being directly correlated with catch rates (Schirmer, per. Comm). Furthermore, the State recognises the importance of the Aboriginal/Traditional communities in accessing South Australia's fisheries resources (PIRSA 2011).

Quantifying the level of catch, and fishing activity, by all sectors forms the foundations of fishery assessment and underpins determining the relative health of fish stocks, development of management arrangements, and understanding resource shares. So far, the best catch and effort information is currently obtained from the commercial fishing sector, as fishers are required to record the details of all fishing activities, including when and where they fished, what gear they used, how long they fished, what species they targeted, what they caught, and how much they retained. Although obtaining the same level of information (at the same spatial and temporal scales) for the recreational and Aboriginal fishing sectors would be beneficial, it is unrealistic and there are simply too many people to survey and is limited by the cost of current techniques.

A recent project (Moyle *et al.* 2020) has explored the potential to collect Indigenous fisheries information for improved decision making. It highlighted that although there are some very good examples of this occurring (e.g., Saunders and Carne 2010; Rogers et al. 2014), considerable work needs to occur before this can be achieved at a broad State or national scale. Critical for this is commencement of a process to establish and / or strengthen relationships between Indigenous community representatives and fisheries agencies, establish overarching principles of co-management and data sharing arrangements and established Indigenous community governance and representation structures.

Historically, the estimates of catch and effort from the recreational sector have been obtained through periodic surveys (e.g., Jones and Doonan 2005; Jones 2009; Giri and Hall 2015). In these surveys, all South Australians had an equal chance of participating in a State-wide telephone/diary survey and the results from those who participated were scaled up, based on population density levels to estimate total catch. The telephone directory (White pages) was used as the principal 'data-frame' to randomly survey South Australians. Although this was considered best practice a decade ago, it is no longer a useful tool, as people no longer rely on phone directories and have largely transitioned to more modern mobile telecommunication (Beckmann *et al.* 2019).

Alternative data frames are required to undertake these randomised surveys. Other States have used recreational fishing licence databases, vessel registration databases, commercially purchased databases, national address files, but in each case, these do not encompass the entire recreational fishing population. For example, vessel databases do not include fishers who do not own a boat, recreational fishing licences do not include those who are exempt from having a licence (i.e., young children, senior citizens), and commercially purchased databases do not always account for all social demographics. A current project, FRDC 2020/056 "Evaluation of a smart-phone application to collect recreational fishing catch estimates, including an assessment against an independent probability-based survey, using South Australia as a case study", is investigating the application of smart phone apps for capturing recreational fishing data as part of the 2021/22 South Australian recreational fishing survey. If successful, smartphone apps could provide a greater opportunity to access recreational fisheries data more regularly for assessment and management purposes. More broadly, the NRFS (FRDC 2018-161) is examining the use of a range of survey sampling frames for future recreational fishing surveys.

One way to capture all recreational fishing activity, would be through a State-wide recreational fishing registry (Beckmann *et al.* 2019), which would provide a platform to collect key demographic and contact information regardless of the fisher's age. This can be done at no cost to the individual although clearly there would be a cost associated with setting up, administering, and maintaining the database. If this platform was set up properly, there would be a record of all recreational fishers in the State, including interstate visitors who fished in South Australia. These recreational fishers could then be cost-effectively surveyed on a regular basis to determine the level of their fishing activity and ultimately estimate a total catch. Given all the emphasis would be on surveying recreational fishers, rather than those who do not fish, the estimates of catch and effort would be considerably more precise than previous surveys. This would then mean that the information would be more reliable, comparable with the high-quality commercial catch data, and would lead to improved assessments of fish stocks. Overall, it would provide the high-quality scientific data needed to ensure the community-shared fisheries resources were sustainably utilised and managed. However, such a database is only likely to achieve high participation by recreational fishers if fishers trusted that the information being collected is being managed and used in ways, they believe are appropriate. Schirmer (2015), in a study examining views of South Australian recreational fishers about recreational fishing licences, found that amongst the factors that made a licence controversial for many fishers was concern about whether the information and fees collected via a licence would 'be used to invest in improving recreational fishing and not for other purposes', and 'there was confidence in the people appointed to oversee' the licence (Schirmer 2015). Similar issues are likely to arise for a database, and a system of governance would need to be established that had support from recreational and commercial fishers if such as database is considered.

Once resource shares are determined amongst sectors at the required regional scale, then they could be applied to the estimates of TAC to determine a Total Allowable Commercial Catch (TACC), and potentially a Total Allowable Recreational Catch (TARC) and the Aboriginal/Traditional sector share. The challenge would then be to monitor these shares through time to ensure that they remained equitable and did not exceed sustainable fishing limits. It was suggested that there may be several ways this could be achieved for the recreational sector, such as real-time monitoring of catches or the use of a controlled quantity of fishing tags, with the necessary fisheries compliance. Snapper in the SE fishing zone provides an example of where a TARC has been implemented and enforced for the recreational and charter sectors. This occurred using fishing tags during the 2020 fishing season that were distributed via a lottery to South Australian recreational fishers. Charter boat operators were also provided with an equal number of tags across licence holders, according to their component of the recreational allocation. In the 2021 fishing season, the recreational fishing component of the TARC was managed using bag limits and mandatory reporting through a smart phone app. Once the TARC had been caught, the fishery was closed to the recreational sector.

3.2 Development of a Tiered Management Framework

Implementing TACs and an ITQ system for multi-species fisheries is more complicated than for single species fisheries due to the unique management needs of the different stocks. While the need for a TAC can be obvious for certain species, the case for others may not be as straight forward. Examples of the difficulties in implementing TACs and ITQs in multi-species fisheries have been well documented for one of Australia's commonwealth fisheries: the Southern and Eastern Scalefish and Shark Fishery (SESSF, see for example Smith and Smith 2001, Smith et al. 2008 and Smith et al. 2014 for a review). New research is underway to develop a multi-species harvest strategy approach for its highly--diverse quota-managed species and other commercial by-product species[9]. Similarly, the number and diversity of stocks caught in South Australia's MSF presents a management challenge for implementing TACs. Presently, up to 18 different taxa (including fish, sharks, crustaceans, and molluscs) are assessed in the annual MSF stock assessment program (Drew *et al*. 2021) using different levels of assessments and management approaches. Given that four new regions of management will be implemented in the MSF following the reform, there will be up to 72 stocks that require a cost-efficient approach to different levels of management and assessment. Given the diversity of these stocks across South Australian waters, a multi-faceted approach that determines and justifies the level of assessment and management requirements and resources is necessary. The concept of tier-based species management is valuable in these circumstances, where instead of determining specific assessment and management plans for every fish stock, plans are determined for broad 'tiers', to which each stock can be assigned.

[9] https://www.frdc.com.au/project/2018-021

Tier-based species/stock assessments and management approaches are currently used in several of Australia's commonwealth fisheries, particularly the SESSF. Here, species are grouped into tiers for assessment purposes based on their economic importance and the level and quality of data and information available: Tier 1 represents the highest quality of information available and typically includes an integrated quantitative stock assessment framework; Tier 2 represents a preliminary quantitative assessment; Tier 3 represents estimates of fishing mortality *F*; and Tier 4 represents the least information available (Smith *et al*. 2007). Since the establishment of this framework, Tier 2 assessments are no longer conducted.

While the SESSF tier-based management framework focuses on data quality and availability for assessments of primarily commercial fisheries, other Australian fisheries, including the SA MSF, have a far higher level of cross-sectoral sharing of the fish resources and require a broader range of factors to be considered in its harvest strategy approach. New South Wales has previously developed a decision analysis for prioritising stocks for monitoring and assessment (Fowler *et al*. 2021). This approach uses a multi-criteria decision analysis (MCDA) to rank stocks based on their importance to fisheries management and factor in priorities for multiple fishing sectors (Fowler *et al*. 2021). This approach enabled the prioritisation of 141 stocks in a resource-limited environment. However, it differs from what is required for the SA MSF, which needs a tier-based approach that groups stocks according to the level of management required, rather than ranking each stock.

The Tiered Management Framework presented here is designed to be a tool for scientists and managers rather than a prescribed framework as part of a management plan. This allows for additional considerations that may be specific to a stock to be considered in management arrangements if they are not appropriately encapsulated by this framework. As part of the MSF reform, an MSF Management Advisory Committee (MSFMAC) was established to provide management recommendations for the fishery. The purpose of this framework is to provide a foundation for the MSFMAC's discussions and assist with their decision making.

While the MSF reform focuses on the commercial sector of the fishery, a stock's tier of management must also account for its social and cultural value and importance to the recreational, charter boat and Aboriginal/Traditional sectors, all of which access this resource. This further complicates assigning stocks to specific tiers, as those that are important to other sectors may be deserving of a higher tier of management, despite having a lower commercial importance. Therefore, consideration of these other sectors as part of a tiered management approach is important.

The purpose of this Tiered Management Framework is to determine the appropriate scale of management required to ensure the shared stock is sustainably utilised. It does not preclude the need for development of stock-specific harvest strategies. Harvest strategy development remains an essential component in the assessment and management of fish stocks and will be required to refine the details of the tiered management approaches.

3.2.1 Tiered Management Framework for the MSF

The MSF is not only a multispecies fishery, but also a multi-gear and multi-sector fishery. Therefore, a broad framework is required that captures as much of the MSF's complexity as possible but distils it into a simple framework that is easy to apply for all stocks. The proposed Tiered Management Framework for the fishery will:

- be applied to every stock of management and assessment interest in each of the four zones of management;
- assign each stock to a tier that defines the key management objectives and tools, and the level of scientific assessment needed to underpin this management.

Three tiers of management that were defined as:

Tier 1: The top tier of the management framework where all assigned stocks will be managed using a TACC, which can be further unitised via an ITQ system. The assessment program for Tier 1 stocks should involve quantitative analyses such as integrated stock assessment models which provide high levels of TACC setting confidence.

Tier 2: The management goal of Tier 2 stocks is to maintain fish stocks at sustainable levels of optimum production without the need for formal TACCs and ITQs. Tier 2 stocks will be managed through reference to a Recommended Biological Catch (RBC). The assessment program needed for Tier 2 stocks should still involve quantitative analyses that allow precautionary RBCs to be set, based on the level of confidence in the assessments. Tier 2 stock assessments may include 'data-limited' models which require fewer resources than integrated assessment models but have less confidence and are more precautionary as a result.

Tier 3: The lowest tier of the management framework will include all stocks that are not assigned to Tier 1 or 2. These stocks will be assessed using fishery dependent performance indicators (e.g., catch, effort and CPUE) and will be managed using similar input controls to those used prior to the reform, such as gear or spatial restrictions.

3.2.2 Framework categories and scoring

The proposed framework consists of six categories that are apportioned into three quantitative or qualitative ranks to align with the three tiers (Table 1). Tier 1 categories have a corresponding score of 3 points, descending to 1 point for Tier 3 categories. The maximum achievable score using this framework is 18 points (i.e., 6 categories x 3 points). Fish stocks that score 12+ points would be assigned to Tier 1; stocks that score 9-11 points would be assigned to Tier 2; and those scoring <9 would be assigned to Tier 3. These categories endeavour to account for stock status, vulnerability to future exploitation (i.e., management need), and stock importance to different sectors (commercial, recreational, and Aboriginal/Traditional).

Table 1. The Tiered Management Framework matrix that is used to score fish stocks in the MSF against different management strategy options.

POINTS	STATUS	RECREATIONAL IMPORTANCE	*ABORIGINAL/ TRADITIONAL IMPORTANCE	COMMERCIAL IMPORTANCE	LEVEL OF TARGETING	MANAGEMENT NEED	MANAGEMENT STRATEGY	SCIENCE
3	Depleted	High	High	High (% Gross Margin is >= 10%)	Specialised Target (>= 75% of catch is targeted)	Management is required to ensure sustainability	TACC (12+POINTS)	Quantitative analyses that provide high levels of TACC setting confidence
2	Depleting / Recovering	Medium	Medium	Medium (% Gross Margin is >= 5%)	Generalised Target (>= 50% of catch is targeted)	Fishery is close to maximum production	RBC (9-11) POINTS	Quantitative analyses that determine Recommended Biological Catches (RBC)
1	Sustainable / Undefined / Negligible	Low	Low	Low (% Gross Margin is <5%)	By-product (< 50% of catch is targeted)	Fishery is underexploited	PERFORMANCE INDICATORS (<9 POINTS)	Continued monitoring of catch and effort statistics

3.2.2.1 Status

A national stock status classification system was developed for the consistent assessment of key Australian fish stocks[10]. It considers whether the current level of fishing pressure is adequately controlled to ensure that the adult stock abundance is not reduced to a point where the production of juveniles is significantly compromised. The system combines information on both the current stock size and the level of exploitation into a single classification for each stock against defined biological reference points. Each stock is then classified as either: 'sustainable', 'recovering', 'depleting', 'depleted', 'undefined, or 'negligible' (Table 2). PIRSA has adopted this classification system to determine the status of all South Australian fish stocks.

Assessing the status of fish stocks can be challenging, particularly for lower value stocks that have limited data to inform quantitative assessments. In these situations, a "weight-of-evidence approach" is required to support stock determination (e.g., see Fletcher 2015). With the exception of three primary MSF species (King George Whiting, Snapper and Southern Garfish) that have supporting sophisticated assessment models capable of integrating fishery-dependent and independent information to inform stock status, determining the status of the remaining species relies heavily on the interpretation of fishery-dependent commercial catch and effort data. Additional information about the species' stock structure, biology and management arrangements can contribute to the decision-making process.

[10] https://www.fish.gov.au/

Table 2. Stock status assignments using a weight-of-evidence approach presented in the Status of Australian Fish Stock Assessments

STOCK STATUS	DESCRIPTION	POTENTIAL IMPLICATIONS FOR MANAGEMENT OF THE STOCK
Sustainable	Stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (i.e. recruitment is not impaired) and for which fishing mortality (or proxy) is adequately controlled to avoid the stock becoming recruitment impaired	Appropriate management is in place
Depleting	Biomass (or proxy) is not yet depleted and recruitment is not yet impaired, but fishing mortality (or proxy) is too high (overfishing is occurring) and moving the stock in the direction of becoming recruitment impaired	Management is needed to reduce fishing pressure and ensure that the biomass does not become depleted
Recovering	Biomass (or proxy) is depleted and recruitment is impaired, but management measures are in place to promote stock recovery, and recovery is occurring	Appropriate management is in place, and there is evidence that the biomass is recovering
Depleted	Biomass (or proxy) has been reduced through catch and/or fishing effects, such that recruitment is impaired. Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements	Management is needed to recover this stock; if adequate management measures are already in place, more time may be required for them to take effect
Undefined	Not enough information exists to determine stock status	Data required to assess stock status are needed
Negligible	Catches are so low as to be considered negligible and inadequate information exists to determine stock status	Assessment will not be conducted unless catches and information increase

3.2.2.2 Recreational Importance

Recreational importance was determined based on the results of the 2007/08 recreational fishing survey (Jones 2009). This survey provides information at the regional level, allowing recreational fishing to be considered for each zone rather than at a State-wide scale. The importance of a species in each zone was determined based on a percentage breakdown of catch by number of fish, catch by total weight and effort (number of fisher days) for all species within a fishing zone. If a species accounted for 8% or more of any of these metrics, then it scored 3 points, if a species accounted for 3 – 7.9% for catch in number or weight, or 1 – 7.9% for effort, then it scored 2 points, and if a species accounted for less than 3% for catch in number or weight, or less 1% for effort, then it scored 1 point. The highest score of any metric was used to assign the final recreational importance score.

This stepwise process was undertaken as there is no single metric that sufficiently identifies recreational fishing importance across all stocks. Ideally a recreational fishing indicator would be based on a socio-economic score that encapsulates the community value of a stock. However, this information is not available at the scale required to assess such a large number of species across multiple zones. Until such information becomes available, data on recreational catch and effort are the best information available. The results of the 2021/22 recreational fishing survey that is currently underway will enable these values to be updated with more recent data.

3.2.2.3 Commercial Importance

The importance of stocks to the commercial MSF was determined using economic indicators to determine each stock's profitability. This was performed using fishery level gross margins which are a descriptor of overall fishery profitability. Gross margins were determined in November 2020 based on the corresponding economic survey conducted for the fishery (BDO EconSearch 2020). Gross margins were calculated as the Gross Value of Production (GVP) of each stock (i.e., each taxon in each of the four regions of management) minus the Total Variable Costs (TVC) associated with fishing for each stock. The TVC of a stock is made up of several considerations which include: the cost of labour, fuel, bait/ice, repairs and maintenance and other variable costs (BDO EconSearch 2020). A fishery gross margin provides a better indicator of economic importance of a stock than GVP as it accounts for the costs of fishing as well as the gross revenue generated by the sale of the fish.

Commercial importance scores were calculated by determining the overall gross margin in each zone of management and determining the contribution to this gross margin by each stock in that zone. Stocks that accounted for more than 10% of the region's gross margin scored 3 points, stocks that accounted for 5–10 % of the region's gross margin scored 2 points, and stocks that accounted for < 5 % of the region's gross margin scored 1 point (Table 1).

3.2.2.4 Level of Commercial Targeting

Early recognition of an increased level of targeting will be valuable following the reform as the MSF has the potential for substantial latent effort which can be activated at any point. Given that several key stocks will be managed under ITQs following the reform, it is likely that levels of targeting will increase for other stocks and could pose a risk to sustainability. Recognising this through a dedicated targeting indicator provides a proactive approach whereby a species may be escalated to a higher management Tier in order to maximise its productivity without jeopardising sustainability.

The level of targeting can be determined for any stock as targeted species are reported in commercial MSF logbook returns. There are two criteria for determining whether a species catch was targeted on a given fishing event: 1) The species is listed as the target species in the logbook return, or 2) The species composes more than 90% of the catch of that record even though it was not listed as the target species. This second criterion was added as licence holders can list "any target" on a logbook return and so the level of targeting can be underreported for gears that often have mixed catches.

The level of targeting for each stock was determined based on its percentage of its target versus non-target catch by weight over a five-year period. A stock whose level of targeting is above 75% (i.e., 75% percent of its total catch is targeted) will be classed as 'Specialised Target' and score 3 points, a stock whose level of targeting is 50-75% will be classed as 'Generalised Target' and score2 points, and a stock whose level of targeting is less than 50% will be classed as 'By-product' and score 1 point (Table 1).

3.2.2.5 Management Need

Management need is a broader category that aims to determine the scale of management intervention needed to achieve maximum production without risking over-exploitation. It considers the existing management arrangements that are in place to ensure sustainability and the impact that these arrangements have provided. Examples of ongoing management include gear restrictions, spatial or temporal fishing closures and size limits. It also considers the vulnerability of a species to over-exploitation based on biological characteristics such as potential for localised depletion due to disaggregated sub-populations within a biological stock, whether a stock is shared with other State jurisdictions with large catches, and a species life history and propensity to sustain current levels of fishing pressure.

It is a more qualitative category than the other indicators so that specific considerations for each stock can be more easily factored into the framework. A stock scores 3 points if ongoing management is required to ensure sustainability. A stock scores 2 points if ongoing management is not essential for sustainability, but increased exploitation may require additional management intervention. Lastly, a stock scores 1 point if ongoing management is not essential, and increased exploitation would not require increased management intervention.

A recent report identified which MSF species could be considered under-utilised and the risk of increased catches for these species (Fowler 2020a). The results of this report were considered as part of this framework when scoring the management need of a stock.

3.2.2.6 Aboriginal/Traditional Importance

As previously noted, this is a reform of the commercial MSF. However, the MSF is a shared access fishery and therefore the importance of fish stocks to the Aboriginal/Traditional sector must be considered as part of management arrangements. Currently, the Aboriginal/Traditional sector maintains 1% of the total allocation for all stocks as per the PIRSA allocation policy (PIRSA 2011).

Although Aboriginal/Traditional fishers are defined as one sector under the *Fisheries Management Act 2007*, they encapsulate multiple groups with different languages, values, and cultures. The value to First Nations peoples of Sea Country's marine, intertidal and estuarine resources is more than just for subsistence; it has value both culturally or spiritually, and includes all living things, beliefs, values, creation spirits and cultural obligations connected to that area. The goal of the framework is to determine a simple method to score each indicator. Therefore, creating an indicator that captures the importance of different stocks to the Aboriginal/Traditional sector is complicated by a need to understand the importance of these stocks across individual Aboriginal/Traditional communities, some of which are inland. Capturing and distilling information on Aboriginal/Traditional importance as part of this framework is difficult in its own right, but the added risk of the COVID-19 pandemic prevented appropriate and meaningful discussions with coastal Aboriginal communities. Further discussions and research are required to understand the importance of different fish species to Aboriginal/Traditional communities across SA for sustenance, social/cultural reasons and general management of Sea Country. The scope of this task is such that rather than incorporating it into this existing project, it has been identified as an area that requires additional research and resources.

For the purposes of the MSF Tiered Management Framework, the Aboriginal/Traditional importance indicator has not been completed nor have any stocks been scored according to different tiers. Instead, this indicator is listed in the framework as incomplete and all stocks have been assigned a provisional score of one for Aboriginal/Traditional importance. This does not signify that these stocks are unimportant to Aboriginal/Traditional groups, but rather acknowledges that a greater level of understanding is required to appropriately fill this knowledge gap. Provisionally scoring each stock with a score of one is risk adverse as completing the Aboriginal/Traditional indicator and its application will only increase a stock score and escalate its final tier assignment. Ecological risk assessments or harvest strategies often take an opposing approach when faced with uncertainty, where higher scores may be assigned as a precaution. However, in these situations management measures are often temporary and can be adjusted if a stock improves or more data becomes available. In this framework, the assignment of a stock to Tier 1 and ITQ management is a permanent management arrangement. Therefore, this same approach cannot be applied as it may inadvertently assign stocks to an incorrect tier with long term repercussions. The approach outlined here creates a situation where identifying key stocks to Aboriginal/Traditional groups may result in a prompt management response, befitting the importance of those stocks. The completion of this indicator has been identified as a key area for future research.

3.2.3 Caveats

3.2.3.1 MSFMAC Endorsement

While the goal of the proposed framework is to distil the complexity of the MSF into a simplified and easy-to-apply framework, it is important to recognise that a 'one size fits all' approach can create unpredicted outcomes in some situations. Therefore, the recommendations of this framework are not intended to be binding, but rather to be considered by the MSFMAC when determining the appropriate management level in terms of catch control for each species/stock. This will allow full consideration of all aspects of a stock's management needs to be determined, including any that may not be adequately captured by the framework.

The endorsement of a stock's assigned tier level by the MSFMAC is particularly important for those that are recommended for Tier 1 status. The routine application of the framework means that stocks can move between tiers as appropriate. This is uncomplicated for stocks that transition between Tiers 2 and 3 as management arrangements can be tailored more easily over time. However, additional considerations are required when a stock is transitioned to Tier 1 as they will become eligible for the implementation of ITQs through an allocation process. Once ITQs have been implemented, a stock cannot be downgraded to Tier 2 as ITQs are a non-depreciating tradeable asset that add economic complexity to a fishery. Therefore, MSFMAC endorsement is required for ITQs to be applied once stocks are assigned to Tier 1. Therefore, ITQs would only be applied once stocks are assigned to Tier 1 following an endorsement from the MSFMAC and a determination by the Minister.

3.2.3.2 Frequency of Application

As the framework is designed to simply provide background material for the MSFMAC and help inform their recommendations, its frequency of application will be determined by the MSFMAC. It is expected that following the reform, as the commercial fishery adapts to TACs and ITQs for the Tier 1 species, the dynamics of the commercial fishery will change considerably over a period of a few years, as will the levels of targeting and sectoral importance of different stocks. Therefore, it is anticipated that this framework will be assessed and reviewed regularly for the first few years following the reform as the MSF adjusts to the new management and assessment landscape. Once a level of stability is reached for the fishery's dynamics, it is likely that the framework will be applied less frequently.

3.2.3.3 Avoiding 'Choke Species'

The nature of several MSF stocks is that while they have a high level of importance to recreational, charter boat or Aboriginal/Traditional sectors, they may have limited importance or low catches for the commercial sector, where most management measures will be applied. In this situation, strict adherence to the proposed management framework could result in unduly low TACCs being recommended for stocks that have minor commercial allocations. In a situation where a by-product stock co-occurs with another target species under a low TACC, catches of that by-product species may be inadvertently constrained. Such situations are common in other TAC-managed multi-species fisheries where these TAC-limited stocks are referred to as 'choke species' because they limit overall fishery productivity (McQuaw and Hilborn 2020). Therefore, clear justification is needed for a stock to be assigned to Tier 1, as unnecessarily setting TACCs for some stocks could impede total fishery production and unnecessarily increase costs. Early recognition of this potential conflict is important and will be addressed by two criteria that have been designed to identify these stocks:

1. the average annual catches over a five-year period must be greater than 5 t; or,
2. an increase of 20% from the five-year average annual catch occurs in a given year.

The catch threshold was set at 5 t because this level of catch was considered low for the MSF and stocks with an average annual catch below this threshold are not considered to be at risk of overfishing. The increase in average catch threshold (20%) is intended to help with early recognition of displaced fishing effort for non-ITQ stocks following the reform. A large increase in relative catches over a short time period, could be indicative of this and would trigger a species tier assignment for consideration by the MSFMAC, as appropriate.

3.3 Setting catch limits

The successful management of Tier 1 and Tier 2 stocks will rely on appropriate Recommended Biological Catches (RBCs). An RBC is the maximum level of catch that can be sustained by a stock at a given point in time. An RBC is different to a maximum sustainable yield (MSY) which is the maximum long-term catch that can be taken when a stock is at a healthy size. In situations where the stock size is low, catches based on MSY would be too high and cause a stock to further decline. On the other hand, an RBC accounts for stock size when determining the level of sustainable catch. An RBC can therefore be tailored to align with different management goals such as maximising production or stock recovery. If a management goal was to rebuild a depleted stock, then the appropriate measure would be to ensure that the RBC remained low enough so that population growth can occur. Tier 1 and Tier 2 stocks will be managed using target total catches that have reference to the RBC. RBCs are the maximum annual catch that can be sustainably harvested from a stock by all sectors (i.e., commercial, charter, recreational and Aboriginal/Traditional).

3.3.1 Determining an RBC

RBCs can be determined through numerous methods and ideally will be applied together with harvest control rules as part of a harvest strategy. As harvest strategy development will occur following the reform, initial RBCs are required to inform provisional TACCs. The RBC estimation method that is used for a particular stock is determined by the level of biological and fishery information available. If a high level of information is available for a stock, then its RBC will have a high level of confidence. If very limited information is available for a stock, then the RBC must be set at a precautionary value that is commensurate with the level of uncertainty in the underpinning assessment.

The level of confidence in the fishery assessment program should align with the Tier that a stock has been assigned to. For example, as Tier 1 stocks will be managed through an ITQ system, a higher level of confidence is required for their assessment. There are three methods for determining an RBC for a given stock that will be applied following the MSF reform. Each of these has a cost-risk trade off where methods that provide more information require more resources, while methods that require less information may provide lower confidence and result in more conservative management. It is recommended that for stocks assigned to Tier 1 and Tier 2, an appropriate fisheries assessment program is required to provide a high level of confidence in the RBC.

3.3.2 Tier-specific assessments

3.3.2.1 Tier 1 – Integrated stock assessment models

Integrated stock assessment models are currently available for King George Whiting, Southern Garfish and Snapper (Steer *et al.* 2018a; Steer *et al.* 2018b; Fowler *et al.* 2020b). These models are structured by length and age using the slice partition algorithm to better account for size-based fishing mortality (McGarvey *et al*. 2007). The time-steps in these models are biannual for Snapper and Southern Garfish and monthly for King George Whiting. These models produce annual estimates of stock biomass, recruitment and harvest fraction (annual proportion of the exploitable biomass being harvested), which can form the basis of future harvest strategies and RBCs. These models can also be used for management strategy evaluation (MSE) to provide a greater level of management advice and underpin harvest strategy development.

An RBC estimated from an integrated stock assessment model will be based on an appropriate harvest fraction for a stock given its management objectives. Target harvest fractions for each primary species (Southern Garfish, Snapper and King George Whiting) are provided in the MSF management plan (PIRSA 2013) and when combined with current estimates of stock biomass, can be used to determine an RBC. As harvest strategies are developed, the target harvest fractions for each species may be updated and used to determine future RBCs.

While integrated stock assessment models are a “gold” standard for fishery assessment and supporting management advice, a significant trade-off is the cost of collecting the necessary data and developing and operating the models. The minimum data requirements for these models are catch and effort data from logbook records, and length and age structure data from routine market sampling. Snapper stocks in Spencer Gulf and Gulf St Vincent require estimates of spawning biomass from the daily egg production method (DEPM) as a model input (Fowler *et al*. 2020b). While logbook records are available for all MSF species from 1983 to present, market data are not available for species other than King George Whiting, Southern Garfish and

Snapper. Biological data are expensive to collect, particularly over long-time frames, and often a cost-risk-catch trade-off for many stocks cannot justify their expense. DEPM estimates of biomass are also expensive to obtain and could be inappropriate and difficult to justify for most species based on their GVP. Therefore, if a stock is assigned to Tier 1, decisions are required on the resources that will be made available for assessing these stocks. In some instances, precautionary RBCs may need to be based on Tier 2 assessment programs until the additional costs of a Tier 1 program can be justified.

3.3.2.2 Tier 2 – Data-limited stock assessment models

Without on-going market sampling to collect population age and length samples, Tier 2 stocks will not have sufficient information to conduct Tier 1 stock assessments. However, for many stocks there may be sufficient information to conduct stock assessment modelling that does not require information on population structure.

A recent database has been established of available 'off the shelf' stock assessment packages that could be used for stocks with varying degrees of data availabilities (http://toolbox.frdc.com.au/; Dichmont *et al.* 2021)[11]. This database will be used to determine potential candidate models that could be applied for different stocks as the need arises. Potential models could include surplus production models which do not require data on population structure (Haddon 2012) or Bayesian models, where auxiliary information can be provided as 'priors' to help inform the models (Winker *et al.* 2018).

There may still be instances where some stocks have insufficient data for these off the shelf assessments and the only available data are a time series of catch and effort. For these stocks, catch-only models may provide the most pragmatic assessment. Another recent FRDC project developed the 'simpleSA' R package (Haddon *et al.* 2019) which implements a variety of data-limited stock assessment models that included a catch-MSY assessment (cMSY)[12]. A cMSY assessment is a model-assisted analysis which uses a Schaefer production model to determine viable estimates of MSY based on prior specification for species productivity and depletion levels at the beginning and end of the time series (Martell and Froese 2013). These assessments can be very effective when changes in population size are evident in the catch history of a stock. However, they are less successful if changes in catches have been affected by management or changes in fishery dynamics. As they rely strongly on catch data, they may not be suitable for stocks with large or variable recreational catches and do not have recreational data regularly available. Therefore, while they are a valuable tool that can be applied to any stock, they must be used judiciously and in a precautionary manner if being used to determine RBCs.

cMSY assessments were performed for all Tier 1 and Tier 2 stocks that did not have existing stock assessment models. These models included commercial MSF catch data from logbook records and estimates of recreational catch from State-wide surveys in 2000/01, 2007/08 and 2013/14. As annual catch estimates are required by cMSY assessments, State-wide recreational catches were linearly interpolated between survey years. Recreational catches prior to 2000/01 were estimated by scaling estimates from that survey to the estimated South Australian population size during 1984 to 2000. These State-wide estimates were then divided across regions based on proportional regional catches from the 2007/08 survey where this level of information was available.

The RBC for a stock was determined using the lower value of the MSY estimate or the harvest fraction that relates to MSY (H_{MSY}) multiplied by the final year's biomass. This provides an RBC that matches the MSY when the stock is above the biomass that corresponds to MSY (B_{MSY}) or is less than MSY when the current biomass is depleted and below B_{MSY}.

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[11] https://www.frdc.com.au/project/2018-148
[12] https://www.frdc.com.au/project/2017-102

All cMSY applications were qualitatively assessed and if each assessment was deemed appropriate for a stock, then that RBC was provided in management advice. Future research will aim to update these assessments with more appropriate and data-rich models as appropriate.

3.3.2.3 Tier 3 or data-poor stocks – Average catch history

As future stocks are assigned to Tier 1 or Tier 2, the appropriate assessment programs will need to be developed. This may take an extended period should new data sources be required (for example, time series of ages and lengths from market sampling) or to construct new stock assessment models. In the interim, RBCs will need to be set using the best available information. In these situations, average annual catches may serve as the best basis for setting an initial and precautionary RBC. A key principle behind using average annual catches is that the time period of catches used represents a time when the fish stock is healthy, so that the catches caught during this period could be considered sustainable.

This approach has two important assumptions:

1. the stock was stable during this time period and was not unknowingly in decline;
2. the current stock size is similar to the stock size during the period of average annual catches.

If either of these assumptions is not valid then stock declines could potentially result. Therefore, if average annual catches are used to set an RBC, then there would be less confidence in the result. Fishery managers should then set TACs that are lower than the RBC in order to be conservative

3.3.3 Sector Shares

For Tier 1 stocks, the commercial share of the RBC will be used to set a TACC that may be further unitised into ITQs. The current sector allocations for the MSF were set at the State level (PIRSA 2011). However, a regional distribution of these shares was required that aligned with the four new fishing zones (Table 3). These regional distributions of the State-wide sector shares were based on the 2007/08 recreational survey and the commercial MSF logbook data as per the original allocations at the State level (PIRSA 2011). The *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013) specifies the share of the fishery to be allocated to each fishing sector, based on the existing shares at the time the management plan was requested. The Aboriginal/Traditional sector maintains a 1% allocation for all stocks as per the PIRSA allocation policy (PIRSA 2011).

Table 3. Recreational catch shares for Tier 1 stocks based on the percentage of total catch for each stock accounted for in the 2007/08 recreational survey against MSF commercial logbook data. The Aboriginal/Traditional allocation of 1% is not included in these recreational allocations.

Species	GSV/KI	SE	SG	WC
Southern Garfish	18%	79%	21%	26%
King George Whiting	58%	98%	55%	29%
Snapper	41%	24%	12%	13%
Southern Calamari	39%	71%	37%	59%

As the MSF reform is only being implemented for the commercial sector, a TARC is not being applied for Tier 1 stocks as part of the reform. However, for the 2019/20, 2020/21 and 2021/22 fishing seasons, a TARC has been trialled for Snapper in the South East region. This management decision was independent of the commercial MSF reform and was recommended by the Snapper MAC. Details of this decision were provided in the Chair's notes of the 3rd Snapper MAC meeting[13]. Given that a TACC and TARC have been applied for this

[13] https://www.pir.sa.gov.au/__data/assets/pdf_file/0003/372144/Meeting_3_Chairs_report_11_August_2020.pdf

stock, it's RBC was implemented as a TAC given that catch limits are also in place for charter and recreational fishing sectors. For all remaining stocks, the term RBC is used rather than TAC to indicate that catch limits have not been applied across all sectors.

3.4 Application of Tiered Management Framework for MSF stocks

3.4.1 Stock Status

Stock statuses were determined for each stock in the most recent MSF stock status report (Drew *et al.* 2021) (Table 4). Several species such as Australian Herring and Western Australian Salmon have statuses assigned at the State level as they have a broad single stock structure. Here, those State-wide statuses have been assigned to all four fishing zones for such species. Currently, four stocks are classified as depleted, and one stock is classified as recovering. All remaining stocks, with the exception of Bronze Whaler Sharks, are classified as sustainable. Bronze Whaler Sharks are currently classified as Undefined as they are assessed as part of a species complex and scored 1 point in the Tiered Management Framework

Table 4. The stock statuses of MSF stocks in 2019 (Drew et al. 2021). Stocks classified as Depleted scored 3 points (red shading), stocks classified as Depleting or Recovering scored 2 points (yellow shading), and stocks classified as sustainable scored 1 point (green shading). Undefined stocks (grey shading) also scored 1 point.

Species	GSV/KI	SE	SG	WC
Australian Herring	Sustainable	Sustainable	Sustainable	Sustainable
Black Bream	Sustainable	Sustainable	Sustainable	Sustainable
Blue Crab	Sustainable	Sustainable	Sustainable	Sustainable
Bronze Whaler Shark	Undefined	Undefined	Undefined	Undefined
Cuttlefish	Sustainable	Sustainable	Sustainable	Sustainable
Southern Garfish	Depleted	Sustainable	Recovering	Sustainable
King George Whiting	Sustainable	Sustainable	Sustainable	Sustainable
Leather Jacket	Sustainable	Sustainable	Sustainable	Sustainable
Mulloway	Sustainable	Sustainable	Sustainable	Sustainable
Ocean Jacket	Sustainable	Sustainable	Sustainable	Sustainable
Octopus	Sustainable	Sustainable	Sustainable	Sustainable
Blue Throat Wrasse	Sustainable	Sustainable	Sustainable	Sustainable
Sand Crab	Sustainable	Sustainable	Sustainable	Sustainable
Snapper	Depleted	Sustainable	Depleted	Depleted
Snook	Sustainable	Sustainable	Sustainable	Sustainable
Southern Calamari	Sustainable	Sustainable	Sustainable	Sustainable
Trevally	Sustainable	Sustainable	Sustainable	Sustainable
Western Australian Salmon	Sustainable	Sustainable	Sustainable	Sustainable
Yellow-Eye Mullet	Sustainable	Sustainable	Sustainable	Sustainable
Yellowfin Whiting	Sustainable	Sustainable	Sustainable	Sustainable

3.4.2 Recreational Importance

Recreational fishing importance was scored across multiple metrics in order to discern the different reasons that a stock may be important to recreational fishers. Some species (e.g., Trevally, Yellow-Eye Mullet, Western Australian Salmon, etc.) were important as they accounted for a higher level of targeting and effort, rather than a quantum of catch. Additionally, the importance for some species (e.g., Snapper and Mulloway) was best determined by catch in weight rather than number of fish, which is traditionally how recreational catch is measured. By using multiple metrics and using the highest scoring one to determine the recreational importance indicator, the multi-faceted nature of recreational fishing has been incorporated into the Tiered Management Framework using the full extent of the available data (Table 5).

Table 5. The recreational fishing information used to score the recreation importance indicator. All data are from the 2007/08 recreational fishing survey (Jones 2009). The percentages of recreational effort and catch (by number of fish and weight) were calculated for each species within a zone. For each metric, a stock that accounted for more than 8% scored 3 points (red shading), a stock that accounted for between 1 and 8% scored 2 points (yellow shading) and a stock that accounted for less than 1% scored 1 point (green shading). The highest scoring metric was used to assign the final score for each stock.

Species	Fishing zone	Effort (%)	Catch by number of fish (%)	Catch by weight (%)
King George Whiting	GSV/KI	16.2%	16.3%	12.5%
Blue Crab	GSV/KI	14.5%	30.8%	22.6%
Southern Calamari	GSV/KI	13.6%	6.7%	8.4%
Australian Herring	GSV/KI	11.2%	9.8%	4.5%
Southern Garfish	GSV/KI	7.5%	12.3%	3.4%
Western Australian Salmon	GSV/KI	6.6%	3.9%	3.4%
Snapper	GSV/KI	5.7%	5.1%	27.3%
Yellow-Eye Mullet	GSV/KI	5.2%	4.5%	2.4%
Black Bream	GSV/KI	4.8%	2.7%	2.4%
Leather Jacket	GSV/KI	3.6%	1.6%	0.9%
Snook	GSV/KI	3.5%	2.1%	4.2%
Yellowfin Whiting	GSV/KI	3.0%	1.7%	1.6%
Sand Crab	GSV/KI	1.4%	1.5%	1.7%
Trevally	GSV/KI	1.1%	0.5%	0.5%
Cuttlefish	GSV/KI	0.8%	0.2%	0.1%
Blue Throat Wrasse	GSV/KI	0.7%	0.2%	0.5%
Mulloway	GSV/KI	0.4%	0.1%	2.8%
Whaler Shark	GSV/KI	0.2%	0.0%	0.8%
Octopus	GSV/KI	0.1%	0.0%	0.0%
Western Australian Salmon	SE	23.3%	25.8%	6.3%
Mulloway	SE	13.4%	8.6%	70.2%*
Australian Herring	SE	11.1%	9.4%	1.2%
King George Whiting	SE	9.8%	6.7%	1.4%
Snapper	SE	7.5%	5.9%	8.7%
Yellow-Eye Mullet	SE	7.4%	12.7%	1.9%
Snook	SE	5.4%	11.8%	6.5%
Southern Garfish	SE	5.0%	10.9%	0.8%
Southern Calamari	SE	3.9%	1.8%	0.6%
Octopus	SE	3.3%	0.1%	0.0%
Black Bream	SE	2.8%	2.9%	0.7%
Leather Jacket	SE	2.3%	1.4%	0.2%
Trevally	SE	1.7%	0.5%	0.1%
Blue Throat Wrasse	SE	0.9%	0.5%	0.3%
Blue Crab	SE	0.7%	0.7%	0.1%
Yellowfin Whiting	SE	0.6%	0.2%	0.0%
Whaler Shark	SE	0.5%	0.1%	0.7%

Cuttlefish	SE	0.3%	0.1%	0.0%
Sand Crab	SE	0.1%	0.0%	0.0%
King George Whiting	SG	25.3%	29.2%	22.6%
Southern Calamari	SG	14.3%	6.4%	8.1%
Australian Herring	SG	14.2%	9.7%	4.5%
Blue Crab	SG	13.1%	23.7%	17.5%
Southern Garfish	SG	7.3%	15.6%	4.3%
Snapper	SG	7.3%	5.8%	31.7%
Western Australian Salmon	SG	5.7%	3.1%	2.8%
Leather Jacket	SG	4.3%	2.0%	1.2%
Snook	SG	2.3%	1.3%	2.6%
Yellowfin Whiting	SG	1.9%	1.3%	1.3%
Trevally	SG	1.4%	0.7%	0.6%
Yellow-Eye Mullet	SG	1.1%	0.6%	0.3%
Blue Throat Wrasse	SG	0.7%	0.2%	0.5%
Sand Crab	SG	0.4%	0.3%	0.3%
Cuttlefish	SG	0.3%	0.1%	0.0%
Black Bream	SG	0.2%	0.1%	0.1%
Octopus	SG	0.2%	0.0%	0.0%
Whaler Shark	SG	0.1%	0.0%	0.4%
Mulloway	SG	0.1%	0.0%	1.0%
King George Whiting	WC	28.7%	38.1%	34.4%
Australian Herring	WC	19.9%	23.7%	12.8%
Western Australian Salmon	WC	15.0%	9.8%	10.3%
Southern Calamari	WC	8.1%	7.0%	10.3%
Trevally	WC	8.0%	3.5%	3.5%
Southern Garfish	WC	6.0%	5.9%	1.9%
Blue Crab	WC	4.6%	7.0%	6.1%
Snook	WC	2.0%	0.7%	1.7%
Leather Jacket	WC	1.7%	1.2%	0.9%
Yellow-Eye Mullet	WC	1.7%	0.9%	0.6%
Snapper	WC	1.3%	0.5%	2.9%
Blue Throat Wrasse	WC	1.2%	0.9%	2.3%
Mulloway	WC	1.0%	0.3%	9.7%
Whaler Shark	WC	0.3%	0.1%	1.9%
Sand Crab	WC	0.2%	0.4%	0.6%
Cuttlefish	WC	0.1%	0.0%	0.0%
Black Bream	WC	0.1%	0.0%	0.0%
Yellowfin Whiting	WC	0.1%	0.0%	0.0%

* Does not include catches from the Coorong.

3.4.3 Commercial Importance

The percentage of total gross margin for each species within fishing zones demonstrates the important of a few key species to the commercial sector (Table 6). The majority of species constitute less than 5% of a zone's total gross margins. However, key species such as King George Whiting, Snapper and Southern Calamari have accounted for more than 30% of the gross margin in some zones.

Table 6. The percentages of total gross margins for MSF species in each fishing zone. Stocks that accounted for more than 10% of the gross margin scored 3 points (red shading), stocks that accounted for between 5 and 10% of the gross margin scored 2 points (yellow shading), and stocks that accounted for less than 5% of the gross margin scored 1 point (green shading). Note that these columns do not sum to 100% for all regions as some species included in this economic assessment (such as Gummy Sharks) are not included in the Tiered Management Framework.

Species	GSV/KI	SE	SG	WC
Australian Herring	2%	0%	3%	0%
Black Bream	0%	0%	0%	0%
Blue Crab	0%	0%	0%	18%
Whaler Shark	3%	0%	4%	0%
Cuttlefish	0%	0%	0%	0%
Southern Garfish	14%	1%	15%	1%
King George Whiting	9%	1%	9%	59%
Leather Jacket	0%	0%	0%	0%
Mulloway	1%	1%	0%	0%
Ocean Jacket	1%	0%	2%	0%
Octopus	0%	0%	0%	0%
Blue Throat Wrasse	0%	0%	0%	0%
Sand Crab	0%	0%	2%	1%
Snapper	24%	72%	9%	0%
Snook	2%	0%	1%	0%
Southern Calamari	39%	4.7%	30%	4.7%
Trevally	0%	0%	0%	0%
Western Australian Salmon	2%	1%	1%	0%
Yellow-Eye Mullet	0%	2%	1%	0%
Yellowfin Whiting	3%	0%	13%	0%

3.4.4 Level of Commercial Targeting

Level of commercial targeting ranged from 0% for stocks that have minor catches in some zones to stocks that are 100% targeted. Stocks with 0% targeting often occurred for species that are caught in low numbers in some fishing zones, where targeting would not be expected (Table 7). This included stocks such as Yellowfin Whiting in the SE zone and Yellow-Eye Mullet in the WC zone. Stocks that were 100% targeted often had fishing gears that were specific to those species, such as Octopus and Ocean Jacket.

Table 7. The percentage target versus non-target total catch by weight for each stock over a five-year period (2015/16 – 2019/20). A stock whose level of targeting is above 75% (i.e., 75% percent of its total catch is targeted) scored as 3 points (red shading), a stock whose level of targeting is 50-75% scored 2 points (yellow shading), and a stock whose level of targeting is less than 50% scored 1 point (green shading).

Species	GSV/KI	SE	SG	WC
Australian Herring	10%	13%	15%	37%
Black Bream	97%	82%	1%	0%
Blue Crab	0%*	0%	100%*	100%
Whaler Shark	90%	85%	85%	93%
Cuttlefish	2%	0%	86%	0%
Southern Garfish	77%	100%	63%	91%
King George Whiting	77%	56%	89%	100%
Leather Jacket	11%	14%	3%	7%
Mulloway	54%	94%	4%	48%
Ocean Jacket	0%	0%	100%	100%
Octopus	0%	78%	100%	100%
Blue Throat Wrasse	44%	40%	57%	87%
Sand Crab	100%	0%	100%	100%
Snapper	99%	99%	96%	95%
Snook	31%	100%	20%	87%
Southern Calamari	93%	100%	82%	99%
Trevally	9%	57%	68%	80%
Western Australian Salmon	85%	98%	91%	62%
Yellow-Eye Mullet	38%	97%	27%	0%
Yellowfin Whiting	69%	0%	61%	9%

*Blue Crab fishing by MSF fishers in GSV/KI and SG is restricted to areas east of Elliston.

3.4.5 Management Need

The management need of each MSF species within each fishing zone was scored as follows:

3.4.5.1 Snapper

Snapper fishing is currently prohibited in in the GSV/KI, SG and WC zones due to the depleted statuses of the GSV and SG/WC stocks. Fishing is permitted for all sectors in the SE fishing zone through a TAC which is divided into a TACC and TARC based on sectoral catch shares. Snapper scored 3 points for management need in all four fishing zones as ongoing management is required to ensure sustainability.

3.4.5.2 King George Whiting

King George Whiting have had numerous management measures implemented in recent fishing seasons to ensure sustainability in the SG and GSV/KI fishing zones. These included changes to legal minimum lengths, and spatial and temporal closures to protect spawning aggregations. While the SG and GSV/KI stocks are now classified as sustainable (Drew *et al.* 2021), this was achieved through directed management. Therefore, King George Whiting scored 3 points for management need in both the SG and GSV/KI fishing zones.

King George Whiting in the WC fishing zone have lower harvest fractions than the SG and GSV/KI stocks due to its large biomass. Much of the adult portion of the stock resides offshore away from the primary fishing grounds, providing refuge from most fishing activities. This stock has been classified as sustainable and has not required management intervention. Therefore, King George Whiting in the WC fishing zone scored 1 point for management need.

King George Whiting in the SE fishing zone have negligible commercial catches and have not required directed management. Therefore, it scored 1 point for management need.

3.4.5.3 Southern Garfish

Southern Garfish in the SG and GSV/KI zones have had substantial management interventions that have included changes to legal minimum lengths, gear restrictions, and spatial and temporal closures. Therefore, Southern Garfish in the SG and GSV/KI fishing zones scored 3 points for management need.

Southern Garfish have negligible commercial catches in the SE and WC fishing zones. Therefore, they scored 1 point for management need in these zones.

3.4.5.4 Southern Calamari

Southern Calamari has a single biological stock that spans southern Australia. Although the resource is considered ‘sustainable’ at the biological stock level, there are concerns within industry about local productivity, with anecdotal reports suggesting some areas may show localised depletion (Drew *et al.* 2021). These inferences have been based on Southern Calamari becoming increasingly difficult to catch in areas that were previously highly productive, a lack of eggs in known spawning areas, and a notable absence of large animals. Although localised depletion can occur through intense fishing pressure on spawning aggregations, their high-paced life history, dynamic spawning behaviour, and movement potential, favours population replenishment at the broader biological stock level (Pecl et al. 2006). There has been a declining trend in commercial CPUE in southern SG, where recent catches have been highest for several years, further indicating that localised depletion is possible and may be occurring (Drew et al. 2021). A ‘High’ risk level was assigned to Southern Calamari should catches increase by 25% and a ‘Severe’ risk level was assigned for catches larger than this (Fowler et al 2020a). Therefore, Southern Calamari have scored 3 points for SG zones and 2 points for the GSV/KI and WC zones for management need. Commercial catches of Southern Calamari in the SE fishing zone are negligible and scored 1 point for management need.

3.4.5.5 Yellowfin Whiting

The stock structure of Yellowfin Whiting is currently unresolved but is treated as two stocks in SG and GSV/KI for assessment purposes. Commercial catches in the rest of the State are negligible. Yellowfin whiting are associated with shallow, tidal creeks and adjacent coastal waters which may allow for localised depletion to occur through easy targeting. Recent research has demonstrated the potential for small and isolated sub-populations to exist in each gulf. There have been reports of localised depletion from both recreational and commercial sectors for both gulfs although at present both stocks are classified as sustainable. As commercial catch and effort dynamics have been driven by market demands for this species, it is likely that effort displacement will occur for this species following the reform, given that it is one of the more valuable secondary species in the fishery. A 'High' risk level was assigned to Yellowfin Whiting should catches increase by 25 - 50% and a 'Severe' risk level was assigned for catches larger than this (Fowler et al 2020a). Therefore, Yellowfin whiting scored 2 points for both the SG and GSV/KI fishing zones. However, this may warrant a higher score in future applications of this framework should increased targeting occur following the reform.

3.4.5.6 Western Australian Salmon

Western Australian Salmon have a migratory biological stock that extends from southern Western Australia to the east coast of Tasmania, with each State harvesting different life-history stages. A 'Medium' risk level was assigned to Western Australian Salmon should catches increase by 25% and a 'High' risk level was assigned for catches larger than 50% (Fowler et al 2020a). The commercial harvest of Western Australian Salmon in SA has been managed through a TACC with varying entitlements allocated to licence holders with net endorsements. Given this existing TACC management, as well as Western Australian Salmon being a single stock shared with jurisdictions with high commercial catches than SA, this species scored 2 points for all four fishing zones.

3.4.5.7 Australian Herring

Similar to Western Australian Salmon, Australian Herring have a migratory biological stock that extends from Shark Bay in WA to Forster in NSW. In SA, commercial catch and effort have declined due to netting closures implemented in 2005. Large catches of this shared stock also occur in WA. The WA portion of the stock has previously been overexploited but has now recovered through management intervention. A 'Medium' risk level was assigned to Australian Herring should catches increase by 50% and a 'High' risk level was assigned for catches larger than this (Fowler et al 2020a). As a result of the current management in SA and the high levels of catch that occur interstate, Australian Herring scored 3 points for the SG and GSV/KI fishing zones. Commercial catches in the WC and SE zones are negligible and therefore scored 1 point for management need.

3.4.5.8 Snook

There is little information on the stock structure of Snook throughout its broad distribution. In SA, Snook are managed using a legal minimum length and with fishing effort limited through general input controls on netting gear. A 'Low' risk level was assigned to Snook should catches increase by 25% (Fowler et al 2020a). Snook scored 1 point for management need in all four fishing zones.

3.4.5.9 Blue Crab

Blue Crab catch and effort for the MSF is limited by gear endorsements for lift/hoop/crab nets on specific licences. The majority of Blue Crab catch and effort by MSF fishers occurs in the WC zone, outside of the Blue Crab Fishery (BCF) fishing zones. As the BCF is managed separately, only Blue Crabs in the WC fishing zone are included in this framework. This species was not assessed in Fowler et al (2020a). This fishing zone scored 1 point for management need.

3.4.5.10 Sand Crab

Sand crabs are managed through gear endorsements on a small number of MSF licences and a legal minimum size. A 'low' risk level was assigned to Sand Crabs should catches increase by 25% (Fowler et al 2020a). Sand Crabs scored 1 point for management need in all four fishing zones.

3.4.5.11 Yelloweye Mullet

Yelloweye mullet are a fast-growing, short-lived species with a life history that provides tolerance to over-exploitation from small to moderate catches. Data suggest that there are two stocks across Southern Australia, with fish from SG, GSV/KI and the SE fishing zones belonging to the Eastern stock. Broad netting restrictions limit the commercial effort for Yelloweye Mullet and recent catches have been low in comparison to historical levels. A 'Low' risk level was assigned to this species should catches increase by 25% (Fowler et al 2020a). Yelloweye scored 1 point for management need in all four fishing zones.

3.4.5.12 Mulloway

Mulloway is a slow-growing and late-maturing species which has higher recreational catches in comparison to the commercial sector. Broad netting restrictions limit the commercial effort. A 'High' risk level was assigned to Mulloway should catches increase by 25% and a 'Severe' risk level was assigned for catches larger than this (Fowler et al 2020a). However, catches of Mulloway are low for the commercial sector and occur mostly through the recreational sector. Therefore, Mulloway scored 1 point for management need in all four fishing zones.

3.4.5.13 Whaler Sharks

There are two species of Whaler Sharks, Bronze Whalers (*Carcharhinus brachyurus*) and Dusky Whalers (*C. obscurus*) that are caught in the MSF but are not differentiated in logbooks. Both are considered in a combined assessment, but each classified as 'undefined' as a result (Drew et al. 2021). Both species are long-lived and slow-maturing, which provides increased vulnerability to over exploitation. Input controls on netting and longline gears are used to limit effort. However, there are no minimum commercial size limits. A 'Severe' risk level was assigned to Whaler Sharks should catches increase by 25% (Fowler *et al.* 2020a). Whaler Sharks scored 2 points for management need in all four fishing zones.

3.4.5.14 Ocean Jacket

The Ocean Jacket is a large species of Leatherjacket that is short-lived and fast-growing. Current regulations restrict access to a small number of MSF licence holders who have endorsements for Ocean Jacket traps. These restrictions have curtailed the expansion of the fishery and recent catches have been significantly lower than the historical high catches. A 'Negligible' risk level was assigned to Ocean Jackets should catches increase by 25% (Fowler et al 2020a). Ocean Jackets scored 1 point for management need in all four fishing zones.

3.4.5.15 Blue Throat Wrasse

Blue Throat Wrasse has a harvest slot limit due to their sequential hermaphroditic reproduction. A 'High' risk level was assigned should catches increase by 25% (Fowler et al 2020a). However, commercial catch and effort are low or negligible in all four fishing zones. Blue Throat Wrasse scored 1 point for management need in all four fishing zones.

3.4.5.16 Silver Trevally

Silver Trevally are long-lived and slow-growing, but their population structure is poorly understood. Commercial catches are negligible in all four fishing zones. A 'High' risk level was assigned to Trevally should catches increase by 25% (Fowler et al 2020a). However, commercial catch and effort are low or negligible in all four fishing zones. Silver Trevally scored 1 point for management need in all four fishing zones.

3.4.5.17 Leatherjackets

There are several species of Leatherjackets that occur in South Australia (in addition to Ocean Jackets) which are assessed as a species complex with a stock status classified as 'undefined'. A 'Medium' risk level was assigned to Leatherjacket should catches increase by 25% (Fowler et al 2020a). There is minimal management in place for Leatherjackets and commercial catches are low in all four fishing zones. Leatherjackets scored 1 point for management need in all four fishing zones.

3.4.5.18 Cuttlefish

A large Cuttlefish aggregation exists at False Bay in northern Spencer Gulf which has suffered population declines and subsequent recovery in recent years. A cephalopod fishing closure is in place to protect this population. Commercial catches of Cuttlefish are negligible in all fishing zones. The SG zone scored 3 points for management need. All three remaining fishing zones scored 1 point for management need.

3.4.5.19 Black Bream

Black Bream is a slow-growing and long-lived species that complete most of their life cycle within a single estuary. This results in some vulnerability to population depletion through over-exploitation or changes in environmental conditions. The stock in the Coorong is currently depleted which demonstrates its susceptibility to population declines. A 'High risk level was assigned to Leatherjacket should catches increase by 25-50% (Fowler et al 2020a). Catch and effort in the MSF are low in all fishing regions and are limited through general netting restrictions imposed by management. Commercial catches are negligible in all four fishing zones. Black Bream scored 1 point for all four fishing zones.

3.4.6 Final Tier Classifications

A total of 32 stocks were assigned a management Tier, based on having five-year average annual commercial catches that were greater than 5t (Table 8). This included ten stocks from Gulf St Vincent (GSV/KI), 15 stocks from Spencer Gulf (SG), six stocks from the West Coast (WC) and one stock from the South East. A total of eleven stocks were assigned as Tier 1, eleven stocks as Tier 2 and ten stocks as Tier 3. The four current primary species in the MSF (Southern Garfish, King George Whiting, Snapper and Southern Calamari) were all assigned as Tier 1 stocks in SG and GSV/KI, Snapper in the SE and King George Whiting in the WC were assigned as Tier 1 (Table 8). The Tiered Management Framework results for all assessed stocks across the four zones is provided in Appendix B. This includes stocks that were classed as 'negligible' and for which management tiers will not be applied (Appendix B).

Table 8. Results of the Tiered Management Framework for MSF stocks that qualify for a Tier assignment (i.e., five-year average catch > 5t). *The Aboriginal/Traditional Importance indicator remains under development. Therefore, all stocks were assigned a temporary score of 1 that will be increased as necessary once this indicator has been completed and applied.

		Tiered Management Indicators							
Species	Zone	Stock Status	Aboriginal/ Traditional Importance*	Commercial Importance	Management Need	Level of Commercial Targeting	Recreational Importance	Total Score	Tier
Southern Garfish	GSV/KI	3	1	3	3	3	3	16	Tier 1
Snapper	GSV/KI	3	1	3	3	3	3	16	Tier 1
Snapper	SG	3	1	2	3	3	3	15	Tier 1
Southern Garfish	SG	2	1	3	3	2	3	14	Tier 1
Snapper	SE	1	1	3	3	3	3	14	Tier 1
Southern Calamari	SG	1	1	3	3	3	3	14	Tier 1
King George Whiting	GSV/KI	1	1	2	3	3	3	13	Tier 1
King George Whiting	SG	1	1	2	3	3	3	13	Tier 1
Snapper	WC	3	1	1	3	3	2	13	Tier 1
Southern Calamari	GSV/KI	1	1	3	2	3	3	13	Tier 1
King George Whiting	WC	1	1	3	1	3	3	12	Tier 1
Blue Crab	WC	1	1	3	1	3	2	11	Tier 2
Southern Calamari	WC	1	1	1	2	3	3	11	Tier 2
Yellowfin Whiting	SG	1	1	3	2	2	2	11	Tier 2
Australian Herring	GSV/KI	1	1	1	3	1	3	10	Tier 2
Australian Herring	SG	1	1	1	3	1	3	10	Tier 2
Western Australian Salmon	GSV/KI	1	1	1	2	3	2	10	Tier 2
Western Australian Salmon	SG	1	1	1	2	3	2	10	Tier 2
Whaler Sharks	GSV/KI	1	1	1	2	3	1	9	Tier 2
Whaler Sharks	SG	1	1	1	2	3	1	9	Tier 2
Whaler Sharks	WC	1	1	1	2	3	1	9	Tier 2
Yellowfin Whiting	GSV/KI	1	1	1	2	2	2	9	Tier 2
Ocean Jacket	SG	1	1	1	1	3	1	8	Tier 3
Octopus	SG	1	1	1	1	3	1	8	Tier 3
Octopus	WC	1	1	1	1	3	1	8	Tier 3
Sand Crab	SG	1	1	1	1	3	1	8	Tier 3
Leather Jacket	GSV/KI	1	1	1	1	1	2	7	Tier 3
Leather Jacket	SG	1	1	1	1	1	2	7	Tier 3
Blue Throat Wrasse	SG	1	1	1	1	2	1	7	Tier 3
Snook	GSV/KI	1	1	1	1	1	2	7	Tier 3
Snook	SG	1	1	1	1	1	2	7	Tier 3
Yellow-Eye Mullet	SG	1	1	1	1	1	2	7	Tier 3

3.5 RBCs for MSF Stocks

RBCs were determined for all Tier 1 and Tier 2 stocks according to the best available information (i.e., integrated stock assessment models, catch only models or recent average catches) (Table 9). The commercial share of the RBC was calculated using the regional sectoral catch shares for each species (Table 3).

Table 9. The Recommended Biological Catches (RBCs) for Tier 1 and Tier 2 species determined by the Tiered Management Framework. The assessment programs used to estimate these RBCs are also provided.

Species	Zone	Tier	Scientific assessment program	RBC (t)	Commercial share of RBC (t)
Southern Garfish	**GSV/KI**	Tier 1	Age/Length structured model	61	50
Southern Garfish	**SG**	Tier 1	Age/Length structured model	79	61
King George Whiting	**GSV/KI**	Tier 1	Age/Length structured model	188	76
King George Whiting	**SG**	Tier 1	Age/Length structured model	394	175
King George Whiting	**WC**	Tier 1	Age/Length structured model	672	473
Snapper	**SE**	Tier 1	Age/Length structured model	48	36
Snapper	**SG**	Tier 1	Age/Length structured model	0	0
Snapper	**WC**	Tier 1	Age/Length structured model	0	0
Snapper	**GSV/KI**	Tier 1	Age/Length structured model	0	0
Southern Calamari	**SG**	Tier 1	Average commercial catch (2015/16 – 2019/20)	NA	204
Southern Calamari	**GSV/KI**	Tier 1	Average commercial catch (2015/16 – 2019/20)	NA	162
Southern Calamari	**WC**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	9
Blue Crab	**WC**	Tier 2	cMSY	61	49
Yellowfin Whiting	**SG**	Tier 2	cMSY	133	110
Yellowfin Whiting	**GSV/KI**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	14
Australian Herring	**GSV/KI**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	27
Australian Herring	**SG**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	60
Western Australian Salmon	**GSV/KI**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	77
Western Australian Salmon	**SG**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	204
Whaler Sharks	**SG**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	18
Whaler Sharks	**WC**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	16
Whaler Sharks	**GSV/KI**	Tier 2	Average commercial catch (2015/16 – 2019/20)	NA	18

3.5.1 Tier 1 RBCs

3.5.1.1 Southern Garfish (GSV/KI and SG)

An age-and-length structured stock assessment model (McGarvey *et al.* 2007) was used to determine RBCs for Southern Garfish in Tier 1 zones (SG and GSV/KI). This model is currently applied every three years to determine stock status for Southern Garfish in South Australia and was last applied in 2017 (Steer *et al.* 2018b). It is next due to be applied in 2022. The average modelled biomass from the final five years of the model time series (2013 – 2017) was used to determine an RBC using the target harvest fraction listed in the management plan (PIRSA 2013).

The RBCs for SG and GSV/KI were 265t and 204t, respectively (Fig 25). The target harvest fraction listed in the management was 0.3. Therefore, the RBCs for SG and GSV/KI were 80 t and 61t, respectively. As the commercial shares for SG and GSV/KI were 78% and 81%, respectively, the recommended TACCs were 61t and 50t (Table 9).

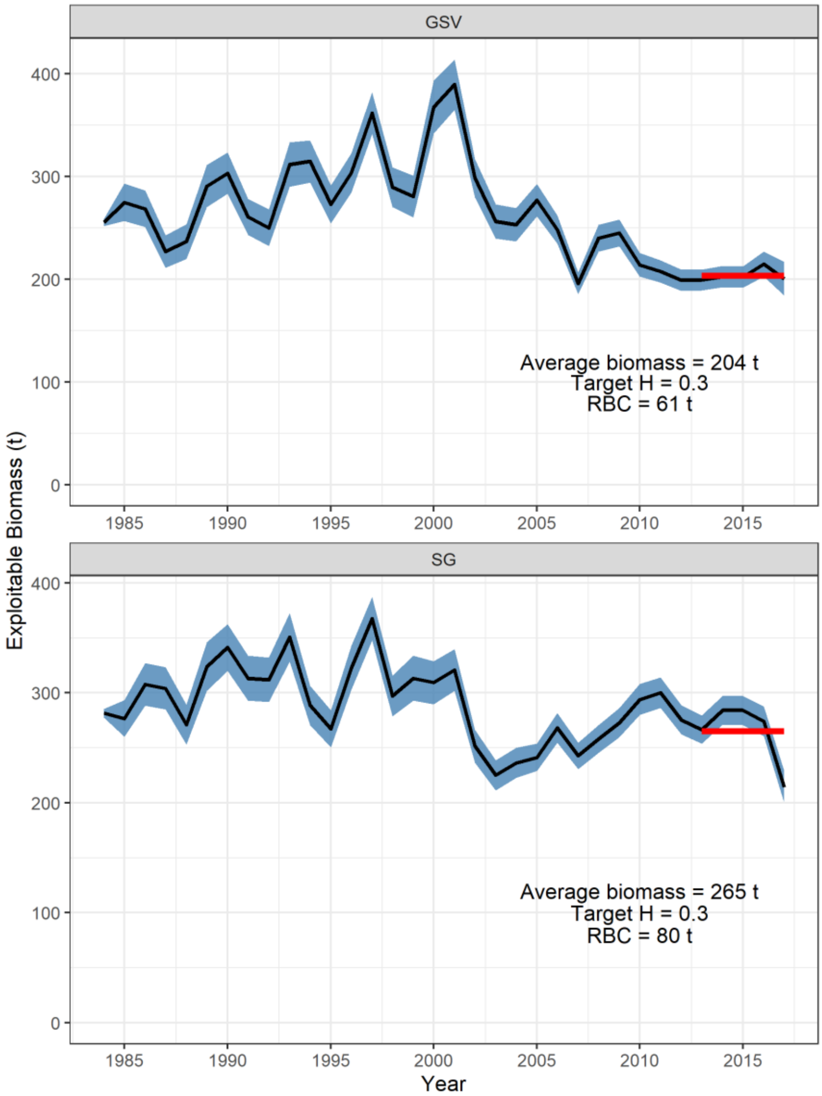

Figure 25. Model-based exploitable biomass estimates for Southern Garfish in Gulf St Vincent (GSV/KI) and Spencer Gulf (SG). Black line indicates the model estimates of annual exploitable biomass, and the blue shading represents the standard error of these estimates. The red line indicates the time period used to determine the RBC for each stock.

3.5.1.2 King George Whiting (GSV/KI, SG, and WC)

Similar to Southern Garfish in Tier 1 zones, an age-and-length-structured stock assessment model was used to determine the RBCs for King George Whiting in Tier 1 fishing zones. This model is also applied every three years to determine stock status for Southern Garfish in South Australia and was last applied in 2016 (Steer *et al.* 2018a). The average modelled biomass from the final five years of the model time series (2012 – 2016) was used to determine an RBC using the target harvest fraction listed in the management plan (PIRSA 2013).

The RBCs for Tier 1 King George Whiting stocks were 1,408 t, 671 t and 2,401 t for SG, GSV/KI and WC, respectively (Fig 26). The target harvest fraction listed in the management plan is 0.28. Thus, the RBCs for SG, GSV/KI and WC were 394 t, 188t and 672 t, respectively. As the commercial shares for SG, GSV/KI and WC were 44%, 41% and 70%, respectively, the recommended TACCs were 175t, 76t and 473t (Table 9).

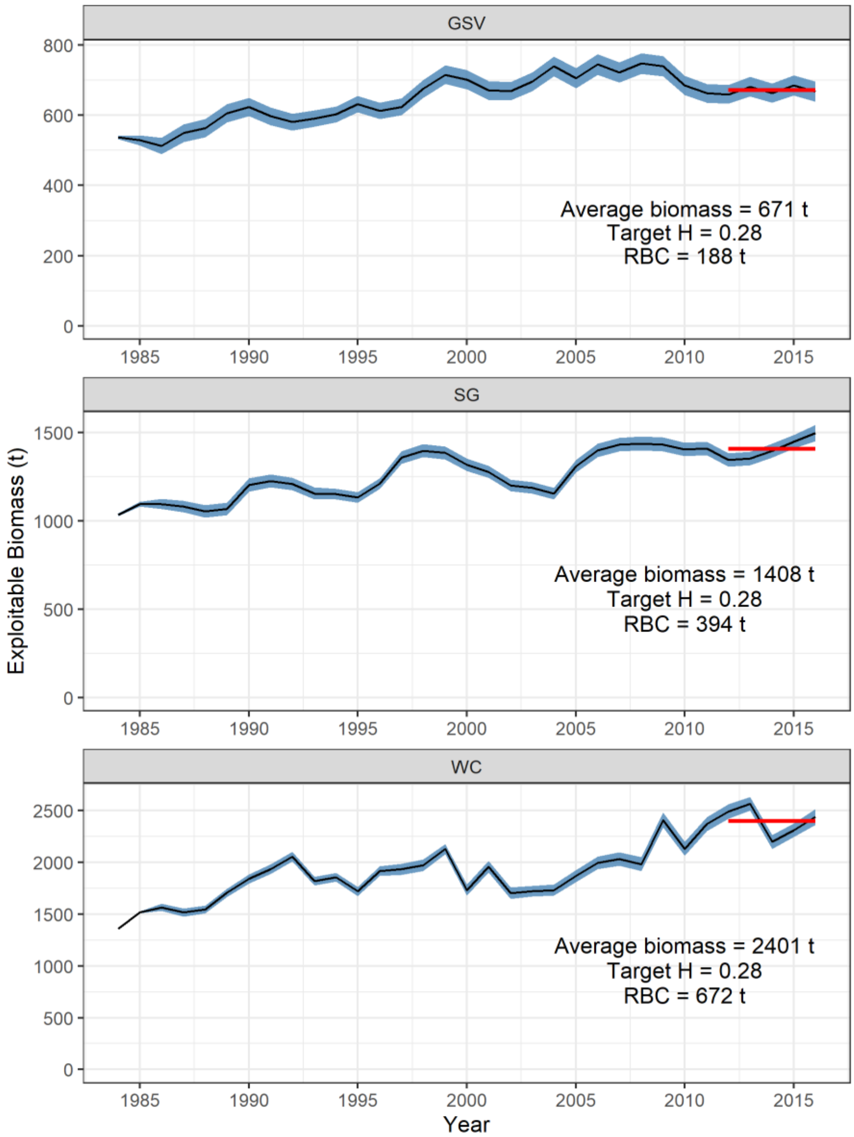

Figure 26. Model-based exploitable biomass estimates for King George Whiting in Gulf St Vincent (GSV), Spencer Gulf (SG) and the West Coast (WC). Black line indicates the model estimates of annual exploitable biomass, and the blue shading represents the standard error of these estimates. The red line indicates the time period used to determine the RBC for each stock.

