

# **The dynamics of targeted fishing effort between different species in the Marine Scalefish Fishery**

**Report to PIRSA**

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## TABLE OF CONTENTS

TABLE OF CONTENTS .....	iii
LIST OF TABLES.....	v
LIST OF FIGURES .....	vi
ACKNOWLEDGEMENTS.....	ix
EXECUTIVE SUMMARY .....	x
<b>1 GENERAL INTRODUCTION .....</b>	<b>1</b>
1.1 <i>Fishing Fleet dynamics</i> .....	1
1.2 <i>Complexities of South Australia’s Marine Scalefish fishery</i> .....	2
1.3 <i>Contribution of effort to the MSF by southern rock lobster fishers</i> .....	6
1.4 <i>Need</i> .....	6
1.5 <i>Aims and Objectives</i> .....	7
<b>2 SPATIAL AND TEMPORAL TRENDS IN TARGETED FISHING EFFORT .....</b>	<b>8</b>
2.1 <i>Introduction</i> .....	8
2.2 <i>Methods</i> .....	9
2.2.1 <i>Data considerations</i> .....	9
2.2.2 <i>Confidentiality</i> .....	10
2.3 <i>Results</i> .....	10
2.3.1 <i>Trends in licence holders</i> .....	10
2.3.2 <i>Commercial marine scalefish fishers</i> .....	11
2.3.3 <i>Species-specific trends</i> .....	15
2.3.3.1 <i>King George Whiting</i> .....	15
2.3.3.2 <i>Snapper</i> .....	21
2.3.3.3 <i>Southern Calamary</i> .....	27
2.3.3.4 <i>Garfish</i> .....	33
2.3.3.5 <i>Yellowfin Whiting</i> .....	39
2.3.3.6 <i>Any Target</i> .....	43
2.3.4 <i>Southern rock lobster fishers</i> .....	47
2.4 <i>Discussion</i> .....	53
2.4.1 <i>King George whiting</i> .....	53
2.4.2 <i>Snapper</i> .....	53
2.4.3 <i>Calamary</i> .....	54
2.4.4 <i>Garfish</i> .....	55
2.4.5 <i>Yellowfin whiting</i> .....	55
2.4.6 <i>Southern rock lobster fishers</i> .....	56
<b>3 SPECIALIST MARINE SCALEFISH FISHERS.....</b>	<b>57</b>
3.1 <i>Introduction</i> .....	57
3.2 <i>Methods</i> .....	57
3.3 <i>Results</i> .....	57
3.3.1 <i>Targeted effort by specialist fishers</i> .....	57
3.3.2 <i>Alternate target species</i> .....	58
3.3.3 <i>Spatial distribution of targeted effort</i> .....	59
3.3.4 <i>Specialist fishers’ catch contribution</i> .....	59
3.4 <i>Discussion</i> .....	64

<b>4</b>	<b>EXTERNAL INFLUENCES.....</b>	<b>66</b>
4.1	<i>Introduction.....</i>	66
4.2	<i>Methods.....</i>	66
4.3	<i>Results .....</i>	67
4.3.1	<i>Market value .....</i>	67
4.3.2	<i>Weather conditions .....</i>	71
4.4	<i>Discussion .....</i>	72
<b>5</b>	<b>LATENT EFFORT IN THE MSF.....</b>	<b>73</b>
5.1	<i>Introduction.....</i>	73
5.2	<i>Methods.....</i>	73
5.3	<i>Results .....</i>	75
5.4	<i>Discussion .....</i>	77
<b>6</b>	<b>GENERAL DISCUSSION .....</b>	<b>78</b>
6.1	<i>Synthesis of broad-scale trends.....</i>	78
6.2	<i>Implications for management.....</i>	80
6.3	<i>Data limitations and future directions.....</i>	81
<b>7</b>	<b>REFERENCE LIST.....</b>	<b>83</b>
<b>8</b>	<b>APPENDIX.....</b>	<b>85</b>

