Fisheries

Assessment of the South Australian Marine Scalefish Fishery in 2018

MA Steer, AJ Fowler, PJ Rogers, F Bailleul, J Earl,
D Matthews, M Drew and A Tsolos

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SARDI Aquatics Sciences
PO Box 120 Henley Beach SA 5022

April 2020

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South Australian Research and Development Institute
SARDI Aquatic Sciences
2 Hamra Avenue
West Beach SA 5024

Telephone: (08) 8207 5400
Facsimile: (08) 8207 5415
http://www.pir.sa.gov.au/research

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Author(s): MA Steer, AJ Fowler, PJ Rogers, F Bailleul, J Earl, D Matthews, M Drew and A Tsolos.

Reviewer(s): Craig Noell and Adrian Linnane

Approved by: Dr Stephen Mayfield
Science Leader – Fisheries

Signed:

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EXECUTIVE SUMMARY

This report is the third in the annual reporting series for the South Australian Marine Scalefish Fishery (MSF). Data considered in this report extend for 35 years from 01 January 1984 to 31 December 2018. It provides a description of the dynamics of the multi-species, multi-gear fleet and assigns a stock status to 21 species or taxonomic groups that are harvested in the fishery. The report builds on the previous reports of Steer et al. (2018a, b), and includes a summary of the taxon-specific fishery information relating to: population biology; fishing access; management arrangements; trends in commercial fishery statistics at the State-wide scale, biological stock or regional management units; and assessment of fishery performance.

Fleet Dynamics

Many of the changes in the operation of the MSF fleet in the past four decades occurred in response to changes made to the fisheries management arrangements. These have included the reduction in fishing effort that has resulted from the rationalisation of the fishing fleet through the licence amalgamation scheme implemented in 1994, reductions in the number of B-class licences and two voluntary net buy-back initiatives during 2005 and 2014.

Declines in the productivity of the premium finfish species have contributed to the diversification of the MSF fleet over the last five years, with many commercial fishers switching their effort from Snapper, King George Whiting and Southern Garfish to targeting Southern Calamari. As a consequence, Southern Calamari has recently surpassed Snapper and King George Whiting as the most valuable MSF species. Increased fishing of Calamari in some regions has caused concern, including in southern Spencer Gulf where targeted jig CPUE declined over five consecutive years.

A number of species considered in this report are taken in the hauling net sector, and some are caught when more valuable species are being targeted. Of these, Yellowfin Whiting, Australian Herring, Snook, Leatherjackets and Yelloweye Mullet are of medium value. These species share similar commercial catch and effort trends, whereby fishing effort within the hauling net sector has been sequentially reduced.

Despite the long-term trend in declining effort, Snook and Leatherjackets have been increasingly targeted by hauling net fishers. There has also been an increase in catches of Ocean Jackets and Western Australian Salmon over the past four years, using fish traps and seine gear, respectively.

Stock Status

Overall, this report assessed the fishery performance of 21 species (or species groups) taken in South Australia's MSF. Collectively, these taxa were considered across 33 management units at a resolution that aligned with either the biological stock or jurisdictional level. Of these, 26 (79%) stocks were classified as sustainable, three (9%) were classified as depleted, one (3%) was classified as depleting and one (3%) was classified as recovering. The remaining two (6%) were classified as undefined as there was insufficient information to assign stock status (Table E-1). Since the previous MSF assessment (Steer et al. 2018b), the Snapper stock in Gulf St. Vincent (GSV) changed from sustainable to depleting as a result of reduced biomass, declining catches and catch rates, and an absence of recruitment (Table E-1).

Future Directions

Considerable funding will be directed towards addressing research priorities to support the recovery of the Spencer Gulf–West Coast (SG-WC) and GSV Snapper stocks. These include: undertaking a stock assessment for Snapper using the daily egg production method (DEPM) during 2019/20; developing a cost-effective method for monitoring the numbers of juvenile Snapper to provide an early indication of recruitment strength (FRDC 2019/046); quantifying post-release survival rates of Snapper in all sectors of the fishery (FRDC 2019/044); and undertaking a restocking program.

A significant knowledge gap remaining in the assessment of the status of MSF fish stocks continues to be the relative contribution to the State-wide catch by the recreational fishing sector. Previously, annual recreational catches have been estimated using phone survey methods. Imprecision in these estimates has implications for the assessments of King George Whiting and Snapper, for which the recreational component is significant. Improving the precision of the estimates of the recreational catches remains a priority, and will benefit the assessment and future management of the MSF.

The MSF is currently undergoing considerable transition through the structural reform process, development of new harvest strategies, and a review of the Fishery Management Plan that is underway. An FRDC project that will provide statistical support to this structural reform will review current fishery assessment methods and consider the implementation of data-limited approaches to optimise the sustainable use of the resource.

Keywords: Marine Scalefish Fishery, fleet dynamics, stock status.

Table E-1. Status of South Australia's Marine Scalefish Fishery stocks and fishery performanace indicators assessed between 2016–2018. * indicates 2017 stock status as 2018 stock status not yet determined.

SPECIES	STOCK	STATUS 2016	STATUS 2017	STATUS 2018	INDICATORS
SNAPPER	SG/WC	Transitional - Depleting	Depleted	Depleted	Catch & Effort
	GSV	Sustainable	Sustainable	Depleting	Catch & Effort
	WV	Sustainable	Sustainable	Sustainable	Catch & Effort
KING GEORGE WHITING	WC	Sustainable	Sustainable	Sustainable	Catch & Effort
	SG	Sustainable	Sustainable	Sustainable	Catch & Effort
	GSV/KI	Transitional - Depleting	Sustainable	Sustainable	Catch & Effort
GARFISH	WC	Sustainable	Sustainable	Sustainable	Catch & Effort
	NSG	Tranistional - Recovering	Recovering	Recovering	Catch, CPUE, age structure, biomass
	SSG	Sustainable	Sustainable	Sustainable	Catch & Effort
	NGSV	Overfished	Depleted	Depleted	Catch, CPUE, age structure, biomass
	SGSV	Sustainable	Sustainable	Sustainable	Catch & Effort
	SE	Sustainable	Sustainable	Sustainable	Catch & Effort
CALAMARI	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
YELLOWFIN WHITING	NSG	Sustainable	Sustainable	Sustainable	Catch & Effort
	NGSV	Sustainable	Sustainable	Sustainable	Catch & Effort
WA SALMON	WA/SA	Sustainable	Sustainable	Sustainable	Catch & Effort
AUST. HERRING	WA/SA	Sustainable	Sustainable	Sustainable	Catch & Effort
VONGOLE	WCCFZ	Sustainable	Sustainable	Sustainable*	Harvest fraction, recruitment
	CBCFZ	Sustainable	Sustainable	Sustainable*	Harvest fraction, recruitment
	PRCFZ	Overfished	Depleted	Depleted*	Harvest fraction, recruitment
SNOOK	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
BLUE CRABS	MSF	Sustainable	Sustainable	Sustainable	Catch & Effort
SAND CRABS	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
YELLOW-EYE MULLET	MSF	Sustainable	Sustainable	Sustainable	Catch & Effort
MULLOWAY	MSF	Sustainable	Sustainable	Sustainable	Catch & Effort
WHALER SHARKS	STATE	Undefined	Undefined	Undefined	Limited data
OCEAN JACKETS	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
BLUE-THROAT WRASSSE	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
SILVER TREVALLY	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
LEATHERJACKETS	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
RAYS & SKATES	STATE	Sustainable	Sustainable	Undefined	Limited data
CUTTLEFISH	STATE	Sustainable	Sustainable	Sustainable	Catch & Effort
BLACK BREAM	MSF	Sustainable	Sustainable	Sustainable	Catch & Effort

1. INTRODUCTION

1.1. Overview

This is the third report in this series for the South Australian Marine Scalefish Fishery (MSF) that provides a taxon-specific summary of information on: 1) fisheries biology; 2) fishing access; 3) management arrangements; 4) trends in commercial fishery statistics at the scales of the biological stock or regional management units, and 5) assessment of fishery performance. Data included in this report were sourced from logbook returns provided to SARDI by MSF licence holders over 35 years between 01 January 1984 and 31 December 2018.

This report is partitioned into four sections. Section one provides an overall description of the MSF, its management arrangements, performance indicators, and details the indicators used to assess the status of the stocks within the fishery. Section two describes the dynamics of the commercial fleet, catch composition, and spatial and temporal trends in fishing effort.

Section three consists of a series of species-based sub-sections arranged in order of their descending priority by catch. These are structured as 'stand-alone' updates for various taxa taken in the fishery, for each of which a summary of the relevant biological information is presented, along with a description of the fishery, associated management regulations, the State-wide and/or regional fishery statistics, assessment of the fishery against the general performance indicators, and the classification of the stock status for 2018.

The final section, the General Discussion, synthesises the overall performance of the fishery, details emerging trends within the fishing fleet, and identifies key research priorities that will enhance the assessment and management of South Australia's MSF.

1.2. Description of the Marine Scalefish Fishery

The MSF is a multi-species, multi-gear, multi-sector fishery with >300 active licence holders. Because of the number of licences, gear types used, the species taken, fishers ability to switch target species and the geographical range, it is considered to be the most complex fishery in South Australian waters.

Commercial fishers in the MSF are permitted to take in excess of 60 marine species, including bony fishes, molluscs, crustaceans, annelid worms, sharks, rays and skates. Fishery production by weight of catch is mainly comprised of Southern Calamari (*Sepioteuthis australis*), Snapper (*Chyrsophrys auratus*), King George Whiting (*Sillaginodes punctatus*), Southern Garfish (*Hyporhamphus melanochir*) and Yellowfin Whiting (*Sillago schomburgkii*). Other species such as Western Australian Salmon (*Arripis truttaceus*), Australian Herring (*A.*

georgianus), Sand Crabs (*Ovalipes australiensis*) and Vongole (*Katelysia* spp.) also contribute significantly to the overall catch.

Currently there are 30 types of fishing gear (or devices) endorsed in the MSF. Their uses differ depending on the location of fishing and the 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. For the commercial sector there are two types of licences, i.e. Marine Scalefish and Restricted Marine Scalefish (B-class). Marine Scalefish licence holders are more common. A proportion of the Marine Scalefish licence holders have specific net endorsements and are permitted to use hauling nets and set/gill nets to target certain species. Restricted Marine Scalefish licence holders have fewer gear endorsements and are prohibited from using nets. In addition, licence holders from the Miscellaneous Fishery, the Northern (NZRLF) and Southern Zone Rock Lobster (SZRLF) fisheries, the Lakes and Coorong Fishery (LCF), three Western King Prawn fisheries and the Blue Crab Fishery (BCF) all have varying levels of access to the key MSF resources. For example, the three Prawn fisheries can only take certain MSF species as by-products.

The broad mixture of participants, gear types, licence conditions and regulations associated with the MSF make the task of assessing the status of the stocks extremely challenging. This is further compounded by the highly dynamic nature of fisher behavioural responses to resource availability and seafood markets, as they can switch their target effort between species and regions throughout State waters. This complexity means there is considerable capacity for the fishery to expand through the activation of latent effort.

The recreational fishing sector also has access to many of the MSF species. Most recreational fishing effort occurs in marine waters, including estuaries, with fishers permitted to use several gear types to target a variety of MSF species.

1.3. Management Arrangements

The MSF is managed by the South Australian State Government's Primary Industries and Regions South Australia (PIRSA) Fisheries and Aquaculture in accordance with the legislative framework provided within the *Fisheries Management Act 2017*, and subordinate *Fisheries Management (General) Regulations 2017*, *Fisheries Management (Marine Scalefish Fisheries) Regulations 2017* and licence conditions.

The commercial MSF has undergone considerable management changes over the past 40 years, including a settlement with the Commonwealth Government Australian Fisheries Management Authority (AFMA) for offshore waters resources management (Offshore Constitutional Settlement), limitation through gear restrictions and configuration, licensing, spatial and temporal closures related to protection of spawning areas, and size limits. During this time, there have been three notable changes that were primarily implemented to limit, and then reduce, the number of participants in the commercial sector. The first occurred in 1977, when a freeze was imposed on the issue of new licences, 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. Non-transferable Restricted MSF licences were also created at this time to recognise part-time fishers. The second change was the licence amalgamation scheme which was introduced in 1994. This scheme is essentially a fractional licensing initiative which requires prospective fishers to purchase a certain number of points when buying a licence (Steer and Besley 2016). The third change, implemented in 2005, was a voluntary buy-back of net fishing endorsements and subsequent spatial closures to net fishing. A similar, smaller licence buy-back scheme was also implemented in 2014 in association with the establishment of the network of South Australian Marine Parks.

With the exception of the recreational targeting of Southern Rock Lobster, the recreational fishery is not licensed but subjected to a range of regulations, such as size, boat, bag and possession limits, restrictions on the types of gear that may be used, temporal and spatial closures, and the complete protection of some species.

1.4. Fishery Performance Indicators

For each taxon, general performance indicators (PIs) are used to benchmark the performance of the fishery. These are derived from commercial catch, target effort and CPUE and vary amongst the taxa. Annual time-series of these PIs were derived from commercial fishery statistics from 1984 to 2018 (reference period). Each performance indicator was benchmarked against the following trigger points:

1. the third highest and third lowest values of the reference period;
2. the greatest (%) inter-annual variation (+ and -) over the reference period;
3. the greatest rate of change (+ and -) over a five-year period; and
4. whether the PI have decreased over the most recent five consecutive years.

1.5. Stock Status Classification

A national stock status classification system was recently developed for the assessment of key Australian fish stocks (Flood et al. 2014; Stewardson et al. 2018). It considers whether the current level of fishing pressure is adequately controlled to ensure that the 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 level of exploitation into a single classification for each stock against defined biological reference points. Each stock is then classified as: sustainable, recovering, depleting, depleted, undefined, or negligible (Table

1-1). PIRSA has adopted this classification system to determine the status of all South Australian fish stocks (PIRSA 2015).

Table 1-1. Classification scheme used to assign fishery stock status. The description of each stock status and its potential implications for fishery management are also shown (Stewardson et al. 2018).

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 non-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

2. FISHING FLEET DYNAMICS

2.1. Introduction

Fishing fleet dynamics reflect the decisions made by fishers that relate to when and where to fish, the most appropriate gear to use for the target species, and the economics of seafood production. These decisions are influenced by a range of factors, such as the seasonal availability, movement and migration of target stocks, seasonal changes in weather conditions, management arrangements, running costs, and socio-economics.

A comprehensive evaluation of the spatial and temporal characteristics of fishing activities is required before stock assessment models can be reliably developed to inform management decisions (Hilborn and Walters 1992, Mahévas et al. 2008). In most cases, this includes a detailed break-down of fishery catch patterns, fishing effort, catch rates, the spatial distribution of catches, fishing gear, location and season for each species (Hilborn and Walters 1992).

Whilst most of this report is devoted to the assessment of fishery statistics for specific taxa taken in the MSF in order to determine stock status, this section provides a holistic view of the fishery by examining and comparing trends in catches, fishing effort, gear use, regions and seasonality. This summary illustrates the dynamic nature of this fishery at different spatial and temporal scales, the changes in licence participation rates, and the relationships and trends between target species.

2.2. Methods

The MSF is divided into 58 Marine Fishing Areas (MFAs) for the purpose of statistical reporting and monitoring of commercial fishing activity (Figure 2-1). Licensed fishers are required to log their fishing activities by reporting specific details such as MFA fished, number of fishers on board, species targeted, species caught, weight of catch, and method of capture. Prior to 2003 these details were recorded on a monthly basis, but since then the fishers have been required to provide a daily log of fishing activity. These records are submitted monthly to SARDI Aquatic Sciences where they are entered into the Marine Scalefish Fisheries Information System. This database is routinely reviewed 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 and provides the primary source of data used for the assessments of stock status presented in this report. As such, they are based on a 35-year time-series.

The complexity of the MSF database was reduced to a smaller, more manageable dataset that allowed analysis of the major trends in fisher behaviour and fleet dynamics. Two main approaches were adopted to achieve this. One approach involved aggregating the data into monthly categories. This level of temporal resolution was considered appropriate as monthly data were provided by many fishers prior to 2003, and it aligned with some of the short-term management arrangements for this fishery (e.g. Snapper spatial and temporal closures). The other approach involved aggregating certain gear types into broader categories. Hauling nets, floating garfish nets, sinking and floating garfish nets, sinking mesh nets, and sinking mixed mesh nets were collectively categorised as hauling nets, but were differentiated from large mesh nets (>15 cm mesh size) and set gill nets (5 cm mesh size) which were considered set nets. Similarly, hand lines, troll lines and fishing rods/poles in the line sector were categorised as hand lines. Long lines, drop lines and trot lines were grouped as long lines where appropriate.

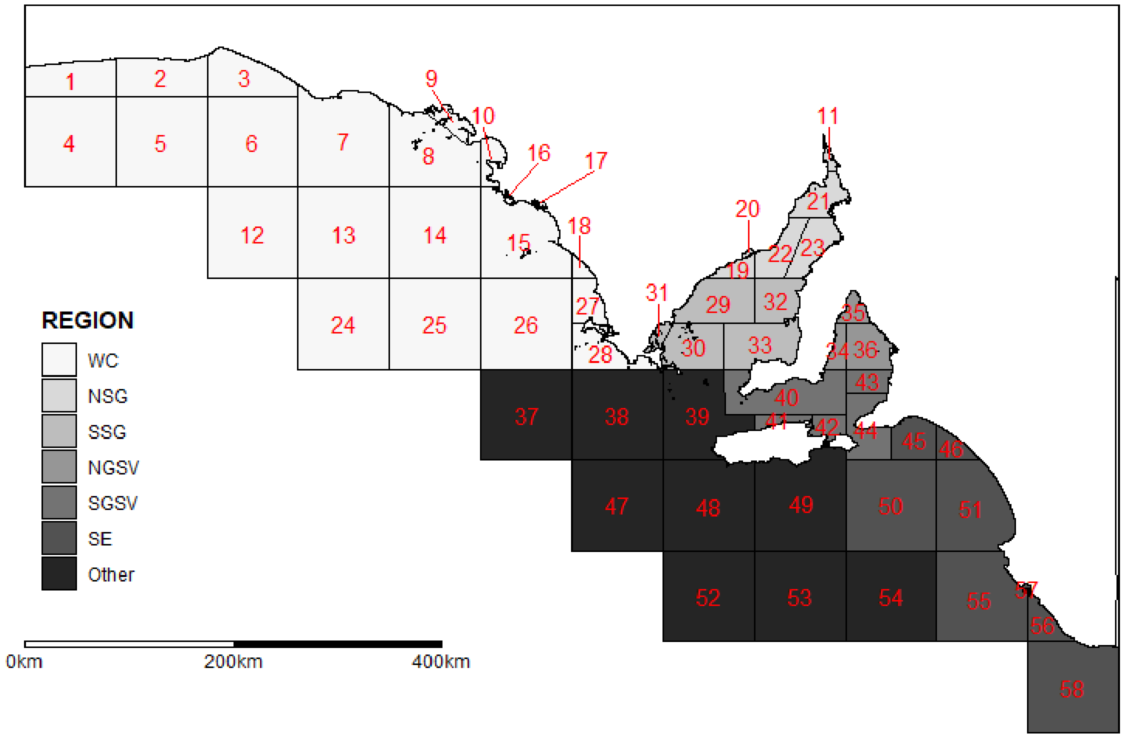

Figure 2-1. Marine Fishing Areas of South Australia's Marine Scalefish Fishery showing the seven regions: West Coast (WC), Northern Spencer Gulf (NSG), Southern Spencer Gulf (SSG), Northern Gulf St. Vincent (NGSV), Southern Gulf St. Vincent (SGSV), South East (SE), and Other.

2.3. Results

2.3.1. Trends in Number of Active Licences

There has been a 64% reduction in the number of licence holders actively operating in the MSF from 865 to 310 between 1984 and 2018 (Figure 2-2). The largest proportional reduction occurred for the Rock Lobster fisheries, as the number of active licence holders that accessed MSF species declined from 175 to 31 over the same period, representing an 82% reduction. The active MSF and Miscellaneous Fishery licence holders declined by 59% and 68%, respectively. The rate of decline was accelerated from 1994 following the implementation of the licence amalgamation scheme. Two net buy-back schemes also contributed in removing active licences in 2005 and 2014 (Figure 2-2). Since implementation of the licence amalgamation scheme, the number of active licence holders has declined at a rate of approximately 15 licences.year^{-1}.

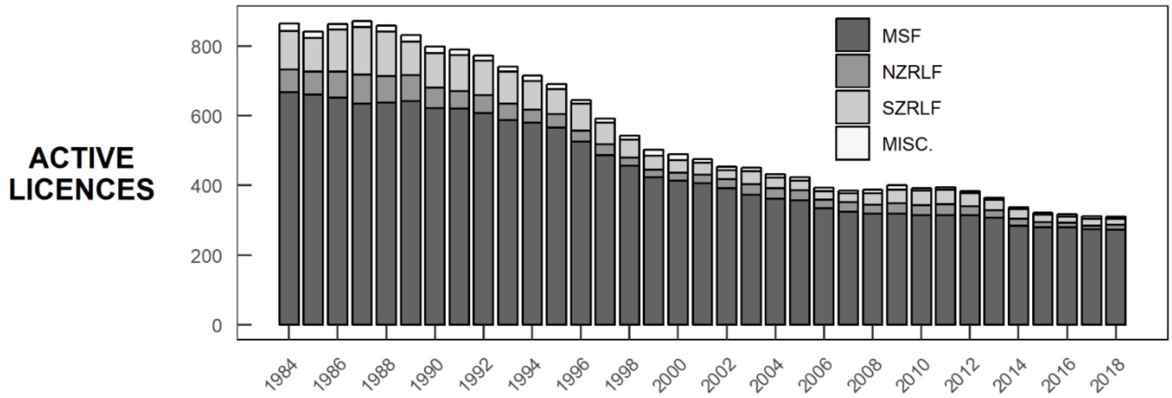

Figure 2-2. Long-term trend in the number of active licence holders that have access to the Marine Scalefish Fishery (MSF), including those from the Southern and Northern Zone Rock Lobster (SZRLF, NZRLF) and Miscellaneous (MISC.) Fisheries.

2.3.2. Trends in Commercial Catch

Since 1984, there has been a major shift in the composition of the commercial MSF catches. This related to the substantial removal of 'other' species catch in 2001, and was a result of the establishment of an exclusive South Australian Sardine Fishery (Figure 2-3). In the six years prior to this separation, Sardines accounted for up to 58% of the total MSF catch. Annual catches in the contemporary MSF fishery are dominated by the four primary species (>50%), followed by the secondary (approximately 30%), tertiary (12%), and the remaining permitted species (6%) (Figure 2-3).

Total catch of primary species peaked at 2,089 t in 2001 and has since declined to a record low of 1,079 t in 2018, representing a 48% decline over 18 years (Figure 2-3). Prior to 1999, the composition of catch of the primary species was relatively stable, where annual King

George Whiting catch accounted for approximately 40%, followed by Southern Garfish (30%) Snapper (20%) and Southern Calamari (15%). Since then, the relative proportions of the KGW and Garfish catches have declined to 23% and 16%, respectively, whereas annual catches of Calamari (34%) have increased, particularly from 2007 onwards (Figure 2-3). By 2018, the proportion of Snapper in catches has decreased significantly from that in 2010 from 53% to 26% of the catch composition of the primary target species.

The total annual catch of secondary species was above 1,000 t from 1984 to 2006, and peaked at 2,025 t in 1995 (Figure 2-3). Western Australian Salmon and Australian Herring, collectively accounted for most (up to 74%) of the catch of secondary species up to 2002. From 2002 until 2009, the annual catch of Vongole substantially increased, accounting for up to 34% of the catch of secondary species at its peak in 2007. Before separating as a dedicated fishery in 1996, Blue Crabs accounted for approximately 30% of the catch of secondary species. Total annual catch has since declined to a low of 670 t in 2012 but has remained above 800 t per annum since 2015 (Figure 2-3). The overall trend remained the same in 2018, with the exception of a substantial decline in the total catch of Western Australian Salmon which fell by 58% from 374 t in 2017 to 156 t in 2018. Annual catches of Leatherjackets and Ocean Jackets peaked in 1991, yet have rarely exceeded 100 t since 2006 (Figure 2-3). Appendices 1 and 2 provide summaries of annual commercial catches of permitted species taken in the Marine Scalefish Fishery between 1984 and 2018.