3.5.1.3 Snapper (GSV/KI, SG, WC and SE)

The Snapper fisheries in the GSV/KI, SG and WC zones of management are currently closed following stock declines that lead to a 'Depleted' status for the Gulf St Vincent stock (GSVS) and Spencer Gulf/West Coast stock (SG/WCS) (Fowler *et al.* 2020b). However, the SE Snapper fishery was classified as sustainable and has been managed with a TAC since February 2020. The RBC for SE Snapper was determined from the model-based biomass estimate from 2020 of 160t and a 0.3 target harvest fraction. This target harvest fraction was determined by examining the stock's response to exploitation using the time series of biomass and harvest fraction from the stock assessment model. This revealed that the stock remained stable during periods when the harvest fraction remained below 0.3. Therefore, this was recommended as the target harvest fraction which provided an RBC of 48t. The commercial share of the RBC was 75% which equated to a 36t TACC (Table 9).

3.5.1.4 Southern Calamari (GSV/KI and SG)

No stock assessment models are currently available for Southern Calamari, nor are there any target harvest fractions listed in the management plan. Therefore, cMSY models were applied to initially determine RBCs for each Tier 1 fishing zone. For SG, the 2019 biomass was above B_{MSY} so the MSY was used to determine an RBC of 370t. For GSV/KI zones of management and provide RBCs. The harvest fraction corresponding to MSY (H_{MSY}) determined by, the cMSY also determined that the 2019 biomass was above B_{MSY} (693 t) and therefore the MSY provided the RBC of 373 t. As the commercial shares for SG and GSV/KI were 62% and 60%, respectively, the commercial shares of these RBCs were 234t and 228t.

Both fishing zones have variable recreational catches which were highest in the 2000/01 survey and therefore provide large hindcasted catches prior to this. This is problematic as it suggests that annual recreational catches can be quite variable and the interpolation of catches between and prior to surveys may be overly influential for a cMSY assessment. Therefore, a low level of confidence is attributed to both of these assessments. Using these RBCs to set provisional TACCs is not recommended for either fishing zone.

As the results of the cMSY assessments were not suitable for management, five-year average catches were used to provide provisional TACCs. These were 204 t and 162 t for SG and GSV/KI, respectively (Table 9).

3.5.2 Tier 2 RBCs

3.5.2.1 Southern Calamari (WC)

A cMSY model was initially used to determine an RBC for Southern Calamari in the WC fishing zone. Similar to Southern Calamari in the Tier 1 fishing zones, annual estimates of recreational catch introduced high levels of uncertainty into this assessment. As recreational catches are larger than commercial catches, they are particularly important for this assessment and the level of certainty in these annual estimates is insufficient for management decisions to be based on them. As the results of the cMSY assessment were not suitable for management, the five-year average catch of 9t was used to provide a target commercial catch (Table 9).

3.5.2.2 Blue Crab (WC)

The RBC for Blue Crabs on the WC was successfully determined using a cMSY model (Fig 27). The cMSY determined that the biomass in 2019 was above B_{MSY}. Therefore, the MSY of 61 t provided the RBC. The commercial share of the RBC was 82% which equates to 49 t (Table 9).

Recreational catches have been stable between fishing surveys, providing moderate confidence that this time series is representative of the annual recreational catches within the WC zone. As commercial catches of Blue Crabs in most years have been higher than recreational catches, these data provide the most information to the cMSY assessment. Therefore, these results are appropriate for management advice.

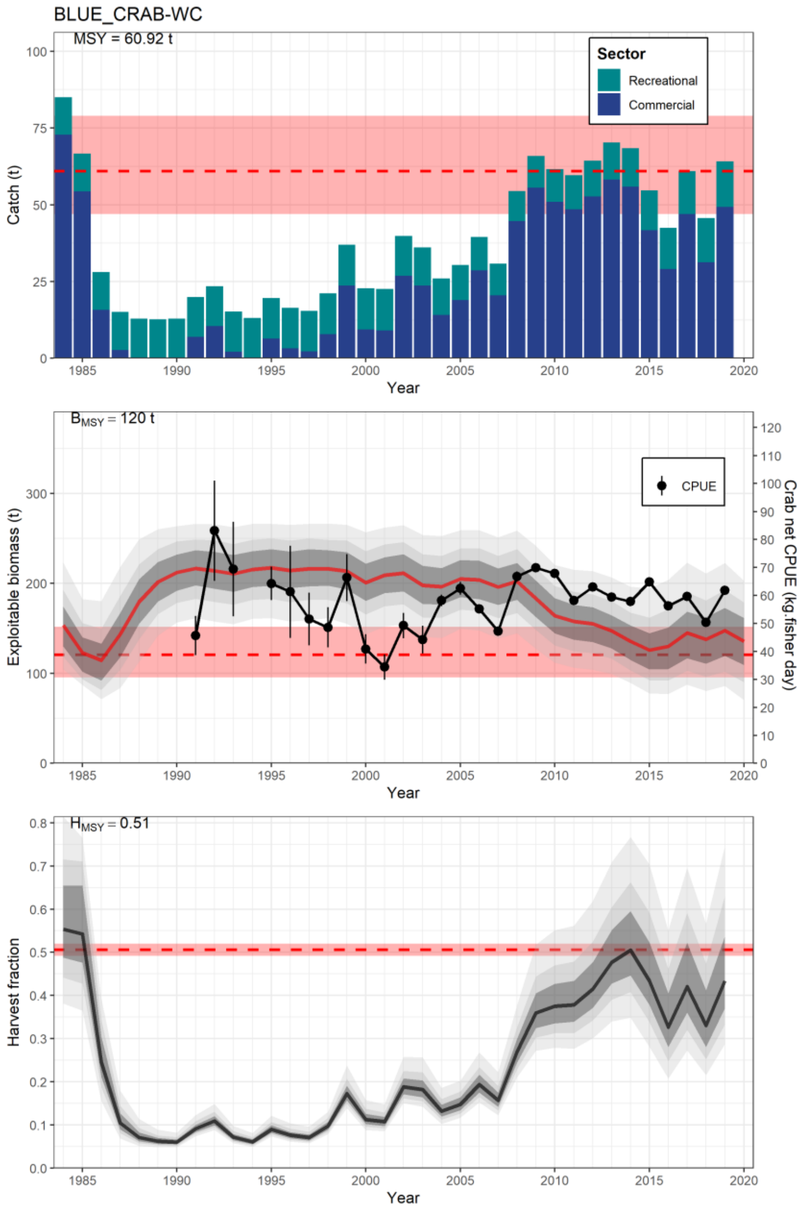

Figure 27. Outputs of the cMSY model for Blue Crab on the West Coast. The top panel displays annual commercial catch and estimated recreational catch which has been linearly interpolated between surveys in 2000/01, 2007/08 and 2014/15. The middle panel displays the time series of exploitable biomass (red solid line) with 50th, 75th and 95th percentiles (Grey shading that goes from darker to lighter shades, respectively) and commercial crab net CPUE (kg.per fisherday) (Black line and points). The bottom panel displays annual harvest fraction (*H*) (black line) with 50th, 75th and 95th percentiles (Grey shading that goes from darker to lighter shades, respectively). Each panel displays its respective value relating to MSY (red dashed line) and its 95th percentiles (red shading).

3.5.2.3 Yellowfin Whiting SG

The RBC for Yellowfin Whiting in the SG fishing zone was determined using a cMSY model (Fig 28). The cMSY determined that the biomass in 2019 was above B_{MSY}. Therefore, the MSY of 133 t provided the RBC. The commercial share of the RBC was 83% which equates to 110 t (Table 9).

Recreational catches have been stable between surveys and substantially lower than commercial catches across all years. Haul net restrictions implemented in 2005 have not impacted catches, as has occurred for other species (Fig 28). Therefore, the results provided from this assessment can be used in management advice.

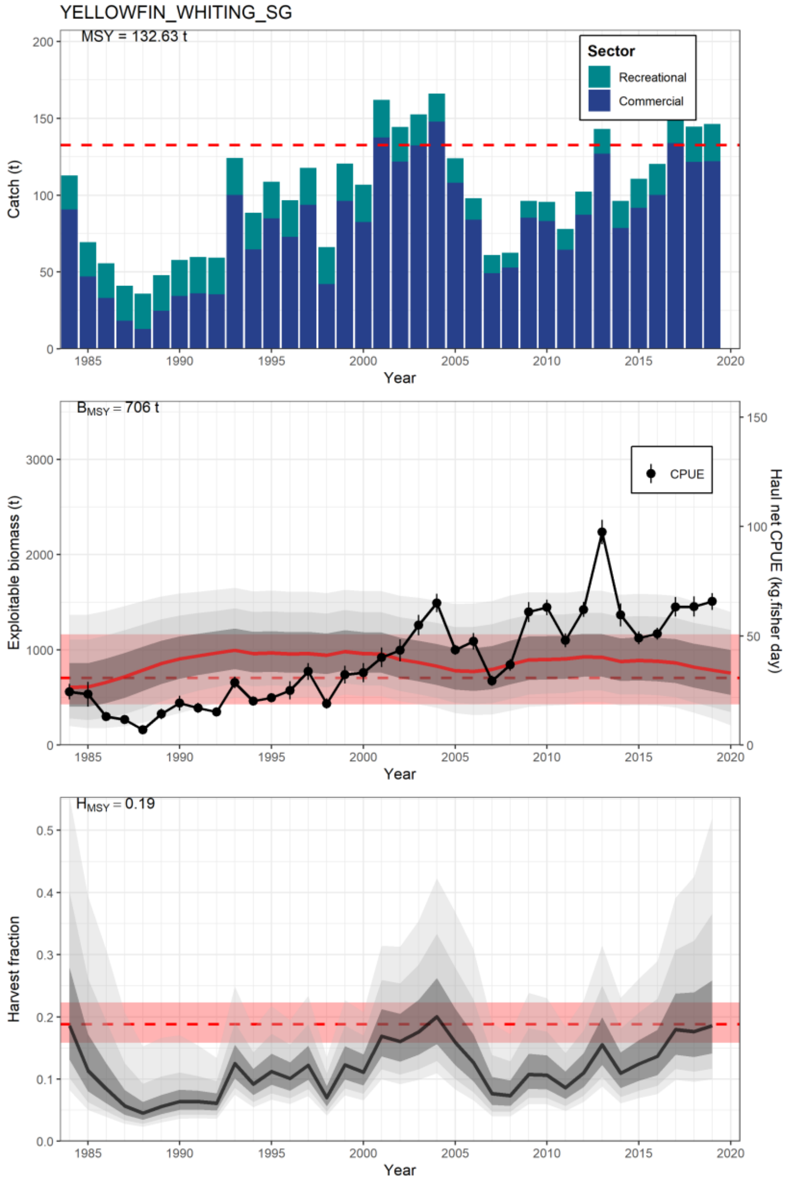

Figure 28. Outputs of the cMSY model for Yellowfin Whiting in SG. The top panel displays annual commercial catch and estimated recreational catch which has been linearly interpolated between surveys in 2000/01, 2007/08 and 2014/15. The middle panel displays the time series of exploitable biomass (red solid line) with 50th, 75th and 95th percentiles (Grey shading that goes from darker to lighter shades, respectively) and commercial haul net CPUE (kg.per fisherday) (Black line and points). The bottom panel displays annual harvest fraction (*H*) (black line) with 50th, 75th and 95th percentiles (Grey shading that goes from darker to lighter shades, respectively). Each panel displays its respective value relating to MSY (red dashed line) and its 95th percentiles (red shading).

3.5.2.4 Yellowfin Whiting GSV

A cMSY model was initially used to determine an RBC for Yellowfin Whiting in the GSV/KI fishing zone. However, as recreational catches are uncertain and potentially larger than commercial catches, the RBC from this assessment was not suitable for use in management advice. Recreational catch was highest in the 2000/01 survey and therefore hindcasted catches prior to this were large and potentially overestimated, especially when compared to commercial catches in the 1990's. Recreational catches were higher than commercial catches in most years, except for some years in between 2002 and 2013.

As the results of the cMSY assessment were not suitable for management, the five-year average catch of 14t was used to provide a target commercial catch (Table 9).

3.5.2.5 Western Australian Salmon (GSV/KI and SG)

A cMSY assessment could not be performed for Western Australian Salmon due to its life history. Western Australian Salmon constitute a single stock across southern Australia where the spawning population is located in WA and juveniles are harvested in SA as ontogenetic movement occurs via western migration. As a result, stock assessment models must include data and information from other jurisdictions as well as SA. Therefore, cMSY assessments could not be applied and five-year average catches were used to provide management advice for target commercial catches in both Tier 2 fishing zones (Table 9). These were 204t and 77t for SG and GSV/KI, respectively.

3.5.2.6 Australian Herring (GSV/KI and SG)

Australian Herring have a similar life history to Western Australian Salmon and therefore a cMSY assessment could also not be performed for this species. Five-year average catches were used to provide management advice for target commercial catches in both Tier 2 fishing zones (Table 9). These were 60t and 27t for SG and GSV/KI, respectively.

3.5.2.7 Whaler Sharks (GSV/KI, SG and WC)

Whaler Sharks are assessed as part of a species complex in MSF assessment reports as the different species are not distinguished in logbook records (Drew et al. 2021). Therefore, cMSY assessments could not be applied and five-year average catches were used to provide management advice for target commercial catches (Table 9). These were 18t, 18t and 16t for SG, GSV/KI and WC, respectively.

3.5.3 Interim TACCs

Because the formal co-management forum (MSFMAC) had not yet been established, the interim TACCs for Tier 1 stocks (with the exception of King George Whiting in the WC zone and Snapper in the SE zone) were recommended by the Snapper MAC based on recent five-year catch averages (Table 10). For SE Snapper, the TACC was set using model-derived outputs in the most recent Snapper stock assessment (Fowler *et al.* 2020b), as recommended by the Snapper MAC. Similarly, a TACC was set using the commercial share of the model-based RBC for King George Whiting in the WC zone, although this stock was not unitised through ITQs.

Table 10. The interim Total Allowable Commercial Catches (TACCs) for Tier 1 stocks for the 2021/22 fishing season. [14]

	King George Whiting (t)	Southern Garfish (t)	Calamari (t)	Snapper (t)
West Coast Fishing Zone	473	N/A	N/A	0
Spencer Gulf Fishing Zone	111	100	204	0
Gulf St Vincent Fishing Zone	46	71	162	0
South East Fishing Zone	N/A	N/A	N/A	36

These TACCs were maintained for the 2022/23 fishing season based on recommendations from the MSFMAC. The only exception was King George Whiting in the West Coast Fishing Zone where the TACC was reduced to 183 t. The reduction of the TACC for this stock was made to align with a harvest fraction (12.5%) that corresponds with MSY instead of the ≤28% harvest fraction provided in the MSF Management Plan. Whilst there was no concern for the stock the MSFMAC considered a harvest fraction of 12.5% relating to 2/3 natural mortality was more appropriate (as a proxy for the level of fishing mortality that gives MSY). Whilst a substantial reduction, this recommended TACC was substantially larger the five-year average catch[15].

3.6 Discussion

The evolution of the MSF to ITQ-based management for key commercial species is a landmark event for the fishery and one of the motivations for its reform. Unitising the commercial MSF was complicated because its multi-species nature meant that the need for ITQ-based management would differ between stocks. Similarly, this shared-access fishery needed to consider the importance of each stock to the recreational and Aboriginal/Traditional sectors. This was achieved through the development of the Tiered Management Framework which provides an objective approach to determining the management and assessment needs for each stock. These can then be considered by the MSFMAC that has been formed since the reform was implemented. The Tiered Management Framework presented here is a tool to assist decision making by a committee rather than a process embedded in a management plan. This will allow its use to be tested and monitored as part of the development of impending harvest strategies. Therefore, it can be amended and further tailored as the need arises.

One of the primary uses of the Tiered Management Framework following the MSF reform will be to escalate relevant stocks to higher tiers of management as necessary. This is required as the Tier 1 stocks will potentially be managed via ITQs, restricting their access across the fishery. Therefore, it is strongly anticipated that shifts in effort will occur towards Tier 2 and Tier 3 stocks in the fishery. This will mostly be a desired outcome as it will spread fishing effort across a variety of stocks, reducing the potential for over-exploitation of a few key stocks, as has previously occurred (Steer *et al.* 2018b; Fowler *et al.* 2020b). However, it will be important for

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[14] https://www.pir.sa.gov.au/primary_industry/commercial_fishing/commercial_fisheries/marine_scalefish_fishery/reform/total_allowable_catches
[15] https://www.pir.sa.gov.au/__data/assets/pdf_file/0010/426169/msfmac_meeting_2_chairs_report.pdf

fishery assessments to detect such effort shifts towards species such as Yellowfin Whiting, Western Australian salmon and Australian Herring and for a timely and proportionate management response to occur when necessary. This is a key design element of the Tiered Management Framework that will be implemented following the reform. Initially, its primary use was to determine and justify which stocks required ITQ management and to assign them a Tier 1 status.

Once Tier 1 stocks were established, a quota allocation process was undertaken in order to distribute the TACCs to licence holders according to their licence type and relative catch histories. This process was guided by an independent allocation advisory panel (IAAP) who provided recommendations to the Minister as to how ITQs should be distributed across the fishery. Their final recommendations are provided in Appendix C. ITQs were distributed to licence holders based on their licence type (i.e., net or line licence) and their relative catch history within a reference period. Eighty percent of the ITQ was distributed across licence holders according to their relative catch history, which was calculated for each stock as the sum of their best five years of catch between 2010/11 to 2015/16. An investment warning following this period prevented catch histories in subsequent years from being included. The remaining 20% of ITQs was distributed to licence holders according to the value of their licence, which differed between net licences ($180,000 per licence) and line licences ($140,000 per licence). Licence values were determined through an economic analysis presented in Appendix D (see p. 32).

Currently, no Tier 2 stocks have integrated stock assessment models available to determine an appropriate RBC (Steer *et al.* 2018a). The remaining eligible Tier 2 stocks such as Yellowfin Whiting in SG and Blue Crabs on the WC, have had cMSY models applied to determine their RBCs. These are defined as “data-poor” models as they rely on strong assumptions, qualitative inputs, and minimal levels of data to estimate RBCs (Haddon *et al.* 2019, Martell and Froese 2013). Therefore, despite the application of cMSY assessments to other Tier 2 stocks, their application has been limited to two stocks as the assumptions were not met for the remaining applications (such as Southern Calamari in all zones and Yellowfin Whiting in GSV/KI). For these remaining Tier 1 and Tier 2 stocks, the most defensible RBCs were based on recent estimates of catch. This is not ideal as it relies on these catch levels being sustainable. When this is not the case, stock declines can occur and be perpetuated through TACCs maintaining increasing levels of exploitation (Carruthers et al. 2014). Therefore, this chapter has identified that important Tier 1 and Tier 2 species such as Southern Calamari, Yellowfin Whiting, Western Australian Salmon, Australian Herring and Whaler Sharks all require more sophisticated fishery assessments which should be developed as soon as possible. This could be performed using the recently developed ‘Stock Assessment Toolbox’ to reference the methods available for different stocks based on data availability (Dichmont *et al*. 2021).

Finally, a key area of future research is understanding the importance of MSF stocks to the multiple Aboriginal/Traditional groups in South Australia and developing the indicator for this sector. This represents a significant knowledge gap which has prevented the finalisation of this Tiered Management Framework. To address this, future research is required to consult with different Aboriginal/Traditional groups and determine how this indicator may be developed. The complexity of this task is such that it requires a dedicated research focus and as such, each stock scored here has been assigned a placeholder score of one point for this indicator. Therefore, there is potential for several stocks to be reassigned to a higher tier should the completion and future scoring of the Aboriginal/Traditional indicator warrant it. Currently, it is possible for seven Tier 2 stocks to be reassigned as Tier 1 should they receive a higher score for Aboriginal/Traditional importance (Table 8). Therefore, completion of this tiered management indicator remains imperative and once complete, using it to score these four stocks will need to be prioritised so that appropriate management recommendations can be made by the MSFMAC.

4 Rationalise

4.1 Introduction

Rationalisation is principally about the removal of commercial licences from the fishery to address excessive effort and latent effort issues. If every commercial licence holder fished in a reasonably full-time manner under the current stock status and access arrangements there would be too much exploitation of stocks that are already under pressure from both sectors and, in some cases, classified as depleted.

There have been three notable changes in the history of the MSF that were principally implemented to limit, and then reduce, the number of participants in the commercial sector. The first arrangement was a freeze on the issue of all new licences in 1977, which converted the commercial sector into a limited-entry fishery. This also involved a 'show cause provision' that prevented the re-issue of licences to fishers if a minimum level of commercial fishing had not been met. The second was the licence amalgamation scheme which was introduced in 1994 (Steer and Besley 2016). This scheme was essentially a fractional licensing initiative which required prospective fishers to purchase a certain number of fishing "points" when buying a licence. To either enter the fishery, or hold a transferable licence, fishers were required to purchase at least two existing licences and combine them for a minimum number of points. This scheme had an underlying caveat where only licences that share similar endorsements were permitted to be completely amalgamated. The third effort control strategy, which was implemented in 2005, was a voluntary buy-back of net fishing endorsements, which also coincided with significant spatial closures to net fishing. A similar, smaller licence buy-back was initiated in 2014 in association with implementation of the South Australian Marine Park network.

Despite these historic management approaches, the current size and efficiency of the MSF continued to challenge the sustainable management of this community-shared resource. There remains a need to further reduce fishing capacity to achieve a sustainable and commercially-viable fishery. Fleet rationalisation can be achieved by a variety of approaches, which can be enhanced by government and industry co-funding arrangements.

In order to rationalise the commercial MSF fleet, three important questions were addressed:

1. What benefits to the fishery could be achieved through rationalisation?
2. How many licences would need to be removed to realise these benefits?
3. What is the value of an MSF licence that could be set for a voluntary licence surrender program (VSLP)?

Each of these questions was addressed through economic analyses undertaken by BDO EconSearch and were presented as external reports. These reports are summarised in this chapter with the full reports available as Appendices D, E, and F.

4.2 Financial benefits of rationalisation

An economic analysis of the proposed VLSP was undertaken to demonstrate the impact that it would have on the fishery and justify the commitment of government funds to support the program. The analysis compared two options against a base case: 1) an investment option included investing in buying out approximately 50% of MSF licences and introducing individual transfer quotas (ITQs) for key species, and 2) an input control option included fisheries managers continuing to use input controls to manage the sustainability of the fishery. The base-case was envisaged as the continuation of current conditions, with the MSF becoming unsustainable in the near future.

4.2.1 Methods

The analysis was undertaken using a modified cost benefit analysis (CBA) to determine the incremental net economic return (NER) of the two management options and the base case scenario, as described below:

- Base Case: No further fishery input control measures, stocks continue to decline.
- Option 1: Ongoing fishery input control measures and no buy out of licences, stocks continue to decline but at a slower rate than under the base case.
- Option 2: Effective catch control and stock recovery including a buyout of licences and introduction of ITQs.

The modified CBA was conducted over a 20-year period and one standard evaluation criterion was employed: incremental NER. Economic impact analysis was also undertaken using the BDO EconSearch RISE model of South Australia in 2017/18 (BDO EconSearch 2019). The model uses an extension of the conventional input-output method and was developed for use by the Government of SA in 2019. The indicators used in the impact analysis include full-time equivalent employment, gross state product and household income.

4.2.2 Results

The modified CBA demonstrated whether the proposed investment represents an efficient use of government resources with the following outcomes:

- Option 1 has an incremental net economic return of $2.7m over 20 years
- Option 2 has an incremental net economic return of $51.4m over 20 years

Both options were preferable to the base-case of no further management input, but Option 2 would generate the largest NER. Between the two options, the most profitable was Option 2, namely effective catch control and stock recovery with a buyout of licences and introduction of ITQs.

In terms of gross state product (GSP), Option 1 would generate around $40m more than the Base Case over the 20-year period and around 43 additional fte jobs. The impact of Option 2 was estimated to be much greater; an additional $277m in GSP above the base case over the 20-year period and employment generation of 107 fte jobs above the base case level.

Under Option 2, the proposed fleet size reduction would be expected to reduce employment in the short term but in the longer term would be expected to increase after stocks recover, businesses become more efficient and profitable and catch increases, leading to increased downstream economic activity.

4.3 Fishery Carrying Capacity

The target number of licences to be rationalised through the VLSP was determined by an economic analysis that determined the regional ‘fleet carrying capacity’, i.e., how many licences could each region support economically viable regional fisheries. The overall approach to this analysis is one of ensuring sustainability in the SA MSF where the NER generated by the fishery is greater than zero. Using data on the average catch and effort levels of key species, the number of licences needed in each region to achieve a NER greater than zero was estimated, i.e., lifting the fishery from a position of generating negative economic returns to one of long-term positive returns. The modelling process provided an estimate of the number of licences that needed to be removed from each zone under a fishery restructure to achieve a positive NER.

4.3.1 Methods

The approach was an iterative one where licences and fixed costs associated with these licences, were incrementally removed from the fishery and the income and variable costs associated with these licences redistributed to the remaining licence holders. After each licence was removed the NER was recalculated, and the process continued until the NER in each region became positive.

Two assumptions regarding the structure of fishing businesses were used in this analysis. Businesses that left the fishery were assumed to be either:

- similar to the average financially performing business in that zone; or
- similar to poorer financially performing businesses in that zone who also are less efficient (i.e., have a lower catch per unit effort (CPUE)).

The financial performance indicators report for the SA MSF (BDO EconSearch 2019) provided the data that formed the basis for the economic analysis. The financial indicators were reported for average businesses in each of four financial performance quartiles. The first quartile denoted the worst performing businesses in the fishery in terms of return to total capital, and the fourth quartile denotes the best performing businesses. While the average across all quartiles was used to represent the average performing business, the second quartile data were used to represent the poorer performing businesses.

In addition to the two levels of business performance, three different levels of catch were analysed in the modelling:

1. current catch levels (average between 2011/12 and 2015/16)
2. a 20% reduction in current catch levels for key species, and
3. indicative TACCs for key species.

This analysis was undertaken in October 2019 in advance of the VLSP in order to recommend the number of licences that should be rationalised. Therefore, some information used in this analysis was provisional and has since been updated in other chapters of this project. This included:

- The final zone boundaries. This economic analysis used boundaries provided in Option II presented in the Regionalisation chapter. These zone boundaries were further refined after this economic analysis was complete (Fig. 20).
- Provisional TACCs were used that were later updated by the Snapper MAC.
- The Snapper fishery in the SG, GSV/KI and WC fishing zones was closed in October 2019.

The impacts on the analysis of each of these updates differ. The refinement of the zone boundaries was minor and did not impact the conclusions of this analysis. The provisional TACCs differed to those eventually implemented and included stocks that were ultimately not assigned to Tier 1 (such as King George Whiting on the WC). Therefore, scenario three of this analysis that focused on these provisional TACCs is not presented further in this chapter.

4.3.2 Results

The estimated number of licences that would need to be removed to achieve a positive NER under each of the six scenarios are detailed at a zone level in Table 11. If the fishery were able to operate sustainably at current levels of catch then between 97 and 165 licences would need to be removed to achieve a positive NER, depending on whether those licences had average or poor performances, respectively. This represents a State-wide carrying capacity of 128 – 196 licences.

If the fishery were to operate sustainably with 20% reductions in catch for key species, then between 134 and 186 licences would need to be removed to achieve a positive NER, depending on whether those licences had average or poor performances, respectively. This represents a State-wide carrying capacity of 107 – 159 licences.

The zones that required the greatest proportional licence reductions were WC and GSV/KI which required reductions of 48% and 47% of licences, respectively, under the current catch and average performing business scenario (Table 11). However, under the scenario with current catch levels and poorer performing businesses, the SE zone would require the greatest proportional reduction of 80%.

Table 11. Estimated number of licences to be removed to achieve a positive net economic return. Does not include the 14 licences with Sardine quota.

		WC	SG	GSV/KI	SE	Total
Average business						
	current catch	27	19	44	7	97
	20% reduction in catch of key species	34	35	55	10	134
Poorer performing business						
	current catch	39	53	57	16	165
	20% reduction in catch of key species	43	61	65	17	186
Current number of licences (2017/18)		**56**	**124**	**93**	**20**	**293**

4.4 Voluntary licence surrender program (VLSP)

Rationalisation of the MSF was performed through a dedicated voluntary licence surrender program (VLSP). The program allowed fishers to decide whether to remain in the fishery following the commencement of the reform in July 2021 or surrender their licence for a set price of $180,000 (excluding GST) for a net licence and $140,000 (excluding GST) for a line licence. These prices were determined through an economic analysis of licence valuations that considered industry surveys, productive value of an average net or line licence, holding cost, broker data, transfer values and information collected in BDO EconSearch (2019).

The economic carrying capacity of the MSF was demonstrated to be approximately half its current capacity depending on business performance and catch levels (Table 11), requiring a target of 150 licence surrenders through the VLSP. This required a substantial investment to support the program. As a result, a $24.5 million investment was provided from the South Australian Government to support the VLSP and to cap licence fees for remaining licence holders for five years following the reform.

The VLSP opened in May 2020 with applications for surrender accepted until November 2020. Indicative ITQ allocations for Tier 1 stocks were sent to all licence holders in September 2020 to assist with their decision making. Indicative ITQ allocations were subsequently updated in November with licence surrenders to date removed from the allocation process which increased the ITQ allocations of remaining licence holders. This information was also provided to licence holders to assist in their decision to participate in the VLSP.

Prior to and independent of the MSF reform, ITQs have been in place for Vongole and Sardine for select MSF licences, which have effectively operated as sub-fisheries within the MSF. As part of the reform, the commercial taking of both of these species was separated from the MSF and were constituted as new fisheries under their own regulations. This allowed quota holders of these new fisheries to surrender their MSF licences as part of the VLSP while retaining their access rights to these new fisheries.

4.4.1 Outcome of VLSP

A total of 100 licences were removed from the fishery through the VLSP (Table 12) with 207 licences remaining following the reform. The reduction in licences in each zone was determined by identifying the dominant zone of fishing (total boat days) for the fisher surrendering each licence or based on their home region if no fishing activity was recorded. This identified that licences affiliated with Spencer Gulf (SG) and Gulf St Vincent (GSV/KI) had the highest rates of surrender at 37% and 40%, respectively. Licences on the West Coast (WC) and South East (SE) had lower rates of surrender at 27% and 10% respectively (Table 12). Across the fishery, 33% of licences were surrendered which is less than the target of a 50% reduction in licences (~ 150 licences).

Table 12. The number of licences removed from each zone through the VLSP and the percentage of each zones licences that this constitutes.

	WC	SG	GSV/KI	SE	Total
VLSP surrendered licences	15	49	34	2	100
Number of licences prior to reform (excluding MSF licences that had sardine access)	56	124	93	20	293
% of licences surrendered	**27%**	**40%**	**37%**	**10%**	**33%**

4.5 Impact of rationalisation on fishery dynamics

The voluntary surrender of 100 licences from the fishery will initially result in reductions to catch and effort across the fishery due to fewer operators. Forecasting the long-term impact of fleet rationalisation with a high degree of confidence is not possible because the autonomous industry adjustment that will occur through quota trading cannot be pre-empted. However, hindcasting the effects of fleet rationalisation on fishery statistics may provide insight into the impacts on fishery dynamics for immediate post-reform fishing seasons when this industry adjustment will be underway. Hindcasted effects of fleet rationalisation will provide important information for fisheries management in the first few seasons following the reform while industry adjustment to management changes are underway.

The rationalisation of the MSF fleet also presents complications for comparing fishery indicators pre-and post-reform, such as CPUE. Should the CPUE of various stocks change notably due to fleet rationalisation then it may be difficult to determine the underlying cause following the reform. For example, if fleet rationalisation has led to less effective fishers leaving the fishery, then CPUE may increase as the lower fishing efficiency of these fishers would no longer depress the overall fishery CPUE. This increase could be inadvertently interpreted as an increase in stock size if the effect of fleet rationalisation was not appropriately understood. By hindcasting the impacts of rationalisation, stocks whose fishery indicators may be compromised can be identified. Similarly, provisional TACCs for the fishery were set as five-year average catch for most Tier 1 stocks. If the rationalisation has reduced the number of fishers targeting certain stocks, then there is the potential for TACCs to go uncaught for imminent fishing seasons until the industry adjustment has occurred.

4.5.1 Methods

Hindcasting the fishery statistics required a stepwise approach to determine the effects of fleet rationalisation. Firstly, fishery statistics were calculated using all records in the MSF logbook data, which includes licence holders that have previously exited the fishery independent of the reform. Secondly, fishery statistics were calculated using the current licence holder composition immediately prior to the reform (i.e., as of 30 June 2021). This was required as the MSF has had a high turnover of licence holders and failing to distinguish whether fishers have left the fishery due to the reform or for other reasons would not allow the effects of the VLSP to be determined. Lastly, fishery statistics were calculated using the licence holders who remained following the VLSP. This would allow the immediate effects of fleet rationalisation to be examined. This hindcasting was only applied as far back as 2007/08 when licence transfers were available from digital records. The fishery statistics that were calculated included total catch, total effort, CPUE and number of active fishers for the stocks managed by TACC (Tier 1 stocks and King George Whiting in the WC zone) between 2007/08 and 2019/20 for the three scenarios.

The catch-per-unit-effort (CPUE) of each stock was calculated as the mean targeted catch-per-fisher-day in each financial year using the dominant gear type for that stock. For example, Snapper in SG was calculated using targeted handline CPUE, while Snapper in GSV/KI was calculated as targeted longline CPUE. Any fishery statistics that included fewer than five licence holders in a financial year were treated as confidential and are not presented.

This analysis demonstrates how fleet dynamics (i.e., licence transfers) have impacted the fishery dynamics over the past 13 financial years and how the removal of licences via the VLSP has further influenced these dynamics.

4.5.2 Results

The historical turnover of the MSF fleet was evident through the number of active licence holders fishing for different stocks through time (Fig 29). These results also demonstrated that new entrants to the fishery did not necessarily fish for the same stocks as licence holders who exited the fishery. This is demonstrated by opposing trends in the complete fishery records and the pre or post reform fleet fishery statistics. For example, the number of licence holders that fished for Snapper in SG declined substantially over time, while the composition of pre-reform fleet has increasingly targeted stocks such as Southern Calamari in SG and GSV/KI (Fig 29).

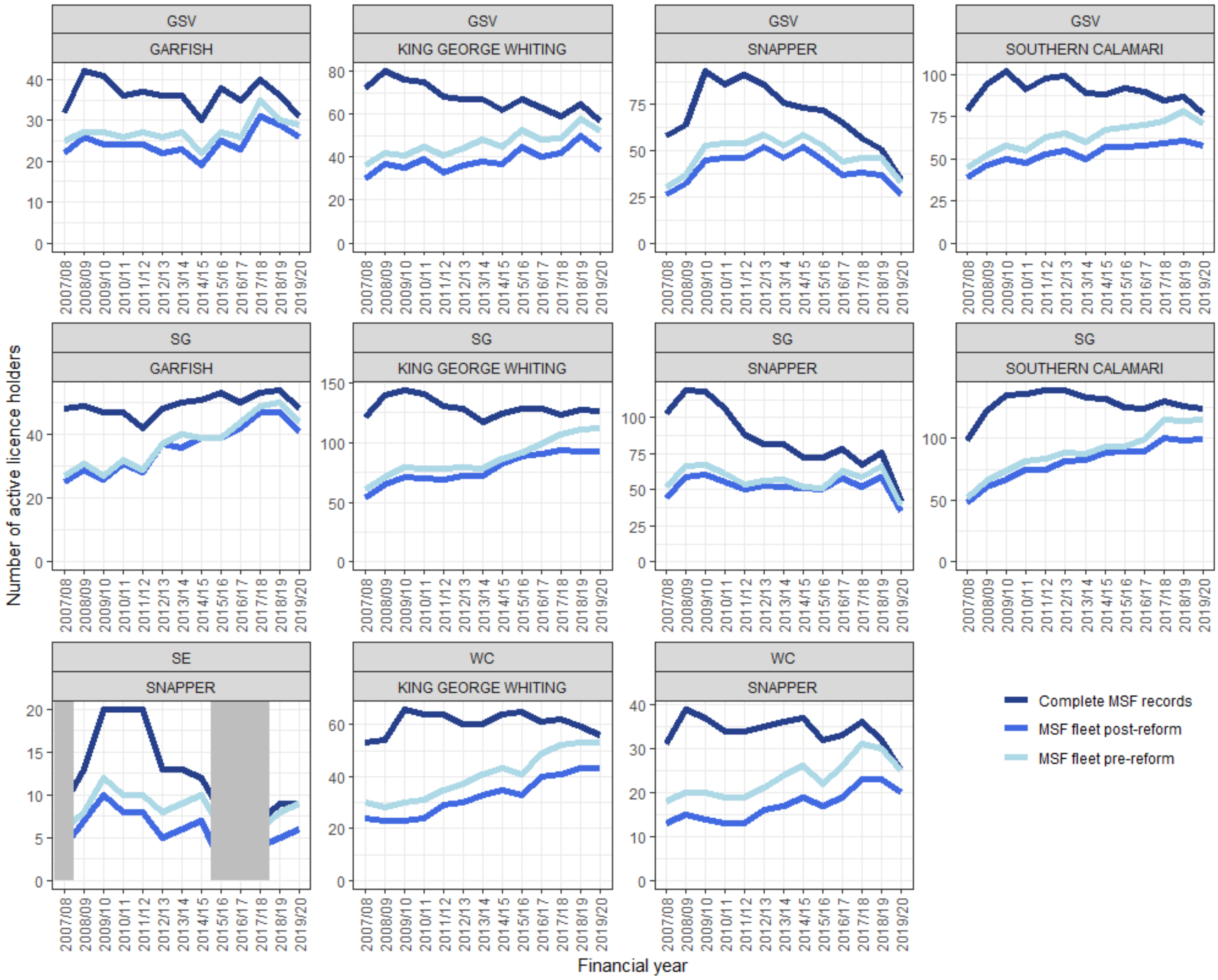


Figure 29. The number of active licence holders between 2007/08 – 2019/20 that caught MSF stocks that will be managed under a TACC. The dark blue line represents the number of licence holders based on complete logbook records, the light blue line represents the number of licence holders of the pre-reform fleet (i.e., licence holders that have left the fishery prior to 30 June 2021 have been removed), and the royal blue line represents the number of licence holders of the post-reform fleet (i.e., licence holders that have left the fishery through the VLSP have been removed). Grey shading indicates confidential data (fewer than five licence holders in a given year).

Changes in the MSF fleet composition due to licence transfers was most evident in the effort statistics for the fishery (Fig 30). While a large portion of total effort dating back to 2007/08 was still accounted for by the post-reform fleet, substantial amounts of effort for most stocks can be attributed to licence holders that have not been active in the fishery for several years. It is also apparent that very little active effort has been removed by the VLSP, especially for Southern Garfish in SG and GSV/KI (Fig 30).

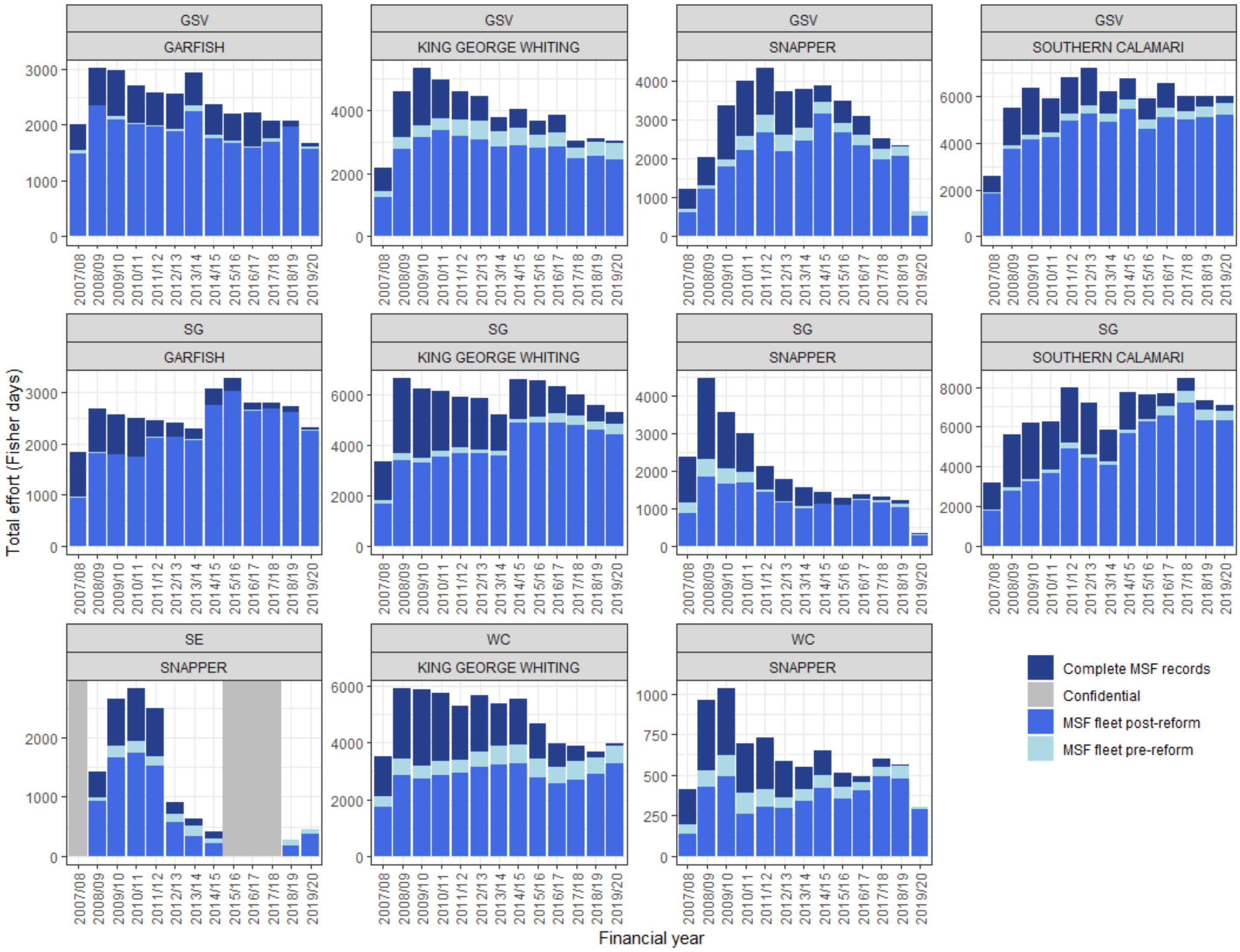


Figure 30. The total effort in fisher days of MSF stocks between 2007/08 – 2019/20 that will be managed under a TACC. The dark blue bars represent the total effort based on complete logbook records, the light blue bars represent the total effort of the pre-reform fleet (i.e., licence holders that have left the fishery prior to 30 June 2021 have been removed), and the royal blue bars represent the total effort of the post-reform fleet (i.e., licence holders that have left the fishery through the VLSP have been removed). Grey shading indicates confidential data (fewer than five licence holders in a given year).

The catch statistics for the fishery demonstrate that the post-reform fleet was responsible for most of the total catch and that overall, very little catch has been removed by the VLSP (Fig 31). The greatest proportional catch reductions that have occurred through the VLSP were for King George Whiting in the GSV/KI and WC zones. Catch reductions for remaining stocks were minor relative to the total catches that have previously occurred for each of these stocks, demonstrating again that most licence holders that exited the fishery through the VLSP were less productive and/or part-time members of the fleet.

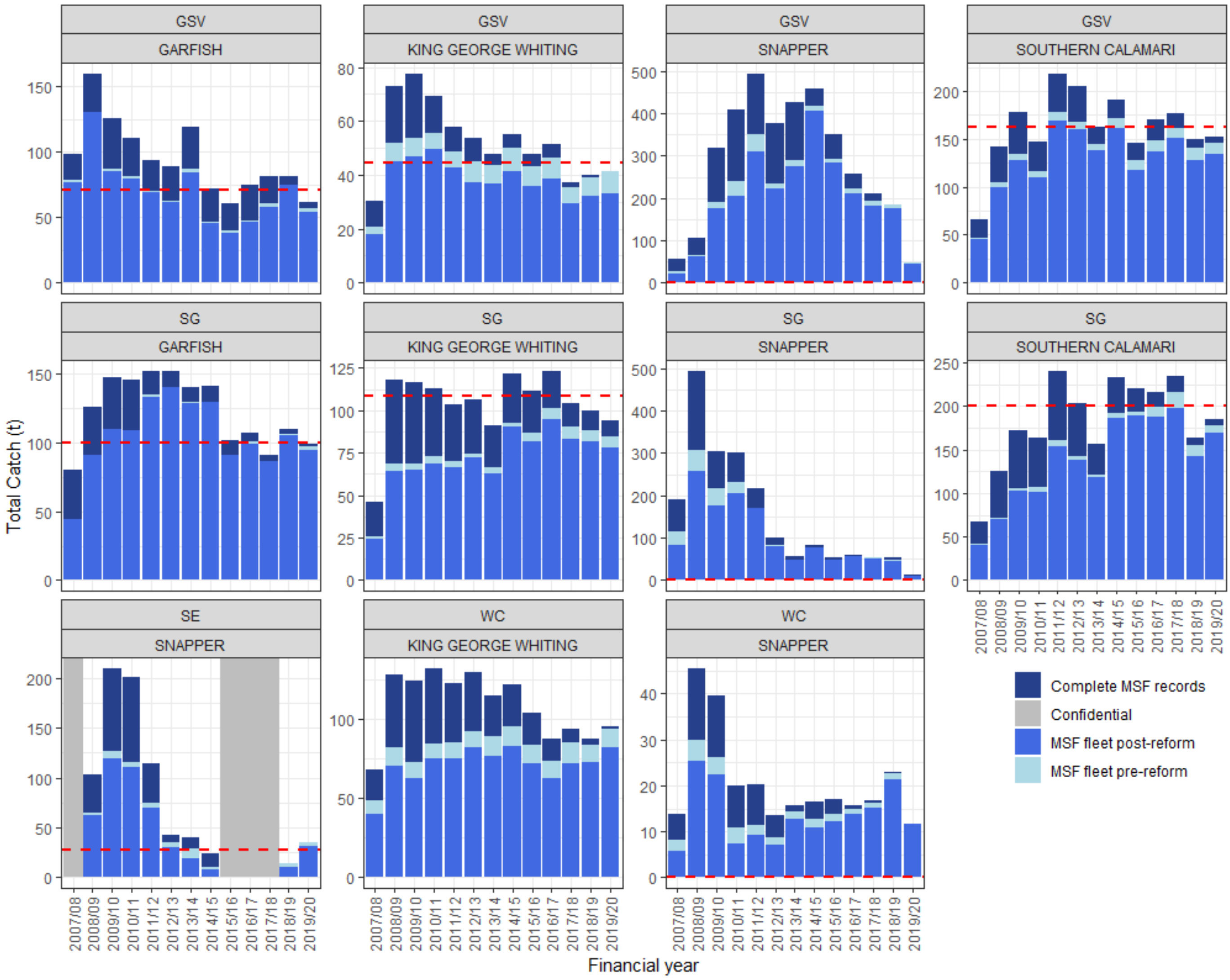


Figure 31. The total catch (t) of MSF stocks between 2007/08 – 2019/20 that will be managed under a TACC. The dark blue bars represent the total catch based on complete logbook records, the light blue bars represent the total catch of the pre-reform fleet (i.e., licence holders that have left the fishery prior to 30 June 2021 have been removed), and the royal blue bars represent the total catch of the post-reform fleet (i.e., licence holders that have left the fishery through the VLSP have been removed). Grey shading indicates confidential data (fewer than five licence holders in a given year). The red dashed line represents the TACC for Tier 1 stocks. This was set as zero for Snapper in the GSV/KI, SG and WC zones.

For most stocks, the CPUE for the dominant gear type was not overly affected by fleet rationalisation (Fig 32). Exceptions to this were King George Whiting in the GSV/KI and WC zones. King George Whiting in GSV/KI had a reduced CPUE across the time series once licence holders that exited the fishery through the VLSP were removed from CPUE calculations (Fig 32). Conversely, King George Whiting on the WC had an increased CPUE across the time series once licence holders that exited the fishery through the VLSP were removed from CPUE calculations (Fig 32). This demonstrates that in GSV/KI, some efficient King George Whiting fishers have exited the fishery through the VLSP while on the WC, several part time and/or less efficient fishers have left the fishery. The VLSP had little effect on the pre and post reform CPUE calculations for the remaining stocks, particularly in the most recent years (Fig 32).

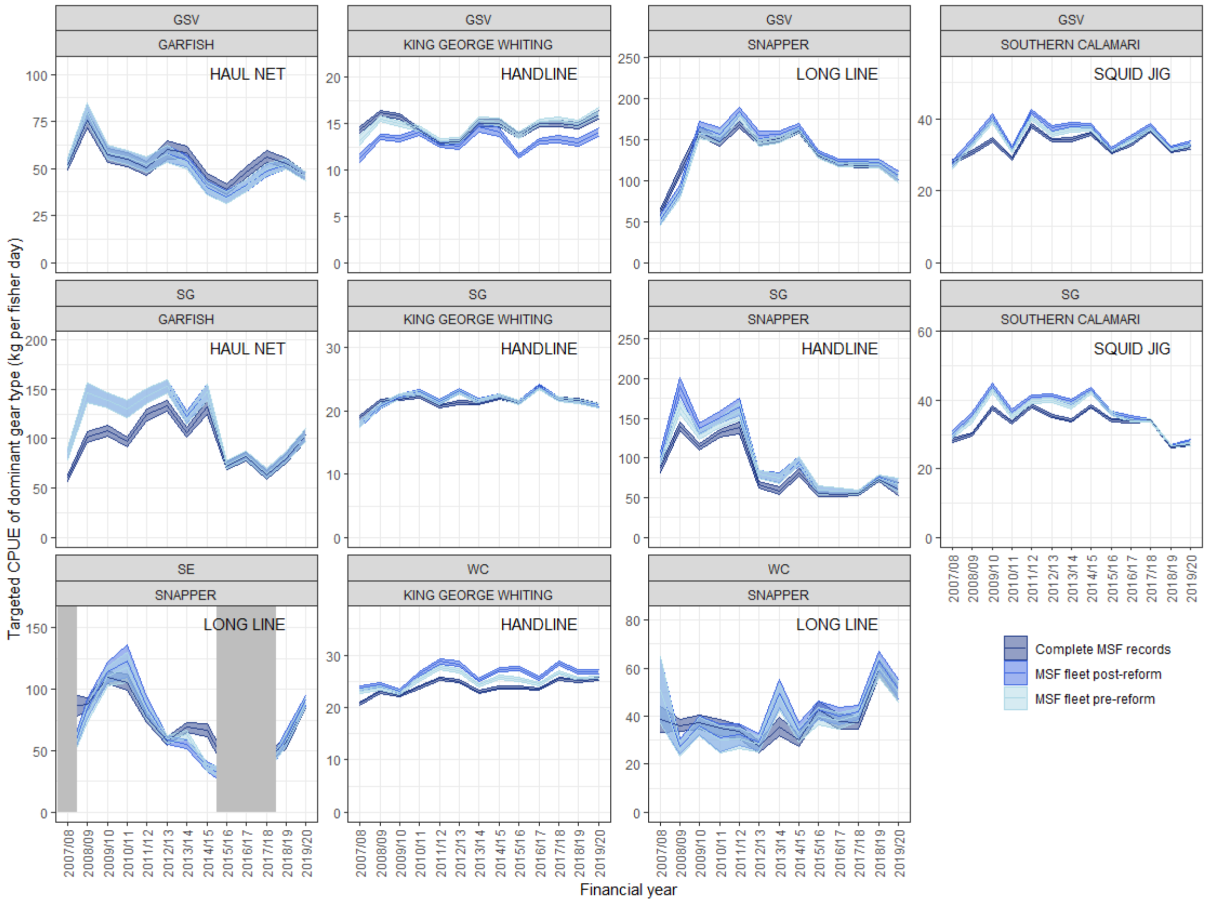


Figure 32. The mean CPUE ± SE (kg per fisher day) of the dominant gear type for MSF stocks between 2007/08 – 2019/20 that will be managed under a TACC. The dark blue line and shading represents the CPUE based on complete logbook records, the light blue line and shading represents the CPUE of the pre-reform fleet (i.e., licence holders that have left the fishery prior to 30 June 2021 have been removed), and the royal blue line and shading represents the CPUE of the post-reform fleet (i.e., licence holders that have left the fishery through the VLSP have been removed). Grey shading indicates confidential data (fewer than five licence holders in a given year).

4.6 Discussion

Rationalisation of the MSF fleet was a core component of the commercial MSF reform because it has long been recognised that the fleet was over-capacity and contained a lot of latent effort. The economic analyses identified that a fleet reduction of approximately 150 licences (~50%) would enable the full benefits of the reform to be realised, subject to uncertainty around: (i) the relative efficiency of those that surrender their licence; and (ii) underlying trends in stock abundance. Noting these uncertainties, the goal of the VLSP was to achieve the surrender of 150 licences with a minimum target of 100 licences surrendered. In total, 100 licences were surrendered through the VLSP, which included some licences that had previously held Sardine and Vongole quota and are now licenced operations in those new fisheries. This represents a 33% reduction of the 307 licences (including previous MSF Sardine quota holders) in the fishery achieved through the VLSP. However, several of the surrendered licences were owned by licence holders with multiple licences, many of whom remained in the fishery through retaining at least one licence. Therefore, while 100 licences were surrendered through the VLSP, only 65 licence holders left the fishery. This occurred because in South Australia, catch history belongs to the licence holder rather than the licence. Therefore, fishers with multiple licences could surrender additional licences while maintaining rights to ITQ allocations as they retained the catch history of those surrendered licences.

While the VLSP has now been finalised, there is potential for further fleet rationalisation to occur through autonomous industry adjustment. Anecdotally, there are several licence holders who are considering exiting the fishery but will receive quota allocations that are more valuable than the price offered for their licence through the VLSP. Therefore, it is likely that as quota trades commence in the fishery, several licences will profit from their initial quota allocations and either exit the industry or shift their fishing operations towards Tier 2 or Tier 3 stocks.

While the target of 150 licence surrenders was not accomplished through the VLSP, there remains the potential for the surrender of 100 licences to achieve the economic goals outlined by the economic analysis presented here. It is likely that many fishers who have exited the fishery would have been classified as a ‘poor performing business’ using the criteria included in the economic analysis. The 100 surrendered licences closely corresponded with the 97 licences required to achieve a positive NER based on the performance of an average business. Therefore, while the target number of licences was not achieved by the VLSP, there are indications that its impact on the profitability of the fishery will be substantial. The catch statistics of the remaining fleet suggests that the poorer performing fishers have left the fishery as only small reductions in catch occurred. For all stocks with the exception of King George Whiting in GSV/KI, CPUE either remained the same or had a minor increase in recent years. The true impact of the VLSP will be determined through future and on-going economic analyses of the fishery to be undertaken by BDO EconSearch and PIRSA.

There was concern from some members of industry that setting the TACCs based on recent average catches would lead to uncaught quotas because they considered that fleet rationalisation would lead to fewer fishers attempting to match the catches of the larger pre-reform fleet. However, the pre- and post-reform analysis of fishery dynamics indicates that the VLSP has mostly removed fishers that contributed little to the overall fishery production in comparison to the remaining fishers. This analysis demonstrated that since 2007/08, post-reform fleet has been capable of catching the TACCs for all Tier 1 stocks with the exception of King George Whiting and Southern Calamari in SG. These stocks may require adjustments to future TACCs to address any uncaught quota that could occur. For Southern Garfish in GSV/KI and SG, very little catch was removed from the fishery via the VLSP demonstrating that these TACCs will likely be caught in the fishing seasons following the reform.

The removal of 33% of licences in a single event in the fishery’s history may have been problematic for time-series indicators important for assessing fishery performance, such as CPUE (Haddon *et al.* 2018). In 2005, the South East Scalefish and Shark Fishery (SESSF) underwent fleet rationalisation with a 40% reduction in the trawl fleet (Vieira *et al.* 2010). Subsequently, substantial analyses were undertaken through CPUE standardisation to ensure that the impacts of management changes did not disrupt indices of abundance determined from catch and effort data (Haddon *et al.* 2018). Similar analyses may be required for some MSF species following reform as changes in fleet dynamics and levels of targeting can disrupt CPUE series (Dowling *et al.* 2017).

Following the MSF reform, a goal for the fishery will be to increase its profitability. This can occur through increased production and/or an increase in fishing efficiency. Gauging whether the fishery is becoming more efficient following the reform would have been complicated if the fleet rationalisation changed the baseline CPUE against which future estimates would have been compared. For example, the removal of 100 licences in the fishery could have caused CPUE to increase as fishers whose CPUE had previously depressed the fleet wide average have exited the fishery. Therefore, the CPUE in subsequent fishing seasons would increase regardless of any improvements offered through the reform, obfuscating its impact. This effect occurred for some species within the SESSF immediately following its fleet rationalisation (Sporcic and Haddon 2015). However, with the exception of King George Whiting in the GSV/KI and WC zones, this did not occur. Therefore, CPUE should remain an appropriate indicator for most stocks following the reform. For King George Whiting in the GSV/KI and WC regions, additional analyses such as those presented here will be required to account for the impacts of the reform.

The State-wide carrying capacity for the fishery was estimated to be between 107 and 196 licences depending on the business performance of licence holders and the catch levels available to the fishery (Table 13). Most licence holders that left the fishery via the VLSP could be classified as part-time or poorer-performing businesses as they contributed little to recent total catches and their removal from statistics did not influence fleet CPUE in most instances. Therefore, the carrying capacity of the fishery is likely closer to the number of licences required to support average performing businesses if current catches were maintained. The closure of the Snapper fishery in 2019 has already impacted fishery carrying capacity and therefore, it would be more appropriate to consider the estimate of 159 licences under the 20% catch reduction scenario as the fishery's carrying capacity (Table 13). This indicates that the fishery may still be over-capitalised, despite the VLSP because the 50% reduction in licences was not achieved. A further reduction in licences may occur should some licence holders trade their total quota allocations and surrender following the reform. However, the most effective way to achieve a future positive NER across the fishery will be to improve business profitability and increase production, which is reliant on stock recovery, rather than rely on further rationalisation.

Table 13. The carrying capacity of each fishing zone based on the number of average performing businesses and poorer performing businesses that could produce a positive NER for current catch and a 20% reduction in key species. Does not include the 14 licences with Sardine quota.

		WC	SG	GSV/KI	SE	Total
Average business						
	current catch	29	105	49	13	196
	20% reduction in catch of key species	22	89	38	10	159
Poorer performing business						
	current catch	17	71	36	4	128
	20% reduction in catch of key species	13	63	28	3	107
Remaining licences following reform		**41**	**79**	**59**	**18**	**197**

5 Social Analysis

5.1 Background

This chapter provides a social analysis of the MSF to inform understanding of the social conditions in the fishery leading into the reform, identify potential areas of vulnerability related to changing management of the fishery, and identify potential areas of impact and options for reducing risk of these impacts. This assessment focuses on the social value of the fishery for commercial fishers, their households, and the communities they live in.

The analysis contains the following components:

- Identification of social objectives and values of the fishery
- Baseline assessment of social conditions, including
    - Current social benefits to fishers and households
    - Vulnerability and resilience to change
    - Understanding social 'carrying capacity' of the fisher to support subsequent assessment of likely social impacts of proposed changes
- Assessment of potential social impacts
    - Areas of risk for negative impact
    - Areas of potential opportunity
    - Mitigation options to reduce risk of negative impact and maximise positive impacts
- Future measurement of social metrics for the fishery.

5.2 Methods

This chapter is based primarily on three sources of data:

- Qualitative thematic analysis of past reports and data on social dimensions of the MSF
- Survey of commercial MSF fishers
- Data on social conditions in the communities in which most MSF fishers live and work.

Each of these is described briefly in the sections below. Originally, the methods for this project were intended to include direct interviews and/or group discussions with MSF fishers, to be held directly with them during 2020 in South Australia. These discussions were intended not to collect primary data, but to present findings from analysis of the data sources listed above and ask fishers and stakeholders to identify any additional information or differences. However, restrictions on travel relating to the COVID-19 pandemic meant it was not possible to conduct these workshops. Instead of workshops, phone conversations with a limited number of MSF stakeholders were conducted throughout the analysis of data to assist with data interpretation. These were not formally recorded or thematically analysed, instead taking the form of discussions to check data and to assess whether issues identified in past reports remained of concern for some in the fishery. As these conversations did not identify new or different areas compared to those identified through the data analysis, they are not formally reported in this chapter. In addition, as described below, thematic analysis of submissions and survey responses submitted by MSF fishers in response to reform consultation were conducted.

5.2.1 Qualitative analysis of past MSF reports and data

The MSF is unique in that multiple studies examining social and economic dimensions of the fishery have been conducted over the last 20 years. This includes data collected regularly by BDO EconSearch as part of monitoring economic performance of the fishery, with the surveys conducted by BDO EconSearch including questions about social aspects of the fishery and extended questions about a range of social aspects of the fishery in some years. These past studies were analysed, together with analysis of submissions made as part of the MSF reform consultation, including both the written submissions (MSF Reform 2020), summaries of regional consultation meetings (Regional Consultation Meetings Summaries 2020), and comments made in online survey responses by MSF fishers who responded to an online survey asking their views about MSF Reform Stage 1 and 2 information (Online survey responses 2020).

Rather than treating past reports and information from submissions as a literature review, a systematic thematic qualitative analysis was undertaken. This form of structured analysis involves first identifying key topics of interest, and then systematically searching past data and reports for these topics. Within each topic of interest, the data identified are coded thematically to identify the different themes and findings emerging. This approach ensures that documents are systematically examined for evidence, and that all evidence related to themes is recorded and categorised appropriately.

The systematic review was conducted as a three-stage process:

1. Identifying social objectives relevant to the MSF fishery. In this first stage, past reports, data and documents were reviewed and all data identifying a potential social objective of the fishery identified. When each objective was documented, the strength of evidence regarding its importance to MSF fishers was also documented where possible. This review identified that objectives typically fell into one of four types which each included several objectives. This review informed the design of key questions asked in the survey conducted by BDO EconSearch (2020).
2. Assessing current conditions against social objectives. For the social objectives identified in the first stage, available data were assessed, and where possible, current social conditions assessed.
3. Identification of other relevant themes related to vulnerability, resilience, risk of negative social impact, potential for positive social impacts and social carrying capacity. This third stage involved reviewing all documents to identify all themes that had relevance to understanding vulnerability and resilience of fishers, and in turn what these aspects of vulnerability and resilience mean for risk of experiencing negative social impacts or opportunities for positive social impacts. Implications for social carrying capacity were also evaluated.

5.2.2 Survey of MSF fishers

In 2020, BDO EconSearch conducted a survey of MSF licence holders using methods described in BDO EconSearch (2020). This survey was part of a series of economic indicator surveys; in 2020 the survey questions were extended to include social questions designed to provide data for this chapter. In total, 35% of the 276 MSF licence holders participated in the survey (95 usable responses), and BDO EconSearch identified that the participants were reasonably representative of the fishery.

Questions on social aspects of the fishery included in the 2020 survey were designed based on findings of the early stages of the literature review. A series of questions sought to identify the extent to which different types of social objectives were being achieved, as well as to assess key aspects of vulnerability and resilience to change amongst MSF fishers.

5.2.3 Data on social conditions in fishing communities

When assessing issues such as social licence for fishing, and vulnerability to negative social impacts, it is important to have information on not only those who directly work in the fishery, but also on the communities in which they live. This information can provide insight into whether fishing is viewed as a significant part of a community's identity and social fabric, and whether changes to the fishery are likely to interact with other existing social processes already affecting the wellbeing of a community (such as high rates of unemployment, or rapid change in population size). Data on social conditions in fishing communities from the following sources were analysed to provide insight into these aspects of social conditions in the fishery, and to assist in identifying potential risks of negative social impact and opportunities related to community characteristics:

- Australian Bureau of Statistics *Census of Population and Housing* (CPH): Data from the 2016 CPH were drawn on to understand key characteristics of fishing communities, particularly relating to employment opportunities, volunteering, and social advantage and disadvantage.
- Regional Well-being Survey (RWS): The RWS is an annual survey focused on understanding well-being, resilience, and liveability of communities across Australia, with a particular focus on rural and regional communities. Data collected include information for coastal South Australian communities in which the MSF operates, albeit often with relatively low sample size from these regions. Information from this survey was accessed and analysed, particularly focused on access to services and social opportunity, and views on importance of fishing to communities.

5.3 Social objectives and values of the Marine Scalefish Fishery

To achieve ecologically sustainable development (ESD) requires clearly identifying ecological, economic, and social objectives (Triantafillos *et al.* 2014). Social objectives may vary from fishery to fishery and will differ for individual fishers operating within a fishery, as well as across communities. In 2014, a nationwide project identified several common social objectives important to successful fisheries management. Those relevant to commercial fisheries were (amended version based on Triantafillos *et al.* 2014):

- Providing flexible livelihood opportunities for fishers
- Maximising cultural, recreational and lifestyle benefits of fishing (including health benefits)
- Ensuring fishers can be involved in development of fisheries management advice and ability to do so
- Building trust in management of fisheries amongst fishers and communities
- Maximising stewardship of fisheries resources
- Ensuring transparent decision-making processes by fisheries agencies
- Ensuring equitable treatment and access for fishers
- Ensuring adequate access to infrastructure needed for fishing activities
- Ensuring fisheries information is available in a timely and publicly accessible manner
- Positively influencing fisheries related socio-economic benefits for regional communities
- Facilitating and supporting cohesion and connectedness of fishers with their regional communities
- Maintaining cultural and heritage values related to fishing activities.

These various social objectives, while all related to fishing, fall into four broad categories, shown in Figure 33. Two of these – governance and social licence – together form the enabling environment in which commercial fishing businesses can operate. This enabling environment influences the extent to which social benefits can be achieved by (i) fishers and (ii) communities in which fishing activities occur. While factors other than governance and social licence also influence the extent to which fishers and communities experience social benefits, they are less likely to be readily acted on by those involved in the fishing industry. For example, they might include external factors influencing a fisher's household such as family illness or changes in jobs held outside the fishery.

To assist in understanding the different types of social objectives, in the remainder of this chapter the social objectives identified for the MSF are analysed using the framework of the four types of social objectives shown in Figure 33. As social licence is often measured by examining the views of communities, in some cases it is considered together with fishing communities.

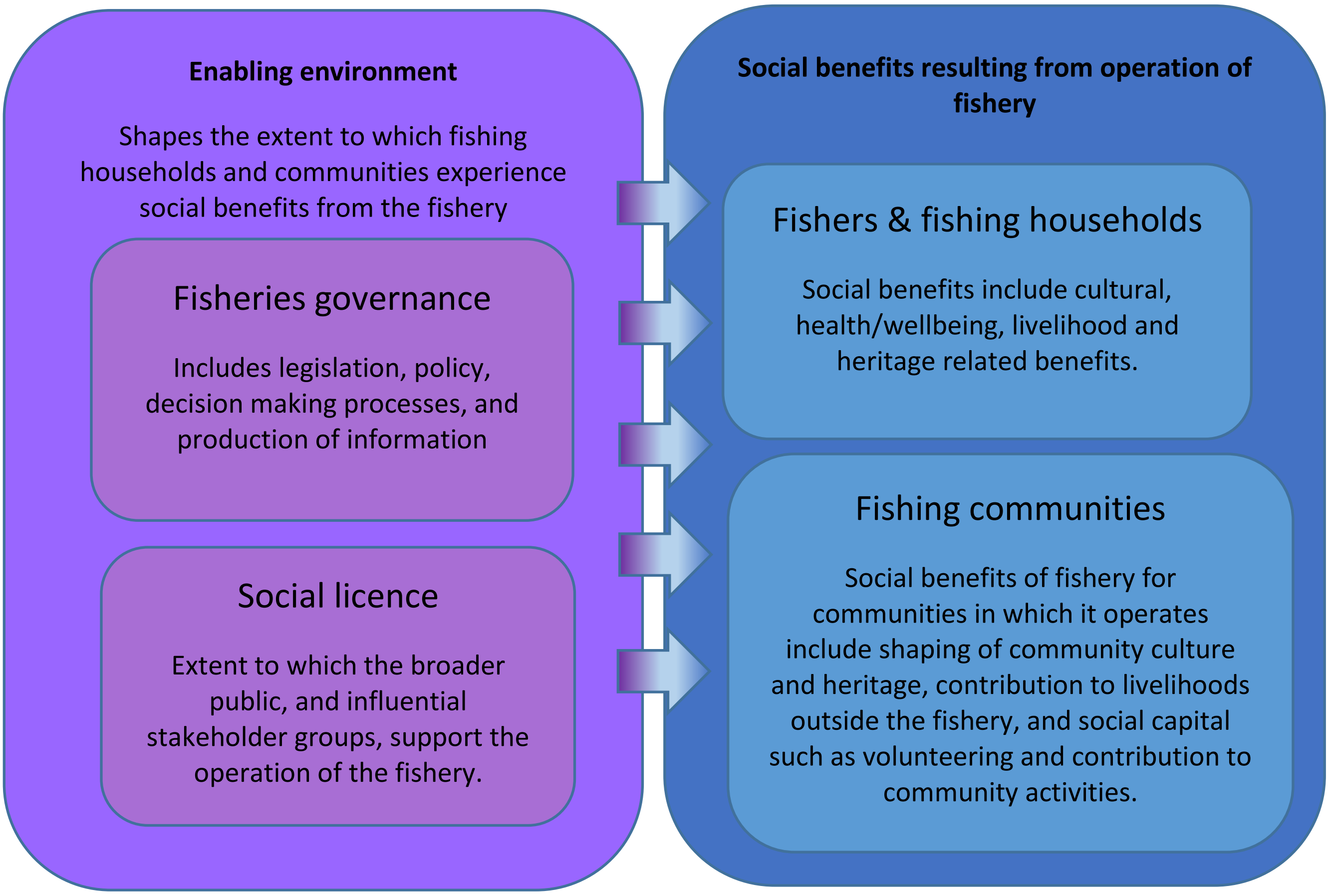


Figure 33: Four dimensions of social objectives: fisheries governance, social licence, fishers & fishing households, and fishing communities

Data on social objectives and values of MSF fishers have been documented in the past as part of several projects. The principal sources of information are the following:

1. In 2004, MSF licence holders and other stakeholders were surveyed and participated in workshops, in which they discussed the social objectives and values important about the MSF (Schirmer and Pickworth 2005)
2. In 2007, a follow-up survey of 37 licence holders was conducted to identify impacts of reform and change in social conditions (Brooks 2010)
3. In 2011-12, MSF licence holders were surveyed as part of a broader survey of commercial fishers with licences in the MSF, rock lobster and abalone fishers in South Australia; the survey specifically examined social objectives and values of those in the three fisheries, and identified which objectives were of highest priority (Schirmer 2013). This study informed the overall social objectives recommended for consideration in fisheries management by Triantafillos *et al.* (2014).
4. In 2015-16, a survey of MSF fishers further examined priorities amongst a number of social and economic objectives (Nursey-Bray *et al.* 2017, 2018).

5. In addition to these past projects, a smaller number of questions related to key social objectives were asked as part of the 2018-19 economic and social indicators report for the fishery (BDO EconSearch 2020), which were analysed for this chapter. Past BDO EconSearch surveys have similarly asked some questions that examine important dimensions of social objectives, and these reports were examined as part of the identification of these objectives and values.