## LIST OF TABLES

Table 1.1. Permitted Marine Scalefish species under Schedule 1 of the <i>Fisheries Management (Marine Scalefish Fisheries) Regulations 2006</i> . Primary (1), secondary (2) and tertiary (3) priority species are indicated according to Noell et al. (2006). * indicates those species that are managed under different management schemes. ....	3
Table 1.2. Fishing gear and devices endorsed in the Marine Scalefish Fishery. * Hauling nets include haul nets, floating garfish nets, sinking and floating garfish nets, sinking mesh nets, and sinking mixed mesh nets.....	3
Table 1.3. Management history of the commercial Marine Scalefish fishery (1970 – 2006). ...	5
Table 4.1. Results of regional Pearson’s correlation analyses between monthly targeted effort and wind strength for each of the seven areas around South Australia’s coastline. Significance denoted as * ( $p < 0.05$ ), ** ( $p < 0.01$ ), *** ( $p < 0.001$ ). ....	71

## LIST OF FIGURES

Figure 2.1. The commercial Marine Fishing Areas (MFAs) of the South Australian Marine Scalefish Fishery. ....	8
Figure 2.2. Long-term trend in the number of licence holders from various commercial sectors that have access to the Marine Scalefish Fishery. ....	10
Figure 2.3. Long-term trend in total effort in the commercial Marine Scalefish Fishery partitioned into targeted effort and non-targeted “any target” effort (top) and into species-specific targeted effort, presented in order of priority status. ....	12
Figure 2.4. Long-term trend in gear usage (%) for targeted effort and non-specific “any target” effort for the five priority species. ....	13
Figure 2.5. Spatial and temporal distribution of total fishing effort in the Marine Scalefish Fishery. ....	14
Figure 2.6. Long-term trend in the seasonal targeted effort for King George whiting. ....	16
Figure 2.7. Long-term seasonal trends in State-wide total targeted effort, catch and CPUE for King George whiting for the main gear types used by commercial Marine Scalefish fishers. ....	17
Figure 2.8. Spatial and temporal distribution of targeted effort on King George whiting. ....	18
Figure 2.9. Spatial and temporal distribution of targeted handline effort on King George whiting. ....	19
Figure 2.10. Spatial and temporal distribution of targeted haulnet effort on King George whiting. ....	20
Figure 2.11. Long-term trend in the seasonal targeted effort for snapper. ....	22
Figure 2.12. Long-term seasonal trends in State-wide total targeted effort, catch and CPUE for snapper for the main gear types used by commercial Marine Scalefish fishers. ....	23
Figure 2.13. Spatial and temporal distribution of targeted effort on snapper. ....	24
Figure 2.14. Spatial and temporal distribution of targeted handline effort on snapper. ....	25
Figure 2.15. Spatial and temporal distribution of targeted longline effort on snapper effort. ....	26
Figure 2.16. Long-term trend in the seasonal targeted effort for southern calamary. ....	28
Figure 2.17. . Long-term seasonal trends in State-wide total targeted effort, catch and CPUE for calamary for the main gear types used by commercial Marine Scalefish fishers. ....	29
Figure 2.18. Spatial and temporal distribution of targeted effort on southern calamary. ....	30
Figure 2.19. Spatial and temporal distribution of targeted squid jig effort on southern calamary. ....	31
Figure 2.20. Spatial and temporal distribution of targeted haulnet effort on southern calamary. ....	32

