Figure 2.19. Spatial and temporal distribution of targeted squid jig effort on southern calamary.
Figure 2.20. Spatial and temporal distribution of targeted haulnet effort on southern calamary.
Of the five priority fisheries considered in this report, the garfish fishery has contracted the most over the past three decades, with total targeted effort declining by 69.8%. This decline has occurred at an almost linear rate of 340 fisherdays.year\(^{-1}\) from a peak of 14,592 in 1984 fisherdays to 4,412 fisherdays in 2007. Historically most of this effort has been concentrated in late summer and early autumn, with fishers frequently expending >1,500 fisherdays.month\(^{-1}\) over the peak fishing season (Fig. 2.21). In recent years, the peak season has contracted to January and February, with fishers expending <650 fisherdays.month\(^{-1}\) targeting garfish and rarely exceeding 400 fisherdays.month\(^{-1}\) for the remainder of the year.

Haul nets and dab nets are the two main gear types used to target garfish. Haul nets are the dominant gear type accounting for >80% of the total annual targeted effort. Catch rates in this sector have typically peaked in winter and have steadily increased by approximately 80%, from ~80 kgs.fisherday\(^{-1}\) in 1984 - 1986 to ~144 kgs.fisherday\(^{-1}\) in 2005 – 2007 (Fig. 2.22). The highest targeted haul net CPUE was 224 kgs.fisherday\(^{-1}\) recorded in July 2002. Dab netters have targeted garfish at relatively low levels throughout the year, rarely expending more than 200 fisherdays.month\(^{-1}\) (Fig. 2.22). The temporal pattern in peak catches and catch rates in this sector have been highly variable, and have exhibited no clear seasonality. Peak catch rates have also markedly increased over the past 24 years from ~27 kgs.fisherday\(^{-1}\) in 1984 - 1986 to ~48 kgs.fisherday\(^{-1}\) in 2005 – 2007, representing a long term increase of ~78% (Fig. 2.22).

Garfish are predominantly targeted in the northern parts of the two gulfs, with estimates of annual effort generally exceeding 2,000 fisherdays in MFAs 21, 23 and 35 (Fig. 2.23). Fishers have also historically targeted garfish at relatively low levels (i.e., < 1,000 fisherdays.year\(^{-1}\)) around Yorke Peninsula (MFAs 32, 33 & 34), Eyre Peninsula (MFAs 27, 30 & 31), Venus Bay (MFA 17) and Backstairs Passage (MFAs 42 & 44), occasionally extending into Investigator Strait (MFA 40) (Fig. 2.23). In the last three years targeted effort around Yorke Peninsula and Venus Bay has significantly declined as a result of the implementation of spatial netting closures and the buy-back of net fishing endorsements. These management arrangements have accentuated the reduction and northward contraction of targeted fishing effort in the haul net sector (Fig. 2.24). Dab netters are permitted to target garfish in areas that
are closed to haul netting and, as such, the distribution of their fishing effort encompasses a greater proportion of the State (Fig. 2.25). Most of the dab net effort has historically been concentrated in Backstairs Passage, with fishers regularly expending >200 fisherdays.year\(^{-1}\) targeting garfish. Northern Gulf St. Vincent (MFA 35) has also been consistently targeted, but, in general, the spatial distribution of fishing effort in this sector is skewed towards the southern-most regions of the gulfs and the south western coast of Eyre Peninsula (MFA 27 & 28) (Fig. 2.25).

![Figure 2.21. Long-term trend in the seasonal targeted effort for garfish.](image)
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.
Figure 2.23. Spatial and temporal distribution of targeted effort on garfish.
Figure 2.24. Spatial and temporal distribution of targeted haulnet effort on garfish.
Figure 2.25. Spatial and temporal distribution of targeted dab net effort on garfish.
2.3.3.5 Yellowfin Whiting

Yellowfin whiting has supported a small, highly dynamic fishery that has undergone periods of development and contraction over the past 24 years. Total annual targeted effort in this fishery peaked in 1984 at 1,734 fisherdays, with most concentrated in April, May and June (Fig. 2.26). By 1989, effort had declined 84% to 282 fisherdays, with fishers targeting yellowfin whiting in June and December. This modest level of fishing continued until 1992 when it began to redevelop. By 2002 total targeted effort had increased again to 1,700 fisherdays. It remained above 1,500 fisherdays until 2005, but over the last two years has declined to 980 fisherdays. Since 2001, fishing intensity has peaked above 150 fisherdays.month\(^{-1}\) at least twice during the year, typically in May and November, with smaller peaks (~100 fisherdays.month\(^{-1}\)) occasionally in the summer and winter months (Fig. 2.26).