In the first three studies listed above, the fisheries objectives examined were in large part identified through direct consultation with fishers. This means that they reflect fishers' priorities regarding the aspects of the fishery most important to them. The economic and social indicator reports examine social indicators identified as important in other studies, although they are also based on consultation with industry and managers regarding important concepts to measure in the indicators. Thus, while not based on direct information from fishers to shape the objectives measured in indicators, the indicators are derived from processes of consultation that included identification of objectives important to different stakeholders in the fishery.

These past studies provide a strong basis for understanding social objectives and values of commercial fishers in the MSF. They also provide the opportunity to identify if there is any apparent change in these social objectives over time, and to understand which objectives are given higher priority by fishers, with two of the studies explicitly asking fishers to rank which objectives/values were more and less important to them.

These past studies, together with data collected in the 2018-19 BDO EconSearch survey, were systematically analysed using a qualitative thematic analysis. This was used to identify key social objectives of the fishery, and available evidence regarding the importance of these objectives, the extent to which they were being achieved, and any evidence of change over time or of variation within the fishery.

The following describes social objectives, focusing on objectives related to (i) fisheries governance, (ii) social licence, (iii) fishers and fishing households, and (iv) fishing communities. This section focuses on describing objectives; the next evaluates 'baseline' conditions as well as evidence of historical change, and considers what this means for vulnerability, resilience, and more broadly social carrying capacity.

5.3.1 Social objectives related to fisheries governance

Fisheries governance is sometimes considered a part of the social objectives of a fishery, and sometimes as a separate set of objectives: for example, Nursey-Bray *et al.* (2017, 2018) separated governance objectives from social objectives. In this chapter, fisheries governance is included as part of social objectives for the following reasons:

- The ability of fishers to derive key social benefits from fishing depends on governance arrangements, which shape the types of fishing that can occur and aspects of working conditions.
- Governance processes can directly affect the wellbeing of fishers: for example, fishers who feel governance processes are fair are more likely to report positive wellbeing and good working conditions than those who feel governance processes are unfair or inequitable.

Nursey-Bray *et al.* (2018) identified that governance objectives were considered of highest importance by 32% of MSF fishers, and that social objectives received less priority as fishers viewed social benefits as flowing from economic and environmental objectives, which in turn were shaped by governance objectives. Similarly, Schirmer and Pickworth (2005) found that fair and consistent management of the fishery was ranked as the most important aspect of their fishing work by MSF participants, with 91.6% considering this to be important.

Six specific governance objectives were identified from past studies as having potential importance for the MSF. Most of these have been identified in specific studies of the MSF; others have been recommended as social objectives for commercial fisheries in Australia in general as part of the national study by Triantafillos *et al.* (2014):

- An **enabling fisheries management system** (legislation, administration) (Nursey-Bray *et al.* 2018), which in turn supports flexibility of livelihood opportunities for fishers (Triantafillos *et al.* 2014). The MSF is a complex multi-species fishery in which there has been ongoing effort to reduce total effort through licence amalgamation schemes implemented from 1994, as well as some buy-back of licences, resulted in reducing of licences from 666 in 1984 to 284 in 2014, with a corresponding 52% decline in total fishing effort (Steer and Besley 2016). As of 2011, 55% of MSF fishers felt fishing management plans were not sufficiently flexible to enable fishers to adapt to changing conditions (Schirmer 2013). Enabling livelihood opportunities here means not simply opportunity to earn income, but opportunity to have a livelihood the fisher can be proud of, where they are able to earn sufficient income and feel confident that they can fish sustainably in the long-term and be a 'good steward' of the fishery within existing management arrangements. Studies of the fishery have highlighted that many MSF participants rate having personal autonomy and independence to carry out their work as important (Schirmer and Pickworth 2005; Brooks 2010): 91.3% of MSF fishers rated 'ability to exercise independent control over my work' as important in 2004 (Schirmer and Pickworth 2005). Nursey-Bray *et al.* (2017, 2018) identified significant concerns amongst MSF fishers about whether management systems were enabling appropriate livelihood opportunities, having concern about declines in catch due to both reduced effort and reduced catch per unit effort, and concerns about how levels of recreational fishing effort were affecting stock levels and their ability to maintain a sustainable commercial fishery. These issues are also identified in historical trends in catch statistics in the fishery (Fowler *et al.* 2015) and recorded in assessments of the status of the fishery (Steer *et al.* 2020).
- Enabling **stakeholder involvement**, particularly ensuring that all stakeholders have capacity to participate, are given opportunity to participate, and are listened to (Triantafillos *et al.* 2014; Nursey-Bray *et al.* 2018). As of 2011, there was significant difference of view amongst MSF fishers regarding whether consultation of fishers in the MSF was sufficient, with 42% disagreeing that they were satisfied with the consultation PIRSA undertook, 14% neither agreeing or disagreeing, and 38% agreeing (Schirmer 2013). In addition, 62% did not feel fishers' concerns and preferences were taken into consideration in fisheries management decision making at the time (Schirmer 2013).
- Ensuring **equitable access and cost** sharing between fishers[16] (Triantafillos *et al.* 2014, Nursey-Bray *et al.* 2018). Equity of treatment has historically been a concern in the MSF: as of 2011, 69.4% of MSF fishers reported they felt the commercial sector was not treated fairly and equitably compared to other users of fisheries resources (Schirmer 2013), and this concern continued to be expressed in subsequent studies, with concerns about equity of access of commercial versus recreational users of fisheries resources being identified as a key concern by Nursey-Bray *et al.* (2017, 2018).
- Ensure **transparent and accountable decision-making processes** by fisheries agencies (Triantafillos *et al.* 2014) to ensure trust in fisheries governance. Schirmer (2013) found that almost 50% of MSF fishers disagreed with the statement 'fisheries decision making is transparent', suggesting this was an area of concern.
- Ensure adequate **access to infrastructure** needed for fishing activities (Triantafillos *et al.* 2014). Schirmer (2013) found that amongst MSF fishers, a relatively small proportion reported dissatisfaction with their access to infrastructure, suggesting that this objective was to a large degree being fulfilled at the time the survey was undertaken (2011).
- Ensure **fisheries information is available** in a timely and publicly accessible manner (Triantafillos *et al.* 2014).

[16] Ensuring equity is sometimes categories as a social outcome of the fishery for fishers (e.g. Nursey-Bray et al. 2018), and sometimes considered a part of governance. As it is largely a product of governance processes, in this report is it included as part of governance objectives.

Nursey-Bray *et al.* (2018) also identified that improving management processes and systems more generally may be an objective; however, this improvement typically occurs through ensuring the above six dimensions of governance are achieved, and hence was not included as a separate objective here.

5.3.2 Social objectives related to fishers and fishing households

The social benefits of fishing for fishers and fishing households can be many and varied, and there is often an overlap between social and economic benefits. For example, having a viable livelihood is clearly an economic benefit (in the form of earning income) and a social benefit (in the form of having a livelihood that shapes social interactions, ability to participate in social activities, and a person's identity, amongst other things).

Past studies suggest six social objectives related to their work in fishing are regularly identified by licence holders in the MSF, as well as often more broadly by commercial fishers in Australia:

- **Viable livelihood opportunities** that enable a fisher to have a meaningful livelihood that can be adapted to changing conditions over time. This objective is strongly related to the similar governance-related objective of having an enabling fisheries management system, and measures of it overlap to some extent. This objective focuses on being able to earn sufficient income to be able to have a financially sustainable livelihood. However, it is important to note the objective is about earning sufficient income – not necessarily high income. While earning sufficient income is important, earning a high income may not be as important to many MSF fishers, with Schirmer (2013) identifying that the wellbeing of MSF fishers was not strongly correlated with their household income beyond a certain point. Schirmer and Pickworth (2005) asked MSF fishers how important eight aspects of their fishing work were to them: having a high income was less likely to be considered important than all other aspects of work, with 59.1% of fishers identifying earning a high income as important, while having a good work life balance (89.1%), ability to have independence in work (91.3%) and a sense of worthwhile accomplishment in work (80.5%) were much more commonly rated as being important. Schirmer (2013) found that, as of 2011, MSF fishers were typically reasonably, but not highly, satisfied with the income their household earned. 'Livelihood opportunities' also includes the aspects of livelihood considered in the next objective: these opportunities are not only being able to earn sufficient income from the livelihood, but also having positive working conditions, being able to be a good steward of fisheries resources, and being able to achieve culture, heritage and identity benefits of fishing (Triantafillos *et al.* 2014, Nursey-Bray *et al.* 2018).
- **Being a fisher (culture, heritage, and identity):** When engaging in fishing, this objective seeks to ensure fishers can maintain the aspects of their livelihood that are important to their personal identity, culture, and heritage. Effectively, this objective is about fishers feeling able to be a 'good' fisher and be proud of and enjoy the occupation of fishing. This includes being able to be a good steward of fishery resources and being able to utilise fishing and business skills and participate in an occupation many feel very strongly connected to (Schirmer 2013, Triantafillos *et al.* 2014). There is evidence that in the MSF, a key benefit of the fishery is the opportunity to be a fisher, a benefit that is separate to the income earned from fishing. In a 2011 survey, only 26.8% of MSF fishers stated that they would move to a land-based job if offered equivalent income to the income earned in the MSF, while 73.2% would not (Schirmer 2013). Most indicated that they would need to be offered significantly more income than they were currently earning to be willing to move away from their fishing work. This suggests a strong identity-based connection to the fishery, in which the activity of fishing is as important to a person. Schirmer (2013) found that the overall wellbeing of MSF licence holders was strongly correlated with their satisfaction with their work in fishing, further reinforcing the importance of the culture, heritage, and identity of being a fisher to the wellbeing of fishers. Satisfaction with fishing in turn, was not a function simply of earning income, but was about being able to have positive working conditions and feel able to be a positive steward of fisheries resources. Nursey-Bray *et al.*

(2017, 2018) reported that a key concern of many MSF fishers was inability to fulfil the central objective of being a good steward of the fishery, with many fishers raising concerns about stock status, and feeling unable to act to address this as the factors influencing stock levels were often viewed as being driven by issues such as recreational fishing.

- **Positive working conditions/work health and safety** that enable **positive quality of life**: The conditions a person experiences in their work are an important social benefit (or cost) of that work. Working conditions is a term that incorporates many dimensions of work, including physical health and safety, mental health and safety, working hours, level of control over work, and job security, amongst others. The importance of positive working conditions, and their influence on overall wellbeing, have been identified in past studies of both the MSF and commercial fishers in Australia more generally (Schirmer and Pickworth 2005; Triantafillos *et al.* 2014). Schirmer and Pickworth (2005) identified that while not explicitly referred to as an objective, many MSF fishers raised concerns about aspects of their working life, particularly the impacts of uncertainty about the future of their work in fishing, as being central concerns.
- **Maintenance of a skilled and capable workforce:** Brooks *et al.* (2015) and Triantafillos *et al.* (2014) identified maintaining knowledge and skills, and skills development more broadly as a critical social objective for commercial fisheries across Australia, based in part on data collected in the MSF. Schirmer (2013) found that most MSF fishers learn and build skills and knowledge by working in the fishery, highlighting that there is a high risk of loss of fishery-specific skills and capability if reforms cause disruption to the passing on of skills and knowledge. The impacts of ongoing fishery structural reform on transfer of skills have been identified as of concern in some reports (Schirmer and Pickworth 2005), with the fishery recognised as having an ageing workforce, 30% being over 55 as of 2016 (SRWG 2016), with relatively low numbers of new entrants to the fishery.
- **Building and maintaining adaptive capacity/resilience:** Fisheries often experience considerable change over time, not only in terms of changes in management such as the ongoing reforms in the MSF referred to earlier, but also changes in markets, climatic conditions, technology, and fish stocks. This means fishers need to have the capacity to cope with and adapt to change, something often referred to as being resilience, or having adaptive capacity. This objective seeks to ensure fishers maintain the personal and business capacity to adapt to change as the fishery evolves over time (Schirmer and Pickworth 2005; Brooks 2010; Triantafillos *et al.* 2014; Nursey-Bray *et al.* 2017). This capacity to adapt typically involves both having psychological, financial, and social resources, something identified as important in the MSF by both Schirmer and Pickworth (2005) and Brooks (2010). Experiencing high levels of stress and uncertainty on an ongoing basis, as well as multiple type of change occurring in a short space of time, can all place stress on adaptive capacity and potentially reduce resilience of fishers to further change (Tuler *et al.* 2008).
- **Positive social connection within the MSF**: This was identified as an important social objective by Brooks (2010) and Schirmer and Pickworth (2005), who identified that the long-term success of the MSF was in some cases threatened by strong internal divisions between groups of fishers within the MSF, and a lack of effective connection between commercial fishers that reduced sharing of ideas and reduced development of new initiatives. This had the effect of reducing a sense of shared identity, reducing ability to effectively advocate for the objectives fishers felt were important. Minimising social conflict in general was also identified as an objective by Nursery-Bray *et al.* 2018, although more in the context of conflict between fishers and communities.

5.3.3 Social objectives related to social license to operate

The importance of achieving social license to operate has been emphasised in recent years as an objective for commercial fisheries across Australia and internationally (see for example Voyer and van Leeuwen 2019). Social license to operate can be broadly defined as an industry – in this case a fishery – being viewed by stakeholders such as the public, local communities, fisheries managers, commercial and recreational fishers as have a legitimate right to operate, and their activities being socially acceptable (Dare *et al.* 2014).

There is conflicting evidence about the importance of social license to MSF licence holders. Nursey-Bray *et al.* (2018) found that improving social licence to operate was considered a high priority by 20% of MSF fishers compared to governance, economic and social objectives, but pointed out that it was given lower priority than other social objectives and finding that the concepts was not well understood or defined by MSF licence holders. Schirmer and Pickworth (2005) asked MSF fishers how important 'interactions with the public related to my work' were, and 69.3% of fishers rated this as an important aspect of their work that mattered to them, indicated somewhat high interest in maintaining positive interactions. However, of the eight aspects of work asked about, six were more likely to be rated as important than interactions with the public, supporting Nursey-Bray's finding or relatively lower importance of social licence to MSF fishers.

Other past studies of the MSF have not specifically examined social license but have examined central components generally considered critical to having a social license. These studies suggest there is a high priority given to maintaining sufficient social acceptance and legitimacy to ensure ongoing operation of the fishery, meaning that achieving social license is an important objective – while not necessarily being labelled 'social license' when it is discussed.

Triantafillos *et al.* (2014) identified amongst their social objectives that building trust in management of fisheries, and maximising stewardship, were important, two factors often considered important components of social licence, but which do not define the outcome or objective. Schirmer (2013) found that in 2011, 50% of MSF fishers felt most people in the general community perceived commercial fishers negatively: this suggests that there is high concern about a lack of social licence for fishing, and that despite the term 'social license' not necessarily having strong resonance for fishers, it is relevant as an objective for the fishery.

Social license is sometimes considered a governance or community objective: in reality, it relates to governance, fishers and communities as it relies on the views of those external to fishers it is included together with social objectives relating to communities when examined.

5.3.4 Social objectives related to fishing communities

Ideally, any activity occurring in a community should have positive benefits for that community and minimise potential negative impacts. Thus, it is important to identify social objectives of the MSF for the communities it operates in. There is, however, some debate about what the specific social objectives are regarding the social benefits a fishery provides to a community. Many reports simply refer to having an objective of 'contributing to community wellbeing', without defining what this means in detail. For example, Triantafillos *et al.* (2014) identified community wellbeing as both an overarching objective of fisheries management (with respect to the Australian community), and the wellbeing of local communities as something the operation of a commercial fishery seeks to contribute positively towards. They proposed a social objective for fisheries of positively influencing fisheries related socio-economic benefits for regional communities. However, this needs to be more specifically defined to be able to identify the extent to which objectives are being met.

Specific types of socio-economic benefits of fisheries for communities identified in previous studies include economic benefit in the form of expenditure and investment. These economic benefits have been examined in detail in reports produced by BDO EconSearch on the MSF and are not examined further in this chapter (see EconSearch 2012, 2014, 2017 and BDO EconSearch 2020 for detailed analyses). Beyond this, the types of socio-economic benefits discussed in past studies include maximising local employment, participation of fishing households in community activities and services, enhancement of public amenity including culture and heritage, and social cohesion between fishers and communities.

Maximising employment in local communities is not included here as a social objective of the MSF. This objective is referenced in multiple reports, including Nursey-Bray *et al.* (2017, 2018). However, consultations undertaken with stakeholders, including some from the MSF, held by Triantafillos *et al.* (2014) identified a view that maximising employment was an inappropriate social objective, as 'more employment' is not necessarily better or sustainable. Instead, they recommended that ensuring quality employment that promoted a high quality of life was a more appropriate objective than seeking a high quantity of employment, while also recognising that it is important to monitor levels of employment in fishing to understand how the economic contribution of fisheries is changing over time. Additionally, levels of employment in communities are typically included in economic objectives and examined in the reports produced by BDO EconSearch referenced above.

This results in three social objectives related to fishing communities:

- Ensuring **participation of fishing households in the community**, including in community groups, local schools, and in contributing through actions such as volunteering. This is sometimes viewed as an objective achieved through maximising numbers of fishers and their families who live in local communities, and/or through maximising the number of jobs and flow of spending occurring in local communities. Past surveys of the MSF have included recording information on the proportion of fishers who volunteer in local communities, send children to local schools, or otherwise participate in community activities (e.g., BDO EconSearch 2020, Schirmer and Pickworth 2005).
- **Social connection between fishers and local communities**: Schirmer and Pickworth (2005) and Brooks (2010) identified that MSF fishers often felt they were socially marginalised from the communities they lived in, having sometimes limited ability to socialise due to their working hours and their beliefs that fishers were negatively perceived. This leads to a broader objective of having positive social connection between fishers and the local communities they live and operate in – which in turn means minimising social conflict and facilitating and supporting social cohesion and connectedness of fishers with their regional communities (Schirmer and Pickworth 2005; Triantafillos *et al.* 2014), also referred to as social capital (Brooks 2010). Overall, in 2011, 50% of MSF fishers felt most people in the general community perceived commercial fishers negatively, although this varied, with only 15% of those in the Far West region reporting this, and 55% to 70% of those located in the Eyre Peninsula and Yorke Peninsula (Schirmer 2013). This was similar to findings of Schirmer and Pickworth (2005), who found that 53.8% of MSF fishers felt others in their local community perceived commercial fishers negatively, and 62.9% felt people in South Australia more generally perceived them negatively. This suggests that achieving positive social relationships between fishers and communities is an important social objective, together with minimising conflict between the two (Nursey-Bray *et al.* 2017, 2018). This objective is relevant to both fishing households and communities, as any lack of cohesion negatively impacts both, and presence of positive cohesion benefits both.
- **Contributing to public amenity** in communities through contributing positively to public enjoyment, maintaining and growing culture and heritage (Triantafillos *et al.* 2014). The presence of a fishing fleet can have benefits for communities in the form of providing a valued visual amenity that contributes to tourism, while facilities such as jetties can be used by a range of groups beyond commercial fishers. The heritage of fishing can also contribute to the identity of a community.

In addition to these objectives, there is a recognised need to assess the ability of communities to cope with changes occurring in the fishery, which have the potential to affect social and economic conditions in local communities the fishery operates in (e.g., Brooks 2010). This is not considered an additional objective of the fishery, as the resilience of a community will depend on many factors, the majority of which are likely to be outside the direct influence of the fishery, which is one of multiple activities contributing to the communities it operates in. However, capacity of communities to cope with change is considered in the next section.

5.3.5 Which objectives are most important?

It is not readily possible to assess which of the social objectives identified above are most important to the MSF. Available evidence suggests that the relative importance of different objectives will vary depending on the context and point in time – meaning that depending on the individual circumstances a fishery is experiencing at a given point in time, the relative importance of different social objectives will change (Triantafillos *et al.* 2014). There is also typically some variance in rankings of the importance of different objectives, both between different users of a resource (e.g., commercial fishers and recreational fishers), and between those in a single sector such as commercial fishing (Triantafillos *et al.* 2014). For example, Nursey-Bray *et al.* (2017) found that there were some differences in objectives of MSF fishers, with net/line fishers appearing to prioritise achieving livelihood goals in the form of economic return more than other objectives, while line-only fishers had a broader range of priorities.

When asked to rank objectives, many fishers produce rankings that are internally inconsistent, suggesting that fishers themselves find it difficult to identify clearly which objectives are more important than others. This difficulty of clearly ranking objectives meant, when 78 fishers attempted to rank the relative importance of different objectives for the MSF, only 40 respondents had consistent rankings that reliably ranked particular objectives as being more or less important (Nursey-Bray *et al.* 2017, 2018).

Many of the social objectives identified are interdependent – meaning that achieving one objective makes it more likely a second objective will be also achieved. Because of this, it may be common for fishers to rate one objective as a higher priority in ranking processes not because it is ultimately the more important objective, but instead because it is the precondition necessary to achieving the most important objective. For example, Nursey-Bray *et al.* (2018) noted that social objectives overall were ranked of lower importance than achieving environmental and economic objectives in the MSF, and that this was not necessarily because social objectives were of lesser importance, but rather because they were viewed by MSF fishers are being largely achieved via ensuring economic and environmental objectives are achieved. This interdependence of objectives means ranking some as being more important than others may therefore not always be meaningful.

Given this, only limited attempt has been made to identify the relative priority of the different objectives in this section. Of note is that some objectives – particularly social connection and social cohesion, availability of infrastructure, provision of timely information, public amenity – have typically not been identified by MSF fishers in past studies, instead emerging in commentary on the fishery by researchers conducting social studies or identified as part of broader efforts to identify social objectives of commercial fisheries more generally (Triantafillos *et al.* 2014). They also did not emerge strongly in consultations by Nursey-Bray *et al.* (2017) used to identify objectives that were subsequently ranked. These are therefore likely to be of lower priority than other objectives and are noted as such as in the following section.

5.4 Baseline assessment of social conditions

This section assesses what is known about social conditions in the MSF. First, available data are analysed to examine the extent to which the social objectives identified in the previous section were being achieved as of 2020. Where earlier data are available, they were examined to identify whether there is any evidence of change in the extent to which objectives are being met over time.

A summary of areas of social vulnerability and social resilience in the MSF was undertaken, again drawing on available evidence. In this section, factors known to be associated with vulnerability versus resilience are briefly reviewed, before assessing overall vulnerability and resilience of the fishery, and of different regions and fishers.

The concept of the social carrying capacity was then considered as well as the extent to which it is possible to assess this, and what available evidence suggests regarding limits to this social carrying capacity, and where those limits may be at risk of being breached.

5.4.1 Social conditions in the MSF

5.4.1.1 Current and historical social conditions - governance

Table 14 summarises available data that identify current and historical social conditions related to fisheries governance.

Enabling fisheries management

The extent to which fisheries management is enabling was assessed using three main indicators. First, fishers were asked the extent to which they agreed that ‘fishing rules and regulations are easy to understand and comply with’. Second, they were asked the extent to which they agreed that ‘fisheries management is flexible enough to allow fishers to adapt to changing conditions’. Finally, they were asked about the security of their fishing rights: this question has been asked in several ways in different studies. A fourth area asked about in past studies was the perceived fairness of decisions made about fisheries management.

In total, 48.9% of MSF licence holders felt fishing rules and regulations were easy to understand and comply with, while 31.8% disagreed with this, and 19.3% neither agreed nor disagreed. There are unclear trends over time about this aspect of governance, with the proportion finding fishing rules and regulations easy to understand fluctuating up and down between 30% and 50%.

There was greater disagreement that fisheries management was sufficiently flexible. In 2020, 59.1% disagreed that management was flexible enough to allow fishers to adapt to changing conditions, and only 19.3% agreed (21.6% neither agreed or disagreed or were unsure). This is similar to past results, with 12% agreeing in 2017, and 25% in 2014. Given small sample sizes, the differences in the proportion agreeing may be due to sampling error and should not be considered to represent a trend.

Table 14. Current and historical social conditions in the MSF – fisheries governance

Objective	Relative importance	Indicator	Most recent evidence		Historical evidence
			Year, source[a]	Findings	Year, source, findings
Enabling fisheries management	High	Fisheries rules and regulations easy to understand and comply with	2020, BDO	48.9% agree, 31.8% disagree	2017: 32% agree, 52% disagree (ES2017) 2014: 54% agree, 29% disagree (ES2017)
		Fisheries management flexible enough to allow fishers to adapt to changing conditions	2020, BDO	19.3% agree, 59.1% disagree	2017: 12% agree, 69% disagree (ES2017) 2014: 25% agree, 55% disagree (ES2017))
		Perceived security of fishing rights	2020, BDO	68.2% felt they had less equitable access to fishing rights than others; 14.8% felt they had fair access	2016: 10% felt they had fair access to fishing rights (ES2017) 2014: 17% felt they had fair access to fishing rights (ES2017) 2007: 24.3% felt they had control over decisions affecting their future; 18.9% felt secure about long-term future (small sample, Brooks 2010) 2004: 41.1% felt they had control over decisions affecting their future; 26.7% felt secure about long-term future (SP2005)
		Perceived fairness of decisions about fisheries management	2017, ES2017	72% felt processes used to make decisions about fisheries management unfair (EconSearch 2017)	2014: 59% felt processes used to make decisions about fisheries management unfair (EconSearch 2017)
Stakeholder involvement	High	Ability to contact representatives	2020, BDO	84% able to contact people representing their interests on advisory committee	2013: 75% reported knowing the members of the Marine Fishers Association (at that time recognised peak representative body for MSF) (SC2014)
		Confidence to have a say in fisheries management	2020, BDO	62.5% knew how to have a say in the management of the fishery if they wanted to; 22.7% did not, and 14.8% were neutral or unsure	2016: 63% knew how to have a say in fisheries management if they want to (EconSearch 2017) 2014: 61% knew how to have a say in fisheries management if they wanted to (EconSearch 2017) 2007: Brooks (2010) identified that 60% felt they had no ability to influence fisheries management or were unsure whether they could. 2004: 42.4% were dissatisfied with the amount of control they had over decisions affecting how they could fish, and 44.6% satisfied

Objective	Relative importance	Indicator	Most recent evidence		Historical evidence
			Year, source[a]	Findings	Year, source, findings
		Satisfaction with level of consultation PIRSA undertakes with fishers on management decisions	2013	42% were dissatisfied, 38% satisfied, and 20% neither, with level of consultation by PIRSA (SC2014)	
		Proportion wanting industry to have greater say in management decisions	2020, BDO	75.0% felt fishers should have a greater say	2013: 63% disagreed that 'fishers concerns and preferences regarding management options are fully taken into consideration in management decision making' (SC2014)
		Interaction between fishers	2007	Brooks (2010) identified that, as of 2007, only 8% of a small sample of licence holders were members of a fishing industry association, and 37% of these 'believed they did not receive any benefit' from this involvement.	2004: 36.8% of MSF members were members of one or more fishing groups, with highest membership in the West Coast (51.4%) (SP2005)
Equitable access and cost	High	Perceived fairness of access to catch, fishing areas, and fishing gear/technology	2020, BDO	50-60% felt they had inequitable access in terms of gear, areas and catch allocation; 20-30% felt they were treated fairly.	2013: 69.4% felt MSF fishers were not treated equitably and fairly by fisheries managers compared to other users of fisheries resources (SC2014)
Transparent, accountable decision making	High	Perceived fairness of processes used to make decisions	2020, BDO	65.2% felt processes were unfair, 15.7% that they were fair, and 19.1% that they were neither fair nor unfair	2004: 50.9% dissatisfied with fairness of decisions about management of the fishery and 24.2% satisfied; 60.4% were dissatisfied with the rules guiding how the MSF could operate (SP2005)
		Understand how decisions about fisheries management are made	2020, BDO	55.7% of MSF fishers agreed, while 33.0% disagreed, and 11.4% neither agreed nor disagreed.	2017: 43% agreed, 29% disagreed (EconSearch 2017) 2014: 49% agreed, 33% disagreed (EconSearch 2017)
Access to infrastructure	Lower	Access to infrastructure	2013	Majority of fishers were satisfied with all types of infrastructure asked about (SC2014)	
Availability of information	Lower	See 'skills and knowledge' in the next section			

[a] Data sources are as follows: SP2005 = Schirmer and Pickworth 2005; SC2013 = Schirmer 2013; NB2017 = Nursey-Bray *et al.* 2017; NB2018 = Nursey-Bray *et al.* 2018; BDO2020 = BDO EconSearch 2020 dataset; EconSearch reports referenced by year as ES YEAR.

Fishers were asked whether they felt MSF fishers were treated fairly compared to other recreational and commercial users of fisheries with regard to security of access to fishing rights. Security of fishing rights is an important aspect of management that enables livelihood: 68.2% felt MSF fishers were treated unfairly, 17.0% that they were treated neither fairly or unfairly, and 14.8% that they were treated fairly. These results mirror those in previous surveys, with 17% feeling they were treated fairly in 2014 and 10% in 2016 (EconSearch 2017). It is also consistent with findings of related questions in other surveys, with less than half of MSF fishers reporting feeling they had control over decisions affecting their future as far back at 2004 (41.1%), and only 26.7% feeling secure about their long-term future in 2004 (Schirmer and Pickworth 2005).

This suggests that there is significant concern about the level of flexibility and security of management settings, which reduces the extent to which fishers feel enabled to have a successful livelihood, or able to invest in the long-term future of their business.

There is also evidence of ongoing strong concerns about fairness of fisheries management decisions, with what appears to be a growing proportion of MSF fishers over time reporting that they feel processes used to make decisions about fisheries management are unfair, growing from 51% in 2004 to 72% in 2017.

Overall, the findings suggest that current governance arrangements are viewed as inflexible and insecure, and that fishers feel highly limited in their ability to influence outcomes of fisheries management processes. These factors will reduce ability to adapt successfully to changes emerging from these processes.

Stakeholder involvement

The ability of MSF licence holders to be meaningfully involved in fisheries management was assessed through identifying whether fishers feel able to contact those who represent their interests in decision making processes, their confidence in being able to have a say in fisheries management decisions that affect them, the proportion wanting industry to have a greater say, and overall satisfaction with consultation processes:

Most MSF fishers know how to contact the people who represented their interests on the fisheries advisory committee: as of 2020 84.1% knew how to contact them, while 11.4% did not and 4.5% were unsure. This was a slight increase from 2013, when 75% reported knowing how to contact representatives; the small change may represent sampling variation rather than an actual increase.

Around 3 in 5 MSF licence holders feel able to have a say in fisheries management processes if they want to: as of 2020, 62.5% agreed with this statement, 22.7% disagreed, and 14.8% were either unsure or neither agreed/disagreed. In 2014 and 2016, findings were similar. However, being able to have a say does not equate to feeling confident the views expressed are heard an acted on as of 2013, 63% of MSF licence holders disagreed that 'fishers concerns and preferences regarding management options are fully taken into consideration in management decision making' (Schirmer 2014).

Most fishers – 75% as of 2020 – feel industry should have a greater say in management decisions. A smaller majority – 58.3% - supported the principle of representative bodies collecting fees through the license to enable representation of fisher interests.

Overall, this suggests possibly growing confidence in being able to contact people and have a say, but ongoing lower confidence that views of fishers will be heard and acted on in the decision-making processes.

Equitable access and cost

Views about whether fishers are treated equitably in terms of access, costs and other aspects of the fishery were identified by asking fishers in 2020 how fairly they felt MSF fishers were treated compared to other recreational and commercial users in terms of:

- Gear restrictions: 55.7% felt they were treated unfairly, 23.9% fairly and the remainder that they were treated neither fairly nor unfairly
- Access to fishing areas: 55.1% felt they were treated unfairly, 31.5% fairly and 13.5% that they were treated neither fairly nor unfairly
- Allocation of catch: 58.6% felt they were treated unfairly, 26.4% fairly and the remainder that they were treated neither fairly nor unfairly

This suggests a similar view about equity of access in general, with between 50-60% feeling they had inequitable access in terms of gear, areas and catch allocation, and 20-30% fair access.

Transparent, accountable decision making

Many measures can be used to identify whether decision making processes are transparent and accountable. There is evidence that transparent decision making is more likely to be considered fair, even if the decisions are not liked, as the transparency ensures there is good understanding of the rationale for the decisions (Gross 2008). This was examined by asking fishers how fair they felt the processes used to make decisions about fisheries management were. In total, in 2020, 65.2% felt processes were unfair, while 15.7% felt they were fair, and 19.1% that they were neither fair nor unfair. This is similar to findings of the 2013 survey, where 69.4% of MSF fishers felt that overall, they were not treated equitably and fairly compared to other users of fisheries resources (Schirmer 2014). Transparent and accountable processes also typically have the property of being readily understood. When asked in 2020 if they understood how decisions about fisheries management were made, 55.7% of MSF fishers agreed, while 33.0% disagreed, and 11.4% neither agreed nor disagreed. Past surveys have relatively similar results with 43% to 49% agreeing they understood and 29% to 33% disagreeing.

Access to infrastructure

Access to infrastructure was identified by Triantafillos *et al.* (2014) as an important social objective. However, it has been less commonly raised as an issue by MSF fishers, either in past studies, or in submissions made as part of the Stage 1 and 2 reform process. The large majority of MSF fishers reported having adequate access to infrastructure required for fishing (e.g., access to fuel and ice supply, fish handling and processing facilities, jetties/wharves, etc) when asked in 2013 (Schirmer 2014). This suggests that infrastructure availability is largely sufficient or, at least, not a significant barrier to achieving a viable fishing business for most MSF fishers.

Availability of information

Fishers were asked if they agreed or disagreed that 'fishers are provided with adequate training and advice about good fishing'. This relates to both availability of information, and to being able to build and pass on skills and knowledge, and the findings are described with regard to maintaining skills and knowledge in the fishery, in the next section.

Conclusions

Overall, the social objective of feeling governance processes enable viable businesses and are being partially met. A reasonably high proportion of fishers are able to contact representatives and feel confident they can have a say in fisheries processes. However, of particular concern is the low proportion of MSF fishers feeling they have sufficient flexibility to manage changing conditions in the fishery and feeling confident in the security of fishing rights and access into the future. This may in part be a consequence of low confidence resulting from multiple processes of reform in the fishery over a long period of time, which reduces confidence that there will be stability of fisheries rules and regulation after the current reforms are finalised. Low flexibility and low confidence in future security reduces ability to make longer-term investments in the business, particularly investing in new skills and knowledge, development of new product and market niches, and investing in upgrading equipment to improve business efficiency. This in turn can increase vulnerability of businesses to a range of changes: a business that has held off investing in more efficient technology is more vulnerable to price pressures in the market (increasing operating expenses and/or falling prices for produce); one where workers have had limited investment in skills development may be less likely to successfully adopt changing practices as they emerge.

Overall, the findings regarding governance suggest low certainty about the future, and key concerns that may reduce capacity of businesses to adapt to change, in turn threatening ability to maintain a viable and successful business.

5.4.1.2 Current and historical social conditions – fishers and fishing households

Table 15 summarises available data on current and historical social conditions relating to fishers and fishing households. This focuses on whether fishers have a viable livelihood in terms of both income and work accomplishment/achievement, are able to fulfil the things important to them about being a fisher, have sustainable working conditions, are able to develop and pass on skills and knowledge, have positive social connection, health and wellbeing; and have other characteristics of positive ability to adapt to change and be resilient to challenges.

Viable livelihood

Around 2/3 of MSF fishers report being reasonably or very comfortable in terms of household income and standard of living, while around 1/3 report being poor or 'just getting along' financially. While 47.2% had experienced some form of household financial stress event in the last year, the most common stress event was delaying non-essential purchases such as holidays, while fewer reported being unable to pay bills, going without food, heating or cooling, or having to ask for financial help from family and friends. This indicates that under conditions as of 2020, most MSF fishers were able to achieve a viable household income (for most derived not solely from the MSF, but from income earned from the MSF and from other household income earning activities). However, one in three is not able to earn a comfortable living.

It is important to recognise that threats to livelihood viability can be wide ranging. As of 2004, threats to livelihood viability identified by MSF fishers included changes to market prices that reduced business viability (78.6%), increasing operating expenses (75.6%), reduced availability of fish (71.3%) and changes in regulation of the MSF (67.1%) (Schirmer and Pickworth 2005), and submissions to the Stage 1 and 2 reform process highlight that threats to viability as of 2020 include declining species availability, and concern about ability to understand impacts of recreational fishing on stocks.

Fisheries reform processes are therefore taking place in a context in which fishers are likely to be experiencing multiple challenges to livelihoods, only some of which are able to be addressed through fisheries reform. Currently, a majority of fishers are maintaining a viable livelihood, indicating that as long as reforms do not reduce flexibility of business management and ability to achieve livelihood, a majority may continue to do so.

Being a fisher (culture, heritage, and identity)

When asked about their satisfaction with their fishing activities, just under 38% of MSF fishers reported low satisfaction with their fishing activities in the 12 months to 2020, an increase from 23% in 2014 and 30% in 2017. This suggests potential growth in dissatisfaction with ability to achieve desired outcomes from work, although most MSF fishers are still able to achieve moderate to high satisfaction with their fishing activities. Of concern is that almost two-thirds report their work satisfaction has declined in recent years, and only 7% report an increase in satisfaction in the last three years.

Working conditions

Multiple aspects of working conditions can be examined for any industry. Three were examined for the MSF: certainty in the future; work-life balance and working hours.

The level of certainty MSF licence holders feel in the future was measured in 2020 by asking fishers how likely they would make the investments they had planned for their business in the next three years. This identifies if uncertainty about the future is causing fishers to delay or hold off on making investments needed for business operations. In total, 61.9% said it was likely they would be making investments that were planned, while 21.4% were unsure if they would, and 16.7% said it was unlikely previously planned investments would occur. This did not differ significantly between fishers depending on number of boats owned or region. It did however vary with age of the fisher, with older fishers less likely to be confident they would make planned investments. In total, 87.5% of those aged 40 were confident they would make planned investment, dropping to 76.2% of those aged 41-50, 53.3% of those aged 51 to 60, and 50.0% of those aged 60 and older.

Fishers were also asked how satisfied they were with their future security: 55.7% reported low satisfaction and only 17% high satisfaction. There is evidence that low confidence in future security has been an issue for many years: as of 2004, 33.1% of MSF fishers reported being satisfied with the level of job security they had. This reinforces findings regarding fisheries governance, in that low confidence in future employment security is of key concern in the fisheries, and confidence appears to have declined over time.

MSF fishers often work long hours, with 56.3% reporting working 50 hours or more a week as of 2020. This length of working hours is known to represent a potential threat to health and wellbeing, and may reduce resilience to change for some through reducing capacity to invest in adapting to change. While most MSF fishers are satisfied with their personal relationships (80.2%) and being able to be part of their community (72.7%), indicating that these are being maintained despite long working hours, the long working hours identified are of concern.

Table 15. Current and historical social conditions in the MSF – fishers and fishing households

Objective	Relative importance	Indicator	Most recent evidence		Historical evidence
			Year, source[a]	Findings	Year, source, findings
Viable livelihood	High	Self-rated financial prosperity	2020, BDO	36.4% reported being poor or just getting along; 43.2% were 'reasonably comfortable' and 20.4% were very comfortable or prosperous. While 52.8% reported they had not experienced any major financial stress events in the last 12 months, the remainder had. Of these, 22% had delayed non-essential purchases such as holidays or recreation expenses, 12% could not pay some bills on time, 6% went without food, heat or cooling at some point, 8% asked for financial help from friends or family.	
		Satisfaction with standard of living	2020, BDO	30.7% had low satisfaction with their standard of living, while 69.3% were moderately to highly satisfied.	2004: 42.5% satisfied with financial situation, 34.8% unsatisfied (SP2005)
		Other relevant data	As of 2004, threats to livelihood viability identified by MSF fishers were growing recreational fishing (80.1%), changes to market prices that reduced business viability (78.6%), increasing operating expenses (75.6%), reduced availability of fish (71.3%) and changes in regulation of the MSF (67.1%). As of 2004, 64.8% of MSF fishers would not encourage young people to enter the MSF (SP2005).		
Being a fisher (culture, heritage and identity)	High	Satisfaction with fishing activities in last 12 months	2020, BDO	37.9% of MSF fishers reported low satisfaction with their fishing activities in the last 12 months, 27.6% moderate satisfaction, and 34.5% high satisfaction. When asked how satisfied they were with what they were achieving in life overall, 40.2% reported having little or low satisfaction, 44.8% moderate satisfaction and 14.9% high satisfaction.	2007: In a small sample of 37 licence holders, Brooks (2010) found that 89.2% were satisfied with their working environment 2017: 30% reported low satisfaction with fishing activities in last 12 months, and 30% high satisfaction (EconSearch 2017) 2014: 23% reported low satisfaction with fishing activities in last 12 months, 35% high satisfaction (EconSearch 2017) 2004: Schirmer and Pickworth found that 67.8% were satisfied with their working environment overall, and 64.9% were satisfied with their work in commercial fishing overall
		Change in work satisfaction over time	2020, BDO	65.9% of MSF fishers say their work satisfaction has declined in the last 3 years, 63.9% that it declined in the last 5 years, and 57.0% that it declined in the last	2004: Around 40% of MSF fishers reported lower satisfaction with fishing work compared to 3, 5 or 10 years

Objective	Relative importance	Indicator	Most recent evidence		Historical evidence
			Year, source[a]	Findings	Year, source, findings
				10 years. Work satisfaction increased for 7.1% in the last 3 years, 16.9% in the last 5 years and 24.1% in the last 10 years.	ago, while between 20% (3 years) and 38% (10 years) reported their satisfaction had grown (SP2005)
		Attachment to fishing industry			2004: 73.2% of MSF fishers stated they would not move to a land-based job if offered the same income they earned from fishing, while 26.8% would
Working conditions	High	Certainty in future	2020, BDO	61.9% felt confident to make planned investments in business; 21.4% unsure and 16.7% delaying investment. Older fishers less certain about making future investment. 55.7% reported having low satisfaction with their 'future security' and only 17% high satisfaction.	2010: 89.2% satisfied with working environment; 78.4% satisfied with return on effort (small sample, Brooks 2010) 2004: 67.8% satisfied with working environment; 41.1% satisfied with return on effort; 33.1% were satisfied with 'the level of job security I have' (SP2005)
		Work-life balance	2020, BDO	80.2% were satisfied with their personal relationships, and 72.7% with being able to be part of their community, suggesting some level of work-life balance is being achieved by most.	As of 2004, 26.1% were satisfied with the amount of time they had to spend working to make a living, while 37.6% were dissatisfied and 26.3% neither satisfied nor dissatisfied. 65.3% were satisfied with the balance between work life and home life, and only 11.3% dissatisfied. 26.9% reported their long work hours were a high risk to their health. SP2005
		Work hours	2020, BDO	56.3% of MSF fishers reported working 50 or more hours per week; 20% worked 40 to 45 hours; 23.7% worked less than 40 hours.	
Skills and knowledge	High	Access to training and advice	2020 BDO	40.9% felt there was not adequate access to training/advice on good fishing; 36.4% felt there was.	2014: 50% disagreed that 'PIRSA provides Marine Scalefish Fishers adequate training and advice about good fishing practices'; 25% agreed; 25% neither agreed/disagreed 2007: 62.2% had self-taught fishing skills and 73% taught by family member; 56.7% rarely or never accessed information from others in the fishery beyond immediate family/business workers (Brooks 2010)

Objective	Relative importance	Indicator	Most recent evidence		Historical evidence
			Year, source[a]	Findings	Year, source, findings
		Formal educational attainment			2004: Highest level of formal education was primary school for 23.7%, fourth year high school for 39.6%, Year 12 or equivalent for 20% and post-high school for 16.6% (SP2005)
Social connection	Possibly lower	Social connection to local community	2020, BDO	72.7% reported being satisfied with their ability to be part of their community.	2007: 63% engaged in local community groups, of which 37% engaged at committee levels (small sample, Brooks 2010) 2004: 49.5% were members of one or more community groups; many reported being limited in ability to be engaged in community social life and civic activities due to irregularity of fishing hours (SP2005)
		Interaction between fishers	2007	Brooks (2010) identified that, as of 2007, only 8% of a small sample of licence holders were members of a fishing industry association, and 37% of these 'believed they did not receive any benefit' from this involvement.	2004: 36.8% of MSF members were members of one or more fishing groups, with highest membership in the West Coast (51.4%) (SP2005)
Health and wellbeing	Unknown	Satisfaction with quality of life	2020, BDO	65.9% reported being satisfied or very satisfied with their quality of life, while 34.1% reported low satisfaction. This is a smaller proportion compared to previous surveys and may indicate loss of overall wellbeing.	2014: 75% satisfied or very satisfied with quality of life in general (SC2013) 2007: 89.2% satisfied with quality of life (small sample) (Brooks 2010) 2004: 74.8% satisfied with quality of life in general (SP2005)
		Health	2020, BDO2020	34.1% reported low satisfaction with their health. When asked to rate their general health, 42% reported having excellent or very good health, 27% good health, and 31% fair or poor health. This is relatively similar to Australian averages (when compared to data from the Regional Wellbeing Survey), however slightly more poor health is reported amongst MSF fishers.	2004: 69.5% satisfied with health, 79% experienced back pain; many experienced health problems; low rates of seeking medical attention from GPs or other medical practitioners identified (SP2005)
Adaptive capacity/ resilience	High	Dependence on MSF for income	2020, BDO	There is varying dependence on the MSF for household income. Just under 40% of fishers (39.7%) earned 80% or more of their household income from	2004: 52.7% of MSF workers reported having at least one member of their household who earned income outside the MSF; on average, 70.3% of household income was derived

Objective	Relative importance	Indicator	Most recent evidence		Historical evidence
			Year, source[a]	Findings	Year, source, findings
				the MSF; 20.5% earned between 50% and 79% of income, while 39.8% earned less than half their household income from the MSF.	from commercial fishing, with most of this from fishing in the MSF (SP2005)

[a] Data sources are as follows: SP2005 = Schirmer and Pickworth 2005; SC2013 = Schirmer 2013; NB2017 = Nursey-Bray *et al.* 2017; NB2018 = Nursey-Bray *et al.* 2018; BDO = BDO EconSearch 2020 dataset

Skills and knowledge

Fishers were asked if they agreed or disagreed that 'fishers are provided with adequate training and advice about good fishing'. This relates to both availability of information, and to being able to build and pass on skills and knowledge. Overall, 40.9% of MSF fishers disagreed with this statement, 22.7% neither agreed or disagreed, and 36.4% agreed. This suggests concern about ability to maintain and build skills and knowledge.

There is evidence that, over time, there has been increasing reliance on passing on fishing skills and knowledge through highly inter-connected, often family-based social networks. Brooks (2010) found that between 2004 and 2007, reform of the MSF fishery resulted in those who had been in a fishery for a shorter time being more likely to leave the fishery, arguing that remaining licence holders were more likely than those who had exited the fishery to fish as part of a family business that had been engaged in fishing for two generations or more compared to the 46.7% reporting this in 2004 (Schirmer and Pickworth 2005). However, as of 2013, 50% of MSF fishers reported having two or more generations who had worked in commercial fishing, suggesting the change observed by Brooks (2010) was either short-term in nature, or possibly reflected small sample size. Overall, learning was highly reliant on informal passing on of knowledge: 62.2% learned commercial fishing skills through self-teaching and 73% from a family member (Schirmer and Pickworth 2005, Brooks 2010). There was also evidence of lack of interconnectedness through the fishery, with 56.7% of fishers surveyed in 2007 reporting they never or only occasionally accessed skills and knowledge via a broader network of contacts in the industry and placing high importance on self-reliance, something that can be associated with a lack of ability to rapidly share new skills/knowledge through an industry.

Formal educational attainment is relatively low amongst MSF fishers. As of 2004, 23.7% reported their highest level of schooling was primary school, 39.6% that it was the fourth year of high school, while 20% had achieved Year 12 or equivalent of high school, and 16.6% had post-high school qualifications from a tertiary education institution such as a TAFE or university. This compared to 42% of adult South Australians have post-high school qualifications in 2004 (Schirmer and Pickworth 2005). As of the 2016 Census of Population and Housing, commercial fishers in South Australia continued to have substantially lower than average formal educational attainment, likely reflecting the high reliance on learning skills 'on the job' rather than through formal education. With limited social connection across the industry, this means there is a high risk of skills and knowledge loss if a significant number of fishers leave the industry in a short period of time, with resulting risk of loss of social carrying capacity in the fishery. Low levels of formal educational attainment also reduce ability of fishers to obtain alternative employment in other industries if they leave fishing.

Social connection

Most MSF fishers (72.7%) were satisfied with their ability to be part of their community as of 2020. While previous studies have raised concern about limited ability to engage in community and civic activities such as community groups, the rates of community group membership reported by MSF fishers in past studies (see Table 16) are similar to those reported across rural and regional Australia in the Regional Wellbeing Survey and do not indicate a significant lack of social connection in local communities.

Health and wellbeing

Overall wellbeing reported by MSF fishers in 2020 was lower than is typical for rural and regional Australians: 65.8% were moderately to highly satisfied with their life as a whole, while 34.1% reported low satisfaction. This represents a likely decline from previous studies in which 75% or more of MSF fishers reported moderate to high life satisfaction. Around 1/3 of MSF fishers report poor health, slightly higher than the average for rural and regional Australians. In 2004, Schirmer and Pickworth (2005) identified that MSF fishers had low rates of medical treatment for health problems, being unlikely to seek medical attention for health issues. These findings are of concern as declining wellbeing and poor health are indicators of low resilience and can reduce ability to invest in the business and adapt successfully to change.

Adaptive capacity/resilience

All aspects of fisher and fishing households examined above can be considered aspects of adaptive capacity and resilience. In addition to these, it is useful to understand how directly dependent fishing households are on the MSF for their household income. As of 2020, just under 40% of fishers (39.7%) earned 80% or more of their household income from the MSF; 20.5% earned between 50% and 79% of income, while 39.8% earned less than half their household income from the MSF.

5.4.1.3 Current and historical social conditions – social license and fishing communities

Table 16 summarises data on social license to operate and fishing communities. The MSF contributes to the communities in which it operates in a range of ways. While many studies focus on employment, this is not the only measure of contribution. For example, Schirmer and Pickworth (2005) found that as of 2004, the proportion of employed people working in the MSF was between 1% and 2.9% in the regions where MSF licence holders were most clustered (1.3% of workers on Kangaroo Island, 1.0% in Barunga West and the Copper Coast, 1.6% in the Yorke Peninsula, 1.2% in Port Lincoln, and 2.9% in the West Coast). This represents only direct employment and does not include indirect employment generated as a result of MSF. They also identified in qualitative interviews that fishing was often highly important to the social identity of towns, even where it contributed a relatively small proportion of employment.

The community a fisher lives in may impact their ability to adapt successfully to change, for example through being unsupportive, or through having few opportunities for new employment or markets. Table 17 shows unemployment rates in different communities: higher unemployment rates in communities located in western parts of South Australia (Ceduna, Streaky Bay) as well as in the Copper Coast, mean that MSF fishers in these areas are likely to have fewer alternative employment opportunities available to them if income from the MSF falls. Over time, views of MSF fishers about how the general community perceives fishers have improved: whereas in 2004, 63% of MSF fishers believed most people in SA perceived commercial fishers negatively, this had fallen to 45% by 2020, while the proportion feeling they are viewed positively grew from 8% in 2004 to 31% in 2020. This may partly explain why social license is given less priority by some fishers, with apparently growing confidence in perceptions of commercial fishing. However, a large proportion of MSF fishers remain concerned about public perceptions of the fishery.

While many are concerned about how the general public, most feel that fishers are good stewards, with 75% feeling most fishers are responsible stewards who comply with rules and regulations and only 13.6% disagreeing with this. This suggests fishers predominantly feel confident they are able to be good stewards in terms of fishing responsibly. The exception for some is concern regarding species availability: in submissions to the reform process, and in discussions reported in Nursey-Bray *et al.* (2017), it is clear that many fishers are concerned about stock availability and want to see these concerns addressed.

Most fishers also report being satisfied with their ability to connect to community. In BDO EconSearch reports, fishers report making a wide range of community contributions, including to specific types of volunteering and community events (see BDO EconSearch 2020; EconSearch 2017, 2014). Overall, the findings suggest that while there are concerns about social licence to operate, fishers feel mostly confident in their stewardship, in terms of complying with rules and regulations and fishing responsibly, despite concerns about stock availability. They also suggest that fishers living in western areas, and the Copper Coast, have somewhat fewer alternative economic opportunities outside fishing, whereas in other regions unemployment is at levels similar to that of SA as a whole. However, as noted in the previous section, low formal educational attainment may reduce ability of fishers to achieve alternative employment outside the fishing sector.

Fishers do contribute significantly to their communities. It is likely that even if leaving fishing, many fishers would remain living in their local region and continue contributing to communities, particularly with many households earning only part of their household income from the MSF.

Table 16. Current and historical social conditions in the MSF – social license and fishing communities

Objective	Relative importance	Indicator	Most recent evidence		Historical evidence
			Year, source[a]	Findings	Year, source, findings
Social license to operate	High	Engagement in responsible stewardship	2020, BDO	75.0% of fishers agree that most fishers comply with rules and regulations and fish responsibly; 13.6% disagreed, and 11.4% neither agreed nor disagreed.	
		Perceived reputation of commercial fishers by general community	2020, BDO	44.8% of fishers believe the general community perceive commercial fishers negatively, 24.1% feel they are perceived neither negatively or positively, and 31.0% believe they are perceived positively.	2014: 50% MSF fishers believed most people in the general community perceived commercial fishers negatively; 22% that they perceived them positively; and 28% that they were perceived neither positively nor negatively 2004: 62.9% of MSF fishers believed most people in SA perceived commercial fishers negatively and 7.6% positively; 53.8% believed most people in their local community perceived commercial fishers negatively, 17.5% that they were perceived positively and 28.7% that local community members had neither positive nor negative views
Participation in and liveability of local communities	High	Community participation, connection, and liveability	2020	72.7% satisfied with connection to local community.	2007: Of 37 licence holders surveyed, 37% did not interact with community groups at all, while 63% did (Brooks 2010) 2004: 49.5% were members of at least one community group, with sporting clubs the most common. 2004: 85.1% of MSF fishers were satisfied with the local area they lived in; 83.9% felt their community was an excellent or good place to live; 56.5% reported feeling strong or very strong attachment to their local community, and 29.5% some attachment (SP2005).
		Employment opportunities in local communities	2020	See Table 17. Employment alternatives vary by community substantially.	

[a] Data sources are as follows: SP2005 = Schirmer and Pickworth 2005; SC2013 = Schirmer 2013; NB2017 = Nursey-Bray *et al.* 2017; NB2018 = Nursey-Bray *et al.* 2018; BDO2020 = BDO EconSearch 2020 dataset

Table 17. Unemployment rates by local government area for key MSF fishing regions: 2015 to 2020 (Source: National Skills Commission, 2020)

Local Government Area (LGA) (2020 ASGS)	Mar -15	Jun -15	Sep -15	Dec -15	Mar -16	Jun -16	Sep -16	Dec -16	Mar -17	Jun -17	Sep -17	Dec -17	Mar -18	Jun -18	Sep -18	Dec -18	Mar -19	Jun -19	Sep -19	Dec -19	Mar -20	Jun -20	Sep -20	Dec -20
Barunga West (DC)	6.4	6.4	7.0	7.8	7.5	7.4	6.8	5.5	5.2	4.8	5.1	5.7	6.3	6.2	6.0	5.7	6.2	6.7	7.4	7.2	6.7	7.0	6.2	5.9
Ceduna (DC)	6.6	5.8	5.6	5.8	6.5	5.9	5.9	6.0	6.0	6.7	6.6	7.0	7.1	6.4	5.9	5.2	5.5	6.0	7.3	7.8	7.6	8.4	8.2	8.4
Copper Coast (DC)	10.2	10.2	11.2	12.2	11.6	11.9	10.8	8.7	8.2	7.3	7.7	8.9	10.0	9.9	9.6	8.9	9.2	9.6	10.6	10.3	9.7	10.2	9.0	8.5
Kangaroo Island (DC)	5.3	5.5	5.8	5.4	4.7	4.2	3.8	3.8	3.7	3.7	3.6	3.4	3.3	3.0	3.1	3.2	3.2	3.3	3.1	3.0	3.1	3.5	4.2	4.7
Port Lincoln (C)	6.0	4.9	4.3	4.5	5.3	5.2	5.5	5.6	5.2	5.5	5.2	5.1	5.1	4.3	3.6	3.0	3.4	3.8	4.8	5.3	5.2	6.1	5.9	6.2
Streaky Bay (DC)	5.5	4.9	4.9	5.2	6.0	5.8	5.9	5.8	5.6	5.9	5.5	5.7	5.9	5.0	4.5	3.8	4.2	4.6	5.7	6.2	6.2	7.1	6.9	7.1
Tumby Bay (DC)	2.8	2.2	2.0	2.0	2.4	2.3	2.4	2.7	2.5	2.8	2.7	2.8	2.8	2.3	2.1	1.7	1.7	1.8	2.2	2.4	2.3	2.9	2.9	3.2
Yorke Peninsula (DC)	7.5	7.3	7.9	8.4	8.0	8.1	7.3	5.9	5.3	4.5	4.5	5.1	6.1	6.2	6.3	6.1	6.1	6.6	7.3	7.1	6.9	7.4	6.6	6.4
South Australia (ABS Labour Force Survey)	6.3	8.4	7.7	7.1	7.0	7.4	6.8	6.6	7.1	6.8	5.9	6.0	5.6	5.5	5.5	6.0	5.9	6.1	6.3	6.3	6.3	8.8	7.0	6.4

5.4.2 Social vulnerability and resilience in the MSF

This section summarises areas of social vulnerability and social resilience in the MSF, again drawing on available evidence. The data presented include data identifying a range of areas of vulnerability and resilience. Here, vulnerability is defined in relation to the MSF, and is defined as the risk of a fisher experiencing harm or loss if there is a change to their ability to participate in the MSF as a successful fisher. This definition emerges from an understanding that there is no single definition of vulnerability, and there is ongoing debate about what makes a person 'vulnerable' (see for example Ruof 2004), and that vulnerability is typically defined in relation to something: for example, assessing whether a person is vulnerable to experiencing loss of their home if they experience financial stress, or vulnerable to experiencing loss of property in a storm. Wingate *et al.* (2007) highlight that the many characteristics that may predict higher vulnerability to a specific event (in their case, disasters; in the context of this report, change in access to or operation of the MSF):

> *Vulnerable populations can be defined broadly to include those who are not able to access and use the standard resources offered …. Age, class, race, poverty, language, and a host of other social, cultural, economic, and psychological factors may be relevant … (p. 422)*

A general definition of vulnerability that reflects elements common to most disciplines and uses of the term is that 'vulnerability is … the risk that a "system" (such as a household, community, country) would be negatively affected by 'specific perturbations that impinge on the system' (Gallopin 2006, cited in Sumner and Mallet 2011). This suggests two critical elements to define: what is considered the 'negative effect' and what is meant by 'specific perturbations'.

In this chapter 'negative effect' is considered to be risk of experiencing loss of overall health, wellbeing and quality of life, often related to loss of specific tangible assets such as income. Health and wellbeing may be reduced if a person experiences ongoing stress or difficulty adapting to change, even if they succeed in maintaining income. Therefore, it is inappropriate to define vulnerability only with respect to loss of income. The definition of vulnerability used also defined vulnerability as being a function of capacity to cope with and adapt to a shock or challenge that a person or business experiences. A less vulnerable person will be able to cope with a stressful or challenging event in ways that overall reduce the impacts of that shock or challenge on their wellbeing, and that enable rapid recovery of wellbeing after the shock/challenge. A more vulnerable person will be less able to protect their wellbeing when a shock/challenge occurs, more likely to experience a large loss of wellbeing, and less able to recover wellbeing after the shock/challenge occurs.

Vulnerability is often presented as being somewhat the inverse of resilience, in that resilience is broadly defined as having access to resources that enable a person to cope with challenges and take advantage of opportunities, while vulnerability is related to lacking those resources and thus being at higher risk of experiencing loss during challenging times, or less able to achieve benefits by capitalising on opportunities. This has been challenged by some, based on the multi-dimensional nature of vulnerability and resilience: a person may be vulnerable in some respects, while having high resilience in other aspects of their life. For example, a person may be at high risk of experiencing social isolation, indicating high vulnerability to any events that further reduce ability to connect to others socially, while having high financial resilience in the form of a high level of income and savings.

In this section, factors known to be associated with vulnerability versus resilience are briefly reviewed, with key areas in which there is higher vulnerability and resilience identified.

A person can be vulnerable or resilient with regard to any of the following dimensions of their life:

- Financial resources – ability to earn a sustainable livelihood and maintain a sufficient and comfortable standard of living. While economic viability of the fishery as a whole is also relevant here, it is not discussed as this is reported on by BDO EconSearch (2020).

- Human resources - skills, knowledge, education
- Human resources – achievement and self-efficacy (ability to achieve desired outcomes in life and feeling able to control or direct these outcomes)
- Human resources – health, wellbeing, including levels of stress and anxiety, physical health, and mental health; these in turn are affected by factors including working conditions
- Social resources – social connections with family and friends; work-related networks; and broader social connections in the community
- Physical resources – access to services, infrastructure in local area, safety, and amenity of local area and of workplace
- Natural resources – availability and sustainability of natural resources a person relies on; in this case, fisheries resources are key. As this is the subject of environmental science, it is not examined further here, as other reports assess this aspect.

Table 18 summarises areas of vulnerability and resilience identified with regard to these. Key areas of vulnerability are in the areas of self-efficacy, skills/knowledge transfer, and health/wellbeing. These flow on to affect the ability of fishers to maintain a sustainable livelihood, meaning that as a result of these things, financial resources is also an area of key vulnerability. Overall, MSF fishers have high resilience in terms of having extended experience of navigating fisheries reform and change and being self-reliant; many also earn a comfortable income and have positive social connections. However, there is a limit to the extent fishers can be expected to continue to cope successfully with uncertainty, and declining wellbeing and evidence of growing uncertainty and lack of confidence in the future suggests many fishers may be reaching their limits in terms of ability to cope with these issues. Declining wellbeing is of high concern, as is lack of social connection across the fishery, with lack of strong social networks outside individual fishing businesses reducing resilience and increasing vulnerability to change.

Table 18. Assessment of areas of vulnerability and resilience

	Vulnerability rating	Areas of vulnerability	Resilience rating	Areas of resilience/ opportunity
Financial resources	Moderate	1/3 fishers experiencing financial difficulty; high proportion rely on MSF for 50% or more of household income	Moderate	2/3 earning sufficient income to be comfortable or prosperous; many have income sources other than MSF
Human resources – skills, knowledge	High	High reliance on informal and close networks for passing on skills and knowledge means high risk of loss if key fishers exit fishery without passing on skills. Low formal education reduces employment opportunities.	Low	While highly skilled, these skills are at high risk of not being passed on to others in the fishery, and unlikely to be recognised outside the fishing industry.
Human resources – achievement, self-efficacy	High	Lack of certainty about the future and low sense of control means many fishers feel unable to make business decisions with certainty.	Moderate	Despite uncertainty about future, many fishers are still investing in businesses, and many have successfully operated for many years in an uncertain environment, with skills gained in managing uncertainty as a result.
Human resources – health, wellbeing, identity	Moderate	Evidence of declining wellbeing and high levels of psychological stress. These increase vulnerability to change and reduce decision making capacity in times of stress and change. Long working hours for many likely compound stresses. High attachment to fishing as a lifestyle may also increase vulnerability to experience negative impacts on health and wellbeing when change occurs.	Low	See notes on vulnerability.
Social resources – family, friends, community	Moderate to high	Most fishers report good social connection both personally and in community.	Moderate	With many fishers placing high value on self-reliance, it is likely social networks are not well utilised to obtain support during times of change.
Social resources – MSF/ commercial fishing	Moderate to high	Limited broader social networks within fishery reduce ability to fishers to work together and support each other across the fishery	Low	High self-reliance is both a positive and negative resilience trait; with regard to social connection, it has some negative implications as it makes help seeking and collaboration less likely.
Physical resources	Low; higher in west	Few identified; higher unemployment in some communities.	Moderate to high	Moderate to good access to infrastructure and services for most

5.4.3 Social carrying capacity of the fishery

This section considers the concept of the social carrying capacity of the fishery. Social carrying capacity is a term that lacks clear definition in the literature. It is most commonly used to refer to the idea of maximum social use of a particular area of land or water (Lopez-Bonilla *et al.* 2007): for example, what is the maximum number of people who can go recreational fishing simultaneously before quality of experience declines for all?

In the context of a commercial fishery, the term refers to where a limit may be reached where, beyond that limit, a person's wellbeing, or capacity to operate effectively diminishes. Social carrying capacity in the broader context of commercial fishing can refer to where a limit is reached in terms of demand for fisheries resources between commercial and recreational sectors in which any extra demand from either sector reduces overall quality and access of both sectors to resources. However, this cannot be assessed in this chapter. What can be assessed is whether there is evidence that tipping points are likely to be reached, or have been reached, beyond which there is a risk of loss of wellbeing or capacity in the fishery.

Two key areas where social carrying capacity may be at risk in processes of fisheries reform were identified. The first was 'carrying capacity' for reform processes. People who experience regular change and uncertainty may reach a point where they are no longer able to cope and manage these change processes. There is evidence this point is being reached for many fishers in the MSF, with multiple reform processes over many years resulting in high levels of stress for many. This reduces ability to maintain successful operation in the fishery, and reduces overall quality of life, for some substantially.

Additionally, available evidence suggests some potential limits to the social carrying capacity of the fishery in terms of the passing on of skills and knowledge. Fewer fishers being present, and many leaving the fishery without passing on skills and knowledge, risks a reduction in viability of the fishery, and potential in ability to fish responsibly, over the longer term.

There is also potential for loss of fishers to impact on supply chains: this is an economic impact, and not assessed here, but should be noted. It is important to identify what thresholds of production are required for supply chains in each local region to continue operating successfully.

5.5 Assessment of potential social impacts

This section briefly summarises areas of potential social impact from reform of the fishery, and the circumstances under which they would occur, synthesising findings from earlier parts of the chapter to do so.

5.5.1 Areas of risk for negative impact

Key areas of risk for negative impact are:

- Risk of ongoing under-investment in businesses due to uncertainty about the future. This risks vulnerability not just to fisheries reform, but to other changes such as shifting markets, as businesses may be less able to adapt to changes in operating environment and markets due to under-investment
- Difficulty obtaining employment outside the fishing industry that provides similar income and work satisfaction. This is a high risk for those who opt to exit the fishery, or who reduce activity in the MSF and seek to increase income sources outside the MSF, in response to reforms. Lack of formal educational attainment and lack of recognition of the high level of skills attained through working in the industry contribute to this risk, as does high rates of unemployment in some MSF communities.
- Risk of declining psychological capacity to adapt to change. Ongoing stress and uncertainty are known to be triggers for burn out and reduced capacity. This can reduce capacity of fishers to adapt successfully to reforms that in other circumstances would be able to be managed successfully by the

fisher and their business. Cumulative stress over multiple years is a key risk area likely to contribute to negative outcomes from fisheries reform, in particular high levels of stress and anxiety, and loss of mental health. This in turn can contribute to reduced success of the fishing business, as those with poorer mental health have lower capacity to achieve success in the day-to-day management of their business. If reforms reduce ability to fish in a way fishers view as responsible, sustainable, and viable, this is likely to have a significant negative impact on mental health.

- Financial loss: Depending on whether reforms enable sufficient certainty and flexibility in business operation, some businesses may experience financial loss. Financial loss may also occur as a consequence of under-investment and loss of mental health identified above.
- Long-term loss of fishing skills and knowledge. Informal methods for passing on skills and knowledge mean that any exit of fishers risks long-term loss of skills and knowledge critical to the fishery.

5.5.2 Areas of potential opportunity

One key area of opportunity was identified: increased certainty. If reforms result in greater stability moving forward, and longer-term certainty regarding fisheries regulation and governance, fishers may be better able to invest in businesses and adapt to other forms of change. They will also be less likely to experience psychological stress and be less likely to lose fishing skills and knowledge over time. Whether increased certainty and stability if achieved is entirely dependent on whether reforms are able to achieve this. It is unlikely to be achieved in the short-term, as it would require a period of stability before fishers are likely to feel confident in stability of fisheries management. This also requires increasing confidence of commercial fishers that the demand on fisheries resources from recreational fishing is being understood and managed well. This suggests a potential need for support in the short-term until fishers build confidence that fisheries reform has resulted in more stable and predictable management settings going forward.

5.5.3 Mitigation options to reduce risk of negative impact and maximise positive impacts

A range of mitigation actions can assist in reducing risk of negative impact and maximising positive impacts. The following are potential actions identified:

- Providing funding and resources for MSF fishers to access financial counselling and business development support. This can assist in decision making, particularly for those experiencing both financial and psychological stress, for whom decision making is likely to be difficult. Experience with drought support suggests that facilitating and funding access to these types of services can be very positive in terms of helping reduce both financial and psychological stress.
- For those choosing to leave fishing and wishing to transition to other employment: Support for actions such as training to have skills recognised in formal certificates, and support to enter mainstream labour market processes. This type of support has been used successfully to achieve positive outcomes for other workforces with similar low levels of formal education and high levels of informal skills, with a recent example being the Tasmanian forest reform, where 90% of almost 2,000 workers in the forest industry achieved new employment after being provided free access to trained support workers who assisted them to identify training opportunities, to build skills in writing a CV and job interviews, and supported in identifying potential alternative employment pathways.
- Identify and support processes for skills and knowledge transfer, particularly for those who are exiting fishing. This could for example involve providing funding for workshops or fishing trips where exiting fishers work with those who are remaining in the fishery to pass on skills and receive payment for doing so.
- Acknowledgment of stress and uncertainty. Recognising the impacts of ongoing reform on fishers is an important part of addressing the mental health burden it can create. This should be an important part of communication by fisheries managers.

- Access to psychological support. While it is common to provide access to psychological counselling services when reform processes occur, it is also common for these to have low rates of uptake by groups such as fishers. Employing liaison officers who have a background in fishing, and ideally existing relationships with fishers, and who can reach out and maintain contact and act as a 'bridge' to link fishers to psychological support if and when needed can be more effective than simply providing an unfamiliar counselling service that fishers have to reach out to on their own initiative. Psychological support should be provided for the entire fishing household, not only licence holders.

5.6 Future measurement of social metrics for the fishery.

It is recommended that the following be measured in future surveys of the fishery to continue measuring whether social objectives are being achieved, and how vulnerability and resilience are changing:

- Security of income from fishery (current and future)
- Ability to earn viable livelihood from fishery
- Sense of accomplishment, stimulation, and challenge from fishing work
- Ability to achieve lifestyle benefits desired from fishing
- Being able to continue family history/cultural identity
- Perceptions of community support for commercial fishers
- Confidence in ability to be good steward of fishery
- Ability to maintain connections with local community
- Strength of social connections with family and friends
- Willingness and ability to seek assistance from family/friends, others in fishing industry, and local community, when needed

5.7 Discussion

The assessment of social aspects of the fishery suggests several areas of both challenge and opportunity, highlighted throughout this chapter. They are discussed here in relation to the three pillars of reform examined in other chapters in this report.

5.7.1 Regionalise

Regionalisation seeks to establish zones of fisheries management that recognise economic, ecological and social diversity. From the perspective of social capacity, the key issue to consider regarding regionalisation is whether it will affect ability to achieve desired social objectives in the fishery, and whether it will have any positive or negative effects on the social vulnerability and resilience of fishers. Regionalisation involves change in how the fishery is governed, and hence has potential to affect how well the fishery achieves social objectives related to governance. It also has potential to affect the ability of fishers to achieve social objectives related to livelihood and building and maintaining adaptive capacity and resilience.