Figure 2.21. Long-term trend in the seasonal targeted effort for garfish.....	34
Figure 2.22. . Long-term seasonal trends in State-wide total targeted effort, catch and CPUE for garfish for the main gear types used by commercial Marine Scalefish fishers.....	35
Figure 2.23. Spatial and temporal distribution of targeted effort on garfish.....	36
Figure 2.24. Spatial and temporal distribution of targeted haulnet effort on garfish.....	37
Figure 2.25. Spatial and temporal distribution of targeted dab net effort on garfish.....	38
Figure 2.26. Long-term trend in the seasonal targeted effort for yellowfin whiting. ....	40
Figure 2.27. . Long-term seasonal trends in State-wide total targeted effort, catch and CPUE for yellowfin whiting for the main gear types used by commercial Marine Scalefish fishers ....	41
Figure 2.28. Spatial and temporal distribution of targeted effort on yellowfin whiting .....	42
Figure 2.29. Long-term trend in the seasonal targeted effort for “any target”. ....	44
Figure 2.30. Long-term trends in the composition of catch by non-specific “any target” fishers. ....	45
Figure 2.31. Spatial and temporal distribution of non-specific “any target” effort. ....	46
Figure 2.32. Long-term trend in targeted MSF effort by Northern and Southern Zone rock lobster licence holders. Numbers in parentheses indicate the relative proportion of annual total MSF targeted effort.....	48
Figure 2.33. Long-term trend in gear usage by rock lobster licence holders to target marine scalefish species.....	49
Figure 2.34. Long-term trend in the seasonal targeted MSF effort by rock lobster licence holders.....	50
Figure 2.35. Long-term, species-specific allocation of targeted effort by rock lobster licence holders.....	51
Figure 2.36. Spatial and temporal distribution of targeted MSF effort by rock lobster licence holders.....	52
Figure 3.1. Long-term trend in the relative proportion of specialist fishers within the MSF fishery broken down by species. Numbers in parentheses indicate the total number of MSF licence holders. ....	58
Figure 3.2. Long-term trend in the amount of effort (%) targeted to alternate species by specialist fishers.....	61
Figure 3.3. Long-term trend in the number of Marine Fishing Areas fished by specialist and generalist MSF fishers. Data indicates whether the two distributions significantly differ (Mann-Whitney test).....	62
Figure 3.4. Long-term trend in the relative proportion of total catch by the top 10 commercial fishers for each of the five priority species.....	63

Figure 4.1. Long-term trend in the total production and value of South Australia's Marine Scalefish Fishery. ....	67
Figure 4.2. Relative value of the major species caught in the MSF in 2007/2008. Numbers in parentheses indicate percentage contribution. ....	67
Figure 4.3. Long-term trends in the annual production (brown bars) and value (red line) for each of the five priority species in the MSF. ....	69
Figure 4.4. Long-term correlation of the State's market price and targeted fishing effort for each of the five priority species in the MSF. Pearson's correlation coefficients are shown. Significance denoted as * (p <0.05), ** (p <0.01), *** (p <0.001). ....	70
Figure 4.5. Regional breakdown of 24-year average wind speed and direction. ....	71
Figure 5.1. Unconstrained estimate of latent effort incorporating the maximum number of fisher days and the maximum number of additional agents permitted by each licence holder. ....	75
Figure 5.2. Estimate of latent effort incorporating the average number of fisher days expended by licence holders ( $\pm$ 95% confidence limit) and their maximum number of permitted additional agents. ....	76
Figure 5.3. Estimate of latent effort incorporating the average number of fisher days expended by licence holders ( $\pm$ 95% confidence limit) and their average number additional agents used ( $\pm$ 95% confidence limit). ....	76
Figure 8.1. Spatial and temporal distribution of average, species-specific, targeted effort from 1984 - 1986. ....	85
Figure 8.2. Spatial and temporal distribution of average, species-specific, targeted effort from 1987 - 1989. ....	86
Figure 8.3. Spatial and temporal distribution of average, species-specific, targeted effort from 1990 - 1992. ....	87
Figure 8.4. Spatial and temporal distribution of average, species-specific, targeted effort from 1993 - 1995. ....	88
Figure 8.5. Spatial and temporal distribution of average, species-specific, targeted effort from 1996 - 1998. ....	89
Figure 8.6. Spatial and temporal distribution of average, species-specific, targeted effort from 1999 - 2001. ....	90
Figure 8.7. Spatial and temporal distribution of average, species-specific, targeted effort from 2002 - 2004. ....	91
Figure 8.8. Spatial and temporal distribution of average, species-specific, targeted effort from 2005 - 2007. ....	92