Haul nets and set nets are the main gear types used to target yellowfin whiting, with haul nets contributing 70 – 85% of the total annual targeted effort. Both gear types are used throughout the year and follow similar intra-annual trends with catches and catch rates typically peaking during the autumn months. Whilst the monthly catches of the past six years have peaked over 15,000 kgs, they previously rarely exceeded 8,000 kgs (Fig. 2.27). With the exception of 1999 – 2001, peak catch rates in the haul net sector have been at least 40 kgs.fisherday\(^{-1}\) higher than those of the set net sector (Fig. 2.27). Both sectors have experienced long-term increases in their relative catch rates, increasing by approximately 2.6 and 2.3 kgs.fisher.year\(^{-1}\) from 1984 to 2007 for haul netters and set netters, respectively.

South Australia’s yellowfin whiting fishery is confined to the gulf regions of South Australia with the north-western corner of Spencer Gulf (MFAs 21 & 22) generally accounting for >60% of the total annual targeted effort (Fig. 2.28). Fishers also occasionally target yellowfin whiting in north-eastern Spencer Gulf (MFA 23) and northern Gulf St. Vincent (MFA 35 & 36), however the combined annual estimates of effort for these areas have rarely exceeded 15% of the Statewide total. Since 1995, fishing intensity has increased in MFA 21 with average estimates of targeted effort consistently exceeding 500 fisher days per year (Fig. 2.28).
Figure 2.26. Long-term trend in the seasonal targeted effort for yellowfin whiting.
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.
Figure 2.28. Spatial and temporal distribution of targeted effort on yellowfin whiting
2.3.3.6 Any Target

Non-specific effort, where at least one of the five priority species considered in this report was caught, was relatively stable from 1984 until 1997. During this time annual estimates consistently exceeded 23,000 fisherdays.year\(^{-1}\) and peaked at 28,205 fisher days in 1991, with most effort expended throughout autumn (Fig. 2.29). Over the next eight years non-specific effort dropped 70.8% to 7,554 fisher days, representing an annual decline of approximately 2,212 fisherdays.year\(^{-1}\). Despite this, there was still some seasonality as the months of autumn continued to account for a greater proportion of the annual effort (Fig. 2.29). This, however, dissipated in 2006 and by 2007 monthly estimates were homogeneous averaging 757 fisherdays.month\(^{-1}\) (Fig. 2.29). This long-term reduction in non-specific fishing effort is likely to reflect the commercial fishers being more specific in reporting their targeted species rather than an actual decline in effort within the fishery.

King George whiting, garfish and calamary constituted >80% of the annual, non-specific catch from 1984 until 2001, which declined below 70% in subsequent years due to a proportional increase in snapper catch (Fig. 2.30). Although species are not specifically recorded as being targeted, the composition of the catch naturally reflects seasonal abundance. The greatest proportion of garfish was caught through late summer and autumn, whereas King George whiting, calamary and yellowfin whiting were predominantly caught through autumn and winter (Fig. 2.30). Catches of snapper during December have appreciably increased by an order of magnitude, from an average of 2,649 kgs in 1999 – 2001 to 24,864 kgs in 2005 – 2007 (Fig. 2.30).