5.7.1.1 Governance objectives

As noted earlier in this report, implementation of regionalised management has some potential to increase complexity of regulation for those fishers who fish across more than one zone, although the number of fishers who cross zones is limited. For these fishers, the fisheries management environment may be less enabling than it was prior to the reform, depending on the extent to which differing regulations or requirements are implemented in different zones. However, if regionalisation leads to greater certainty in access to stocks and confidence in management, this is likely to increase the extent to which there is an enabling fisheries management environment. From the point of view of achieving social objectives related to governance, it is critical that decisions made about the fishery in each region are transparent, appropriately engage fishers, and support equitable access and cost sharing across fishers operating within and across the four zones.

5.7.1.2 Fisher livelihood objectives

Regionalisation has potential to support livelihoods through improving certainty of access to stocks in regions. It also has some potential, depending on how it is managed, to reduce flexibility of fishers to respond to changes in the fishery by flexibly changing their fishing and the zones and species targeted. This in turn can impact on capacity to adapt and to use strategies of flexibly altering areas or species to maintain livelihood viability over time. Regionalisation may result in further concentration of fishers into fishing in each zone, although most already largely fish in the zones being used, and the decision not to regionalise licences reduces this likelihood. This also minimises the risk of reduced sharing of knowledge and passing on of knowledge across zones, another potential consequence of regionalisation. However, it is important to consider how best to ensure continued sharing of knowledge, skills and information across zones, given that passing on of knowledge is a key area of social vulnerability in the fishery, and regionalisation is unlikely to reduce that risk.

5.7.1.3 Social licence objectives

It is difficult to identify any specific impacts of regionalisation on social licence objectives; however, if in the long-term regionalisation contributes to more stable and sustainable stock levels, this is likely to improve social licence, and fishers confidence in their ability to successfully meet stewardship objectives.

5.7.1.4 Community objectives

Regionalisation has some potential to reinforce the connection many MSF fishers have traditionally had with local communities, and to build the regional identity of the fishery, through the process of regional management. Whether this occurs depends on how regionalised management occurs in practice, and how regionalised management decisions are communicated to and involve the broader community as well as fishers.

5.7.1.5 Overall impacts on key areas of vulnerability and resilience

Overall, while regionalisation has some potential to both improve livelihood and to reduce flexibility of livelihood, the design of the regionalisation minimises the risks of negative social outcomes, while providing the potential for long-term support for sustainable livelihoods through improved certainty of access to the fishery resulting from regionalised management. Many of the potential social impacts of regionalising will depend on how successful the ongoing processes of making decisions regarding fisheries management in each region is: if fishers find these processes result in greater certainty, are viewed as fair and providing equitable access and cost sharing of management costs, they will likely contribute positively to social objectives. Ongoing assessment of the management process and how fishers experience these aspects is important, as it will enable adaptation of management to ensure these outcomes.

5.7.2 Unitise

Unitising involves determining sustainable catch limits for all who share the resource. Similar to regionalisation, the impacts of actions taken as part of the 'unitise' pillar of reform depend in large part on the longer-term success of these actions in increasing certainty about the future of the fishery, and via this, enabling fishers to have confidence in their ability to have a viable long-term livelihood.

5.7.2.1 Governance objectives

The framework developed under the unitise pillar of reform will provide non-binding recommendations that form the basis of management recommendations by the MSFMAC. This enables greater flexibility in fisheries management and enables stakeholder involvement through the MSFMAC. However, it may also result in ongoing uncertainty about the future, as there will be an ongoing process of quota setting. Achieving balance between the flexibility needed to sustainably manage the fishery, and the need to provide a sufficient level of certainty to enable fishers to invest in their livelihood and have positive wellbeing, is an ongoing challenge for all commercial fisheries, and the MSF is no exception. The success of unitising in achieving governance objectives will rest on the processes used by the MSFMAC, and whether they fulfil the governance objectives of enabling stakeholder involvement, ensuring equitable access and cost sharing, and transparent and accountable decision-making processes. Having a clear and easy to understand framework underpinning recommendations does provide the initial conditions required to meet some of these, providing clarity around how and why recommendations were made. It will be critical to ensure the recommendations the MSFMAC then make based on the framework and other considerations are similarly transparent and accountable.

5.7.2.2 Fisher livelihood objectives

Unitising has potential to increase certainty about the future amongst fishers, and to provide a more sustainable basis for viable livelihood opportunities. If unitisation results in greater certainty about the future of the fishers, it is likely to support increased investment in things such as capital equipment, and improved livelihood opportunities for fishers. However, whether it achieves this depends on the extent to which the governance objectives above are met.

There is a possibility that implementing ITQs will reduce health and safety risks as it will remove the ‘race to fish’. A US study found that after ITQs were implemented in an economically important US West Coast fishery, a fisher's probability of taking a fishing trip in high wind conditions decreased by 82% compared with only 31% in the former “race to fish” fishery. Overall, ITQs caused the average annual rate of fishing on high wind days to decrease by 79% (Pfeiffer and Gratz 2016).

5.7.2.3 Social licence objectives

Unitising may positively support social licence, depending on how successfully governance processes work to balance allocation to different users of MSF stocks, and how the governance processes are perceived by both fisheries stakeholders (commercial, recreational, Indigenous) and by the broader community.

5.7.2.4 Community objectives

It is argued by some that implementing ITQs can reduce potential for conflict between different users of fisheries resources, through providing a stronger negotiating position and a simplified mechanism for compensation with other marine users. For example, under the Queensland Fisheries Reallocation Policy, the proponent (e.g., a recreational fishing group wishing to close an area to commercial fishing) has to prepare a cost benefit analysis (CBA) and a proposal as to how compensation will be paid to the Minister. All preparation costs are borne by the proponent (Queensland Government 2017). ITQs provide commercial fishers with a right in which a market value can be easily ascertained, and thus inputted into any benefit cost proposal, they also provide a simple mechanism for compensation should a proponent be able to demonstrate a positive benefit cost ratio and fund the compensation. However, in reality there is limited evidence regarding the success of ITQs in achieving reduced conflict and more positive relationships in practice, and it is not possible to assess with confidence whether this will be the case.

5.7.2.5 Overall impacts on key areas of vulnerability and resilience

Overall, unitisation has potential to improve one key area of vulnerability – uncertainty about the future – and through this to reduce some of the key factors that are contributing to high levels of stress for many MSF fishers and declining wellbeing for some. Whether it achieves this in practice will depend on the success of implementation of the new governance arrangements and the ability of the MSFMAC to meet governance objectives critical to the wellbeing and livelihoods of MSF fishers.

5.7.3 Rationalise

Rationalising sought to improve the economic efficiency of the fishery by reducing capacity. As noted earlier in the report, fewer licences were removed from the fishery than aimed for, and most licences involved relatively small levels of effort in the fishery in recent years. From a social perspective, it is likely that many of those who sought to exit the fishery were those who were identified as most vulnerable in terms of their levels of stress, wellbeing, and difficulty achieving livelihood objectives. These fishers were more likely to be considering existing the fishery irrespective of a licence buy back, and the licence buy back may have provided opportunity for some of these fishers to 'exit with dignity' and with some financial resources to support developing new livelihood opportunities. Studies of those who exit other primary resource-based industries have found that despite a common perception that exiting is associated with a large decline in wellbeing, in fact many people exiting livelihoods such as farming – which share many livelihood characteristics with commercial fishing – find they adapt well after exit and after a period of months or years report higher levels of wellbeing than previously (see for example Peel et al. 2016, Peel et al. 2019). If fishers are similar, it is likely that wellbeing was lowest during the period prior to the reform process being implemented and during the time when decisions were being made about licence buy out; once a decision was made about whether or not to exit the fishery, the increase in certainty about the future may have contributed to a positive change in wellbeing for both those who stayed and those who left. It is recommended that follow up surveys assess whether this is in fact the case for both groups, particularly given the unique challenges and stresses the COVID-19 pandemic presented for many in the fishery during the period in which reform was being carried out, which may have had further impacts on wellbeing of many fishers.

5.7.3.1 Governance objectives

Rationalising sought to provide a more enabling and certain fisheries management environment going forward. With the rationalisation process not achieving removal of the volume of licences originally hoped for, it is not possible at this point to assess whether this will be achieved in practice. A particularly key issue will be whether the rationalisation was sufficient to provide a basis for the reformed fishery to operate for several years without significant further reform being required. If it does, this is likely to increase positive outcomes. If it is identified that further reform is needed within a relatively short period of time, this will likely again increase uncertainty and have negative impacts on the wellbeing of fishers.

5.7.3.2 Fisher livelihood objectives

Rationalising has potential to improve livelihoods through giving greater certainty and providing a more enabling environment for ongoing investment in fishing businesses. Whether this is achieved depends on large part on whether the rationalisation achieved was sufficient to enable stability in fishery management for a significant period of time, and whether fishers remaining in the fishery feel confident they can make decisions about the future and invest in their business.

Those who have exited the fishery may be seeking other livelihoods outside fishing, and it is not known how successful they have been in achieving this. Lack of formal educational attainment, high rates of unemployment in some MSF communities, and the impacts of the COVID-19 pandemic may all have impacted this.

The reduction in licence numbers risks reducing ability to pass skills and knowledge in the fishery, although the finding that many of those who have exited are less likely to have contributed significant effort in recent years may mean this is a lower risk. Nevertheless, the lower number of remaining fishers increases the risk of loss of knowledge and skills simply due to the lower numbers of remaining fishers and suggests an ongoing need to invest in supporting transfer of knowledge and skills between those remaining in the fishery.

5.7.3.3 Social licence and community objectives

No specific impacts of rationalisation on social licence or community-related social objectives were identified.

5.7.3.4 Overall impacts on key areas of vulnerability and resilience

Overall, rationalisation has created greater certainty about the future, and addresses the ongoing under-investment that may have occurred due to uncertainty in the fishery's future. Whether this occurs depends how remaining fishers feel certain about the fishery's future and their confidence in the governance arrangements established to help their decision making. The reform process more generally is likely to have resulted in some decline in psychological capacity to cope with further change: it is important to consider this in future management of the fishery and engagement in reform processes.

6 General Discussion

On July 1st, 2021, management of the MSF was reformed with four new zones of management, a reduced fleet size and the introduction of ITQs for selected Tier 1 stocks. This is the most significant management intervention in the fishery's history, and it is unlikely that the fishery will undergo such a significant reform for decades, if not longer. While these were the three main outcomes of the reform, they were supported by numerous incremental decisions that were based on expert analysis that were summarised in this report and extensive consultation with several working groups, the CMSFRAC, port visits by fisheries managers and public consultation documents. Ongoing industry consultation is occurring through the MFA and Red Tape Reduction Working Group (RTRWG), which aims to maximise the benefit of the reform by reviewing management measures that may no longer be necessary.

It has been apparent for several years that the fishery has been over-capacity and over-exploiting a number of the key target species, as demonstrated by deteriorating statuses of several stocks (e.g., Snapper and Southern Garfish) and the fishery's poor economic performance of the past 20 years. Historically, numerous management measures have been introduced to address these issues, particularly stock sustainability, through a series of input controls and a licence amalgamation scheme. However, it is apparent that these management measures never fully succeeded, hence the need for this fishery reform. By reducing the fleet size by a third through the removal of 100 licences and directly addressing overfishing (or the potential for overfishing) through introductions of precautionary RBCs and TACCs managed under ITQs, the reform process has established a foundation for the MSF to recover fish stocks, optimise sustainable production levels and increase operator profitability. However, each of these potential benefits will only be realised if the next steps in the development of the fishery are carefully considered. A new MSF Management Advisory Committee (MSFMAC) has been created that will guide the fishery's key management decisions through a science-based co-management approach. The MSFMAC will provide advice on management for the commercial MSF, charter boat and recreational fisheries. This will include development, review and implementation of shared fisheries management plans including harvest strategy development.

The 'three pillars': regionalisation, unitisation and rationalisation, were the foundation of the reform and designed to specifically address the needs of the fishery. While individually each pillar addressed specific issues, collectively they provide the fishery with the opportunity to become a sustainable, vibrant and profitable commercial fishery whose resources can be equitably shared with the recreational and Aboriginal/Traditional sectors. This will be realised through several potential benefits to stock sustainability, economic performance, and social aspects of the MSF.

6.1 Economic benefits of reform

6.1.1 A more business-focused industry

It is widely accepted that moving from input controls (the current MSF management approach) to output controls such as ITQs will change fishing operational focus from applying more effort to catch more fish, to maximising profitability per kilogram of quota species. This is likely to result in benefits in improved market prices, innovative marketing and value-adding and operating efficiency gains. A recent positive example of benefits from ITQ management is the Danish demersal inshore fleet which in less than two-years reduced effective capacity by more than 30% and increased vessel profitability (average across all fleet segments) by 77% compared to the average in the previous three years. Government funds, which had previously been allocated for scrapping of vessels, were instead used for innovation and investment in quality and new products. The effect was that the amount of fish caught not only required less capital input, but also yielded higher prices (MRAG *et al.* 2009).

6.1.2 Improved operational efficiency

The expected shift to maximising profit on key quota species is likely to reduce the "race to fish" enabling greater operational economic efficiency. For example, when the Western Australian (WA) Rock Lobster Fishery moved to ITQs in 2010/11, operating costs (e.g., fuel, bait) fell as fishers were able to optimise their operations and no longer competed to maximise their share of the catch (Caputi *et al.* 2015).

The reduction in licences in the MSF through a government sponsored voluntary surrender program of 50% of licences is also likely to result in an increased catch of primary species per unit of effort as standing stock levels recover above the current depleted levels. A 2009 study of European Union ITQ managed fisheries identified positive efficiency gains in the Netherlands, Spain and Denmark brought about by up to a 50% reduction in the number of vessels (MRAG *et al.* 2009). For the SA MSF, introduction of ITQs in conjunction with the surrender program can be expected to prevent the ongoing over-investment in boats and gear that has occurred over decades with effort control management.

6.1.3 Price, quality, and value-adding

The profit-maximising driver of ITQs can be expected to see a change to "fishing to market". This avoids supply gluts and capitalises on higher market prices. Evidence of these benefits come from specific fisheries (WA Rock Lobster, SA Pipis) as well as regional or national studies. In both the WA Rock Lobster and SA Pipi fisheries, patterns of fishing changed as the focus shifting from the peak catch periods to a more even spread of catch throughout the year and an extension of the season to 12-months. This has allowed for market price optimisation and targeting of higher value product. In the WA Rock Lobster Fishery this resulted in an additional increase in beach price of about US$8/kg which added an extra US$48 million to the GVP of the fishery (Caputi *et al.* 2015). In the SA Pipi Fishery, prices have increased by over 150% since the introduction of ITQs and a range of value-added products has been developed, against a backdrop of higher volumes from stock recovery (pers. comm. Goolwa Pipi Co.).

In a 2017 survey spanning multiple Australian quota managed fisheries, over half of the fishers responding to the survey believed that both prices and quality of the product improved as a result of ITQ and ITE management (Pascoe *et al.* 2019)[17].

6.2 Social benefits of reform

6.2.1 Higher stewardship levels and improved social licence though property rights

The allocation of ITQs establishes a higher level of individual property right for quota holders allocated a share of the productive capacity of a fishery than is the case in a purely input-controlled fishery. The removal of the "race to fish" may result in operators taking greater care of the resource and a long-term approach to sustaining stocks. This in turn may support the well-being of fishers, enabling them to meet the stewardship objectives that are important to them.

The higher stewardship level and prescribed limit on catch may enhance the perception of the SA MSF by the general public and recreational fishers and may lead to greater social licence to operate than has historically been the case in this fishery.

6.2.2 Improved wellbeing

The reforms may improve wellbeing and health of fishers through improving certainty about the future and reducing the 'modern uncertainties' found in past studies to be a significant contributor to high stress and

[17] https://www.frdc.com.au/project/2017-159

poor wellbeing amongst commercial fishers. Whether this occurs depends on the success of the on-going implementation of new management decision making processes. Well-being may also improve due to a reduction in the likelihood of fishing in high-risk conditions as part of the 'race to fish', as noted earlier.

6.2.3 Improved resource sharing and reduced conflict levels

It is argued by some that implementing ITQs can reduce potential for conflict between different users of fisheries resources, although there is limited evidence. On-going investment in continuing to maximise the management of the MSFMAC to promote positive relationships, and to use the greater transparency provided by ITQs as part of this, has potential to support long-term, positive outcomes.

6.3 Benefits for fish stocks, management, and fishery dynamics

6.3.1 Regional fisheries management

A regionalised fishery presents several opportunities and benefits to the assessment of the MSF. With over 60 permitted species and 28 endorsed gear types, the MSF is South Australia's most complex commercial fishery. However, creating four new fishing zones addresses that complexity by allowing more tailored regional assessment and management. For stock assessment purposes, key fish stocks in each zone can be identified through the Tiered Management Framework and have the appropriate level of science applied. For example, King George Whiting was assigned a Tier 1 status in Gulf St Vincent, Spencer Gulf and the West Coast and a Tier 3 status in the South East. However, ITQs were only applied to the two gulf zones while the WC zone will operate under a TACC. The level of management implemented in each of those fishing zones is now regionally appropriate, and as a result ITQ management was only implemented in the two gulf zones.

Input controls can also be regionally tailored following the reform to ensure that unnecessary gear restrictions are not applied. For example, since the reform commenced in July 2021, the minimum mesh size in hauling net pockets has been decreased in the West Coast and South East fishing zones. This was facilitated as the dominant species caught by hauling nets at the State level are Southern Garfish, a species with high rates of post-release mortality (Knuckey *et al.* 2002). Smaller mesh sizes in hauling net pockets produce significant catches of undersize fish (Steer *et al.* 2011) which meant that a mesh size of 36 mm was required. However, Southern Garfish are not a dominant species in the South East region and are inaccessible on the West Coast due to spatial closures (Drew *et al.* 2021). Therefore, basing gear restrictions for these fishing zones based on Southern Garfish fishing was not necessary or justifiable. Subsequently, a smaller mesh size of 32 mm was implemented for the WC and SE zones where other species are targeted with hauling nets.

6.3.2 Increased individual catches through fleet rationalisation

A key driver of the reform was the MSF's over-capacity, leading to too many fishers and not enough fish. As the fleet has been reduced by a third through the voluntary surrender of 100 licences, there is now the opportunity for appropriate levels of catch to be shared across fewer fishers, leading to higher profits. This will be realised for Tier 1 species once ITQ adjustments have occurred through autonomous industry trading, allowing licence holders to acquire the level of quota needed for their operations. These licence holders can then refine their operations and focus on maximising the profits from their fishing.

Current TACCs have been set provisionally on 5-year average catches for all Tier 1 stocks except Snapper in the SE and King George Whiting on the WC. Therefore, these TACCs will be larger than the catch volumes taken in recent years by fishers remaining in the fleet. However, future TACCs will be set using RBCs established through a new harvest strategy. The RBCs determined in this report demonstrate that future TACCs may need to be reduced for some species where recent catches have been too high. However, for some Tier 1 stocks, these provisional TACCs may be increased as the RBCs determined were larger than recent catches. This will allow for increased future catches to be shared among fewer fishers and lead to increased fishery profitability.

While the introduction of ITQs will provide long-term benefits for the fishery, fleet reduction will also assist fishers that do not hold quota of Tier 1 stocks and instead target Tier 2 or Tier 3 species. Prior to the reform, a project by Fowler *et al.* (2020a) demonstrated that while there were some 'under-utilised' species in the fishery, many Tier 2 and Tier 3 species were already fished at capacity or had little capacity to support larger catches. However, the reduction in fleet size frees up catch capacity for these species as remaining fishers can fill the gap left by those who have left the MSF fleet. In this example, individual fisher catches, and profitability may increase, and can do so sustainably, so long as the total catch of any particular stock does not exceed the catch levels outlined in Fowler *et al.* (2020a). Should this occur, then the regular implementation of the Tiered Management Framework will identify whether certain stocks need to be escalated to a new management and assessment Tier.

6.3.3 Tiered species management

The need for a Tiered Management Framework became apparent at a number of port visits by staff from PIRSA Fisheries and Aquaculture, and SARDI. While there was an obvious need for ITQ management in some stocks, there were others that generated considerable debate. What became apparent was the diversity of factors that needed to be considered in a tiered management approach. This included the importance of a stock for commercial, recreational and Aboriginal/Traditional sectors as the MSF is a multi-sector and shared access fishery. The Tiered Management Framework developed in this project addressed this by simultaneously considering a broad set of indicators to assign a management and assessments tier to a stock. The main benefit of this framework was to provide a justification for determining the MSF's Tier 1 stocks. However, another benefit is that the re-application of the framework will allow changes in a post-reform fishery to be considered. For example, it is anticipated that fishing effort will be displaced from Tier 1 stocks onto Tier 2 and Tier 3 stocks. As this displacement occurs, the application of the Tiered Management Framework will allow the importance of these stocks to be reconsidered and for management and assessment programs to be suitably adjusted. This will help avoid the over management of any particular stock while avoiding unsustainable levels of fishing going unaddressed.

6.3.4 Recover fish stocks

Output controls such as TACCs are an effective management approach for recovering depleted fish stocks and avoiding unsustainable harvests. In an assessment of 11,135 global fisheries, those that were managed using catch shares were half as likely to collapse compared with those that were not managed using ITQs (Costello *et al.* 2008). Similarly, Melnychuk *et al.* (2021) demonstrated that 78% of depleted stocks with recovery plans showed signs of recovery. The few recovery plans that failed to promote stock recovery often did not have proper catch limits in place (Melnychuk *et al.* 2021). The implementation of TACCs for ten Tier 1 stocks in the MSF therefore follows best practice approaches for sustainably managing stocks and providing the greatest possible opportunity for rebuilding Snapper and Southern Garfish stocks through recovery plans. These will be developed through upcoming harvest strategy development via the MSFMAC.

6.3.5 Less reliance on input controls

Prior to the implementation of TACCs, the MSF was managed through numerous and diverse input controls such as gear restrictions, spatial and temporal closures and trip limits. Several of these management measures attempt to avoid excess catch levels by constraining CPUE. While this may avoid more costly or complex management measures such as ITQs, fisher profitability is reduced through decreased operational efficiency. Given that ITQs are now in place for several stocks, there is opportunity to review and potentially remove some of the input controls that were previously implemented for these species. This will allow the fishery's performance to improve and allow fishers to maximise their productivity and profitability. However, it should be noted that ITQ's are not always sufficient in isolation and there are instances when input controls remain appropriate when used in combination with ITQs (Chu 2009). An example for the MSF would be the protection of spawning aggregations through temporal or spatial closures. These measures are implemented to allow successful spawning events to occur and to avoid high CPUE of aggregating fish that become easy to catch. Even with ITQ's implemented, spawning closures would still be valuable as they provide a biological benefit to the population. Nevertheless, the implementation of ITQs for Tier 1 stocks will allow some input controls to be reconsidered which is currently ongoing via consultation between the RTRWG, fisheries managers and stock assessment scientists.

6.4 Potential drawbacks of the reform

This project has highlighted the potential benefits of the fishery's reform. However, it is also important to acknowledge the drawbacks of the reform, especially those that have raised industry concern, and discuss how these may be addressed. Firstly, the costs of implementing management, assessment and compliance will most likely increase following the reform. The implementation of TACCs and ITQs are the main cost increases due to the fishery's need for higher levels of compliance (to prevent over-catches of ITQs) and the additional administration costs that arise from the introduction of ITQs. This is the main reason that a reform of the MSF did not occur sooner, as industry and management have attempted to address a diversity of issues without resorting to more costly management approaches, such as ITQs. The licence fee costs of the MSF relative to GVP were the highest in SA prior to the reform due to the fishery's relatively low GVP and its high level of management and compliance complexity. To avoid the impact of increased costs shared across a smaller fleet, the SA government has implemented a four-year freeze on licence fees. This offers a window of opportunity for industry and management to determine how the future costs of the fishery can be managed. Higher management costs following ITQ introduction is common in the early stages of quota-managed fisheries. However, comparative economic research suggests that the longer-term economic benefits may outweigh the short-term costs (Mangin *et al.* 2018). One of the goals following the reform will be to ensure that this occurs for the MSF.

Another drawback of ITQ implementation is the potential concentration of quota ownership among a small number of individuals. Concentration of quota ownership and higher prices of quota over time are a possibility and can be viewed both positively and negatively. The outcome for the SA MSF will be determined by the quota ownership arrangements put in place at implementation. Many of the concerns about increased concentration of quota ownership can, to some extent, be managed through appropriate policy settings such as retention of owner operator provisions and maximum quota holdings.

There remains a risk that the reform will not reduce uncertainty about the future sufficiently to support improved livelihoods and well-being of fishers, particularly given that the rationalisation process did not achieve the targeted number of licence surrenders. There is the ability to address this risk through careful monitoring of the processes used for decision-making in the MSFMAC and tracking whether these are supporting a greater degree of certainty for those fishers remaining in the fishery.

The regionalisation of the fishery raised an important question that was discussed at length throughout the reform process: "would licences become regional or remain State-wide". There were advantages to both scenarios as a regional licence would encourage local stewardship and allow for potentially greater levels of regional fisheries management. However, MSF licences have always been State-wide and the ability for new entrants to enter the fishery and decide where to fish has been an important part of the fishery's history and needed to remain an important part of its future. Community consultation demonstrated that most MSF fishers preferred licences to remain State-wide to allow for operational flexibility (written submissions 2020). This view was ultimately upheld, and the reform process designed a regional management regime that could accommodate this. This involved, regionally determined quota for the Tier 1 stocks in each fishing zone and the ability to tailor management at the regional level (for example, different minimum hauling net mesh sizes in different zones), without the need to create four new sub-fisheries through regional licencing. This decision also better supports the ability for fishers to maintain some flexibility in fishing which is critical to meeting the social objective of maintaining adaptive capacity and resilience to variable conditions.

Finally, the need to regularly and more accurately assess the recreational catch of all relevant species is paramount to the success of the reform, especially for those species with high levels of recreational targeting.

7 Conclusion

The reform of the commercial MSF was initiated in 2014 through a working group which ultimately led to its implementation in July 2021. However, this does not mark the end of the fishery's reform but rather the platform from which the MSF starts to be become the vibrant, sustainable, and profitable fishery that has been targeted since the commencement of this process. The establishment of four zones of management will allow fine-scale assessment and management to occur for key stocks across different regions of SA. Primarily, this will be achieved by classifying stocks at different tiers and determining which stocks require ITQ-based management. This allows a species to have a higher level of management in some fishing zones while not requiring such intense management in other zones. This is now occurring for King George Whiting, Southern Garfish and Southern Calamari across SA, where these species are classed as Tier 1 in some zones but not others. Additionally, different input controls can also be applied across zones, as required by the local stocks. Changes in hauling net pocket mesh size have occurred in the SE and WC zones since the reform, where management could be relaxed. ITQ-based management for the Tier 1 stocks will provide an important foundation for sustainable harvests in future fishing seasons. The poor stock statuses of Southern Garfish and Snapper demonstrate the need for this management, while maintaining high levels of production for King George Whiting and Southern Calamari remains important as these are important stock that support the economic performance of the broader fishery. Should their stock statuses decline, then the profitability of the fishery will be jeopardised. The implementation of ITQs and appropriate TACCs will help prevent this. An improvement in stock statuses and fishery productivity will also be supported by the reduced fleet size of the MSF which more closely aligns with the economic carrying capacity outlined in this report. However, these benefits would be jeopardised should recreational catches increase, effectively replacing levels of commercial catch have been removed through the VLSP. More regular and accurate estimates of recreational catch will help to address this and ensure that sustainable levels of total catch can be determined. There is now opportunity for the fishery to use this reform process as a new start and to benefit from an improved operating environment that will occur from increased access rights, recovering fish stocks and the eventual reduction in unnecessary or inefficient management strategies that have reduced catch rates.

8 Implications

There are four main outcomes of the MSF reform that were based on the scientific, economic and social research input from this project:

1. Four new zones of management were established across South Australia
    - Allows fine-scale regional management
    - Fishing access across the State is retained for all licence holders.
2. A Tiered Management Framework was developed to classify stocks to tiers of management
    - Based on several biological, management and sectoral indicators.
    - Justifies application of ITQ management for Tier 1 stocks
    - Allows effort displacement from ITQ stocks to be identified early for Tier 2 and Tier 3 stocks, prompting management action
3. ITQ-based management was implemented for ten Tier 1 stocks.
    - Provides access rights to fishers
    - Allows sustainable catch levels to be set based on harvest strategy implementation
4. One hundred licences were removed from the fishery through a VLSP.
    - Reduced competition for fishing
    - Removed unprofitable fishing businesses from the fishery

The flow-on implications of these four main outputs commercial MSF reform are diverse and will provide a variety of benefits to different groups. The commercial fishers have better property rights to the resource which befits the level and focus of management that occurs for commercial sector of MSF. ITQs provide a stronger negotiating position and a simplified mechanism for compensation with other marine users. As ITQs have a market value, they can be used in the evaluation of any proposal that could arise should access to the fishery be impacted. Given that property rights now belong to the commercial sector, it is likely that a greater level of assessment and management will be required for the recreational sector which also accesses the resource and is responsible for large catch percentages for several stocks. This will need to occur through a co-management approach that enables the resource to be managed across sectors, rather within sectors through the development of multi-sector harvest strategies following the reform. The rationalisation of the fleet will reduce competition for fishing and provide a greater level of resource sharing within the commercial sector. Sharing more fish among fewer fishers will provide both ecological and economic benefits to all users who access the resource. Commercial fishers will benefit from reduced competition at local markets that could lead to better beach prices, as has occurred in several other ITQ managed fisheries.

Fishery managers will benefit from the Tiered Management Framework outlined in this project which considers a broad range of information before assigning a stock to a tier. This removes ambiguity from the level of management that may be required for different stocks, especially when accessed by several sectors. The application of ITQ-based management will also benefit management decisions, as well as scientific assessments, as it is a more direct management control than the many input controls that have been applied to the fishery previously. The ability to apply different levels of management to different regions will benefit decision makers who do not need to consider what effects local management decisions may have on broader regions, as may have occurred previously.

9 Recommendations

It is recommended that the results of this project be broadly disseminated to PIRSA Fisheries and Aquaculture (managers); the commercial, recreational, charter boat and Aboriginal/Traditional sectors of the South Australia Marine Scalefish Fishery (MSF); DPI Vic, DAFF QLD; NSW DPI; national and international fisheries scientists; general public.

9.1 Further development

There are three areas of further development required following this report:

1. A better understanding of the use, importance and impact of recreational fishers for MSF stocks. The updated zonal catch shares determined that several stocks are taken in greater quantities by recreational fishers than by commercial fishers. In particular, this occurred in the GSV/KI fishing zone which is adjacent to the greater Adelaide region. Several Tier 1 stocks in SG and GSV/KI have substantial recreational allocations, notably King George Whiting in both gulfs which has a recreational allocation of more than 50%. Sustainable management and optimal resource sharing of these stocks should consider the catches and economic values that emanate from the recreational sector more regularly than is currently occurring. This will benefit all user groups as recreational fishing interests will get a greater emphasis in management decisions while commercial fishing will benefit from greater inclusivity and consideration of recreational information in stock assessments. A recreational fishing survey is currently underway in SA which is determining whether new technologies such as phone apps can provide better access recreational data more regularly. However, future research will still be required to collect regular and long-term data, and better understanding recreational fishing interests and include them in management decisions.

2. A better understanding of the importance of MSF fish stocks to Aboriginal/Traditional fishers and communities. The development of the Tiered Management Framework in this project highlighted the paucity of information on Aboriginal/Traditional fishing that is available. Subsequently, it was not possible to appropriately determine which stocks would be of most importance to different Aboriginal/Traditional fishers and communities. This highlights that a greater research focus is required to better understand the significance of the MSF to the Aboriginal/Traditional sector and to incorporate this in decision making.

3. Improved stock assessments are required for Southern Calamari (SG, GSV/KI and WC), Yellowfin Whiting (GSV/KI), Australian Herring (SG and GSV/KI), Western Australian Salmon (SG and GSV/KI) and Bronze Whaler Sharks (SG, GSV/KI and WC). Southern Calamari in the SG and GSV/KI fishing zones are classified as Tier 1 stocks and are managed using ITQs. However, the existing assessments and the application of cMSY analyses undertaken in this report were not sufficient to determine an RBC. Therefore, the RBCs for these fishing zones could only be determined from recent average catches. Future research is required to develop an assessment program for Southern Calamari that can be used to set quotas in the Tier 1 fishing zones. The remaining stocks requiring improved assessments are all classified as Tier 2. These stocks will not be managed via a TACC, although RBCs are required to ensure that catches remain sustainable and that elevation to a Tier 1 status is not required. Currently, an FRDC funded project is researching Western Australian Salmon and developing survey techniques using aerial drones (FRDC 2018/035). This will provide an improved assessment for this species. Australian Herring constitute a single stock across multiple State jurisdictions and therefore, any

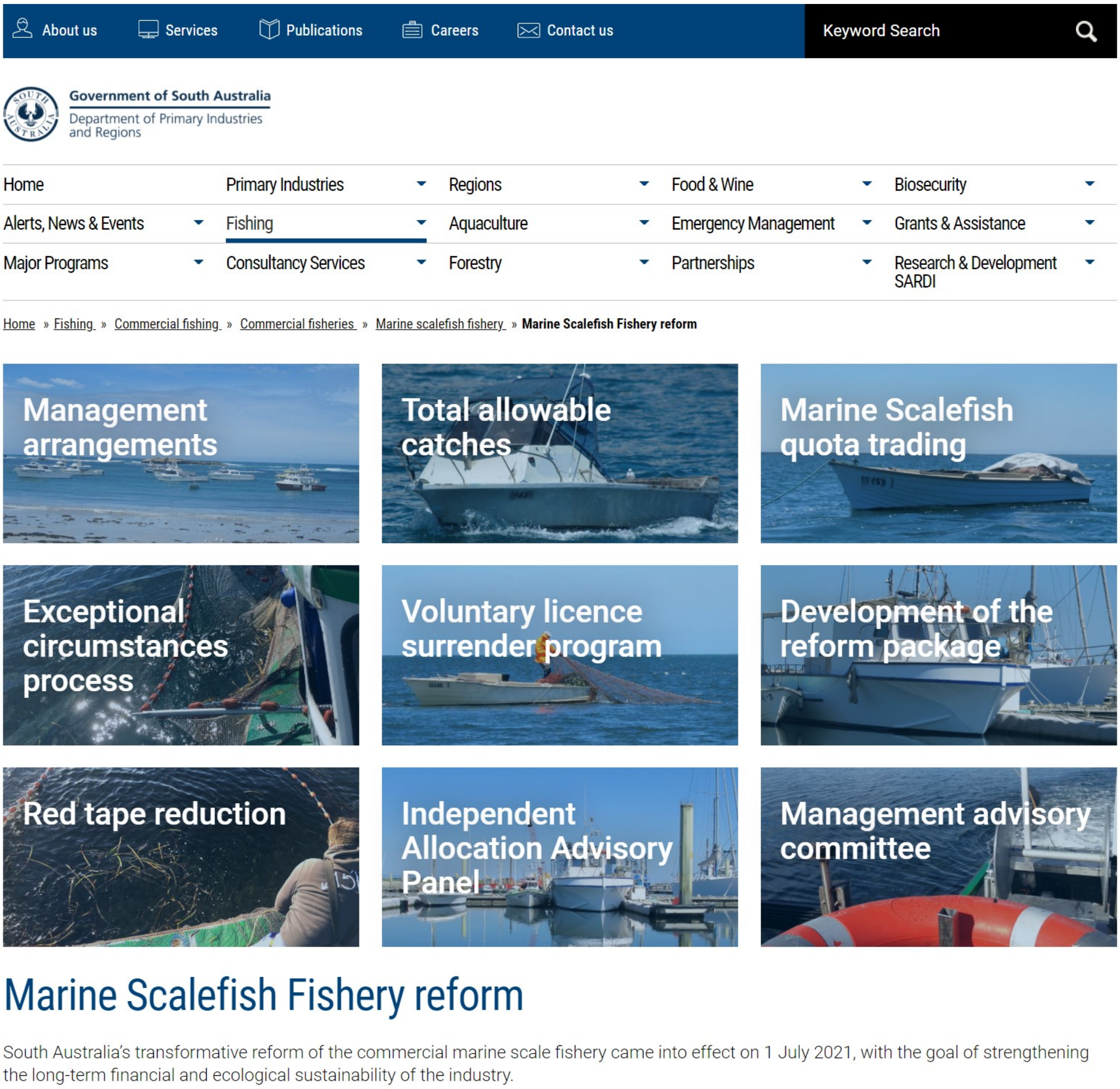
potential assessment will need to consider these dynamics. Lastly, assessments for Bronze Whaler Sharks are complicated by a lack of detail in commercial logbook reporting as they are not differentiated from similar whaler shark species. Therefore, a lack of accurate catch data prevents their assessments. As a result, Bronze Whaler Sharks are currently classified as ‘Undefined’ in MSF assessments.

10 Extension and Adoption

10.1 Project coverage

10.1.1 Online and Written communications

Progress of the reform was communicated to fishers at several points during its implementation. A website maintained by PIRSA provided access to all of this information after it was released to industry (https://www.pir.sa.gov.au/fishing/commercial_fishing/fisheries/marine_scalefish_fishery/reform). This website provided information on the VLSP, TACC setting, new management arrangements, the exceptional circumstances process following the VLSP and information on the quota trading platform.



An industry consultation paper was provided to industry in August 2019 by the Commercial Marine Scalefish Fishery Reform Advisory Committee in consultation with the MFA, that outlined options for potential reform (Appendix A). Further information was also provided to fishers at several stages in the process via a three-stage update between June 2020 – July 2021:

Stage 1 – June 2020

- Information on new fishing zones
- Indicative TACCs
- Proposed Species for ITQ by Zone

Stage 2 – August 2020

- Information on quota allocation and attached copy of the report of the Independent Allocation Advisory Panel (Appendix C)
- Description of options for post-reform compliance and science programs
- Preliminary information on the Tiered Management Framework
- Red Tape Reduction within the fishery
- FAQs on licencing
- Support services for industry

Stage 3 – July 2021

- New regulations
- Licence registration and conditions
- Reporting requirements
- Voluntary Licence Surrender Program details
- Exceptional circumstances process
- Quota trading system
- Marine Scalefish Fishery Management Advisory Committee.

Following the publication of information in Stage 1 and Stage 2, industry feedback via an online survey was received (https://www.pir.sa.gov.au/__data/assets/pdf_file/0007/373984/Online_survey_responses_-_MSF_Reform_Stage_1_and_2.pdf).

10.1.2 Port meetings

In order to communicate progress of the reform to industry, a series of regional meetings were undertaken prior to, during and following the implementation of the reform:

2019

Attended by Dr Ian Knuckey (Fishwell Consulting), Jon Presser (PIRSA) and Dr Mike Steer (PIRSA -SARDI).

- 16 September - Yorketown
- 16 September - Wallaroo
- 17 September - Port Pirie
- 18 September - Ceduna
- 19 September - Port Lincoln
- 20 September - Cape Jervis
- 20 September - Port Adelaide

2020

Attended by Professor Gavin Begg (PIRSA) and Jon Presser (PIRSA).

- 25 August – Port Lincoln
- 25 August – Streaky Bay
- 26 August – Ceduna
- 27 August – Whyalla
- 27 August – Port Broughton
- 28 August – Minlaton
- 3 September – Cape Jervis
- 4 September – Adelaide

2021

Attended by Professor Gavin Begg (PIRSA) and Jon Presser (PIRSA).

- 1 November – Port Lincoln
- 1 November – Streaky Bay
- 2 November – Ceduna
- 3 November – Port Broughton
- 3 November – Yorketown
- 9 November – Adelaide
- 11 November – Cape Jervis
- 11 November – Kingscote.

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Industry Consultation Paper

Options for the Reform of South Australia's Commercial Marine Scalefish Fishery

Commercial Marine Scalefish Fishery Reform Advisory Committee

August 2019

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1 Summary

South Australia's clean marine waters are home to some of the most sought after premium seafood in the world. The South Australian Government—through the Primary Industries and Regions SA (PIRSA) Fisheries and Aquaculture division—manages the sustainable development of marine resources and the balanced growth of fisheries in partnership with industry and the community.

Accessed by Indigenous, recreational and commercial fishers alike, many of SA's key coastal and marine species form part of the commercial Marine Scalefish Fishery (MSF). Unfortunately, as a legacy of the fishery's initial open access policy prior to the late 1970s when commercial fishing licences were issued to anyone who wanted to participate in the fishery, over-capacity, stock depletion, over-capitalisation, constant increases in fishing technology and catching efficiency, and poor economic performance has challenged the MSF over recent decades.

Put simply, there are too many commercial fishers and not enough fish to sustain a vibrant and profitable industry. To address this, the Government of South Australia is committed to investigating and implementing key reforms in the commercial sector of the MSF to ensure long-term resource sustainability and improve the industry's future viability.

This paper — developed by the Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) in consultation with the Marine Fishers Association (MFA) Forum and PIRSA Fisheries and Aquaculture — identifies options to achieve the reform and invites licence holders and key stakeholders to have their say on the changes required to bring about a more vibrant and profitable commercial fishery. Key features of the proposed reform include rationalisation of the fleet, regionalisation of the fishery, and unitisation of access to the resource through implementation of well defined, secure and transferable fishing rights.

Relevant documents relating to the CMSFRAC, including membership, terms of reference, Chair's Report on each of its meetings, and this Industry Consultation Paper, can be found at the following PIRSA web page: www.pir.sa.gov.au/marine-scalefish-reform

Based on its work to date the CMSFRAC acknowledges the current poor state of the fishery, despite decades of management, and the limited resultant financial capacity of licence holders in the fishery to achieve the required reforms without Government funding assistance. Whilst the current situation represents a sub-optimal use of the State's naturally renewable publicly owned fisheries resources, if the necessary management reforms are introduced and key fish stocks are recovered to deliver long-term fish stock sustainability, the increased production and yield from these important fish stocks will translate into increased value generated by the fishery that will flow on through the regional and State economies, providing benefits for all South Australians for years to come. These positive outcomes will translate into improved business opportunities for commercial fishers and seafood processors and regional tourism opportunities for South Australia linked to recreational and charter fishing activities throughout South Australia.

It is important to note that the options presented in this paper have been developed by the CMSFRAC for the purposes of consultation with industry. Any other feedback or written submissions should be emailed to msf.reform@sa.gov.au.

Following the consultation process, all feedback will be considered by the CMSFRAC and a formal proposal will be finalised by 31 October 2019 for the consideration by government and the Minister for Primary Industries and Regional Development.

2 About the Fishery

2.1 Commercial licences

The MSF currently consists of 307 licences with approximately 90 per cent of the licences being actively used. Approximately 40 per cent are considered ‘part-time’ operators, expending less than 90 days a year fishing, with 22 licences not having any recorded fishing effort in recent years.

There are 26 types of fishing gear (or devices) endorsed in the fishery, but their use differs depending on the location of fishing and the types of species being targeted. With the exception of fishing rods and handlines, all devices must be registered on a licence before they can be used to take fish for trade or business. The principal devices include handline, longlines, hauling nets and squid jigs.

Catch from the commercial MSF is mainly comprised of scalefish species, in particular King George Whiting, Snapper, Southern Garfish, Southern Calamari and Yellowfin Whiting. Other species such as Australian Herring, Sand Crabs, Blue Swimmer Crab, West Australian Salmon and Leatherjackets are also important.

The fishery also includes species such as Vongole, Australian Sardine, Australian Anchovy and Goolwa Pipi, which are currently limited by quota owned by a few specialised fishers and these species will not be included in the following discussion.

2.2 Status of fish stocks

Although more the 60 species can be harvested within the MSF, four primary species (King George Whiting, Snapper, Southern Garfish, and Southern Calamari) account for more than half of the state-wide total commercial catch over the last decade by value. Previous stock assessments for King George Whiting, Southern Garfish and Snapper have identified different levels of concern regarding the sustainability of some regional stock for each of these species. Consequently, levels of fishing effort and catches for these species have been restricted through a variety of management approaches that have included spatial closures, closed seasons, gear restrictions, size limits, and catch limits.

Declines in the catches of the primary finfish species have contributed to the diversification of the MSF fishing fleet, with many fishers in recent years switching their effort from Snapper, King George Whiting and Southern Garfish towards Southern Calamari, Yellowfin Whiting, and Snook. This is further compounded by the highly mobile nature of the commercial fishers who can fish throughout South Australian waters.

These changes have largely been economically driven, where it has become more cost-effective to target these secondary species based on their relative abundance, catchability, low set-up costs and increasing market value. Although the capacity of the fishing fleet to adjust their target species provides considerable flexibility and opportunities, there is a risk that increased fishing pressure on these secondary species may create additional sustainability issues.

2.3 Economic and social indicators

In retrospect, too many commercial licences were issued during the early stages of development of the MSF, when fishing technology levels and catching capacity of the fleet were relatively low. Subsequent to the introduction of limited entry licensing during the 1970s, catching capacity and effectiveness of the fishing fleet has been constantly improving through technological advancements in vessels, electronics and improved fisher knowledge and experience.

There has also been considerable latent effort in the fishery where idle or low activity licences have considerable capacity to fish harder given the opportunity and this tends to occur when licences are traded from latent fishers to active and motivated fishers.

To control this increasing effort and to reduce the pressure on fish stocks, a variety of reactive management measures have been introduced over past decades. These measures have become highly restrictive on business profitability and are becoming less effective at ensuring stock sustainability. The MSF is now at a point where there is significant regulatory burden on licence holders, fish stocks are under increasing fishing pressure and the fishery is becoming unprofitable for many licence holders.

The total Gross Value of Production for the MSF has followed a decreasing trend since 1998/99, principally due to a reduction in total commercial catch, from approximately 5,000 tonnes to a current catch of approximately 2,000 tonnes. Over this period, increases in the average costs of catching fish (83 per cent in real terms) has outstripped the average price paid for fish (63 per cent in real terms)(BDO EconSearch 2019[1]).

All indicators of fishing profitability—including such measures as boat cash income and rate of return on total capital—are the lowest of all South Australian commercial fisheries. The MSF has not generated any economic rent since economic indicators were first measured by PIRSA in 1998/99, with a calculated value of -$1.2 million in 2017/18. However, it should be noted that estimated economic rent has improved progressively from as low as -$13 million in 1999/00, with much of the improvement related to a 50 per cent reduction in the number of licences achieved principally through the licence amalgamation scheme.

The combination of working harder for low or negative returns, declining fish stocks, increasing uncertainty of access, and greater restrictions and regulatory burden is taking its toll on industry members. A research report by King et al. (2018)[2] identified that the commercial fishing industry in Australia showed a higher level of psychological distress compared to the wider Australian population.

Of the almost 1,000 registered commercial fishers that were surveyed, South Australian fishers comprised around 10 per cent of these. The results showed a 19 per cent rate of depression among fishing industry workers compared to the estimated national diagnosis of 10 per cent. This indicated that high psychological distress was an occupation-related health issue. Furthermore, as men, in general, commit suicide at a higher rate than women, the high male representation in the fishing industry makes mental health of particular concern.

The top sources of stress were related to uncertainty about future in the fishing industry, changes to government regulations particularly relating to the security of access to fishing, and the high level of ‘red tape’ and complex regulations. Negative media and poor public image were also identified to compound stress levels. In contrast, factors such as isolation, physical danger of fishing, climate change, and succession were not perceived to be associated with stress.

Whilst the current situation represents a sub-optimal use of the State’s naturally renewable publicly owned fisheries resources, if the necessary management reforms are introduced and key fish stocks are recovered to deliver long-term fish stock sustainability, the increased production and yield from these important fish stocks will translate into increased value generated by the fishery that will flow on through the regional and State economies, providing benefits for all South Australians for years to come. These positive outcomes will translate into improved business opportunities for commercial fishers and seafood processors and regional tourism opportunities for South Australia linked to recreational and charter fishing activities throughout regional South Australia.

[1] BDO EconSearch 2019. *Economic and Social Indicators for the South Australian Marine Scalefish Fishery 2017/18*, A report to PIRSA Fisheries and Aquaculture.
[2] King, t., Abernethy, K., Brumby, S., Hatherell, T., Kilpatrick, S., Munksgaard, K. and R Turner. 2018. *Sustainable Fishing Families: Developing industry human capital through health, wellbeing, safety and resilience*. Report to the Fisheries Research and Development Corporation, Canberra.

2.4 Sharing the resource

The MSF resource is shared with an active recreational fishing sector and is culturally significant to South Australia's Indigenous communities. The recreational fishery was estimated in 2013/14 to have approximately 277,000 participants (Giri and Hall 2015[3]). Most recreational fishing effort occurs in marine waters, including estuaries, with fishers permitted to use a variety of gear types. Given the shared nature of the fishery, the reform of the commercial MSF cannot occur in isolation and will need to consider other stakeholder groups.

Licence holders from other fisheries also have some level of access. These include the Northern and Southern Zone Rock Lobster fisheries, the Lakes and Coorong Fishery, the three Prawn fisheries, the Blue Crab Fishery, and the Miscellaneous Fishery. Access varies from the ability to retain some species as a by-product (Prawn fisheries) or for bait only purposes (Blue Crab Fishery), to targeting species within spatially restricted areas (Lakes and Coorong), or that are considered a lower valued species (annelids worms in the Miscellaneous Fishery), to having similar access to a full MSF licence (Rock Lobster fisheries).

South Australia is in a unique position, unlike other Australian jurisdictions, as it has legislative provisions outlined in the *Fisheries Management Act 2007* to enable formal resource sharing frameworks for the fishing sectors (commercial, recreational and Aboriginal Traditional) to be established in formal Management Plans. These legislated resource sharing arrangements are supported by a policy framework that formally recognises the shared nature of the fishery through the allocation of resource shares. The *Fisheries Management Act 2007* provides that a management plan must specify the share of the fishery to be allocated to each fishing sector. The policy addresses the question of allocation of access to aquatic resources between extractive user groups to include the commercial, recreational and Aboriginal traditional fishing sectors. Allocations between fishing sectors in the MSF were set on the basis of the best available information in 2009. They were quantified for a range of species at the state level through analysis of catches.

[3] Giri, K and K Hall, 2015. *South Australian Recreational Fishing Survey 2013/14*, Fisheries Victoria Internal Report Series No. 62, Victorian Government.

3 The Need for Reform

The need for reform has, in recent years, been driven by a strategic review initiated in partnership between PIRSA Fisheries and Aquaculture and Industry in 2014 with a working group established by the former South Australian Fisheries Council.

This review concluded that the management arrangements were complex, inefficient and ineffective in controlling fishing effort and limiting the catch of primary species. There was broad recognition within the commercial sector that the current structure and management framework of the MSF needed reform in order to manage the over-capacity in the fishery and ensure its long-term sustainability and economic viability.

Key management options recommended by the working group included:

- Augmenting existing strategies such as the licence amalgamation scheme and the 'owner-operator' policy
- Assessing the feasibility of zoning the fishery and introducing Individual Transferable Quotas (ITQs) or Individual Transferable Effort (ITEs) units as key management measures to restrain the total catch of primary species, and
- Undertaking a critical review of existing controls to ease the regulatory burden on licence holders.

To address the issues relating to over-capacity and latent effort, the working group recommended a structural adjustment program to provide an opportunity for fishers who wish to exit the fishery to do so and surrender their licence, and for those who choose to remain, to improve their overall viability and profitability. A copy of the review – Report of the SA Marine Scalefish Fishery Strategic Review - can be found on the PIRSA website.

In simple terms, the working group recommended ***'what'*** strategic action was required to secure the future of the fishery.

The South Australian Government agreed, as one of its 2018 election commitments, to deliver reform to:

"…unlock industry's potential, provide long-term sustainability and cost-effective management, and drive efficiencies in inshore and offshore operations to secure a future for the fishery".

In December 2018, the Minister for Primary Industries and Regional Development established the Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) with the purpose to develop, in consultation with licence holders and key stakeholders, recommendations on a reform package for the fishery that may include the key elements of:

- Introducing zones of management within the fishery that recognise the economic, ecological and regional diversity within the fishery
- Achieving fleet rationalisation that secures a minimum of 30% reduction in the total number of licences, and
- Implementing key management reforms, including a system of regional individual transferable quotas that will achieve a more sustainable and commercially viable fishery and a mechanism to facilitate on-going autonomous adjustment.

These are described as the three pillars of reform: Regionalise, Unitise and Rationalise.

In simple terms, the CMSFRAC will develop recommendations on ***'how'*** the reform should be undertaken and implemented.

The CMSFRAC reform objectives are as follows:

- To ensure the ongoing sustainability of fish stocks and the environment which supports them
- To foster a vibrant and profitable commercial MSF
- To provide an effective mechanism for the MSF to autonomously adjust in the future without the need for further government assistance
- To ensure that the commercial sector of the MSF maintains its current allocation of the resource so it can continue the ongoing supply of freshly caught seafood to SA consumers, and
- To foster long-term community support for commercial fishing activities as contributors to South Australian Food industry and broader economy.

The CMSFRAC also needs to ensure that the future management options for the MSF meet the requirements of the *Fisheries Management Act 2007* and are consistent with the principles of ecologically sustainable development stated in the Act - these being:

- Proper conservation and management measures are to be implemented to protect the aquatic resources of the State from over-exploitation and ensure that those resources are not endangered
- Access to the aquatic resources of the State is to be allocated between users of the resources in a manner that achieves optimum utilisation and equitable distribution of those resources to the benefit of the community
- Aquatic habitats are to be protected and conserved, and aquatic ecosystems and genetic diversity are to be maintained and enhanced
- Recreational fishing and commercial fishing activities are to be fostered for the benefit of the whole community, and
- The participation of users of the aquatic resources of the State, and of the community more generally, in the management of fisheries is to be encouraged.

The representative body of licence holders in the MSF, the Marine Fishers Association (MFA), has also developed key principles which it considers are critical to the reform process (see section 6.1). These principles have been adopted by the CMSFRAC and support the concept of establishing separate management zones, reducing the number of licences, and creating catch or effort-based units as the management tools most likely to achieve sustainability, economic and social objectives. First and foremost, however, is the principle that the sustainability of fish stocks is of paramount importance.

Based on input from the MFA and other stakeholders, the CMSFRAC acknowledges the current poor state of the fishery despite decades of management, and the limited resultant financial capacity of licence holders in the fishery to achieve the required reforms without Government funding assistance.

As such, the CMSFRAC needs to develop a compelling case for investment by Government in the proposed reform package. To build such a case, the reform package must be ecologically and economically sound, and socially just. The CMSFRAC also recognises the proposal must align with the Government's growth agenda, which is described in the "Joyce Review" (Joyce 2019).

Wider industry consultation and engagement with all licence holders is an important step in the process of developing a reform package that is to be delivered to the Minister for Primary Industries and Regional Development by 31 October 2019.

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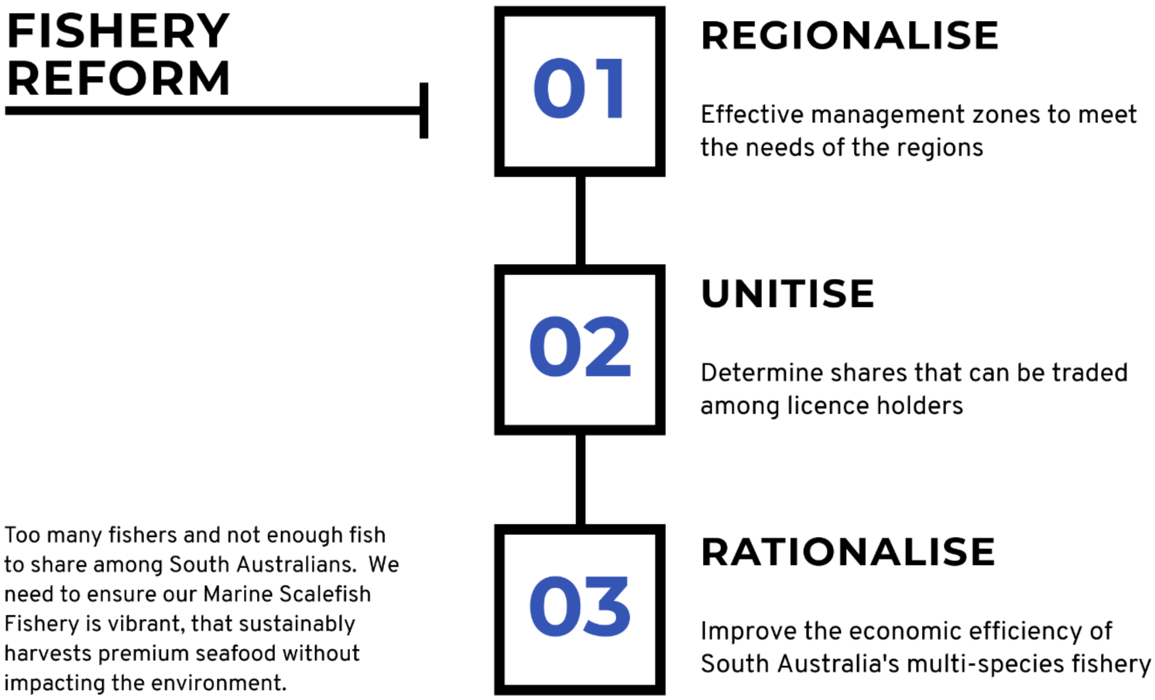
[2] Joyce, S. 2019. *Review of the South Australian Government's International and Interstate Engagement Bodies and Functions*.

4 The Reform Package



Key features of the proposed reform are to regionalise the fishery, unitise access to the resource through implementation of well defined, secure and transferable fishing entitlements, and rationalise the number of licences. These key pillars are described in the following sections with options of how these reform concepts can be implemented.

A depiction of a seven-stage process that provides a more concise and easy to understand summary of the reform options considered by the CMSFRAC is provided as an attachment to this paper in section 6.2.

4.1 Regionalise

Sustainable resource management is central to fisheries management design principles, particularly when it supports the setting of regional boundaries. Regional management of a fishery is common practice and boundaries typically align with either biological stock structure of the targeted species, defined jurisdictional boundaries, practical management areas, or a combination of these. However, regionalisation may have positive and negative flow-on consequences that may constrain patterns of established historical fishing activity, displace some licence holders and impact regional communities.

As such, they need to be carefully considered with industry and relevant stakeholders through the consultative processes.

To inform the proposed zoning options, consideration was given to the biological stock structure, current marine fishing area reporting systems, delineation of current fishing activity by area and cost effectiveness of management and compliance.

Four key factors were considered in design of the regions:

Biological stock structure of Snapper, King George Whiting and Southern Garfish
From a fisheries management perspective it is important to understand the biological stock structure of a species along with its underlying population dynamics, to ensure that harvest rates do not compromise their ecological function and sustainability ***of any stock***. Different biological stocks may vary in abundance, growth and natural mortality rates, and may be influenced by contrasting environmental factors. Consequently, the amount of catch that can be sustainably harvested from one biological stock may differ from another. The biological stock structure of the key MSF species (Snapper, King George Whiting and Southern Garfish) is shown in Figure 1.

Marine Fishing Area reporting blocks
South Australia's MSF is divided into 58 Marine Fishing Areas (MFAs) for the purpose of statistical reporting and monitoring of commercial fishing activity. This MFA grid was used to shape the larger regional boundaries.

Spatial fishing activity and "natural" regional boundaries
Currently fishers can shift their effort to species or areas in response to changes in fish availability, market conditions, or inclement weather. While this provides operational flexibility, it also allows fishers to concentrate their fishing activity into areas which may negatively impact local stocks. The commercial fishery statistics were used to explore the "natural" regional boundaries of the fishing fleet to minimise any significant displacement of licences that may arise through the regionalisation process.

Cost-effective regulation, science, monitoring and compliance
Given the spatial structuring of the key stocks and natural fishing boundaries of the fishing fleet they support, regionalisation of the fishery allows the application of strategic and spatially specific management arrangements where different tools that are tailored more-specifically to the sustainability of local stocks.

Consideration of the above resulted in two regionalisation options (Figures 2.1 and 2.2). In both options the fishery was partitioned into four regions to capture the distinctive West Coast (WC), Spencer Gulf (SG), Gulf St. Vincent (GSV), and the South East (SE) stock structures and fleet dynamics. The area south of Kangaroo Island (KI) area was associated with GSV in Option I and the SE in Option II.

Table 1 on page 14 provides a representative summary of the 10-year average catch and effort statistics, including the number of licences and fishing activity in each zone. This information is provided purely as reference background material only.

The proposed regional structure could apply as state-wide licences with managed access to each zone, or a separately managed regional fisheries with licence holders having access to only one zone.

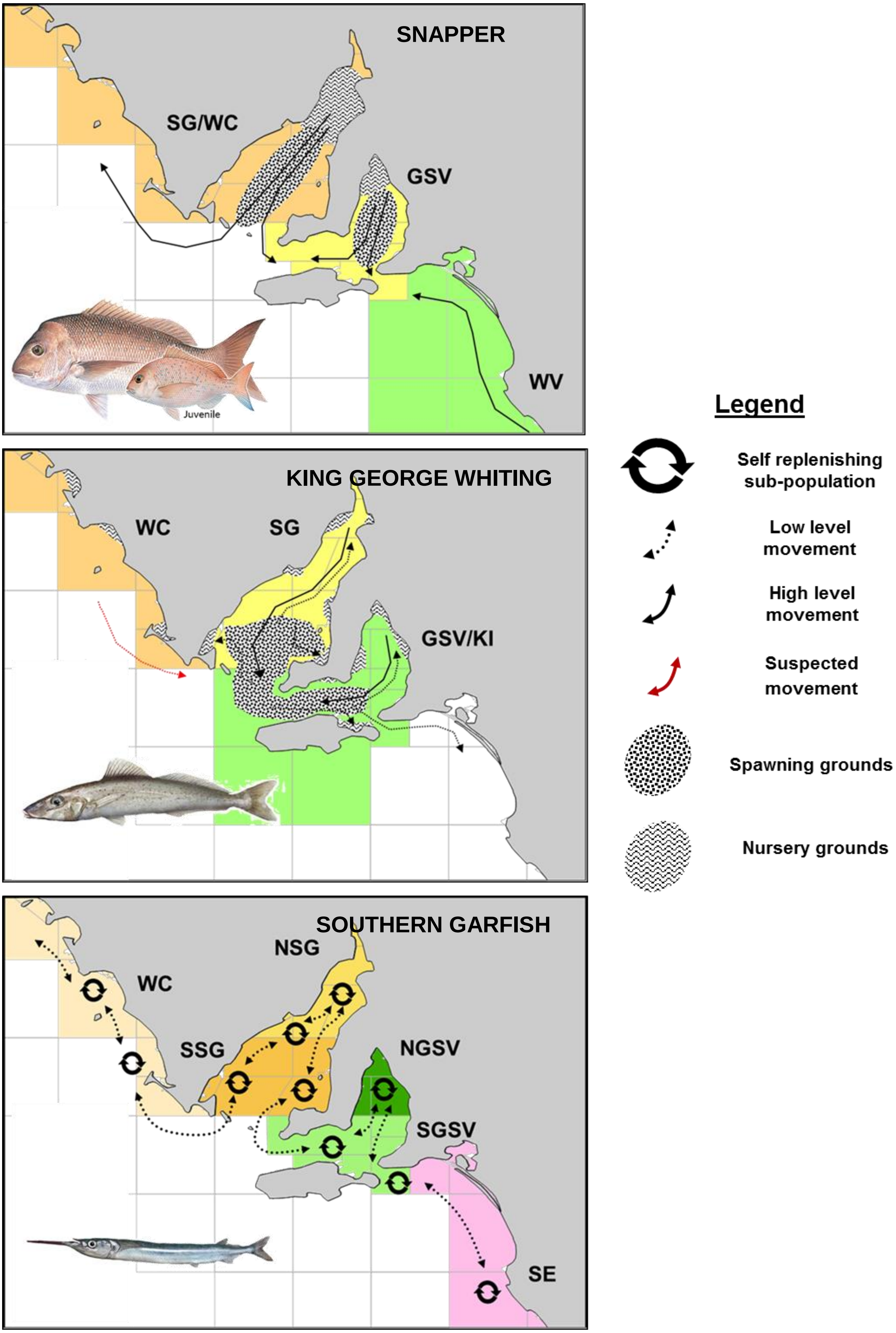


Figure 1. Biological stocks of three key MSF species (Snapper, King George Whiting and Southern Garfish)

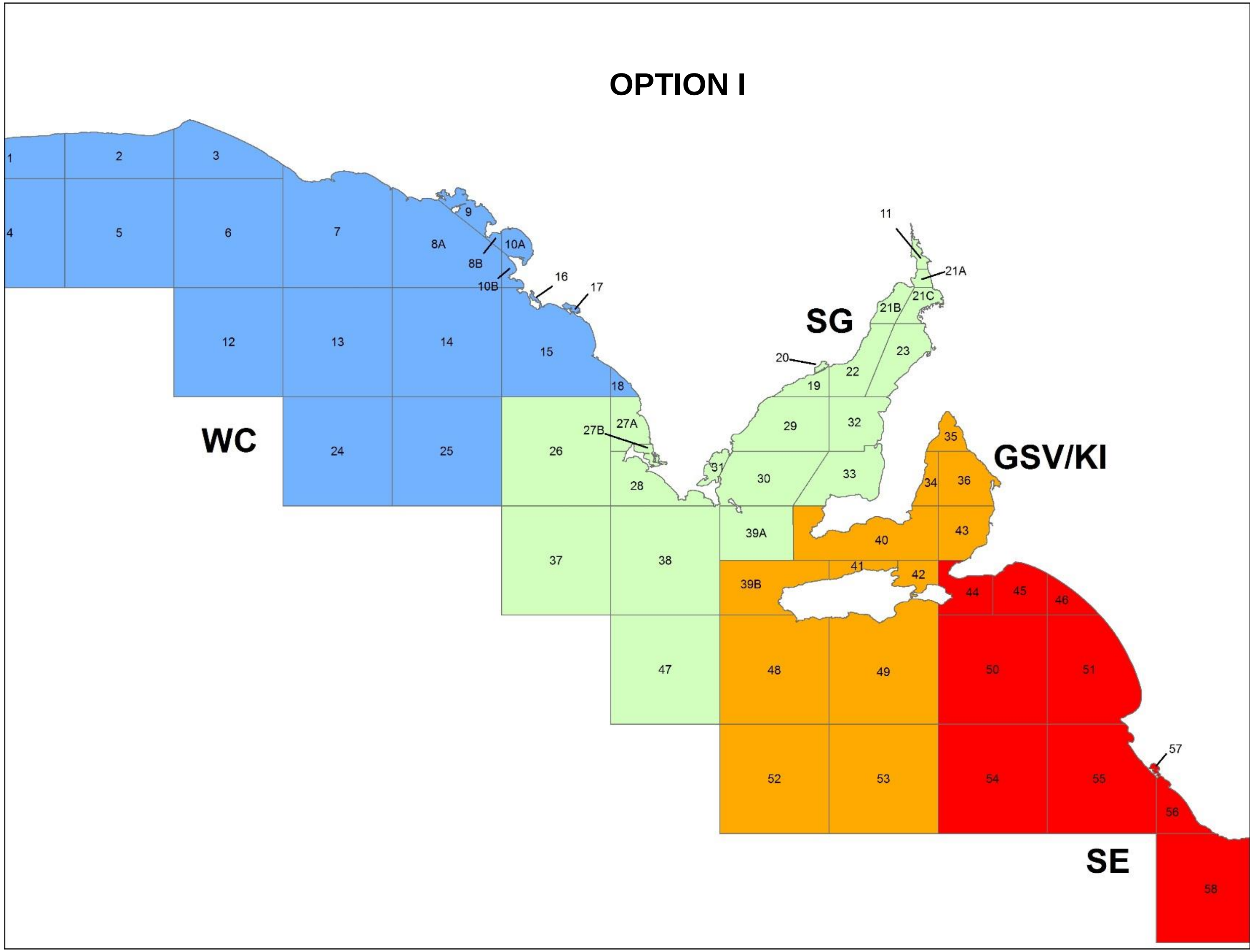


Figure 2.1 Two regional options – Option 1

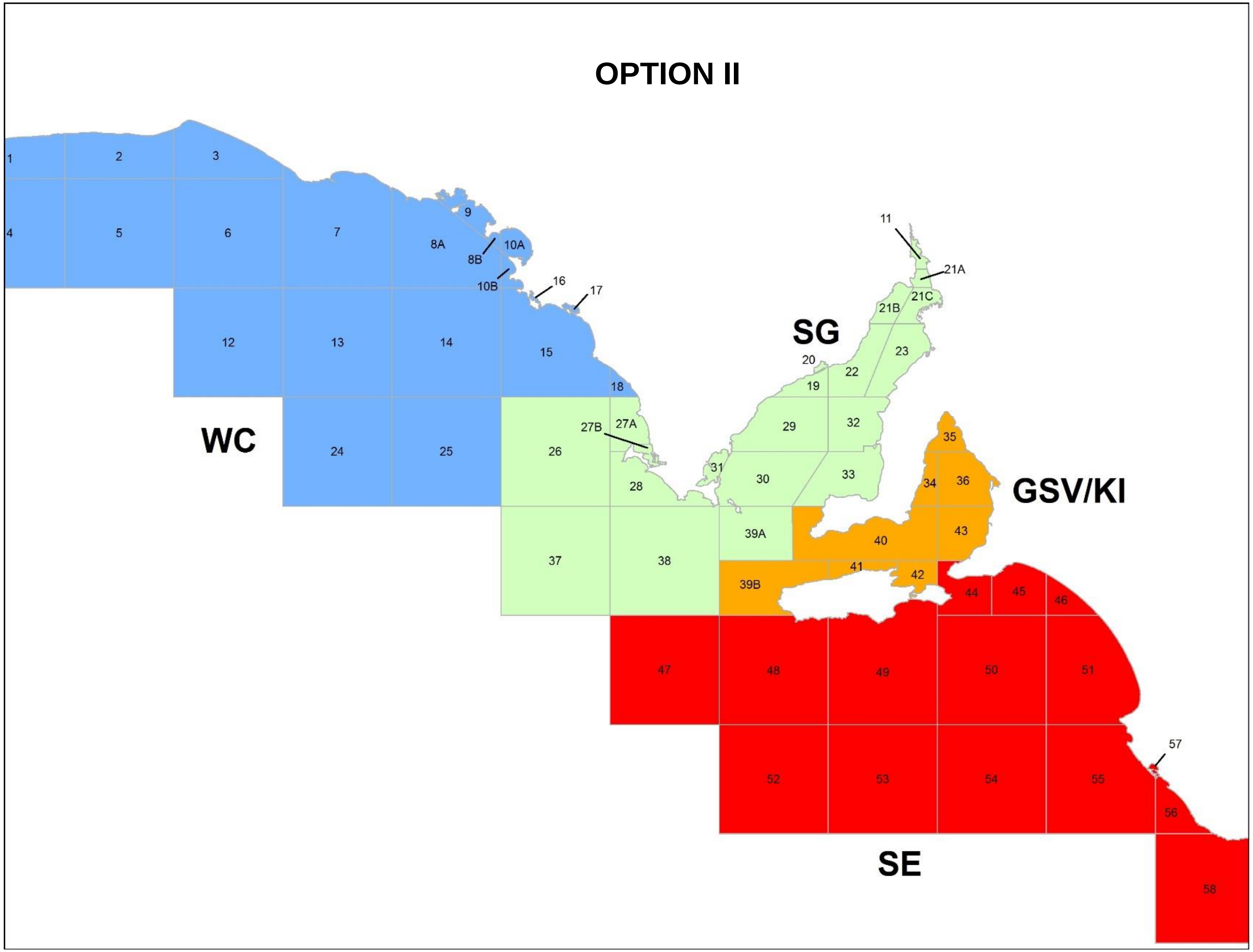


Figure 2.2 Two regional options – Option 2

Table 1. Representative summary of information for both regional options

	West Coast	Spencer Gulf	KI/GSV	South East	Total
Number of MSF licences[1,2]					
Net licences	4	24	26	0	54
Line licences	52	114	67	20	253
Total licences	**56**	**138**	**93**	**20**	**307**
Unamalgamated licences[2]					
Net licences	2	14	13	0	29
Line licences	20	31	23	12	86
Number of licences and Fishing Activity[1]					
> 120 days	28	53	44	7	132
90 - 120 days	7	17	10	2	36
1-90 days	19	54	33	11	117
0 days	2	14	6	0	22
10-year average catch of principal species (tonnes)[3]					
King George Whiting	124.5	116.8	57.6	0.4	299.3
Snapper	22.9	173.7	333.6	22.9	553.1
Southern Calamari	10.2	198.6	130.6	44.9	384.3
Southern Garfish	2.8	130.7	97.3	2.1	232.9
	160.4	**619.8**	**619.1**	**70.3**	**1469.6**
10-year average effort targeting principal species (boat days)[3]					
King George Whiting	4176	3549	1868	22	9615
Snapper	453	843	1493	685	3473
Southern Calamari	322	3879	2571	997	7770
Southern Garfish	32	550	599	56	1238
	4983	**8821**	**6532**	**1760**	**22095**
10-yr average target catch rate (kg/boat day)[3]					
King George Whiting	27.60	27.90	22.50	9.00	
Snapper	44.60	152.70	205.90	121.80	
Southern Calamari	31.00	43.00	43.40	44.70	
Southern Garfish	74.70	118.30	91.70	32.50	

[1] based on 3-year fishing activity 2015/16-2017/18

[2] source PIMMS @ 30 June 2019

[3] based on total commercial catch & targeted effort 2008/09 to 2017/18

4.2 Unitise

Unitisation is about defining specific units or shares in the fishery that can be traded among licence holders. The CMFRAC established key principles of unitisation to be that:

- Units provide the principal management instrument to achieving sustainable fishing of key fish stocks in the Marine Scalefish Fishery
- Units denote a secure property right in the fishery that can be defined in regulation
- The management and administration of units, including ensuring the integrity of the units, is cost-effective and does not impose an unfair burden on the industry and government, and
- Units can be traded within the fishery to facilitate structural adjustment, allowing fishers to invest and build their business, and provides an on-going mechanism for autonomous adjustment.