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## EXECUTIVE SUMMARY

- The aim of this report was to quantify, describe and explain the spatio-temporal dynamics of targeted fishing effort in South Australia's commercial Marine Scalefish Fishery. Estimates of targeted effort were partitioned between marine scalefish and rock lobster licence holders to determine the extent in which the resource is shared.
- Given the large amount of data currently stored on Marine Scalefish catch and effort database, as a consequence of it being a complex multi-species, multi-gear and multi-sector fishery, it was necessary to constrain the data into a smaller, more manageable dataset that still reflected the major trends in fisher behaviour and fleet dynamics. This was primarily achieved through considering only those fishers who caught any of the following 'priority' species: King George whiting, garfish, snapper, southern calamary and yellowfin whiting.
- The dynamics of the Marine Scalefish fishing fleet has changed throughout history. Overall there has been a 41.4% reduction in the number of fishers licensed to harvest MSF species over the past 26 years, declining from 1,132 licence holders in 1982 to 663 in 2007. The rate of decline was accelerated in 1994 as a function of the licence amalgamation scheme and further emphasised by the voluntary net buy-back scheme implemented in 2005.
- There has been an overwhelming spatial contraction of effort across the State, with fishing intensity virtually disappearing from most regional centres and the fishery becoming largely confined to gulf waters.
- The level of detail in the reporting of catch and effort information has improved as there has been a significant reduction (~ 71%) in the number of fisher days reported in the "any target" category.
- For each of the five priority species considered there was strong evidence that the total targeted catch was disproportionately distributed amongst the fishers, with the bulk of the catch being harvested by a relatively small group of 'specialist' fishers. This overall trend was consistent throughout the 24-year

history of the fishery with the exception of the calamary fishery, the 'efficiency' of these 'specialist' fishers improved with time.

- Although all five priority species were targeted by commercial fishers throughout the year, each had distinct seasonal peaks that remained relatively consistent over the past 24 years. There were, however, clear long-term shifts in the level of fishing intensity, the spatial distribution and allocation of targeted effort directed towards each of the priority species.
- Contemporary marine scalefish fishers have become slightly more generalist in nature and have spread their targeted effort more evenly across at least two priority species. The rate of this diversification has been slow, with the proportion of specialist fishers declining by approximately  $0.5 \text{ \%} \cdot \text{year}^{-1}$ . These fishers have logically synchronised their fishing activity to coincide with the natural pattern of the species' seasonal abundance.
- For the five priority scalefish species, southern rock lobster fishers accounted for a minor proportion of targeted fishing effort, with estimates rarely exceeding 2%. There was clear separation in the distribution of fishing effort between the two fisheries. Rock lobster fishers have predominantly targeted scalefish in southern waters and have rarely ventured into the gulfs where most of the commercial marine scalefish effort is concentrated.
- An estimate of latent effort in the Marine Scalefish Fishery indicated that the fishery had the potential to expand a further 14.8% in 2007. Fishing activity was found to be impeded by periods of poor weather and inversely correlated with market price, therefore, it is unlikely that the fishery's full effort potential will ever be completely fulfilled.
- The development of any new species-specific management arrangements needs to take into account the diversification of the fishery and consider the potential, flow-on, effects that may be indirectly transferred to other species.

## 1 GENERAL INTRODUCTION

### 1.1 Fishing Fleet dynamics

Understanding the dynamics of fishers within a commercial fishery is as important in assessing the effects of changing management arrangements as are the population dynamics of the fish and the ecosystem that support them (Hilborn 1985). This is because the metrics of the fishers' catch and fishing effort are used as the basic input in stock assessment models. Catch and effort data are typically analysed in the form of catch-per-unit-effort (CPUE) and is generally used as an index of fish abundance, where a proportionate change in CPUE is expected to reflect a corresponding change in stock size. Management often gauges the status of a fishery by comparing the latest estimate of CPUE with either a historical baseline, or a calculated reference value. This relationship, however, is not always reliable as trends in CPUE may be complicated by the underlying behaviour of the fishers, the types of fishing gear they use and technological advances in their fishing methods (Hilborn and Walters 1992). For example, fishers who efficiently target aggregations of fish can maintain high catch rates as abundance declines (i.e., *hyperstability*). In these circumstances CPUE will remain high until fishing activities no longer remain commercial viable. Conversely, CPUE can decline to a level where the stock appears to be depleted but, in fact, remains relatively abundant (i.e., *hyperdepletion*). This can occur when fishing gear selects a small but highly vulnerable component of the population and leaves the bulk of the remaining population undisturbed.