As the majority of ‘any target’ fishers fall within the haul net sector the spatial distribution of their fishing effort is largely confined to the shallow waters of the northern gulfs and around Yorke Peninsula (Fig. 2.31). There have been modest levels (201 – 1000 fisherdays.year\(^{-1}\)) of fishing effort around Eyre Peninsula (MFAs 27 – 31) particularly through the 1980s and early to mid 1990s, however, this has not been sustained (Fig. 2.31). Over the last ten years the spatial distribution of fishing effort has steadily contracted northwards in both gulfs.
Figure 2.29. Long-term trend in the seasonal targeted effort for “any target”.
Figure 2.30. Long-term trends in the composition of catch by non-specific “any target” fishers.
Figure 2.31. Spatial and temporal distribution of non-specific “any target” effort.
2.3.4 Southern rock lobster fishers

For the five priority scalefish species considered in this report, southern rock lobster fishers constitute a minor proportion of the total fishing effort, with estimates rarely exceeding 2.0% (Fig. 2.32). During the 1980s, effort levels consistently exceeded 2,000 fisherdays.year\(^{-1}\), peaking at 2,946 in 1987. This was not sustained and by 1991 effort levels had halved and have remained below 1,000 fisherdays.year\(^{-1}\) for most of the subsequent 16 years. With the exception of a 10-year period spanning the 1990s when fishing effort was split relatively evenly between the two rock lobster sectors, the northern zone fishers have generally been more active than their southern contemporaries. Historically, fishing effort by rock lobster fishers was highest during winter coinciding with the closed rock lobster season (Fig. 2.34). Prior to 2000, nominal amounts of effort (<300 fisherdays.month\(^{-1}\)) were expended targeting the priority scalefish species during the open season. Over the past seven years, effort levels have rarely exceeded 80 fisherdays.month\(^{-1}\) (Fig. 2.34).

Handlines have been the predominant gear type used by rock lobster fishers to catch scalefish species, contributing to >60% of total rock lobster fishing effort (Fig. 2.33). Initially haul nets contributed to ~39% of the rock lobster effort, however, this steadily declined and by 1995 was virtually eliminated from the fishery. Subsequent haul net usage has been negligible, rarely exceeding 4% of the total rock lobster effort (Fig. 2.33). Other gears, such as dab nets, longlines and squid jigs have been used sporadically to catch the priority species. Set nets were not used.

All five priority species have been targeted by rock lobster fishers (Fig. 2.35). King George whiting and snapper have consistently been the most targeted, collectively contributing to ~82% of rock lobster fishers targeted effort. Calamary and garfish have attracted 11% and 7%, respectively, whereas <1% of effort has been allocated to yellowfin whiting (Fig. 2.35). King George whiting has historically been targeted during winter and early spring with average effort peaking at 262 fisher days in July of 1984 – 1986 (Fig. 2.35). Although targeted effort on King George whiting has declined considerably over the years, with contemporary estimates rarely exceeding 75 fisherdays.month\(^{-1}\), the seasonality in effort has been consistent. This temporal pattern of fishing activity coincides with the species’ relative abundance and also with the closed rock lobster fishing season. The opposite seasonal trend was evident for snapper. Rock lobster fishers generally targeted snapper during the open lobster
season, concentrating their effort during summer and autumn. Like King George whiting, targeted effort on snapper has also declined from levels of high activity (peaking >70 fisherdays.month\(^{-1}\)) during the 1980s to more conservative and stable levels (peaking ~40 fisherdays.month\(^{-1}\)) in the 2000s. The seasonality of targeted effort for calamary and garfish has been sporadic and in recent years has rarely exceeded 15 and 3 fisherdays.month\(^{-1}\), respectively (Fig. 2.35).

Rock lobster fishers have preferentially targeted scalefish in southern waters, with some fishing in southern Spencer Gulf. During the 1980s, the southern MFAs of Spencer Gulf (MFAs 30 and 33) and the far south east of the State (MFAs 51 and 55) were the most heavily targeted, with effort estimates generally exceeding 200 fisherdays.year\(^{-1}\) (Fig. 2.36). Although effort levels have declined over the years, these two regions have remained the popular scalefish fishing grounds for rock lobster licence holders. There were relatively brief periods when scalefish were targeted in the deep waters northwest of Kangaroo Island (MFA 38 and 39) in the early 1990s and south of Kangaroo Island (MFA 49) in the mid to late 1990s, however this was not sustained. Over the past three years fishing activity has intensified in Investigator Strait (MFA 40) with estimates of targeted effort averaging 256 fisherdays.year\(^{-1}\) (Fig. 2.36).