Under any system of unitisation, the specific tradeable unit must be well defined. Unitisation can be based on inputs or effort (such as fishing days), or output (catch). The choice of effort or catch constrained management systems subsequently depends on the specific fishery.

4.2.1 Input units

Input controls regulate how fishing occurs, such as limiting vessel size, gear restrictions such as length of nets, number of hooks, or the amount of time that can be spent fishing etc. They are an ***indirect means of limiting the catch*** of fish through the management of fishing effort.

One of the major problems of controlling the exploitation of fish through managing fishing effort is that it is extremely difficult to control every facet of fishing effort. Restrictions placed on particular inputs to fishing tend to still allow fishers to expand their use of other uncontrolled dimensions of fishing effort in order to maintain or increase their catch. For example, if we limit the number of days fished, then fishers can get around it by fishing harder each day; if we limit the length of a net then there is nothing stopping the net being set more often. This is commonly referred to as “effort creep” and is one of the biggest challenges in trying to limit catch using effort controls.

Effort controls indirectly present opportunities and, in some cases, incentives for the uncontrolled components of the fishery to expand into subsequent gaps, such as adoption of new fishing methods and technologies, shifting displaced effort into other areas, and targeting other species. Further difficulty arises with input controls when effort units need to be regulated for different gear types, vessel classes, and areas fished. This is because effort units are not equal across fishing fleets, as a day fished with one particular gear type can be completely different in its effective fishing power compared with another gear type, or even a different vessel using the same gear type. There have been attempts to capture these differences by adjusting effort units.

Applying unitisation in an input control system would require setting the Total Allowable Commercial Effort (TACE) that could be specified in various ways, such as a limit on the total number of days that can be fished regardless of what species are being targeted, the total number of fishing days that apply to an individual species, or a maximum number of nets or other gear that can be used in a fishery, or other units that limit the total fishing capacity of a fleet. These effort limits would be unitised (for example, as individual fishing days) and apportioned amongst the licence holders in the form of individual transferable effort (ITE) units, usually as a percentage or share of the TACE, thus providing flexibility in fishing operations and an opportunity for a licence holder to adjust their fishing business from year to year.

4.2.2 Output units

In contrast to input controls, output controls require setting of a Total Allowable Commercial Catch (TACC) to directly control the amount (normally weight) of fish that can be caught ***regardless of the effort used to catch them***. Using the best available information on a stock, TACCs are set in line with the sustainable harvest strategy objective, often the maximum sustainable yield (MSY) or equivalent biomass target.

Acquiring the level of information to set a TACC can be challenging, particularly in multi-species, multi-sector, community-shared fisheries like the MSF, where many of the targeted species are data limited. In these situations, designing and implementing an ITQ system to meet specific ecological, economic and social objectives is best considered through a sensible co-management approach with the appropriate mix of stakeholder representation and broad consultation.

A TACC can apply across a fishery without unitisation, in which case all fishers can keep catching until the TACC is reached. This is commonly called an Olympic Quota system as it gives an incentive for fishers to ‘race to catch’ the fish before other fishers get them and the fishery is closed. These Olympic TACC management systems can be accompanied by a daily catch limit for fishery participants to reduce the ‘race to fish’.

Unitisation under an output control system for a species requires the assigning of the TACC amongst the licence holders in the form of Individual Transferable Quota units or ITQs. These individual shares provide flexibility in fishing operations and an opportunity for a licence holder to adjust their fishing business. They create opportunities for fishers to concentrate on catching their own quota allocation in the most cost-effective manner, rather than racing to catch fish. Fishing activity can become more market driven with a greater emphasis on improving the quality of catch to get a better price, in order to maximize the return from quota. ITQs essentially give fishers their own exclusive right to a proportion of the TACC.

If ITQs are to work for the MSF they need to be applied to the key species at the right regional spatial scale and be part of a broad management system that safeguards the sustainable and equitable use of the fishery resources and ecosystems that support them. How they are to be implemented is thought to underpin their success and, in most cases, cannot be considered in the absence of other input control measures (i.e. seasonal closures, gear restrictions).

4.2.3 Determining sustainable catch limits

Given the diversity of information, determining the sustainable catch limits for each of the multiple species should adopt a step-wise approach driven by the availability of supporting information.

When sophisticated fisheries models exist, key parameters including biomass, recruitment and exploitation rates are derived and can be used to set a Recommended Biological Catch (RBC) based on the Maximum Sustainable Yield (MSY) of the stock. These are relied upon to set Total Allowable Commercial Catches (TACCs). In the absence of this information there are various second-tier methods that can be used to estimate MSY on the basis of historical trends in total catch and an understanding of the species resilience. These methods are often limited in their application as they do not account for biological parameters (i.e. age, length and growth), recruitment measures, or broad-scale population dynamics (i.e. movement) that are known to influence fish stocks. Given the lack of data and inherent uncertainty in the assessment, a more precautionary approach is usually taken in setting TACCs.

Determining sustainable levels of catch become even more precautionary in situations where data are limited, particularly for secondary species where only commercial catch data are available. In these situations, using average catch history over a prescribed reference period can be used to set RBCs; but these present a simplified approach and are best supported by expert judgement by representative stakeholders.

4.2.4 Establish management strategies

Three principal management strategies can be implemented within the reform package with varying levels of application. Each strategy would be designed around an established TACC for the stock of interest and applied using a tiered management approach, descending from:

TIER I – highly regulated individually transferable catch or effort quota system (ITQ/ITE)
TIER II – based on total allowable commercial catches or effort (TACC/TACE)
TIER III – monitored against prescribed performance indicators

The underlying metrics that inform the management strategy decisions need careful consideration to sufficiently address biological, ecological, social and economic concerns. The establishment of a Management Advisory Committee (MAC) that consists of relevant stakeholders to inform the process and routinely assess the management approaches would be highly beneficial. The decision-making framework should be flexible enough to adjust the management strategies when required. For example, a developing fishery may need to transition from a Tier III to a Tier II management strategy to minimise its sustainability risk. This approach can be applied to all MSF permitted species.

The proposed framework consists of eight criteria that are divided into three quantitative or qualitative ranks to align with the three tiers. Tier I criteria have a corresponding score of 3 points, descending to 1 point for Tier III criteria. The maximum achievable score using this framework is 24 points (i.e. 8 criteria * 3 points). It is suggested that fish stocks that score 18+ points would require an ITQ/ITE management system; 15 to 17 points a TACC/TACE-based system; and those scoring <15 points may only require monitoring against prescribed performance indicators.

The application of this framework can be demonstrated for two MSF stocks with different priorities and supporting information; Spencer Gulf/ West Coast (SG/WC) Snapper stock and South Australia's Snook stock. The SG/WC Snapper stock would score highly (18+ points) on the basis of its currently depleted stock status and high level of resource sharing with the recreational sector along with the fact that it is a specialised fishing target, of high value, and supported by an integrated fisheries assessment model. Consequentially, a Tier I ITQ/ITE-based management strategy would be most appropriate for this stock. Conversely, Snook would yield a low score (<15 points) due to its sustainable state-wide status, that it is largely a by-product species with low economic value and is currently assessed through trend analysis of fishery-dependent catch and effort statistics. Managing this species through monitoring performance indicators through a Tier III approach would therefore be more appropriate than submitting it to an ITQ/ITE-based management system. For those stocks that score within the 15-17 point range (e.g. Western Australian Salmon), an 'Olympic' style TACC/TACE management system may be considered to be appropriate. Each stock would need to be reassessed on a regular basis.

MSF MANAGEMENT STRATEGY DECISION MAKING FRAMEWORK

TIER	POINTS	STATUS	TACC SETTING (CONFIDENCE)	RESOURCE SHARE	SPECIALISE	ECONOMIC VALUE (GVP)	DEVELOPMENT POTENTIAL	ECOSYSTEM EFFECTS	FISHERY ASSESSMENT	MANAGEMENT STRATEGY
I	3	Depleted	HIGH	>30%	SPECIALISED TARGET	>10%	FULLY UTILISED	HIGH	FULL INTEGRATED PROGRAM	ITQ (18+ POINTS)
II	2	Recovering / Depleting	MEDIUM	10-30%	GENERAL TARGET	5-10%	UNDER-UTILISED	MEDIUM	CATCH SAMPLING	TACC (15 - 17 POINTS)
III	1	Sustainable / Undefined	LOW	<10%	BY-PRODUCT	<5%	INCIDENTAL	LOW	FISHERY-DEPENDENT	PERFORMANCE INDICATORS (<15 POINTS)

4.2.5 Assessment of options

In considering unitisation options to reform the MSF, the CMSFRAC referred to its terms of reference which directs it to "examine the practicality of implementing individual transferable catch quotas as a preferred method of managing the fishery unless it can be shown that another form of management is more effective at achieving the objectives of the reform program".

The CMSFRAC considered five unitisation concepts for the MSF to achieve sustainable fishing of key fish stocks, three of which establish units (catch and effort units), with two alternative management arrangements proposed by the Southern Yorke Peninsula Professional Fishers Association and the West Coast Professional Fishers Association.

In summary, these options can be described as:

1. ITQ x Key Species - Establishing Total Allowable Commercial Catch (TACC) for each of the key species, with allocations through Individual Transferable Quotas units (ITQ). This would restrict a fisher to only take their allocation of each key species. This catch allocation can be traded.
2. ITE x total boat days - Establishing Total Allowable Commercial Effort (TACE) for the fishery, with Individual Transferable Effort units (ITE) in terms of total boat-days available for fishing. This would restrict a fisher to only use their allocation of the number of boat-days. This effort allocation can be traded.
3. ITE x Species - Establishing Total Allowable Commercial Effort (TACE) that apply to fishing for individual species, with Individual Transferable Effort units (ITE) in terms of total boat-days available for fishing that species. This would restrict the number of boat days a fisher can target and take species for which they have as ITE.
4. Individual Weekly Allowable Commercial Cap x Species – Establishing TACC for species and restricting all fishers with an equal and non-transferable weekly catch cap for the four primary species (similar to the trip limit for Snapper). A licence holder can increase their individual weekly allowable catch by purchasing another licence.
5. Individual Seasonal Allowable Commercial Cap - Establishing TACC for species and restricting all fishers with an equal and non-transferable seasonal catch cap for each species, with regular monitoring and adjustments to the cap throughout the year. A licence holder can increase their individual seasonal allowable catch by purchasing another licence.

The CMSFRAC assessed each option against ecological sustainable development (ESD) principles – ESD is the main objective of the *Fisheries Management Act 2007*. A summary of this assessment is illustrated in Table 2.

Overall, an ITQ management system was assessed as the option which best met the ESD principles listed through removing the incentive to race to fish and effort creep. This approach restricts the activation of latent effort on primary species providing greater flexibility to fishers to adjust their business activities and driving economic benefits over the longer term.

This assessment is consistent with the findings of the Australia's Productivity Commission Inquiry Report into the regulation of Australian marine fisheries (Productivity Commission 2016[4]) that recommended that ITQ systems should be the 'default' management technique for commercial wild-caught fisheries. The report suggests that this system will provide greater confidence on stock sustainability, more scope for innovation and efficient fishing practices, and facilitate structural adjustment.

[4] Productivity Commission 2016, *Marine Fisheries and Aquaculture, Final Report*, Canberra

Table 2. Framework for Assessing Management Options

ESD Principles		ITQ x species	ITE x total	ITE x Species	IWACC	ISACC
Ecological / Biological						
	Contribute to any stock rebuilding and recovery	✓✓✓	✓	✓✓	✓✓✓	✓✓✓
	Directly control or constrain the total catch or effort levels within an agreed precautionary range	✓✓✓	✓	✓✓	✓✓✓	✓✓✓
	Address the expansion in effective fishing effort	✓✓✓	✓	✓	✓✓✓	✓✓
Social Values						
	Equity between and within each sector and security of resource shares	✓✓✓	✓	✓	✓✓✓	✓✓✓
	Industry stewardship and co-management	✓✓	✓	✓	✓✓	✓✓
	Social licence to fish / pride	✓✓✓	✓	✓✓	✓✓✓	✓✓✓
	Compliance and enforcability	✓	✓✓	✓✓	✓	✓✓
	Safety and wellbeing of fishers	✓✓	✓	✓	✓	✓✓
Economic Development						
	Positive impacts for regional communities and regional development	✓✓✓	✓	✓✓	✓	✓
	Relative strength of the access right provided	✓✓✓	✓	✓✓	✓	✓
	Autonomous adjustment in the fishery	✓✓✓	✓✓	✓✓	✓	✓
	Vibrant and profitable commercial fishery	✓✓✓	✓	✓✓	✓	✓✓
Business Development						
	Level of operational flexibility provided	✓✓✓	✓✓✓	✓✓✓	✓	✓✓
	Ability to maximise the return from the available fish stocks	✓✓✓	✓✓	✓✓	✓	✓
	Reduced regulatory burden / red tape	✓✓	✓	✓	✓	✓
	Cost and affordability	✓	✓✓	✓	✓	✓

4.3 Rationalise

Rationalisation is principally about the removal of licences out of the fishery to address excessive effort and latent effort issues. If everyone fished with the current stock status and access arrangements, there would be too much effort being exerted on stocks that are already under pressure and, in some cases, classified as depleted. The key principles of rationalisation proposed by CMSFRAC are that it:

- Achieves the voluntary surrender of at least 100 commercial fishing licences in the Marine Scalefish Fishery
- Is supported by co-funding by government and industry, with the industry contribution to be through the associated unitisation and autonomous adjustment process, including re-investment into the fishery, and
- Provides a mechanism to rationalise other commercial fisheries that have some level of shared-access to marine scalefish species.

The CMSFRAC considered a number of options to achieve the above objectives on the premise that an ITQ-based system is used to manage key species in the reform. Four alternative approaches were considered that involved a voluntary surrender of licences and a government supported quota trading system (that could also include the further voluntary surrender of licences). Variations were based on when ITQs were allocated and whether any units that were removed through a voluntary licence surrender process were redistributed across the fleet or purchased by remaining licence holders in the fishery.

4.3.1 Voluntary licence surrender program

The CMSFRAC considers there is an urgent and compelling need to provide an opportunity for licence holders to exit the fishery through a Government-funded and voluntary licence surrender program prior to any allocation of ITQs within the fishery.

This option recognizes the high levels of anxiety and financial stress within the fishery that would be assisted through an immediate licence buy-out program. There are a number of licence holders within the fishery that are unable, or unwilling, to endure the reform process which is likely to extend over multiple years. Given rationalisation is a key pillar of the reform process, it would be beneficial to accommodate these licence holders through a voluntary buy-out program at the outset.

There are three ways this can be achieved:

Government offer at a set price

The value of licences is determined through an independent evaluation process. The government offers a set price for particular categories of licences. Licence holders choose to accept this offer and surrender their licence, until the licence removal target is met, or until available funds are exhausted.

Competitive tender process

Individual licence holders nominate their surrender price. The government purchases licences from the lowest offer price until the rationalisation target is met, or until the budget is exhausted. This program is more cost-effective than a simple buy-out at fixed values as licence holders receive their nominated price. The risk is that nominated prices are too high (beyond market value) and few offers are accepted. This can be mitigated against by having multiple rounds allowing licence holders to reconsider their offers. This process may cause friction within the industry if identical licences are bought by government for different prices.

Clearing price auction

First, individuals nominate their surrender price. The government assesses the range of offers against the rationalization target and budget, then determines the ‘clearing’ price. Those licence holders who have nominated an equal, or lower value to the clearing price will be successful. This means that all offers below the clearing price will receive a price higher than they offered. To be effective, it is usually necessary to have more than one round of this auction before “closing the market” as bidders often start out with unrealistic expectations about the value of their licences. Although this process is not necessarily the most cost-effective for the government, a uniform price mitigates against community conflict.

The CMSFRAC acknowledges that it will be up to government to determine a fair and reasonable method to conduct a voluntary licence surrender program and to ensure essential probity and strong administrative processes are developed.

4.3.2 Supported quota trading system

A Supported Quota Trading system provides an efficient option to further rationalize the fleet as it facilitates trades between willing sellers and buyers using government funding assistance. Those who want to exit the fishery are encouraged to set a price on their quota holdings.

Buyers who are keen to develop their business are encouraged to offer a purchase price. The timeframe of the nomination process will be restricted within a set ‘trading round’ period. The market matches up all willing buyers and sellers and uses government funding assistance to optimise the trade of quota units and to buy-out licences.

These supported trades would depend on the size of the available budget and rationalisation target. If the government's objectives cannot be met in the first trading round another trading round can be carried out which would encourage licence holders to adjust their offers. Trading rounds can be repeated until the Government's objectives are met. This process offers the best value for government and industry as it provides a rationalisation platform while assisting licence holders remaining within the fishery.

In summary, this trading system assumes there are willing buyers and sellers of ITQs. The process could be as follows:

- Sellers submit an offer sell price for their quota units, and buyers submit an offer buy price for quota units. Both buyers and sellers are encouraged to make realistic offer prices.
- Government support is used to facilitate (subsidise) quota unit trades in order to match as many buyers and sellers as possible, and "pay" licences that may be offered for surrender in this process.
- When the trading round closes, an evaluation is made to see whether objectives have been met within budget. If they are not met, buyers and sellers are provided information on what the clearing price would have been to meet objectives and whether their offers would have been accepted at that price. Both buyers and sellers are then invited to adjust their offers for a subsequent trading round.
- The sell and buy offer process may be repeated in several rounds until the objectives are met within budget. Experience in other markets shows that buyers and sellers make more realistic bids once they get an idea of likely clearing prices. Often first to second round bids are overly optimistic and bidders are discovering what prices of quota/licences are.
- When the market closes:
    - Buy and sell bids are matched. Government support facilitates more matches. The market matches up all willing buyer and sellers (market clearing price) and then increases the number of trades with government support.
    - All successful sellers receive the same price (uniform) for their units and/or licence.
    - All successful buyers pay the same price (uniform) price for quota units.

Industry's contribution to this rationalisation approach is through individual licence holders choosing to invest and accelerate an adjustment through purchasing quota units from others in the fishery. Government's contribution would be through subsidising the initial trading of quota units (thereby providing an incentive for individuals to trade) and in providing payments to individuals willing to surrender a licence, which would otherwise have limited value.

4.3.3 Further options

There may be some licence holders who may choose not to participate in the initial voluntary licence surrender program and are prepared to wait until quota shares are allocated to make an informed decision regarding their future business. The CMSFRAC considers other options to exit the fishery could be available that include a secondary voluntary licence buy-out that includes the surrender of associated quota shares attached to the licence. The quota shares that are removed through this "post allocation" government buy-out could then be redistributed among the remaining licence holders prior to the commencement of a supported quota trading process. The supported quota trading process may or may not include the option for government to further buy-out licences that are offered for surrender.

While on-going autonomous adjustment to fishing businesses would occur with the trading of quota units between licence holders thereafter, any further reduction in the number of licences would be limited if there are no further incentives or mechanisms to surrender a licence.

4.3.4 Autonomous adjustment

A successfully reformed fishery, characterised by an economically viable fleet that sustainably harvests premium species without unduly impacting the environment and is responsibly managed, should have the capacity to autonomously adjust.

This will transition the fishery into a positive market-driven business environment that support: profitable fish production and value adding; business specialisation and proficiency; a confident investment climate; creation of employment opportunities; efficient management and administration; stewardship of shared resources; a secure social licence to operate; and succession opportunities.

5 Other Considerations

5.1 What will the cost of the ongoing management program be?

Implementing any reform in the MSF is likely to impact on the management program and associated costs of services in a number of ways. The fishery will continue to be managed in accordance with the PIRSA Cost Recovery Policy that requires licence fees to fund services related to commercial fishery management costs.

Segmenting the fishery into zones, implementing quota management systems for species that may differ between zones, and reducing the number of licences and rationalizing the shared-access to the fishery by other commercial sectors will have the primary objectives of preventing future overfishing and increasing the profitability of individual fishing operations over time. It will also fundamentally impact on the licence fees that apply to licence holders that remain in the fishery.

Table 3 summarises the costs of managing the MSF in 2019-20 and the recovery of these costs from the commercial fishing sectors that have access to the fishery.

As licence numbers are removed through any voluntary licence surrender process, individual fees are expected to rise (as overall costs are recovered from fewer licences) unless management and research costs are reduced and/or some of the costs of management are met by government. Management and research programs and their associated costs will be reviewed towards the end of the reform process.

In relation to the potential impact on licence fees and affordability of fishing associated with the proposed reforms, the CMSFRAC agreed to include information in the consultation paper relating to assisting the transition of the fishing industry through the reform process, such as keeping licence fees constant, adopting and adapting to new technologies, and restructuring business operations. Specifically the government assistance package should include any direct upfront and marginal costs associated with the implementation of catch quota management for at least a three-year period.

It is recognized that proposed reforms must be affordable to industry in the short and longer term and this will likely require that the reform package delimits that average individual licence fees should not increase from approximately their present (2019/20) levels, at least in the initial years after implementation. Given that the required management and research program is likely to represent a higher figure than this as a result of reduced licence numbers (30%) and the likely need to invest in an ITQ catch monitoring system, government assistance to provide licence fee relief will be required especially in the early years of reform.

The net impact of the reform on future management costs will depend on a number of factors such as the change in the fisheries research and assessment services resulting from a shift to a quota management system, the type of quota monitoring regime implemented, and the extent to which existing regulations and licence conditions can be reduced. While it is expected that there will be savings in the longer term through the progressive removal of inefficient input controls and associated red tape it is likely that management costs in the shorter term will increase.

Advice from PIRSA Fisheries Compliance is that moving to a digital based catch disposal record system is likely to be more costly in the initial stages due to investment in necessary hardware and software systems but less expensive in the longer term compared to a paper-based system. The approximate marginal cost per annum associated with the implementation of a quota management scheme on the four primary species for 200 licence holders across all regions will be discussed as part of this consultation process.

Should CMSFRAC's agreed position be adopted by government there would be approximately $2.4 million plus the marginal cost of the quota management system over three years provided by government as part of the industry assistance package to maintain current individual licence fees as licences are removed from the fishery. This assumes 2019-20 management costs remain constant over this period. While there would be CPI related cost increases during this period there is also expected to be an offset reduction in compliance costs associated with the gradual removal of regulations and licence conditions.

It is anticipated that a combination of improved profitability levels and management efficiency increases will ensure that management reforms are affordable to industry participants three years after implementation of the reforms.

In addition to the above, CMSFRAC has supported the design principles developed by the MFA Forum (see section 6.1) that states "in the future, commercial licence fees should be based on a user-pays principle; with lower base licence fees and the remainder paid on amount of catch/effort shares".

Clearly there is a need to cost the implementation of the reform process in some detail to determine the level of government support required to achieve the objectives of the reform.

The South Australian Research and Development Institute's (SARDI) Fisheries Program that currently assesses the status of South Australia's finfish stocks, addresses key knowledge gaps in fisheries science and informs the development of management strategies will need to be renewed in line with the reformed fishery.

The overall objectives of this program will remain the same, with a requirement to monitor the catches amongst the shared sectors, routinely acquire biological samples, and undertake fisheries-independent research to support stock assessment. However, the program's scope is likely to increase to specifically address the research and management needs of the four zones.

The cost structure of the research program will depend on the relevant harvest strategies. Clearly established harvest strategies, developed through a co-management approach, will clarify the role and nature of the supporting research program and associated service costs. There are also likely to be significant opportunities to improve its cost-effectiveness through the adoption of advancing data collection technologies, industry and community supported biological sampling programs, and the availability of more sophisticated fisheries assessment tools.

Regardless of these changes the science program will continue to support the responsible and effective management of the MSF and will need to be agile to meet the expectation of government, relevant stakeholders and the South Australian community.

In addition to providing licence fee relief over the first three years and providing cost effective and affordable management services the State and Federal Governments can potentially assist the reform process through other means such as –

- Low interest loans
- Business advice and small grants
- Taxation treatment/concessions on reforms

These and other avenues need to be investigated to the fullest extent as part of the proposed reform to reduce the financial and social impact on operators.

Table 3. Summary of costs of managing the MSF

Management Costs	2019-20	
Research costs		
Stock assessment and monitoring	770,947	
Economic assessment	25,055	
Other research	13,796	
		809,798
PIRSA related costs		
Policy and management	211,200	
Legislation	10,300	
Licensing	68,040	
Directorate	15,056	
Compliance	1,236,793	
Vessel costs	45,984	
		1,587,373
Other costs		
FRDC	53,570	
Co-management services	208,880	
		262,450
	TOTAL	**2,659,621**

Cost Recovery	2019-20	
MSF/RMSF	1,910,606	
		1,910,606
NZRLF	200,313	
SZRLF	435,248	
L&C	34,622	
Sardines	78,832	
		749,015
	TOTAL	**2,659,621**

5.2 Is the current scientific assessment methodology capable of providing reliable Total Allowable Catch estimates?

Sophisticated fisheries models are commonly relied upon to support TAC setting and the development of fisheries performance indicators. The level of sophistication is generally proportional to the quality and quantity of data available for a managed stock. In many cases, fisheries are considered data-poor where there is a limited time series of catch and effort data, or distinct information gaps in the species' life-history processes and population dynamics. This is typical of low value, small-scale fisheries, and although this lack of information my present additional management challenges it is not considered a reason to avoid developing harvest strategies.

Fisheries management relies on the best scientific information available at the time and will subsequently need to be responsive when new information arises. There are a range of simple, pragmatic, empirical options that can be applied to data-poor fisheries. These approaches are generally enhanced by positive stakeholder engagement, embracing the precautionary principle and adaptive management.

The multi-species and multi-method MSF clearly demonstrates the variation in available information that can be used to support the development of harvest strategies and estimate TACs. The assessment of three of the primary species - King George Whiting, Southern Garfish and Snapper - are supported by sophisticated fisheries models that integrate multiple fisheries-dependent and –independent data sources and population biology metrics across different spatial scales.

Fishery-independent methods also exist to estimate spawning biomass for Snapper and King George Whiting, which can contribute in TAC setting and fishery assessment. The subsequent assessment of the remaining secondary and tertiary species predominantly rely on the interpretation of commercial catch and effort data.

Given the diversity of information, the development of TACs for each of the multiple species should adopt a cascading approach driven by the availability of supporting empirical data. When sophisticated models exist, key parameters including fishable biomass, recruitment and exploitation rates are derived and can be used to determine the maximum sustainable yield (MSY) of the stock and set precautionary TACs. In the absence of this information there are various second-tier 'catch-only' models that can be used to estimate MSY on the basis of historical trends in total catch and an understanding of the species resilience.

These models are often limited in their application as they do not account for biological parameters (i.e. age, length and growth), recruitment measures, or broad-scale population dynamics (i.e. movement) that are known to influence fish stocks. Using average catch history over a prescribed reference period can also be used to set TACs. However, these present a relative base-case approach and are best supported by expert judgement by representative stakeholders.

Determining TACs from average catches in isolation in an already depleted fishery is only going to perpetuate stock decline, so it is increasing important that all available information is considered when determining catch limits.

5.3 How will units be allocated among licence holders?

Allocating quota to individual fishers in an established fishery, particularly a multi-species fishery and one that is as diverse as the MSF is probably the most contentious issue facing managers and industry when introducing a quota management system. It is a question that is upper-most in the minds of licence holders who will be affected and thus is a major factor in their acceptance to the adoption of a quota management system approach (Kaufmann et al. 1999[5]).

Regardless whether ITQ or ITE unitisation is implemented, there is a need to establish explicit and sound principles underlying the method of allocation of units to fishers. Associated with this is the need for independence in determining a fair and reasonable allocation formula, and removing the management agency (PIRSA) and licence holders from direct involvement in developing a recommended allocation formula.

The establishment of an independent allocation panel to investigate and determine the most appropriate allocation formula is crucial. In carrying out their function, allocation panels are expected to consult widely with stakeholders and relevant parties and any person or organisation with appropriate knowledge of or experience with the fishery to gain a full appreciation of the particular circumstances of the fishery.

Typically, an independent allocation panel makes recommendations on eligibility, how units are allocated (i.e. catch history, licence status, gear endorsements), and enables consideration of exceptional circumstances (e.g. new entrants). Each fishery has its own specific circumstances that determine how units are best allocated among fishers. In some fisheries, equal allocations could be provided to all participants, while in others allocations may be based solely on catch history or various combinations of catch history, fishing days, vessel size, gear endorsement, level of investment; others may provide a minimum base quantity of quota to all individuals. While the method chosen endeavours to be fair and equitable across the fishery there are inevitably perceived individual winners and losers.

Particular decisions that will need to be made relating to allocation in the MSF include:

- What species should be allocated by quota, individually or collectively, and whether all species need to be included in a catch quota system
- If the fishery is to be regionalised based on the biological distribution of key fish stocks, how are straddling stocks (and straddling fishing activity) managed under a quota system? What are the considerations for varying quota management arrangements that may apply to the same species in different regions?
- If fishing history (effort and/or catch) is to be used in an allocation formula:
    - What years, or period, of years are considered?
    - What consideration should be given to the investment warning issued by PIRSA in December 2017, and the policy that the history of fishing activity remains with the licence holder and not with the licence?
- What consideration is given to fishers who may not qualify for catch history as a result of recent licence transfers or a new entrant?
- What consideration is given to the spatial distribution of fishing activity and its relevance to the management of catch quotas, particularly if separate zones of management are introduced?

[5] Kaufmann, B., Geen, G. and S Sen. 1999, *Fish futures: Individual transferable quotas in fisheries*, Report to the Fisheries Research and Development Corporation, Canberra

5.4 What is the current value of licences in the Fishery?

Options to achieve a reduction in the number of licences in the MSF and rationalise access in the fishery include a voluntary licence buy-out and (following unitization) a market-based trading program in which licence holders can restructure their fishing business and invest in additional unit entitlements. This should also enable those who decide to exit the fishery to sell their entitlements and receive a fair reparation upon the surrender of their licence.

An independent valuation of current licences, prior to implementing any reform in the fishery will provide guidance to industry and the CMSFRAC about the potential price of various licence categories ahead of a restructure or licence surrender program.

This will assist CMSFRAC to develop a reform package that includes the estimated expenditure required to reduce the number of licences in the fishery by 100 and to provide information that would assist licence holders to make an informed decision on whether to remain in the fishery, or to surrender their licence and leave the fishery.

5.5 Shared access of other commercial fisheries

An important principle of rationalisation proposed by the CMSFRAC is the development of a mechanism to integrate other commercial fisheries that have some shared access to marine scalefish species that address issues to do with latent effort and on-going access. To date, the CMSFRAC has focussed on options to remove at least 30% of the 307 licences in the MSF, described in this Consultation Paper.

Discussions have commenced with the industry associations of the rock lobster and prawn fisheries to consider some options of how those fisheries could be integrated into the reform package. These discussions will continue throughout the consultation process, facilitated by the MFA and PIRSA. Consultation will also be undertaken with the Sardine and Lakes and Coorong fisheries to address issues related to their shared access to the MSF, bearing in mind the existing allocated shares of the commercial allocation for specified species, formalised in the Management Plan for the South Australian Commercial Marine Scalefish Fishery.

The level of access and restrictions on access varies between each fishery, with these restrictions implemented through a mix of regulations, licence conditions and other legal instruments.

Rock Lobster fisheries

The level of access to marine scalefish species by both the Southern and Northern Zone Rock Lobster fisheries is dependent upon one of three options fixed by licence concession to each rock lobster licence.

- Option A: allows the take of incidental bycatch of MSF species (other than snapper) for bait purposes.
- Option B: allows the take of MSF species for bait purposes only using a bait net or as incidental bycatch in pots (not including Snapper).
- Option C: allows the take of permitted MSF for trade and business.

In the Northern Zone Rock Lobster Fishery, there are two (2) licences with Option B, and 60 licences with Option C.

In the Southern Zone Rock Lobster Fishery, there are nine (9) licences with Option B and 148 licences with Option C.

Lakes & Coorong Fishery

There are 36 Lakes and Coorong licence holders who have restricted access to some of the same species as MSF licence holders. These fishers operate in coastal waters between Goolwa Beach Road to the jetty at Kingston, out to three nautical miles from the low water mark. The main species targeted are Mulloway, Western Australian Salmon, Black Bream, Yellow-eye Mullet, and Greenback Flounder.

Prawn fisheries

All prawn fisheries (Gulf St Vincent (10 licences), Spencer Gulf (39 licences) and West Coast (3 licences) are permitted to retain for trade and business Southern Calamari that are incidentally taken during prawn fishing operations. Licence holders in the West Coast Prawn Fishery are also permitted to retain Octopus and Scallop.

Sardine Fishery

The Sardine Fishery has evolved directly from within the MSF. There are 14 MSF licences authorised to use a sardine (purse seine) net to harvest Australian Sardine and other small pelagic species, including Anchovies, Blue Sprat, Sandy Sprat and Maray. These licence holders retain access to all species permitted under a MSF licence.

6 Attachments

6.1 The Marine Fishers Association (MFA) Forum – Principles of Reform

The Marine Fisheries Association (MFA) Forum
Principles of Reform

Background

The South Australian Government established the 'Commercial Marine Scalefish Fishery Reform Advisory Committee' (the Committee) to guide the development and implementation of a reform package for the South Australian commercial Marine Scalefish Fishery. Guided by their principal vision of having an economically optimal and sustainable industry that supports profitable, small scale and regionally-focused fishing operations, the Committee has a three-pillar approach to reforming the fishery, incorporating regionalisation, rationalisation (commercial licence reduction) and unitisation. They recognise that reform requires an inclusive process that engages all licence holders and listens to their concerns. As a key part of the consultative process, the Marine Fisher's Association established a forum to consider requests from the Committee and develop an industry position on different matters before the Committee.

Following three meetings of the MFA Forum during the first half of 2019, we provide the following key principles which it believes are critical to the reform process.

Sustainability of stocks is paramount

Recognising that management of the fishery includes ecological, economic and social objectives, sustainability of stocks is paramount. Regardless of the proportion of the stock taken by each sector (commercial, recreational – including indigenous), the total fishing mortality (from all sectors) on each stock must not exceed sustainable levels.

Integrated cross-sectoral management

The MFA Forum advocates that any reform mechanism should explicitly include both the commercial and recreational (including Indigenous) sectors in future management arrangements.

In order to achieve sustainable management, annual total allowable catch (TAC) limits must be determined and applied to the four key MSF stocks (Snapper, King George Whiting, Southern Calamari, Southern Garfish) as a minimum. This will be applied in the form of a Total Allowable Commercial Catch (TACC) and a Total Allowable Recreational Catch (TARC).

Costs of management (monitoring, research, assessment, compliance) must be paid by each sector in proportion to their cross-sectoral catch shares. In the future, commercial licence fees should be based on a user-pays principle; with lower base licence fees and the remainder paid on amount of catch/effort shares.

Each sector should have appropriate and adequate monitoring and compliance systems in place to ensure sectoral catches do not exceed annual sectoral limits. Real-time reporting and fish tags may be a component of such systems. We recognize that these systems may be different for each sector and for different regions of the fishery.

Regionalisation

In addition to supplying fresh fish for Adelaide markets, commercial MSF fishers recognize the importance of their industry in providing for and supporting coastal communities across South Australia.

We recognize the diversity of fishing operations in the MSF as they have evolved to reflect spatial differences in regional fish stocks, coastal habitats, infrastructure and pressures placed on fishery resources through growing coastal populations. We desire to maintain a regional base for our industry and the communities it supports in any future management.

There is a high level of support for regionalisation of the fishery to meet the various sustainability, economic and social objectives of cross-sectoral fisheries management. Most industry options suggest development of regional licences as the best way to achieve this, but recognize that different management mechanisms may be applied in the different regions.

There is currently a state-wide allocation of the TAC to different extractive sectors (commercial, recreational, indigenous); this needs to be reconsidered on a regional basis. We want this to be a key component of ongoing discussions.

Rationalisation

In order to have a sustainable Marine Scalefish Fishery that supports economically viable and profitable fishing businesses into the future, the MFA recognizes the need for rationalisation of the ~300 commercial licences that currently have access to the fishery.

Any rationalisation of the fishery must acknowledge the fishing entitlement of current licence holders and provide a fair reparation for those choosing to surrender their licence and leave the fishery. We support the use of economic data to inform the future composition of the MSF fleet so that it consists of viable businesses for both full-time and part-time operators.

Given the preference for regional management in the future and the different commercial and recreational fishing pressure in the different regions, we recognize that some regions require more rationalisation of commercial fishing licences than others.

Despite the fishery having operated under various Management Plans since the 1970s, the current fishery is not ecologically sustainable and the commercial sector is not economically viable. We believe that there is a positive business case to be made for the SA Government to assist in funding a once-off reform of the fishery so that it can achieve its ecological, economics and social objectives into the future.

Unitisation

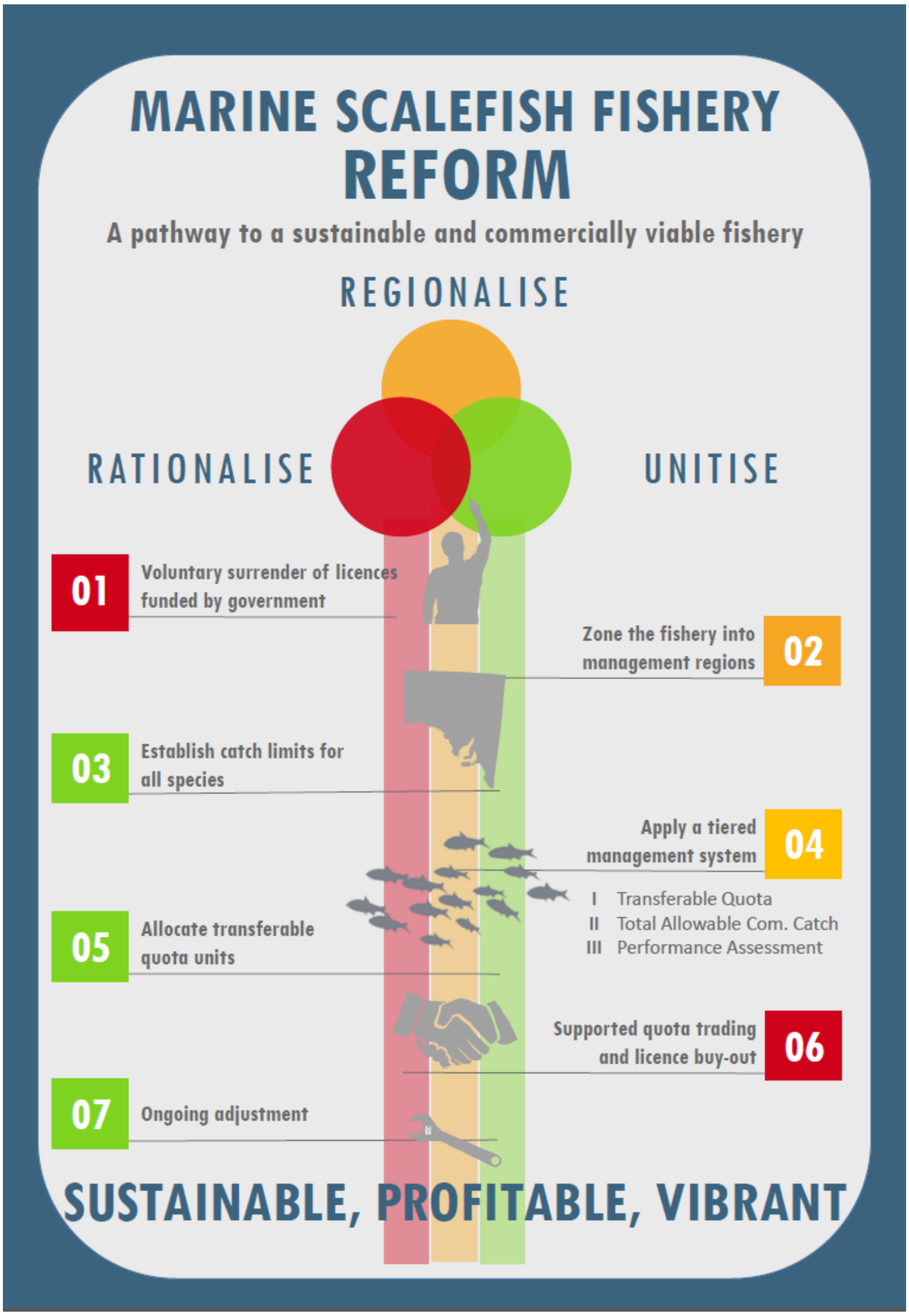
Either following or as part of rationalisation, we recognize that future unitisation of the fishery (catch- and/or effort-based) is the management tool most likely to achieve the sustainability, economic and social goals of cross-sectoral management.

Allocation of the units must be fair and equitable across all those currently involved in the commercial and recreational fishery. There may be a need for transitional arrangements to be implemented for groups of operators in specified circumstances.

Although unitisation may be focused on key species in the fishery, future management arrangements must ensure that catches of secondary byproduct species and bycatch are not detrimental to the overall ecological sustainability of the fishery.

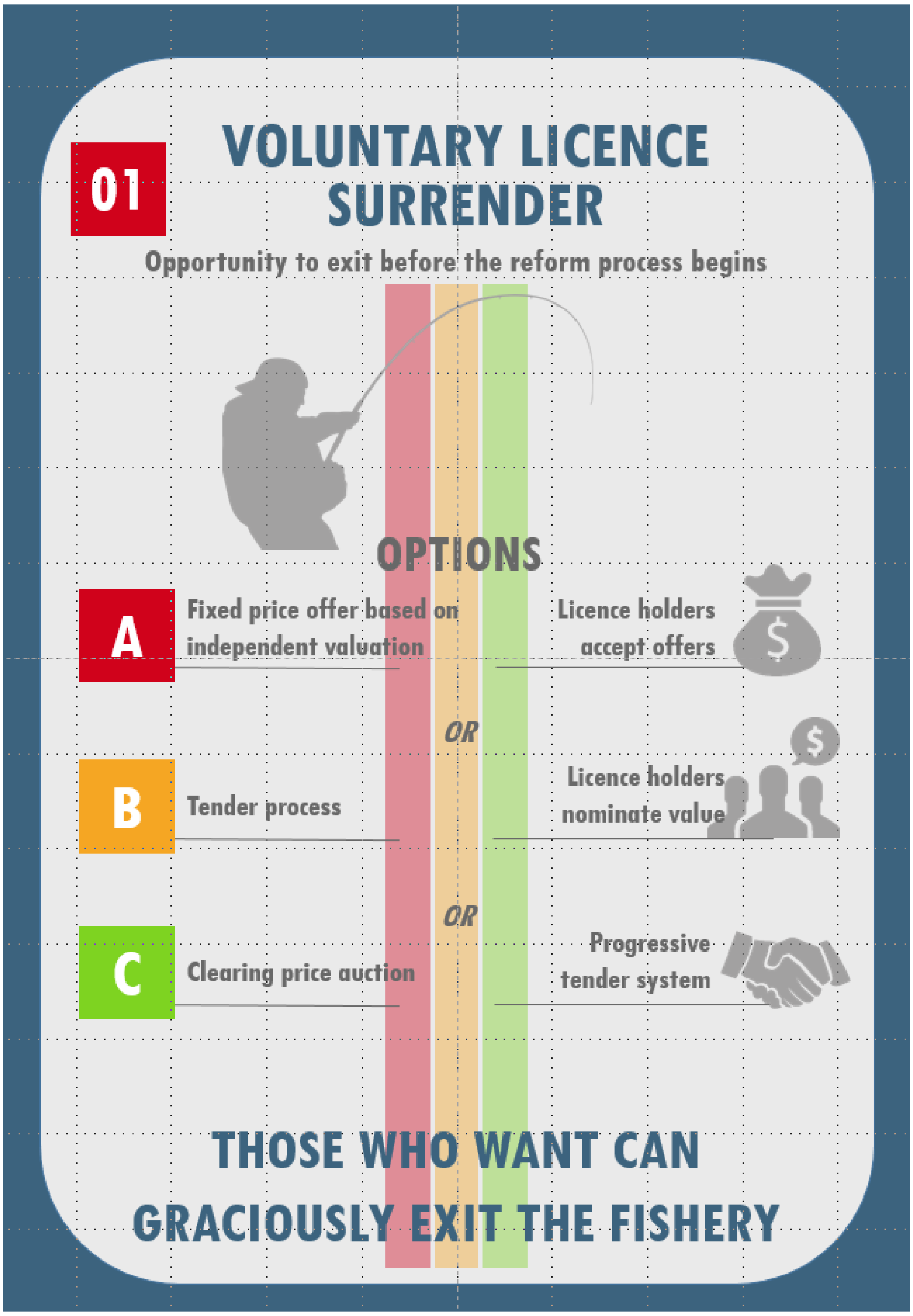
6.2 Seven steps to fishery reform

There are too many commercial fishers and not enough fish to sustain a vibrant and profitable industry. To address this, the Government of South Australia is committed to investigating and implementing key reforms in the commercial sector of South Australia's Marine Scalefish Fishery to ensure long-term resource sustainability and improve the industry's future viability. Consistent with the CMSFRAC's Terms of Reference, the following seven step infographic summarises options for rationalising, regionalising and unitising the fishery based on the premise that a TACC and ITQ-based system is used to manage primary species.



1. VOLUNTARY SURRENDER

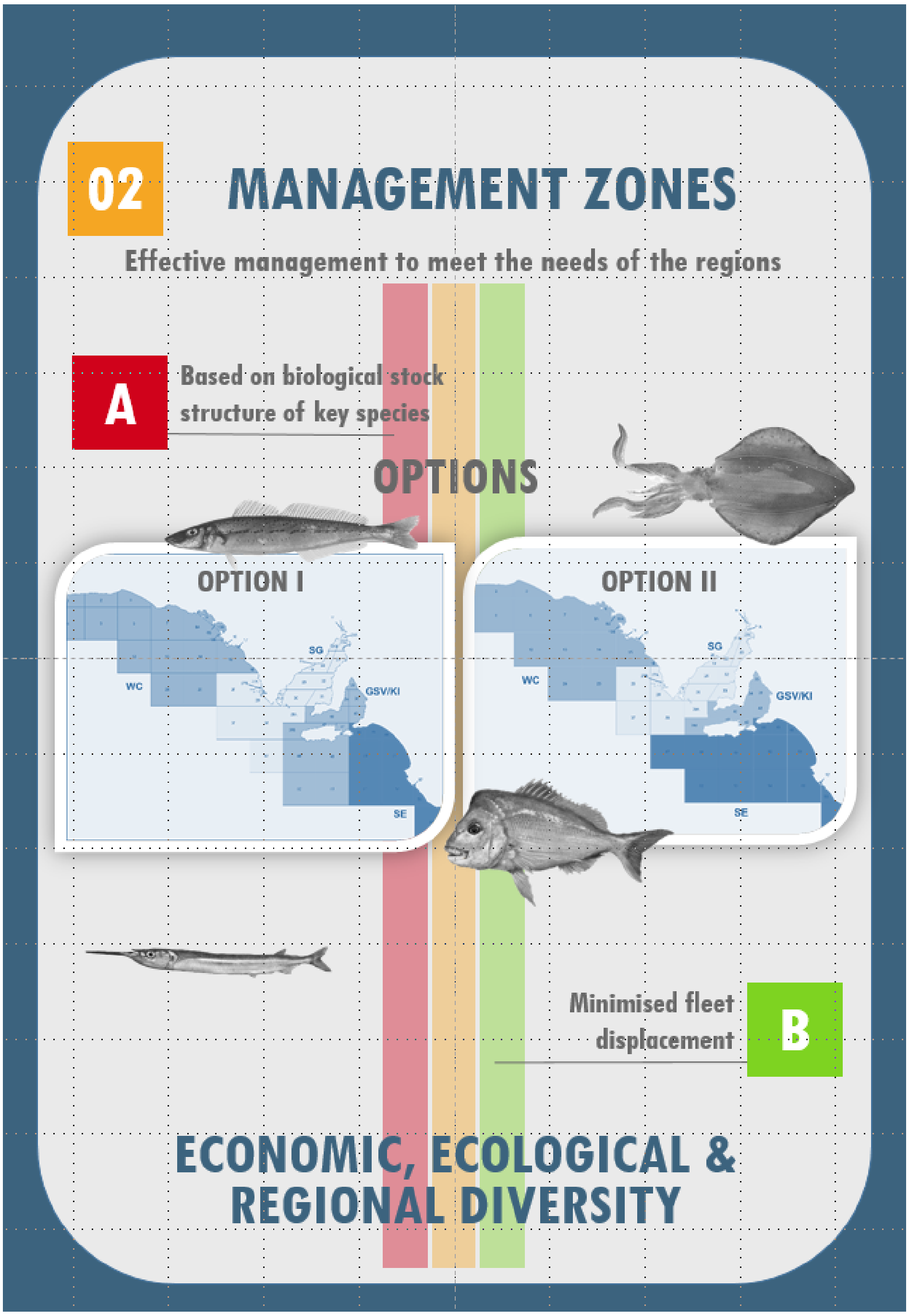
There are a number of licence holders within the fishery that are unable or unwilling to endure the reform process which is likely to extend over multiple years. Given rationalisation is a key pillar of the reform process, it would be beneficial to offer the opportunity for an early voluntary licence buy-out program.



2. MANAGEMENT ZONES

To inform the proposed zoning options, consideration was given to the **biological stock** structure, current **marine fishing area** reporting systems, delineation of current **fishing activity** by area and cost effectiveness of **management and compliance**.

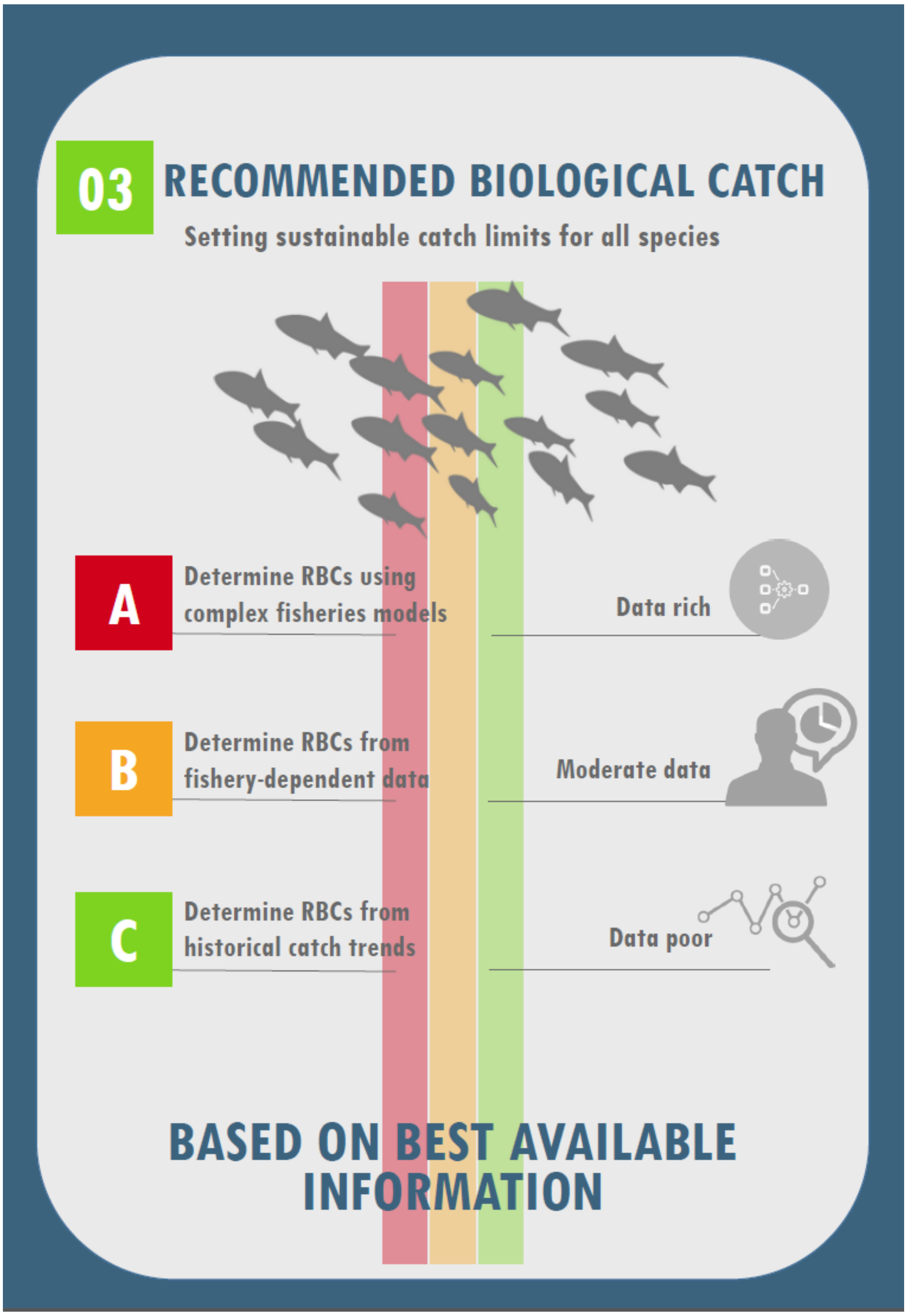
Consideration of the above resulted in two regional options. In both options the fishery was partitioned into four regions to capture the distinctive West Coast (WC), Spencer Gulf (SG), Gulf St. Vincent (GSV), and the South East (SE) stock structures and fleet dynamics. The area south of Kangaroo Island (KI) area was associated with GSV in Option I and the SE in Option II.



3. RECOMMENDED BIOLOGICAL CATCH

Given the diversity of information, the development of a Recommended Biological Catch (RBC) for each of the multiple species should adopt a step-wise approach driven by the availability of supporting information. When sophisticated fisheries models exist key parameters including biomass, recruitment, exploitation rates are derived and can be used to determine the **Maximum Sustainable Yield** (MSY) of the stock and set precautionary **Total Allowable Commercial Catches** (TACCs).

In the absence of this information there are various methods to estimate MSY on the basis of historical trends in total catch and an understanding of the species resilience.

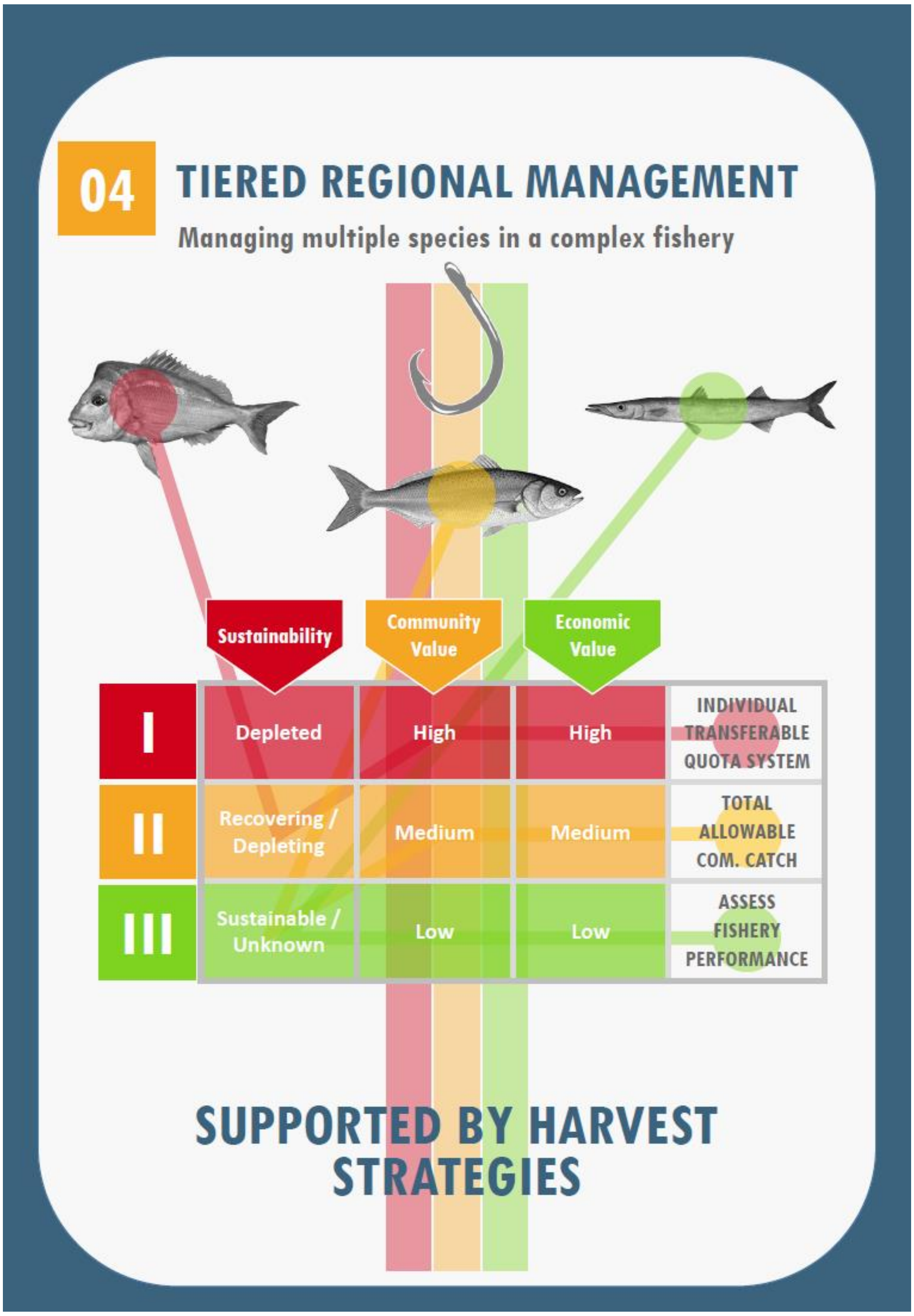


4. TIERED REGIONAL MANAGEMENT

Three principal management strategies can be implemented within the reform package with varying levels of application. Each strategy would be designed around an established TACC (Stage 3) for the stock of interest and applied using a tiered management approach, descending from:

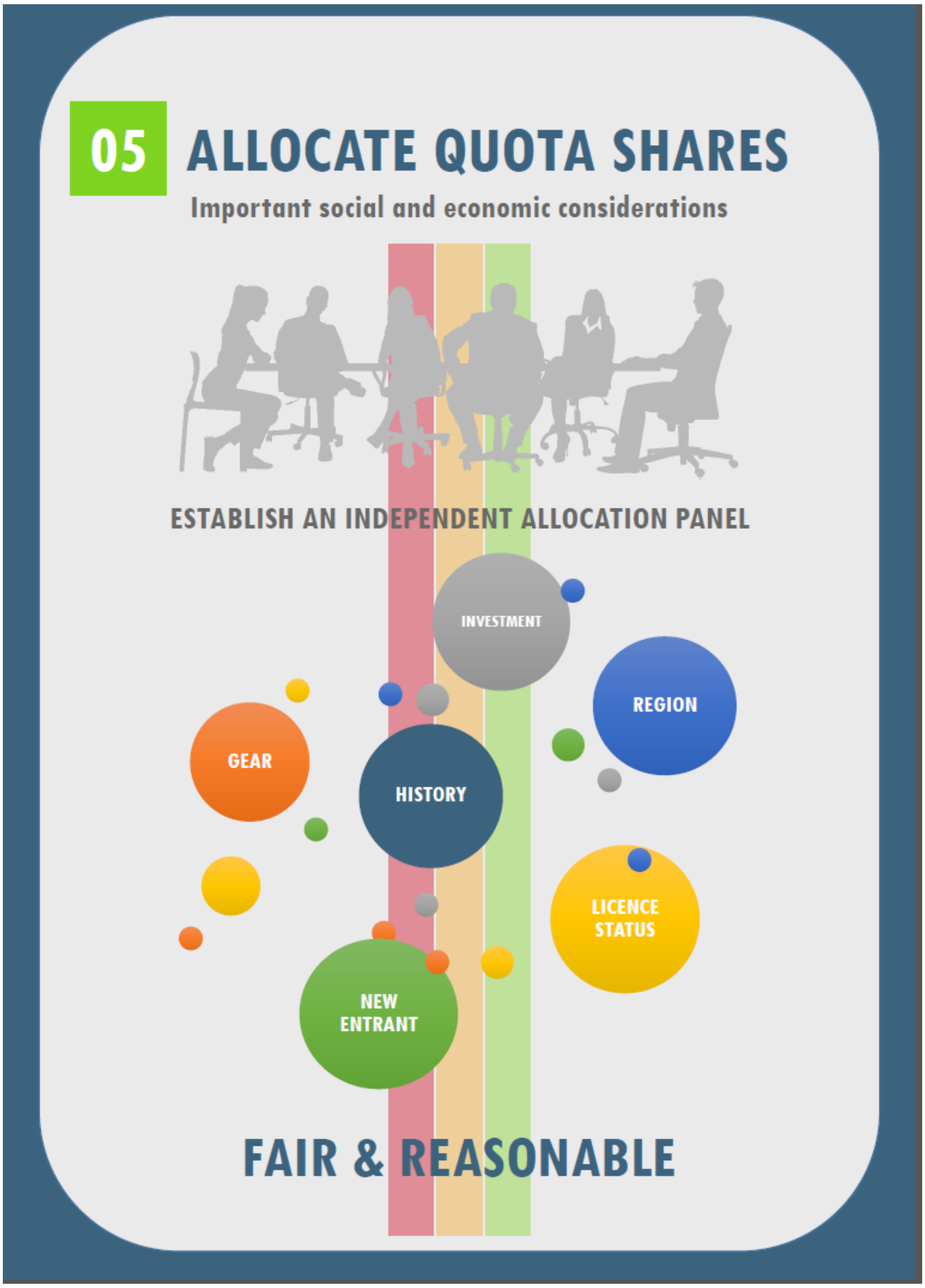
TIER I – HIGHLY REGULATED TRANSFERABLE QUOTA SYSTEM (ITQ)
TIER II – BASED ON TOTAL ALLOWABLE COMMERCIAL CATCHES
TIER III – MONITORED AGAINST PRESCRIBED PERFORMANCE INDICATORS

The decision-making framework should be flexible enough to adjust the management strategies when required. For example, a developing fishery may need to transition from a Tier III to a Tier II management strategy to minimise its sustainability risk. This approach can be applied to all MSF permitted species.



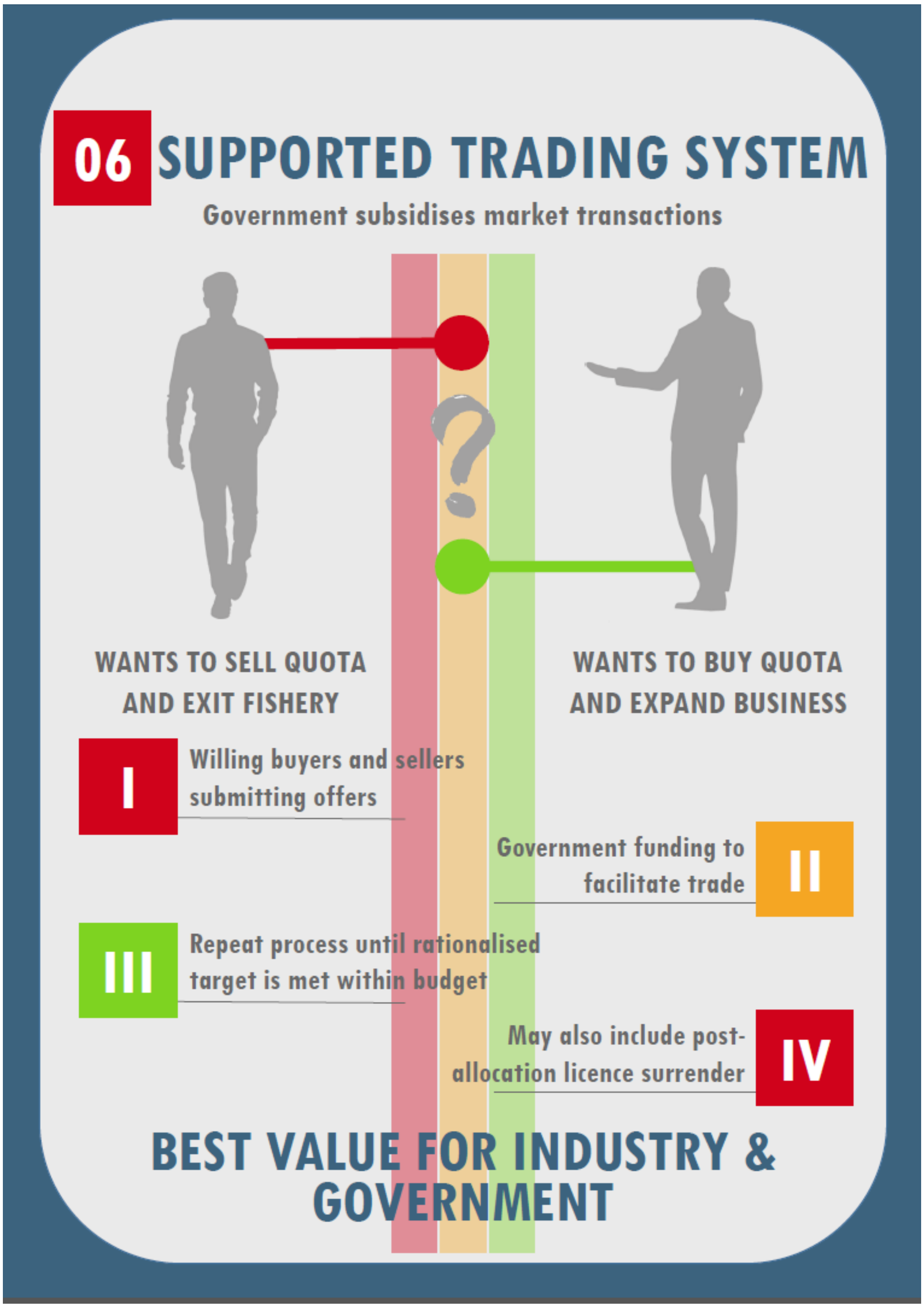
5. ALLOCATE QUOTA SHARES

The need to establish explicit and sound principles underlying any allocation method is paramount. Associated with this is the need for independence in recommending a fair and reasonable allocation formula. The establishment of an **independent allocation panel** to investigate and recommend the most appropriate allocation formula is crucial. Typically an independent allocation panel makes recommendations on eligibility, how units are allocated (i.e. catch history, licence status, gear endorsements), and consideration of exceptional circumstances (e.g. new entrants).



6. SUPPORTED TRADING SYSTEM

A supported quota trading system provides an option to further rationalise the fleet following the allocation of quota shares. It facilitates trades between willing sellers and buyers using government funding assistance. Sellers set a selling price on their quota holdings. Buyers, who are keen to develop their business, set a purchase price. Government funding facilitates (subsidises) the trading to match as many buyers and sellers as possible, and purchases licences that are offered for surrender in this process.



7. AUTONOMOUS ADJUSTMENT

A successfully reformed fishery, characterised by an economically viable fleet that sustainably harvests premium species without impacting the environment and is responsibly managed, should have the capacity to autonomously adjust. This will transition the fishery into a positive market-driven business environment that supports: profitable fish production; business specialisation and proficiency; a confident investment climate; create employment opportunities; less regulation; efficient management and administration; stewardship of shared-resources; a secure social licence to operate; and succession opportunities.

Appendix B – Complete application of the Tiered Management Framework

Table A1: The results of the Tiered Management Framework for all MSF stocks currently assessed in SARDI MSF assessments. The tiers are only assigned if average five-year annual commercial catches are greater than 5t.