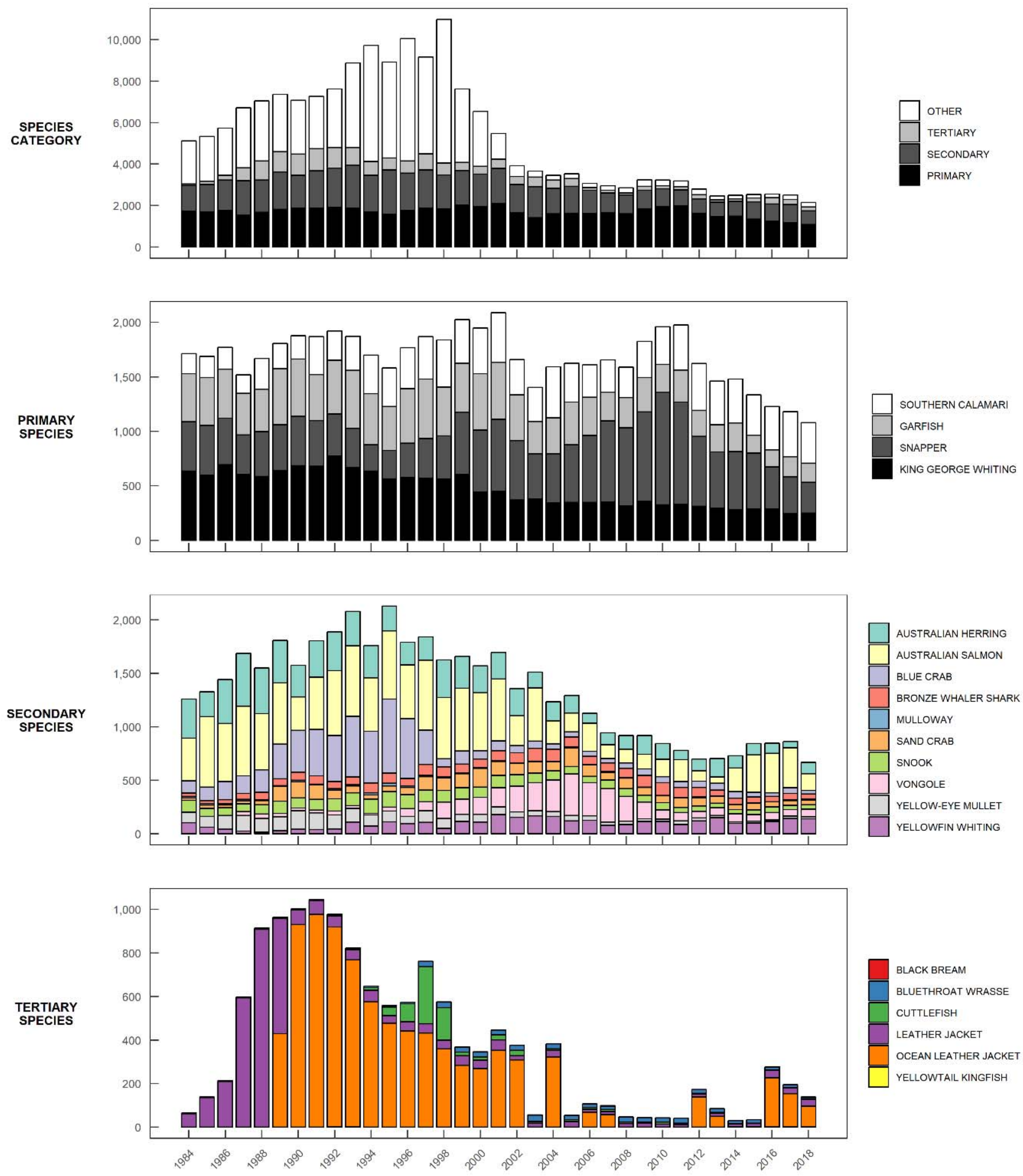

Figure 2-3. Long-term trends in total catch (t) in the commercial Marine Scalefish Fishery for primary, secondary and tertiary species.

2.3.3. Trends in Fishing Effort

Species

Annual estimates of total fishing effort in the MSF peaked at 136,623 fisher-days in 1992 (Figure 2-4). This peak represented an 18.2% increase in annual effort since 1984, after which there has been a 58.2% reduction to 66,313 fisher-days in 2018.

Up until 2015, most (>75%) fishing effort was targeted at particular species. In 2018, 23.6% of the effort was non-specific, with fishers identifying 'any target' in their catch returns. This level of 'non-specific' reporting was the second highest on record, and was marginally lower than in 2016 when 24.5% of fishers were non-specific in their fishing target. Of the reported targeted effort, the four primary species have consistently accounted for the greatest proportion of which King George Whiting has historically dominated. Since 2011, there has been a distinct shift in fishing activity, as fishers have directed targeted effort away from Snapper and King George Whiting towards Southern Calamari. The relative proportion of effort targeted towards Southern Calamari has increased to a historical peak of 21.4% in 2018, representing a doubling in fishing effort since the late 1990s and 2000s (Figure 2-4).

The secondary species attracted approximately 7.5% of the total fishing effort in 2018. The distribution of targeted effort amongst these species has changed over the past 35 years. Historically, Blue Crabs, Western Australian Salmon, Snook and Yelloweye Mullet attracted the most effort during the mid-1980s accounting for up to 98% of targeted effort directed at secondary species. Fishers increasingly targeted Sand Crabs from the late 1980s, and Vongole became a prominent target from 2002 onwards, accounting for up to 15% and 40% of secondary species effort, respectively (Figure 2-4). In each instance, these increases were associated with management initiatives that supported the development of the fisheries.

During 2018, approximately 1.2% of the State-wide fishing effort was targeted towards the six tertiary species considered in this report (Figure 2-4). There were a few periods of notable expansion for some 'niche' tertiary species across the time period, such as Leatherjackets, Ocean Jackets and Cuttlefish. Targeted effort for each of these species doubled over short (<5 years) periods but did not persist. The remaining permitted species accounted for approximately 5% of the State-wide total targeted effort in 2018.

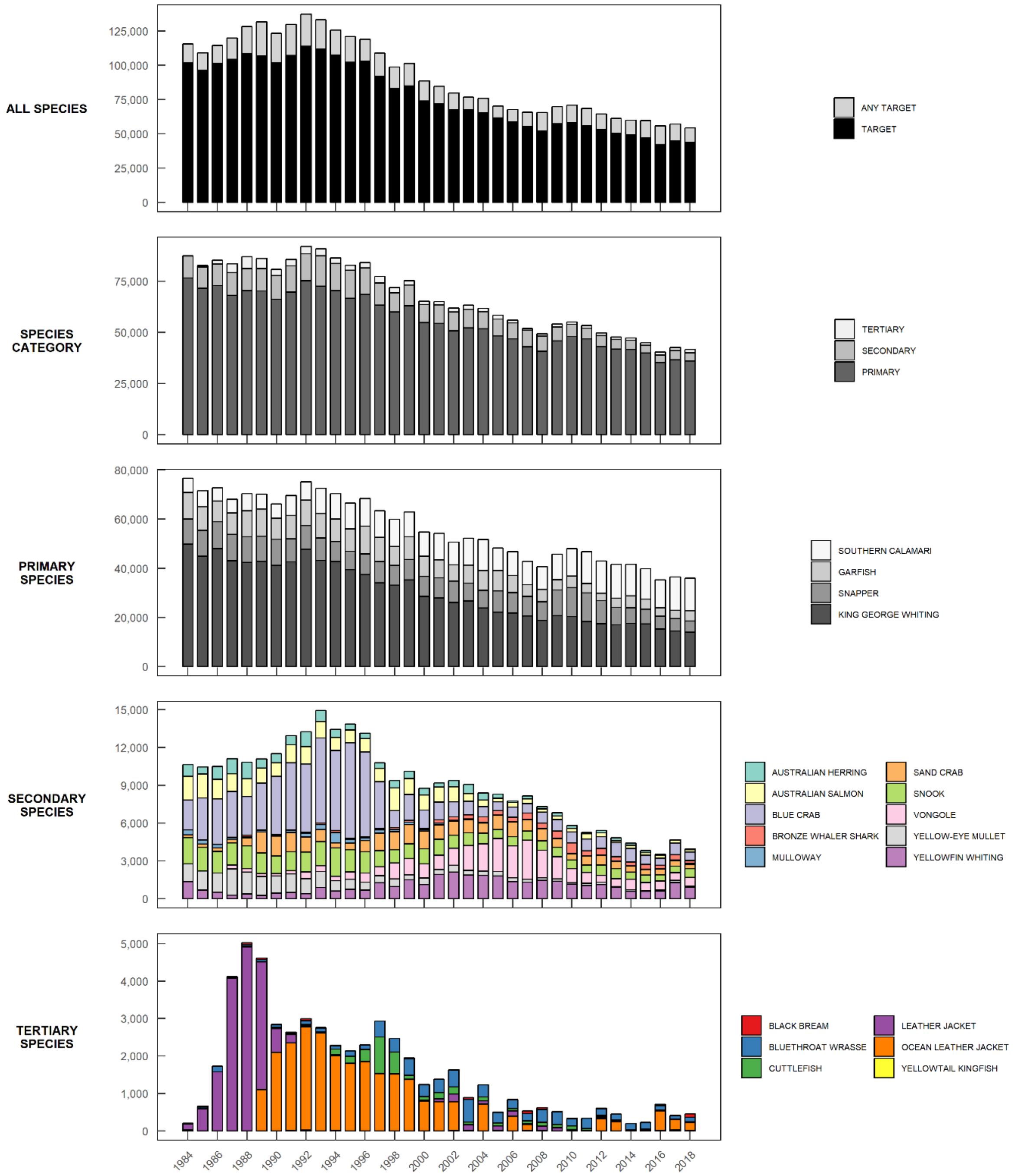

Figure 2-4. Total effort (fisher-days) in the commercial Marine Scalefish Fishery partitioned into targeted and non-targeted (‘any target’) effort (top graph) and into species-specific targeted effort.

Gear

Hauling nets and handlines have consistently been the dominant gear types used in the fishery, collectively accounting for >60% of the total fishing effort (Figure 2-5). The proportional use of set nets has declined from 16% in 1987 to 1.5% in 2018, with the greatest reduction occurring throughout the late 1990s and early 2000s in response to the State-wide netting review and associated restrictions. The relative use of squid jigs has steadily increased from 1994 as the Southern Calamari fishery evolved from a bait resource to a priority species, and has further increased from 2011 onwards, accounting for approximately 20% of the State-wide total fishing effort. The proportional use of longlines doubled throughout the mid-2000s, and has since accounted for approximately 10% of the total fishing effort (Figure 2-5).

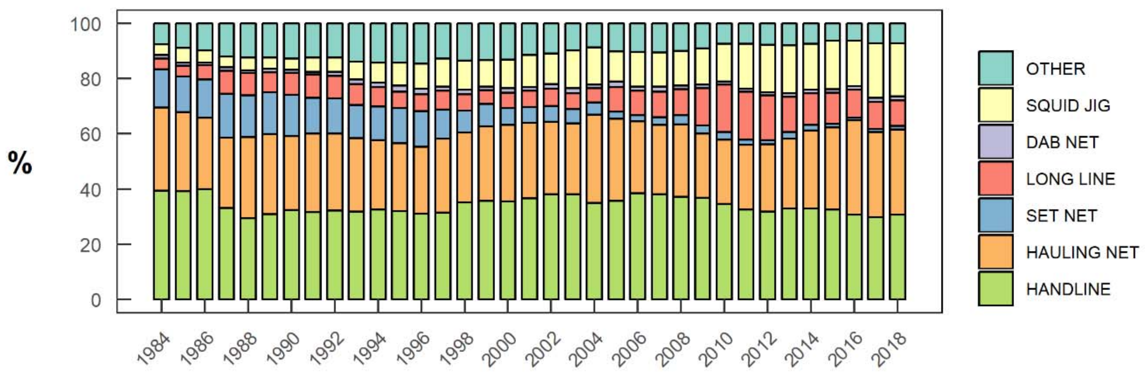

Figure 2-5. Gear usage (% of total fishing effort) within the commercial Marine Scalefish Fishery (MSF).

Location

Historically, the spatial distribution of fishing effort was widespread with most of the State's MFAs registering some level of fishing activity (Figure 2-6). Fishing effort was most intense in the northern gulfs and near the major regional ports of Ceduna (MFAs 8, 9, 10), Coffin Bay (MFAs 27, 28), Port Lincoln (MFAs 30, 31) and Beachport (MFAs 55, 56, 57). Since 2000, fishing effort has largely contracted to within the gulfs as fishing intensity around the regional centres has diminished to relatively low levels (<4,000 fisher-days.year^{-1}) (Figure 2-6). Of the regional centres only Port Lincoln and Ceduna have maintained some consistent fishing activity. The northern gulfs have continued to account for most fishing effort, but this has also declined over the past 34 years, from an average of >40,000 fisher-days.year^{-1} during the 1980s and 1990s to <29,000 fisher-days.year^{-1} since 2005. Average annual fishing effort within MFAs 19 and 29 in southern Spencer Gulf was below 500 fisher-days.year^{-1} over the last three years (2015 to 2018), declining to the lowest level recorded for this area (Figure 2-6).

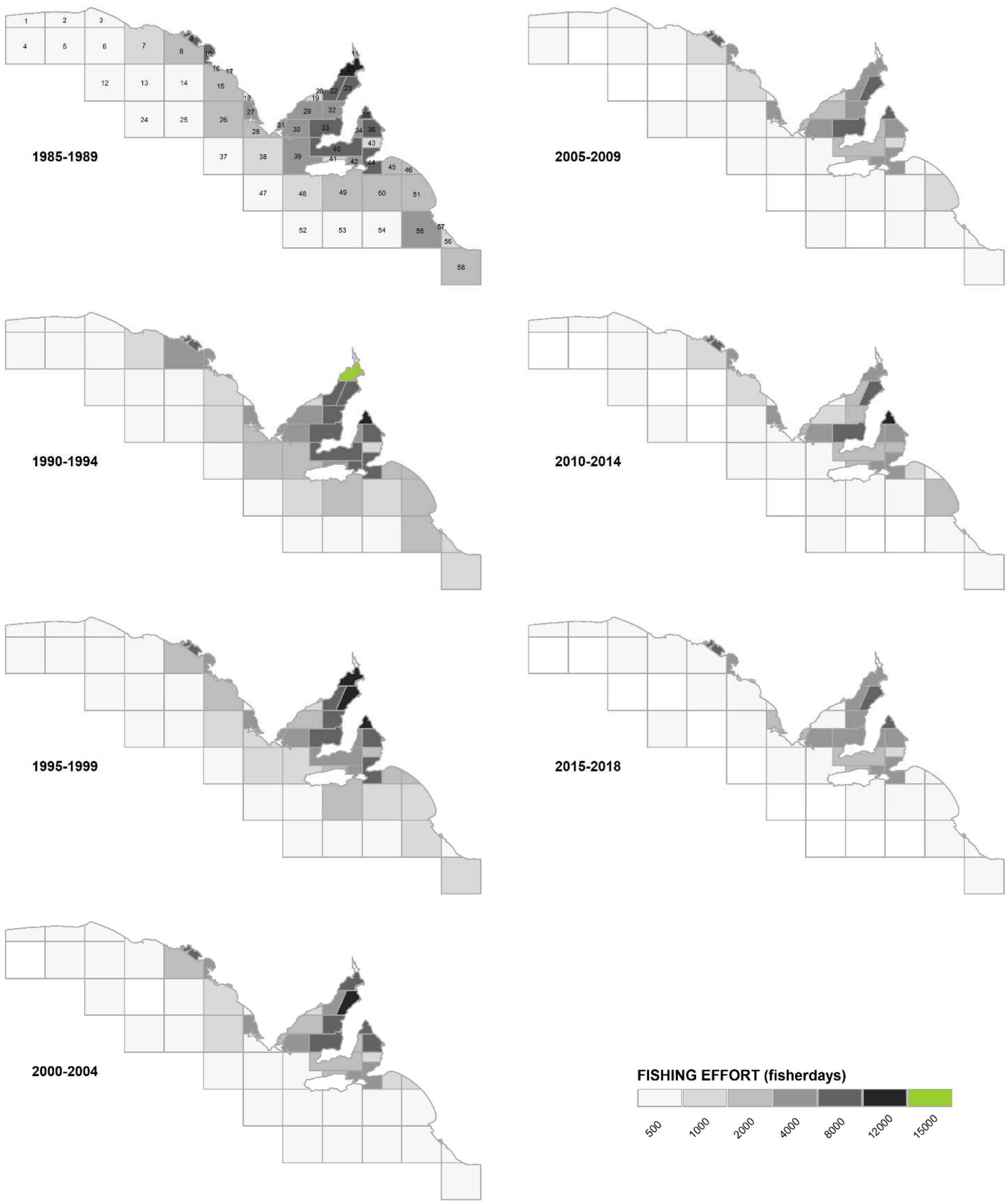

Figure 2-6. Spatial and temporal distribution of fishing effort (fisher-days) in the Marine Scalefish Fishery. Effort data by MFA were averaged over five year periods from 1985 to 2018.

Season

The high diversity of target species within the MSF provides fishers with considerable flexibility (Figure 2-7). Among the four primary species, monthly targeted fishing effort for KGW peaked at just under 1,500 fisher-days in June, and although this species was targeted throughout the year its fishing activity remained highest during winter. Conversely, targeted effort for Southern Garfish was highest during late summer, peaking at just over 300 fisher-days in February. Fishing effort for Garfish was affected by the closure of the fishery in late winter and early spring. The seasonal pattern of fishing activity for Southern Calamari and Snapper was similar, where they both maintained relatively high levels of fishing effort throughout the year, peaking in autumn and again in late spring (Figure 2-7). Low effort in November reflects the Snapper closure during this month.

Targeted effort for most of the remaining species peaked during the spring and summer months although some level of fishing activity was maintained throughout the year. Yellowfin Whiting, Bluethroat Wrasse, Silver Trevally and, to a lesser extent, Black Bream were the only species that displayed distinct increases in fishing activity during winter (Figure 2-7).

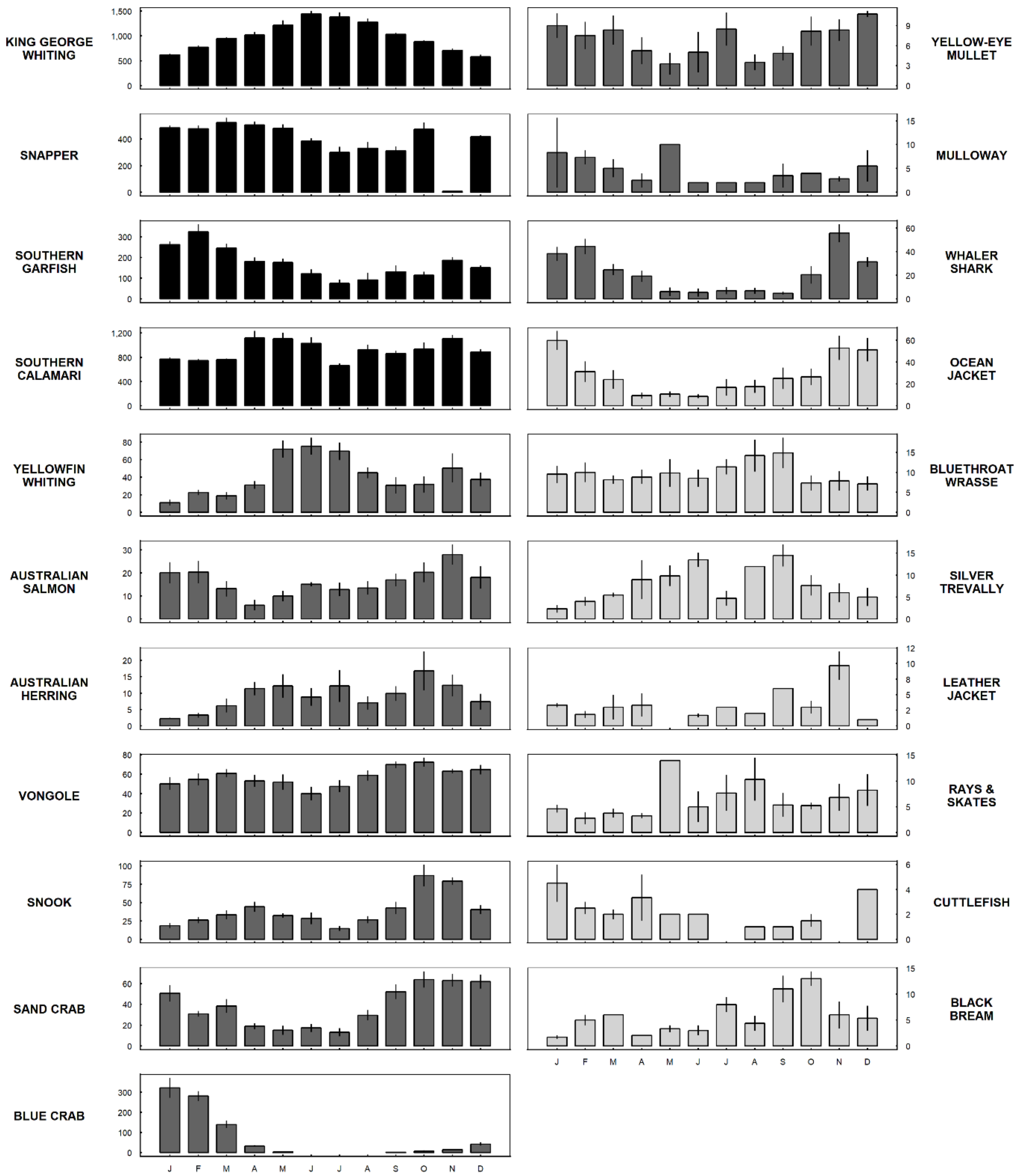

Figure 2-7. Monthly pattern of targeted fishing effort (fisher-days averaged (± se)) from 2012 to 2018 for each species/taxon assessed. The different shades denote species category; primary (black), secondary (dark grey), tertiary (light grey).

2.4. Summary

The dynamics of the MSF fleet have changed in recent years with many changes appearing to relate to management arrangements. The most obvious changes have been the: a) decline in fishing effort driven by the licence amalgamation scheme, two voluntary net buy-back initiatives and reduction in the number of B-class and Rock Lobster licences active in the fishery, and b) expansion and reduction in Snapper catches, a steady reduction in King George Whiting and Southern Garfish catches, and the shift in effort towards targeting Southern Calamari.

Since their implementation, the major management arrangements have successfully reduced the number of active licence holders by 63.9%, which has led to a 58.2% reduction in fishing effort. This has been manifested in a gradual spatial contraction of effort across the State, with fishing effort virtually disappearing from most regional centres outside the gulfs and the fishery becoming almost exclusively confined to gulf waters and a few protected bays on the west coast of the Eyre Peninsula. Most fishing effort within the MSF was targeted, although a greater proportion of fishers in 2016–2018 were non-specific in their target species indicating that they are either becoming more general in their fishing activity or are not specifically recording a target species in their catch returns.

Collectively, the fishery's four primary species accounted for the greatest proportion (62%) of targeted effort, of which King George Whiting has historically dominated. Since 2011, there have been substantial declines in targeted effort for Snapper, King George Whiting and Southern Garfish as a consequence of a range of management arrangements (i.e. spatial closures, closed seasons, netting restrictions and catch limits). Conversely, targeted effort for Southern Calamari has steadily increased. This species has effectively become a year-round opportunistic target for many fishers, possibly to offset the loss of access to the other primary species. The increasing trend in the relative use of squid jigs also reflects this shift in behaviour in the fishing fleet.

The ephemeral periods of increased fishing activity for other secondary and tertiary species, such as Western Australian Salmon and Snook also 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 an increased diversity of 'under-utilised' species and to synchronise their fishing activity to the species' patterns of seasonal abundance. Despite this, the diversity of secondary and tertiary species targeted by the fishing fleet has diminished in recent years.

3. STOCK STATUS OF KEY MARINE SCALEFISH SPECIES

3.1. Introduction

This section of the report uses a weight-of-evidence approach to determine the stock status of 21 MSF species or taxonomic groups that are distributed across the 'Primary', 'Secondary' and 'Tertiary' species categories, as defined in the Management Plan (PIRSA 2013).

For each species or taxon, including Snapper (*Chrysophrys auratus*) for which a stock assessment was delivered in 2019 (Fowler et al. 2019), the relevant biological information is presented, along with a description of the fishery; associated management regulations; interrogation of the fishery statistics at either the biological stock, State-wide or regional scale; assessment of the fishery against the general performance indicators; and a classification of stock status.

3.2. Method

Commercial catch and effort data are the primary data considered in this section. The appropriate data for each taxon were extracted from the SARDI Aquatic Sciences' commercial Marine Scalefish Fisheries Information System which includes data from the Marine Scalefish, Northern and Southern Zone Rock Lobster fisheries. These data span a 35-year time-series from 1984 to 2018 and were aggregated at either the biological stock, State-wide or regional scales to provide annual estimates of catch and effort for the main gear types (Table 3-1). Data on Snapper catches by the Lakes and Coorong Fishery (LCF) and by-product of Southern Calamari by SA's three Western King Prawn fisheries are also included.

The presentation of data was limited by constraints of confidentiality, i.e. data could only be presented for years when summarised from five or more fishers. Estimates of recreational catch obtained from three telephone/diary surveys (Henry and Lyle 2003, Jones 2009, Giri and Hall 2015) were also presented. The general performance indicators for 2018 were benchmarked against the trigger reference points calculated from the historical data. The national stock status classification system developed for the assessment of key Australian fish stocks (Stewardson et al. 2018) was used to assign stock status for 2018 (see Table 1-1).

Table 3-1. List of MSF categories and species/taxa considered in this section, the scale of their stock boundary, main gear types, and the resolution of catch and effort data (targeted or total).