The dynamics of a fishing fleet essentially result from a series of decisions made by individual fishers that relate to when and where to fish, what gear to use and what species to target. These decisions can be influenced by a range of related factors such as the seasonal movement and migration of the target species, weather conditions, management arrangements, and socio-economics. In order to reliably evaluate the impact of a fishing fleet on a resource it has been argued that a thorough knowledge of the fishery is initially required, followed by a comprehensive evaluation of the spatial and temporal characteristics of the fishing activities before any reliable stock assessment and forecast models can be developed for management purposes (Hilborn and Walters 1992, Mahévas et al. 2008). In most cases, a detailed decomposition of fishing effort by season, location, target species and fishing gear is considered necessary to fundamentally characterise patterns of fishing activity (Hilborn and Walters 1992).

## 1.2 Complexities of South Australia's Marine Scalefish fishery

The Marine Scalefish fishery is the most complex fishery in South Australia, based on it being a multi-species, multi-gear and multi-sector fishery. Commercial fishers are permitted to take in excess of 55 marine species that include fishes, molluscs, crustaceans, annelid worms and sharks (Table 1.1). The majority of the fishery production is comprised of traditional scalefish species, in particular King George whiting (*Sillaginodes punctatus*), snapper (*Chyrosphrys auratus*), southern garfish (*Hyporhamphus melanochir*) and yellowfin whiting (*Sillago schomburgkii*). Other species such as southern calamary (*Sepioteuthis australis*), gummy shark (*Mustelus antarcticus*), sand crabs (*Ovalipes australiensis*) and mud cockles (*Katelaysia* spp.) also provide an important contribution to the total catch. Whilst some marine scalefish licence holders have access to blue crabs (*Portunus pelagicus*) and Australian sardines (*Sardinops sagax*) there are separate schemes of management for fisheries on these species.

The commercial Marine Scalefish fishery is a limited-entry fishery which is managed through a series of input controls designed to ensure that the resource is harvested within sustainable limits. These controls include gear restrictions, size limits, seasonal and spatial closures. Currently there are 30 types of fishing gear endorsed in this fishery whose use differs, depending on the location of fishing and the types of species being targeted (Table 1.2). With the exception of rods and handlines, all devices must be registered on a licence before they can be used to take fish for trade or business. Within the commercial sector there are two types of licences, 'Marine Scalefish' and 'Restricted Marine Scalefish'. 'Marine Scalefish' licence holders are the most common. They generally have full access to marine scalefish species and encompass a wide variety of gear endorsements. These licences can be traded through family transfers and through the amalgamation scheme. They can include up to four additional fishing agents, however, most have two additional agents. A proportion of these licence holders have specific net endorsements and, as such, are permitted to use hauling nets to target certain species. 'Restricted Marine Scalefish' licence holders also have a variety of gear endorsements but are prohibited from using hauling nets. These licences can only be traded through the amalgamation scheme.

**Table 1.1.** Permitted Marine Scalefish species under Schedule 1 of the *Fisheries Management (Marine Scalefish Fisheries) Regulations 2006*. Primary (1), secondary (2) and tertiary (3) priority species are indicated according to Noell et al. (2006). \* indicates those species that are managed under different management schemes.