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.
Figure 2.33. Long-term trend in gear usage by rock lobster licence holders to target marine scalefish species.
Figure 2.34. Long-term trend in the seasonal targeted MSF effort by rock lobster licence holders.
Figure 2.35. Long-term, species-specific allocation of targeted effort by rock lobster licence holders.
Figure 2.36. Spatial and temporal distribution of targeted MSF effort by rock lobster licence holders
2.4 Discussion

A species' pattern of distribution and abundance is intrinsically associated with its life history schedule, such as its timing of reproductive maturation, spawning activity and patterns of movement and migration, which conform to seasonal cycles. Fishers synchronise their fishing activity accordingly to maximise their efficiency and profitability. Although the five priority species were targeted by commercial fishers throughout the whole year, each had distinct seasonal peaks in targeted effort that were generally consistent over the past 24 years. King George and yellowfin whiting were primarily winter-based fisheries, whereas snapper and garfish were targeted during summer. Seasonal peaks in the calamary fishery were gear-specific, as haul netters targeted calamary during winter whereas jig fishers expended more targeted effort during summer. While the seasonality of fishing effort has remained temporally stable, there have been clear long-term shifts in fishing intensity, the spatial distribution and allocation of targeted effort towards each priority species.

2.4.1 King George whiting

Total targeted effort on King George whiting has declined by ~60%, the majority of which has been removed from the net sector as a consequence of numerous management arrangements. Targeted handline effort has also been substantially reduced, which however, has consistently remained the most significant sector in the Marine Scalefish Fishery. The pattern of spatial contraction of targeted effort on King George whiting has not reflected that of the other priority species. Regional centres, particularly the Far West Coast, have consistently accounted for most of targeted effort, whereas the level of fishing intensity within Gulf St. Vincent has decreased in recent years. This pattern has been exclusively determined by the handline sector, which targets fish in deeper water and accounts for >80% of the total targeted effort in this fishery.

2.4.2 Snapper

Targeted effort on snapper has declined by ~40% over the past 24 years. This is most likely a consequence of the licence amalgamation scheme, although there have been other specific management arrangements for snapper that may have contributed. The first was a ban on using nets to catch snapper in 1993. During this time the net sector accounted for 4% of the total targeted effort on snapper. Most of
the affected fishers remained within the fishery and either used alternate gear to
target snapper or redirected their effort to other species. The other relates to two
short-term (3 week) State-wide closures that were implemented in August and
November 1999 which were subsequently restructured into a single, on-going
November closure in 2003. Although catches and catch rates of snapper
substantially increased upon the re-opening of the fishing season (i.e. December),
there were no real appreciable increases in targeted effort when compared to
previous years (Fowler and McGarvey 2006). Therefore the level of fishing intensity
expended in December did not compensate for the effort lost during the November
closure. Consequently, the closures have been effective in reducing targeted effort
on snapper. A previous investigation into the effects of the snapper closures from
2000 to 2005 estimated that effort reductions were in the order of 1 to 12% per
annum, depending on the spatial, temporal and geartype breakdown of the analysis
(Fowler and McGarvey 2006).

In recent years, targeted effort on snapper, which has predominantly been expended
in the northern and eastern parts of Spencer Gulf, has extended southwards. This
shift in effort did not appear to relate to the southerly movement of stock as a recent
assessment has indicated that there has been minimal recruitment of fish into these
regions from northern Spencer Gulf (Fowler et al. 2007). Furthermore, model
estimates have also determined that the fishable biomass in southern Spencer Gulf
has declined marginally since mid 2002 (Fowler et al. 2007). Some fishers have
indicated that they have been displaced from the more productive northern snapper
grounds by an increase in number of recreational fishers (Lloyd pers. comm.).