CATEGORY	SPECIES / TAXON	STOCK	GEAR	TARGETED OR TOTAL
PRIMARY	SNAPPER	Biological	Handline, Longline	Targeted
	KING GEORGE WHITING	Biological	Handline, Hauling Net, Gillnet	Total
	SOUTHERN CALAMARI	State-wide and regional	Squid Jig, Hauling Net	Targeted
	SOUTHERN GARFISH	State-wide and regional	Hauling Net, Dab Net	Targeted
SECONDARY	YELLOWFIN WHITING	Biological	Hauling Net	Targeted
	WA SALMON	State-wide	Hauling Net	Targeted
	AUST. HERRING	State-wide	Hauling Net	Targeted
	VONGOLE	Biological	Cockle Rake	Total
	SNOOK	State-wide	Hauling Net	Targeted
	BLUE CRABS	State-wide	Crab Net	Targeted
	SAND CRABS	State-wide	Crab Net	Targeted
	YELLOWEYE MULLET	State-wide	Hauling Net	Total
	MULLOWAY	State-wide	Handline, Set Net	Total
	WHALER SHARKS	State-wide	Longline	Targeted
TERTIARY	OCEAN JACKETS	State-wide	Fish Trap	Targeted
	BLUETHROAT WRASSE	State-wide	Handline, Longline	Total
	SILVER TREVALLY	State-wide	Handline	Total
	LEATHERJACKETS	State-wide	Hauling Net	Total
	RAYS AND SKATES	State-wide	Hauling Net. Longline	Total
	CUTTLEFISH	State-wide	Squid Jig	Total
	BLACK BREAM	State-wide	All	Total

3.3. Results

3.3.1. SNAPPER

Biology

The Snapper (*Chrysophrys auratus*) is a species of teleost fish in the family Sparidae. It is a large, long-lived, demersal, finfish species that is broadly distributed throughout the Indo-Pacific region, where its extensive distribution includes the coastal waters of the southern two-thirds of the Australian continental mainland as well as northern Tasmania (Kailola et al. 1993). Throughout this distribution, Snapper occupy a diversity of habitats from shallow bays and estuaries to the edge of the continental shelf across a depth range to at least 200 m. The stock structure for Snapper in Australian waters is complex, as there are considerable differences in the spatial scales over which populations are divisible into separate stocks (Fowler et al. 2016a; 2017). A recent study indicated that there are three stocks that occur in South Australian coastal waters (Fowler 2016, Fowler et al. 2017). The Western Victorian Stock (WVS) is a cross-jurisdictional stock that extends westward from Wilsons Promontory, Victoria into the south eastern waters of South Australia (SA) as far west as Cape Jervis. There are also two wholly South Australian stocks, i.e. the Spencer Gulf / West Coast Stock (SG/WCS) and Gulf St. Vincent Stock (GSVS) (Fowler 2016, Fowler et al. 2017).

The recent study of the stock structure of Snapper was also informative about the demographic processes responsible for the replenishment of the three stocks. It indicated that each stock depends on recruitment into a primary nursery area: Port Phillip Bay (PPB), Victoria for the WVS; Northern Spencer Gulf (NSG) for the SG/WCS; and Northern Gulf St. Vincent (NGSV) for the GSVS (Fowler 2016). For the South East Region (SE), Snapper abundance varies episodically, as fish of a few years of age migrate westwards to this region over hundreds of km from PPB (Fowler et al. 2017). This occurs when strong year classes recruit to PPB, and as such is likely to be a density dependent process related to inter-annual variation in recruitment. The populations of Snapper that occupy the two northern gulfs are independent and self-recruiting. They also experience inter-annual variation in recruitment of 0+ year old fish (Fowler and Jennings 2003, Fowler and McGlennon 2011), most likely as a consequence of variable larval survivorship (Hamer et al. 2010). Each is an important nursery area that acts as a source of emigration that replenishes regional populations in adjacent coastal waters (Fowler 2016). NSG is the source region for Southern Spencer Gulf (SSG) and most likely also for the West Coast of Eyre Peninsula (WC), whilst NGSV is the source for Southern Gulf St. Vincent (SGSV). As such, the dynamics in the regional populations of SA are primarily driven by temporally variable recruitment and subsequent emigration of fish from the source regions supporting the nursery areas to adjacent regional populations (Fowler 2016).

Fishery

Snapper is an iconic fishery resource in each mainland State of Australia (Kailola et al. 2003). Throughout the mid-2000s, SA was the dominant State-based contributor to the national total catches of both the commercial and recreational sectors (Fowler et al. 2016a). SA's Snapper fishery is geographically extensive and encompasses most of the State's coastal marine waters from the far west coast of Eyre Peninsula to the SE region, although the highest abundances have generally been in Spencer Gulf (SG) or Gulf St. Vincent (GSV), which have consequently produced the highest fishery catches (Fowler et al. 2016a, Steer et al. 2018).

Snapper is a primary target species of the commercial and recreational sectors of SA (PIRSA 2013). Licence holders from four different commercial fisheries have access to the fishery, i.e. the Marine Scalefish Fishery (MSF), the Northern Zone and Southern Zone Rock Lobster Fisheries (NZRLF, SZRLF) and the Lakes and Coorong Fishery (LCF) (PIRSA 2013). The main gear types used to target Snapper by commercial fishers are handlines and longlines, since using hauling nets to take Snapper was prohibited in 1993. For local recreational fishers and others from inter-state, Snapper has been an important species in SA's waters because of their desire to catch the large trophy fish (Fowler et al. 2016a). Such recreational fishers target Snapper using rods and lines, primarily from boats, although jetty and land-based catches do occur. Based on the most recent recreational fishing survey in 2013/14, the contributions to total catch by the commercial and recreational sectors were 62% and 38%, respectively (Giri and Hall 2015, Fowler et al. 2016a).

The spatial structure of SA's Snapper fishery underwent considerable change between 2008 and 2012 (Fowler et al. 2016a). Historically, SG supported the highest catches and catch rates, but these have declined considerably, whilst contemporaneously those in NGSV and the SE increased to unprecedented levels (Steer et al. 2018a, b). For the three different stocks these changes reflected different, independent demographic processes that related to recruitment and adult migration (Fowler 2016, Fowler et al. 2017). From 2011 onwards, the changes in the spatial structure of the fishery and stock status caused considerable concern with respect to the management of the fishery. This has resulted in numerous management changes being implemented to limit commercial catches and to maximise the opportunities for spawning and recruitment success whilst several FRDC-funded research projects were undertaken to firstly identify the demographic processes responsible for the observed spatial changes (FRDC 2012/020, Fowler 2016), and also to develop a fishery independent index of fishable biomass (FRDC 2014/019, Steer et al. 2017).

Management Regulations

Regulations for the commercial sector of South Australia's Snapper fishery involve a suite of input and output controls (PIRSA 2013, 2014). The four commercial fisheries with access to Snapper each have limited-entry, i.e. the numbers of fishers who can target Snapper have been limited for many years. In SA, there is a legal minimum length of 38 cm total length (TL), whilst there are also several gear restrictions. Snapper cannot be taken with fish traps, whilst the use of all nets, including hauling nets and large mesh gill nets for targeting Snapper has been prohibited since 1993. Commercial handline fishers are limited with respect to the numbers of handlines and hooks per line that can be legitimately used. From December 2012, for commercial fishers who operate in SG and GSV, the number of hooks that can be used on set lines was reduced from 400 to 200, but remains at 400 for other regions. Also, a daily commercial catch limit of 500 kg was introduced for all South Australian waters. In December 2016, this was further reduced due to on-going concerns about stock status for the different stocks (Fowler et al. 2016a). For the SG/WCS, it was reduced to 200 kg with a limit of two days per trip. For GSV and the SE region, the daily trip limit was reduced to 350 kg. For the former region, a trip limit of two days was set, whilst for the latter the limit of five days was set. There is also a 50 kg bycatch trip limit for the Commonwealth-managed Southern and Eastern Scalefish and Shark Fishery.

For the recreational sector, the minimum legal length of 38 cm TL as well as bag and boat limits apply. In December 2016, bag and boat limits were reduced in response to changes in the spatial structure of the fishery and the classifications of stock status (Fowler 2016, Fowler et al. 2016a). Up until this time, the bag and boat limits differed geographically. However, from the review of the recreational fishery in 2016 (PIRSA 2016), the bag limit of 5 and boat limit of 15 fish for the size range of 38 - 60 cm TL, and bag limit of 2 fish and boat limit of 6 fish for fish >60 cm TL now apply for all State waters. For the Charter Boat sector, from December 2018, the individual bag limit for Snapper was reduced to three small fish (38-60 cm TL) and one large (>60 cm TL) fish. There is no boat limit. Since 2000, the management regime for Snapper has involved at least one seasonal closure per year for both fishing sectors. From 2003 to 2011, this was a month-long fishery closure throughout November. From 2012, the seasonal closure was extended for several weeks until 15th December for all fishing sectors. Furthermore, in 2013, five Snapper spawning spatial closures were implemented in the northern gulfs to extend the duration of protection of important spawning aggregations until the 31st January, thereby conferring protection for most of the reproductive season. The four spatial closures in NSG and one in NGSV were circular in shape with a 4-km radius from a fixed point. In December 2018, the spawning spatial closure in NGSV was removed and replaced with two new closures located in the southern part of the gulf at Tapley Shoal and

Sellicks Beach. These closures were extended to the 31st March 2019. For SG, a new closure at Point Lowly was added to the existing four closures, whilst all were extended to December 2019.

Commercial Fishery Statistics

State-wide

Estimates of total State-wide commercial catch of Snapper show cyclical variation, with the cycles typically encompassing a number of years (Figure 3-1). Since 2003, i.e. the year that produced the minimum catch at the start of the most recent cycle, State-wide catch increased to a record level of 1,032 t in 2010, before declining by more than 72.8% to 281 t in 2018. The economic value of the commercial catch of Snapper in 2018 was approximately $3 M (*c.f.* $3.5 M in 2017) (Fig. 3-1a). Historically, handlines were the most significant gear type, and these catches largely accounted for the cyclical variation in total catch until 2008. However, the proportional contribution of longlines to total catch increased considerably between 2005 and 2010, when it became the dominant gear type. Both longline and handline catches have declined since 2010.

There was a long-term, gradual declining trend in targeted commercial fishing effort between the mid-1980s and 2008 (Figure 3-1b). This was followed by a period of elevated fishing effort between 2009 and 2012 that related to the increase in longline effort. However, since 2010, longline effort has declined, complementing the on-going, long-term declining trend in handline effort. As such, the total fishing effort of 4,691 fisher-days in 2018 was the lowest recorded since 1984. State-wide handline CPUE showed cyclical variation, superimposed on a long-term increasing trend. However, since 2007 it has decreased considerably, concomitant with the emerging dominance of longline fishing. In contrast, longline CPUE increased considerably between 2004 and 2015, before declining in 2016, 2017 and 2018 (Figure 3-1c).

The numbers of fishers from across all four commercial fisheries who reported taking Snapper, declined consistently from 403 in 1984 to 245 in 2000. It then stabilised for a number of years before declining from 260 in 2010 to 168 fishers in 2018. The numbers who targeted Snapper varied similarly and fell from 201 in 2009 to 133 in 2018. In 2018, the commercial catch was dominated by the MSF which contributed 96.3% of the reported catch (Figure 3-2d). The SZRLF accounted for most of the remaining catch.

Regional

The relative contributions of the three stocks to total State-wide annual catches have changed considerably over time particularly with respect to significant change in the spatial structure of the fishery that occurred between 2008 and 2012 (Figure 3-2a). The SG/WCS provided the highest annual catches up to 2009, after which they declined and fell to their lowest levels between 2012 and 2018 (Figure 3-2b). The catches from the GSVS were generally very low until around 2004 after which they increased gradually for a few years before accelerating between 2007 and 2010. This stock became and has subsequently remained the main contributor to the State-wide catch up to 2018. The catches from the South East region also increased dramatically between 2007 and 2010, before declining back to a low level in 2017. They increased marginally in 2018.

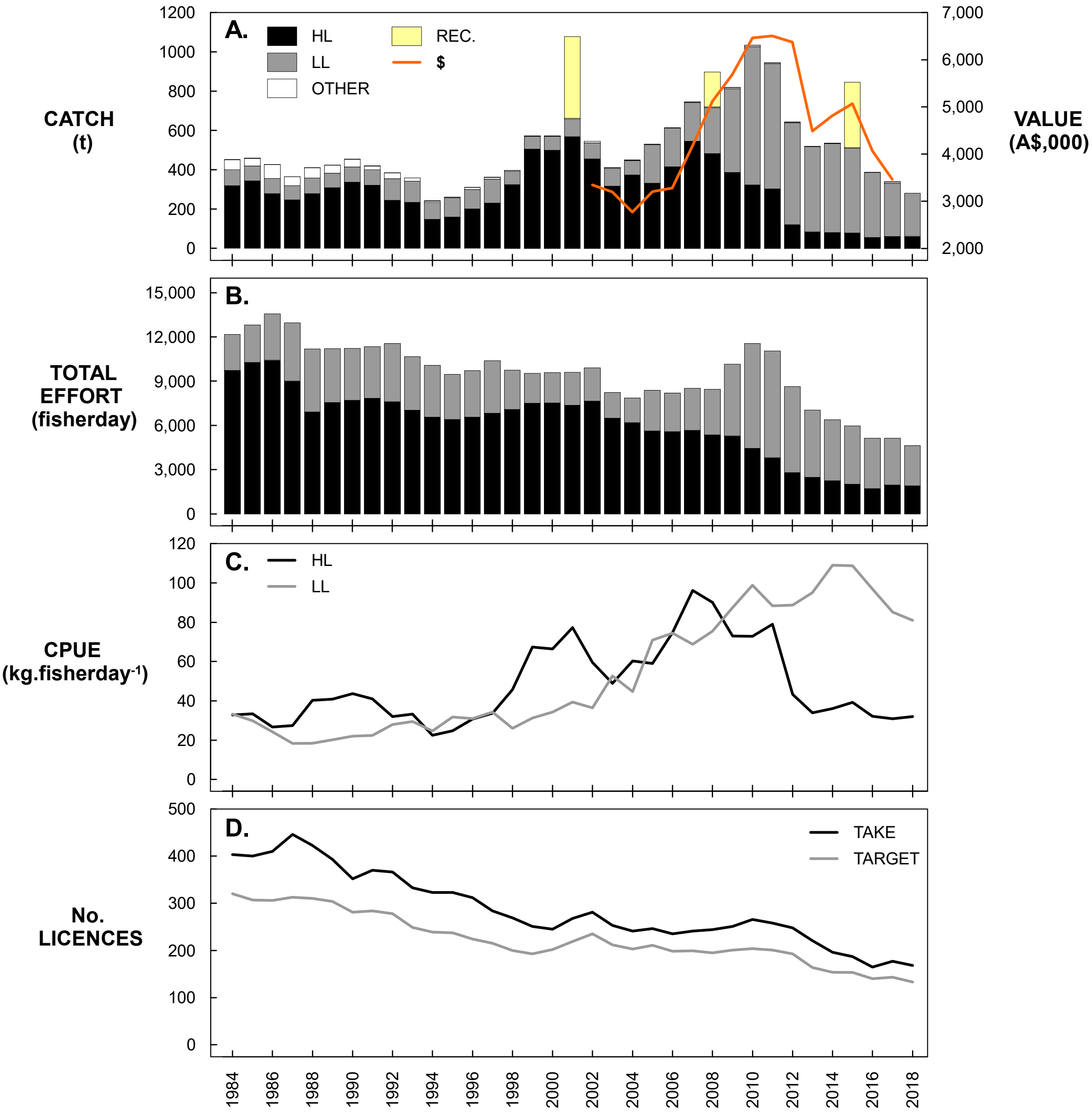

Figure 3-1. Snapper. Long-term trends in: (A) total catch of the main gear types (handlines and longlines) and gross production value; (B) total effort for handlines and longlines; (C) total catch per unit effort (CPUE) for handlines and longlines; and (D) the number of active licence holders taking or targeting the species.

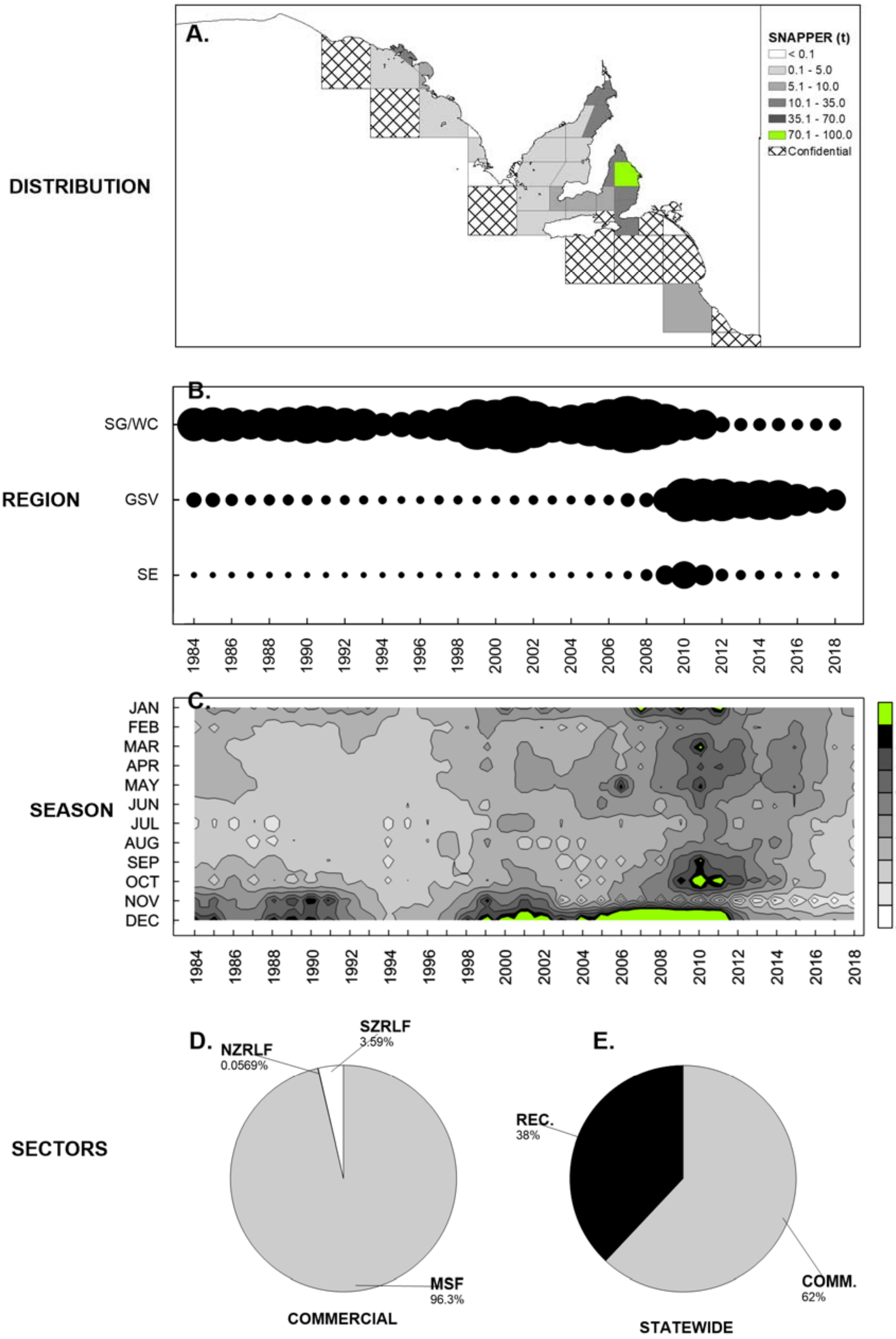

Figure 3-2. Snapper. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among biological stocks, (C) months of the year t); the proportion of catch distributed among the commercial sector in 2018 (D); and among the state-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Spencer Gulf/ West Coast Stock

Annual catches from the SG/WCS have varied cyclically with peaks in 1990, 2001 and 2007. The latter year produced the highest catch of 616.6 t (Figure 3-3a). From 2007 to 2013, annual catches fell considerably. They have subsequently remained relatively stable at a low level up to 2018. The lowest catch of 66.3 t was taken in 2016, which increased marginally to 77.9 t in 2017 before dropping back to 73.5 t in 2018.

Targeted handline catches have also varied cyclically over time. The highest of 516.1 t was taken in 2001, which has since fallen to the lowest of only 28.2 t in 2018 (Figure 3-3b). Targeted handline effort increased between 1984 and 2002 to the highest level of 5,138 fisher-days. Since then, it has declined to the lowest of 563 fisher-days in 2017 before increasing marginally to 587 fisher-days in 2018 (Figure 3-3c). Targeted handline CPUE has varied cyclically, but has also shown a long-term increasing trend to 2011, which peaked in 2007 at 138.2 kg.fisher-day^{-1}, but in 2012 declined steeply to 64.6 kg.fisher-day^{-1}, before dropping to 48.1 kg.fisher-day^{-1} by 2018 (Figure 3-3d). The number of licence holders who took and targeted Snapper with handlines declined slowly through the 1980s and 1990s but the rates of decline increased through the 2000s (Figure 3-3e). Those taking Snapper with handlines fell from a high of 216 in 1985 to 97 in 2018, and those targeting fell from 175 to 65 over the same period. The number of reported daily handline catches (between February and October) declined considerably from almost 1500 in 2004 to around 250 in 2018. The estimates of the proportion of handline fishing trips for which catches reached 200 kg (Prop200kgHLTar) were variable, declining from the maximum of around 30% in 2010, to low levels (10%) in 2012 and 2013. They increased again in 2014 and 2015 before declining to 10% again in 2018 (Figure 3-3f).

Targeted longline catch for the SG/WCS was relatively flat from 1984 to 2004 (Figure 3-3g). It then increased and peaked at 154.1 t in 2006 before declining again. By 2018, it had fallen to 35.8 t. Since targeted LL effort peaked at 2,578 fisher-days 1997, it has declined considerably (Figure 3-3h). By 2014 it had fallen to 591 fisher-days, before it increased to 679 fisher-days in 2018. Targeted LL CPUE peaked between 2005 and 2008, with the highest at 99.4 kg.fisher-day^{-1} in 2006 (Figure 3-3i). From 2008, it has fallen considerably and by 2014 had dropped to 34.2 kg.fisher-day^{-1}. Subsequently it has increased to 52.8 kg.fisher-day^{-1} in 2018. The numbers of fishers taking and targeting Snapper with longlines have declined steadily from 1988 to 2018. Those taking Snapper fell from 116 to 41 and those targeting it fell from 99 to 40 (Figure 3-3j). The numbers of reported daily longline catches fell between 2006 and 2011 and have subsequently remained relatively low. The annuals estimates of Prop200kgLLTar declined to approximately 10% in 2011 and have since remained at this low level since then (Figure 3-3k).

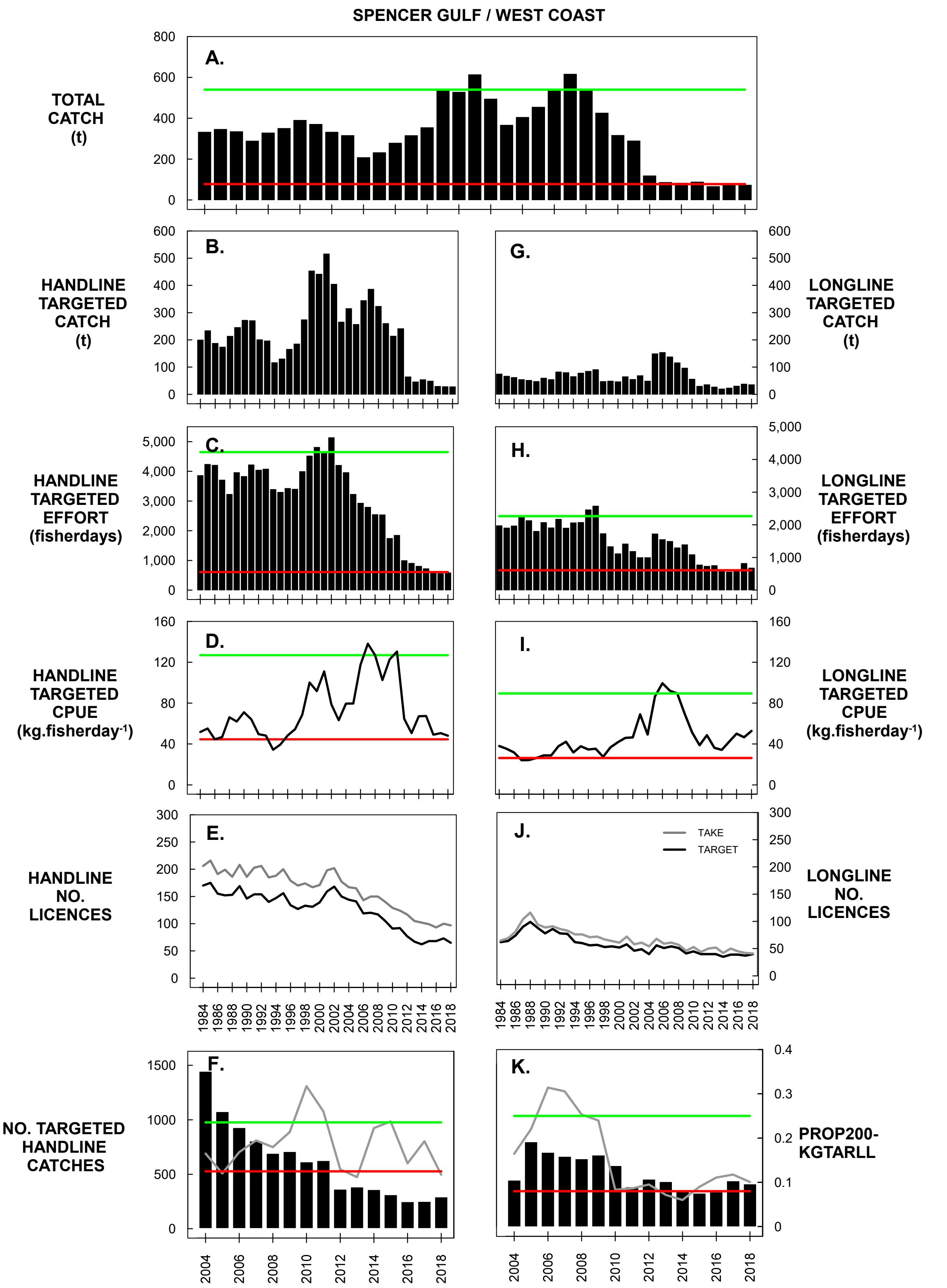

Figure 3-3. Key fishery statistics used to inform the status of the Spencer Gulf/ West Coast Stock of Snapper. Long-term trends in (A) total catch. (Left) trends in (B) targeted handline catch; (C), effort , (D) catch rate; and (E) the number of active licence holders taking and targeting the species; (F) number of targeted daily catches and Prop200kgTarHL. (Right) trends in (G) targeted longline catch; (H), effort, (I) catch rate; and (J) the number of active licence holders taking and targeting the species; (K) number of targeted daily catches and Prop200kgTarLL. Green and red lines represent the upper and lower reference points identified in Table 3-3.