Scalefish		
King George Whiting	<i>Sillaginodes punctatus</i>	1
Snapper	<i>Chrysophrys auratus</i>	1
Southern Garfish	<i>Hyporhamphus melanochir</i>	1
Australian Herring	<i>Arripis georgianus</i>	2
Black Bream	<i>Acanthopagrus butcheri</i>	2
Bluethroat Wrasse	<i>Notolabrus tetricus</i>	2
Mulloy	<i>Argyrosomus hololepidotus</i>	2
Ocean Leatherjackets	<i>Nelusetta ayraud</i>	2
Snook	<i>Sphyræna novaehollandiae</i>	2
West Australian Salmon	<i>Arripis truttaceus</i>	2
Yellowfin Whiting	<i>Sillago schomburgkii</i>	2
Flathead	Family Platycephalidae	3
Red Mullet	Family Mugilidae	3
Sea Sweep	<i>Scorpius aequipinnis</i>	3
Yellow-eye Mullet	<i>Aldrichetta forsteri</i>	3
Yellowtail Kingfish	<i>Seriola lalandi</i>	3
Australian Sardine	<i>Sardinops sagax</i>	*
Australian Anchovy	<i>Engraulis australis</i>	-
Barracouta	<i>Thyrsites atun</i>	-
Bight Redfish	<i>Centroberyx gerrardi</i>	-
Blue Mackerel	<i>Scomber australasicus</i>	-
Blue-eye Trevalla	<i>Hyperoglyphe antarctica</i>	-
Bluespotted Goatfish	<i>Upeneichthys vlamingii</i>	-
Cod	Family Moridae	-
Common Jack Mackerel	<i>Trachurus declivis</i>	-
Dory (Family Zeidae)	Family Zeidae	-
Flounder	Family Bothidae or Pleuronectidae	-
Leatherjacket	Family Monacanthidae	-
Morwong	Family Cheilodactylidae	-
Mullet	Family Mugilidae	-
Pink Ling	<i>Genypterus blacodes</i>	-
Redfish	<i>Centroberyx affinis</i>	-
Southern Sole	<i>Aseragodes haackeanus</i>	-
Swallowtail	<i>Centroberyx lineatus</i>	-
Trevally	<i>Caranginae</i> spp.	-
Whiting	Family Sillaginidae	-

  

Crustaceans		
Sand Crab	<i>Ovalipes</i> spp.	2
Blue Swimmer Crab	<i>Portunus pelagicus</i>	*
Velvet Crab	<i>Nectocarcinus tuberculatus</i>	-

  

Molluscs		
Southern Calamary	<i>Sepioteuthis australis</i>	1
Cuttlefish	<i>Sepia</i> spp.	2
Mud Cockle	<i>Katelysia</i> spp.	2
Razorfish	<i>Pinna bicolor</i>	3
Cockle	Suborder Teledonta	-
Gould's Squid	<i>Nototodarus gouldi</i>	-
Mussel	<i>Mytilus</i> spp.	-
Octopus	<i>Octopus</i> spp.	-
Oyster*	Family Ostreidae	-
Scallop*	Family Pectinidae	-

  

Sharks		
Sharks*	Class Elasmobranchii	2
Rays	Class Elasmobranchii	-
Skate	Class Elasmobranchii	-

  

Annelids		
Beachworm*	Class Polychaeta	3
Bloodworm*	Class Polychaeta	3
Tubeworm*	Class Polychaeta	3

**Table 1.2.** Fishing gear and devices endorsed in the Marine Scalefish Fishery. \* Hauling nets include haul nets, floating garfish nets, sinking and floating garfish nets, sinking mesh nets, and sinking mixed mesh nets.

Gear Type		
Bait fork	Diving	Large mesh net
Bait net	Drop line	Longline
Bait pump	Drop net	Mussel dredge
Bait spade	Fish spear	Oceanjacket trap
Brailing net	Fish trap	Octopus trap
Cockle net	Fishing rod/pole	Pilchard net
Cockle rake	Gill net (<15 cm)	Razorfish tongs
Crab net	Handline	Sand crab pot
Crab rake	Hauling net*	Squid jig
Dab net	Hoop net	Squid jigging machine

There are two additional sectors in this fishery, i.e. the recreational and charter boat sectors, for which different regulations and conditions apply. Fishing effort in these sectors are controlled by a range of gear limitations, size, bag and boat limits specific for individual species, and closed areas which include aquatic reserves. Furthermore, there are other commercial licence holders that have access to marine scalefish species. Almost all licence holders in the northern and southern rock lobster fisheries have some level of access, whereas all Lakes and Coorong licensed fishers have restricted access to some marine scalefish species. There is also a small group of fishers within the Miscellaneous Fishery that are permitted to harvest annelid worms.