Species	Zone	Stock Status	Aboriginal/ Traditional Importance *	Commercial Importance	Management Need	Level of Commercial Targeting	Recreational Importance	Total Score	Tier	Average 5-year catch (t)	Tier Assignment
Southern Garfish	GSV	3	1	3	3	3	3	16	Tier 1	72	Tier Assigned
Snapper	GSV	3	1	3	3	3	3	16	Tier 1	210	Tier Assigned
Snapper	SG	3	1	2	3	3	3	15	Tier 1	47	Tier Assigned
Southern Garfish	SG	2	1	3	3	2	3	14	Tier 1	102	Tier Assigned
Snapper	SE	1	1	3	3	3	3	14	Tier 1	20	Tier Assigned
Southern Calamari	SG	1	1	3	3	3	3	14	Tier 1	205	Tier Assigned
King George Whiting	GSV	1	1	2	3	3	3	13	Tier 1	44	Tier Assigned
King George Whiting	SG	1	1	2	3	3	3	13	Tier 1	110	Tier Assigned
Snapper	WC	3	1	1	3	3	2	13	Tier 1	17	Tier Assigned
Southern Calamari	GSV	1	1	3	2	3	3	13	Tier 1	159	Tier Assigned
King George Whiting	WC	1	1	3	1	3	3	12	Tier 1	97	Tier Assigned
Western Australian Salmon	SE	1	1	1	2	3	3	11	Tier 2	2	Negligible
Blue Crab	WC	1	1	3	1	3	2	11	Tier 2	41	Tier Assigned
Southern Calamari	WC	1	1	1	2	3	3	11	Tier 2	9	Tier Assigned
Yellowfin Whiting	SG	1	1	3	2	2	2	11	Tier 2	115	Tier Assigned
Australian Herring	GSV	1	1	1	3	1	3	10	Tier 2	27	Tier Assigned
Australian Herring	SG	1	1	1	3	1	3	10	Tier 2	60	Tier Assigned
Western Australian Salmon	GSV	1	1	1	2	3	2	10	Tier 2	77	Tier Assigned
Western Australian Salmon	SG	1	1	1	2	3	2	10	Tier 2	204	Tier Assigned
Western Australian Salmon	WC	1	1	1	2	2	3	10	Tier 2	1	Negligible
Blue Crab	SG	1	1	1	1	3	3	10	Tier 2	4	Negligible
Cuttlefish	SG	1	1	1	3	3	1	10	Tier 2	4	Negligible
Southern Garfish	SE	1	1	1	1	3	3	10	Tier 2	1	Negligible
Mulloway	SE	1	1	1	1	3	3	10	Tier 2	1	Negligible
Snook	SE	1	1	1	1	3	3	10	Tier 2	0	Negligible
Yellow-Eye Mullet	SE	1	1	1	1	3	3	10	Tier 2	0	Negligible
Black Bream	GSV	1	1	1	1	3	2	9	Tier 2	2	Negligible
Black Bream	SE	1	1	1	1	3	2	9	Tier 2	0	Negligible

Whaler Shark	GSV	1	1	1	2	3	1	9	Tier 2	18	Tier Assigned
Whaler Shark	SE	1	1	1	2	3	1	9	Tier 2	2	Negligible
Whaler Shark	SG	1	1	1	2	3	1	9	Tier 2	18	Tier Assigned
Whaler Shark	WC	1	1	1	2	3	1	9	Tier 2	16	Tier Assigned
Southern Garfish	WC	1	1	1	1	3	2	9	Tier 2	2	Negligible
King George Whiting	SE	1	1	1	1	2	3	9	Tier 2	0	Negligible
Octopus	SE	1	1	1	1	3	2	9	Tier 2	0	Negligible
Blue Throat Wrasse	WC	1	1	1	1	3	2	9	Tier 2	2	Negligible
Sand Crab	GSV	1	1	1	1	3	2	9	Tier 2	1	Negligible
Snook	WC	1	1	1	1	3	2	9	Tier 2	2	Negligible
Southern Calamari	SE	1	1	1	1	3	2	9	Tier 2	1	Negligible
Trevally	WC	1	1	1	1	3	2	9	Tier 2	2	Negligible
Yellowfin Whiting	GSV	1	1	1	2	2	2	9	Tier 2	14	Tier Assigned
Australian Herring	SE	1	1	1	1	1	3	8	Tier 3	0	Negligible
Australian Herring	WC	1	1	1	1	1	3	8	Tier 3	2	Negligible
Blue Crab	GSV	1	1	1	1	1	3	8	Tier 3	0	Negligible
Mulloway	WC	1	1	1	1	1	3	8	Tier 3	0	Negligible
Ocean Jacket	SG	1	1	1	1	3	1	8	Tier 3	199	Tier Assigned
Ocean Jacket	WC	1	1	1	1	3	1	8	Tier 3	1	Negligible
Octopus	SG	1	1	1	1	3	1	8	Tier 3	6	Tier Assigned
Octopus	WC	1	1	1	1	3	1	8	Tier 3	6	Tier Assigned
Sand Crab	SG	1	1	1	1	3	1	8	Tier 3	52	Tier Assigned
Sand Crab	WC	1	1	1	1	3	1	8	Tier 3	2	Negligible
Trevally	SE	1	1	1	1	2	2	8	Tier 3	0	Negligible
Trevally	SG	1	1	1	1	2	2	8	Tier 3	5	Negligible
Leather Jacket	GSV	1	1	1	1	1	2	7	Tier 3	10	Tier Assigned
Leather Jacket	SE	1	1	1	1	1	2	7	Tier 3	0	Negligible
Leather Jacket	SG	1	1	1	1	1	2	7	Tier 3	12	Tier Assigned
Leather Jacket	WC	1	1	1	1	1	2	7	Tier 3	1	Negligible
Mulloway	GSV	1	1	1	1	2	1	7	Tier 3	3	Negligible
Blue Throat Wrasse	SG	1	1	1	1	2	1	7	Tier 3	8	Tier Assigned
Snook	GSV	1	1	1	1	1	2	7	Tier 3	21	Tier Assigned
Snook	SG	1	1	1	1	1	2	7	Tier 3	20	Tier Assigned
Trevally	GSV	1	1	1	1	1	2	7	Tier 3	1	Negligible
Yellow-Eye Mullet	GSV	1	1	1	1	1	2	7	Tier 3	3	Negligible
Yellow-Eye Mullet	SG	1	1	1	1	1	2	7	Tier 3	13	Tier Assigned
Yellow-Eye Mullet	WC	1	1	1	1	1	2	7	Tier 3	0	Negligible
Black Bream	SG	1	1	1	1	1	1	6	Tier 3	0	Negligible

Black Bream	WC	1	1	1	1	1	1	6	Tier 3	0	Negligible
Blue Crab	SE	1	1	1	1	1	1	6	Tier 3	0	Negligible
Cuttlefish	GSV	1	1	1	1	1	1	6	Tier 3	1	Negligible
Cuttlefish	SE	1	1	1	1	1	1	6	Tier 3	0	Negligible
Cuttlefish	WC	1	1	1	1	1	1	6	Tier 3	0	Negligible
Mulloway	SG	1	1	1	1	1	1	6	Tier 3	1	Negligible
Ocean Jacket	GSV	1	1	1	1	1	1	6	Tier 3	0	Negligible
Ocean Jacket	SE	1	1	1	1	1	1	6	Tier 3	0	Negligible
Octopus	GSV	1	1	1	1	1	1	6	Tier 3	0	Negligible
Blue Throat Wrasse	GSV	1	1	1	1	1	1	6	Tier 3	1	Negligible
Blue Throat Wrasse	SE	1	1	1	1	1	1	6	Tier 3	1	Negligible
Sand Crab	SE	1	1	1	1	1	1	6	Tier 3	0	Negligible
Yellowfin Whiting	WC	1	1	1	1	1	1	6	Tier 3	0	Negligible
Yellowfin Whiting	SE	1	1	1	1	1	1	6	Tier 3	0	Negligible

Final Report Of The Independent Allocation Advisory Panel On Priority Species In The Marine Scalefish Fishery

27 OCTOBER 2020

EXECUTIVE SUMMARY

1. This summary is not to be taken as a substitute for a reading of the complete report and supporting material. It is intended to be a summary of the basis, conclusions and recommendations in this report.

2. The Independent Allocation Advisory Panel (IAAP) on priority species in the Marine Scale Fishery (MSF) was established in May 2020, with the following membership:
   - Mr Tim Mellor (Chair) - Legal Expertise
   - Ms Sevaly Sen – Economic Expertise
   - Mr Ian Cartwright – Fisheries Management Expertise

3. The IAAP is to provide recommendations to the Minister for Primary Industry & Regional Development as to the formulation of an Individual Transferable Quota (ITQ) system in relation to the following four priority species – Snapper, King George Whiting, Southern Garfish and Southern Calamari. A draft report was provided to the Minister and released to fishing licence holders 15 August 2020 for consultation. The feedback from that consultation process has been further considered by the IAAP in the preparation of this final report.

4. The MSF is regarded as a small-scale fishery which is of particular significance to coastal communities and regional areas. The priority species account for about 70% of the gross value of production of the MSF.

5. Over the last twenty years a decline in the catch of the priority species has been noted, with an associated decline in the financial viability of the fishery businesses constituting the MSF. This has led to various changes in management of the fishery and some reduction in licence numbers. In recent years, these issues have been considered by advisory bodies which have included representatives for fishing licence holders. As a result, a reform process was developed, including the following proposed features:
   - The division of the MSF into four management zones
   - The formulation of an ITQ system for allocation in respect of the priority species
   - The introduction of a voluntary licence surrender program to provide an option for licence holders in the MSF to exit the fishery prior to quota allocation.

6. This report contains eleven final recommendations including those providing recommendations as to how the ITQ allocation should be undertaken.

7. The IAAP has recommended that that on a date determined by the Minister of Primary Industries and Regional Development before 1 July 2021, all holders of an authority to take marine scalefish species for the purposes of trade or business in South Australia (excludes taking of marine scalefish species for bait) be eligible for quota allocation.

8. The IAAP identified eight criteria to be considered in the ITQ allocation process. Only two of those criteria were recommended to be included in any such allocation formula, being:
   - Licence holding (base allocation)
   - Catch history

9. The report sets out the IAAP's conclusions as to the appropriate base allocation for licence holding, the basis on which there would be an allocation for catch history, and, ultimately, the rationale for a weighting between these two criteria.

10. The base allocation for licence holding utilises an indication of market value provided reports supplied by BDO EconSearch, in relation to four different categories of licence, being the combination of either net or line licences, and amalgamated or unamalgamated licences.

11. Catch history in the MSF was considered with the following components in mind:

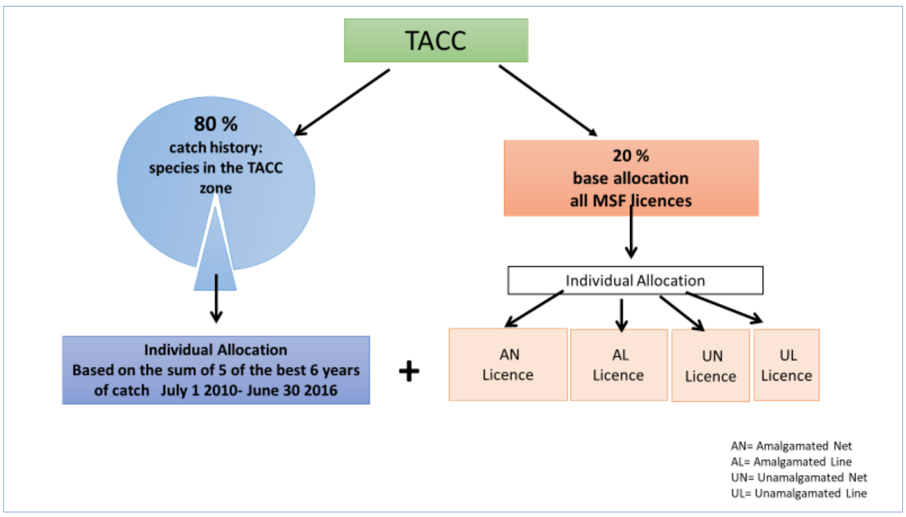
- ***Investment warning and reference period***: In December 2017 PIRSA issued a Notice to Fishers with an investment warning. This advised of the State government's decision to reform the MSF and also warned that, if any management changes required a specific allocation process, only fishing prior to June 2016 would be considered in the allocation of quota. The IAAP, on the basis of the investment warning, considered the appropriate reference period for catch history should be from 1 July 2010 – 30 June 2016, with the sum of the highest five years catch from that six year period being used to calculate catch history.
- ***Minimum catch threshold:*** The IAAP determined that setting minimum catch thresholds may lead to inequitable outcomes.
- ***Attribution of catch history:*** The IAAP concluded that in accordance with PIRSA policy, catch history remains with the licence holder.

12. The weighting between the two criteria referred to in paragraph 8 was the central and most divisive issue upon which the IAAP was asked to provide recommendations. It also generated the greatest volume and most diverse range of views in the public consultation process. Having considered all those views and factors, the final recommendation of the IAAP was a confirmation of the recommendation in the draft report – that catch history and base entitlement should be weighted 80:20 in reaching the ITQ allocation.

13. Certain other fisheries in South Australia have some access to the priority species. With one exception, it was not considered appropriate to provide an allocation to any of those fisheries. The exception was in relation to Rock Lobster Fisheries Option C licences. This form of licence entitles the holder to take the marine scale fish species for the purposes of trade or business, and involves payment of a licence fee, being portion of the usual MSF licence fees. The IAAP concluded that ITQ's for priority species should be allocated to Rock Lobster Fisheries Option C licence holders on the basis of catch history only, with a 50 kg minimum threshold for any priority species ,and by reference to the same period as is utilised in relation to MSF licences.

14. The IAPP noted that situations of exceptional circumstances may well arise in the course of the ITQ allocation process. A means to deal with such events should be established in order to ensure fairness, good management and consistency.

15. The figure below summarises the recommended allocation formula for MSF licence holders.



SUMMARY OF FINAL RECOMMENDATIONS

Recommendation 1	Two criteria should be included in an MSF ITQ allocation formula: a. Licence holding (base allocation), and b. Catch history
Recommendation 2	Relative market values of licences based on the estimates provided by licence holders from in the BDO EconSearch Valuations Report (BDO,2019)should be used to determine the base allocation for licence types (amalgamated net, amalgamated line, unamalgamated net and unamalgamated line).
Recommendation 3	A proportion of the Total Allowable Commercial Catch (TACC) should be allocated to all eligible MSF licences state-wide as a base allocation based on the relative values of four categories of licences: amalgamated net, amalgamated line, unamalgamated net and unamalgamated line.
Recommendation 4	Each eligible licence holder should receive a proportion of this allocation based on their relative value of their licence, where: (i) Amalgamated Line = is 78% the value of an amalgamated net licence (ii) Unamalgamated Net =is half the value of an amalgamated net licence (iii) Unamalgamated Line = is half the value of an amalgamated line licence
Recommendation 5	The period of six years (1 July 2010 - 30 June 2016) is an appropriate catch history reference period.
Recommendation 6	The total of the highest 5 years' catch from 6 years should be used to calculate licence holders' proportions of catch history.
Recommendation 7	No minimum catch history threshold should apply for MSF licences.
Recommendation 8	Catch history and base entitlement should be weighted 80:20.
Recommendation 9	ITQs for priority species should be allocated to Option C endorsed licence holders in the rock lobster fisheries on catch history only, with a minimum threshold catch of 50 kg for any priority species, and using the same reference period as MSF licences.
Recommendation 10	No ITQs for priority species should be allocated to the Spencer Gulf, Gulf St Vincent and West Coast Prawn Fisheries
Recommendation 11	No ITQs for MSF priority species should be allocated to MSF endorsed licence holders in the Lakes and Coorong Fishery.

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1 Introduction

The Independent Allocation Advisory Panel (IAAP) on quota species in the Marine Scalefish Fishery (MSF) was established on the 14 May 2020 by the former Minister for Primary Industries and Regional Development (PIRD), the Hon. Tim Whetstone, MP., with the following membership:

- Mr. Tim Mellor (Chair) Legal expertise
- Ms. Sevaly Sen - Economic expertise
- Mr. Ian Cartwright – Fisheries management expertise

The IAAP Terms of Reference (TORs) are annexed.

The IAAP was tasked to investigate and provide advice on an appropriate basis for the allocation of catch quota to individual licence holders[1] in South Australia's commercial MSF and licence holders who have access to marine scalefish species in other South Australian commercial fisheries, through an Individual Transferable Quota-based system (ITQs). The allocation is for the following priority species: Snapper, King George Whiting (KGW), Southern Garfish and Southern Calamari. The IAAP submitted its initial advice in the form of a draft report to the Minister on the 10 July 2020.

The draft IAAP report, including the allocation formula was included in the MSF Reform: Stage 2 Information package released for consultation on 15 August until 18 September 2020. The consultation process comprised an online survey (177 responses), written submissions via post and email (69). This material received is referred to in this report as “the submissions.” The submissions were provided to the IAAP by The Department of Primary Industries and Regions, South Australia (PIRSA). Some licence holders made multiple submissions, taking the opportunity to participate in the survey as well as make at least one written submission. PIRSA also made available to the IAAP their notes from a series of port meetings (17 meetings with 210 attendees in total). In finalising our report to the Minister for Primary Industries and Regional Development, the IAAP gave careful consideration to and where appropriate, addressed issues raised in both the submissions and port meetings.

As outlined in the Minister’s letter to licence holders on 20 October 2020, after the Minister has considered the IAAP final report, a final decision in relation to the allocation formula will be announced.

2 The MSF

The MSF is a small-scale fishery of significance to coastal communities, particularly in regional areas. Many fishers are closely connected to both the industry and the communities in which they live. The MSF was initiated as one of the few owner-operator fisheries in Australia, in which the licence holder and the fisher were one and the same. Following the implementation of the National Competition Policy in 1995, the owner operator policy was relaxed following the removal of the one person-one licence restriction. Despite being described as an owner operator fishery in the current management plan (P103), an individual or entity can own two or more MSF licences and, while operating one, may place a registered master on other vessel(s) under the additional licence(s).

Current arrangements for access to the aquatic resources prescribed within the MSF are very complex. Nine separate commercial fisheries, using 26 different gear types, have some level of access to priority marine scalefish species (KGW, Snapper, Southern Garfish and Southern Calamari), within the four proposed zones of the fishery. In addition to MSF licence holders, licence holders

[1] Licence holder=licence owner

from South Australian prawn fisheries, rock lobster fisheries, the Lakes and Coorong fishery, the Blue Crab fishery and the Miscellaneous fishery all have some level of access to MSF species.

Total catch in the MSF followed a declining trend between 1999/00 and 2018/19. The fall, from 4,869 tonnes to 2,099 tonnes, is due to a decrease in catch of a number of key species including Australian Salmon, Shark, King George Whiting, Snapper and Garfish. This decline in catch was somewhat offset by a 140 per cent increase in nominal average price of Marine Scalefish species between 1999/00 and 2018/19, equivalent to a 47 per cent rise in real price (BDO EconSearch, 2020).

There have been numerous changes to the management of the MSF, which were principally aimed to reduce latent effort and address increasing fishing efficiency within the diverse fishing fleet. These have included the development of separately managed fisheries, licence buy-backs and the current licence amalgamation scheme introduced in the early 1990's. Despite these initiatives reducing the number of licences to less than half of those in 1978, it has been recognised that a further reduction of effort remains the most significant challenge of the MSF.

Access to priority species varies, from the ability to retain some species taken as bycatch (prawn fisheries), to bait only (blue crab fishery), to relatively open access to all marine scalefish species for holders of an MSF licence and rock lobster licence holders with an Option C endorsement. Species taken in the MSF also support a significant amount of recreational fishing activity both in terms of participation and catch.

A resource sharing arrangement applies whereby proportions of the total catch of the four priority species have been allocated between the recreational, commercial and Aboriginal traditional sectors based on state-wide estimates of total catch. Within the commercial fishing sector, shares of these species have been allocated between various commercial fisheries within South Australia.

According to surveys of licence holders reported in the 2018/19 BDO EconSearch Economic and Social Indicators report (p.26, BD0 2020), licence holders vary considerably in their operations, from those who fish infrequently (less than 50 days) and may be considered 'lifestyle fishers' who may not rely on fishing activities as their main source of income, to those who fish more than 150 days. 'Lifestyle' fishers tend to have a lower value of boat capital and in 2018/19 had an average rate of return to total capital of -2.5%, while fishers who fished more than 150 days had a positive return of 5.3%. Not covered in these surveys are licence holders with no catch in recent years.

The 2016 Report of the MSF Strategic Review Working Group found that the MSF faced a number of challenges, including poor profitability, a cumbersome, constantly adjusting and complex regulatory system, an excess of licences with varying levels of activity, and management restrictions that have reduced efficiency. The report, circulated to all licence holders, concluded that the fishery needed to be restructured to ensure its long-term sustainability and economic viability.

On 28 December 2017, PIRSA issued an investment warning in the form of a Notice to Fishers. The notice outlined a package of measures to support restructuring the fishery, two of which were of particular significance to the allocation process; the targeted removal of licences through a voluntary licence surrender, and a statement on catch history warning that:-

> "*if any management changes require a specific allocation process to be followed, only fishing prior to 30 June 2016 will be considered, which aligns with the date of the discussion paper entitled SA Marine Scalefish Fishery Strategic Review Proposals, circulated to all licence holders in June 2016. This is also consistent with the letter and information contained on page 10 of*

> *the Report of the SA Marine Scalefish Fishery Strategic Review provided to licence holders in July 2017."*

On the 8th May 2020, following the final report of the Commercial Marine Scalefish Fishery Reform Advisory Committee[2], the Minister for Primary Industries and Regional Development announced a $24.5 million reform of the MSF, to be implemented by 1 July 2021. Included in the reform package were details of the voluntary surrender of up to 150 licences, the introduction of Total Allowable Commercial Catches (TACCs) for priority species (which accounted for 68% if the Gross Value of Production in 2018/19[3]) and the allocation of Individual Transferable Quotas (ITQs) for these species.

The voluntary licence surrender program, which commenced in May 2020 and closes on 13 November 2020, offers $140,000 and $180,000 for the surrender of line and net licences respectively. The program provides an opportunity for licence holders in the MSF to exit the fishery prior to the issuance of ITQs and implementation of other proposed reforms.

3 Information Considered

PIRSA, including the South Australian Research and Development Institute (SARDI) provided a wide range of information relevant to the task of the IAAP. A list of the documents considered by the IAAP is provided as an Appendix. The IAAP also took account of existing South Australian government policies relating to the allocation of marine resource, key changes in management arrangements, including relevant Notices to Fishers as well as allocation approaches used in other fisheries. Information on the species which were to be allocated ITQs, clarification of proposed management arrangements (boundaries of proposed management zones, indicative TACCs for priority fish stocks (excluding Snapper) and indicative priority species to be managed under ITQs (Table 1) were provided to the IAAP on 24 June 2020. (MSF Reform – Stage 1 information). These indicative TACCs were used in the analysis of allocation scenarios discussed in our draft report. In October 2020, the IAAP were provided with revised TACCs for 1 July 2021 to 30 June 2022 ("final TACCs") and revisited the impacts of these on our final recommendations.

Table 1 Species for ITQ Allocation in the MSF

	KGW	Snapper	Southern Garfish	Southern Calamari
West Coast	ITQ	ITQ		
Spencer Gulf	ITQ	ITQ	ITQ	ITQ
Gulf St Vincent/ Kangaroo Island	ITQ	ITQ	ITQ	ITQ
South East		ITQ		

[2] In 2018, a Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) was established, to develop - in consultation with licence holders and key stakeholders - recommendations on a reform package for the South Australian commercial Marine Scalefish Fishery (MSF). CMSFRAC included: six members from the commercial MSF, one Rock Lobster Fishery member in recognition of its formal access to marine scalefish species, one recreational fisher in acknowledgement of the recreational sector's interest in this shared access fishery, an independent chair, and one independent economist.

[3] BDO, 2020

To support the deliberations of the IAAP, SARDI, which is the research division of PIRSA, provided data analysis using anonymized catch history data. This analysis included the number of licence holdings, gear endorsements and fishing activity, including catch history by management zone. SARDI, in response to requests by the IAAP, ran allocation scenarios to determine the impact on individual licence holders and the MSF as a whole.

The IAAP used the number of licences on record as of 30 June 2020 for analysis in the IAAP draft report and licence holdings as of September 2020 for the IAAP final report. When allocation occurs, licence numbers used will depend on the final outcome of the voluntary surrender scheme.

The IAAP was advised that PIRSA's present policy is that all MSF licence holders remaining in the fishery after the reform will have access to all marine scalefish species across the area of the fishery, including priority species (subject to holding quota). The IAAP understands that there is no intention to move to zonal MSF licences.

4 Application of IAAP Guiding Principles

Throughout our deliberations, the guiding principles (as specified in the TOR - Appendix 1) were considered and applied, namely:

- **Fairness and Equity** – the IAAP explored allocation criteria and options that would distribute the benefits of use fairly amongst participants. Using data analysis based on (anonymous) licence holdings, the IAAP considered the differential economic impacts of various options on current licence holders, seeking to minimise impacts to the extent possible.

- **Consistency and transparency** – Consideration of options was based on understanding the operating context of the fisheries with access to marine scalefish species after consideration of a range of possible allocation criteria. An explanation as to how recommendations were arrived at is provided. This should facilitate the development and implementation of future species allocations in a consistent and transparent manner.

- **Certainty for licence holders**– Giving due consideration to those who rely on marine scalefish priority species for their livelihood and recognising the importance of the MSF to users of these resources, was central to IAAP considerations. The IAAP has sought to recommend an allocation method that recognises these needs, and provides the certainty required to those who want to stay in the fishery. The IAAP notes that the voluntary licence surrender program also provides certainty for those fishers who choose to exit the fishery.

- **Opportunities to be heard** – Participants in the MSF have had the opportunity to comment on the IAAP draft report and recommendations through a transparent process run by PIRSA over the period July-September 2020. The submissions and issues raised at port meetings have been thoroughly reviewed by the IAAP in finalising this report. Due to COVID-19 restrictions, the IAAP was unable to hold face- to face consultations with licence holders.

- **Rights of existing licence holders and level of activity to be recognised** – The allocation process and formulae recommended by the IAAP recognises the historical rights and activity of participants in a fishery particularly, through the use and weighting of appropriate allocation criteria.

- **Best available information** – PIRSA and SARDI were most cooperative in providing the best available administrative, catch and effort and other relevant information to the IAAP.

- **Integrity of fisheries management arrangements** – Allocation recommendations were developed to be consistent with legislative requirements, the 2013 MSF Fisheries Management Plan and any other relevant fisheries management objectives. The IAAP did note the disparity between the original owner-operator nature of the MSF and the ability of fishers to hold and benefit from multiple licences.

The IAAP has made every effort to abide by the principles outlined above in making our allocation recommendations for the benefit of the entire fishery, taking account of economic and sustainability considerations. While the impacts of prospective allocation formulae on individual licence holders has been attempted, the IAAP notes that as in any allocation process, there will be differing outcomes, particularly in the short term. The IAAP understands that the Minister has established a process to take into account exceptional circumstances raised by individual licence holders in allocating ITQs.

5 Eligibility Criteria

To be eligible for quota allocation, the IAAP concludes that the following should apply:

- Holding of an authority to take marine scalefish species for the purposes of trade or business in South Australia (excludes taking of marine scalefish species for bait), and.

- Holding of such an authority on a date to be determined by the Minister of Primary Industries and Regional Development, which the IAAP is advised will be before 1 July 2021.

6 ITQ Allocation Criteria Considered by the IAAP

Experience from other allocations has shown that there is no one method to recognise relative economic position, existing rights to fish, and asset values. This is because any selected method is dependent on the circumstances of the individual fishery, including: the legislative framework, the management context of the fishery, fishing patterns, and the quantity and quality of data available.

The IAAP gave consideration to the following criteria for inclusion in an allocation formula(e) prior to making our final recommendations:

- Catch history
- Licence holding
- Gear endorsements
- Licence points
- Fishing effort (days)
- Years active in the fishery
- Management fees
- Investment in the fishery

6.1 Catch History

There is a widespread global acceptance that catch is a reasonable proxy for income. Catch history, as recorded in logbooks, has been used in other quota allocations both in Australia and worldwide to recognise the needs of users who rely on the species for their livelihood.

In the submissions, over half of survey respondents who answered the question on catch history expressed support for a catch history component; many written submissions were also supportive.

Conclusion: to recognise the level of fishing activity of a licence holder and to minimise the change in their relative economic position, catch history of the licence holder should be a criterion for the allocation of ITQs for priority species.

6.2 Licence holding

Fair market value of a licence may be defined as the price that would be negotiated in an open and unrestricted market between a knowledgeable, willing, but not anxious buyer and a knowledgeable, willing, but not anxious seller, acting at arm's length. In the case of fully transferable licences, a licence has value as a tradable asset. Transferable licences that have similar characteristics should have similar asset values. For a non-transferable licence, all value is captured in its ability to earn an income for the licence holder. Consequently, it has no tradeable asset value.

In the case of the MSF licences, the IAAP relied on the BDO EconSearch Valuation report of 12 September 2019 (BDO,2019) for information as to market values for MSF licences. The report was commissioned by the then Executive Director Fisheries and Aquaculture and was prepared by BDO EconSearch Advisory (SA) Pty Ltd. The purpose of the report was to provide estimates of current values MSF licences.

The IAAP also took into consideration the following MSF licence attributes:

- Amalgamated licences are fully transferable.
- Amalgamated line and net licences have different market values (BDO EconSearch,2019).
- Two unamalgamated licences are required to achieve one transferable amalgamated licence and they "*should be valued at half the value of an amalgamated licence*" (BDO EconSearch,2019).
- Unamalgamated licences can be transferred to another family member.

Additionally, within the broad net licence categories there are endorsements for specific gears, some of which are designed and used specifically to target quota species e.g. crab pots and longlines. Some fishers could argue that market value of an unamalgamated net licence with an endorsement for crab pots or longlines would be worth more than an unamalgamated net licence with no such additional endorsements. However, the IAAP was provided with no information on which to differentiate the values of licences with different gear endorsements, beyond the line and net categories mentioned above.

The IAAP considered the impact of ITQs on MSF licence asset value, as we understand that ITQs will only be able to be held by MSF licence holders. This differs from many other fisheries, where ITQs can be held separately from the licence, leading to some transfer of asset value from the licence (access right) to the ITQ.

The IAAP also considered the likely impacts of this requirement on licence value, especially given the high contribution of the four priority species to the overall Gross Value of Production (GVP) in the MSF. A licence prior to ITQ implementation allowed a licence holder to fish for priority species; after ITQ implementation, unless quota is held, this licence can no longer be used as a right to fish commercially for these species. The IAAP acknowledges that the impact of introducing ITQs may cause some loss of licence value pre and post ITQ implementation. The IAAP also notes that any loss may be offset to some extent by i) the effects of reduced numbers of active licences due to the voluntary licence surrender program and ii) continued access to non-quota species.[4]

The IAAP also considered impacts on licence value in the context of other commercial fisheries endorsed to take priority species – noting that these endorsements could not be separated from the licence to which they were attached.

In the submissions, over half of survey participants who answered the question expressed support for a licence holding component. All written submissions were supportive of inclusion of this criteria in the allocation formula, although there were differing views as to the weight should be given licence holding relative to catch history.

Conclusion: Licences in the MSF have a value that should be recognised in the form of a base allocation of ITQs. The IAAP notes that all licence holders choosing to remain in the MSF retain the ability to access priority species provided quota is owned, leased or purchased and will continue to have access to all other marine scalefish species.

6.3 Gear Endorsements

Each MSF licence has endorsements for different gear types. Some gears are non-selective and can take a range of species, including priority species. Others are species-specific, including those for several species that are already under quota management (Vongole, Pipis, Blue Crab, Sardine). With the exception of this specialised gear, the main categories of gear used in the MSF are nets and lines.

The IAAP is of the view that gear endorsements should not be included as an allocation criteria because priority species can be caught by a range of gear endorsed on licences and because the relative value of the main gears used and some specialised gears (e.g. longlines for snapper) are reflected in the licence market values and catch history. Furthermore, as stated above, the IAAP was not provided with any information on which to differentiate licence values based on gear endorsements.

Gear endorsements as a criterion for quota allocation was not raised in any of the submissions.

Conclusion: gear endorsements, other than the net/line categories, should not be included as an allocation criterion for ITQs.

6.4 Licence Points

In 1994, as a key part of the new Licence Amalgamation Scheme, licence points were allocated based on the relative GVP of each licence. Licences ranged in point value from 11 to 18 points.[5] In the early days of the Amalgamation Scheme, a buyer had to amalgamate two (or more) licences to a total value of 29 points. This was subsequently lowered to 24 points.

[4] PIRSA advised the IAAP that there is a significant amount of work being undertaken by PIRSA and the industry to promote and develop ‘lesser known species’, in order to reduce pressure on the four priority species and diversify the economic opportunities in the fishery. The strategy aims to encourage a behaviour change for recreational fishers and seafood consumers by providing educational information about seasonality, fishing and cooking tips (including catch quality, gear, location, tides and recipe ideas). The strategy also aims to educate audiences on the benefits of choosing lesser known species, and the substitutes available.

[5] The exception was Restricted Licences which were accorded 7 points – PIRSA has advised that no restricted licences remain in the MSF.

Other than a comment on licence points in the BDO EconSearch Economic and Social Indicators Report (BDO EconSearch, 2020), the IAAP has been provided with no evidence to suggest licences with points over the amalgamated threshold of 24 points have differential market values. The IAAP concludes that the value of licence points is likely to be encapsulated in the market value of unamalgamated and amalgamated licences.

Licence points as a criterion for quota allocation was not raised in any of the submissions.

Conclusion: licence points should not be used as an allocation criterion.

6.5 Fishing Days (Effort History)

In other allocations, fishing days have been used as an alternative proxy for income earned in the fishery. However, based on the data made available to the IAAP, fishing days are not closely correlated with catch. Furthermore, fishing days do not necessarily reflect the efficiency of various licence holders, potentially leading to inequitable outcomes, as a fisher with a lower relative catch per day may receive the same quota as a fisher with a higher catch per day.

Fishing days as a criterion for quota allocation was not raised in any of the submissions.

Conclusion: fishing days should not be used as an allocation criterion.

6.6 Years Active in the Fishery

Years active in the fishery has been used, albeit rarely, in allocation formulae – most notably in the 2008 allocation of Vongole quota in the MSF. In this allocation, a base unit was allocated to licence holders for each year they were active (catch of Vongole only) over the catch history period. The Vongole Independent Allocation Advisory Panel (the Vongole Panel) concluded that this was an appropriate alternative to an allocation based on the right to fish, as it would leave the industry in relatively few hands, making it easier to manage and assist the orderly development of markets, and allow beneficiaries to have access to amounts sufficient to make a living. The Vongole Panel concluded that those that did not have any activity would not receive quota, which diminished their access right. In acknowledging this outcome, the Vongole Panel recommended that consideration be given to compensating those who lost 'a right of significant value.' While the IAAP reached a similar view on the loss of value of MSF licences with little or no catch history post allocation, the IAAP considered the use of years active in the fishery as an allocation criterion and noted the following difficulties in applying this criterion:

- defining thresholds for activity in the MSF in which some species can either be targeted or taken as a byproduct will be very difficult; and
- the rights of licence holders who had decided not to exercise their rights to fish would be excluded.

Fishing days as a criterion for quota allocation was not raised in any of the submissions.

Conclusion: years active in the fishery should not be used as an allocation criterion.

6.7 Management Fees

The South Australian Government has a policy of full cost recovery for the management of commercial fisheries. Licence fees from MSF licence holders are collected in accordance with the PIRSA Cost Recovery Policy and the Australian Government's Cost Recovery Guidelines (July 2014). Licence fees for the commercial MSF cover costs which include biological and economic research, compliance, policy and management, licensing, legislation and co-management consultative services. The costs for these services are shared among licence holders, with proportions attributed to all MSF licence holders (base fee), MSF licence holders with a net endorsement (net fee) and rock lobster licence holders with MSF access. Lakes and Coorong fishers with coastal nets pay their own base fee. Other than these, no other commercial fisheries with access to marine scalefish species contribute directly to the management of the fishery.

It was argued in some industry association feedback to the Industry Consultation Paper on Options for the Reform of South Australia's Commercial Marine Scalefish Fishery (and provided to the IAAP) that those licence holders who contribute more than others should receive a higher allocation. The IAAP disagreed in our draft report on the basis that licence fees cover regulatory costs and are not correlated with wealth distribution nor economic activity.

The issue was raised again in the submissions by many respondents, frequently as support for an equal allocation to all licence holders on the basis that licence holders with the same endorsements all pay the same fees. The IAAP reinforces its view that the payment of licence fees represents a contribution to regulatory costs and, as they are not representative of economic position, they should not be used as an allocation criterion.

Conclusion: management fees should not be used as an allocation criterion as they are not a measure of relative economic position.

6.8 Investment in the Fishery

Investment in the fishery has been used, albeit rarely as an allocation criterion. Such investment could be linked to investment in vessel capacity and fishing gear, or the investment to amalgamate licence. The IAAP noted the challenges in identifying relevant investment criteria in a diverse multi-species multi-method fishery such as the MSF.

Conclusion: past investment in the fishery is not a practical criterion for inclusion in any allocation formula.

FINAL RECOMMENDATION 1
Two criteria should be included in any MSF ITQ allocation formula: **i. Licence holding (base allocation), and** **ii. Catch history**

7 Allocation to MSF Licences

This section describes the IAAPs consideration and approach to allocation of ITQs for priority species using the two recommended criteria: licence holding and catch history. The final section discusses the rationale for a weighting between these two recommended criteria.

7.1 Base Allocation for Licence Holding

Given the current number of eligible MSF licence holders, the IAAP was conscious that applying an allocation formula based on licence holding to all licence holders will result in quota fragmentation and small quota packages, particularly where TACCs are low. Currently, eleven different species/zone ITQ allocations spread across up to 250 licences are considered in the reform package. This may lead to high transaction costs for some buyers and sellers of quota as well as contribute to financial stress for some high catch fishers who will need to source additional quota to maintain their livelihoods and economic viability. However, the IAAP understands that PIRSA intends to implement an online quota trading platform as part of the reform and believes that this should overcome many of these concerns. Our recommendations are therefore based on this assumption.

The submissions which mentioned this issue were supportive of an online trading system to assist quota trades across the State as licence holders buy and sell quota to match individual fishing opportunities.

Conclusion: An efficient, online, quota trading system is an essential component of the reform process to facilitate ITQ trades.

Relative value of licences

The IAAP first considered whether a base allocation should be weighted to reflect the relative values of different licences based on their transferability and endorsements (see Section 6.2).Amalgamated licences are fully transferable although transfer values differ according to the net and line endorsements held. The only way to enter the fishery is through the purchase of an amalgamated licence, the purchase of two unamalgamated licences (to form one amalgamated licence) or a family transfer.

From an equity perspective, of relevance to the IAAP, is the relative (not actual) value of licences i) between net/line and line, and ii) between amalgamated and unamalgamated licences. We examined the various methods used to value licences in the BDO EconSearch Valuations Report (BD),2019), noting that there is very limited publicly available transfer price data. We concluded that in the absence of comprehensive and reliable data, licence values should be based on licence holders' estimates found in the BDO EconSearch Valuations Report (BDO EconSearch,2019) where the relative value of a line licence is at 78% of a net licence (2016-2018).

With regard to the relative value of amalgamated compared to unamalgamated licences, we concluded that transferability is an important attribute of relative value and thus should be reflected in any base allocation for licence type. Given two non-transferable unamalgamated licences are required to achieve one transferable amalgamated licence and the possibility of family transfers of unamalgamated licences, we concluded that the relative value of an unamalgamated licence should be half that of an amalgamated licence.

A small number of submissions suggested licence values used in our draft report and the BDO EconSearch Valuations Report (BDO EconSearch,2019) are inaccurate and, in particular, undervalued. The IAAP concluded that licence transfer values may go up and down, as with any other asset. Since our draft report was written, the IAAP was provided with the most recent BDO EconSearch Economic and Social Indicators report for 2018/19(BDO EconSearch,2020). Whilst economic rent in the fishery remains negative, licence holders reported an increase in their self-valuation of their net licence. BDO EconSearch observed that this may be attributed to the ongoing reform program raising expectations around a licence surrender scheme.

After careful consideration, the IAAP reaffirmed its view that the FYE 2018 licence valuations provided by survey respondents found in the BDO EconSearch Valuations report (BDO EconSearch, 2019) should form the basis of estimates of relative value given there was insufficient reliable and independent evidence to justify a change in assumed values.

FINAL RECOMMENDATION 2
Relative market values of licences based on the estimates provided by licence holders from in the BDO EconSearch Valuations Report (BDO EconSearch,2019) should be used to determine the base allocation for licence types (amalgamated net, amalgamated line, unamalgamated net and unamalgamated line).

Application of Base Allocation

The IAAP then considered three options for application of this base allocation by licence type:

1. **State-wide Allocation**: All licence holders receive a base entitlement. For the current allocation of the four priority species (KGW, Southern Garfish, Snapper and Southern Calamari), each licence holder would receive eleven separate allocations reflecting the zones and species in Table 1. The IAAP considers this option as the most equitable, as all licences (within each licence group) and in all zones of the fishery will receive the same base allocation and are therefore treated equally. One of the disadvantages of this option is that small quota packages will be distributed across the State leading to a very fragmented quota market. In the IAAP's view, this is not likely to represent a significant problem provided PIRSA develops and introduces the online quota trading system discussed above. However, if PIRSA does not implement such a system in time or licence holders refrain from using it, there is a risk that those who need the quota will not be able to access it and those that wish to sell or lease out their quota, are unable to find willing buyers. There is also a risk that holders of some small quota packages may decide to "sit on" their allocation, preventing the optimum utilisation of the resource. Notwithstanding these issues, the IAAP considered that a state-wide allocation to all licence holders of a base entitlement was the best option for equitably dealing with a base allocation.

2. **Principal Zone Allocation:** Under this option, licence holders are designated a "principal zone" by PIRSA, based on past fishing activity over recent years and receive a base allocation for that zone only. Whilst not current PIRSA policy, the IAAP considered this option for completeness. For the purposes of analysing the outcome of this allocation option, zone assignment was determined according to where each fisher caught most of their catch over the reference period. If a licence holder did not have any catch history (i.e. recently purchased a licence or has remained inactive over the time period) then a principal zone was assigned based on their postcode.

   Licence holders would receive species allocations only for their principal zone. The advantage of this method would be fewer licence holders in each zone eligible for quota. The disadvantage of this option is that holders of the **same licence type** in each principal zone will receive a **different base allocation**. Applying FY 18 relative values of licences based on the BDO EconSearch Valuations report (BDO EconSearch,2019) and the number of licences as at 30 September 2020, a hypothetical example of base allocation for priority species by licence type by principal zone is shown in Table 2. This example shows a quota package for a licence with no catch history assuming a 20% base allocation. Base allocations in kgs has been converted to dollars (using a quota price of $30/kg).

   The IAAP rejected this option on grounds of equity.

Table 2 Hypothetical Example of Principal Zone (PZ) valuation of ITQs - 20% Base Allocation only for priority Species

Licence Group	Spencer Gulf PZ	GSV PZ	West Coast PZ	South East PZ
Amalgamated Net	$ 44,827	$47,656	$22,446	-
Amalgamated Line	$ 34,810	$37,007	$17,430	$54,000
Unamalgamated Net	$ 22,414	$23,828	$11,223	-
Unamalgamated Line	$ 17,405	$18,503	$ 8,715	$27,000

3. **Nominated Zone Allocation:** Under this option considered by the IAAP, licence holders nominate one zone for their base allocation. Depending on the zone nominated, they would receive between 1-4 species ITQ allocations (like Option 2). The amount of quota received would be unknown until after the allocation process as it would depend upon the numbers of licence holders nominating for that zone.

   The advantage of this option is that, like Option 2, it would lead to less quota fragmentation. It also allows a free choice for licence holders. To some extent this option may address the differential value problem described in Option 2. This is because it could be anticipated that some/many licence holders would nominate for the zones with more quota (SG and GSV), resulting in a lower allocation of ITQs/licence holder. The disadvantages of this option are complexity, the likelihood that differential values will not be resolved entirely, and the reasonable expectation that SG and GSV would be highly subscribed – potentially leading to further fragmentation. This option may have caused conflict, particularly if licence holders nominate for quota outside their principal zone where most of their historical catch was taken. For all these reasons, the IAAP rejected this option.

In the submissions, a small number suggested that the base allocation be equal across all licences as all licences are "equal.". Some submissions and the majority present at most regional meetings (as per PIRSA advice) also suggested that the base (licence) allocation should not differentiate between amalgamated and unamalgamated because:

- The licence surrender process payment did not discriminate between amalgamated and unamalgamated and so the IAAP is being inconsistent, and
- Many fishers holding unamalgamated licences are long term fishers and therefore should not receive a lesser allocation.

The IAAP carefully considered these views in particular, the perceived contradiction of licence value treatment in the voluntary licence surrender program compared to the approach recommended by the IAAP. The IAAP noted that it is important to discriminate between the objectives of the two processes:

- The objective of the voluntary licence surrender program is to make licence values sufficiently attractive to achieve a desired overall reduction in the number of licence holders in the MSF.
- The objective of the IAAP is to minimise any differential economic impacts.

Given the acknowledged differences in value between i) net and line licences and ii) amalgamated and unamalgamated licences, the IAAP reiterates its view that it would be less equitable and inconsistent to have an equal base allocation applied across all four licence categories. We therefore maintain our view that the base allocation should account for relative licence values in an allocation process.

FINAL RECOMMENDATION 3
A proportion of the TACC should be allocated to all eligible MSF licences statewide as a base allocation based on the relative values of four categories of licences: amalgamated net, amalgamated line, unamalgamated net and unamalgamated line.

FINAL RECOMMENDATION 4
Each eligible licence holder should receive a proportion of this allocation based on their relative value of their licence, where: **(i) Amalgamated Line = is 78% the value of an amalgamated net licence** **(ii) Unamalgamated Net =is half the value of an amalgamated net licence** (iii) **Unamalgamated Line = is half the value of an amalgamated line licence**

Compensation as an Alternative to a Base Allocation

As an alternative to a base allocation, the IAAP considered, and subsequently rejected, the payment of appropriate monetary compensation to recognise the impact of ITQ implementation on licence value to licence holders with no, or low, catch history in a priority species. We rejected this option for two reasons.

Firstly, offering monetary compensation for loss of licence value instead of quota may result in encourage fishers with low catch history to remain in the fishery. This would be in direct conflict with the current objective of MSF reform funds to reduce the numbers of licences in the MSF.

Secondly, even if funds were made available, certainty regarding compensation amounts could only be provided to licence holders after the licence surrender program was closed. If these amounts were low, it would then be too late for licence holders to take up the voluntary licence surrender option. The Panel considered this inequitable.

7.2 Catch History

The IAAP considered four components of catch history:

i. Investment warning and reference period
ii. Minimum catch history threshold
iii. Attribution of catch history

Investment Warning and Reference Period

The choice of catch history reference period for allocation seeks to balance the historical effort of licence holders with a need to provide reasonable weighting to those who have been active in more recent times. In the case of the MSF, the IAAP considered the investment warning sent to licence holders on 28 December 2017 and the following statement on the PIRSA website:

> *…. if any management changes require a specific allocation process to be followed, only fishing prior to **30 June 2016** will be considered, which aligns with the date of the discussion paper entitled SA Marine Scalefish Fishery Strategic Review Proposals, circulated to all licence holders in June 2016. This is also consistent with the letter and information contained on page 10 of the Report of the SA Marine Scalefish Fishery Strategic Review provided to licence holders in July 2017. (Notice to Fishers dated the 28 December 2017)*

As part of the MSF reform process, PIRSA also conducted numerous port visits and consultations over the period July 2016- December 2017 where licence holders and fishers were made aware of MSF reform, including a proposed catch history reference period end date of June 2016. The IAAP also noted the changes to Snapper management arrangements over the period 2010-2017. This issue is discussed in more detail in Section 7.4 of this report.

The IAAP considered examples of other fisheries where 'weighted catch history', based on before and after a catch history cut-off date has been used in an ITQ allocation. In the case of the MSF, this date was specified in the December 2017 investment warning. There may be some justification for including catch history after a cut-off date if a significant period of time has elapsed between the cut-off date, the date of the investment warning and the commencement of the allocation process. In the case of the MSF, the IAAP does not consider the time-period to be significant.

Nevertheless, different catch history scenarios were analyzed to determine the effect of including post investment warning catch history, and the effect that would have on allocation.

The following weightings were tested:

a. Catch history (sum of best of 5 of 6 years) July 2010- June 2016
b. Catch history (average 10 years) July 2006- June 2016
a. 70% Catch history (sum of best of 5 of 6 years) July 2010- June 2016: 30% catch history (average 3 years July 2016- June 2019)
b. 70% catch history (average 10 years) July 2006- June 2016: 30% catch history (average 3 years July 2016- June 2019)
c. 80% Catch history (sum of best of 5 of 6 years) July 2010- June 2016: 20% catch history (average 3 years July 2016- June 2019)
d. 80% catch history (average 10 years) July 2006- June 2016: 20% catch history (average 3 years July 2016- June 2019)
e. 90% Catch history (sum of best of 5 of 6 years) July 2006- June 2016: 10% catch history (average 3 years July 2016- June 2019)
f. 90% catch history (average 10 years) July 2006- June 2016: 10% catch history (average 3 years July 2016- June 2019)

It was found that many licence holders that have high catch history after June 2016, also had high catch history in the 6 - 10 years prior.

In the submissions, the recommendation for an end point of the reference period of 30 June 2016 was controversial (50 % of survey respondents who answered the question opposed or strongly opposed) and a number of written submissions suggested that the reference period should be extended to the time of the investment warning, which was issued to fishers on 28 December 2017 (see above).

The IAAP notes that is common practice in allocation processes for investment warnings to backdate the end of a reference period, to take account of any speculative behaviour, including efforts to increase fishing activity in order to build catch history as a hedge against any future allocation process (e.g. Victoria, WA, Torres Strait).

Had an investment warning been issued on 30 June 2016 instead of 28 December 2017, the issue arises as to what buyers and sellers would have done differently. PIRSA informed us that thirteen licences were transferred during this period. Whenever a licence is transferred, the buyer/transferee does not receive any catch history because catch history is attached to the licence holder not the licence. Buyers can be expected to have known of this. Furthermore, if any purchaser/transferee of a licence had carried out due diligence in the period 1 July 2016 – 28 December 2017, they would have learned that a reform and restructure of the MSF was planned and, unless they had personal catch history, should have proceeded with caution. Those requiring third party financing would be expected to take particular care before investment. Sellers/transferors would have been aware of the reform (discussion documents were sent to all licence holders; port meetings). They would also have known that when they transferred the licence, they would lose their catch history entitlement to any future quota allocation, unless they subsequently acquired a licence or held more than one licence against which they could attribute their personal catch history.

There was little explicit disagreement with the reference period in comments concerning Recommendation 6 (catch history based on the best 5 of 6 years).

Opposition to Recommendation 6 appears to be based on a more general opposition to the use of catch history, particularly as a dominant criterion for allocation, rather than the ability to ‘drop’ one year in five. This issue is covered under Section 7.3 below.

FINAL RECOMMENDATION 5
The period of six years (1 July 2010 - 30 June 2016) is an appropriate catch history reference period.

FINAL RECOMMENDATION 6
The total of the highest 5 years’ catch from 6 years should be used to calculate licence holders’ proportions of catch history.

Minimum Catch History

Frequently, eligibility for an ITQ based on catch history in a fishery requires a minimum catch of each of the quota species within a proposed reference period because:

a) it provides a reasonable threshold indicator of the reliance on that species by the licence holder,

b) those below the threshold will have access to that quota species through purchase or lease of quota, and

c) awarding all licence holders who had a nil, or below minimum, catch with an allocation of the quota species would lead to fragmentation of the industry where there are a high number of licences, such as in the MSF.

Unusually, the IAAP for the MSF is not dealing with an allocation for a whole fishery; rather the allocation of four priority species across four zones. This will result in fishers potentially receiving small amounts of quota for priority species for a base allocation irrespective of catch history. The IAAP explored the possibility of a minimum catch history requirement under various catch history scenarios (time periods, weighting, minimums). We concluded that setting a catch history minimum threshold may lead to inequitable outcomes - particularly due to the multispecies nature of the fishery where, small amounts of catch of a particular species may be valuable to the business as a whole. In addition, licence holders retain the ability to take non-quota species and consequently relatively small quota packages could make a significant difference to viability.

However, the IAAP also noted that the costs of administration of small amounts of quota may be high and for this reason there may be a rationale for setting a small minimum quota holding. However, for allocation purposes, this was not relevant.

In the submissions, the majority of survey respondents who answered the question were supportive or neutral to this recommendation. It was not raised as a substantive issue in the written submissions.

FINAL RECOMMENDATION 7
No minimum catch history threshold should apply for MSF licences.

Attribution of Catch History

The question arises as to the attribution of catch history. In SA there has been a long history of catch being attributed to the licence holder and not the licence. The IAAP found an early reference to this practice in the 2009 Select Committee Report on the Conduct of PIRSA with regard to pipis in the MSF and Lakes and Coorong fishery:

> *" ….. the central tenet of the (allocation of catch history) policy is that catch history should be subscribed to the person who actually puts in the effort to catch the fish'.*

PIRSA also advised that it has included this policy statement in annual licence renewal notices to licence holders going back 'many years.

More recently, the 2020 Notice to Holders of a Marine Scalefish or Restricted Marine Scalefish Fishery Licence for the 2020/21 Financial Year states that:

> *Catch history is the amount of fish taken by a licence holder pursuant to a licence issued under the Fisheries Management Act 2007. In some fisheries, when management arrangements have changed, catch history has been used as one of the relevant criteria when allocating access to resources. It is important to note that it is NOT policy in South Australia to recognise the transfer of catch history from one licence holder to another when a licence is sold or transferred.*
>
> *Implicit in this policy is the assumption that catch history remains with the original licence holder. That person may have their catch history recognised when re-entering the fishery with a licence purchase, however:*

- *Catch history will only be recognised for species which can be legally taken pursuant to the new licence and*
- *Catch history will only be recognised for years during which the person held the licence.*

Any adjustment to fisheries management arrangements in a fishery where catch history is used for allocating future access will be undertaken according to specific criteria established in the circumstances. Nevertheless, it is PIRSA Fisheries & Aquaculture's policy that any such criteria will be consistent with the approach set out above.

The IAAP understands there is a practice whereby licence holders transfer licences to fishers with the understanding that they will be re-transferred back to the original holder, sometimes for short periods (i.e. < 12 months). The IAAP considers that this practice, incorrectly referred to as 'leasing', does not change the attribution of catch history to the licence holder. As discussed above, all catch histories accumulated under registered fishing masters, even in the case of multiple licence holdings, will be attributed to licence holders. Other than in circumstances where the licence holder is indisposed, this provision seems clearly at odds with the owner-operator nature of the fishery. Due to existing catch history policy, the IAAP is constrained on this issue (see also section 10.1).

Conclusion: Catch history remains with the licence holder.

7.3 Weighting of Base Entitlement and Catch History

Another key allocation consideration relates to the weighting of criteria i.e. catch history: base allocation. As with all allocation decisions, the main objective is to maintain the current relative economic position of licence holders as much as possible, while bearing in mind the full range of guiding principles set out in Section 4.

In order to inform the weighting decision, the IAAP initially considered four weighting options to assess against the objectives of the allocation process, and also compared this with the current economic position of licence holders (as measured by catches over the period 2016/7-2018/9 and 2005/6-2015/16. One of these options was a proposal by industry association in the Industry Consultation Paper on Options for the Reform of South Australia's Commercial Marine Scalefish Fishery (and provided to the IAAP) for a preference for an equal weighting of catch history and licence.

A. 80:20 catch history: base allocation
B. 70: 30 catch history: base allocation
C. 60: 40 catch history: base allocation
D. 50: 50 catch history: base allocation

Following scenario testing, we recommended in our draft report a weighting of 80% catch history and 20% base entitlement as the most equitable balance between recognition of the needs of users of the resource, particularly those who rely on it for their livelihood, and minimization, to the extent possible, any differential economic impacts of allocation.

As expected, this draft recommendation was very divisive among licence holders. In the submissions, there was some strong support for the proposed formula and a solid body of opposition, either opposing or strongly opposing the proposal. Issues opposing the draft formula included:

- Low/nil fishing inactivity for the priority species in some or all of the reference period.
- Recent and often, younger, entrants who have invested in good faith will struggle to remain viable and thus be forced out of the fishery.

- An ageing group of licence holders with high catch histories in the reference period should not be rewarded as they may not continue fishing –some submissions also claiming they were responsible for overfishing.
- As licences pay the same management fees they should get the same allocation (we address this issue in section 6.7).
- An 80:20 weighting has been rarely, or never, been used in other allocations.

The IAAP understands that each licence holder would wish to maximise their allocation and seeks out the best formula to do so and some of the submissions may reflect this inclination. Those opposed to the weighting submit that their asset (licence) should receive a higher base allocation, either because they had had not used their licence much, were recent entrants to the fishery with little catch history in the reference period or because of the payment of management fees . A strong preference was expressed in the submissions by this group for at least a 50:50 allocation, or in some cases a 20:80 weighting in favour of base allocation. A few submissions suggested that the allocation should be equal for all licence holders, i.e. 100% of quota allocated on licence holding only. Some submissions suggested using the allocation process used for the Southern Zone Rock Lobster fishery or some derivation of that.

Those supportive of the recommended formula placed greater weight on the productive value of licence, as represented by previous catch history to recognise the needs of users of the resource, particularly those who rely on it for their livelihood.

On behalf of its members, the MFA proposed an alternative model allowing licence holders to choose their own allocation (catch history or licence holding). In support of this proposal, the MFA submission provided results of preliminary modelling. This approach is similar to the initial Southern Zone Rock Lobster allocation, whereby each licence holder was allowed to select either catch history or pot holdings as the determinant of their quota allocation. The IAAP notes the following:

- Such an allocation is likely to work best when there is a single gear, single target species and limited distortion (i.e. most of the catch is not caught by a small number of fishers).
- With any quota allocation, the challenge is not to satisfy the desires of all licence holders but to fairly and equitable share of “the pie” – especially when TACCs are lower than historical catches. The main defect of a "choose your own allocation" is that whilst it may optimise for an individual it will not produce an overall optimum. Although the effect of one individual getting a higher allocation may be small, the cumulative effect of many individuals would be significant and impact the livelihoods of those currently viable businesses that are catching the fish.
- The preliminary MFA modelling assumes uniform catch histories in the low, medium high groups and less distortion than is present in the MSF with an assumption is made that 30% of licence holders have high catch history. As shown in Table 3, distortion is more extreme in the MSF, with around 2% -11% of licence holders taking 80% of the catch.
- The allocation may discourage licence surrenders, especially of licences with no catch history.

Table 3 Number of MSF licence holders accounting for 80% of the catch

Region	Species	Number of MSF licence holders who account for 80% of the MSF catch (FYE-2016)
Spencer Gulf	Garfish	10
	KGW	33
	Southern Calamari	30
	Snapper	8
Gulf St Vincent	Garfish	9
	KGW	14
	Southern Calamari	20
	Snapper	12
West Coast	KGW	15
	Snapper	8
South-East	Snapper	5

Some submissions suggested the application of the allocation finally adopted in the SZRL, commonly known as the "APACHE" formula.[6] In that fishery, over a period of four years, individual quota holdings were adjusted up or down by one-quarter of a licence holder's existing allocation per pot and the average allocation per pot. After four years, all quota holders received the same allocation per pot. The effect of this 'APACHE' formula was to allocate quota away from those who had higher than average catches per pot towards those who had lower than average catches per pot.

The IAAP considered the APACHE model in our initial deliberations, and revisited it again following receipt of submissions. Noting the differences in the two fisheries described above the complexities of estimating average catches in a multi-gear multi-species fishery, we concluded that this allocation model would not achieve the IAAP objectives.

In reviewing its position on catch history weighting, the IAAP also revisited relevant fisheries legislation and examined Government policy positions, with the aim of clarifying the objectives of the reform. We found:

> Goal 2 f(i) of the MSF Management Plan states: "*When implementing management changes, where possible ensure that the management framework does not unnecessarily reduce ability of fishers to successful run a business".*

The IAAP has taken the term 'business' to refer to those licence holders who rely heavily on the MSF for their livelihood and have a commercial focus i.e. rely on fishing as their primary source of income. This is somewhat in contrast to those who most likely have other sources of income and do not rely on income from fishing in the MSF, some of whom consider themselves 'lifestyle' fishers (BDO EconSearch,2020).

Furthermore, the Liberal Government election commitment (Commercial Fishing – Review and Reform 2036) states:

> "*It's important that our commercial fisheries remain viable and that fish stocks are healthy*" and *"Once the fleet is rationalised, a system of Regional Individual Transferable Quotas is needed to achieve a sustainable and commercially viable fishery".*

[6] Adjusted Preferred Allocation Catch History Equation

Again, the inference the IAAP has drawn from term 'viability' means the commercial viability of fishers, whose primary source of income is from fishing i.e. not a business where fishing is supplemental to other, primary sources of income, including investments.

In the light of this guidance and the submissions, the IAAP concluded that reducing the catch history weighting in favour of a higher base allocation weighting would likely have the following effects:

- reduce the allocation to many of the most productive, full time fishers to a point where they would need to buy or lease considerable amounts of quota to remain viable.
- give recent entrants, concerned that they will have insufficient catch history to continue current fishing operations, a greater chance remaining in the fishery.
- further disperse the available quota including to those that have not used their licence at all.
- disproportionally reward those holding multiple licences (12 licence holders own more than one licence); and
- encourage some licence holders to remain in the fishery, thus prejudicing the success of the licence surrender program.

For the IAAP, the major consequence of giving a higher weighting to licence value, combined with the prospect of lower TACCs than current catches will result in already marginal full-time fishing businesses becoming less profitable. We consider this outcome to be counter to the evident policy position of the government and the objectives of the MSF management plan.

The most recent BDO EconSearch Economic and Social Indicators Report (BDO EconSearch,2020) reported that in 2018/19 licence holders who fished more than 150 days/year are already marginal with an average boat business profit estimated to be $10,500. Reductions in TACCs combined with smaller allocations for catch history would have a detrimental impact on these fishing businesses. Conversely, boat business profits of fishers who fished 50 days or less was estimated to be -$13,000 suggesting that their fishing business is reflective of a lifestyle focus and in some cases may be subsidised from other sources of income.

Contrary to the view that an 80% weighting for catch history has been rarely or never used in other quota allocations (or allocation heavily weighted towards catch history), the IAAP is aware of examples of this actual weighting used both in Australia and the US.[7]

Based on the above reasoning, the IAAP reaffirms its draft recommendation regarding catch history and base allocation weighting.

FINAL RECOMMENDATION 8
Catch history and base entitlement should be weighted 80:20.

7.4 Snapper

There have been numerous reviews undertaken of the Snapper fishery management resulting in a range of changes to management arrangements over time, based on various input controls designed

[7] Atlantic Surf Clam Fishery, USA; Torres Strait Tropical Rock Lobster and Finfish fisheries; NSW Ocean Trap and Line (East); Ocean Trawl, Southern Fish Trawl and Hand Gathering (pipi) fisheries; Commonwealth South-East trawl fishery (for traditional fish species).

to reduce fishing mortality, which for the most part, appear to have been unsuccessful. The IAAP considered that these changes been sufficiently different to those of other stocks to warrant specific consideration of the allocation arrangements for Snapper.

The fishery is based on three stocks: The Western Victorian Stock is a cross-jurisdictional stock that extends westward from Wilsons Promontory, Victoria, into the south eastern waters of South Australia. The remaining waters of South Australia are divisible into the Spencer Gulf / West Coast Stock and Gulf St. Vincent. Using handlines and longlines, commercial catches peaked at over 1,000t in 2010, following a major shift in the spatial structure of the fishery. Catches and catch rates declined in Spencer Gulf, driving a shift of effort to the South East, where effort and catch reached unprecedented levels before a general decline in commercial and recreational catches.

A major review of the management arrangements for all sectors and the science to support sustainable stocks occurred between 2010 to 2012. This review led to an extended state-wide seasonal closure (an additional 15 days) for all fishers, reduction of the commercial daily catch limit to 500 kg, reduction of the maximum number of hooks permitted to be used by commercial fishers to 200 at any one time, prohibition on transshipment, implementation of a three-day limit on multi-day commercial trips and commercial prior reporting arrangements. A series of Snapper spatial spawning closures were also implemented as an outcome of the review.

In 2013, the MSF Management Plan was subsequently implemented, including a harvest strategy and the inter-sectoral allocations of the resource. In the face of a continued decline, the commercial trip limit in the MSF was reduced further during 2016, to 200 kg in Spencer Gulf and 350 kg in Gulf St Vincent and the South East, and there was a reduction in bag-limits and boat-limits for the recreational sector. Despite these changes, stocks declined further to the point where the Minister for Primary Industries and Regional Development announced a closure of the West Coast and Gulfs to Snapper fishing from 1 November 2019 until 2023, with a seasonal closure from 1 November to 31 January in the south east for each year until 31 January 2023.

In addition to the decision to close fishing for two Snapper stocks until 2023, a TACC will be set for the South East region from 1 February to 31 October each year. Consequently, any allocation will only apply in this region at least until 2023. The TACC for Snapper in the South East from 1 July 2021 to 30 June 2022 has been set at 36 tonnes.

Investment warning

On 18th February 2011, a Notice to Licence Holders regarding a review of MSF management and, specifically Snapper was circulated to all licence holders. In additional to strongly encouraging licence holders not to invest in methods to increase efficiency, the Notice included the following investment with respect to catch history:

*"…**if** any Snapper management changes require a specific allocation process to be followed, only fishing prior to 31 December 2010 will be considered."*

The question arises as to the application of this warning the current allocation process. Reference to this warning was made in only one submission. PIRSA advised the IAAP that the investment warning was superseded by the decision on the outcome of the 2011/12 Snapper management review, which implemented other management arrangements that were communicated to licence holders, namely:

- The announcement, via a Notice to Licence Holders on 8 October 2012 of new Snapper management arrangements based on input controls, developed through the Snapper Working Group and following a period of public consultation. ITQs and allocation were not part of the final management arrangements referred to under this notice.

- The development and subsequent approval of the MSF Management Plan and harvest strategy in October 2013, which again makes no mention of ITQ allocation and neither ITQs nor catch history are listed as a management option/tool.

The key issues recognized by the IAAP are that i) only provisional reference was made to the use of the investment warning in relation to catch history in the February 2011 investment warning ("***if*** *any Snapper management changes require a specific allocation process to be followed…..*") and ii) that subsequently management changes arising from the 2011/12 review did not require allocation.

Based on this advice, the IAAP could not find sufficient evidence to support the application of pre 31 December 2010 catch history, as per the February 2011 investment warning.

Conclusion: The catch history reference period for Snapper should be the same as the other priority species: KGW, Garfish and Southern Calamari.

8 Allocation Formula for other than MSF fisheries

Licence holders in other fisheries have some level of access to marine scalefish priority species:

- Southern Zone Rock Lobster Fishery (SZRLF)
- Northern Zone Rock Lobster Fishery (NZRLF)
- Spencer Gulf Prawn Fishery (SGPF),
- Gulf St Vincent Prawn Fishery (GSVPF),
- West Coast Prawn Fishery (WCPF)
- Lakes and Coorong Fishery (LCF),

The current (2013) MSF Management Plan allocates commercial sector shares (in percentages) of the four priority species between the MSF the rock lobster, prawn and Lakes and Coorong fisheries (P.32).

The IAAP also considered whether it was necessary to make an ITQ allocation to licence holders in these fisheries. In doing so, the IAAP considered the following:

- The proportion of the fishery's share of the TACC.
- Whether the priority species was targeted.
- The level of access to the MSF and priority species:
- The transferability of the endorsement

8.1 Northern and Southern Zone Rock Lobster Fisheries

Option C conditions on Northern and Southern Zone Rock Lobster licences allow the take and sale of all MSF species, including the four priority species. Option C is a licence condition ("Option C licence holders") and cannot be transferred independently of a rock lobster licence.

There are 60 NZRLF and 148 SZRLF licences with option C. If a RL licence has Option C, they contribute to the recovery of management, science and compliance fees for the MSF – a fee being equivalent to 50% of the base fee that MSF licence holders pay. Having Option C is optional and a RL licence holder can voluntarily surrender that option and revert to Option A or Option B. Southern Zone Rock Lobster Fishery licences are restricted to their zone (South East) and licence holders cannot utilise their Option C outside of this rock lobster zone. Similarly, the NZRLF is restricted, albeit over a larger area, west of the Murray Mouth.

Catch data provided to the IAAP by SARDI show that the majority of Option C licence have no recorded catch of marine scalefish priority species in the period 1 July 2010- 30 June 2016 (73% NZRLF; 56% SZRLF).

Rock lobster fisheries were included in the initial sectoral allocation (resource sharing) of marine Scalefish species based on catch history for the 2007/8 financial year. These shares are specified in the 2013 MSF Management Plan (Table 4) for each fishing sector at a state-wide level and for each commercial fishery within the overall commercial sector allocation.

Table 4 Catch Shares in the MSF (2013 MSF Management Plan)

Species	Commercial		Recreational		Aboriginal traditional	Total
King George Whiting	MSF	49.5%	REC	45.5%	1%	
	SZRL	0.0%	CHARTER	3.0%		
	NZRL	1.0%				
Total	50.5%		48.5%		1%	100%
Snapper	MSF	79%	REC	8%	1%	
	SZRL	1.45%	CHARTER	10%		
	NZRL	0.55%				
	LCF	0.03%				
Total	81%		18%		1%	100%
Southern Garfish	MSF	79.33	19.5		1%	
	SZRL	0.13				
	NZRL	0.04				
Total	79.5%		19.5%		1%	100%
Southern Calamari	MSF	56%	37.4		1%	
	NZRL	0.45%				
	GSVP	0.45%				
	SGP	4.6%				
	WCP	0.1%				
Total	61.6%		37.4%		1%	100%

For the allocation of TACCs, the commercial sector shares above have been separated into each of the four MSF management zones using the same catch history period that was used to calculate the state-wide shares. One relevant example is the case of snapper allocation and the SZRL. In this case, Option C licence holders catch snapper in the SE, which will be under quota. Catch history at the time of the initial sectoral allocation shows that Option C licence holders took 1.45% of the state-wide Snapper catch in 2007/08. The bulk of this total state-wide commercial catch for all sectors came from Spencer Gulf (547 tonnes) and relatively little from the SE (62 tonnes).Of the 62 tonnes from the SE, 77.4% was taken by MSF fishers and 20.8% by SZRL Option C licence holders.

Summarising, while the SZRLF had a 1.45% share of the Snapper state-wide catch in 2007/8 (all sectors), this equates to 1.8% of the total commercial catch share and 20.8% of the Snapper caught commercially in the South East zone.

As with the MSF, only two criteria were considered for determining the allocation of quota to the holders of rock lobster licences: licence holding (base) and catch history. On that basis, the IAAP considered three options to allocate quota for priority species:

1. **An equal allocation to all Option C licence holders**. The advantages of this option are that all Option C licence holders receive some quota, which may me be sold or taken for personal use. However, there are two disadvantages. Firstly, the small resource share (see Table 5) of the TACCs of priority species for SZRL and NZRL fisheries would result in

very small amounts of quota equally distributed across 60 SZRL and 148 NZRL licence holders. As the majority have no catch history, this would also give insufficient recognition of the historical fishing activity of the small number of licence holders who target these priority species.

2. **An allocation using a combination of catch history and base allocation.** The advantages of this option are recognition of historical fishing activity for priority species and for holding of an Option C endorsement. The disadvantage of this option is that a base allocation, with small shares of the TACC for SZRL and NZRL fisheries, would result in negligible amounts of quota distributed across many licences, leading to very significant quota fragmentation.

3. **An allocation on catch history only**. The advantages of this option are that since it recognises the historical activity of the small number of licence holders who have targeted priority species, it minimizes quota fragmentation of the small share of the resource. Application of a minimum catch threshold to qualify for allocation would further minimise quota fragmentation. For example, for Snapper in the SE zone, over a six year period [8] four Option C licence holders accounted for 83% of the catch and an estimated 0.5% (335 kgs) of the total SZRL catch of 62.5 mt was taken by 16 of the 148 licence holders (catches ranged from 4 to 35 kgs). The disadvantage of this option is that there is no recognition for holding an Option C endorsement.

After considering all options carefully including consideration of the size of sectoral share and the characteristics of access to marine scalefish species by Option C, the IAAP found that that Option 3 - catch history, was the most appropriate option. The IAAP also considered that a minimum catch threshold should be added, being 50 kgs in total over the same review period for any priority species in respect to which an allocation is sought. The IAAP also notes that under Option 3, Option C licence holders continue to retain access to marine scalefish species.

In the submissions, two -thirds of the survey participants who answered the question supported or were neutral about this recommendation. Some submissions from RL licence holders wished for an equal allocation based on the payment of management fees – but the IAAP's position remains that management fees are independent of an allocation process and should not be a criterion for allocation (see section 6.7.)