Gulf St. Vincent Stock

Between 1984 and 2006, the GSVS produced relatively low catches. However, from 2006 to 2010, total catch increased exponentially culminating in the record catch of 454.1 t (Figure 3-4a). Total catch declined marginally between 2010 and 2015 after which the rate of decline increased. Total catch in 2018 was 188.3 t, i.e. 41.5% of the record level.

Targeted HL catch has generally been low for this stock despite the high effort levels during the early 1980s (Figure 3-4b). Targeted effort declined to a low level in 1995 and has since remained low but varied cyclically (Figure 3-4c). Estimates of annual targeted HL CPUE were low until 2006, before they increased to the highest levels between 2007 and 2013. It has subsequently decreased to moderate levels, with 42.4 $kg.fisher\text{-}day^{-1}$ recorded in 2018 (Figure 3-4d). The numbers of handline fishers fell considerably through the 1980s and 1990s. Throughout the 2000s the numbers have been variable but shown no long-term trends (Figure 3-4e). The numbers of reported daily handline catches have remained relatively low since 2004. The estimates of Prop200kgTarHL were relatively high between 2007 and 2012. From then, they declined to <0.1 in 2015 and have since remained low (Figure 3-4f).

The LL fishery for the GSVS largely accounted for the recent rapid increase in total catches. Between 2008 and 2015, targeted LL catch increased from 46.7 t to 388.2 t (Figure 3-4g). This increase was associated with a 334.1% increase in targeted longline fishing effort from 657 to 2,852 fisher-days. Targeted fishing effort has declined in each of 2016, 2017 and 2018 dropping to 1,551 fisher-days in the latter year (Figure 3-4h). Longline CPUE demonstrated a long-term increase primarily between 2000 and 2010, when it peaked at 145.7 $kg.fisher\text{-}day^{-1}$. Since 2015, it has declined consistently to 103.8 $kg.fisher\text{-}day^{-1}$ in 2018 (Figure 3-4i). The numbers of LL fishers who took and targeted Snapper peaked in 2012 at 66 and 64, respectively (Figure 3-4j). They have declined considerably to 33 and 32 respectively, in 2018. The numbers of daily longline catches increased from 2007, peaked in 2012 and have subsequently declined from then until 2018. Prop200kgTarLL was relatively high from 2011 to 2015, but has declined considerably in 2016, 2017 and 2018 (Figure 3-4k).

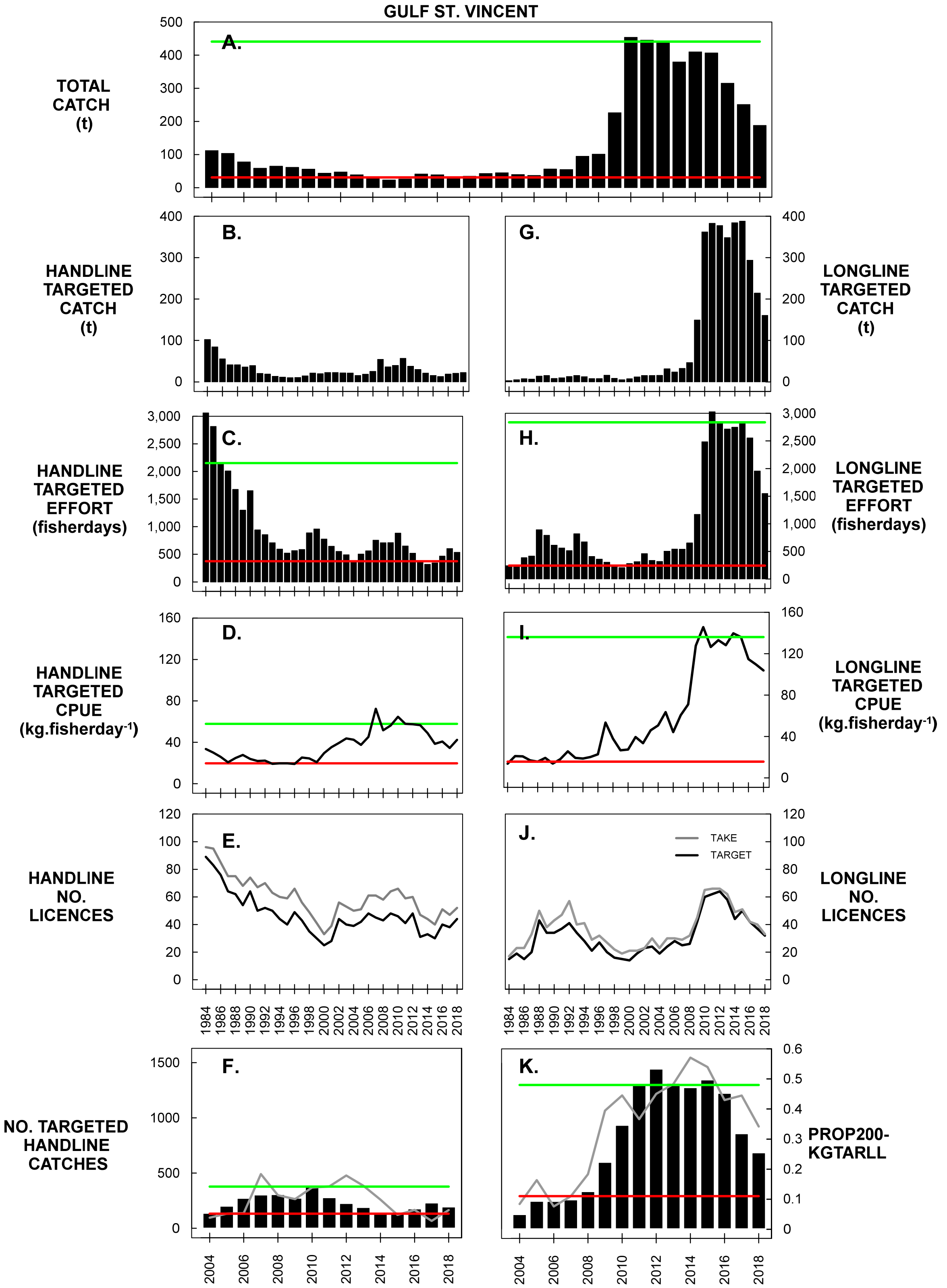

Figure 3-4. Key fishery statistics used to inform the status of the Gulf St. Vincent Stock of Snapper. Long-term trends in (A) total catch. (Left) trends in (B) targeted handline catch; (C), effort , (D) catch rate; and (E) the number of active licence holders taking and targeting the species; (F) number of targeted catches and Prop200kgTarHL. (Right) trends in (G) targeted longline catch; (H), effort, (I) catch rate; and (J) the number of active licence holders taking and targeting the species; (K) number of targeted catches and Prop200kgTarLL. Green and red lines represent the upper and lower reference points identified in Table 3-3.

South East Regional Population

The SE region has generally produced only marginal catches of Snapper (Figure 3-5a). However, from 2006 to 2010 there was an exponential increase in catch that peaked in 2010 at 257.9 t. It then fell consistently and in 2017 total catch was 9.4 t, before increasing to 19.1 t in 2018.

Targeted HL catch in the SE has always been low. There was a minor increase between 2006 and 2009, which peaked in 2007 at 12.4 t, but which has subsequently declined (Figure 3-5b). Such catches reflect low but variable fishing effort, which peaked at 316 fisher-days in 2007 (Figure 3-5c). Up to 2003, targeted HL CPUE was generally <20 kg.fisher-day^{-1}. It then increased to its highest levels from 2006 to 2009, peaking at 68.6 kg.fisher-day^{-1} in 2008 (Figure 3-5d). The numbers of HL fishers who took and targeted Snapper recently peaked in 2009, at 16 and 13, respectively (Figure 3-5e). They have subsequently declined to three fishers each in 2018. The numbers of reported daily catches have remained low since 2004. Prop200kgTarHL was highest from 2006 to 2009, but has been less than 10% (Figure 3-5f).

Up to 2007, targeted LL catches were less than several tonnes.yr^{-1}. After this, there was a rapid increase to the maximum level of 239.2 t in 2010 (Figure 3-5g). It then declined to 9.0 t in 2017 before increasing to 18.6 t in 2018. There was a considerable increase in targeted longline effort that peaked in 2010 at 2,614 fisher-days, which subsequently declined to only 162 fisher-days in 2017 before increasing to 308 fisher-days in 2018 (Figure 3-5h). Targeted CPUE also increased considerably between 2007 and 2010, peaking at 91.5 kg.fisher-day^{-1} before declining to 60.2 kg.fisher-day^{-1} in 2018 (Figure 3-5i). The numbers of LL fishers who took and targeted Snapper increased dramatically from 2005 and peaked in 2010 at 34 and 27, respectively (Figure 3-5j). They declined to 11 and 9, respectively in 2018. The reported numbers of daily catches increased from 2007, peaked in 2010 and subsequently declined to a minimum in 2016, before increasing marginally in 2017 and 2018. Prop200kgTarLL also peaked in 2010 and declined to 2016. It has risen again to >0.2 in 2018 (Figure 3-5k).

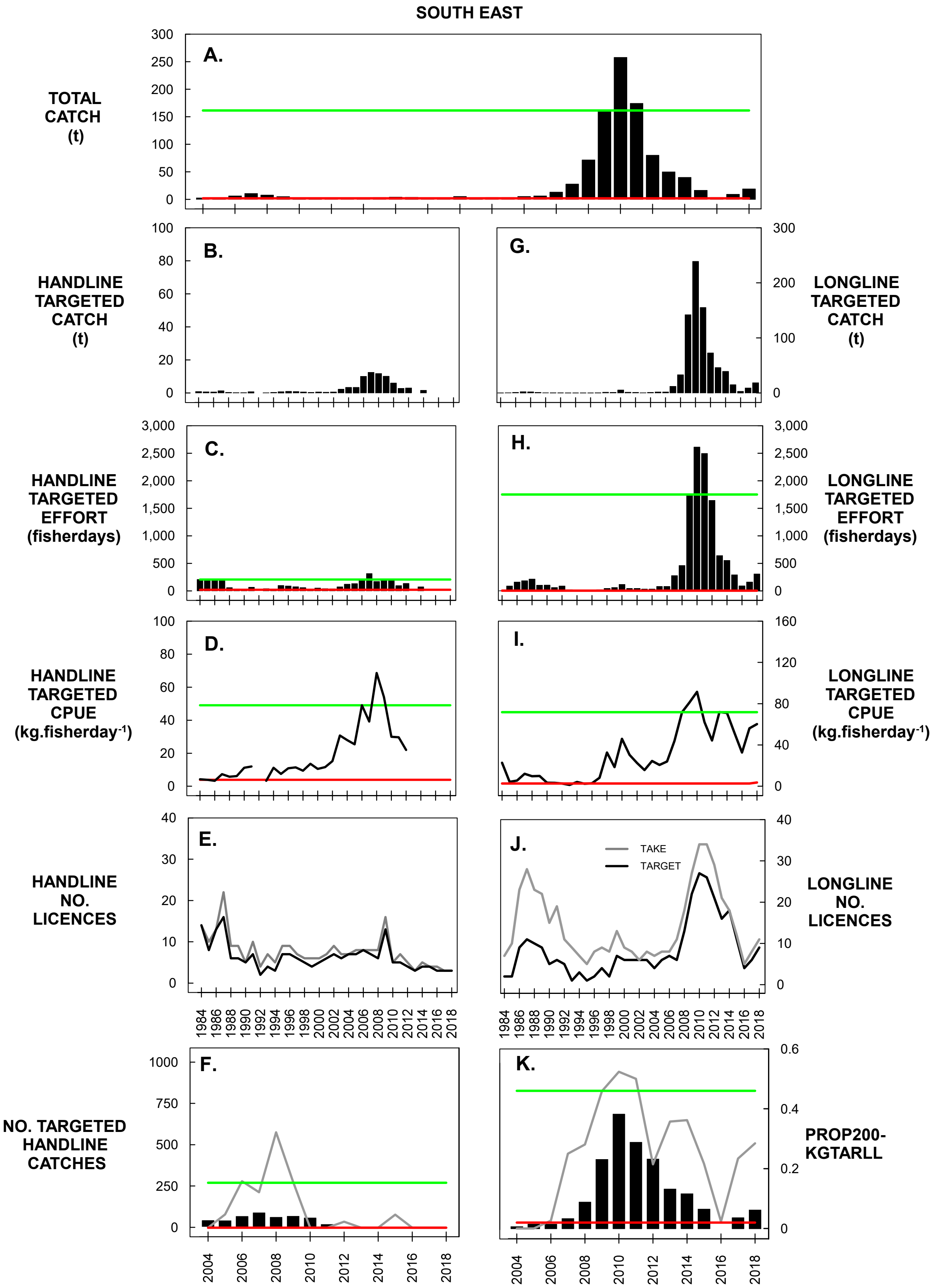

Figure 3-5. Key fishery statistics used to inform the status of the South East regional population of Snapper. Long-term trends in (A) total catch. (Left) trends in (B) targeted handline catch; (C), effort , (D) catch rate; and (E) the number of active licence holders taking and targeting the species; (F) number of targeted catches and Prop200kgTarHL. (Right) trends in (G) targeted longline catch; (H), effort, (I) catch rate; and (J) the number of active licence holders taking and targeting the species; (K) number of targeted catches and Prop200kgTarLL. Green and red lines represent the upper and lower reference points identified in Table 3-3.

Fishery Performance

The catch data from the four commercial fisheries in 2018 were compared against their allocations using Triggers 2 & 3 as reference points (Table 3-2). One trigger reference point was exceeded. For the SZRLF, trigger 3 was activated, indicating that the catch from this fishery taken in 2018 exceeded its allocation.

Table 3-2. Comparisons of percentages of commercial catch of Snapper taken by the fisheries, with their allocations and trigger limits specified in the Management Plan (PIRSA 2013). MSF – Marine Scalefish, SZRL – Southern Zone Rock Lobster, NZRL – Northern Zone Rock Lobster. Green colour – allocation not exceeded, red colour – allocation trigger activated.

	MSF	SZRLF	NZRLF	LCF
Commercial allocation	*97.5*	*1.78*	*0.68*	*0.04*
Trigger 2 (%)	*na*	*2.68*	*1.3*	*0.75*
Trigger 3 (%)	*na*	*3.58*	*2.0*	*1.0*
% total 2014	98.91	0.70	0.14	0.25
% total 2015	99.37	0.46	0.18	0
% total 2016	99.90	0.05	0.06	0
% total 2017	98.75	1.10	0.16	0
% total 2018	96.35	3.59	0.06	0

The general fishery performance indicators were assessed for the SG/WCS, GSVS and the SE regional population. In total, there were five breaches of trigger reference points (Table 3-3). In 2018, for the SG/WCS, total catch was the second lowest yet recorded, whilst targeted handline effort was also the second lowest. The lowest value for Prop200kgTarHL was recorded in 2018. There were no breaches for the GSVS. For the SE in 2018, targeted handline effort was the lowest recorded, whilst for Prop200kgTarHL, the lowest value was also recorded in 2018.

Table 3-3. Comparison of trends in South Australia's Snapper Fishery against the general (G) performance indicators prescribed in the MSF Management Plan (PIRSA 2013).

Performance Indicator	Type	Trigger Reference Point	SG/WC	GSV	SE
Total catch	G	3rd lowest/3rd highest	2nd Lowest	×	×
		Greatest interannual change (±)	×	×	×
		Greatest 5-year trend (±)	×	×	×
		Decrease over 5 consecutive years?	×	×	×
Targeted handline effort	G	3rd lowest/3rd highest	2nd Lowest	×	Lowest
		Greatest interannual change (±)	×	×	×
		Greatest 5-year trend (±)	×	×	×
		Decrease over 5 consecutive years?	×	×	×
Targeted longline effort	G	3rd lowest/3rd highest	×	×	×
		Greatest interannual change (±)	×	×	×
		Greatest 5-year trend (±)	×	×	×
		Decrease over 5 consecutive years?	×	×	×
Targeted handline CPUE	G	3rd lowest/3rd highest	×	×	×
		Greatest interannual change (±)	×	×	×
		Greatest 5-year trend (±)	×	×	×
		Decrease over 5 consecutive years?	×	×	×
Targeted longline CPUE	G	3rd lowest/3rd highest	×	×	×
		Greatest interannual change (±)	×	×	×
		Greatest 5-year trend (±)	×	×	×
		Decrease over 5 consecutive years?	×	×	×
Prop200kgTarHL		3rd lowest/3rd highest	Lowest	×	Lowest
		Greatest interannual change (±)	×	×	×
		Greatest 5-year trend (±)	×	×	×
		Decrease over 5 consecutive years?	×	×	×
Prop200kgTarLL		3rd lowest/3rd highest	×	×	×
		Greatest interannual change (±)	×	×	×
		Greatest 5-year trend (±)	×	×	×
		Decrease over 5 consecutive years?	×	×	×

Stock Status

A full stock assessment for Snapper where the statuses of South Australia's stocks were determined using a combination of fishery-dependent and -independent data sources has been published separate to this report (Fowler et al. 2019).

Spencer Gulf / West Coast Stock (SG/WCS)

Overall, there were several independent sets of data that demonstrated that the fishable biomass of the SG/WCS was low (Fowler et al. 2019). The estimates of commercial catch, effort and CPUE remain at historically low values. The age structures from commercial market sampling suggested that the regional population in NSG was severely truncated and provided no evidence of recent recruitment of any new strong year classes. These observations were consistent with this population being recruitment-impaired. The results from the Daily Egg Production Method (DEPM) undertaken in 2018 suggested that the spawning biomass declined further from the low level in 2013, for which it is now apparent that the spawning biomass was already compromised. The estimated commercial harvest fraction has remained >18% over the past two surveys. Assuming a 38% contribution to the total catch by the recreational sector (see Giri and Hall, 2015), the total harvest fraction was estimated at approximately 30% in 2013 and 2018. The available evidence indicated that the SG/WCS harvestable biomass was likely to be depleted and that recruitment was likely to be impaired. Consequently, the SG/WCS was classified as **depleted** in 2018 under the NFSRF (Fowler et al. 2019). This status was unchanged from that in 2017.

Gulf St. Vincent Stock (GSVS)

The current stock status identified in Fowler et al. (2019) was difficult to determine due to uncertainty in the (1) estimate of spawning biomass from the DEPM in 2018 due to incomplete coverage of the potential spawning area; (2) the implications of the recent declines in fishery statistics, which although substantial remain relatively high compared to those prior to the 2000s; (3) potential strength of the 2014 recruitment year class; and (4) magnitude of the recreational catch. Despite this uncertainty, it was clear that the abundance of Snapper in GSV has declined. However, it was not possible to determine whether the GSVS is already recruitment impaired. Given this uncertainty, the GSVS was classified as 'depleting' in 2018 under the NFSRF (Fowler et al. 2019). This means that fishing mortality is too high (i.e. overfishing is occurring) and moving the stock in the direction of becoming recruitment impaired. The classification of **depleting** for 2018 is a change in status from 'sustainable' in 2017.

South East Regional Population

In 2016, the WVS was classified as sustainable. This was largely based on the results of the annual 0+ recruitment survey in PPB, which showed that over the 12 years to 2016, there had been six years for which recruitment was at or above the long-term average (Hamer and Conron 2016). The 2013 and 2014 year classes were two of the largest yet recorded. The evidence above means that biomass is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (i.e. recruitment is not impaired) and fishing mortality is adequately controlled to avoid the stock becoming recruitment impaired. Consequently, the WVS is classified as **sustainable** (Fowler et al. 2019).

3.3.2. KING GEORGE WHITING

Biology

King George Whiting (*Sillaginodes punctatus*) is one of the most valuable, coastal marine finfish species of southern Australia. It occurs in coastal and shelf waters, distributed from Sydney (NSW), around the southern coastline, and to Perth in Western Australia (WA) (Kailola et al. 1993). The species is particularly significant in South Australia (SA), the geographic centre of its distribution, where abundances and fishery productivity are highest.

King George Whiting has a complex life history that involves movement between different habitats associated with ontogenetic development across different life history stages (Fowler and Jones 2008). In SA, spawning occurs during autumn and early winter at off-shore reefs, shoals and mounds in relatively deep water in exposed localities that experience medium/high wave energy (Fowler et al. 2000a, b, 2002). The eggs and larvae are advected throughout a prolonged pre-settlement duration to nursery areas in shallow, protected bays located in the northern gulfs or those on the west coast of Eyre Peninsula and also Kangaroo Island (Fowler and Short 1996, Fowler et al. 2000b, Rogers et al. 2019). Juvenile fish grow and develop in the vicinity of these nursery areas. When they reach approximately three-years of age, those in the northern gulfs undertake significant movement southwards, whilst those in the other bays move off-shore. Such movement ultimately replenishes the populations of older fish on the spawning grounds (Fowler et al. 2000b, 2002). The movement results in a significant ontogenetic shift from relatively protected shallow waters that support extensive meadows of seagrass to more exposed, deep water and reef habitat. As a consequence, population size and age structures of King George Whiting vary geographically (Fowler et al. 2000a). The northern gulfs and inshore bays support populations with only a few age classes, whereas in the south the populations involve multiple age classes with fish up to around 20 years of age. The spawning grounds and nursery areas for King George Whiting can be separated by up to several hundred kilometres. As such, the processes of larval advection and adult movement are significant obligate steps that link the different life history stages and the habitats they occupy (Fowler et al. 2002, Rogers et al. 2019).

The stock structure for King George Whiting 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 those in Tasmania (Kent et al. 2018). The similar genotypes between the SA 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). The genetic homogeneity of the SA regional populations indicate 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 (Fowler et al. 1999, 2000b). These stocks are: west coast of Eyre Peninsula (WCS); Spencer Gulf (SGS); and Gulf St. Vincent / Kangaroo Island (GSV/KIS) (Fowler and McGarvey 2000, Fowler et al. 2014).

Fishery

King George Whiting is a ‘primary’ species of SA’s MSF (PIRSA 2013), that is heavily targeted by both the commercial and recreational sectors (Steer et al. 2018a). Several life history stages are targeted: young, immature adults in the northern gulfs; the immature fish as they travel southwards; and mature adults on the spawning grounds. As such, during their ontogenetic development, the fish run the gauntlet of fishing lines and nets that are used to target them in different habitats. Because of this, SA’s King George Whiting fishery is described as a ‘gauntlet’ fishery.

Three different commercial fisheries have access to SA’s King George Whiting stocks, i.e. the MSF, and the Northern Zone and Southern Zone Rock Lobster Fisheries (NZRLF, SZRLF) (PIRSA 2013). Historically, this species was the most valuable for the commercial sector, but since 2007/08 its ranking by value has varied with Snapper and Southern Calamari, depending on the variation in catches of the different species from year to year. Nevertheless, King George Whiting remains the highest value species by weight. The main gear types with which it is targeted by the commercial sector are hand lines, hauling nets and gill nets. For the recreational sector, this is an iconic species that is heavily targeted with hook and line, principally from boats.

When the current commercial Management Plan was being developed (PIRSA 2013), the three King George Whiting stocks were classified as ‘sustainably fished’ (Fowler et al. 2011). As such, the primary objective of the harvest strategy in the Management Plan was to maintain that positive status and fishery performance. Nevertheless, in the subsequent stock assessment (Fowler et al. 2014), the statuses of the stocks in the two gulf stocks, i.e. the SGS and GSV/KIS were changed to ‘transitional-depleting’. In response, the focus of fishery management was modified towards recovering both stocks, whilst maintaining the ‘sustainable’ status of the WCS. To this end, significant management changes were implemented in December 2016. Based on the positive responses by both stocks, the status of the SGS was changed back to 'sustainable' in 2017 (Steer et al. 2018a), and for the GSV/KIS it was changed back in the following year (Steer et al. 2018b).