The commercial Marine Scalefish fishery has undergone significant management changes over the past 30 years that have seen the fishery restructured and limited through gear restrictions and configuration, licensing, spatial and temporal closures, and size limits (Table 1.3). During this time there have been three notable changes that were principally implemented to limit, and then later 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 reissue of licences to fishers if a minimum level of commercial fishing had not been met. A licence amalgamation scheme was introduced which required prospective fishers to purchase a certain number of points when buying a licence. The amalgamation scheme requires that at least two licences be amalgamated into one before each transfer can be approved. Points were assigned to licences based on catch history and an index of species value. Once amalgamated these licences became fully transferable. This scheme was successful in removing some of the latent effort from the fishery. Fishing effort was further reduced in 2005, through a voluntary buy-back of net fishing endorsements which resulted in the removal of an estimated 45% of commercial net effort, based on data from the calendar years of 2000 to 2003 (McGarvey et al. 2006). This scheme coincided with significant spatial closures to net fishing.

**Table 1.3.** Management history of the commercial Marine Scalefish fishery (1970 – 2006).

Date	Marine Scalefish Fishery Management Arrangements
1958	Denial Bay, Smoky Bay, Baird Bay and Venus Bay closed to net fishing.
Early 1970s	State-wide ban on netting in areas < 5m deep.
1977	Freeze on the issue of new commercial licences. Restricted MSF licence holders able to convert to MSF licences if they met certain criteria.
1977-1982	Show cause provision - licence holders required to demonstrate a minimum level of involvement to qualify for licence renewal.
1979-1980	Some employees of MSF licence holders were allowed to apply for licences.
1980	<p>Netting arrangements:</p> <ul style="list-style-type: none"> <li>• Limit on net length to 600 m for MSF licences and 400 m for Restricted MSF.</li> <li>• Nets cannot be joined, with the exception of a drain-off shot.</li> <li>• Net endorsements made non-transferable.</li> <li>• Freeze on issue of additional permits for use of nets.</li> <li>• Restricted MSF licence holders no longer entitled to use nets other than bait nets.</li> <li>• Restriction on use of nets by northern rock lobster licence holders.</li> </ul>
1980	Restricted MSF licences became non-transferable; owner-operator policy announced; family transferability introduced for MSF net and line licences.
1982	Licences became transferable, although net endorsements were not transferable with the licence unless a family transfer occurred, and Restricted MSF were still not transferable within families.
1983	Inshore Fisheries Advisory Committee established.
1983	More aquatic reserves (closed to both line and net fishing) and restricted netting areas were introduced.
1987	Maximum number of hooks permitted on long lines restricted to 400 in all gulf waters, and attendance of long lines was required. Long lining banned within 0.5 nautical mile of prescribed artificial reefs.
1987	New management controls were introduced for snapper, with minimum legal length increased from 28 to 38 cm TL.
1991	SA Sardine Fishery established
1992	New management controls were introduced for snapper, King George whiting and southern calamary.
1993	A ban on net fishing for snapper was introduced.
1994	Licence amalgamation scheme introduced.
1994	Further areas closed to net fishing in Coffin Bay and areas near Adelaide.
1995	King George whiting minimum legal size was increased from 28 to 30 cm TL.
1995-1996	Net review conducted and further netting restrictions introduced.
1996	Blue Crab Fishery established
1997	A further eight areas were closed to net fishing: Fowlers Bay, Edithburgh, Coobowie, Stansbury, Bay of Shoals, Germain Bay, Tumbly Bay and Port Neill.
1997	Maximum number of 400 hooks permitted on long lines was extended to all State waters.
1997	Jurisdiction transferred to Australian Government for some species under Offshore Constitutional Settlement (OCS) agreement.
1998	A closure (April to September) on northern Spencer Gulf cephalopods (cuttlefish and squid) was implemented.
1999	Split snapper closures implemented in August and November.
2000	OCS developed with Australian Government (Australian Fisheries Management Authority).
2001	Changes to legal minimum lengths and recreational bag and boat limits for several MSF species including snook and garfish.
2002	Coffin Bay sand crab pot fishery approved, with MSF fishers allowed to use crab traps in specified offshore waters.
2002	Scallop dredges prohibited.
2003	November closure for snapper introduced.
2004	Change in legal minimum length to 31 cm for King George whiting taken east of 136°E longitude; licence amalgamation scheme was amended.
2005	Voluntary net buyback scheme implemented; New areas closed to net fishing.
2006	Deep water netting exemptions in GSV revoked.
2008	Qutoa for Mud Cockles established