FINAL RECOMMENDATION 9

The allocation of ITQs for each priority marine scalefish species to Option C endorsed licence holders in the rock lobster fisheries should be based on catch history with a minimum of 50 kg in relation to any priority species in respect to which an allocation is sought.

The period of six years (1 July 2010 to 30 June 2016) is an appropriate reference period for the purposes of a catch history allocation and minimum catch history. The sum of the highest five years' catches from this 6-year period should be used for the calculation of both threshold and the entitlement.

[8] SZRL total of best 5 years for individual licence 1 July 2010-30 June 2016

8.2 Prawn Fisheries (Spencer Gulf, Gulf St Vincent, West Coast)

The IAAP considered both the characteristics of these fisheries with regard to catches of priority species and the nature of the MSF endorsement. These fisheries have access to Southern Calamari but do not target them. Southern Calamari is therefore an unavoidable by-product, of which the quantity taken is capped through a sectoral allocation of Southern Calamari (0.5% of the total allowable commercial catch (TACC), with 4.6% of that catch taken in the Spencer Gulf). There is a negligible catch of other priority species. The MSF endorsement is not fully transferable as it cannot be split from the prawn licence.

The IAAP considered an ITQ allocation to MSF endorsement holders in this fishery and **concluded** that effective implementation of ITQs would be challenging and costly as Southern Calamari is difficult to target and avoid. The IAAP also noted the challenges associated with ensuring a cap is not breached in the case of an unavoidable bycatch species.

There was overwhelming support for this recommendation in the submissions.

FINAL RECOMMENDATION 10
No ITQs for priority species should be allocated to the Spencer Gulf, Gulf St Vincent and West Coast Prawn Fisheries.

8.3 Lakes and Coorong Fishery

There are 36 Lakes & Coorong Fishery licences with an endorsement that provides them with restricted access to the MSF. These fishers are restricted to operate in coastal waters out to 3 nautical miles, from Goolwa Beach Road to the jetty at Kingston. The main species taken are Mulloway, Western Australian Salmon and Yellow-Eye mullet.

Under the 2013 MSF Management Plan, the fishery is provided with a small sectoral allocation of Snapper for the Lakes and Coorong Fishery (0.03 % of the TACC).

In the absence of any evidence to suggest a targeted Snapper fishery in the Lakes and Coorong Fishery, the IAAP concluded that there was no rationale for allocation of ITQs in this fishery.

There was overwhelming support for this recommendation in the submissions.

FINAL RECOMMENDATION 11
No ITQs for MSF priority species should be allocated to MSF endorsed licence holders in the Lakes and Coorong Fishery.

9 Exceptional Circumstances

A licence holder may wish to argue that, by reason of certain events, such as illness, serious misfortune, administrative error etc. his or her circumstances were exceptional and that but for such events, he or she would have been entitled to a higher allocation of priority species than they received. PIRSA has advised the IAAP that an 'exceptional circumstances' process has now been initiated to allow for these circumstances and ensure that the principles of fairness and good management result in consistency in the application of the allocation process.

The IAAP suggests that determining a definition of 'exceptional circumstances' would be helpful in providing greater certainty to those licence holders wishing to apply for reconsideration of their allocation using this provision and in reducing the number of claims.

PIRSA advised the IAAP that if a positive finding is made under 'exceptional circumstances' and an individual's allocation (ITQ) is increased, this will have the effect of reducing the number of quota units to be shared among other licence holders. As a consequence, all licence holders will not know their final allocation of ITQs until the completion of the exceptional circumstances process and the Voluntary Licence Surrender Program.

10 Other observations

Many submissions made reference to issues that were probably outside our Terms of Reference. The issues that the IAAP considers it can usefully make observations on, and have interactions with the MSF allocation process, are covered below. This commentary is provided for consideration by PIRSA and is based on the collective experience of the IAAP and may be of some use in relation to future fishing management decisions such as future allocation issues.

10.1 Owner operator

There was support for ensuring the fishery, including ITQ, remained in the ownership of active fishers. Some suggested a return to a more rigorous application of an ownership policy, including a restriction on owning more than one licence. Constraints on ownership will come with costs, however. Constraints limit flexibility, which may therefore reduce innovation and/ or limit economic performance. However, the IAAP agrees with the sentiments concerning ITQ ownership and the implications for maintaining a community-based fishery. Such an objective is not explicitly covered as a priority in the current management plan or reporting framework. If there is support for strengthening owner-operator provisions, a clear policy and associated operational management objectives should be developed. This would provide current and future participants in the fishery with greater certainty.

10.2 Leasing, and licence and quota ownership

While there is no arrangement in the MSF for the leasing of licences. Some licence holders have made arrangements for the temporary 'sale' of licences, which include an agreement to transfer ('sell') back the licence after a period of time. This is commonly classed as 'leasing' in the MSF. A number of submissions reflected circumstances where individuals appear to have temporarily 'sold' licences with what has resulted in negative outcomes. Ensuring greater clarity over this issue, including the utility of the five-year restriction on repeat sales of licences, would seem to be warranted. Similarly, the leasing and ownership of quota post allocation should be clarified (see next section).

10.3 Integrity of the quota system

The resource sharing framework for the MSF shares the TACs of priority species between the Commercial (TACC), Recreational (TARC) and Aboriginal traditional sectors (see section 2). The State has well-developed processes for auditing catches under quota taken by the commercial sector. A number of the submissions raised the issue that while the commercial sector is under tight management control, the recreational sector does not have the same level of monitoring and assessment. Successful MSF reform requires that catch caps from all sectors are adhered to, and where any sector overruns are identified, they are managed equitably e.g. the commercial sector should not be unduly disadvantaged if the recreational sector, for whatever reason, exceeds its allocation. The failure to do so may not only undermine the integrity of the quota system but also weaken the ITQ right impacting the ability of licence holders to obtain financing to purchase or lease additional quota.

10.4 Investors

Much was made in the submissions of ‘investors’ using the move to quota to buy out and dominate ownership of the fishery. Avoiding the decoupling of licence holding from quota, as suggested in some submissions, would limit the sale and leasing of quota to existing licence holders. This would not ensure that quota would remain in the hands of active fishers/licence holders (additional measures can be considered) but it would be relatively simple measure to implement.

10.5 Management fees

A shift from an input to an output-controlled fishery usually leads to an increase in management costs, particularly in small fisheries. The impact on licence holders is exacerbated by the reduction in the number of licences among which costs are shared. The IAAP notes this may cause financial hardship to some licence holders, particularly those marginal licence holders with limited allocations of quota species. Many submissions expressed concern about this issue. There are some avenues to reduce this impost. PIRSA has advised the IAAP that the State government is providing funding of up to $2.51 million as a component of the reform package to support management services and constrain individual licence fee increases to CPI only for a four year transition period while the number of licences is reduced and new arrangements implemented. The IAAP observes that a new manage fee structure could introduce a tiered system of fees i.e. a base charge for all licence holders and an additional payment, proportional to quota holding.

10.6 Set-aside for new entrants

A few submissions raised the issue of setting aside quota for new entrants to the fishery who do not qualify for a catch history allocation but are actively fishing and may not have the resources to purchase or lease quota. It was also suggested to have set-asides for those considering entering the MSF in the future.

Although uncommon, the IAAP is aware of set-asides used in other allocations, for example in:

- The Argentinian hake fishery: managers set aside portions of the TACC for fishery-specific needs including an artisanal reserve for Argentine hake to accommodate the artisanal fleet, conservation reserves for Patagonian grenadier and southern blue whiting to promote long-term stock health, and administrative reserves for Argentine hake, Patagonian grenadier and Patagonian toothfish to allow managers to address other management needs such as requests for fleet expansion.
- The Central Gulf of Alaska Rockfish fishery: 2.5% of the initial allocation was set aside for participants in the entry level trawl fishery.

Whilst possible to implement, we note that in the Argentinian example there is considerable annual uncertainty for existing licence holders regarding their allocation; the difficulty in application of the Alaskan approach would be determination of the percentage, and questions about the administration of this set-aside including:

- How is eligibility determined?
- Who owns the quota?
- Is it leased or sold? At what price?
- What will the revenue be used for?

The IAAP concluded that while understanding the motivation for the set-aside, the complexity and uncertainty that it would generate would likely render it unworkable in the case of the MSF.

11 Future Allocations

The IAAP suggests that the allocation criteria suggested in this report (see Section 6) should be carefully considered for any future allocations of MSF species. In addition, the following additional observations are made:

- The December 2017 investment warning, while deemed applicable for this allocation process will become less relevant the more time elapses, particularly with respect to catch history.
- It may be appropriate to consider 'pioneer rights', as a criteria particularly where significant funds or expertise has been invested in the harvesting, marketing or processing of a previously lightly exploited species.

Conclusion: applying a 'one size fits all' approach to future allocations based on that used to allocate the four priority species detailed in this report is not recommended.

Appendix 1

SOUTH AUSTRALIAN MARINE SCALEFISH FISHERY REFORM

INDEPENDENT ALLOCATION ADVISORY IAAP (IAAP)

TERMS OF REFERENCE

Governing Authority:	Minister for Primary Industries and Regional Development (Minister)
Agency:	Primary Industries and Regions South Australia (PIRSA)
Agency Responsibility:	A/Executive Director Fisheries and Aquaculture (Executive Director)

1. Background

The South Australian Government has committed to delivering reform in the commercial Marine Scalefish Fishery (MSF) to unlock industry's potential, provide long-term sustainability and cost-effective management, and drive efficiencies in operations to secure a future for the fishery.

In November 2018, consistent with a Government election commitment, the Minister established the Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) with the purpose to develop, in consultation with licence holders and key stakeholders, recommendations on a reform package for the fishery.

The CMSFRAC provided a report describing a strategic 7-step approach and proposes twenty-five recommendations to achieve the required reform including the removal of commercial licences, the creation of four zones of management, and implementation of an individual transferable quota (ITQ) system constrained by a total allowable commercial catch for priority species such as King George Whiting, Snapper, Southern Calamari and Southern Garfish.

The Minister has requested an initial investigation be undertaken to determine a suitable method of allocating ITQs to individual fishers. It is recognised allocating ITQs in an established fishery, particularly a multi-species and shared access fishery and one as diverse as the South Australian MSF, is probably the most challenging issue facing fishery managers and industry when introducing a catch quota management system. In addition to the 307 licence holders in the MSF, there are other licence holders in other fisheries which have some level of access. These include the Northern and Southern Zone Rock Lobster fisheries, the Lakes and Coorong Fishery, the Spencer Gulf, West Coast and Gulf St Vincent prawn fisheries, the Blue Crab Fishery and the Miscellaneous Fishery.

There is a need to establish explicit and sound principles to support the chosen method of allocation of quota units to fishers. Associated with this is the need for independence in determining a fair and reasonable allocation formula by removing the management agency (PIRSA) and licence holders from direct involvement in developing any allocation formula to be considered.

For these reasons, the Minister has agreed for the establishment of an Independent Allocation Advisory IAAP (IAAP) comprising of legal, economic and fisheries management expertise, to work with PIRSA to establish a basis of allocating quota shares (ITQs) between participants in the fishery.

2. IAAP Members

Membership of the IAAP comprises:

- Mr Tim Mellor – Chair and legal expertise
- Dr Sevaly Sen – Fisheries economic expertise
- Mr Ian Cartwright – Fisheries management expertise

3. Purpose

To provide advice to the Minister on the most appropriate basis for the allocation of a commercial share of specified species among holders of an authority to take those species for the purposes of trade or business in South Australian waters.

4. Scope

In developing its recommendations, the IAAP is to consider:

- All holders of an authority to take marine scalefish species for the purposes of trade or business in South Australia that are eligible for an allocation of catch quota.
- Reported fishing catch and effort. The period to be considered will be as deemed appropriate by the IAAP.
- Existing government policies relating to the allocation of marine resources.
- Key changes in management arrangements and any Notice to Fishers which is relevant to the criteria for the allocation of quota shares.
- Any other matters considered relevant by the IAAP or the Executive Director.

In achieving this task, the IAAP will be required to:

- Engage with PIRSA Fisheries and Aquaculture and SARDI Aquatic Sciences to identify the data and information necessary to determine the allocation and undertake analysis of alternative allocation scenarios.
- If deemed necessary by the IAAP, undertake limited informal consultation with technical experts familiar with the MSF to further understand the implications for the fishery of different allocation scenarios.
- Explain and justify the recommended allocation method to the Minister in a written report and be available for discussion of the report recommendations.

- Identify and include in the allocation system any exceptional circumstances the IAAP considers should be taken into account.
- Maintain full records of all activities undertaken by the IAAP.
- Individual IAAP members may be required to undertake separate tasks and variable time commitments.

PIRSA will provide relevant background information, any additional relevant information requested by the IAAP where such information exists, and access to PIRSA's files regarding relevant matters. PIRSA will also provide executive support and administrative services to assist with the deliberations of the IAAP.

5. Reporting Relationship

The IAAP will report directly to the Minister.

6. Deliverables and Timeframe

A draft report of the IAAP is to be completed by 30 June 2020, subject to all necessary data and legal advice being provided to the IAAP in a timely manner.

The draft report of the IAAP will be released for an eight-week consultation period commencing in July 2020. Following the consultation period, PIRSA will provide the IAAP with feedback from stakeholders. The IAAP will consider this feedback and, as appropriate make changes to the draft report, including the allocation method, and provide the Minister with a final report by no later than 31 October 2020.

7. Guiding Principles

In developing its recommendations, the IAAP is to take into account, where relevant, the following guiding principles:

- *Fairness and Equity* – an overarching principle that should inform an allocation issue or management generally is one of fairness and equity. That is, the resource is to be allocated and managed in a way which distributes the benefits of use fairly amongst participants and minimises any differential economic impacts such as wealth redistribution arising from an allocation or management generally.
- *Consistency and transparency* – The allocation process should be developed or implemented in a consistent and transparent manner and should be able to be adopted for future allocations.
- *Certainty for shareholders* – The fishing rights should be allocated in a way that recognises the needs of users of the resource, particularly those who rely on it for their livelihood.

- *Opportunities to be heard* – Participants in the fishery should have the opportunity to comment on draft allocation criteria developed by the IAAP, through a transparent process.
- *Rights of existing licence holders and level of fishing activity to be recognised* – The allocation processes should have due regard to the existing rights and fishing activity of participants in a fishery.
- *Best available information* – Allocation arrangements should take into account the best available information at the time the allocation arrangement is developed.
- *Integrity of fisheries management arrangements* – Allocation decisions, should be consistent with legislative requirements and other fisheries management objectives.

Appendix 2

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VALUATIONS REPORT

12 SEPTEMBER 2019

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Executive Director Fisheries and Aquaculture
PIRSA
Level 14
25 Grenfell Street
ADELAIDE SA 5000

Dear Sir

In accordance with the Draft Terms of Reference PIRSA have engaged BDO Advisory (SA) Pty Ltd (BDO, we, us or our) to prepare this valuation report (Report).

We have considered and relied upon information provided by PIRSA. We consider, on reasonable grounds, that this information is reliable and not misleading. In this regard, PIRSA has represented to us that all information held by PIRSA that may influence our analysis has been provided to us and is accurate and complete.

The information used by BDO in preparing this Report has been obtained from a variety of sources as indicated within the Report. While our work has involved analysis of financial information and accounting records, it has not included an audit or review in accordance with generally accepted auditing and assurance standards.

Accordingly, we assume no responsibility for and make no representations with respect to the accuracy or completeness of any information provided to us by and on your behalf.

PIRSA have reviewed a draft version of this Report and has confirmed that the information provided to us and as presented in this Report is accurate and that no other available information that would be essential to our Report has been withheld.

Please do not hesitate to contact us if you have any questions about this Report or if we may be of any further assistance. This letter should be read in conjunction with our Report, which is attached.

Yours faithfully

BDO Advisory (SA) Pty Ltd

David Fechner

Partner

MESSAGES

Notice to any person not authorised to have access to this report

Any person who is not an addressee of this Report or who has not signed and returned to BDO Advisory (SA) Pty Ltd (BDO) either a "no-reliance" or an "assumption of duty" release letter is not authorised to have access to this Report. We do not accept or assume responsibility to any unauthorised person to whom this Report is shown or any other person who may otherwise gain access to it. If any unauthorised person chooses to rely on the contents of this Report, they do so entirely at their own risk. Should any unauthorised person obtain access to, and read this Report, such person accepts and agrees that:

- This Report was prepared in accordance with instructions provided by the addressees exclusively for the sole benefit and use of each of them and such other parties whom we expressly agreed in writing may have the benefit of, or rely upon, our work.
- BDO, its partners, employees and agents neither owe nor accept any duty or responsibility to the reader, whether in contract or in tort (including without limitation, negligence and breach of statutory duty), or howsoever otherwise arising. We make no representations regarding this Report or the accuracy of the contents including that the information has not changed since the date of this Report. We shall not be liable in respect of any loss, damage or expense of whatsoever nature which results from any use the reader may choose to make of this Report, or any reliance the reader may seek to place on it, or which is otherwise consequent upon access to this Report by the reader.
- Our work has been conducted in accordance with applicable Australian professional guidance. In other jurisdictions, standards and practice relevant to investigating accountants may be different and may not provide for reporting in the manner contemplated herein. Accordingly this Report has not been prepared in accordance with the standards and practice of any professional body in any other jurisdiction.
- This Report is not to be referred to or quoted, in whole or in part, in any other document or made available to any third party.

DEFINITIONS, ABBREVIATIONS AND GLOSSARY OF TERMS

Abbreviation	Meaning
AUD	Australian dollars
BDO EconSearch 2019	Economic and Social Indicators for the South Australian Marine Scalefish Fishery 2017/18, report prepared for PIRSA Fisheries and Aquaculture, Adelaide, July 2019
CAPM	Capital asset pricing model
CMSFRAC	Commercial Marine Scalefish Fishery Reform Advisory Committee
CPI	Consumer price index
CPUE	Catch per unit effort
DCF	Discounted cash flow
EBITDA	Earnings before interest, tax, depreciation and amortisation
FRDC	Fisheries Research and Development Corporation
FYXX	Actual results at 30 June 20XX, or for the accounting year then ended
Licence Holder	Owner of a licence in the MSF
MSF	Marine Scalefish Fishery
PIRSA	Primary Industries and Regions South Australia
Q1	1st quartile
Q2	2nd quartile
Q3	3rd quartile
Q4	4th quartile
R&M	Repairs and maintenance
SA	South Australia
SARDI	South Australian Research and Development Institute
TAC	Total allowable catch
TACC	Total allowable commercial catch
WACC	Weighted average cost of capital

CONTENTS

SECTION 1

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Purpose and scope

- The Government of South Australia is committed to delivering reform in the commercial Marine Scalefish Fishery. The Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) has been established by the Minister for Primary Industries and Regional Development to develop, in consultation with licence holders and key stakeholders in the South Australian Marine Scalefish Fishery, recommendations on a reform package for the fishery that include:
  - Introducing zones of management within the fishery that recognise the economic, ecological and social diversity within the fishery;
  - Achieving fleet rationalisation that secures a minimum of 30% reduction in the total number of licences;
  - Implementing key management reforms, including a system of regional individual transferable quotas, that will achieve a more sustainable and commercially viable fishery and a mechanism to facilitate on-going autonomous adjustment;
- The CMSFRAC is required on or before 31 July 2019 to deliver to the Minister a report that includes, among other things:
  - A recommended approach, detailing the method, timeframes and estimated expenditures, to achieve a minimum 30% reduction in the total number of licences in the Marine Scalefish Fishery.
- To assist the CMSFRAC to deliver on this aspect of the reform package, in particular the estimated expenditure required to rationalise the number of licences, estimated current values of licences are required.

Terms of reference

- To provide to the Executive Director Fisheries and Aquaculture:
  1. A review of possible methods to value a South Australian commercial fishing licence
  2. The most suitable method to be used and the information required, to estimate the value of alternative licence categories in the MSF.
  3. An estimate of the current minimum and maximum values of alternative licence categories taking into account the factors that may differential the value of licences in the MSF including registered fishing gear, amalgamation points, and any other entitlements that may differ between licences.
- The Executive Director Fisheries and Aquaculture will provide required information and statistics available in databases held by PIRSA Fisheries and Aquaculture and SARDI Aquatic Sciences
- Consideration should be given to the fishing gear that is registered on licences, in particular Hauling Net, Gill Net, Longline and Dropline, and any other gear type that may influence the market value of a licence.
- Any catch quota entitlements held by individual licence holders in the Marine Scalefish Fishery, including those associated with Sardine, Vongole, Blue Swimmer Crabs, Goolwa Pipis and Western Australian Salmon are not to be included in the valuations.
- Appropriate consultation with the Marine Fishers Association is expected to seek industry input and feedback on the approach to be taken to estimate the current value of licences, and with industry brokers commonly used for the trading of fishing licences.
- A report is requested to be delivered to the Executive Director Fisheries and Aquaculture by COB Wednesday 31 July 2019.

EXECUTIVE SUMMARY (CONT.)

Definition of value

- The definition of value we have adopted is set out below:
  - Business valuers typically define fair market value as "… the price that would be negotiated in an open and unrestricted market between a knowledgeable, willing but not anxious buyer and a knowledgeable, willing but not anxious seller acting at arm's length."
  - Fair market value, as defined above, is a concept of value which may or may not equal the "purchase/sale price" that could be obtained if the shares were sold to a special purchaser in an actual transaction in the open market. Special purchasers may be willing to pay higher prices to gain control or obtain the capacity to reduce or eliminate competition, ensure a source of material supply or sales, achieve cost savings arising on business combinations following acquisitions or other synergies which could be enjoyed by the purchaser. Our valuation will not be premised on the existence of a special purchaser.
- We have included separate valuation information for line only licences and for net and line licences.

Adjustments to value

- In considering licence endorsements we have included separate valuation information for line only licences and for net and line licences. We have seen no evidence to suggest that the valuations should be adjusted for other licence endorsements.
- In considering a valuation of licences where the value falls above the productive value of a licence to an average licence holder and the amalgamation points associated with the licence falls in the range of 11 to 18 points we would recommend the reduction of the value by half to reflect that two non-amalgamated licences would be required to achieve one transferable amalgamated licence.

Valuation method

- To determine the productive value of a licence held by the average Licence Holder we have calculated the value of the business of an average Licence Holder using the Discounted Cash Flow (DCF) method from which we have deducted the value of tangible assets employed.
- In determining our discount rates for the discounted cash flow method, we have analysed the trading results of broadly comparable listed companies (Comparable Listed Companies) and publicly available transactions involving companies with similar operations to the licence holders.

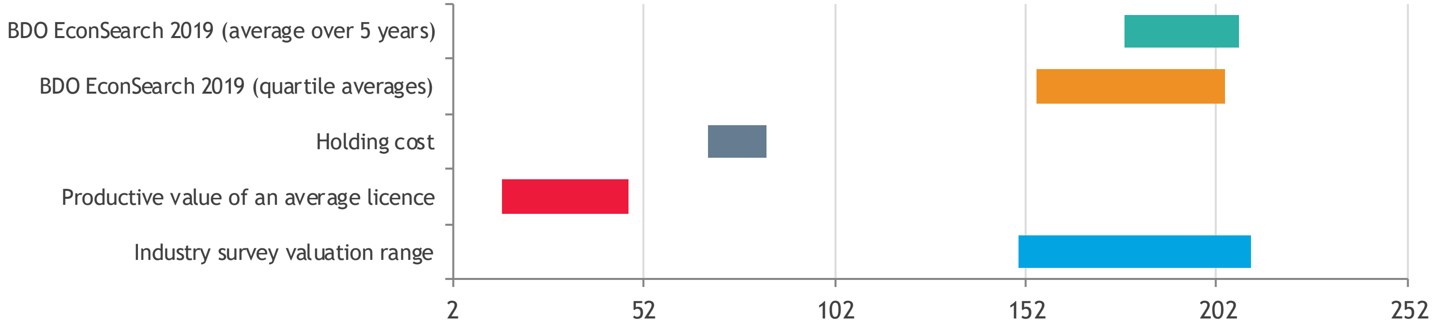
EXECUTIVE SUMMARY (CONT.)

Net and line licence valuation summary

- Financial returns for net and line licence holders is on average low.
- The productive value of a licence of an average licence holder is significantly lower than the transfer values, broker data and licence holder survey valuations.
- In our opinion a buyback at the productive value of a licence to an average licence holder would result in few, if any, buybacks.
- A buyback in the range of $150,000 to $211,000 would be greater or equal to the productive value achieved by the bottom 50% of the number of active net and line licence holders.

Net and line licence

Valuation Methodology	Low	High	Page
Industry survey valuation range	150	211	32
Productive value of an average licence	15	48	25
Holding cost	69	84	31
BDO EconSearch 2019 (quartile averages)	155	204	15
BDO EconSearch 2019 (average over 5 years)	178	208	30



Note: AUD in thousands
Source: BDO analysis

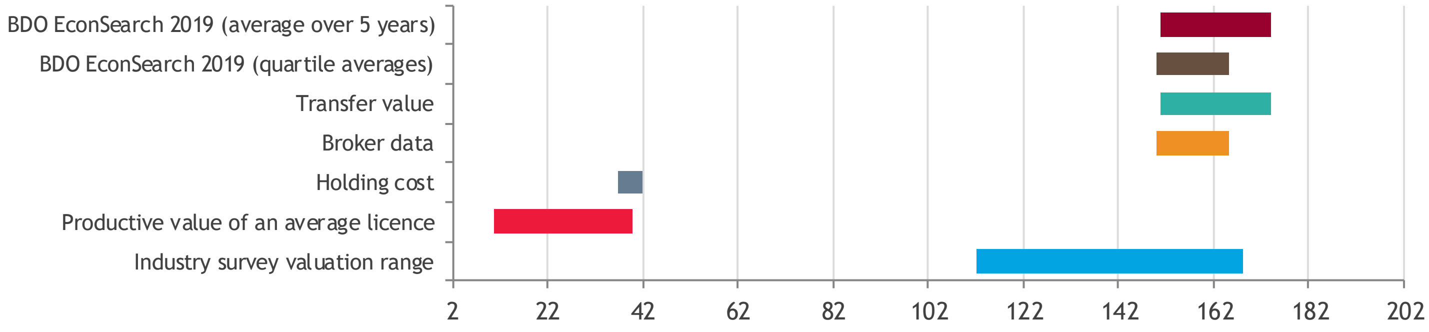
EXECUTIVE SUMMARY (CONT.)

Line only licence valuation summary

- Financial returns for line only licence holders is on average low.
- The productive value of a licence of an average licence holder is significantly lower than the transfer values, broker data and licence holder survey valuations.
- In our opinion a buyback at the productive value of a licence to an average licence holder would result in few, if any, buybacks.
- A buyback in the range of $112,000 to $168,000 would be greater or equal to the productive value achieved by the bottom 70% of the number of active line only licence holders.

Line only licence

Valuation Methodology	Low	High	Page
Industry survey valuation range	112	168	32
Productive value of an average licence	11	40	26
Holding cost	37	42	31
Broker data	150	165	30
Transfer value	151	174	30
BDO EconSearch 2019 (quartile averages)	150	165	30
BDO EconSearch 2019 (average over 5 years)	151	174	30



Note: AUD in thousands
Source: BDO analysis

SECTION 2

BACKGROUND

BACKGROUND
Data

Overview

- The 2017/18 data for licence holders in the MSF were derived using a range of primary and secondary data and survey-based FY16 indicators from the Economic and Social Indicators for the South Australian Marine Scalefish Fishery FY18 report (BDO EconSearch 2019). The following information was used to adjust the FY16 indicators to reflect the fishery's performance in FY18.
  - SARDI data were used to reflect changes in catch and its value between FY16 and FY18. Catch and value data were used to estimate the average total boat income in the fishery.
  - Information on change in fishing effort (number of days fished) between FY16 and FY18 was used to adjust the cost of inputs that were assumed to vary with fishing effort. These inputs included fuel, repairs and maintenance, ice and provisions.
  - The consumer price index (CPI) for Adelaide and components of the CPI were used to adjust the cost of inputs to reflect local levels of inflation (ABS 2018a).

Financial performance indicators

- Financial performance estimates for the MSF were estimated from a 2017 survey of licence holders (BDO EconSearch 2019) which represented 28% of the fishery.
- As a result of the large sample size in the 2017 survey it was possible to divide the survey responses into quartiles for all licences according to rate of return to capital.
  - line-only licence holders 47 in total
  - net licence holders 18 in total
- The first quartile comprises the 25% of boats with the lowest rate of return and the fourth quartile includes the 25% with the highest return to capital. The financial performance measures for 'return to capital' quartiles for FY18 are detailed for the whole fishery on page 13, line fishers on page 14 and for net fishers on page 15.

FINANCIAL PERFORMANCE

MSF licence holders

Financial performance of SA MSF licence holders by return to capital quartile, 2017/18 (average per boat)

[AUD]		Q1	Q2	Q3	Q4	Average
(1)	Total Boat Gross Income	67,589	65,462	108,677	223,412	119,376
	Variable Costs					
	Fuel	7,478	7,504	8,742	13,679	9,563
	Repairs & Maintenance	16,595	9,110	12,214	16,180	13,604
	Bait/Ice	2,393	2,144	3,808	4,066	2,983
	Provisions	853	2,275	1,858	1,084	1,548
	Labour - paid	9,407	7,659	16,863	16,582	12,797
(2)	Labour - unpaid	28,334	21,367	31,001	25,990	26,734
	Other variable costs	2,038	1,119	1,624	3,318	2,222
(3)	Total Variable Costs	67,097	51,180	76,109	80,897	69,451
	Fixed Costs					
	Licence Fee	8,304	6,603	9,334	7,732	7,908
	Insurance	2,395	2,146	2,551	3,525	2,699
(4)	Interest	2,165	2,009	690	9,302	3,715
(5)	Labour - unpaid	10,052	2,330	5,726	5,447	5,749
(6)	Leasing	-	-	1,043	9	230
	Legal & Accounting	987	2,116	1,200	1,538	1,459
	Telephone etc.	1,154	1,696	1,213	1,163	1,363
	Slipping & Mooring	474	1,301	1,250	1,019	992
	Travel	542	1,564	1,023	741	995
	Office & Admin	5,563	3,107	2,710	8,806	5,425
(7)	Total Fixed Costs	31,636	22,872	26,740	39,283	30,537
(8)	Total Boat Cash Costs (3+7)	98,733	74,052	102,850	120,181	99,988
	Boat Gross Margin (1-3)	492	14,282	32,567	142,514	49,925
(9)	Total Unpaid Labour (2+5)	38,386	23,698	36,727	31,436	32,484
	Gross Operating Surplus (1-8+9)	7,242	15,108	42,554	134,667	51,872
(10)	**Boat Cash Income (1-8)**	**(31,144)**	**(8,590)**	**5,827**	**103,231**	**19,388**

[AUD]		Q1	Q2	Q3	Q4	Average
(10)	**Boat Cash Income (1-8)**	**(31,144)**	**(8,590)**	**5,827**	**103,231**	**19,388**
(11)	Depreciation	12,134	17,387	15,696	19,674	16,964
(12)	**Boat Business Profit (10-11)**	**(43,278)**	**(25,976)**	**(9,869)**	**83,557**	**2,424**
(13)	**Profit at Full Equity (12+4+6)**	**(41,113)**	**(23,967)**	**(8,136)**	**92,868**	**6,370**
	Boat Capital					
(14)	Fishing Gear & Equip	54,337	128,053	153,917	171,614	129,313
	Licence Value	137,035	148,831	164,965	148,482	150,927
(15)	Total Boat Capital	191,373	276,884	318,882	320,096	280,240
	Rate of Return on Fishing Gear & Equip (13/14*100)	**-75.7%**	**-18.7%**	**-5.3%**	**54.1%**	**4.9%**
	Rate of Return on Total Boat Capital (13/15*100)	**-21.5%**	**-8.7%**	**-2.6%**	**29.0%**	**2.3%**

Note: Financial performance estimates for 2015/16 to 2017/18 are based on the 2017 licence holder survey (BDO EconSearch 2018).
Financial performance estimates may differ slightly from those reported in other BDO EconSearch reports (BDO EconSearch 2019) as different updating methods have been used in this analysis.
Repairs and maintenance costs have been classified as a variable cost although it is noted that some of these costs may be fixed (e.g. regulated maintenance).
Unpaid labour was divided between variable (time spent fishing and on repairs and maintenance) and fixed (management and administrative duties) based on survey responses.
Licence fee estimates are based on survey responses as individual fishing operations will pay different licence fees depending on their entitlements.
Source: BDO EconSearch analysis

FINANCIAL PERFORMANCE

Line entitlement only licence holders

Financial performance of line entitlement only licence holders by return to capital quartile, 2017/18 (average per boat)

[AUD]		Q1	Q2	Q3	Q4	Average
(1)	Total Boat Gross Income	52,206	53,216	87,060	210,595	104,087
	Variable Costs					
	Fuel	7,516	6,833	7,852	13,283	9,022
	Repairs & Maintenance	11,722	8,932	13,325	13,113	11,588
	Bait/Ice	1,849	1,439	4,904	4,674	3,238
	Provisions	1,117	413	1,573	1,713	1,189
	Labour - paid	2,014	4,584	18,331	16,147	10,253
(2)	Labour - unpaid	28,086	24,079	16,157	29,750	24,631
	Other variable costs	2,297	1,520	1,139	807	1,373
(3)	Total Variable Costs	54,602	47,799	63,280	79,488	61,293
	Fixed Costs					
	Licence Fee	6,819	6,196	7,126	5,177	6,310
	Insurance	2,873	1,910	2,213	3,187	2,584
(4)	Interest	2,670	1,661	864	8,091	3,434
(5)	Labour - unpaid	7,577	1,625	2,246	3,901	3,829
(6)	Leasing	-	-	1,217	11	314
	Legal & Accounting	824	1,247	2,202	1,461	1,411
	Telephone etc.	1,144	1,378	1,415	1,223	1,208
	Slipping & Mooring	263	1,630	1,511	1,226	1,169
	Travel	645	1,355	689	936	898
	Office & Admin	5,676	3,207	2,560	9,324	5,241
(7)	Total Fixed Costs	28,492	20,209	22,043	34,538	26,399
(8)	Total Boat Cash Costs (3+7)	83,094	68,008	85,323	114,025	87,693
	Boat Gross Margin (1-3)	(2,396)	5,417	23,781	131,107	42,793
(9)	Total Unpaid Labour (2+5)	35,664	25,704	18,403	33,651	28,460
	Gross Operating Surplus (1-8+9)	4,776	10,912	20,141	130,221	44,854
(10)	**Boat Cash Income (1-8)**	**(30,888)**	**(14,792)**	**1,737**	**96,570**	**16,394**

[AUD]		Q1	Q2	Q3	Q4	Average
(10)	**Boat Cash Income (1-8)**	**(30,888)**	**(14,792)**	**1,737**	**96,570**	**16,394**
(11)	Depreciation	10,703	11,851	16,328	19,079	14,829
(12)	**Boat Business Profit (10-11)**	**(41,592)**	**(26,643)**	**(14,590)**	**77,490**	**1,565**
(13)	**Profit at Full Equity (12+4+6)**	**(38,921)**	**(24,982)**	**(12,509)**	**85,592**	**5,312**
	Boat Capital					
(14)	Fishing Gear & Equip	50,556	101,564	160,612	185,052	127,046
	Licence Value	129,253	129,922	168,679	135,242	142,157
(15)	Total Boat Capital	179,808	231,486	329,291	320,294	269,202
	Rate of Return on Fishing Gear & Equip (13/14*100)	**-77.0%**	**-24.6%**	**-7.8%**	**46.3%**	**4.2%**
	Rate of Return on Total Boat Capital (13/15*100)	**-21.6%**	**-10.8%**	**-3.8%**	**26.7%**	**2.0%**

Note: Financial performance estimates for 2015/16 to 2017/18 are based on the 2017 licence holder survey (BDO EconSearch 2018).
Financial performance estimates may differ slightly from those reported in other BDO EconSearch reports (BDO EconSearch 2019) as different updating methods have been used in this analysis.
Repairs and maintenance costs have been classified as a variable cost although it is noted that some of these costs may be fixed (e.g. regulated maintenance).
Unpaid labour was divided between variable (time spent fishing and on repairs and maintenance) and fixed (management and administrative duties) based on survey responses.
Licence fee estimates are based on survey responses as individual fishing operations will pay different licence fees depending on their entitlements.
Source: BDO EconSearch analysis

FINANCIAL PERFORMANCE
Net licence holders

Financial performance by net licence holders by return to capital quartile, 2017/18 (average per boat)

[AUD]		Q1	Q2	Q3	Q4	Average
(1)	Total Boat Gross Income	122,919	138,386	185,083	168,822	155,551
	Variable Costs					
	Fuel	14,209	12,827	12,351	10,004	12,403
	Repairs & Maintenance	29,945	7,475	21,966	19,570	19,403
	Bait/Ice	6,405	1,007	342	2,109	2,823
	Provisions	1,007	8,935	1,369	230	2,679
	Labour - paid	33,591	20,645	23,565	11,509	20,968
(2)	Labour - unpaid	32,549	38,324	30,899	24,300	31,991
	Other variable costs	643	2,998	6,862	6,659	4,373
(3)	Total Variable Costs	118,349	92,211	97,354	74,381	94,640
	Fixed Costs					
	Licence Fee	13,307	14,068	10,453	10,491	12,285
	Insurance	1,364	3,441	4,463	3,045	2,849
(4)	Interest	622	1,243	4,236	7,116	4,244
(5)	Labour - unpaid	19,886	9,632	13,796	7,724	12,170
(6)	Leasing	-	-	-	-	-
	Legal & Accounting	3,233	1,043	1,335	1,478	1,852
	Telephone etc.	1,780	1,277	2,388	1,676	1,807
	Slipping & Mooring	1,302	261	438	432	588
	Travel	-	2,737	1,376	776	1,194
	Office & Admin	4,570	3,806	9,281	4,592	5,801
(7)	Total Fixed Costs	46,063	37,508	47,766	37,330	42,789
(8)	Total Boat Cash Costs (3+7)	164,413	129,719	145,120	111,710	137,429
	Boat Gross Margin (1-3)	4,570	46,175	87,728	94,441	60,912
(9)	Total Unpaid Labour (2+5)	52,436	47,957	44,695	32,023	44,161
	Gross Operating Surplus (1-8+9)	10,942	56,624	84,658	89,134	62,283
(10)	**Boat Cash Income (1-8)**	**(41,494)**	**8,667**	**39,963**	**57,111**	**18,122**

[AUD]		Q1	Q2	Q3	Q4	Average
(10)	**Boat Cash Income (1-8)**	**(41,494)**	**8,667**	**39,963**	**57,111**	**18,122**
(11)	Depreciation	16,786	31,030	26,906	16,878	22,595
(12)	**Boat Business Profit (10-11)**	**(58,280)**	**(22,363)**	**13,057**	**40,233**	**(4,472)**
(13)	**Profit at Full Equity (12+4+6)**	**(57,658)**	**(21,120)**	**17,292**	**47,349**	**(229)**
	Boat Capital					
(14)	Fishing Gear & Equip	110,199	188,107	186,111	118,064	140,399
	Licence Value	192,170	204,223	171,726	155,396	182,478
(15)	Total Boat Capital	302,369	392,330	357,837	273,460	322,877
	Rate of Return on Fishing Gear & Equip (13/14*100)	**-52.3%**	**-11.2%**	**9.3%**	**40.1%**	**-0.2%**
	Rate of Return on Total Boat Capital (13/15*100)	**-19.1%**	**-5.4%**	**4.8%**	**17.3%**	**-0.1%**

Note: Financial performance estimates for 2015/16 to 2017/18 are based on the 2017 licence holder survey (BDO EconSearch 2018).
Financial performance estimates may differ slightly from those reported in other BDO EconSearch reports (BDO EconSearch 2019) as different updating methods have been used in this analysis.
Repairs and maintenance costs have been classified as a variable cost although it is noted that some of these costs may be fixed (e.g. regulated maintenance).
Unpaid labour was divided between variable (time spent fishing and on repairs and maintenance) and fixed (management and administrative duties) based on survey responses.
Licence fee estimates are based on survey responses as individual fishing operations will pay different licence fees depending on their entitlements.
Source: BDO EconSearch analysis

ECONOMIC RENT

- Economic rent is defined as the difference between the price of a good produced using a natural resource and the unit costs of turning that natural resource into the good. In this case the natural resource is the MSF and the good produced is the landed fish.
- The unit costs or long term costs all need to be covered if the licence holder is to remain viable in the fishery. These long-term costs include direct operating costs such as fuel, labour (including the opportunity cost of a self-employed fisher's own labour), ice, overheads such as administration and licences and the cost of capital invested in the boat and gear (excluding licence). Capital cost includes depreciation and the opportunity cost of the capital applied to the fishery. The opportunity cost is equivalent to what the fisher's investment could have earned in the next best alternative use. What remains after the value of these inputs (labour, capital, materials and services) has been netted out is the value of the natural resource itself.
- Determining the opportunity cost of capital involves an assessment of the degree of financial risk involved in the activity. For a risk-free operation, an appropriate opportunity cost of capital might be the long-term real rate of return on government bonds. The greater the risks involved, the greater is the necessary return on capital to justify the investment in that particular activity. For this analysis the long term (10 year) real rate of return on government (treasury) bonds of 5% has been used and a risk premium of 5% has been applied.
- In the case of the SA MSF, there is evidence that a 5% risk premium (a component of the opportunity cost of capital) may be too high. The evidence includes the significant number of part-time fishers (who are less vulnerable to price fluctuations) and the existence of local markets (which are less vulnerable to exchange rate fluctuations). There is also evidence that the opportunity cost of labour (used to calculate the total value of unpaid labour) may be overestimated in the SA MSF as the average length of licence ownership was estimated at 20 years (BDO EconSearch 2019). Long-term ownership can create a barrier to exit and therefore licence holders could have a lower opportunity cost for time spent fishing.
- Economic rent (and its components) in the MSF between FY14 and FY18 is presented in **Table X [To Be Updated]** Economic rent has been estimated to be negative in the fishery over this period, with a sustained negative economic rent, licence values can be expected to decrease over time, however, estimated licence values have remained high (**Table Y and Table Z [To Be Updated]**) while rent has been negative. The table also presents a sensitivity analysis in the far-right column to show the effect of adjusting the opportunity cost of capital (using a risk premium of zero) and labour (valuing unpaid labour at two thirds of the standard estimate) on economic rent representing a positive, yet still low economic rent for the period.

Economic Rent in the SA MSF, FY14 to FY18

[AUD] in thousands	FY14	FY15	FY16	FY17	FY18
Gross income	24,396	26,461	23,266	23,361	22,806
Less labour	9,589	10,190	8,307	8,265	8,063
Less cash costs	11,235	12,526	9,993	9,920	10,622
Less depreciation	4,113	3,870	3,698	3,377	3,099
Less opportunity cost of capital (@10%)	3,224	3,034	2,703	2,468	2,266
Economic rent	**(3,765)**	**(3,158)**	**(1,434)**	**(669)**	**(1,243)**

Note: Values are presented in real FY18 dollars.
Cash costs include costs of materials and services and exclude labour and interest costs
Source: BDO Econsearch Analysis

ECONOMIC RENT FOOTNOTE FROM ECONSEARCH REPORT PAGE 8 [To Be Updated]

RESULTS

- Average licence values have been derived from the adjacent table and discussions with brokers where $150,000 was found for line only licences and $180,000 for net and line licences.
- From these averages, the boat cash EBITDA threshold was calculated to be $40,000 for line only and $44,000 for net and line. This indicates that those fishers who, at full opportunity cost of labour (boat cash income plus interest), earn less that their EBITDA threshold would benefit from the buyout at this valuation.
- The table opposite and below sets out the percentage of Licence Holders who fall below their respective threshold.
- For line only licence holders, 85% fall below their threshold, for net and line licence holders, 78% fall below their threshold and for those fishing over 150 days, 82% fall below their respective thresholds.
- As most fishers do not take a wage or may not value their time at $26 per hour, therefore a comparison was made against 50% of opportunity cost of labour (boat cash income plus interest and 50% of labour). This had 70% of line only licence holders below their threshold, 50% of net and line licence holders below their threshold and 46% of those fishing over 150 days below their respective thresholds.

Licence values for SA MSF, FY14 to FY18

	Transfer values	Licence Holder Valuation	
[AUD]	Line Only	Line Only	Net and Line
FY14	154,989	131,836	189,330
FY15	167,205	142,999	207,892
FY16	172,974	139,072	178,519
FY17	174,095	141,848	182,082
FY18	151,125	139,072	178,519

Note: Values are presented in real FY18 dollars
Licence holder values for FY14 to FY15 are based on the 2013 survey and FY16 to FY18 are based on the 2017 licence holder survey (BDO EconSearch 2018).
Source: BDO EconSearch analysis

	Full opportunity cost of labour	50% opportunity cost of labour
Net and line	78%	50%
Line only	85%	70%
<150 days	82%	46%

Source: BDO analysis

SECTION 3

VALUATION METHODOLOGY

VALUATION METHODOLOGY

Overview

There are a number of methodologies available with which to assess the indicative market value of a business. Appendix D sets out the common valuation methodologies that have been considered for the valuation of Licenses in the MSF. Common methodologies are outlined below:

- Discounted cash flow (DCF)
- Capitalisation of earnings (COE)
- Asset-based valuation (NAV)

Primary method - DCF method

- We have elected to use the DCF valuation methodology as our primary valuation methodology in valuing the Business for the following reasons:
  - the Business is in a high growth phase with irregular cash flows given its start up nature and the lack of track record in relation to its business operations and profitability
  - there is limited historical financial performance and it does not provide a reliable guide to future performance
  - the Business will require different rates of return during the initial years compared to the period from which growth rate stabilises and therefore requiring the application of varying discount rates.
- In applying the DCF valuation methodology, we have relied upon the cash flows from the Economic Indicators Report (BDO EconSearch 2019). We have used the cash flows to assist in building an appropriate model. We have relied on the assumptions of the Economic Indicators Report to build the Business cash flows.
- The DCF methodology allows the assessment of separate estimates of future earnings/ cash flows and varying levels of growth and so is well suited to determining the value of a Licence Holder Business.
- We do not consider that the NAV methodology is appropriate for a business valued as a going concern, particularly given that the methodology is being applied to determine the value of an intangible asset.

SECTION 4

DCF VALUATION

DCF VALUATION

Overview

- When performing a DCF valuation we must determine the following:
  - the expected future cash flows that the Licence Holder is expected to generate; and
  - an appropriate discount rate to apply to the cash flows to convert them to a present value equivalent.

Identification of future cash flows

- When performing a DCF valuation we must identify the nature, level and timing of the future cash flows expected to occur.
- In applying this method, the first step is to project the debt-free cash flow that the Licence Holder will generate in the future. Boat cash income for licence holders for FY18 (average per boat) was determined by BDO EconSearch (page 13).
- Interest costs have been added back to the boat cash income determined by BDO EconSearch to reflect the debt-free cash flow of a Licence Holder.
- PIRSA have asked us to assume that licences will be held in perpetuity for the purposes of the Report.
- Based on our assessment of economic and industry growth outlooks, no growth has been factored into the projected cash flows used in compiling our DCF valuation.
- The terminal year projections were prepared based upon a continuation of FY18 cash flows assuming no industry growth and no change in income tax rates.

DISCOUNT RATE

DCF valuation - discount rate

- The discount rate represents the following:
  - the time value of money
  - the required rate of return
  - the risk of achieving projected future cash flows.
- The discount rate is the rate at which future cash flows are discounted to arrive at the present day value of those cash flows.
- Future cash flow is converted to a present value equivalent using an estimated discount rate such as the cost of equity or the weighted average cost of capital (WACC), based on the type of cash flows being discounted.
- The discount rate or required rate of return is a combination of the opportunity cost (what an investor could earn from a risk-free investment such as a Government bond) plus a risk premium (a premium for the risk associated with obtaining the expected returns from the particular investment).
- The WACC is an average cost of capital consisting of two parts:
  - cost of debt
  - cost of equity

Cost of debt

- The Licence Holder’s capital structure is likely to include debt.
- A commercial rate for unsecured debt to the Licence Holder we would estimate at 5.75%

Cost of equity

- The Company has no commercial debt instruments at the Date of Valuation. The Licence Holder’s capital structure is likely to include debt.
- The cost of equity was assessed by applying the capital asset pricing model (“CAPM”).

$$CAPM = rf + \beta(rm - rf)$$

Where:

r_f	represents the risk free rate;
β	represents the beta of the company; and
$(r_m - r_f)$	represents the market risk premium and is equal to the additional return that an investor would require to invest in a fully diversified market portfolio rather than at the risk free rate.

DISCOUNT RATE (CONT.)

Cost of equity

Risk free rate

- We note that Commonwealth Treasury bond yields are currently at historically low levels. It should be noted that the current low yield levels may not persist over the medium to long term.
- Having regard to the above, we have selected the risk free rate based on the 10 year Australian Government Bond rate on the Date of Valuation of 1.38%.

Beta estimation

- It is conventional practice to refer to comparable companies listed on stock exchanges to determine the appropriate equity beta to use in the CAPM. We have considered the equity betas of comparable companies against the S&P / ASX 200 Index using daily and weekly data over the past two to four years as at 31 December 2018. Further information on the comparable companies is in Appendix E.
- Equity betas are the commonly cited measure of the sensitivity of a company's share price to movements in the overall market. To ensure that the betas of these companies are comparable to the Licence Holders, the observed equity betas have been adjusted to remove the impact of the debt in their capital structures. Debt tends to increase the riskiness of a company's cash flows and will therefore increase the sensitivity of a company's returns to market movements. That is, debt serves to inflate equity betas.
- Adjustments to remove the impact of debt allow for the calculation of an ungeared beta. Ungeared betas provide a measure of the sensitivity of a company's returns to movements in the overall market, independent of a company's capital structure. These betas are more appropriate to consider when comparing companies with different capital structures.
- Appendix E sets out the equity betas and ungeared betas we have had regard to, which in our opinion, may be considered broadly comparable companies. The ungeared betas of the broadly comparable companies have been calculated having regard to the capital structures of each company.
- We have performed an analysis of the Betas of the broadly comparable companies with involvement in the aquaculture industry as at 31 December 2018. In our opinion, an ungeared Beta of 0.7 to 0.8 is appropriate for comparably listed companies within the Aquaculture industry

Market risk premium

- To assess an appropriate market risk premium ('MRP'), I have had regard to BDO’s analysis of recent historic Equity Market Risk Premiums in Australia. This research indicates that market risk premiums can be estimated within the range of 6.0% to 8.0%.

Required Return on Equity Estimate

- The assumptions applied in the CAPM included the following:
  - a risk-free rate of 1.38%;
  - the expectation of 25% debt in the Licence Holder’s capital structure; and
  - a market risk premium of 6% to 8%;
- Combining these assumptions yields a cost of equity of 6.6% to 9.3%
- We note that the comparable companies are considerably larger and more diversified companies than the business operations undertaken by the Licence Holders in the SA MSF.
- In our opinion, it is appropriate to apply an Alpha of 4.0% to account for the small size and lack of diversification of the Licence Holders in the SA MSF,
- The required return on equity for a Licence Holders in the SA MSF calculates a range of approximately 10.6% to 13.3%.

WACC

WACC calculation

- The formula used to calculate the WACC is:

$$WACC = re \times EV + rd \times DV \times 1 - \tau$$

Where:

r_e	represents the required return on equity;
$\frac{E}{V}$	represents the portion of the capital that is equity;
r_d	represents the required return on debt;
$\frac{D}{V}$	represents the portion of the capital that is debt; and
τ	represents the tax rate

Balance sheet structure

- In determining the appropriate level of debt for a WACC calculation, the level of debt relates to the debt that can be secured by business income streams and business assets. Where debt is secured by personal guarantee or non-business assets, that debt would be considered equity for the purposes of the WACC calculation.
- A licence will provide a loan value ratio to a financier in the range of 20 to 25%. This is consistent with the survey results of interest expense as a proportion of boat cash income for Q2, Q3 and Q4 net and line licence holders. We consider that an appropriate proportion of the capital that is debt in undertaking the WACC calculation is 25%.
- Accordingly, the portion of capital that is equity is 75%.

Tax rate

- The small business entity company tax rate is 27.5%. In our opinion, a tax rate of 27.5% is appropriate.

- The inputs considered for the WACC calculation are summarised in the table below.

Description	Low	High
r_e	10.6%	13.3%
$\frac{E}{V}$	75%	75%
r_d	5.75%	5.75%
$\frac{D}{V}$	25%	25%
τ	27.5%	27.5%
WACC	**9.0%**	**11.0%**

Source: BDO analysis

VALUATION OF A LICENCE
Net and line licence

Business value

- To determine the productive value of a licence held by the average net and line Licence Holder we have calculated the value of the business of an average net and line Licence Holder from which we will deduct the value of tangible assets employed.
- To determine the value of the business of an average net and Licence Holder we have calculated the perpetual value of the after tax cash flow of the business as follows:
  - The interest cost for an average Licence Holder has been added back to the average boat cash income, determined by BDO EconSearch, to calculate average boat cash EBITDA for FY18 for an average net and line Licence Holder.
  - We calculated the effective taxes (at 27.5%) to determine the debt-free cash flow to be used in the DCF calculation.
- Our calculation of the boat debt-free cash flow for FY18 is set out below.

	[AUD] in thousands	Page Ref
Boat cash income for an average licence	18	13
Add: Interest cost for an average licence	4	13
Boat cash EBITDA	22	
Less: Effective taxes (27.5%)	(6)	
Boat debt-free cash flow	**16**	

Source: BDO EconSearch analysis and BDO analysis

- The inputs in the DCF calculation model are:
  - Average boat debt-free cash flow $16,215;
  - 0% growth factor; and
  - Discount rate (WACC) 9.0% to 11.0% (see page 22).
- Based upon the above and our calculations set out in Appendix F, the value of the business of an average net and line Licence Holder is in the range of approximately $155,300 and $188,100.

Licence value

- Although the value of a business can comprise such things as reputation, customer loyalty, staff loyalty, proprietary processes, brand identity and recognition, for the purposes of the Report we have assumed that
- A Licence Holder’s business generally consists of two major asset categories, fishing equipment and the licence(s).
- To determine the value of the licence in the Licence Holder’s business, we have deducted the average value of fishing gear and equipment from the business value. This leaves the remaining value to be attributed to the remaining assets of the business, being the licence.
- The average value of fishing equipment for an average net and line Licence Holder provided by BDO EconSearch is $140,000.
- The calculation of the implied value of an average net and line licence is set out below.

[AUD] in thousands	Low	High	Page Ref
Business value of an average net and line Licence Holder	155	188	23
Less: Average fishing equipment	(140)	(140)	24
Implied licence value	**15**	**48**	

Source: BDO analysis

- Based upon the above, we have determined the productive value of a net and line licence of an average net and line Licence Holder to be in the range of $15,000 to $48,000.
- In our opinion a buyback at the productive value of a net and line licence of an average net and line Licence Holder would result in few, if any, buybacks.

VALUATION OF A LICENCE (CONT.)

Line only licence

Business value

- To determine the average productive value of a line only licence we have calculated the value of the business of an average line only Licence Holder. **[To Be Updated]** .
- Our calculation of the boat debt-free cash flow for a line only Licence Holder for 2017/18 is set out below.

	[AUD] in thousands	Ref
Boat cash income for an average licence	16	13
Add: Interest cost for an average licence	3	13
Boat cash EBITDA	19	
Less: Effective taxes (27.5%)	(5)	
Boat debt-free cash flow	**14**	

Source: BDO EconSearch analysis and BDO analysis

- Based upon the above, the value of the business of an average line only Licence Holder is in the range of approximately $137,700 and $166,700.

Licence value

- The calculation of the implied value of an average line only licence is set out below.

[AUD] in thousands	Low	High	Page Ref
Business value of an average net and line Licence Holder	138	167	23
Less: Average fishing equipment	(127)	(127)	24
Implied licence value	**11**	**40**	

Source: BDO analysis

- Based upon the above, we have determined the productive value of a line only licence of an average line only Licence Holder to be in the range of $11,000 to $40,000.
- In our opinion a buyback at the productive value of a line only licence of an average line only Licence Holder would result in few, if any, buybacks.

VALUATION OF A LICENCE (CONT.)

Licence value

- The table opposite shows the calculated business value and average productive value of a licence for both net and line and line only Licence Holders.
- The Licence Holders have been divided into quartiles according to rate of return to capital by BDO EconSearch.

BDO comments

- Net and line Licence Holders in Q1 and Q2 have an average productive licence value of nil.
- Surprisingly, the >150 days fishers indicate an average productive licence value of nil.
- The financial returns of Q3 net and line Licence Holders would be more indicative of likely purchasers of a net and line Licence.
- Line only Licence Holders in Q1, Q2 and Q3 have an average productive licence value of nil.
- The financial returns of >150 days line only Licence Holders would be more indicative of likely purchasers of a Line Licence, albeit much higher than our crosscheck values.

Business and licence value by quartile

			Business value			Licence value	
			Low	High		Low	High
[AUD] in thousands	Revenue	Boat cash EBITDA	9.0%	11.0%	Fishing Equipment		
Net and Line							
Q1	123	(41)	-	-	110	-	-
Q2	142	10	69	83	188	-	-
Q3	182	44	307	372	181	125	190
Q4	190	64	446	540	100	346	440
Average	159	22	155	188	140	15	48
> 150 days	182	(17)	-	-	177	-	-
Line Only							
Q1	46	(28)	-	-	64	-	-
Q2	44	(13)	-	-	133	-	-
Q3	105	3	18	22	154	-	-
Q4	231	105	727	880	161	565	719
Average	104	20	138	167	127	11	40
>150 days	150	48	332	403	113	220	290
Q3 & Q4	168	54	372	451	157	215	294

Source: BDO EconSearch analysis and BDO analysis

ADJUSTMENTS TO VALUATION OF A LICENCE

Endorsements

- Based upon our discussion with Brokers and in reviewing the transfer information available the only licence endorsement that indicated a difference in valuation was a net endorsement.
- We have included separate valuation information for line only licences and for net and line licences. We have seen no evidence to suggest that the valuations should be adjusted for other licence endorsements.

Amalgamation

- Our discussion with brokers was that the only licence transfers that they had undertaken were for amalgamated licences.
- The productive value of a licence to an average licence holder will be the same regardless of whether the licence is an amalgamated licence or not.
- In considering a valuation of licences where the value falls above the productive value of a licence to an average licence holder and the amalgamation points associated with the licence falls in the range of 11 to 18 points we would recommend the reduction of the value by half to reflect that two non-amalgamated licences would be required to achieve one transferable amalgamated licence.

SECTION 5

VALUATION CROSSCHECK

VALUATION CROSSCHECK

In addition to considering the productive value of a licence to an average licence holder we have considered alternative indicators of value.

Historic licence transfers and licence holder valuations

- The table opposite details average MSF licence transfer values against average licence holder valuation of their licences for the years FY14 to FY18. The transfer averages were derived from PIRSA data regarding SA MSF licence transfers, all of which have an amalgamation points value of 24 or above. All transfer values are for line only licences as there is no available data on the transfer value of net endorsed licences. Transfers with a value under $100,000 were excluded from the calculations as many of the amounts clearly reflected an annual leasing value rather than a permanent transfer.
- The average reported transfer value for a line only MSF licence increased between FY14 and FY17 from $155,000 to $174,000.
- Licence holder valuations fluctuated throughout the period, reaching a peak of $143,000 for line only licences and $208,000 for net and line licences in FY15.
- Net and line licences were valued by licence holders $40,000 to $65,000 more valuable than line only licences.
- In FY18, the average reported transfer value for line only licences and licence holder valuations for net and line licences dropped to the lowest levels in the 5 year period.

Licence broker discussions

- In discussions with MSF Brokers, we received confirmation that licence transfer values are around the same price point that licences have been sold for over the same period.
- Licence values for line only licences ranged from $150,000 to $165,000 between FY14 and FY16 with no reported transactions after that time.
- Transfers of net and line licences had been as high as $300,000 and had declined in recent years.

Aggregate value of MSF licences

- The adjacent table indicates the aggregate value of licences based upon the BDO EconSearch analysis and we particularly note that the aggregate value for the period from 2001 through 2005 is similar to the value from 2014 through 2018.

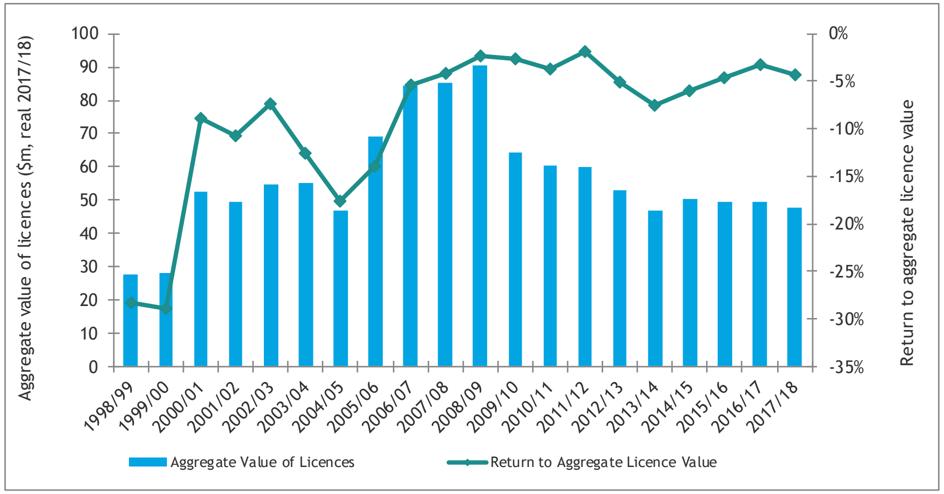
Licence values for SA MSF, FY14 to FY18

	Transfer values	Licence Holder Valuation	
[AUD]	Line Only	Line Only	Net and Line
FY14	154,989	131,836	189,330
FY15	167,205	142,999	207,892
FY16	172,974	139,072	178,519
FY17	174,095	141,848	182,082
FY18	151,125	139,072	178,519

Note: Values are presented in real FY18 dollars
Licence holder values for FY14 to FY15 are based on the 2013 survey and FY16 to FY18 are based on the 2017 licence holder survey (BDO EconSearch 2018).

Source: BDO EconSearch analysis

Aggregate value of MSF licences and return



Source: BDO EconSearch analysis

VALUATION CROSSCHECK (CONT.)

Licence holding cost

- As a crosscheck to our primary methodology we have considered the holders of inactive licences to be investors that are looking to hold the licences for ultimate sale.
- We note that there are 22 licences held within the fishery that are not active.
- The annual cost of holding a line only licence is approximately $5,000 pre annum.
- The annual cost of holding a net and line licence is approximately $10,000 per annum.
- We considered that an alternative investment return in the current market place would be in the range of 6.0% to 8.0%.
- Alternatively we have considered the investment return using the discount rates that we have calculated for industry risk.
- The comparisons are set out in the tables below.

Licence holding cost - investment

[AUD] in thousands		8.0%	6.0%
Line holding cost	5,000	47,100	62,200
Net holding cost	10,000	94,200	124,400

Source: BDO analysis

Licence holding cost - industry

[AUD] in thousands		11.0%	9.0%
Line holding cost	5,000	37,400	42,000
Net holding cost	10,000	69,400	84,100

Source: BDO analysis

BDO Comments

- The expected capital returns to an investor in a non-active licence is likely indicative of a minimum value of a licence.
- The better indication of minimum value would be represented by the perpetual holding costs discounted for industry risk.

VALUATION CROSSCHECK (CONT.)

Industry values

- The Licence values for FY14 to FY15 based on the 2013 survey and FY16 to FY18 based on the 2017 licence holder survey (BDO EconSearch 2018) together with the values indicated by the transfer values and broker discussions suggest licence values approximating $180,000 for net and line licences and $140,000 for line only licences.

Implied Boat Cash EBITDA

- We have considered the implied level of Boat cash EBITDA based upon the licence values implied within the industry.
- The table below shows implied Boat Cash EBITDA for both line only and net and line licence holders.

[AUD] in thousands	Boat cash EBITDA	Business value Low 9.0%	Business value High 11.0%	Fishing Equipment	Industry survey licence value Low	Industry survey licence value High
Net and Line	44	290	350	140	150	211
Line Only	40	263	317	150	112	168

Source: BDO analysis

- A net and line licence holder generating Boat Cash EBITDA of $44,000 per annum calculates a licence value in the range of $150,000 to $211,000 with a midpoint value of $180,000.
- A line only licence operator generating Boat Cash EBITDA of $40,000 per annum calculates a licence value in the range of $112,000 to $168,000 with a midpoint value of $140,000.

Licence Holders below average boat cash EBITDA

- We have reviewed the survey results for FY18 to determine the quantity of operators that fall below the implied Boat Cash EBITDA levels.
- We consider that these participants would be within the pool of licence holders likely to consider a buyback at the indicated value.
- The Boat Cash EBITDA includes an expense item for unpaid wages of a licence holder calculated at approximately $28 per hour. We further considered the number of participants with a financial return less than the Implied Boat Cash EBITDA where the unpaid labour expense is halved to $14 per hour.
- The results are summarised below:

	Full opportunity cost of labour	50% opportunity cost of labour
Net and line	78%	50%
Line only	85%	70%
<150 days	82%	46%

Source: BDO analysis

- Assuming an industry value of $180,000 for a net and line licence we have assessed an implied Boat Cash EBITDA of $44,000 and 78% of active net and line licence holders would generate a financial return below this level (50% when the expense for unpaid labour is reduced by half).
- Assuming an industry value of $140,000 for a line licence we have assessed an implied Boat Cash EBITDA of $40,000 and 85% of industry participants would generate a financial return below this level (70% when the expense for unpaid labour is reduced by half).

SECTION 6

APPENDICES

APPENDIX A
Draft Terms of Reference

Valuation of Licences in the Marine Scalefish Fishery

Draft Terms of Reference

1. Background

The Government of South Australia is committed to delivering reform in the commercial Marine Scalefish Fishery. The Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) has been established by the Minister for Primary Industries and Regional Development to develop, in consultation with licence holders and key stakeholders in the South Australian Marine Scalefish Fishery, recommendations on a reform package for the fishery that include:

- Introducing zones of management within the fishery that recognise the economic, ecological and social diversity within the fishery;
- Achieving fleet rationalisation that secures a minimum of 30% reduction in the total number of licences;
- Implementing key management reforms, including a system of regional individual transferable quotas, that will achieve a more sustainable and commercially viable fishery and a mechanism to facilitate on-going autonomous adjustment;

The CMSFRAC is required on or before 31 July 2019 to deliver to the Minister a report that includes, among other things:

- A recommended approach, detailing the method, timeframes and estimated expenditures, to achieve a minimum 30% reduction in the total number of licences in the Marine Scalefish Fishery.

To assist the CMSFRAC to deliver on this aspect of the reform package, in particular the estimated expenditure required to rationalise the number of licences, estimated current values of licences are required.

2. Terms of Reference

To provide to the Executive Director Fisheries and Aquaculture:

1. A review of possible methods to value a South Australian commercial fishing licence
2. The most suitable method to be used and the information required, to estimate the value of alternative licence categories in the MSF.
3. An estimate of the current minimum and maximum values of alternative licence categories taking into account the factors that may differentiate the value of licences in the MSF including registered fishing gear, amalgamation points, and any other entitlements that may differ between licences.

The Executive Director Fisheries and Aquaculture will provide required information and statistics available in databases held by PIRSA Fisheries and Aquaculture and SARDI Aquatic Sciences

Consideration should be given to the fishing gear that is registered on licences, in particular Hauling Net, Gill Net, Longline and Dropline, and any other gear type that may influence the market value of a licence.

Any catch quota entitlements held by individual licence holders in the Marine Scalefish Fishery, including those associated with Sardine, Vongole, Blue Swimmer Crabs, Goolwa Pipis and Western Australian Salmon are not to be included in the valuations.

Appropriate consultation with the Marine Fishers Association is expected to seek industry input and feedback on the approach to be taken to estimate the current value of licences, and with industry brokers commonly used for the trading of fishing licences.

A report is requested to be delivered to the Executive Director Fisheries and Aquaculture by COB Wednesday 31 July 2019.

APPENDIX B

Sources of information

- BDO EconSearch 2019, Economic and Social Indicators for the South Australian Marine Scalefish Fishery 2017/18, report prepared for PIRSA Fisheries and Aquaculture, Adelaide, July 2019.
- Publicly available information on comparable companies published by Capital IQ.
- Reserve Bank of Australia statistics www.rba.gov.au
- IBISWorld Industry Report – A0410 Fishing In Australia – July 2018

APPENDIX C
Consent and disclaimers

APES 225

This Report has been prepared in accordance with the requirements of APES 225 Valuation Services. The valuation is defined as a 'limited scope valuation' as per APES 225, given the extent of contemporaneous information at the respective valuation dates was limited, as well as the limited procedures BDO has undertaken in relation to management's normalisation adjustments to the earnings of the company.

Limitations

By its very nature, the formulation of a valuation opinion necessarily contains significant uncertainties and the conclusions arrived at, in many cases, will be subjective and dependent on the exercise of individual judgement. Therefore, there is no indisputable value, and we normally express our opinion as falling within a likely range.

Valuation Date

Our opinion is based on economic, market and other conditions prevailing at each Valuation Date. Such conditions can change significantly over relatively short periods of time.

Accordingly, changes in those conditions may result in the valuation becoming quickly outdated and in need of revision. We reserve the right to revise any valuation, or other opinion, in the light of material information existing at each Valuation Date that subsequently becomes known to us.

Use of Report

Our Report is prepared solely for the directors and management of Brett & Watson, and the purpose set out herein.

We do not accept any responsibility for the use of the Report outside this purpose or by any other parties. Except in accordance with the stated purpose, no extract, quote, or copy of our Report, in whole or in part, should be reproduced without our written consent, as to the form and context in which it may appear

No Verification

Our procedures in the preparation of this Report have involved an analysis of financial information and accounting records. As set out in this Report, the work undertaken does not include verification work nor constitute an audit or assurance engagement in accordance with Australian Auditing and Assurance Standards issued by the Australian Auditing and Assurance Standards Board (AUASB). Accordingly, we do not warrant that our inquiries have identified or verified all of the matters which an audit, extensive examination or "due diligence" investigation might disclose.

Reliance on Information

In preparing this Report, we have relied on information provided by Brett & Watson. We have not undertaken any verification of the financial or other information provided by them, or other parties, as set out in this Report. We believe the information provided to be reliable, complete and not misleading and have no reason to believe that any material facts have been withheld. The information provided was evaluated through analysis, inquiry and review for the purpose of satisfying ourselves that there were reasonable grounds for believing that the information was appropriate for use by us in forming our opinion. Where we have relied on the views and judgement of Brett & Watson, the information was also evaluated through analysis, inquiry and review to the extent practical. However, such information is often not capable of external verification or validation.

Brett & Watson has agreed to indemnify BDO and their partners, directors, employees, officers and agents (as applicable) against any claim, liability, loss or expense, costs or damage, arising out of reliance on any information or documentation provided by Brett & Watson, which is false and misleading or omits any material particulars, or arising from failure to supply relevant documentation or information.

APPENDIX D
Common business valuation methodologies

Overview

In conducting our assessment of the indicative market value, the following commonly used business valuation methodologies have been considered.

DCF Method

The DCF method is based on the premise that the value of a business or any asset is represented by the NPV of its future cash flows. It requires two essential elements:

- The forecast of future cash flows of the business asset for a number of years (usually five to 10 years); and
- The discount rate that reflects the riskiness of those cash flows used to discount the forecast cash flows back to the businesses' or project's NPV.