Management Regulations

Regulations for managing South Australia's King George Whiting fishery involve a complex suite of input and output controls (PIRSA 2013). For the commercial sector, the principal means of effort control is 'limited entry', with the number of licence holders having declined considerably over time (Steer et al. 2018b). Furthermore, there is a complexity of regulations that apply to the gears that are used to take King George Whiting. These restrict the numbers of handlines and hooks that can be legitimately used, whilst for hauling nets and gill nets there are gear specifications and spatial and temporal restrictions. The take of the recreational sector is managed through size, bag and boat limits as well as spatial restrictions.

The management regulations for King George Whiting were modified following the 'transitional depleting' statuses that were assigned to the two stocks in the South Australian gulfs (Fowler et al. 2014), and the ensuing extensive review of management arrangements that took place throughout 2016. The considerable changes that were implemented in December 2016 were: (1) an increase in legal minimum length (LML) from 31 to 32 cm TL for all waters east of longitude 136°E, whilst the LML of 30 cm TL was retained in the waters of the west coast of Eyre Peninsula; (2) a State-wide reduction in the recreational bag limit from 12 to 10 legal-sized fish per person, with the boat limit reduced from 36 to 30 fish per boat; (3) a possession limit of either 72 fish or 10 kg of fillets or 36 fish and up to 5 kg of fillets; and (4) an introduction of a spatial spawning closure in Investigator Strait and southern Spencer Gulf from 1st to 31st May that was first implemented in 2017.

Commercial Fishery Statistics

State-wide

There has been a long-term declining trend in total commercial catch of King George Whiting. This involved a 68.4% reduction from the highest catch of 776 t recorded in 1992 to the lowest of 245 t recorded in 2017, followed by a marginal increase to 250 t in 2018 (Figure 3-6a). The annual estimates of catch from the recreational sector of 382 t in 2000/01, 324 t in 2007/08 and 367 t in 2013/14 have been relatively consistent (Fowler et al. 2014, Giri and Hall 2015). The economic value of the commercial catch of King George Whiting in 2018 was approximately $4.3 M (*c.f.* $4.4 M in 2017) (Figure 3-6a).

Hand lines have always been the dominant gear used by the commercial sector to target King George Whiting. Between 1984 and 1999, hand line catches were around 400 t.yr^{-1} (Figure 3-6a). Subsequently, hand line catch fell by 48.0% from 431 t in 1999 to 224 t in 2018. The catch by hauling nets has fallen by 93.2% from the record of 266 t in 1992 to only 18 t in 2018. The total State-wide gillnet catch has always been less than 50 $t.year^{-1}$, and since 2012 has been <10 $t.yr^{-1}$. The value of the annual commercial catch of King George Whiting has varied considerably over time (Figure 3-6a). It fell from $5.5 M in 2003 to $3.6 M in 2005, and was $4.3 M in 2018.

The annual estimates of total fishing effort across gear types used to take the total catches of King George Whiting declined from 54,254 fisher-days in 1984 to 13,212 fisher-days in 2018, i.e. a reduction of 75.6% over 35 years (Figure 3-6b). This declining trend relates, at least partly, to the reduction in number of licence holders in the commercial fishery. Between 1984 and 2018, the number of fishers who reported taking King George Whiting fell from 646 to 236, and those targeting King George Whiting from 592 to 203 (Figure 3-6d). The rate of decline accelerated after 1994 when the licence amalgamation scheme was introduced and again in 2005 through the net buyback.

The estimates of State-wide hand line CPUE have been variable, but have trended upward over time, although divisible into several time periods (Figure 3-6c). It increased from 1984 to 1991, but then declined over several years to 1995. It then increased considerably until 1999, after which there was a noticeable decline to 2002. Subsequently, hand line CPUE gradually increased to the highest recorded level in 2016, and remained around this high level in 2017 and 2018.

The State-wide commercial catches are divisible into those from the three component stocks, which have all declined over time (Figure 3-7b). Through the 1980s and 1990s, the SGS provided the highest catches. Through the 2000s, they fell below those of the WCS, which has continued to produce the highest catches. Those from the GSV/KIS have always been the lowest of the three stocks.

Seasonality in the King George Whiting fishery has been a consistent feature (Figure 3-7c). Catches have generally been higher through the cooler months and lower during summer. In 2018, the commercial catch was dominated by that from the MSF Fishery, with a relatively small contribution of 1.4% from the NZRLF (Figure 3-7d). In 2013/14, the recreational sector accounted for 56.6% of the total catch, i.e. a considerably higher percentage than that of the commercial fishery.

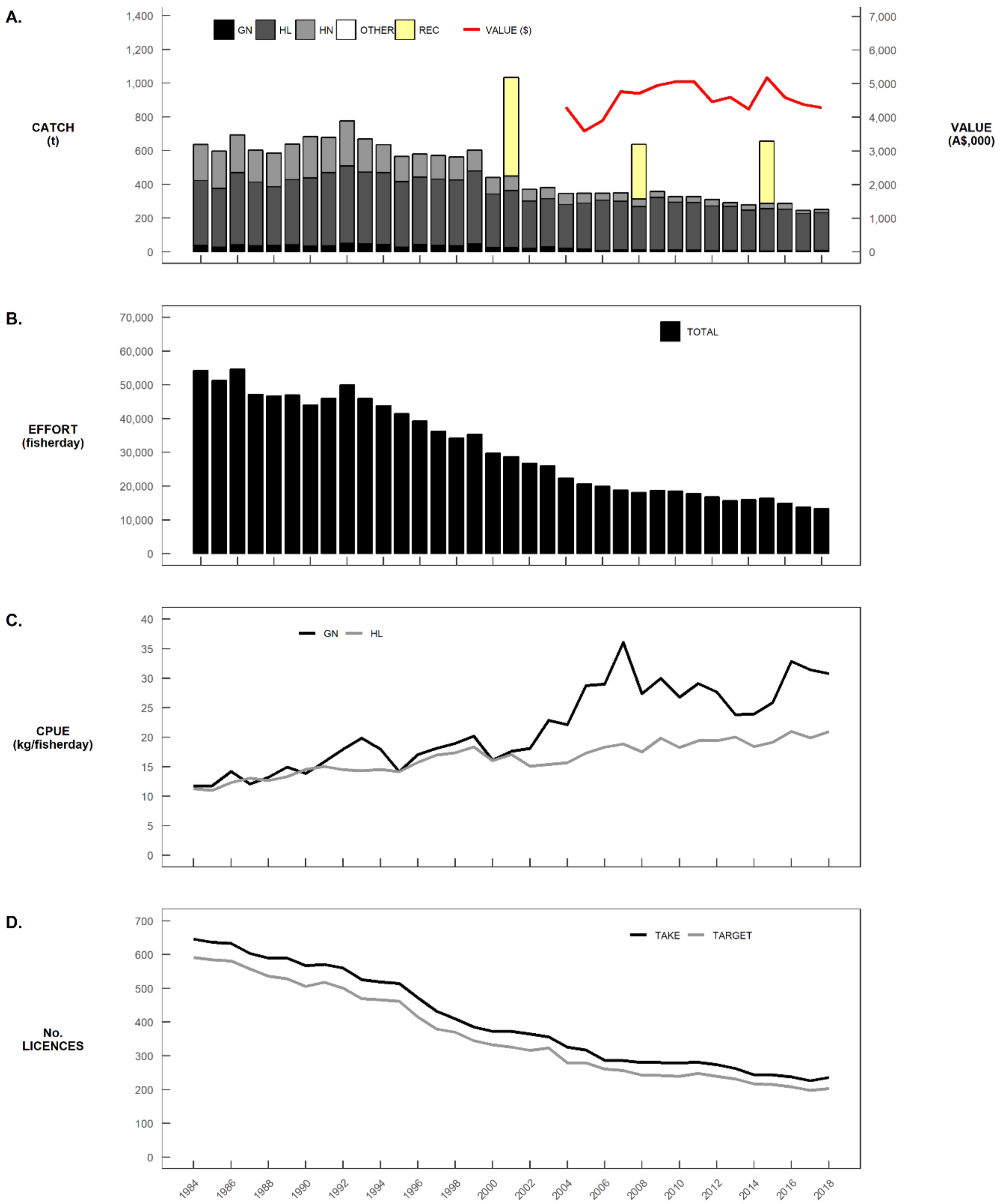

Figure 3-6. King George Whiting. Long-term trends in: (A) total catch of the main gear types (handline, hauling net and gill net), estimate of recreational catch and gross production value; (B) total effort; (C) total catch per unit effort (CPUE) for handline and longline; and (D) the number of active licence holders taking or targeting the species.

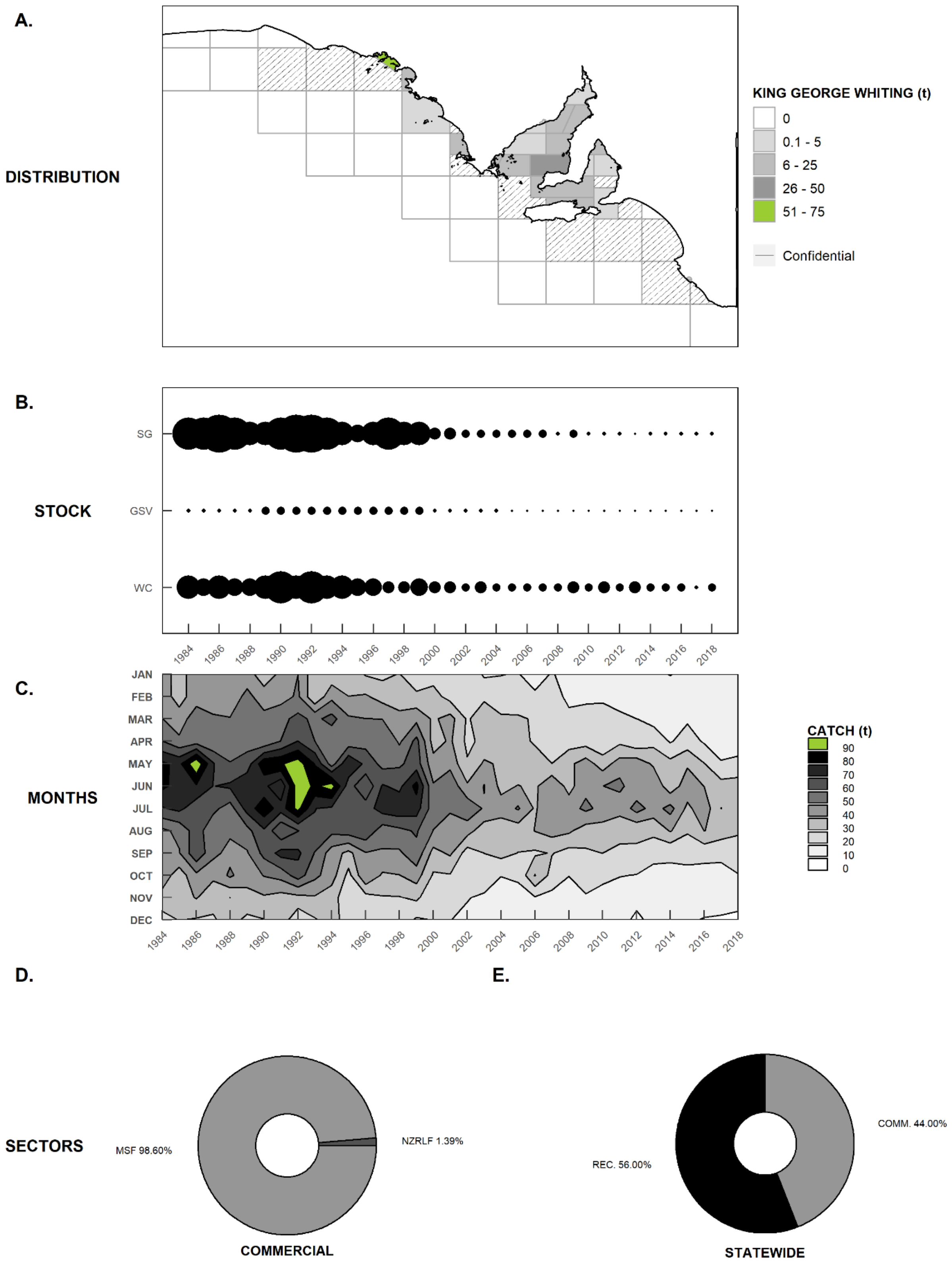

Figure 3-7. King George Whiting. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among biological stocks, (C) months of the year (t); (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Regional

West Coast Stock (WCS)

Annual commercial catches from this stock increased between 1984 and 1992 when the highest annual catch of 283 t was taken (Figure 3-8a). From then, total catch gradually declined by 52.7% to only 134 t in 2002. Subsequently, it increased to 171 t in 2013, before falling to 99 t in 2017, which was the lowest ever recorded. In 2018, it increased marginally to 115 t, the second lowest total.

In all years, hand lines were the dominant gear. Targeted hand line catches dropped from the high of 216 t in 1999 to 98 t in 2017, and increased to 114 t in 2018 (Figure 3-8b). Targeted hand line effort has declined relatively consistently from the maximum of 15,765 fisher-days in 1984 to the lowest of 4,380 fisher-days in 2017, and increased marginally to 4,454 fisher-days in 2018 (Figure 3-8c). In contrast, hand line CPUE has increased considerably in several multi-year steps. It increased between 1987 and 1992 before declining considerably to 1995 (Figure 3-8d). It increased again to 1999 before falling from 20.8 to 15.6 kg.fisher-day^{-1} in 2002. Subsequently, CPUE increased to 25.1 kg.fisher-day^{-1} in 2013. Although it dropped considerably in 2014, it has recovered to the highest recorded level of 25.7 kg.fisher-day^{-1} in 2018. The numbers of fishers taking and targeting King George Whiting from the WCS with hand lines have both declined considerably between 1984 and 2018 (Figure 3-8e). The former fell from 197 to 79, whilst the latter declined from 196 to 79.

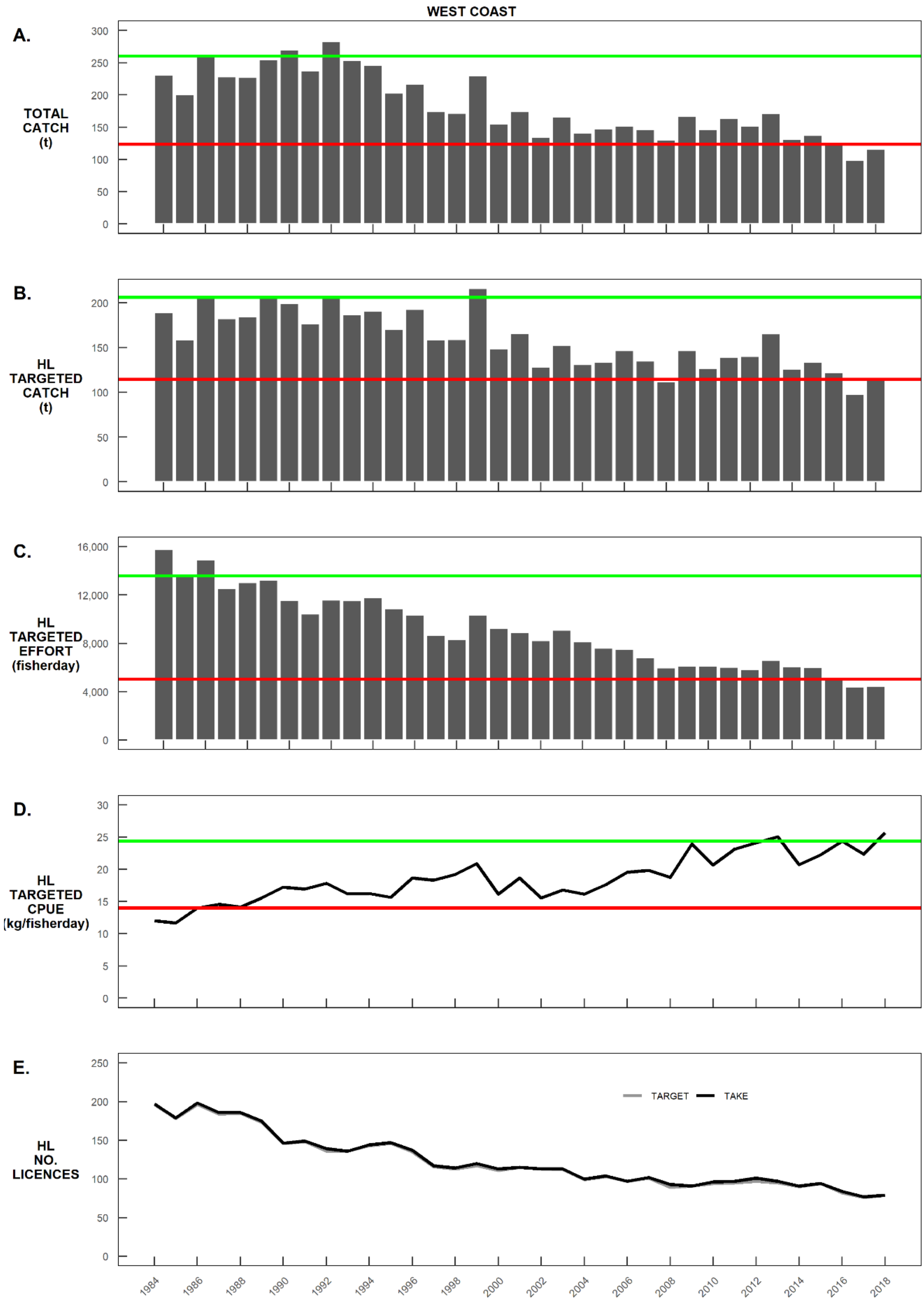

Figure 3-8. Key fishery statistics used to inform the status of the West Coast stock of King George Whiting. Long-term trends in (A) total catch; (B) targeted hand line catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-5.

Spencer Gulf Stock (SGS)

Total commercial catch of King George Whiting from Spencer Gulf was relatively high and varied cyclically between 1984 and 1997 (Figure 3-9a). The highest catch of 346 t was recorded in 1992. From 1997 until 2004, total catch declined by 57.1% and from then until 2013 declined by a further 41.2% to the lowest recorded amount of 70.6 t. From 2014 to 2018, total catch has increased again and has varied around 100 $t.yr^{-1}$.

Throughout the 2000s, targeted hand line catch has been considerably lower than throughout the 1980s and 1990s (Figure 3-9b). It was lowest at 55 t in 2013 before increasing by 36.4% to 75 t in 2018. Hand line fishing effort was variable between 1984 and 1992. Between 1992 and 2004, it declined by 57.8% from 10,727 to 4,530 fisher-days. It was then relatively stable for several years, until declining in 2013 to the lowest level of 3,267 fisher-days, but has since increased by 18.9% to 3,883 fisher-days in 2018 (Figure 3-9c). Hand line CPUE has shown a long-term increase, although with clear cyclical variation. The cycles have typically involved several years during which catch rates increased quickly, followed by several years of decline. From 2003 to 2007, catch rate increased by 34.4% from 15.4 to 20.7 $kg.fisher\text{-}day^{-1}$. However, from 2007 to 2013, there was the longest period of decline during which it dropped by 17.2% to 16.8 $kg.fisher\text{-}day^{-1}$ (Figure 3-9d). Then, between 2013 and 2016, it increased again, attaining the highest recorded level of 21.0 $kg.fisher\text{-}day^{-1}$. It subsequently declined marginally to 20.2 $kg.fisher\text{-}day^{-1}$ in 2017, and again to 19.3 $kg.fisher\text{-}day^{-1}$ in 2018. The number of licence holders who took King George Whiting with hand lines fell from 237 in 1984 to 112 in 2018 (Figure 3-9e), whilst those targeting it fell from 233 to 108 in 2018.

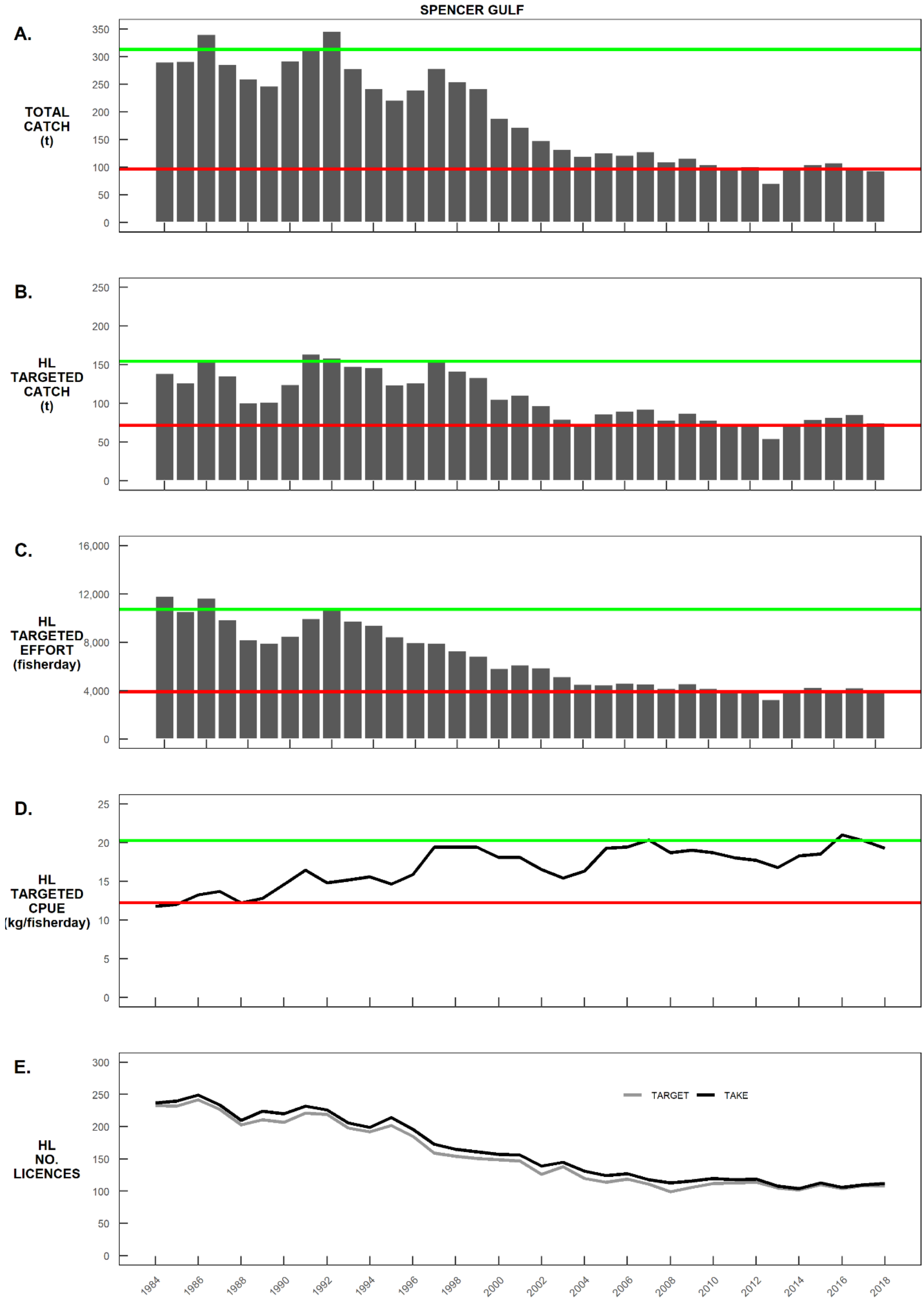

Figure 3-9. Key fishery statistics used to inform the status of the Spencer Gulf stock of King George Whiting. Long-term trends in (A) total catch; (B) targeted hand line catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-5.

Gulf St. Vincent/Kangaroo Island Stock (GSV/KIS)

Total commercial catch from this stock has been consistently lower than for the other two stocks and has varied through several different periods. After declining between 1984 and 1988, it increased to the record level of 145 t in 1994 (Figure 3-10a). Subsequently, it has shown a long-term decline to the lowest annual catch of 40.4 t in 2018.

Targeted hand line catch largely accounted for the variation in total catch, being highest between 1992 and 1995 before declining to 38 t in 2005 (Figure 3-10b). It increased again to 2010, but has subsequently declined to the lowest level of 30 t in 2018. Hand line fishing effort reached its highest level of 7,038 fisher-days in 1992 (Figure 3-10c). It subsequently declined by 55.3% to 3,188 fisher-days in 2000. Since then it has further declined to 1,882 fisher-days in 2018, the lowest targeted effort level yet recorded. Between 1984 and 2007, hand line CPUE was variable but nevertheless increased by 60.4% from 9.6 to 15.4 kg.fisher-day^{-1} (Figure 3-10d). Over the following five years, it declined by 17.5% to the low value of 12.7 kg.fisherday^{-1} in 2012. It has subsequently increased by 23.6% over several years to 15.7 kg.fisherday^{-1} in 2018, the highest yet recorded. The numbers of licence holders who captured or targeted King George Whiting with handlines have declined considerably. In 1984, a total of 128 fishers took King George Whiting, which fell to 46 in 2018 (Figure 3-10e). The numbers who targeted this species with handlines fell from 125 to 37 over the same period.