2.4.3 Calamary

Targeted effort has consistently declined over the years for each priority species
except calamary for which targeted effort has increased by ~50%. Initially, calamary
was a minor bait fishery, or a by-product of the net sector, but it rapidly developed
during the early 1990s due to increased demand for human consumption. During
this time the fishery became increasingly attractive to commercial marine scalefish
fishers as calamary were highly aggregative, considered easy to catch and the set-up
costs associated with targeting them were relatively minor (Steer et al. 2007).
Calamary, therefore, became a cost-effective alternate target species for fishers that
had previously specialised in targeting other priority species. Haul net fishers have
always incidentally caught calamary and sold them as by-product, however, as the
fishery began to expand, a small proportion of netters specifically targeted calamary in northern Gulf St. Vincent. This was short-lived, as although contemporary haul netters have continued to catch calamary in appreciable quantities, the majority have not specifically targeted them, and as such, calamary have largely reverted back to a by-product species in this sector. The calamary fishery has stabilised in recent years with annual estimates of targeted effort fluctuating around 10,000 fisher days.

2.4.4 Garfish

The garfish fishery has contracted the most over the past three decades, with total targeted effort declining by ~70%. This has been most evident in the haul net sector and is largely due to fishers either surrendering their entire licence and exiting the fishery or rescinding their netting endorsements. As haul nets are the dominant gear type taking garfish, any management arrangement specific to this sector will have a significant effect. Spatial netting closures have influenced the dynamics of the garfish fishery since 1958 when a series of west coast bays were closed to net fishing. In the early 1970s netting was further restricted to coastal waters of depths <5m (with a few exemptions) and additional spatial closures were implemented in 1983, 1994, 1995, 1997 and 2005 (Table 1.1). Furthermore, all deep water netting exemptions in Gulf St. Vincent were revoked in 2006. The evolution of these spatial closures has accentuated the reduction of targeted haul net fishing effort and concentrated the fishery in the northern parts of the two gulfs. Currently, these two regions collectively account for approximately 80% of the State’s total commercial garfish catch (McGarvey et al. 2009). This spatial contraction has also emphasised the division between the haul net and dab net sectors within the fishery, with dab netters accounting for all of the targeted garfish effort in the southern gulfs.

2.4.5 Yellowfin whiting

The yellowfin whiting fishery has undergone significant periods of development and contraction over the past 24 years. Targeted effort in this fishery is relatively minor, accounting for ~2% of the total targeted effort in the Marine Scalefish Fishery and ~0.5% of licence holders are classified as specialist yellowfin whiting fishers. Yellowfin whiting are generally netted opportunistically during winter, usually when fishers detect large schools while fishing for other ‘more profitable’ species such as King George whiting (Ferguson 2000). Consequently, effort in this fishery is often reported as non-targeted. Although the level of non-specific reporting makes it
difficult to ascertain the extent to which effort is influencing this fishery, the wide fluctuations in targeted effort appear to be recruitment driven (Ferguson 2000).

2.4.6 Southern rock lobster fishers

For the five priority scalefish species, southern rock lobster fishers account for a minor proportion of total fishing effort, with estimates rarely exceeding 2%. This low level of contribution was expected as there are a number of management arrangements in place that restrict the amount of fishing effort that rock lobster licence holders can expend in the Marine Scalefish Fishery. For example, those fishers that do not have a full marine scalefish entitlement can only target scalefish when their individual transferable quota (ITQ) is reached and, if the licence holder is not on-board, they are restricted to a maximum of 28 days fishing during the rock lobster closed season (Noell et al. 2006).

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 effort of the Marine Scalefish fishers is concentrated. This division is most likely an issue of convenience, as rock lobster fishers are set up to fish more exposed offshore waters where rock lobster abundances are highest, whereas the majority of marine scalefish fishers are better situated to fish the more protected, inshore areas. The geographic division also suggests that each fishery may be targeting different marine scalefish sub-populations. King George whiting and snapper have attracted most (~82%) of the targeted effort of rock lobster licence holders. King George whiting were predominantly targeted during the winter, coinciding with the period of peak abundance and also with the rock lobster closed season. It is likely that rock lobster fishers target the larger and older fish that are known to accumulate in these southern areas after moving from the gulfs (Fowler et al. 2008). Snapper, however, were mainly targeted in the summer and autumn, when they aggregate to spawn (Fowler et al. 2007). Rock lobster fishers also target other scalefish species, particularly those that are most abundant offshore, such as; ocean leatherjackets, Western Australian salmon, blue morwong and various shark species, either for bait or commercial purposes. The level of catch and effort directed towards these species was not quantified in this report.