### **1.3 Contribution of effort to the MSF by southern rock lobster fishers**

South Australia's southern rock lobster fishery is divided into two spatial management zones, the northern and southern zones, with the geographic division located at the mouth of the Murray River (between MFAs 45 and 46) (Fig. 2.1). The Southern Zone Fishery is mainly concentrated in four MFAs (51, 55, 56 and 58), whereas the Northern Zone Fishery has typically targeted rock lobster in 10 MFAs (7, 8, 15, 27, 28, 39, 40, 48, 49 and 50) (Linnane et al. 2008a, b). Although the fishing area in the northern zone is an order of magnitude larger than the southern zone it is limited to fewer commercial licence holders at 68 as compared to 181, however, not all are active. All of South Australia's southern rock lobster licence holders have some level of access to the Marine Scalefish Fishery, that fall into three categories: (1.) incidental catch in lobster pots only; (2.) targeting species for bait purposes only; or (3.) targeting species for purposes of trade or business. Those that have haul net endorsements are not permitted to use them whilst they are pot fishing for lobster. Seasonal closures of variable durations have been enforced in the rock lobster fishery since the late 1950s (Sloan and Crosthwaite 2007a, b). Currently both fisheries close on May 31<sup>st</sup> each year with the Southern Zone Fishery reopening on October 1<sup>st</sup> and the Northern Zone Fishery on November 1<sup>st</sup>. Licence holders can target marine scalefish species throughout the entire closed season provided that they are on-board the vessel, otherwise scalefish fishing is restricted to a maximum of 28 days. As is the case for all marine scalefish licence holders, rock lobster fishers are required to fill out, and submit, monthly catch returns.

### **1.4 Need**

The heterogeneous mixture of participants, fishing devices, licence conditions and regulations associated with South Australia's Marine Scalefish Fishery, makes the task of managing this fishery extremely challenging. This is further compounded by the highly dynamic nature of the commercial fishers who can switch their targeted effort between species at will. Such switches in fishing effort are likely to vary between species at different temporal and spatial scales and are also likely to result in considerable dynamics in the catches. Without an understanding of such dynamic shifts some simple management options may result in serious unforeseen circumstances. For example, model outputs have indicated that increasing the legal minimum size limit of King George whiting by more than 1 cm would increase egg production, but may cause a transfer of fishing effort to offshore spawning aggregations, which predominantly involve larger fish (Zacharin 2006). Such a

change in fisher behaviour could create a serious sustainability problem that would be difficult to rectify (Zacharin 2006). There is, therefore, a need to develop a detailed understanding of South Australia's multi-species, multi-gear and multi-sector Marine Scalefish fishery to provide some basis for predicting the cross species consequences of implementing new management regulations.

### **1.5 Aims and Objectives**

The main aim of this report is to use the data in the Marine Scalefish catch and effort database to undertake analyses that determine the spatial and temporal trends in targeted fishing effort. This will provide information about the dynamics of switching effort between species, and provide a basis for predicting possible consequences of implementing species-specific management changes. The specific objectives addressed were:

- (1.) To characterise patterns of fishing activity in the Marine Scalefish fishery through a detailed decomposition of targeted fishing effort by season, location, target species and fishing gear;
- (2.) To understand what proportion of the fishery consists of specialist fishers and to determine whether they have been stable in their fishing practices, or have diversified their fishing effort across numerous species through time;
- (3.) To examine the effects of weather conditions and market price on targeted fishing effort and fleet dynamics;
- (4.) To provide an indication of the fishery's capacity to expand by quantifying the amount of 'realistic' latent effort that is available within the commercial Marine Scalefish fishery.