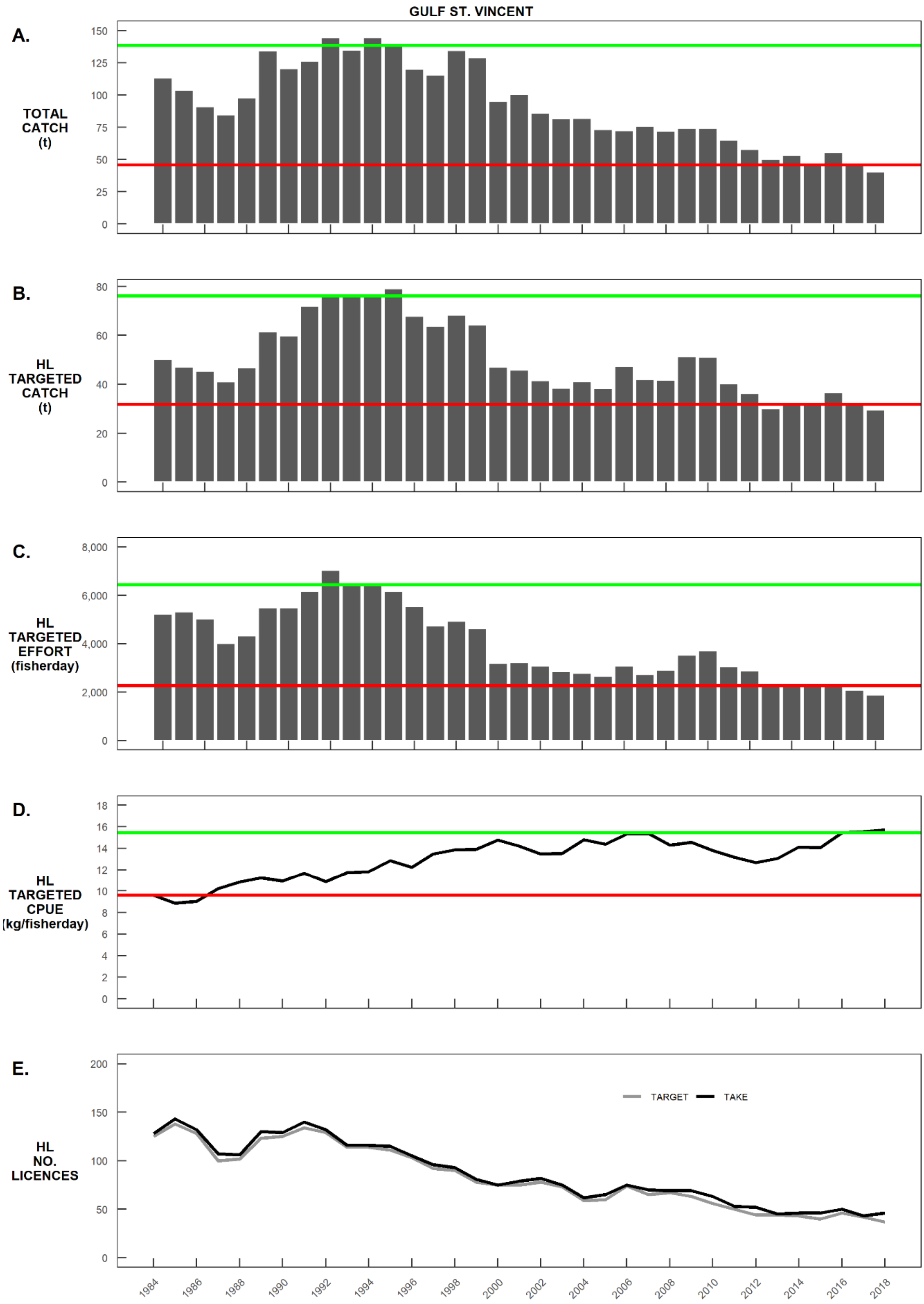

Figure 3-10. Key fishery statistics used to inform the status of the GSV/KI stock of King George Whiting. Long-term trends in (A) total catch; (B) targeted hand line catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-5.

Fishery Performance

The catch data from the three commercial fisheries from 2018 were compared against their allocations using Triggers 2 and 3 as reference points. No trigger reference points were exceeded (Table 3-4).

Table 3-4. Comparisons of percentages of commercial catch of King George Whiting taken by the fisheries, with their allocations and trigger limits specified in the Management Plan (PIRSA 2013). MSF – Marine Scalefish, SZRL – Southern Zone Rock Lobster, NZRL – Northern Zone Rock Lobster. Green colour – allocation not exceeded, red colour – allocation trigger activated.

COMMERCIAL ALLOCATION	MSF 98.10%	SZRL n/a	NZRLF 1.90%
TRIGGER 2	n/a	0.50%	2.97%
TRIGGER 3	n/a	0.75%	3.96%
2014	98.90%	0.00%	1.10%
2015	98.78%	0.00%	1.22%
2016	99.36%	0.00%	0.64%
2017	99.10%	0.00%	0.90%
2018	98.60%	0.00%	1.39%

The general fishery performance indicators were assessed against trigger reference points at the State-level and for each of the three stocks. There were 11 breaches of trigger reference points that were quite consistent at the two spatial scales (Table 3-5). For each stock, and as such also at the State-wide scale, the lowest or second lowest total catches were recorded. Similarly, the lowest or 2nd lowest targeted hand line fishing effort levels were recorded. Finally, for both the WCS and the GSV/KIS the highest hand line CPUE was recorded. Hand line CPUE was also high for the SGS, but it fell outside the range of the top three.

Table 3-5. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the biological stock level for King George Whiting.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE	WC	SG	GSV/KI
TOTAL CATCH	G	3rd Lowest / 3rd Highest	2nd LOWEST	2nd LOWEST	2nd LOWEST	LOWEST
	G	Greatest % interannual change (+/-)	×	×	×	×
	G	Greatest 5 year trend	×	×	×	×
	G	Decrease over 5 consecutive years	×	×	×	×
TARGET HANDLINE EFFORT	G	3rd Lowest / 3rd Highest	LOWEST	2nd LOWEST	2nd LOWEST	LOWEST
	G	Greatest % interannual change (+/-)	×	×	×	×
	G	Greatest 5 year trend	×	×	×	×
	G	Decrease over 5 consecutive years	×	×	×	×
TARGET HANDLINE CPUE	G	3rd Lowest / 3rd Highest	2nd HIGHEST	HIGHEST	×	HIGHEST
	G	Greatest % interannual change (+/-)	×	×	×	×
	G	Greatest 5 year trend	×	×	×	×
	G	Decrease over 5 consecutive years	×	×	×	×

Stock Status

West Coast Stock

This stock includes the populations of King George Whiting that inhabit all the bays and offshore areas of the west coast of Eyre Peninsula. In recent years, it has been consistently classified as sustainable (Fowler et al. 2014, Steer et al. 2018a, b). Between 2002 and 2013, total catch from this stock gradually increased by 27.5%. Nevertheless, between 2013 and 2018 it dropped by 32.6%. Hand line effort shows a long-term decreasing trend, consistent with the declining numbers of fishers taking and targeting this species. However, between 2013 and 2018, the rate of decline increased considerably during which it fell by 32.6%. Hand line CPUE increased by 53.2% between 2002 and 2009. Between 2009 and 2018, it has remained in the high range of 20 – 25 kg.fisher-day^{-1}, and the value of 25.7 kg.fisher-day^{-1} in 2018 was the highest yet recorded. Outputs from the stock assessment model (WhitEst) that was last run in 2017, showed that fishable biomass had gradually increased over time, particularly through the two periods of 1984 to 1999 and 2008 to 2016 (Steer et al. 2018a). This general increasing trend in biomass reflected a long-term increasing trend in recruitment and long-term declining exploitation rate associated with the declining fishing effort relating to the declining numbers of commercial fishers (Steer et al. 2018a).

The levels of catch and effort for this stock have declined since 2013, particularly in 2016 and 2017. These are relatable to reductions in the numbers of commercial fishers. Nevertheless, there is no indication in the estimates of handline CPUE up to 2018 and estimates of fishable biomass, recruitment and exploitation rate up to 2016 (Steer et al. 2018), to suggest that the biomass has been depleted and that recruitment is likely to be impaired. As such, the classification of **sustainable** for this stock is retained.

Spencer Gulf Stock

This stock extends throughout the entire northern and southern regions of Spencer Gulf. Throughout the 2000s, total catch and effort have been low relative to the high levels recorded through the 1980s and 1990s (Fowler et al. 2014, Steer et al. 2018a,b). Also, handline CPUE has varied cyclically over time, but nevertheless has demonstrated a long-term increasing trend. However, between 2007 and 2014, catch effort and CPUE all declined contemporaneously (Fowler et al. 2014). The estimates of biomass from the stock assessment model also declined through this period reflecting a significant decline in recruitment. As such, on the basis of these negative fishery performance indicators, this stock was classified as 'transitional depleting' (Fowler et al. 2014). This prompted a review of the fishery management arrangements that resulted in changes to the management regime that were implemented in December 2016.

Between 2013 and 2017, there were notable increases in the commercial fishery statistics. Over this period, total catch increased by 41.2%, handline effort by 29.7% and handline CPUE by 20.2%. Furthermore, the output from the stock assessment model indicated that from 2013 to 2016, there was an upward trend in recruitment that resulted in an 11.3% increase in fishable biomass (Steer et al. 2018a). Such variable biomass appears typical for this stock, which is evident as cyclical variation in the fishery statistics. It suggests that the population is subject to inter-annual variation in recruitment that impacts on population biomass and fishery productivity over cycles that last a number of years. The fishery statistics to 2017 and outputs from the fishery assessment model to 2016 were not consistent with the biomass at that time being depleted and moving the stock in the direction of being recruitment impaired (Steer et al. 2018b). Rather, they suggested that the biomass had recovered to a level sufficient to ensure that future recruitment was adequate. As such, in that year the stock classification of 'sustainable' was retained. In 2018, there were marginal reductions in total catch, handline catch and CPUE. This brought the catch and effort to near record low levels. Nevertheless, these declines since 2016 are not sufficient to warrant a downgrade in stock status, since handline CPUE remained relatively high. As such, here the stock classification remains at **sustainable**.

Gulf St. Vincent/Kangaroo Island Stock

The GSV/KIS occurs throughout Gulf St. Vincent, Investigator Strait and the waters surrounding Kangaroo Island. The recent stock assessments completed in 2014 and 2017 showed that commercial catch and effort for this stock were considerably lower during the 2000s compared to the 1990s, consistent with a long-term decline in the number of fishers participating in the fishery (Fowler et al. 2014, Steer et al. 2018). In particular, between 2009 and 2013, there were considerable declines in commercial catch and effort (Steer et al.

2018a). Whilst CPUE had shown a long-term increasing trend between 1984 and 2007, this was followed by a period of consistent decline between 2007 and 2012, during which it fell by 17.5%. Consequently, estimates of biomass for the period of 2007 to 2012 from the stock assessment model showed a considerable decline of 11.7% (Steer et al. 2018a). This related to a period of declining recruitment. Based on these fishery performance indicators, the fishery was classified as 'transitional depleting' (Fowler et al. 2014). This, in association with the stock status assigned to the SGS, prompted a review of fishery management arrangements that resulted in the changes that were implemented in December 2016.

For the GSVS since 2013, total catch, hand line catch and hand line effort have been relatively stable. However, in 2016, 2017 and 2018, hand line CPUE was over 20% higher than the low level in 2012. The estimates of CPUE in these three years are the highest ever recorded for consecutive years. In the recent years leading up to 2016, estimates of biomass from the stock assessment model had stabilised, relating to a trend of increasing recruitment (Steer et al. 2018a). Overall, the recent estimates of fishery performance indicators indicate that the biomass of this stock is now unlikely to be depleted and that recruitment is unlikely to be impaired. As such, the status of this stock is maintained at **sustainable**.

3.3.3. SOUTHERN GARFISH

Biology

Southern Garfish (*Hyporhamphus melanochir*) are distributed from Shark Bay in Western Australia, along the southern coast of Australia including Tasmanian waters, and as far east as Eden in New South Wales (Kailola 1993, Noell and Ye 2008). The species forms schools in sheltered bays and shallow, inshore, marine waters to depths of ~20 m. They are particularly abundant throughout the gulf regions of South Australia.

Southern Garfish have an extended spawning season that spans approximately six months from October to March. Within this season only a small proportion (10–20%) of the population are in spawning condition at any given time (Giannoni 2013) indicating that reproductive activity is asynchronous with small pulses of spawning activity. The estimated size at maturity ($L_{50\%}$) for female Southern Garfish in South Australia is 215 mm TL, which is equivalent to the mean age of 17.5 months (Ye et al. 2002).

During the 1990s, a total of 2,079 Southern Garfish from commercial catches in South Australia were aged for a study on age and growth (Ye et al. 2002). There were seven age classes (0+ to 6+ years) that contributed to the commercial catches; however, the catches were dominated (89%) by one- and two-year-old fish. Less than 2% were from 4+ to 6+ age classes. A more recent study, which compared the size and age structures of the fishery with that of the 1950s, indicated that historically the fishery was once dominated by 4+ and 5+ year olds, but the age structure has become considerably truncated to consist of primarily one- and two-year-olds (Fowler and Ling 2010).

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 integration 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 Garfish that had spent significant parts of their lives in different environments and that there was some level of restriction that prevented complete mixing among the regions (Steer et al. 2009b, 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. The remaining two, however, were less distinct: Northern Gulf St. Vincent and Southern Gulf St. Vincent, but demonstrated a level of population structuring requiring them to be considered as separate as a precautionary management measure. A concurrent study examining the spatial variation in parasite abundance in Southern Garfish inferred a similar population structure (Hutson et al. 2011). This level of 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.

Fishery

Southern Garfish is a significant inshore fishery species of southern Australia, with fisheries also existing in Victoria, Tasmania, South Australia and Western Australia. Historically, the national commercial catch for this species has been dominated by that from South Australia where the catch has usually exceeded 400 t per annum, with an approximate value of $1.8 M (Econsearch 2014). This species is also a popular target amongst South Australian recreational anglers (Jones 2009).

In South Australia, licence holders from four different commercial fisheries have access to Southern Garfish. These are the Marine Scalefish Fishery, Northern Zone Rock Lobster Fishery, Southern Zone Rock Lobster Fishery, and Lakes and Coorong Fishery. The Southern Garfish fishery is principally located in Spencer Gulf and Gulf St. Vincent and managed as part of the multi-species, multi-gear MSF through a series of input and output controls. Commercial fishers typically target Southern Garfish using hauling nets and dab nets. Hauling net fishers account for the majority (~90%) of the commercial catch even though their fishing activities are restricted by regulation to waters <5 m deep.

Recreational fishers are permitted to use dab nets but predominantly use traditional hook and line as they fish from boats and shore-based platforms throughout the State. In 2013/14, this sector took an estimated 870,147 Southern Garfish, equating to an estimated catch of 79.2 t (Giri and Hall 2015).

Management Regulations

The commercial MSF has undergone considerable management changes over the past 40 years that has seen the fishery restructured and limited through gear restrictions and configuration, licensing, spatial and temporal closures, and size limits. Although most of these management changes have been generic in nature there have been a few that have largely impacted the Southern Garfish fishery. The most notable of these have been a series of net fishing spatial closures. Areas closed to netting were first implemented on the West Coast in 1958 and were subsequently followed by a depth-delimited ban in the early 1970s when net fishers were restricted to operate in coastal waters <5 m deep. Further netting closures were implemented in 1983, 1994, 1995, 1997 and 2005. In addition, deep water netting exemptions for a few commercial operators were revoked in 2006. These closures have significantly restricted the commercial Southern Garfish hauling net fishers to relatively small areas within the northern gulfs. Currently, it is estimated that net fishers in Northern Gulf St. Vincent have access to 465 km^2 of fishable area, which is approximately 55% less than the 1,028 km^2 available in Northern Spencer Gulf (Steer et. al. 2015).

In 2001, the legal minimum length (LML) for Southern Garfish was increased from 210 mm to 230 mm TL. This increase was made to ensure that at least 50% of Southern Garfish at that size would be reproductively mature and therefore had the opportunity to spawn at least once (Ye et al. 2002). Despite this increase, no corresponding changes to the mesh size regulations for hauling nets were implemented. Reductions in the recreational bag and boat limits were also implemented in 2001.

A specific harvest strategy for Southern Garfish was developed as part of the Management Plan for the South Australian Commercial Marine Scalefish Fishery, which was released in October 2013 (PIRSA 2013). Although no specific management arrangements were prescribed in the Management Plan to achieve these targets, a range of tools were identified and an adaptive management approach outlined to consider the management arrangements needed to meet the targets over time. These included gear modifications, spatial and temporal closures, and effort/catch management (PIRSA 2013). Through collaborative research and consultation amongst PIRSA, SARDI and the commercial fishing industry, it was agreed that a combination of effort and gear-based management strategies should be adopted to reach the operational targets. Furthermore, it was agreed that these strategies should be dynamic and altered in response to the status of the fishery. Initially, two 20-day seasonal closures that alternated between the gulfs were implemented in 2012. The duration of these closures were subsequently increased to 38 days in 2013, 40 days in 2014, 60 days in 2016, and 80 days in 2018 for Gulf St. Vincent. Similarly, the minimum regulated mesh size of the pocket component of the hauling nets was sequentially increased from 30 mm to 32 mm in 2013 and to 35 mm in 2017. Furthermore, the LML of Southern Garfish for commercial fishers was increased from 230 mm to 250 mm in 2015. In 2016, the recreational bag and limit of Southern Garfish was halved from 60 and 180 fish to 30 and 90 fish. The LML, for recreational fishers, remains at 230 mm.

Commercial Fishery Statistics

State-wide

The total commercial catch of Southern Garfish was 176.2 t in 2018 (*c.f.* 183.5 t in 2017) (Figure 3-11a). The 2018 season was the third consecutive year with total catches below 200 t, and was the third lowest recorded since 1984. The economic value of the commercial catch of Southern Garfish in 2018 was approximately $ 1.7 M (*c.f.* $ 1.8 M in 2017) (Figure 3-11a).

The hauling net sector has accounted for ~90% of the State-wide harvest since 1984 (Figure 3-11a). Catches in this sector varied between 325 t and 500 t from 1984 to 2002, averaging

413 $t.yr^{-1}$, before declining to ~130 $t.yr^{-1}$ in 2016. The dab net sector accounts for most of the remaining catch (~10%). This sector yielded higher than average catches throughout the 1990s (~62 $t.yr^{-1}$) compared to the last decade when catches rarely exceeded 30 $t.yr^{-1}$ (Figure 3-11a).

Combined fishing effort for Southern Garfish for the hauling net and dab net sectors has steadily declined from a peak of 17,776 fisher-days in 1984 to a low of 4,770 fisher-days in 2012 (Figure 3-11b). This represents a 73.2% decrease over 28 years declining at a rate of 474 $fisher\text{-}days.year^{-1}$. This decline can largely be attributed to a consistent reduction in hauling net effort. Since then fishing effort has slightly increased to 4,816 fisher-days in 2018 (*c.f.* 4,933 fisher-days in 2017). This trend was consistent for haul net and dabbing gear types.

Catch rates of Southern Garfish remained relatively high in the hauling net sector from 2005 to 2014 averaging 55.5 $kg.fisherday^{-1}$, which was 11.1 $kg.fisherday^{-1}$ more than the average catch rates of the preceding decade (Figure 3-11c). Catch rate for non-target hauling net effort has since declined to 36.4 and 36.2 $kg.fisherday^{-1}$ in 2017 and 2018. Dab net catch rates displayed a long-term increasing trend from 1984 to 2002, rising from 20.2 $kg.fisherday^{-1}$ in 1984 to a peak of 58.6 $kg.fisherday^{-1}$ in 2001 (Figure 3-11c). This increase was not sustained as it dropped to 31.9 $kg.fisherday^{-1}$ in 2007. Catch rates in the dab net sector since 2014 have ranged between 37.7 and 40.9 $kg.fisherday^{-1}$. In 2018, the catch rate of 37.7 $kg.fisherday^{-1}$was similar to the 15 year average (38.7 $kg.fisherday^{-1}$).

Two management strategies have reduced the number of licence holders in South Australia's MSF. The first was the licence amalgamation scheme implemented in 1994, which has contributed significantly to the long-term decline in the number of commercial fishers who land Southern Garfish. The second was the 2005 net buy-back. These two strategies have contributed to the 57% reduction in the number of commercial fishers landing Southern Garfish from 1995 to 2011 (Figure 3-11d). The relative proportion of commercial fishers that nominated Southern Garfish as their specific target has remained relatively consistent at 75% of fishers landing Southern Garfish throughout the last 20 years.

Regional

Most of the State-wide catch of Southern Garfish has historically been landed in the NGSV and NSG (Figure 3-12a, b). Catches from the WC, SSG and SGSV were considerably reduced from 2005 onwards as a result of the implementation of a suite of netting closures.

From 1984 to 1999, most Southern Garfish were landed during autumn (Figure 3-12c). This was followed by two years during which high catches uncharacteristically peaked in mid-winter (July/August). Since then, overall monthly catches have declined considerably from the regular 40 t harvests during autumn, to 10 t to 30 t monthly catches spread from January to August (Figure 3-12c).

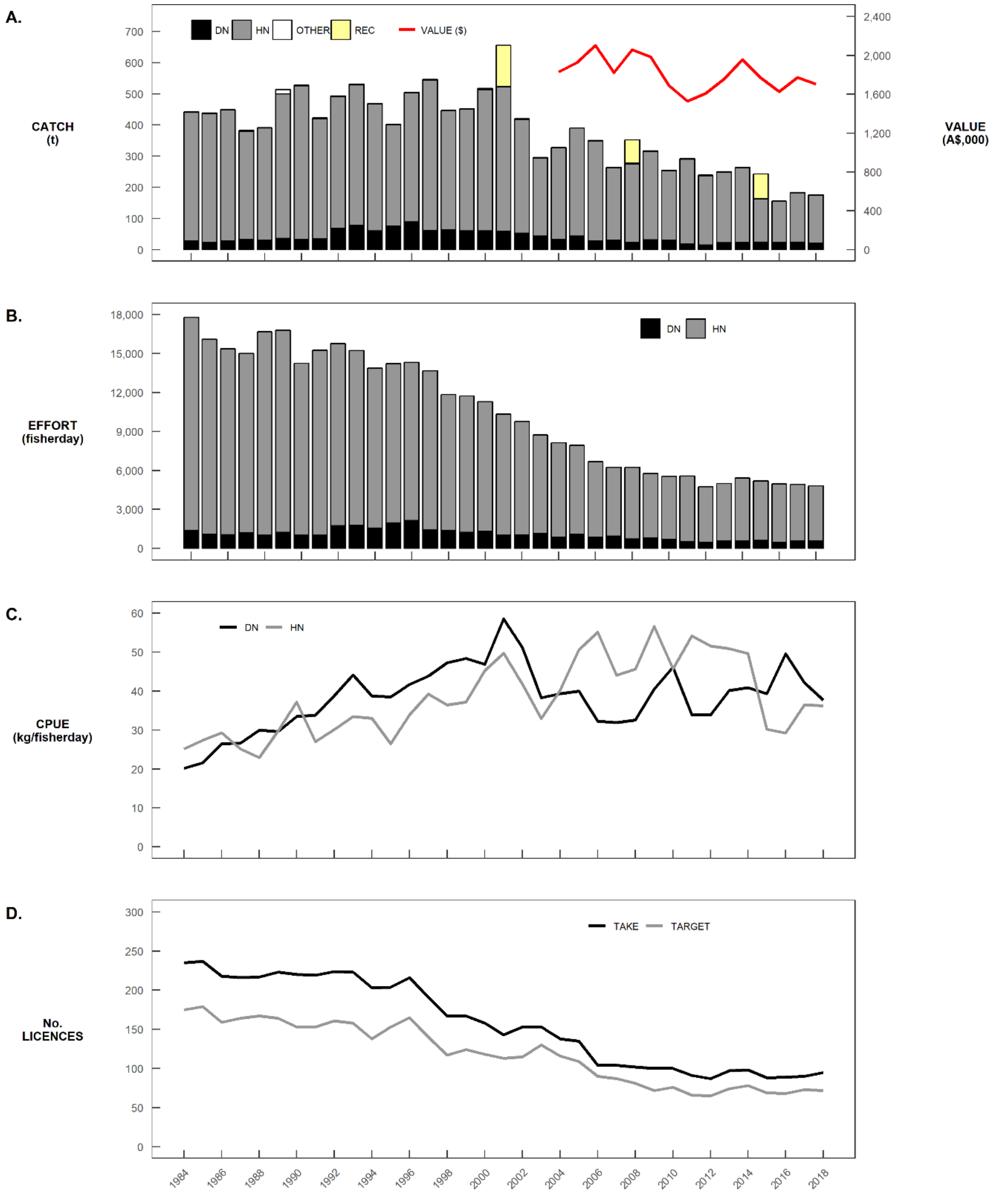

Figure 3-11. Southern Garfish. (A) Catch distribution for 2018; Long-term trends in: (B) total catch for the main gear types (hauling and dab nets) and gross production value; (C) Long-term total effort for hauling and dab nets; (D) total catch per unit effort for hauling and dab nets; and (E) the number of active licence holders taking or targeting the species.