DCF is appropriate where:

- The businesses' earnings are capable of being forecast for a reasonable period (preferably five to 10 years) with reasonable accuracy;
- Earnings or cash flows are expected to fluctuate significantly from year to year;
- The business or asset has a finite life;
- The business is in a 'start up' or in early stages of development;
- The business has irregular capital expenditure requirements;
- The business involves infrastructure projects with major capital expenditure requirements; and
- The business is currently making loss but is expected to recover

COE Method

The COE method involves the capitalisation of estimated future maintainable earnings by an appropriate multiple.

Maintainable earnings are the assessed sustainable profits that can be derived by the business, excluding any one off profits or losses.

An appropriate earnings multiple is assessed by reference to market evidence as to the earnings multiples of broadly comparable companies.

This method is suitable for the valuation of businesses with indefinite trading lives and where earnings are relatively stable or a reliable trend in earnings is evident.

APPENDIX D

Common business valuation methodologies (cont.)

Net Realisable Value of Assets

Asset based valuations involve the determination of the fair value of a business based on the net realisable value of the assets used in the business.

Valuation of net realisable assets involves:

- Separating the business or entity into components that can be readily sold, such as individual business units or collection of individual items of plant and equipment and other net assets; and
- Ascribing a value to each based on the net amount that could be obtained for this asset if sold.

The net realisable value of the assets can be determined on the basis of:

Orderly realisation

This method estimates fair value by determining the net assets of the underlying business including an allowance for the reasonable costs of carrying out the sale of assets, taxation charges and the time value of money assuming the business is wound up in an orderly manner. This is not a valuation on the basis of a forced sale where the assets might be sold at values materially different from their fair value.

Liquidation

This is a valuation on the basis of a forced sale where the assets might be sold at values materially different from their fair value.

Going concern

This method estimates the market value of the net assets but does not take into account any realisation costs. This method is often considered appropriate for the valuation of an investment or property holding company. Adjustments may need to be made to the book value of assets and liabilities to reflect their going concern value.

These approaches ignore the possibility that a company's value could exceed the realisable value of its assets.

The net realisable value of a trading company's assets will generally provide the lowest possible value for the business. The difference between the value of the company's identifiable net assets (including identifiable intangibles) and the value obtained by capitalising earnings is attributable to goodwill.

The net realisable value of assets is relevant where a company is making sustained losses or profits but at a level less than the required rate of return, where it is close to liquidation, where it is a holding company, or where all of its assets are liquid.

It is also relevant to businesses that are being segmented and divested and to value assets that are surplus to the core operating business. The net realisable assets methodology is also used as a check for the value derived using other methods.

APPENDIX E
Comparable companies

Company	Ticker	Market cap ($m)	Geared Beta	Gross Debt to Equity %	Ungeared Beta	Company Description	Beta source
Angel Seafood Holdings Limited (ASX:AS1)	ASX:AS1	18.298	0.779	8%	0.737	Angel Seafood Holdings Limited produces, manufactures, markets, and sells organic oysters in Australia and internationally. The company was incorporated in 2016 and is headquartered in Coffin Bay, Australia.	2 yr daily
Beston Global Food Company Limited (ASX:BFC)	ASX:BFC	66.497	0.893	18%	0.795	Beston Global Food Company Limited, together with its subsidiaries, engages in the manufacture and sale of food and beverage products in Australia and internationally. It operates in four segments: Dairy, Seafood, Health, and Meat. The company owns dairy farms that offer milk, cheese, and other dairy related products; harvests, processes, packages, and distributes live, chilled, and frozen seafood; and produces and processes meat products. It also develops and produces health and well-being focused food, beverage, and pharmaceutical products; processes high pH natural spring water; and develops and commercializes end-to-end food traceability and anti-counterfeit technology solutions, as well as a food e-commerce platform. In addition, the company markets and distributes dairy, seafood, meat, wine, water, health, and nutrition products. Beston Global Food Company Limited was incorporated in 2014 and is based in Adelaide, Australia.	2 yr weekly
Clean Seas Seafood Limited (ASX:CSS)	ASX:CSS	89.343	0.674	3%	0.659	Clean Seas Seafood Limited operates in the aquaculture industry in Australia and internationally. It operates through two segments, Finfish Sales and Tuna Operations. The company engages in the propagation, harvesting, production, and marketing of Hiramasa yellowtail kingfish; and production and sale of fingerlings, mulloways, and tuna. It is also involved in the research and development activities for the production of southern Bluefin tuna. The company serves seafood distributors and wholesalers. Clean Seas Seafood Limited was founded in 2000 and is based in Port Lincoln, Australia.	3yr daily

APPENDIX E
Comparable companies

Company	Ticker	Market cap ($m)	Geared Beta	Gross Debt to Equity %	Ungeared Beta	Company Description	Beta source
Huon Aquaculture Group Limited (ASX:HUO)	ASX:HUO	410.485	0.572	27%	0.481	Huon Aquaculture Group Limited, together with its subsidiaries, hatches, farms, processes, markets, and sells Atlantic salmon and ocean trout in Australia. It also exports its products internationally. The company was founded in 1986 and is headquartered in Dover, Australia. Huon Aquaculture Group Limited is a subsidiary of Surveyors Investments Pty Ltd.	2 yr weekly
Murray Cod Australia Limited (ASX:MCA)	ASX:MCA	76.623	0.828	3%	0.813	Murray Cod Australia Limited, together with its subsidiaries, engages in the breeding, growing, and marketing of Murray Cod fish in Australia. It also constructs and sells aquaculture equipment. The company serves restaurants, wholesalers, and Asian export markets. Murray Cod Australia Limited is headquartered in Griffith, Australia.	4 yr weekly
Mareterram Limited (ASX:MTM)	ASX:MTM	29.362	0.510	78%	0.331	Mareterram Limited engages in the integrated agribusiness in Australia and internationally. It processes, packages, snap freezes, sells, and markets western king prawns, brown tiger prawns, scallops, blue swimmer crabs, squids, and cuttlefishes. The company was formerly known as Style Limited and changed its name to Mareterram Limited in November 2015. Mareterram Limited was incorporated in 1987 and is headquartered in South Fremantle, Australia. Mareterram Limited is a subsidiary of Sea Harvest International Pty Ltd.	3yr daily
New Zealand King Salmon Investments Limited (ASX:NZK)	ASX:NZK	302.085	0.698	6%	0.668	New Zealand King Salmon Investments Limited engages in farming, processing, and selling premium salmon products. It operates through three segments: New Zealand Retail, New Zealand Foodservice, and Export. It offers whole fresh fish, pre-cut fillets, portions, and wood roasted and cold smoked products. The company sells its products to chefs, retailers, and wholesalers under the Ora King, Regal, Southern Ocean, Big Catch Salmon Burley, and Omega Plus brands. It serves customers in New Zealand, North America, Australia, Japan, Europe, and internationally. The company was incorporated in 2008 and is headquartered in Nelson, New Zealand. New Zealand King Salmon Investments Limited is a subsidiary of Oregon Group Limited.	3yr weekly

APPENDIX E
Comparable companies

Company	Ticker	Market cap ($m)	Geared Beta	Gross Debt to Equity %	Ungeared Beta	Company Description	Beta source
Ocean Grown Abalone Limited (ASX:OGA)	ASX:OGA	24.375	0.714	1%	0.707	Ocean Grown Abalone Limited owns and operates an abalone sea ranching business in Australia. It develops its sea ranching hardware design and processes for near-shore aquaculture. The company produces wild, ocean grown, and green lip abalones. The company offers its products under the Two Oceans Abalone brand name. Ocean Grown Abalone Limited was incorporated in 2011 and is based in Augusta, Australia.	2 yr daily
Seafarms Group Limited (ASX:SFG)	ASX:SFG	183.396	1.194	114%	0.665	Seafarms Group Limited, an aquaculture company, produces and sells seafood in Australia and Vietnam. The company operates in three segments: Aquaculture, Carbon Services, and Other. It is involved in the growing, processing, and distribution of farmed prawns under the Crystal Bay Prawns brand; and the development of land-based aquaculture projects. The company also establishes and manages carbon sinks and re-vegetation projects; provides abatement certificates generated from accredited forest carbon sinks; and trades in environmental credits. In addition, it offers carbon project management services; and environmental services, including advisory in ecosystem offsets and carbon farming projects. The company was formerly known as Commodities Group Limited and changed its name to Seafarms Group Limited in March 2015. Seafarms Group Limited is based in Perth, Australia.	2 yr daily
Tassal Group Limited (ASX:TGR)	ASX:TGR	783.506	1.111	23%	0.958	Tassal Group Limited, together with its subsidiaries, engages in the hatching, farming, processing, marketing, and sale of Atlantic salmon in Australia. The company offers fresh deli, fresh salmon, smoked salmon, and canned salmon. It also procures, processes, markets, and sells other seafood species. The company provides its products under the Tassal, Superior Gold, Tasmanian Smokehouse, and De Costi Seafoods brands through retail and wholesale channels. The company also exports its products. Tassal Group Limited was founded in 1986 and is headquartered in Hobart, Australia.	2 yr weekly

APPENDIX F

Discounted Cash Flow (DCF) analysis

[AUD] in thousands For the fiscal year ended [Day Month]		2016A	2017A	2018A	2019F	2020F	2021F	2022F	2023F	Terminal year	*Common size analysis (% of revenue)* 2017	2018	2019	2020	2021	2022	2023	Terminal year
EBITDA		22,366.0	22,366.0	22,366.0	22,366.0	22,366.0	22,366.0	22,366.0	22,366.0	22,366.0	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Less: Effective taxes	27.5%	-6,150.7	-6,150.7	-6,150.7	-6,150.7	-6,150.7	-6,150.7	-6,150.7	-6,150.7	-6,150.7	-27.5%	-27.5%	-27.5%	-27.5%	-27.5%	-27.5%	-27.5%	-27.5%
Debt-free net income (excl. amort.)		16,215.4	16,215.4	16,215.4	16,215.4	16,215.4	16,215.4	16,215.4	16,215.4	16,215.4	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%
Depreciation					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%
Capital expenditure					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%
Investment in net working capital					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%
Debt-free cash flow (2)					16,215.4	16,215.4	16,215.4	16,215.4	16,215.4	16,215.4								
									Capitalised value (3)	162,153.5								
									Implied EBITDA exit multiple	7.3								
First period adjustment factor (4)					0.0													
Periods (months) (5)					0.0	6.0	18.0	30.0	42.0	42.0								
Present value factor (6)	10.0%				1.000	0.954	0.867	0.788	0.716	0.716								
Present value of future cashflows					0.0	15,461.3	14,055.5	12,777.7	11,616.7	116,166.8								
Sum of present value of cashflows and TY					170,077.9													
Implied Enterprise Value (controlling interest - rounded)					170,100.0													

[AUD] in thousands	Low	High	Midpoint
Discount rate (WACC)	11.0%	9.0%	10.0%
Implied Enterprise Value (EV)	155,300.0	188,100.0	171,700.0

		Terminal year growth		
	170,100.0	-0.5%	0.0%	0.5%
WACC	8.0%	200,800	210,700	221,800
	9.0%	180,500	188,100	196,600
	11.0%	150,400	155,300	160,700
	12.0%	138,900	143,000	147,400

	2018	2019	2020
EBITDA	22,366.0	22,366.0	22,366.0
Unusual/non-recurring items	0.0	0.0	0.0
Normalised EBITDA	22,366.0	22,366.0	22,366.0
Revenue multiple (implied)	7.6x	7.6x	7.6x
EBITDA multiple (Implied)	7.6x	7.6x	7.6x
EBITA multiple (implied)	7.6x	7.6x	7.6x

Notes:
(1) Based on information provided by BDO EconSearch
(2) Reflects cash available to service debt obligations and make distributions to equity investors.
(3) Applies Gordon Growth formula. Assumes constant growth after explicit forecast.
(4) Adjustment for time (and cash flows) between Valuation Date and the end of the first year year in the explicit forecast.
(5) Reflects mid period discounting convention from Valuation Date.
(6) Equal to the Weighted Average Cost of Capital (WACC)

APPENDIX G
Qualifications

Qualifications

This Report has been prepared by David Fechner a Director of BDO Advisory (SA) Pty Ltd, Level 7, 420 King William Street, Adelaide, South Australia.

He is a Chartered Accountant and holds a Bachelor of Arts (Accounting) degree obtained from the University of South Australia in 1993 and Public Practicing Certificate with Chartered Accountants Australia and New Zealand.

He has fellowship status with the Tax Institute of Australia.

He has over 25 years' experience in professional accounting services being employed in many areas of accounting including tax, business services, corporate advisory and forensic accounting services.

He specialises in Business and Corporate Advisory services undertaking valuations of businesses for purposes of compliance (CGT, stamp duty, probate, finance, etc.), mergers & acquisitions (business acquisitions, sales, mergers, partnership admissions/retirements, etc.) and expert reports (litigation support, IPO's, etc.) He has prepared over his tenure in excess of 125 valuation and expert reports.

He is a member of ASIC's Professional Liaison Group and subscribes to the Forensic Accounting and Business Valuation Specialist Interest Group of the Institute of Chartered Accountants in Australia.

ECONOMIC ANALYSIS OF THE MARINE SCALEFISH FISHERY BUYOUT

A Report to PIRSA

4 December 2019

Prepared by

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ABBREVIATIONS

CBA	cost benefit analysis
FRDC	Fisheries Research and Development Corporation
fte	full-time equivalent
GSP	gross state product
GVP	gross value of production
IO	Input-output
ITE	Individual Transferrable Effort
ITQ	Individual Transferrable Quota
MSF	Marine Scalefish Fishery
NER	net economic return
PIRSA	Primary Industries and Regions South Australia
PV	present value
RISE	Regional Industry Structure and Employment
SA	South Australia
SARDI	South Australian Research and Development Institute
TACC	total allowable commercial catch
WA	Western Australia

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EXECUTIVE SUMMARY

Introduction

Along with declining volume of catch for key species, the profitability of the South Australian (SA) Marine Scalefish Fishery (MSF) has been negative for the last 20 years. The SA MSF is currently undergoing a strategic review with the principal aim of restructuring the fishery in order to ensure its long-term sustainability and economic viability.

The Government of SA is committed to delivering reform in the MSF with the Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) established by the Minister for Primary Industries and Regional Development (PIRSA). It has committed to the rationalisation of the fishery with an initial aim to remove around 100 licences.

In order to help inform the Minister, PIRSA required economic analysis of the buyout commitment addressing whether the investment option is an efficient use of government resources and what the economic impact on the state economy would be expected.

The analysis compared two options against the base case. An investment option included investing in buying out approximately 50 per cent of MSF licences and introducing individual transfer quotas (ITQs) for key species. An input control option included fisheries managers continuing to use input controls to manage the sustainability of the fishery. The base case was envisaged as the continuation of current conditions, with the MSF becoming unsustainable in the near future.

The introduction of ITQs under the investment option included a change of management regime for the four main species (King George Whiting, Snapper, Southern Garfish and Southern Calamari), from input controls (e.g. boat limits, seasonal closures, etc.) to output controls (ITQs).

The case for introduction of ITQs is usually based on a range of potential benefits including, but not limited to, better control of effective fishing effort (mortality) and improved profitability levels and economic rent from the fishery. It is acknowledged, however, that introduction of ITQs can result in negative social, economic and ecological impacts if they are not implemented and managed appropriately. It is not possible to accurately predict exactly how introduction of ITQs in the MSF will unfold, however, as well as the economic impacts, the report describes a range of likely benefits to the MSF based on experiences in other jurisdictions. It also lists a number of offsetting factors that need to be considered to ensure that the substantial anticipated benefits from ITQ management in this fishery are realised.

Method of Analysis

A key objective of this project was to undertake a modified cost benefit analysis (CBA) to determine the incremental net economic return (NER) of two management options. The two management options were compared against a base case scenario, as described below.

Base Case: No further fishery input control measures, stocks continue to decline.

Option 1: Ongoing fishery input control measures and no buyout of licences, stocks continue to decline but at a slower rate than under the base case.

Option 2: Effective catch control and stock recovery including a buyout of licences and introduction of ITQs.

The modified cost benefit analysis was conducted over a 20-year period and one standard evaluation criterion was employed: incremental NER.

Economic impact analysis was undertaken using the BDO EconSearch RISE model of South Australia in 2017/18. The model uses an extension of the conventional input-output method and was developed for use by the Government of SA in 2019. The indicators used in the impact analysis include full-time equivalent employment, gross state product and household income.

Modified Cost benefit analysis

The modified CBA shows whether the proposed investment represents an efficient use of government resources. The results of the CBA can be summarised as follows:

- Option 1 has an incremental net economic return of $2.7m
- Option 2 has an incremental net economic return of $51.4m

Both options are preferable to the Base Case of no further management input, but Option 2 will generate the largest NER. Between the two options, the most profitable is Option 2, namely effective catch control and stock recovery with a buyout of licences and introduction of ITQs.

There are a range of likely benefits to the SA MSF based on experiences in other jurisdictions from a change of management from input to output controls. These benefits would be in addition to those estimated for Option 2 above (effective catch control and stock recovery with a buyout of licences) and include:

- Recovery of stocks of primary species resulting in enhanced sustainability, profitability and employment.
- A more business focused industry resulting in higher individual operator profitability levels.
- Improved operational efficiency resulting in higher individual operator profitability levels.
- Improved price, quality and value adding resulting in higher individual operator profitability levels.
- Higher property rights resulting in higher stewardship levels and improved social licence.
- Safer fishing practices meaning less injuries and loss of life.
- Improved resource sharing framework for competing users of the marine estate resulting in reduced conflict levels.

However, realisation of net benefits from a small scale, regionally focused, high stewardship level fishery, such as the SA MSF, will depend on a number of things including the level of government funding assistance for reform to occur, getting the policy settings right, efficient enforcement and management and providing equivalent control of other extractive users.

Economic Impact Analysis

In terms of GSP, Option 1 would generate around $40m more than the Base Case over the 20-year period and around 43 additional fte jobs. The impact of Option 2 is estimated to be much greater; an additional $277m in GSP above the base case over the 20-year period and employment generation of 107 fte jobs above the base case level.

Under Option 2, the proposed fleet size reduction can be expected to reduce employment in the short term but in the longer term would be expected to increase after stocks recover, businesses become more efficient and profitable and catch increases, leading to increased downstream activity.

1. INTRODUCTION

1.1. Background

Along with declining volume of catch for key species, the profitability of the South Australian (SA) Marine Scalefish Fishery (MSF) has been negative for the last 20 years. The SA MSF is currently undergoing a strategic review with the principal aim of restructuring the fishery in order to ensure its long-term sustainability and economic viability.

The Government of SA is committed to delivering reform in the MSF with the Commercial Marine Scalefish Fishery Reform Advisory Committee (CMSFRAC) established by the Minister for Primary Industries and Regional Development (PIRSA). It has committed to the rationalisation of the fishery with an initial aim to remove around 100 licences.

In order to help inform the Minister, PIRSA required economic analysis of the buyout commitment addressing whether the investment option is an efficient use of government resources and what the economic impact on the state economy would be expected.

The analysis compared two options against the base case. An investment option included investing in buying out approximately 50 per cent of MSF licences and introducing individual transfer quotas (ITQs) for key species. An input control option included fisheries managers continuing to use input controls to manage the sustainability of the fishery. The base case was envisaged as the continuation of current conditions, with the MSF becoming unsustainable in the near future.

The introduction of ITQs under the investment option included a change of management regime for the four main species (King George Whiting, Snapper, Southern Garfish and Southern Calamari), from input controls (e.g. boat limits, seasonal closures, etc.) to output controls (ITQs).

The case for introduction of ITQs is usually based on a range of potential benefits including, but not limited to, better control of effective fishing effort (mortality) and improved profitability levels and economic rent from the fishery. It is acknowledged, however, that introduction of ITQs can result in negative social, economic and ecological impacts if they are not implemented and managed appropriately. It is not possible to accurately predict exactly how introduction of ITQs in the MSF will unfold, however, as well as the economic impacts, the report describes a range of likely benefits to the MSF based on experiences in other jurisdictions. It also lists a number of offsetting factors that need to be considered to ensure that the substantial anticipated benefits from ITQ management in this fishery are realised.

1.2. Purpose and Scope and the Economic Analysis

PIRSA engaged BDO EconSearch to undertake economic analysis including:

- Modified cost benefit analysis (CBA) to assess whether the investment option is an efficient and appropriate use of government resources (i.e. whether the project provides a positive return to the community)
- Economic impact analysis (EIA) to assess the economic impact on the state economy, using the extended input-output (I-O) RISE model.

While these questions are answered in this report, detailed quantitative modelling of the likely impacts of ITQs was out of scope.

2. METHOD OF ANALYSIS AND DATA

2.1. Modified Cost Benefit Analysis

2.1.1. Method

A key objective of the study was to estimate the net benefit of the Marine Scalefish Fishery (MSF) buyout. The proposed options were compared against a base case scenario within the framework of a cost benefit analysis (CBA). The standard CBA method involves the specification of a base case against which options are compared. The Base Case and two options for this assessment are described in Table 2-1.

Table 2-1 Modified cost benefit analysis options

Options	Description
Base case	No further fishery input control measures, stocks continue to decline.
Option 1	Ongoing fishery input control measures and no buyout of licences, stocks continue to decline but at a slower rate than under the base case.
Option 2	Effective catch control and stock recovery including a buyout of licences and introduction of ITQs.

The CBA conducted for this project conforms to South Australian and Commonwealth Government guidelines for conducting evaluations of public sector projects (Department of Treasury and Finance (2008) and Department of Finance and Administration (2006)).

The starting point for the CBA was to develop the Base Case scenario, that is, the benchmark against which the management options were compared. It is important to note that the Base Case scenario is not a 'spend nothing' or 'do nothing' scenario. Given that costs and benefits were specified in real terms (i.e. constant 2019 dollars), future values were converted to present values by applying a discount rate of 6 per cent. The choice of discount rate is consistent with the rate commonly used by the South Australian Government in this type of analysis.

The analysis was conducted over a 20-year period and results were expressed in terms of net benefits, that is, the incremental benefits and costs of the options relative to those generated by the Base Case.

The evaluation criterion employed for this analysis is the present value (PV) of net economic return (NER) estimated over a 20-year period. The NER is defined as the difference between the price of a good produced using a natural resource and the unit cost of turning that natural resource into the good. In this case the natural resource is the SA MSF and the good produced is the landed seafood. The unit costs or long term costs all need to be covered if a licence holder is to remain in the fishery. These long-term costs include direct operating costs such as fuel, labour (including the opportunity cost of a self-employed fisher's own labour), ice, bait, overheads such as administration and licences and the cost of capital invested in the boat and gear (excluding licence). Capital costs includes depreciation and the opportunity cost of the capital applied to the fishery. The opportunity cost of capital is equivalent to what fisher investment could have earned in the next best alternative use.

Determining the opportunity cost of capital involves an assessment of the degree of financial risk involved in the activity. For a risk-free operation, an appropriate opportunity cost of capital might be the long-term real rate of return on government bonds. The greater the risks involved, the greater is the necessary return on capital to justify the investment in that particular activity. For this analysis the long term (10-year) real rate of return on government (treasury) bonds of 5 per cent has been used and a risk premium of 5 per cent has been applied. The assumed opportunity cost of capital in this analysis is, therefore, 10 per cent.

Under this decision rule, an option was considered to be potentially viable if the PV of NER was greater than zero. The NER for each option (*i*) was calculated as an incremental NER, using the formulation:

$$\text{PV of NER}_i = (\text{PV (Option}_i \text{ income} - \text{Base Case income}) - (\text{PV (Option}_i \text{ costs} - \text{Base Case costs}))$$

2.1.2. Data and assumptions

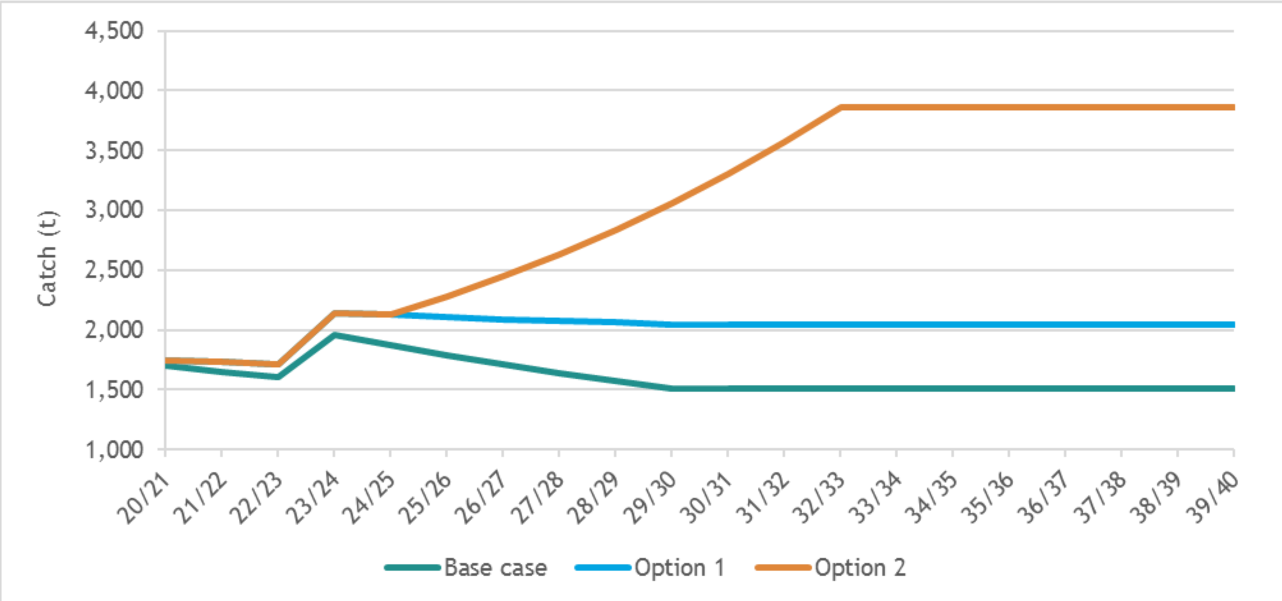
The following data and assumptions were used in the modified CBA.

Catch

The modelled level of catch, presented in Figure 2-1, was provided by SARDI and is based on the following assumptions:

- Base Case: Average annual decline from peak (0.5% average annual decline)
- Option 1: Long term average change (1.0% average annual increase)
- Option 2: Average annual increase to peak (4.4% average annual increase)

Figure 2-1 Catch under the Base Case, Option 1 and Option 2, 2020/21 to 2039/40



Price

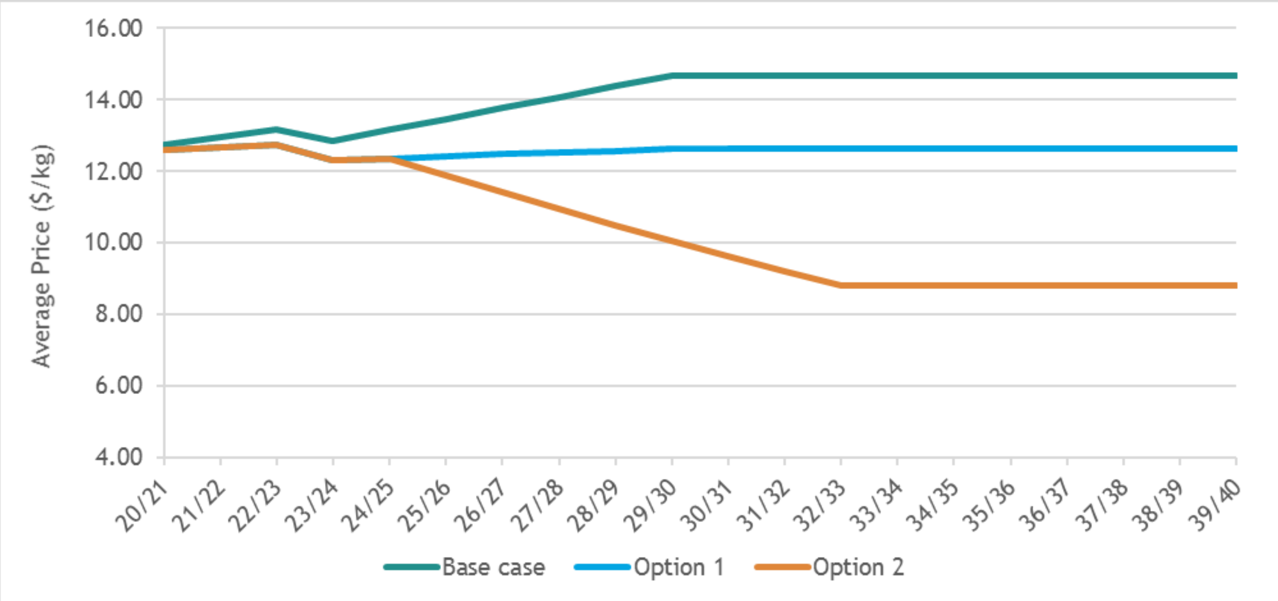
In order to calculate gross value of production (GVP) across the options, average prices by species were sourced from BDO EconSearch (2019a) for 2017/18 and inflated to 2019 dollars. However, a price flexibility assumption was built in to take account of what would happen to price if quantity supplied increased or decreased. The assumptions made for the Base Case and options were:

- Base Case: 0.5% increase in price for each 1% decrease in quantity supplied
- Option 1: 0.5% decrease in price for each 1% increase in quantity supplied

- Option 2: 0.5% decrease in price for each 1% increase in quantity supplied

The average price across all MSF species resulting from this assumption is illustrated in Figure 2-2 for the Base Case and each option.

Figure 2-2 Average price across all MSF species, 2020/21 to 2039/40



Costs

Average variable costs, fixed costs, depreciation and opportunity cost of capital were sourced from BDO EconSearch (2019a) and scaled up to the fishery level according to the number of licences and average catch for each under each option.

Other Assumptions under Option 2

Other assumptions made under Option 2 included:

- target number of licences to buyout (150) is achieved including 120 in year 1 and 30 in year 2
- 10% efficiency improvement in variable costs achieved
- total cost of buyout of $35m spread over 4 years with most of the cost being licence purchases in years 1 and 2.

2.2. Economic Impact - Method and Data

An important component of the economic analysis was to estimate the likely economic impact on SA. This was achieved through economic impact analysis using an extension of the conventional input-output method. Over the past decade BDO EconSearch has developed an extended input-output model known as the RISE model (Regional Industry Structure and Employment). The RISE model provides a comprehensive economic framework that is extremely useful in the resource planning process, particularly for regional economic impact applications. The RISE model of South Australia in 2017/18 was used for the economic impact analysis[1].

2.2.1. Economic activity

The indicators used in economic impact analysis typically include employment, gross state product (GSP) and household income, which are described below and used to present results in this report.

Economic activity indicators: are indicators of the generation of economic activity resulting from the management options.

Economic impact: changes in economic activity are referred to as economic impacts. Generally, changes in *economic activity indicators* results from some stimulus or external shock imposed. In this analysis, the concept of economic impact includes the increase in economic contribution from the management options compared to the Base Case. This *economic impact* is measured in terms of *economic activity indicators* referred to above.

2.2.2. Indicators of economic activity

Employment units: employment numbers are usually reported in either full-time equivalent (fte) units or total job units defined as follows:

- *FTE*: is a way to measure a worker's involvement in a project or industry activity. An fte of 1.0 means that the person is equivalent to a full-time worker, while an fte of 0.5 signals that the worker is only half-time. Typically, different scales are used to calibrate this number, depending on the type of industry and copy of the analysis but the basic calculation is the total hours worked divided by average annual hours worked in full-time jobs.
- *Jobs*: is used to refer to the number of workers employed in an industry or on a project at any point in time. It typically refers to either:
    - The *maximum* number of workers required at any point over the analytical period or the duration of the project; or
    - The *average* number of workers required over the analytical period or duration of the project. This can be calculated on a daily, weekly, monthly or annual basis.

In this report employment has been reported in terms of fte units on a per annum basis.

Gross state product (GSP): is a measure of the contribution of an activity to the economy. GSP is measured as value of gross output (business revenue) less the cost of goods and services (including imports) used in producing the output. In other words, it can be measured as the sum of household income, gross operating surplus and gross mixed income net of payments to owner managers and taxes less subsidies on products and production. It represents payments to the primary inputs of production (labour, capital and land). Using GSP as a measure of economic impact avoids the problem of double counting that may arise from using value of output for this purpose.

Household Income: is a measure of the wages and drawings by owner operators generated by the economic activity. This is a component of GSP as described above.

[1] RISE models for 2017/18 have been constructed for the Government of South Australia at both a state and regional level (BDO EconSearch 2019b).

2.2.3. Data and assumptions

Some additional assumptions to those outlined in Section 2.1.2 were required to undertake the economic impact assessment. These included the standard assumptions embodied in IO analysis as well as the following:

- The impacts were measured using a model that represents the structure of the state economy for the year in which the most recent data are available (2017/18). However, over time there are likely to be improvements in primary factor productivity in these economies. To allow for the improvements as an across-the-board (all sectors) labour productivity improvement rate of 1 per cent per annum for subsequent years has been incorporated into the model.
- When new jobs are created, it should be determined where the people come from to fill those jobs. In some cases, the jobs will be taken by previously unemployed locals or by someone who is currently employed locally but whose own job is taken be a previously unemployed local. In both cases the impact of the newly created job and associated income is particularly offset by the fact that someone who was previously receiving unemployment benefits (and spending them on consumption items) is no longer doing so. To calculate this effect requires estimates of the parameter *rho*, the proportion of new jobs that are likely to be filled by previously unemployed locals. This was estimated to be 0.9 in this case as almost all jobs lost and filled are likely come from the SA pool of labour.

3. MODIFIED COST BENEFIT ANALYSIS RESULTS

3.1. Results

The results of the modified CBA, detailed in Table 3-1, show that both options are preferable to the Base Case of no further management input and that Option 2 will generate the largest NER. For an option to be viable the incremental NER needs to be greater than zero. Between the two options, the most profitable is Option 2, namely effective catch control and stock recovery with a buyout of licences and introduction of ITQs.

Table 3-1 Modified cost benefit analysis results[a]

Result	$m
Present Value of Net Economic Return	
Base Case	-30.9
Option 1	-28.2
Option 2	22.3
Incremental Present Value of Net Economic Return	
Option 1	**2.7**
Option 2	**53.1**

[a] All values are a present value over the 20-year period using a discount rate of 6 per cent.

Source: BDO EconSearch analysis

3.2. Sensitivity Analysis

The results of the CBA were re-estimated using values for key variables that reflect the uncertainty of those variables. The sensitivity analysis included the following:

- Discount rate
- Cost of buyout
- Price flexibility
- Efficiency improvements
- Management costs

The range of values used for each uncertain variable and detailed results of the sensitivity analysis are set out below with some interpretation of the results. Note that each sensitivity analysis for each variable was undertaken by holding all other variables constant at their 'expected' values. The assumptions and results of the sensitivity analysis are summarised and described in the following sections.

3.2.1. Discount rate

Costs and benefits are specified in real terms (i.e. constant 2019 dollars) and future values are converted to present values by applying a discount rate of 6 per cent. A sensitivity analysis was conducted using discount rates of 4 and 8 per cent (Table 3-2).

Table 3-2 Sensitivity of incremental prevent value of net economic return to discount rate

Discount rate	Option 1	Option 2
4%	3.3	66.7
6%[a]	2.7	53.1
8%	2.2	42.4

[a] Expected value.

Source: BDO EconSearch analysis

As expected, the incremental PVs of NER improve with the lower (4 per cent) discount rate and decrease under the higher discount rate (8 per cent). This occurs because, although the bulk of the project costs are 'up front' and are not significantly affected by the discount rate, the benefits accrue over many years and are greater, in present value terms, when the discount rate is lower. Therefore, with 25 percent increase or decrease in discount rates, the positive PVs of NER indicate that Options 1 and 2 are still preferable to the Base Case.

3.2.2. Cost of buyout

The cost of the buyout under Option 2 has the potential to vary from current estimates. Accordingly, a sensitivity analysis was undertaken to illustrate the effect of the buyout costing \$20m, \$40m and \$50m. The results of this analysis are summarised in Table 3-3.

Table 3-3 Sensitivity of incremental prevent value of net economic return to cost of buyout

Cost of Buyout (\$m)	Option 1	Option 2
20.0	2.7	68.2
35.4 [a]	2.7	53.1
40.0	2.7	48.7
50.0	2.7	39.0

[a] Expected value.

Source: BDO EconSearch analysis

The results are moderately sensitive to the cost of buyout but even with a 40 per cent increase in buyout costs (to \$50m) under Option 2, the option would still be viable. Not surprisingly, any decrease in buyout costs will increase the appeal of the option.

3.2.3. Price flexibility

The price flexibility coefficient (-0.5%) used under all options has the potential to vary from current estimates. Accordingly, a sensitivity analysis was undertaken to illustrate the effect of the price flexibility coefficient. The results of the sensitivity analysis are summarised in Table 3-4

Table 3-4 Sensitivity of incremental prevent value of net economic return to price flexibility[a]

Price flexibility	Option 1	Option 2
-0.25%	15.0	94.6
-0.50%	2.7	53.1
-0.75%	-10.3	14.1

[a] -0.50% is the expected value.

Source: BDO EconSearch analysis

The results are sensitive to the price flexibility coefficient but even with an increase in the price flexibility coefficient (for a 1% increase in quantity the will be a 0.75% decline in price), Option 2 would still be viable. However, Option 1 would no longer be viable. A decrease in the price flexibility coefficient (for a 1% increase in quantity there will be a 0.25% decline in price) improves the result for both options relative to the Base Case.

3.2.4. Efficiency improvement

Under Option 2 it was assumed the remaining licences holders would be able to fish more efficiently. As such, a 10% efficiency improvement was assumed under option 2. However, this has the potential to vary from the current estimate. Accordingly, a sensitivity analysis has been undertaken to illustrate the effect of changing the efficiency improvement assumption. The results of the sensitivity analysis are summarised in Table 3-5.

Table 3-5 Sensitivity of incremental prevent value of net economic return to efficiency improvement

Efficiency improvement	Option 1	Option 2
No efficiency improvement	2.7	32.5
10% improvement [a]	2.7	53.1
20% improvement	2.7	73.8

[a] Expected value.

Source: BDO EconSearch analysis

The results for Option 2 (no change under Option 1) are sensitive to the efficiency improvement assumption but even with no efficiency improvement, Option 2 would still be viable. Not surprisingly, any increase in efficiency will increase the appeal of the Option 2.

3.2.5. Management costs

Under Option 2 it was assumed that total management costs will be 20% higher than under the current management arrangements to incorporate the cost of running a quota management system. However, management costs under Option 2 have the potential to vary from the current estimate. Accordingly, a sensitivity analysis has been undertaken to illustrate the effect of changing the management cost assumption. The results of the sensitivity analysis are summarised in Table 3-6.

Table 3-6 Sensitivity of incremental prevent value of net economic return to management costs

Management costs	Option 1	Option 2
20% increase [a]	2.7	51.4
50% increase	2.7	46.3
100% increase	2.7	31.1

[a] Expected value.

Source: BDO EconSearch analysis

The results for Option 2 (no change under Option 1) are moderately sensitive to management costs and even with a 100% increase in management costs Option 2 would still be viable.

3.3. Non-Priced Benefits

Described in this section of the report are a range of likely benefits to the SA MSF based on experiences in other jurisdictions from a change of management from input to output controls. These benefits would be in addition to those estimated in Section 3.1 for Option 2 (effective catch control and stock recovery with a buyout of licences).

Recovery of stocks of primary species = enhanced sustainability, profitability and employment

One of the key benefits from direct control on the total catch of primary species is the expected recovery of stocks and subsequent increases in catch rates and volumes to market. Higher volumes will impact on overall profitability, operational efficiency and employment.

However, an important caveat around benefits being captured through the SA reform is that total allowable commercial catches (TACCs) are not set too high. In addition, all extractive users including the recreational sector in particular will need to be subject to equivalent control of effective catch. If this this does not occur, it is reasonable to expect that improvements in fish stocks will not occur as predicted and the benefits outlined are likely to dissipate.

A more business focused industry = higher individual operator profitability levels

It is widely accepted that moving from input controls (the current management approach) to output controls (ITQ's) will change fishing operational focus from applying more effort to catch more fish, to maximising profitability per kilogram of quota species. This is likely to result in benefits in improved market prices, innovative marketing and value adding and operating efficiency gains.

A relevant recent positive example of benefits from ITQ management is the Danish demersal inshore fleet which in less than a two year period reduced effective capacity by more than 30% and increased vessel profitability (average across all fleet segments) by 77% compared to the average in the previous three years. Government funds which had previously been allocated for scrapping of vessels were instead used for innovation and investment in quality and new products. The effect was that the amount of fish caught not only required less capital input, but also yielded higher prices (MRAG et al. 2009).

The SA MSF proposal is for only key species to be subject to a catch quota, hence a second driver can be expected with a greater focus on non-quota and less targeted species, as a strategy for operators to increase incomes.

Improved operational efficiency = higher individual operator profitability levels

The expected shift to maximising profit on key quota species is likely to reduce the "race to fish" enabling greater operational economic efficiency. For example, when the Western Australian (WA) Rock Lobster fishery moved to ITQs in 2010/11, operating costs (e.g. fuel, bait) fell as fishers were able to optimise their operations and were no longer competing to maximise their share of the catch (Caputi et al. 2015).

The proposed reduction in vessel numbers in the SA MSF through a government sponsored buyout of 50% of licences is also likely to result in an increased catch of primary species per unit of effort as standing stock levels recover above the current depleted levels. A 2009 study of European Union ITQ managed fisheries identified positive efficiency gains in the Netherlands, Spain and Denmark brought about by up to a 50% reduction in the number of vessels (MRAG et al. 2009).

Importantly in the SA MSF, introduction of ITQs in-conjunction with a buy out can be expected to prevent the ongoing over-investment in boats and gear that has occurred over decades in this fishery with effort control management.

Price, quality and value adding = higher individual operator profitability levels

The profit maximising driver of ITQs can be expected to see a change to "fishing to market". This avoids supply gluts and capitalises on higher market prices. Evidence of these benefits come from specific fisheries (WA Rock Lobster, SA Pipis) as well as regional or national studies. In both the WA Rock Lobster and SA Pipi fisheries, patterns of fishing changed with the focus shifting from the peak catch periods to a more even spread of catch throughout the year and an extension of the season to 12-months. This has allowed for market price optimisation and targeting of higher value product.

In WA Rock Lobster Fishery this resulted in an additional increase in beach price of about US$8/kg adding an extra US$48 million to the GVP of the fishery (Caputi et al. 2015). In the SA Pipi Fishery, prices have increased by over 150% since the introduction of ITQs and a range of value added products has been developed, importantly against a backdrop of higher volumes from stock recovery (pers. comm. Goolwa Pipi Co.)

In a 2015 Fisheries Research and Development Corporation study (FRDC Project No 2017-159), over half of the fishers responding to the survey believed that both prices and quality of the product improved as a result of ITQ and ITE management (Pascoe et al. 2019).

Higher property rights = higher stewardship levels and improved social licence

The allocation of ITQs establishes a higher level of individual property right for quota holders allocated a share of the productive capacity of a fishery than is the case in a purely input controlled fishery. The removal of the "race to fish" is likely to result in operators taking greater care of the resource and a long term approach to sustaining stocks.

The higher stewardship level and prescribed limit on catch may enhance the perception of the SA MSF by the general public and recreational fishers and may lead to greater social licence to operate than has historically been the case in this fishery.

Safer Fishing = less injuries and loss of life

A further benefit of no longer having to "race to fish" is the reduction in health and safety risks (as the incentive to fish in all weathers before someone else catches "my fish" is removed). A US study found that after ITQs were implemented in an economically important US West Coast fishery, a fisher's probability of taking a fishing trip in high wind conditions decreased by 82% compared with only 31% in the former "race to fish" fishery. Overall, ITQs caused the average annual rate of fishing on high wind days to decrease by 79% (Pfeiffer and Gratz 2016).

Improved resource sharing framework for competing users of the marine estate = reduced conflict levels

ITQs provide a stronger negotiating position and a simplified mechanism for compensation with other marine users. For example, under the Queensland Fisheries Reallocation Policy, the proponent (e.g. a recreational fishing group wishing to close an area to commercial fishing) has to prepare a cost benefit analysis (CBA) and a proposal as to how compensation will be paid to the Minister. All preparation costs are borne by the proponent (Queensland Government 2017). Not only do ITQs provide commercial fishers with a right in which a market value can be easily ascertained, and thus inputted into any benefit cost proposal, they also provide a simple mechanism for compensation should a proponent be able to demonstrate a positive benefit cost ratio and fund the compensation.

A word of caution = factors to be considered to realise benefits

There are a range of potential negative impacts that need to be considered from the introduction of ITQs in the SA MSF including:

- The initial allocation of ITQs may result in some redistribution of income and/or licence values between licence holders although an allocation panel will aim to minimise this as much as possible.
- The proposed fleet size reduction can be expected to reduce employment in the short term but in the longer term would be expected to increase after stocks recover and operations become more efficient and profitable over time.
- The costs of management and compliance may be higher in the early stages of the introduction of ITQs, but comparative economic research suggests that the longer term economic benefits may outweigh the short term costs (Mangin et al. 2018).
- Concentration of quota ownership and higher prices of quota over time are a possibility and can be viewed both positively and negatively. The outcome in the SA MSF will be determined by the quota ownership arrangements put in place at implementation and many of the concerns about increased concentration of quota ownership can, to some extent be managed through appropriate policy settings such as retention of owner operator provisions and maximum quota holdings.

In summary, realisation of net benefits from a small scale, regionally focused, high stewardship level fishery, such as the SA MSF, will depend on a number of things including the level of government funding assistance for reform to occur, getting the policy settings right, efficient enforcement and management and providing equivalent control of other extractive users.

4. ECONOMIC IMPACT RESULTS

The results of the impact analysis for options 1 and 2 are presented in Table 4-1. These are the incremental impacts compared to the level of economic activity attributable to the base case. It is important to note that the GSP and household impact estimates are present values calculated over the 20-year period whereas employment impacts are an average annual value over the same period.

In terms of GSP, Option 1 would generate around $40m more than the Base Case over the 20-year period and around 43 additional fte jobs. The impact of Option 2 is estimated to be much greater; an additional $277m in GSP above the base case over the 20-year period and employment generation of 107 fte jobs above the base case level.

Under Option 2, the proposed fleet size reduction can be expected to reduce employment in the short term but in the longer term would be expected to increase after stocks recover, businesses become more efficient and profitable and catch increases, leading to increased downstream activity.

Table 4-1 Economic impact results[a]

Indicator	Option 1	Option 2
GSP ($m) - 20 Year Present Value		
Direct	19.1	225.5
Indirect		
Production	*5.6*	0.1
Consumption	*15.5*	51.2
Total Indirect	21.2	51.3
Total	**40.3**	**276.8**
Household Income ($m) - 20 Year Present Value		
Direct	15.1	62.6
Indirect		
Production	*3.9*	0.2
Consumption	*7.8*	25.9
Total Indirect	11.8	26.1
Total	**26.9**	**88.7**
Employment (fte) - 20 Year Average		
Direct	29	77
Indirect		
Production	5	*8*
Consumption	9	*21*
Total Indirect	14	30
Total	**43**	**107**

[a] GSP and household impact results are total present values over the 20-year period and employment impacts are an average values over the same period.

Source: BDO EconSearch analysis

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Disclaimer

The assignment is a consulting engagement as outlined in the 'Framework for Assurance Engagements', issued by the Auditing and Assurances Standards Board, Section 17. Consulting engagements employ an assurance practitioner's technical skills, education, observations, experiences and knowledge of the consulting process. The consulting process is an analytical process that typically involves some combination of activities relating to: objective-setting, fact-finding, definition of problems or opportunities, evaluation of alternatives, development of recommendations including actions, communication of results, and sometimes implementation and follow-up.

The nature and scope of work has been determined by agreement between BDO and the Client. This consulting engagement does not meet the definition of an assurance engagement as defined in the 'Framework for Assurance Engagements', issued by the Auditing and Assurances Standards Board, Section 10.

Except as otherwise noted in this report, we have not performed any testing on the information provided to confirm its completeness and accuracy. Accordingly, we do not express such an audit opinion and readers of the report should draw their own conclusions from the results of the review, based on the scope, agreed-upon procedures carried out and findings.

ECONOMIC ASSESSMENT OF FISHING CAPACITY OF THE SA MARINE SCALEFISH FISHERY

A Report to PIRSA

30 October 2019

Prepared by

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ABBREVIATIONS

CPUE	catch per unit effort
GSV	Gulf St Vincent
GVP	gross value of production
KI	Kangaroo Island
NER	net economic return
PIRSA	Primary Industries and Regions South Australia
SA	South Australia
SA MSF	South Australia's Marine Scalefish Fishery
SE	South East
SG	Spencer Gulf
SARDI	South Australian Research and Development Institute
TACC	total allowable commercial catch
WC	West Coast

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EXECUTIVE SUMMARY

Economic rent in South Australia's Marine Scalefish Fishery (SA MSF) has been negative for more than 20 years and the aggregate value of licences has been declining for the last nine years. Along with these pressures on the financial profitability of the fishery, total catch has followed a significant declining trend.

The SA MSF is currently undergoing a strategic review with the principal aim of restructuring the fishery in order to ensure its long-term sustainability and economic viability. The SA Government have committed to the rationalisation of the fishery with an initial aim to remove 100 licences.

Four regional scenarios (different boundary definitions) were developed through the Commercial Marine Scalefish Fishery Research Advisory Committee (CMSFRAC). One of these regional scenarios[1] has been selected for this analysis.

The overall approach to this analysis is one of ensuing sustainability in the SA MSF where the net economic return (NER) generated by the fishery is greater than zero. Using data on the average catch and effort levels of key species, BDO EconSearch were tasked with estimating the number of licences needed in each region to achieve a NER greater than zero, i.e. lifting the fishery from a position of generating negative economic returns to one of long-term positive returns. The modelling process provides an estimate of the number of licences in each region that need to be removed under a fishery restructure to achieve a positive net economic return.

The approach is an iterative one where licences, and fixed costs associated with these licences, are incrementally removed from the fishery and the income and variable costs associated with these licences redistributed to the remaining licence holders. After each licence is removed the NER is recalculated and the process continues until the NER in each region becomes positive.

Two assumptions regarding the structure of fishing businesses were used in this analysis. Businesses that leave the fishery were assumed to be either:

- similar to the average financially performing business in that region of the fishery; or
- similar to poorer financially performing businesses in that region of the fishery who also are less efficient (i.e. have a lower catch per unit effort (CPUE)).

The financial performance indicators report for the SA MSF (BDO EconSearch 2019) provides the data that form the basis for the economic analysis. The financial indicators are reported for average businesses in each of four financial performance quartiles. The first quartile denotes the worst performing businesses in the fishery, in terms of return to total capital, and the fourth quartile denotes the best performing businesses. While the average across all quartiles was used to represent the average performing business, the second quartile data were used to represent the poorer performing businesses.

In addition to the two level of business performance, three different levels of catch were analysed in the modelling:

- current catch levels (average between 2011/12 and 2015/16)
- a 20 per cent reduction in current catch levels for key species, and

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[1] Referred to as Scenario 3.1 by the committee.

- indicative TACCs for key species .

Catch levels in each of the four regions for scenario 3.1 are provided in (Table ES-1).

Table ES-1 Catch levels scenarios by region (t)

	WC	SG	GSV/KI	SE	Total
Current catch	271	1,049	739	147	2,207
20% reduction in current catch of key species [a]	245	955	624	128	1,952
Indicative TACCs for key species	277	1,048	492	148	1,965

[a] Catch of remaining species held constant at current levels.

In total six scenarios were analysed, three catch levels applied to the two levels of financial performance.

The estimated number of licences that would need to be removed to achieve a positive NER under each of the six scenarios are detailed at a regional level in Table ES-2.

Table ES-2 Estimated number of licences to be removed to achieve a positive net economic return

	WC	SG	GSV/KI	SE	Total
Average business					
Current catch	27	19	44	7	97
20% reduction in catch of key species	34	35	55	10	134
Indicative TACCs	28	18	68	6	120
Poorer performing business					
Current catch	39	53	57	16	165
20% reduction in catch of key species	43	61	65	17	186
Indicative TACCs	39	58	82	18	197
Current number of licences (2017/18)	56	124	93	20	293

1. INTRODUCTION

1.1. Background

Economic rent in South Australia's Marine Scalefish Fishery (SA MSF) has been negative for more than 20 years and the aggregate value of licences has been declining for the last nine years. Along with these pressures on the financial profitability of the fishery, total catch has followed a significant declining trend. The fall, from 5,036 tonnes in 1998/99 to 2,303 tonnes in 2017/18, is due to a decrease in catch of a number of key species including Australian Salmon, Shark, King George Whiting and Garfish. Catch of Snapper followed an increasing trend between 2002/03 and 2010/11, although it has declined significantly since (BDO EconSearch 2019).

The SA MSF is currently undergoing a strategic review with the principal aim of restructuring the fishery in order to ensure its long-term sustainability and economic viability. The SA Government have committed to the rationalisation of the fishery with an initial aim to remove 100 licences.

BDO EconSearch have been engaged by PIRSA to undertake an economic assessment of the fishing capacity within the SA MSF. The aim was to estimates the number of licences (and fishing activity) in each region that achieve the objectives of stock sustainability and economic viability.

1.2. Report Scope

Four regional scenarios were developed through the Commercial Marine Scalefish Fishery Research Advisory Committee (CMSFRAC). One of these regional scenarios, Scenario 3.1, was selected for this analysis.

Using data on the average catch levels of key species BDO EconSearch were tasked with estimating the number of licences needed in each region to achieve a net economic return (NER) greater than zero, bringing the fishery out of negative territory. In turn, this provided the number of licences that need to be removed under a fishery restructure.

Two assumptions regarding the structure of fishing businesses were used in this analysis, Businesses that leave the fishery are either:

- similar to the average financially performing business in that region of the fishery; or
- similar to poorer financially performing businesses in that region of the fishery who also are less efficient (i.e. have a lower catch per unit effort (CPUE)).

In addition to analysing current catch levels (average between 2011/12 and 2015/16), a 20 per cent reduction in catch and indicative Total Allowable Commercial Catches (TACCs) for key species were analysed under the assumptions of average performing businesses and poorer performing businesses.

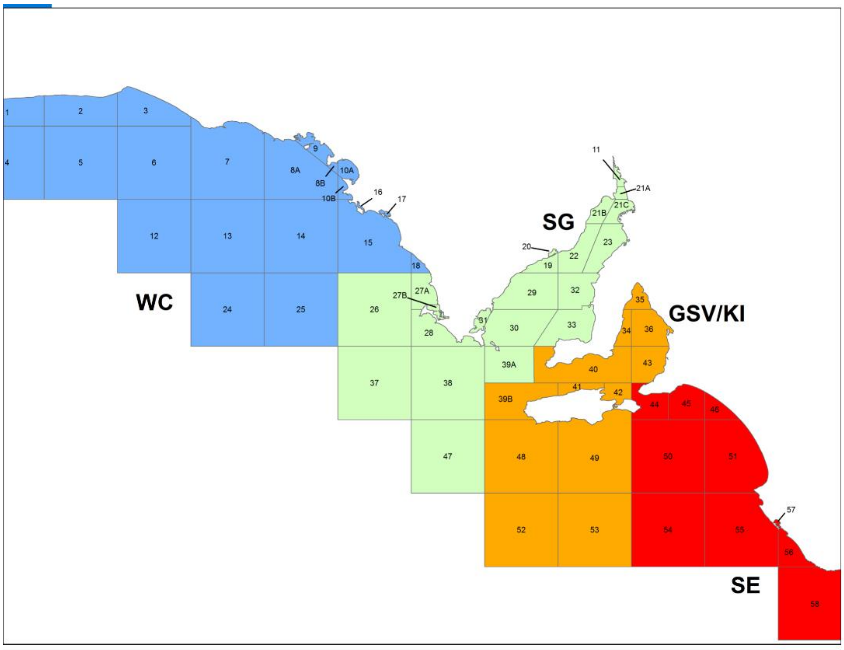
2. METHOD OF ANALYSIS AND DATA.

A description of the regional scenario, data and method used in the analysis are provided in this section.

2.1. Regional Scenario

Four regional scenarios were developed by the Commercial Marine Scalefish Fishery Research Advisory Committee (CMSFRAC) with the scenario[2] selected for the analysis provided in this report illustrated in Figure 2-1.

Figure 2-1 Regional scenario



The regional scenarios were based on a biological unit stock concept for the major species (Snapper, King George Whiting, Garfish and Southern Calamari) and Yellowfin whiting, Australian Salmon and Australian Herring and on an understanding of fleet dynamics and stock boundaries.

2.2. Method

The overall approach to this analysis is one of ensuring sustainability in the SA MSF where net economic return (NER) generated by the fishery is greater than zero. As previously stated, net economic return in the SA MSF has been negative for more than 20 years.

Net economic return (NER) is defined as the difference between the price of a good produced using a natural resource and the unit cost of turning that natural resource into the good. In this case the natural resource is the SA Marine Scalefish Fishery and the good produced is the landed fish. The unit costs or long-term costs all need to be covered if a licence holder is to remain in the fishery. These long-term costs include direct operating costs such as fuel, labour (including the opportunity cost of a self-employed fisher's own labour), ice, overheads such as administration and licence fees, and the cost of capital invested in the

[2] Referred to as Scenario 3.1 by the Committee.

boat and gear (excluding licence). Capital costs includes depreciation and the opportunity cost of the capital applied to the fishery. The opportunity cost is equivalent to what the fisher's investment could have earned in the next best alternative use.

Using data on the average catch and effort levels of key species, the number of licences needed in each region to achieve a NER greater than zero, i.e. to lift the fishery from a position of generating negative economic returns to one of long-term positive returns. The modelling process thereby provides an estimate of the number of licences in each region that need to be removed under a fishery restructure to achieve a positive and sustainable net economic return.

The approach is an iterative one where licences, and the fixed costs associated with these licences, are incrementally removed from the fishery and the income and variable costs associated with these licences redistributed to the remaining licence holders. After each licence is removed the NER is recalculated and the process continues until the NER in each region becomes positive.

Two assumptions regarding the structure of fishing businesses were used in this analysis. Businesses that leave the fishery were assumed to be either:

- similar to the average financially performing business in that region of the fishery; or
- similar to poorer financially performing businesses in that region of the fishery who also are less efficient (i.e. have a lower catch per unit effort (CPUE)).

The financial performance indicators report for the SA MSF (EconSearch 2016) provides the data that form the basis for the economic analysis. The financial indicators are reported for average businesses in each of four financial performance quartiles. The first quartile denotes the worst performing businesses in the fishery, in terms of return to total capital, and the fourth quartile denotes the best performing businesses. While the average across all quartiles was used to represent the average performing business, the second quartile data were used to represent the poorer performing businesses.

In the analysis under the assumption that the poorer performing businesses would be those that exit the fishery, a further assumption was made that the remaining businesses would be more efficient than those that leave. To validate this assumption, or at least confirm that it is reasonable, data on catch per unit effort (CPUE) were provided by SARDI. The average CPUE per licence over the five years, 2011/12 to 2015/16 was sorted into four quartiles according to catch, smallest to largest. These data showed a significant jump in efficiency (69 per cent increase in CPUE) between the second and third quartiles, which provides strong support to the assumption of higher than average efficiency of remaining businesses.

2.3. Data

Catch and effort

Catch by major species under the regional scenario is detailed in Table 2-1. These data are an average annual catch in each of the four regions over the five year period, 2011/12 to 2015/16.

Table 2-1 Catch by region by major species (t)

	WC	SG	GSV/KI	SE	Total
Snapper	15	85	344	54	498
Garfish	1	115	72	1	189
KGW	106	94	44	0	243
Southern Calamari	9	178	115	41	342
Other	140	578	165	52	935
Total	**271**	**1,049**	**739**	**147**	**2,207**

Source: SARDI Aquatic Sciences (unpublished data)

Licences

The current number of licences under the regional scenario, including both active[3] and inactive licences, per region was provided by PIRSA and is detailed in Table 2-2. For the most recent financial year for which data were available (2017/18), 16 of the 293 licences were inactive (PIRSA). By region there were three inactive licences in the WC, four in the SG, eight in the GSV/KI region and one in the SE. It is important to note these inactive licences because, in the event of a restructure, we have assumed that these licence holders will choose to leave first. Removing these licences has no impact on the NER for the fishery or on employment levels as their inactivity implies they are currently employing no capital or labour in the fishery.

Table 2-2 Number of licences by region [a]

	WC	SG	GSV/KI	SE	Total
Active licences	53	120	85	19	277
Inactive licences	3	4	8	1	16
Total licences	**56**	**124**	**93**	**20**	**293**

[a] Excludes all 14 Sardine licences.

Source: PIRSA Fisheries and Aquaculture

Costs and returns

Average costs and returns for the four main species and the remaining species by region were developed for the report titled *SA Marine Scalefish Fishery Economic Analysis of Core Species 2013/14* prepared for PIRSA Fisheries and Aquaculture (EconSearch 2016). To utilise these financial data for this study the following information was used to adjust the 2013/14 indicators to reflect the fishery's performance in 2017/18.

- SARDI data were used to reflect changes in catch and its value between 2013/14 and 2017/18. Catch and value data were used to estimate the average total boat income in the fishery.
- Information on change in fishing effort (number of days fished) between 2013/14 and 2017/18 was used to adjust the cost of inputs that were assumed to vary with fishing effort. These inputs included fuel, repairs and maintenance, ice and provisions.
- The consumer price index (CPI) for Adelaide and components of the CPI were used to adjust the cost of inputs to reflect local levels of inflation (ABS 2018).

[3] A licence is considered active if it was used to fish for one or more days in that financial year.

2.4. Scenarios for Analysis

In addition to the two level of business performance (as noted in Section 2.2), three different levels of catch were analysed in the modelling:

- current catch levels (average between 2011/12 and 2015/16)
- a 20 per cent reduction in current catch levels for key species, and
- indicative TACCs for key species .

Catch levels in each of the four regions for scenario 3.1 are provided in (Table ES-1).

Table 2-3 Catch levels scenarios by region (t)[a]

Catch Scenario	WC	SG	GSV/KI	SE	Total
Current catch	271	1,049	739	147	2,207
20% reduction in current catch of key species [a]	245	955	624	128	1,952
Indicative TACCs for key species	277	1,048	492	148	1,965

[a] Catch of remaining species held constant at current levels.

Source: SARDI

In total six scenarios were analysed to estimate the number of licences that would need to be removed to enable the fishery to generate a positive NER. The scenarios can be categorised under two levels of financial performance, with three catch levels applied to both, as shown below.

- Average business performance:
  - Current catch
  - 20% reduction in catch of key species
  - Indicative TACCs
- Poorer performing business:
  - Current catch
  - 20% reduction in catch of key species
  - Indicative TACCs

3. RESULTS

3.1. Remove Average Performing Businesses

The results reported in this section are based on the assumption that the financial performance of businesses leaving the fishery are at the fishery average. The anlaysis was replicated for each of the three catch scenarios, current catch, reduced catch (20%) and indicative TACCs, as detailed in Table 2-3.

3.1.1. Current catch

The *current* number of licences by region and method (line and net) and the number of licences that would *need to be removed* to generate a positive NER are detailed in Table 3-1 under the current catch, average business scenario.

Under this scenario, a total of 97 licences would need to be removed to ensure a positive NER in all four regions. Almost half (44 licences) would need to be removed from GSV/KI, followed by WC (27), SG (19) and SE (7). The majority would be line only licences (83) with the balance net licences (14).

The estimated improvement in fishery NER of removing one more boat in each region was, on average, approximately $28,000 in the WC, $44,000 in SG, $52,000 in GSV/KI and $51,000 in the SE.

Table 3-1 Number of licences to be removed for positive NER: current catch, average business scenario [a]

	WC	SG	GSV/KI	SE	Total
Current licences					
Net	4	21	26	0	51
Line	52	103	67	20	242
Total	**56**	**124**	**93**	**20**	**293**
Licences to be removed					
Net	0	5	8	0	14
Line	27	14	36	7	83
Total	**27**	**19**	**44**	**7**	**97**

[a] Includes inactive licences but excludes all 14 Sardine endorsed licences.

Source: BDO EconSearch analysis

3.1.2. Reduction in catch

The 'reduction in catch' scenario assumes a 20 per cent reduction in the level of catch for each of the four key species in each region and that the businesses leaving the fishery have average financial performance. The current number of licences by region and method (line and net) and the number of licences that would need to be removed to generate a positive NER are detailed in The estimated improvement in fishery NER of removing one more boat in each region was, on average, $18,000 in the WC, $14,000 in SG, $38,000 in GSV/KI and $20,000 in the SE.

Table 3-5 under the reduction in catch, average business scenario.

Under this scenario, a total of 134 licences would need to be removed to ensure a positive NER in all four regions. Over 40 per cent (55 licences) would need to be removed from GSV/KI, around 25 per cent each from the WC (34) and SG (35), and less than 10 per cent from the SE (10). The majority would be line only licences (112) with the balance net licences (22).

The estimated improvement in fishery NER of removing one more boat in each region was, on average, $28,000 in the WC, $18,000 in SG, $44,000 in GSV/KI and $19,000 in the SE.

Table 3-2 Number of licences to be removed for positive NER: catch reduction, average business scenario[a]

	WC	SG	GSV/KI	SE	Total
Current licences					
Net	4	21	26	0	51
Line	52	103	67	20	242
Total	**56**	**124**	**93**	**20**	**293**
Licences to be removed					
Net	0	11	10	0	22
Line	34	24	45	10	112
Total	**34**	**35**	**55**	**10**	**134**

[a] Includes inactive licences but excludes all 14 Sardine endorsed licences.

Source: BDO EconSearch analysis

3.1.3. Indicative TACCs

Total catch by region for each of the scenarios, including the indicative regional TACCs scenario, were provided in Table 2-3. The indicative TACCs *by species* by region are detailed in **Error! Reference source not found.**Table 3-3. These indicative TACCs were developed by SARDI but will require further development prior to the setting of actual TACCs.

Table 3-3 Indicative TACCs for the major species by region (t) [a]

	WC	SG	GSV/KI	SE	Total
Snapper	24	12	33	17	86
King George Whiting	80	125	54	1	260
Southern Calamari	21	209	151	73	454
Garfish	10	124	90	6	230

[a] Indicative only - actual TACCs will need further development.

Source: SARDI Aquatic Sciences

The ‘indicative TACCs’ scenario is based on the quota for key species reported in Table 3-3, catch levels for other species as per the ‘current catch scenario, and the assumption that the businesses leaving the fishery have average financial performance. The current number of licences by region and method (line and net) and the number of licences that would need to be removed to generate a positive NER are detailed in Table 3-4 under the indicative TACCs, average business scenario.

Under this scenario, a total of 120 licences would need to be removed to ensure a positive NER in all four regions. Around 57 per cent (68 licences) would need to be removed from GSV/KI, around 23 per cent from the WC (28), 15 per cent from the SG (18) and just 5 per cent from the SE (6). As with the previous two scenarios, the majority would be line only licences (101) with the balance net licences (19).

The estimated improvement in fishery NER of removing one more boat in each region was, on average, $27,000 in the WC, $48,000 in SG, $31,000 in GSV/KI and $61,000 in the SE.

Table 3-4 Number of licences to be removed for positive NER: indicative TACC, average business scenario[a]

	WC	SG	GSV/KI	SE	Total
Current licences					
Net	4	21	26	0	51
Line	52	103	67	20	242
Total	**56**	**124**	**93**	**20**	**293**
Licences to be removed					
Net	0	5	13	0	19
Line	28	13	55	6	101
Total	**28**	**18**	**68**	**6**	**120**

[a] Includes inactive licences but excludes all 14 Sardine endorsed licences.

Source: BDO EconSearch analysis

3.2. Remove Poorer Performing Businesses

The results reported in this section are based on the assumption that the financial performance of businesses leaving the fishery are below the fishery average. Under this scenario it was further assumed (detailed in Section 2.1) that the remaining businesses would be more efficient (higher CPU) than those that leave. The anlaysis under these assumptions was replicated for each of the three catch scenarios, current catch, reduced catch (20%) and indicative TACCs, as detailed in Table 2-3.

3.2.1. Current catch

The *current* number of licences by region and method (line and net) and the number of licences that would *need to be removed* to generate a positive NER are detailed in The estimated improvement in fishery NER of removing one more boat in each region was, on average, $18,000 in the WC, $14,000 in SG, $38,000 in GSV/KI and $20,000 in the SE.

Table 3-5 under the current catch, poorer performing business scenario.

Under this scenario, a total of 165 licences would need to be removed to ensure a positive NER in all four regions.

The estimated improvement in fishery NER of removing one more boat in each region was, on average, $18,000 in the WC, $14,000 in SG, $38,000 in GSV/KI and $20,000 in the SE.

Table 3-5 Number of licences to be removed for positive NER: current catch, poorer business scenario[a]

	WC	SG	GSV/KI	SE	Total
Current licences					
Net	4	21	26	0	51
Line	52	103	67	20	242
Total	**56**	**124**	**93**	**20**	**293**
Licences to be removed					
Net	0	18	11	0	29
Line	38	35	46	16	136
Total	**38**	**53**	**57**	**16**	**165**

[a] Includes inactive licences but excludes all 14 Sardine endorsed licences.

Source: BDO EconSearch analysis

3.2.2. Reduction in catch

The following results assume a 20 per cent reduction in the level of catch for each of the four key species in each region and are based on a poorer financially performing business. The current number of licences by region and method (line and net) and the number of licences that need to be removed are detailed in The estimated improvement in fishery NER of removing one more boat in each region was, on average, $17,000 in the WC, $12,000 in SG, $33,000 in GSV/KI and $19,000 in the SE.

Table 3-6.

Under this scenario, a total of 186 licences would need to be removed to ensure a positive NER in all four regions.

The estimated improvement in fishery NER of removing one more boat in each region was, on average, $17,000 in the WC, $12,000 in SG, $33,000 in GSV/KI and $19,000 in the SE.

Table 3-6 Number of licences to be removed for positive NER: catch reduction, poorer business scenario[a]

	WC	SG	GSV/KI	SE	Total
Current licences					
Net	4	21	26	0	51
Line	52	103	67	20	242
Total	**56**	**124**	**93**	**20**	**293**
Licences to be removed					
Net	1	21	12	0	34
Line	42	40	53	17	152
Total	**43**	**61**	**65**	**17**	**186**

[a] Includes inactive licences but excludes all 14 Sardine endorsed licences.

Source: BDO EconSearch analysis

3.2.3. Indicative TACCs

Indicative regional TACCs were developed by SARDI as detailed in Table 3-3. The following results are based on a poorer financially performing business. The current number of licences by region and method (line and net) and the number of licences that need to be removed are detailed in Table 3-7. Under this scenario, a total of 197 licences would need to be removed to ensure a positive NER in all four regions.

The estimated improvement in fishery NER of removing one more boat in each region was, on average, $18,000 in the WC, $12,000 in SG, $25,000 in GSV/KI and $18,000 in the SE.

Table 3-7 Number of licences to be removed for positive NER: indicative TACCs poorer business scenario[a]

	WC	SG	GSV/KI	SE	Total
Current licences					
Net	4	21	26	0	51
Line	52	103	67	20	242
Total	**56**	**124**	**93**	**20**	**293**
Licences to be removed					
Net	1	20	16	0	36
Line	38	38	66	18	161
Total	**39**	**58**	**82**	**18**	**197**

[a] Includes inactive licences but excludes all 14 Sardine endorsed licences.

Source: BDO EconSearch analysis

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Australian Bureau of Statistics (ABS) 2018, *Consumer Price Index, Australia*, Cat. No. 6401.0.

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