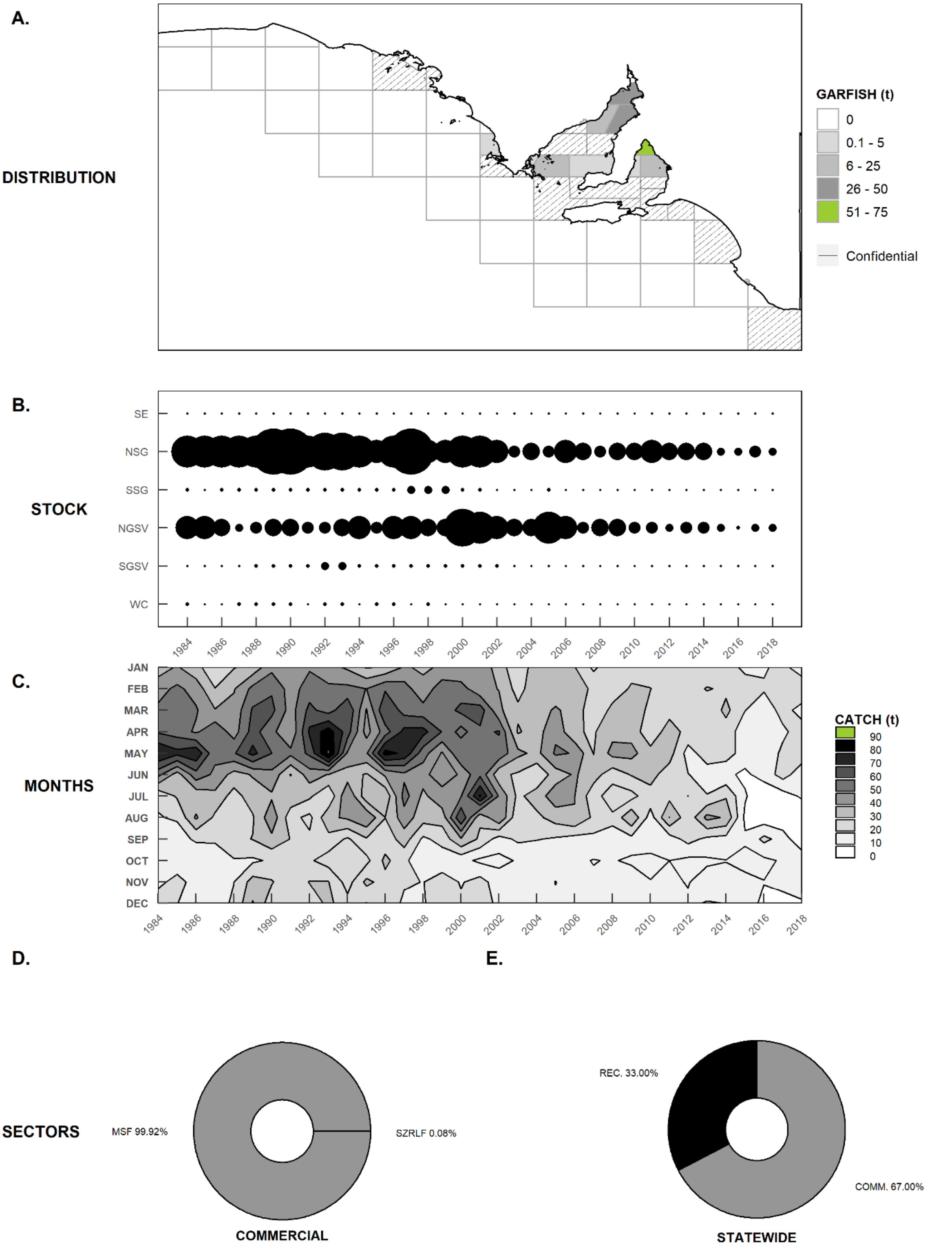

Figure 3-12. Southern Garfish. Long-term trends in the annual distribution of catch among biological stocks (A) and months of the year (B). The proportion of catch distributed among the commercial sector in 2018 (C); and among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015) (D).

West Coast

From 1984 to 1999, the annual commercial catch of Southern Garfish from the West Coast accounted for approximately 7% of the State's catch. This has since declined to 1.3 t or 0.8% of the state catch in 2018, which is equivalent to the lowest catch recorded. This has been driven by a continuous reduction in hauling net effort through the implementation of commercial netting restrictions (Figure 3-13b). Annual Southern Garfish catch peaked at 37.2 t in 1992 of which hauling net sector landed 86% (Figure 3-13a). Over the past three years, catches have remained below 5 t, falling to the lowest recorded level of 1.3 t in 2013, before increasing by to 4.4 t in 2015. Total fishing effort has declined 92% since 1984, with fishers expending 36 days catching Southern Garfish in 2018, compared to 79–107 days in the past 5 years. Dab nets emerged as the dominant gear type in 2006, and in 2018 this sector accounted for all of the targeted catch in this region (Figure 3-13f). The targeted catch rates in the hauling net sector peaked at 77.1 kg.fisher-days^{-1} in 1999 (Figure 3-13d). Since 2005, less than five hauling net fishers have operated in this region per year (Figure 3-13e). Targeted catch rates in the dab net sector ranged from 16.7–62.2 kg.fisher-days^{-1}, with the most recent estimate for 2018 representing the highest on record (Figure 3-13h).

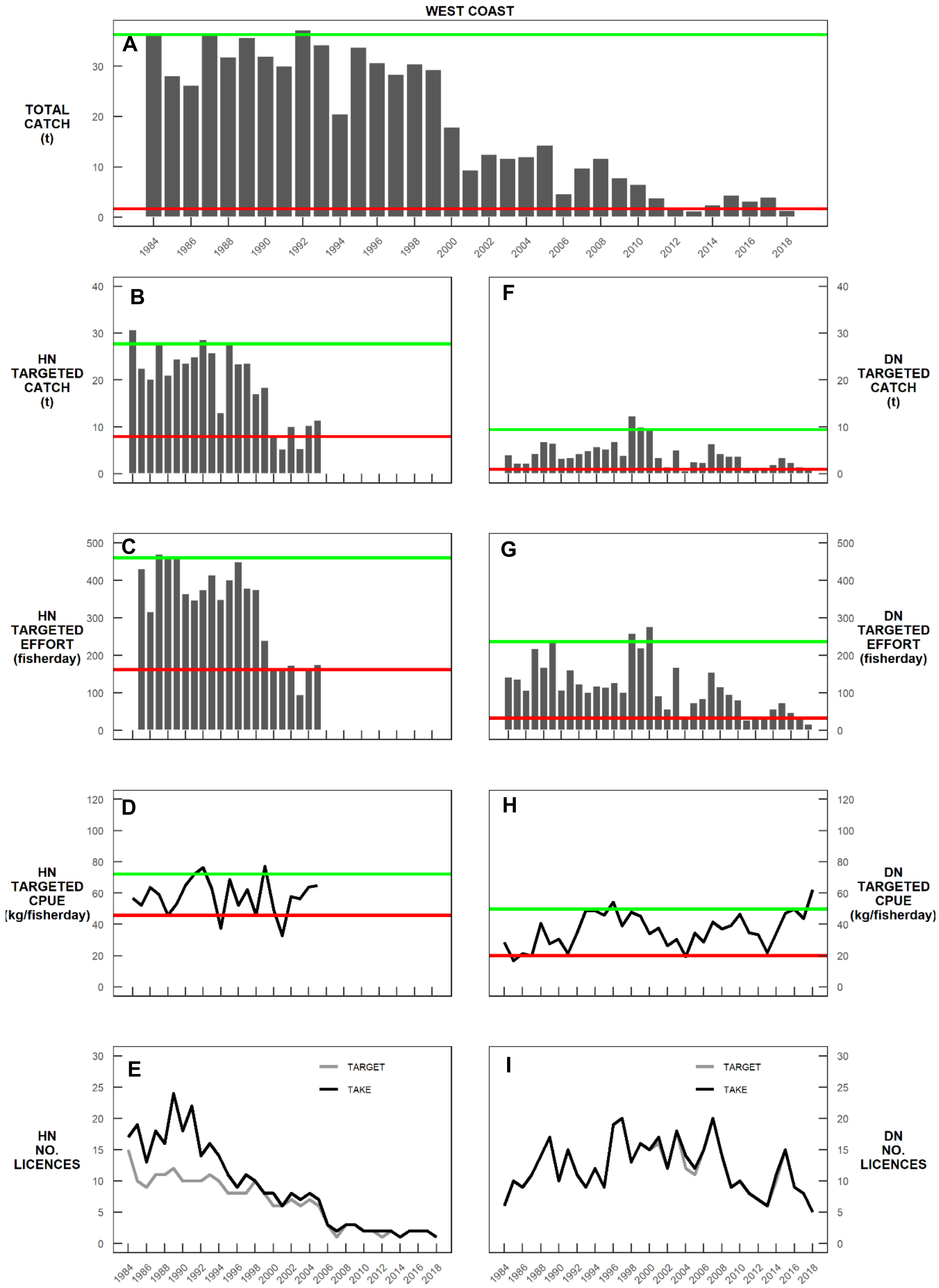

Figure 3-13. Key fishery statistics used to inform the status of the West Coast stock of Southern Garfish. (Left) Trends in total catch, hauling net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with hauling nets. (Right) Trends in total effort; dab net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with dab nets. Green and red lines represent the upper and lower trigger reference points outlined in Section 1.5.

Northern Spencer Gulf

Northern Spencer Gulf has been the most productive fishing ground for Southern Garfish in South Australia since 1984. The highest recorded catch was 271.4 t in 1990 and the lowest 78.4 t in 2015 (Figure 3-14a). There was a relatively rapid decline in catch from 1997 to 2003, during which it dropped 61% from 250 t to 98 t. Annual catches exceeded 160 t twice since 2003 (2006 and 2011) and remained relatively stable between 142 and 150 t from 2012 to 2014, before decreasing below 100 t from 2015 onwards. The total catch of Garfish in northern Spencer Gulf was 85.3 t in 2018.

There has been a long-term trend of decreasing fishing effort in this region, declining from a peak of 7,500 fisher-days in 1988 to 2,129 fisher-days in 2012, at ~215 fisher-days.yr^{-1}. This trend has been driven by the hauling net sector, which has consistently contributed to >95% of the fishing activity (Figure 3-14c). Catch rates for target hauling net fishers trended upwards from 2003 rising from 44.7 kg.$fisherday^{-1}$ to 129.9 kg.$fisherday^{-1}$ in 2012, representing a 190% increase over nine years (Figure 3-14d). Catch rates subsequently fell from 101.8 kg.fisher-$days^{-1}$ in 2014 to 51.6 kg.fisher-$days^{-1}$ in 2018 (Figure 3-14d). Few dab net fishers (<13) have historically targeted Southern Garfish in this region each year, catching on average 36 kg.$fisherday^{-1}$ (Figure 3-14e).

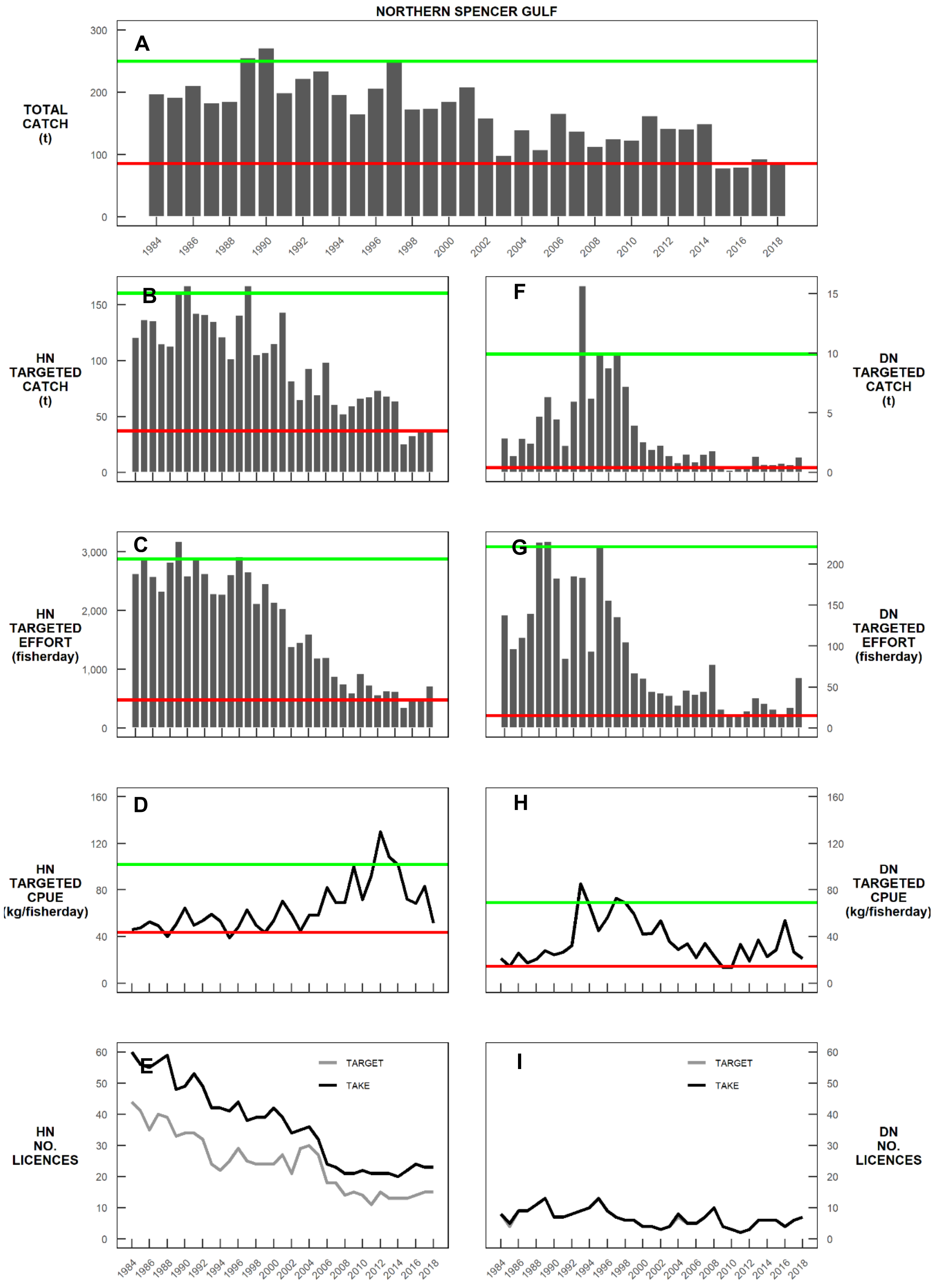

Figure 3-14. Key fishery statistics used to inform the status of the Northern Spencer Gulf stock of Southern Garfish. (Left) Trends in total catch, hauling net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with hauling nets. (Right) Trends in total effort; dab net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with dab nets. Green and red lines represent the upper and lower trigger reference points outlined in

Southern Spencer Gulf

Large areas of Southern Spencer Gulf have been closed to commercial hauling net fishing since 2005, and as a result the relative contribution of this region to the State-wide catch has decreased from ~10% up to 2005 to 3% over the past decade (Figure 3-15a). Approximately half of the hauling net fishers who operated in this region specifically targeted Southern Garfish. This sector historically accounted for ~30% of the total catch of the species, which peaked at 71.2 t in 1998. However, it has been reduced through spatial restrictions imposed in 2005 and is now almost exclusively fished by the dab net sector.

Total catch of Southern Garfish in this region ranged between 9.3 and 12.4 t in the past 5 years (Figure 3-15a). Total catch was 10.8 t in 2018 (*c.f.* 9.9 t in 2017).

Targeted dab net effort remained relatively stable at ~121 fisher-days from 2011 to 2014, before increasing to reach a peak of 237 fisher-days in 2015, before declining slightly to 228 fisher-days in 2018 (Figure 3-15f).

Targeted dab net CPUE peaked at 55.6 kg.fisher-days^{-1} in 2010, dropping to 38.5 kg.fisher-days^{-1} in 2012 before returning to 41.6 kg.fisher-days^{-1} in 2018 (Figure 3-15h). Most dab netters specifically record Southern Garfish as their target species (Figure 3-15i).

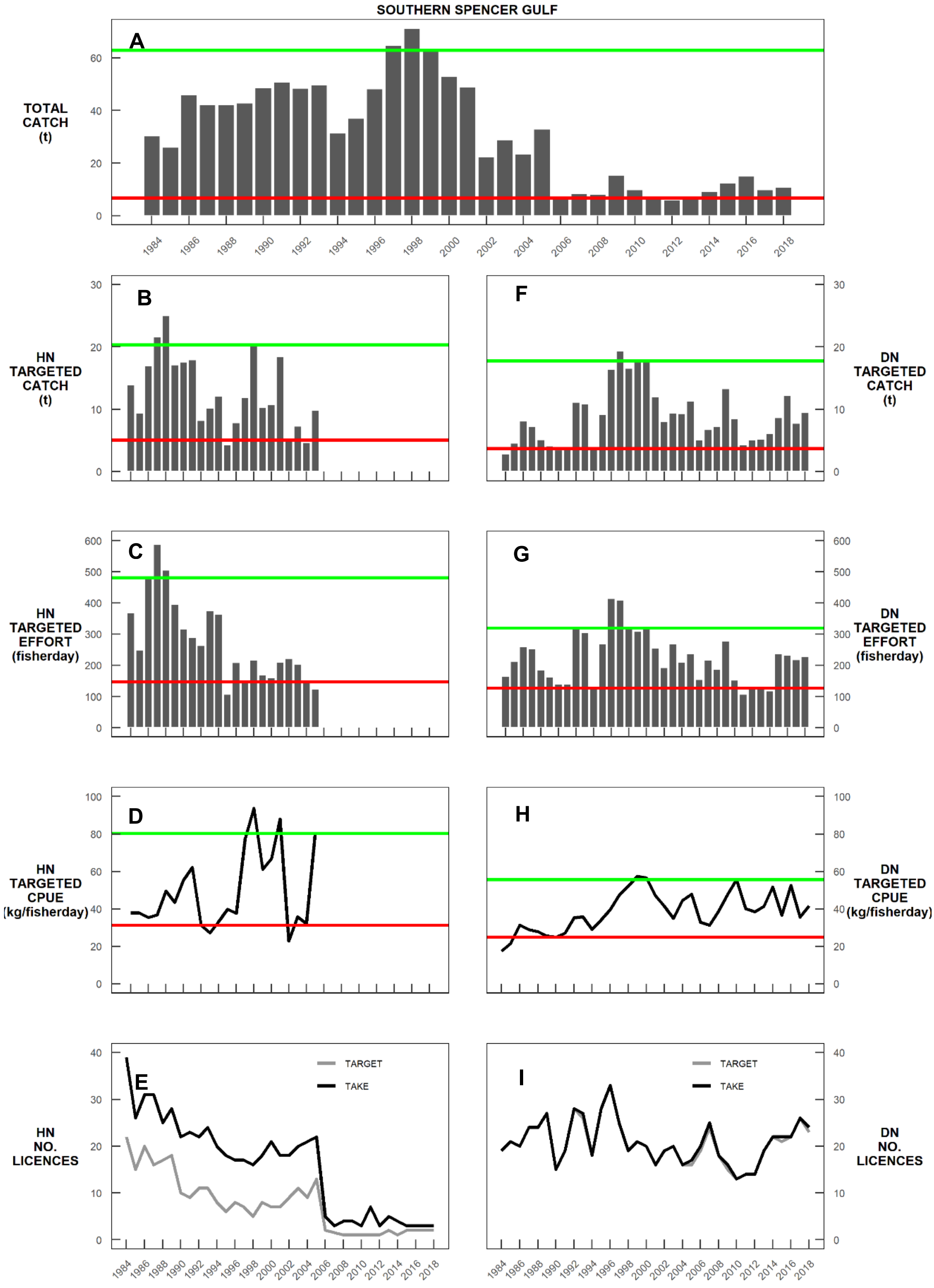

Figure 3-15. Key fishery statistics used to inform the status of the Southern Spencer Gulf stock of Southern Garfish. (Left) Trends in total catch, hauling net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with hauling nets. (Right) Trends in total effort; dab net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with dab nets. Green and red lines represent the upper and lower trigger reference points outlined in Section 1.5.

Northern Gulf St. Vincent

Northern Gulf St. Vincent is the second-most productive commercial fishing region in South Australia for Garfish. Annual catches of Garfish were > 200 t twice in the past 31 years; 221.4 t in 2000 and 209.6 t in 2005, before declining to a record low of 53.4 t in 2016. Catches then stabilised at low levels of 67.7 t in 2017 and 73.1 t in 2018 (Figure 3-16a). This represents a 22% decline over the past 5 years, which corresponds with decreases in hauling net targeted effort, and overall declines in targeted CPUE from 110 to 53 kg.fisher-day^{-1} (Figure 3-16d).

Conversely, levels of annual targeted catch and effort in the dab net sector have increased and were > 5 t and 115 fisher-days over the past five years, respectively (Figures 3-16f, g). This level of dab net activity has not occurred since 2006. Targeted catch rates in this sector were 41 to 45 kg.fisher-days^{-1}) between 2014 and 2016, and then decreased to 35.8 kg.fisher-days^{-1} in 2018 (Figure 3-16h).

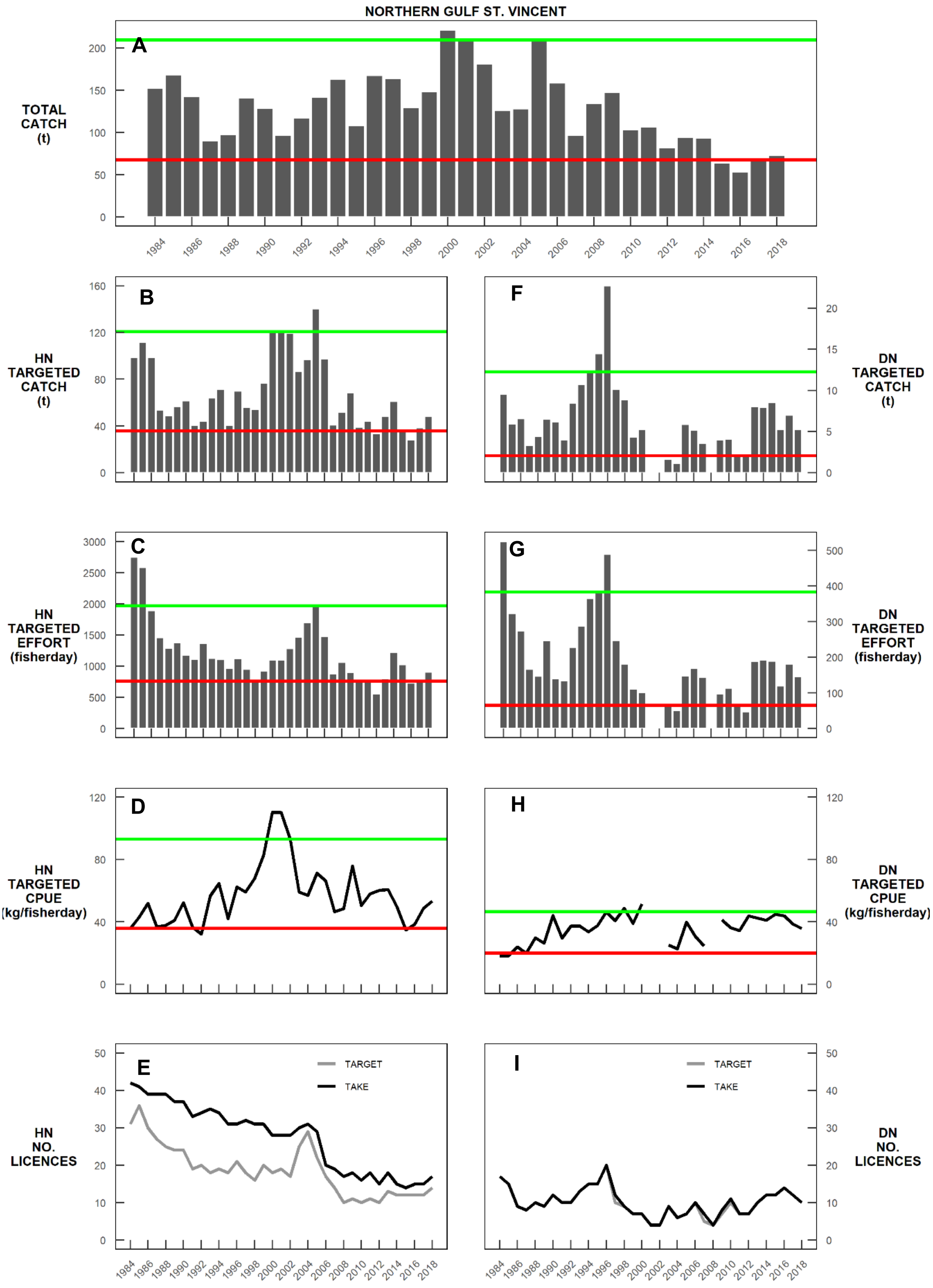

Figure 3-16. Key fishery statistics used to inform the status of the Northern Gulf St. Vincent stock of Southern Garfish. (Left) Trends in total catch, hauling net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with hauling nets. (Right) Trends in total effort; dab net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with dab nets. Green and red lines represent the upper and lower trigger reference points outlined in Section 1.5.

Southern Gulf St. Vincent Stock

The relative contribution of the commercial Southern Garfish catch from this region to the annual State-wide total has rarely exceeded 10%. Annual catches steadily increased from 24 t in 1984 to 70 t in 1993 with both the hauling net and dab net sectors contributing equally (Figure 3-17a). From 1993, the contribution of Southern Garfish catch by the hauling net sector declined in line with steady reductions in effort (Figure 3-17b). From 2005 onwards the dab net sector accounted for >75% of annual commercial fishing effort in Southern Gulf St. Vincent as the implementation of netting restrictions virtually removed all hauling net activity from the region. Targeted dab net effort declined from 558 fisher-days in 2005 to a record low of 39 fisher-days in both 2015 and 2016. In 2017, targeted dab net catches increased to 7.1 t, before decreasing to 4.1 t in 2018 (Figures 3-17f, g). Catch rates in the dab net sector fluctuated between 42.7 and 70.03 kg.fisher-days^{-1}, with the overall mean target dab netting CPUE for the region equalling 42.9 kg.fisher-days^{-1} (Figure 3-17h).

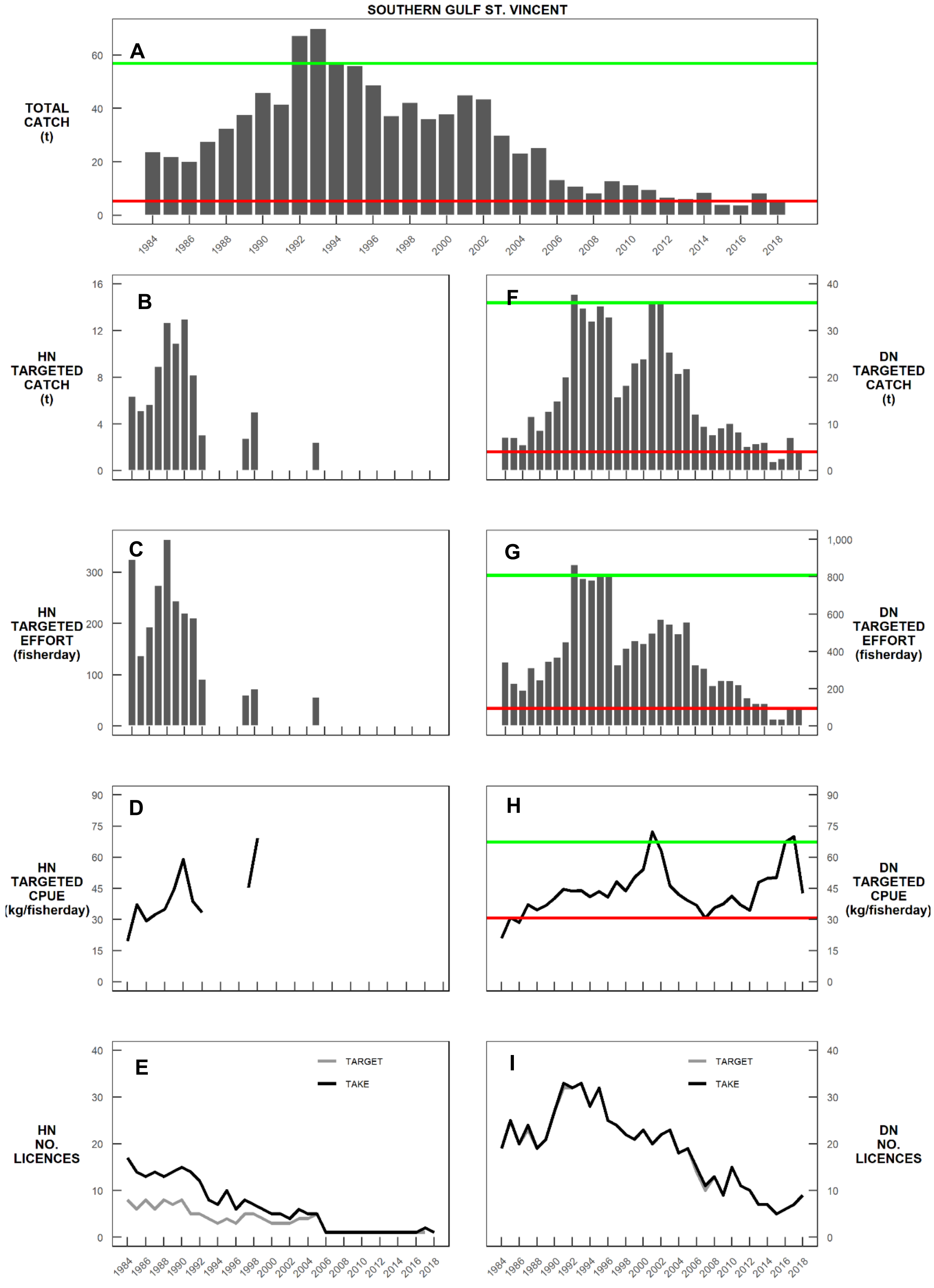

Figure 3-17. Key fishery statistics used to inform the status of the Southern Gulf St. Vincent stock of Southern Garfish. (Left) Trends in total catch, hauling net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with hauling nets. (Right) Trends in total effort; dab net targeted catch, effort and catch rates (CPUE); The number of active licence holders taking or targeting Southern Garfish with dab nets. Green and red lines represent the upper and lower trigger reference points outlined in Table 3-7.

South East

A negligible amount of Southern Garfish is landed by the commercial sector in the South East, with only 10.6 t landed in the region across the 35 year time-series. Total catch and effort has remained below 500 kg and 25 fisher-days per year since 2004, respectively (Figure 3-18).

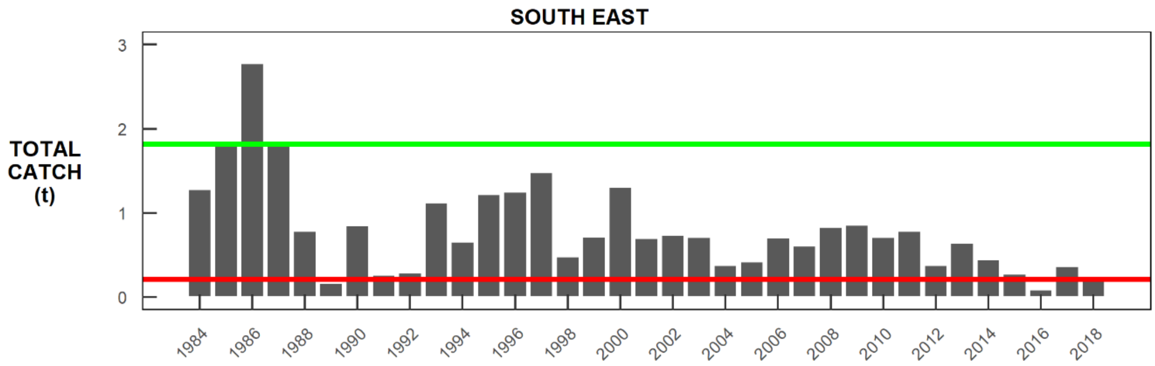

Figure 3-18. Key fishery statistics used to inform the status of the South Eastern stock of Southern Garfish. (Left) Trends in total catch; (Right) Trends in total effort. Green and red lines represent the upper and lower trigger reference points outlined in Table 3-7.

Fishery Performance

The relative contributions to the total State-wide catch from the three commercial fisheries have been relatively stable over the past five years. In 2018, neither Trigger 2 nor Trigger 3 was breached (Table 3-6). One minor exception was the SZRLF which exceeded 0.2% in 2013, however, it was not large enough to breach the prescribed trigger limit.

The general performance indicators were assessed at the biological stock level. There were 7 breaches of trigger reference points across the six stocks (Table 3-7). In 2018, low catches breached the lower limit reference points on the WC and in SGSV. NGSV also recorded the lowest estimates of target hauling net effort in 2018 and it decreased over 5 consecutive years. Dab net effort was the second lowest level recorded on the WC and in SGSV. Dab net CPUE was the highest on the WC.

Table 3-6. Results from consideration of commercial catches of Southern Garfish by fishery against their allocation percentages and trigger reference points. MSF = Marine Scalefish, SZRL = Southern Zone Rock Lobster, NZRL = Northern Zone Rock Lobster. Green colour – allocation not exceeded, red colour – allocation trigger activated.

COMMERCIAL ALLOCATION	MSF 99.79%	SZRL 0.16%	NZRLF 0.05%
TRIGGER 2	n/a	0.75%	0.75%
TRIGGER 3	n/a	1.00%	1.00%
2013	99.72%	0.25%	0.03%
2014	99.89%	0.11%	0.01%
2015	99.89%	0.11%	0.00%
2016	99.95%	0.03%	0.02%
2017	99.81%	0.19%	0.00%
2018	99.92%	0.08%	0.01%

Table 3-7. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the biological stock spatial scales for Southern Garfish.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	WC	NSG	SSG	NGSV	SGSV	SE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	2nd LOWEST	×	×	×	3rd LOWEST	
	G	Greatest % interannual change (+/-)	×	×	×	×	×	
	G	Greatest 5 year trend	×	×	×	×	×	
	G	Decrease over 5 consecutive years	×	×	×	×	×	
TARGET HAULING NET EFFORT	G	3rd Lowest / 3rd Highest		×		LOWEST		
	G	Greatest % interannual change (+/-)		×		×		
	G	Greatest 5 year trend		×		×		
	G	Decrease over 5 consecutive years		×		✓		
TARGET HAULING NET CPUE	G	3rd Lowest / 3rd Highest		×		×		
	G	Greatest % interannual change (+/-)		×		×		
	G	Greatest 5 year trend		×		×		
	G	Decrease over 5 consecutive years		×		×		
TARGET DAB NET EFFORT	G	3rd Lowest / 3rd Highest	2nd LOWEST		×	×	2nd LOWEST	
	G	Greatest % interannual change (+/-)	×		×	×	×	
	G	Greatest 5 year trend	×		×	×	×	
	G	Decrease over 5 consecutive years	×		×	×	×	
TARGET DAB NET CPUE	G	3rd Lowest / 3rd Highest	HIGHEST		×	×	×	
	G	Greatest % interannual change (+/-)	×		×	×	×	
	G	Greatest 5 year trend	×		×	×	×	
	G	Decrease over 5 consecutive years	×		×	×	×	

Stock Status

West Coast Stock

A negligible amount of Southern Garfish is landed by the commercial sector on the SA WC, with its contribution to the State-wide total rarely exceeding 2%. The implementation of commercial netting restrictions in this region has contributed to the continuous reduction in hauling net effort since the late 1950s (Steer et al. 2016). In the absence of hauling net fishing, the current level of exploitation of Southern Garfish off the WC is unlikely to cause the biological stock to become recruitment overfished. On this basis the WC Southern Garfish stock is classified as **sustainable**.

Northern Spencer Gulf Stock

From the stock assessment in 2017, the NSG stock of Southern Garfish was assigned the status of 'recovering' (Steer et al. 2018b). This status reflected favourable reductions in the exploitation rate which has continued to track below the operational target trajectory of reaching ≤ 30% by 2020. Egg production and fishable biomass had remained relatively stable since the previous stock assessment undertaken in 2015 (Steer et al. 2016), and there were positive signs of an increase in population age structure.

Targeted catch rates in the hauling net sector declined to 51.6 kg.fisherday^{-1} in 2018, representing a 50% reduction since 2017. This large decline in catch rates was likely a result of management intervention, where a 60 day closure, extending from 2 August until 30 September 2018, was implemented to reduce catches and catch rates during the peak of the Garfish fishing season.

Based on the fishery statistics presented here up to and including December 2018 for NSG in association with the most recent management arrangements, there is no evidence of any change in the status of this stock. A full stock assessment for Southern Garfish will be conducted in 2021 when the fishery is be assessed against modelled biological performance indicators. It appears that the appropriate management is currently in place and the stock biomass is continuing to recover.On this basis, the current status of the NSG Garfish stock remains classified as **recovering**.

Southern Spencer Gulf Stock

Large areas of SSG have been closed to hauling net fishing, with the most recent closure being implemented around southern Yorke Peninsula in 2005. Consequently, the hauling net sector has been effectively removed from this region and, as such, it has become predominantly fished commercially by dab netters. Targeted dab net fishing effort has remained moderately high and stable (>200 fisherdays^{-1}) over the past 4 years and associated catch rates have remained within the general performance trigger reference points. This indicates that the biomass is at a sufficient level to ensure that future levels of recruitment are adequate (i.e. not recruitment impaired) and fishing mortality is adequately controlled to avoid the stock becoming recruitment impaired. Consequently, the SSG Garfish Stock is classified as **sustainable**.

Northern Gulf St. Vincent Stock

In the most recent stock assessment the NGSV stock of Southern Garfish was classified as 'depleted' (Steer et al. 2018b). This assessment indicated that targeted catch rates in NGSV increased in the hauling net sector; harvest fraction had trended downwards; fishable biomass, egg production and recruitment had remained relatively stable; older Southern Garfish appeared in the population age structure, and that current fishing mortality appeared to be constrained by management to a level that should allow the stock to recover from its recruitment impaired state. Despite these positive signs, measurable improvements were yet to be detected to alter stock status. Furthermore, 2017 was the first year the fishing closure extended into October, increasing the opportunity for Southern Garfish schools to disperse, reducing their vulnerability to the hauling net fishers. Despite these extended closures that aimed to reduce catches and catch rates during the peak fishing season, targeted catches and catch rates in the hauling net sector have increased consecutively over the past three years. This suggests that adequate management may now be in place to recover the stock. A full stock assessment for Southern Garfish will be conducted in 2021 when the fishery is assessed against modelled biological performance indicators. Until this is undertaken, the NGSV stock will remain classified as **depleted**.

Southern Gulf St. Vincent Stock

Prior to 1993, the commercial catch of Southern Garfish from SGSV was equally shared between the hauling net and dab net sectors. Since then, the hauling net sector declined as a function of a steady reduction in fishing effort. In 2006, dab nets became the dominant gear type. Hauling nets were removed from his region by implementation of the voluntary net buy-back scheme and spatial netting closures in 2005. Prior to this management restructure, the commercial Southern Garfish catch from this region rarely exceeded 10% of the State-wide harvest, however, after its implementation this was reduced to <5%. The history of this regional fishery and its current status is almost identical to SSG, characterised by relatively low levels of fishing activity and commercial catch and extensive netting closures. The relatively low levels of exploitation in SGSV indicate that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. Furthermore, the above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired. On this basis, the SGSV biological stock is classified as **sustainable**.

South East Stock

Like the West Coast, a negligible amount of Southern Garfish is landed by the commercial sector in the South East, with the State-wide contribution rarely exceeding 0.3%. The current level of exploitation of Southern Garfish in the South East is unlikely to cause the biological stock to become recruitment overfished. On this basis, the South East Garfish stock is classified as **sustainable**.

3.3.4. SOUTHERN CALAMARI

Biology

Southern Calamari (*Sepioteuthis australis*) 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.

The life-history of Southern Calamari is characterised by rapid growth and a sub-annual life-span (Jackson 2004). In South Australia, adults and juveniles are predominantly found in shallow, inshore waters. Offshore waters to depths <70 m tend to be occupied by sub-adults (Winstanley et al. 1983). The distribution and abundance patterns of adult Southern Calamari in South Australia's gulfs tend to conform to a seasonal pattern that is consistent amongst years (Triantafillos 2001). Adult abundance typically increases for six months to a peak and declines for the remainder of the year. Timing of these peaks varies among regions and follows an anti-clockwise progression around the gulfs. This cycle starts in the south-east during late spring and concludes along the western coasts during late winter. Seasonal patterns in water clarity, associated with the prevailing cross-offshore winds, appear to drive this progression as Calamari spawn in shallow seagrass habitats found along protected leeward shores (Triantafillos 2001; Steer et al. 2007). Spawning occurs throughout the year and recruitment to the fishery is continuous.

The biological stock structure across the distribution of Southern Calamari is complex and potentially dynamic. One study used allozyme markers to identify three genetic types with overlapping distributions and possible stocks off Western Australia, South Australia, New South Wales and Tasmania (data are not available for Victoria) (Triantafillos 2004). In contrast, another study using microsatellite markers found little genetic differentiation between seven study sites in Western Australia, South Australia, Victoria and Tasmania (Smith et al. 2015). It 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). For the purpose of this assessment South Australia's Southern Calamari is considered to comprise a single stock; however, the catch and effort data are assessed at the regional scale to match the spatial dynamics of the fishery.

Fishery

In South Australia, the Southern Calamari resource is shared by three sectors. Adult Southern Calamari are targeted by commercial MSF fishers, charter fishery clients, and recreational fishers on the inshore spawning grounds, while juveniles and sub-adults are incidentally caught by commercial prawn trawlers operating in the deeper (>10 m), offshore, gulf waters.

The commercial prawn trawling fleet are permitted to retain and sell Southern Calamari as by-product.

Recreational fishers target Southern Calamari fish from jetties, breakwaters and rocky shorelines. Most of the catch is landed by handlines and rods and reels using squid jigs that are shaped like a prawn. Commercial fishers also mostly use these jigs, but are also licensed to use hauling nets, gill nets and dab nets.

Daily boat and bag limits apply to the recreational sector. In 2013/14, this sector took an estimated 473,803 Southern Calamari, equating to an estimated catch of 154.9 t (Giri and Hall 2015).

Management Regulations

As far back as 1992, there were fishery management concerns about the increasing popularity of Southern Calamari fishing by both recreational and commercial fishers and the potential vulnerability of the spawning stocks (Marine Scalefish White Paper 1992). There were also reports of the illegal sale of Southern Calamari. These concerns resulted in the implementation of recreational bag and boat limits in 1995 (i.e. 15 per bag/45 per boat per day) and have remained unchanged. Currently, input controls such as spatial and temporal closures and gear restrictions (minimum mesh size 30 mm and lengths 600 m) apply to the net sector; however, these are generic measures rather than being specific to Southern Calamari. Restrictions currently prevent netting in all metropolitan waters and in waters >5m deep, as well as in numerous bays and marine protected areas. The jigging sector dominates the Southern Calamari fishery and is permitted in most State waters, with the exception of several aquatic reserves. In 2004, a full-time cephalopod fishing closure was implemented in False Bay, northern Spencer Gulf, to protect the annual spawning aggregation of the Giant Australian Cuttlefish, *Sepia apama*. It is not known whether this spatial closure inadvertently provides some regional protection for spawning Southern Calamari.

Commercial Fishery Statistics

State-wide

The total reported commercial catch of Southern Calamari remained relatively stable (>350 t) over the last six years (Figure 3-19a). Southern Calamari is taken as by-product in all three prawn fisheries and has consistently accounted for <10% of total state-wide catches since it was first reported in 2004; however, it increased to 10.5% and 11.3% in 2016 and 2017, respectively.

In 2018, the prawn fisheries by-product component equated to ~10% of the total statewide commercial catch, noting, however, that the size structure of the catch of Southern Calamari differs in the MSF and prawn fleets, with the latter mostly taking sub-adults in deeper water. The economic value of the commercial catch of Southern Calamari in 2018 was approximately $ 6 M (*c.f.* $ 5.1 M in 2017) (Figure 3-19a).

Total State-wide catch of Southern Calamari inclusive of the prawn fisheries was 412.1 t in 2018, and 371 t in the MSF (*c.f.* 412.7 t in the MSF in 2017). In the past 5 years, fishers using haulnets have taken 18.5–30.6% of the MSF catch (22.1% in 2018). Fishers using jigs have taken 69.2–81.2% of the total catch in the MSF (77.7% in 2018). Prior to 1992, the jig and hauling net sectors of the MSF contributed equally to annual catches. Since then, jigs have become the preferred gear type and have generally accounted for ~70% of the annual catch. Total fishing effort combined for both jig and hauling net fishers had remained relatively stable from 2005 until 2016 ranging between 11,461 fisher-days in 2008 to 14,487 fisher-days in 2011. In 2018, 14,444 fisher-days (*c.f.* 15,294 fisher-days in 2017) were spent catching Southern Calamari within the MSF (Figure 3-19b). Catch rates have gradually increased over the past 35 years for both gear types, at a rate of 0.51 kg.fisher-day.year^{-1} (Figure 3-19c). Since the implementation of the licence amalgamation scheme in 1994, the number of licence holders taking Southern Calamari has declined from 355 to 209 in 2017, with 223 licence holders taking the species in 2018. This represents a 45% reduction over 25 years. The number of licence holders specifically targeting Southern Calamari has remained relatively stable, averaging 215 licences per year (Figure 3-19d).

Regional

Southern Calamari is caught throughout the State with the majority landed within the gulfs (Figure 3-20a). Catches have increased in NSG, SSG and NGSV since 2008, with all three regions accounting for similar proportions of the State-wide commercial total (Figure 3-20b). Although, Calamari can be caught throughout the year, they tend to peak during late spring and late autumn (Figure 3-20c). In 2018, the commercial catch of Southern Calamari was dominated by the MSF fishers, prawn fleets (10%) and Southern and Northern Zone Rock Lobster fishers accounted for <1% (Figure 3-20d). In 2013/14 the recreational sector accounted for 30% of the State-wide catch of Southern Calamari.

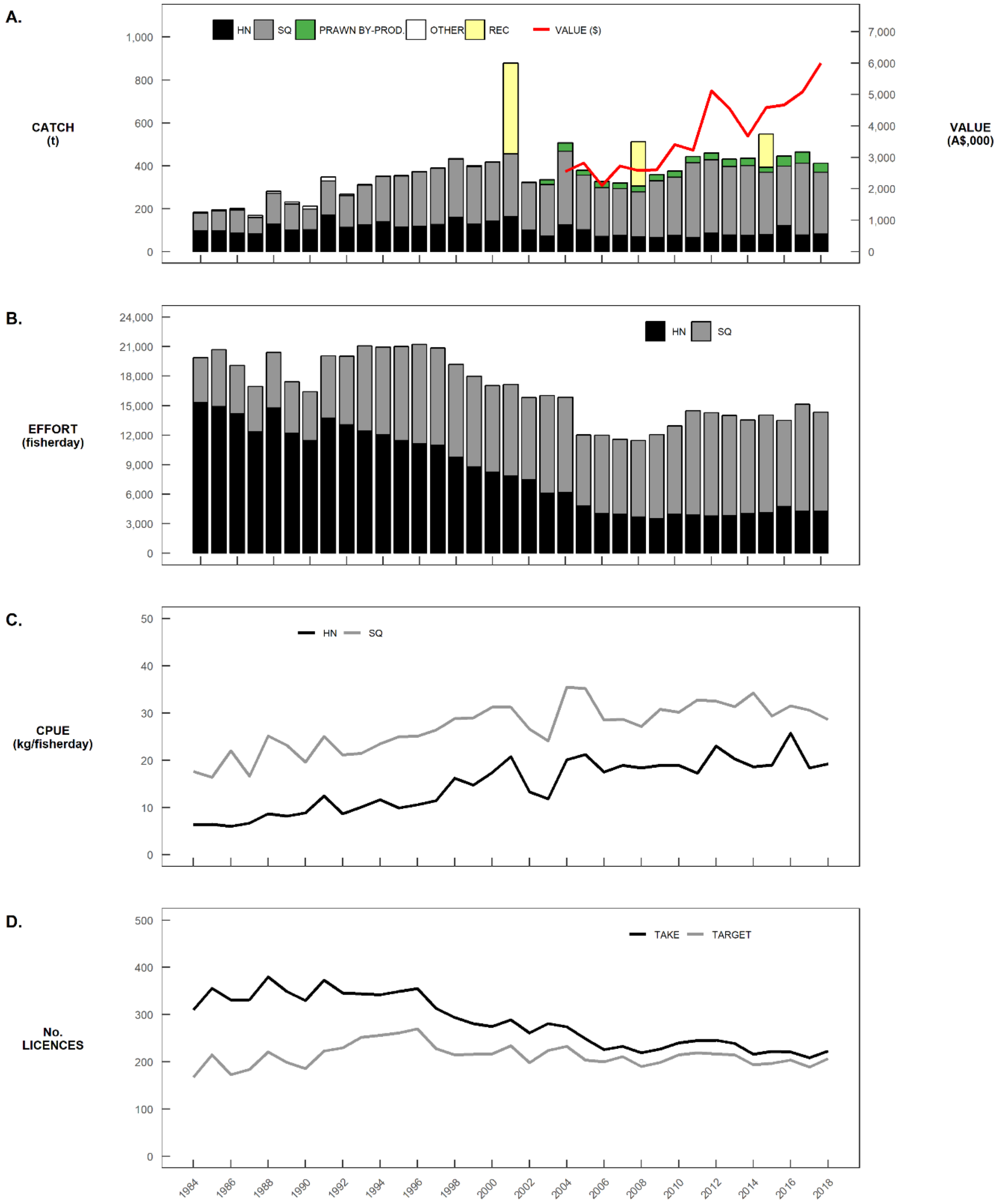

Figure 3-19. Southern Calamari (A) Long-term trends in total catch for the main gear types (squid jig, hauling net, prawn bycatch), estimated recreational catch and gross production value; (B) Long-term total effort for squid jigs and hauling nets; (C) total catch per unit effort for squid jigs and hauling nets; and (D) the number of active licence holders taking or targeting the species.

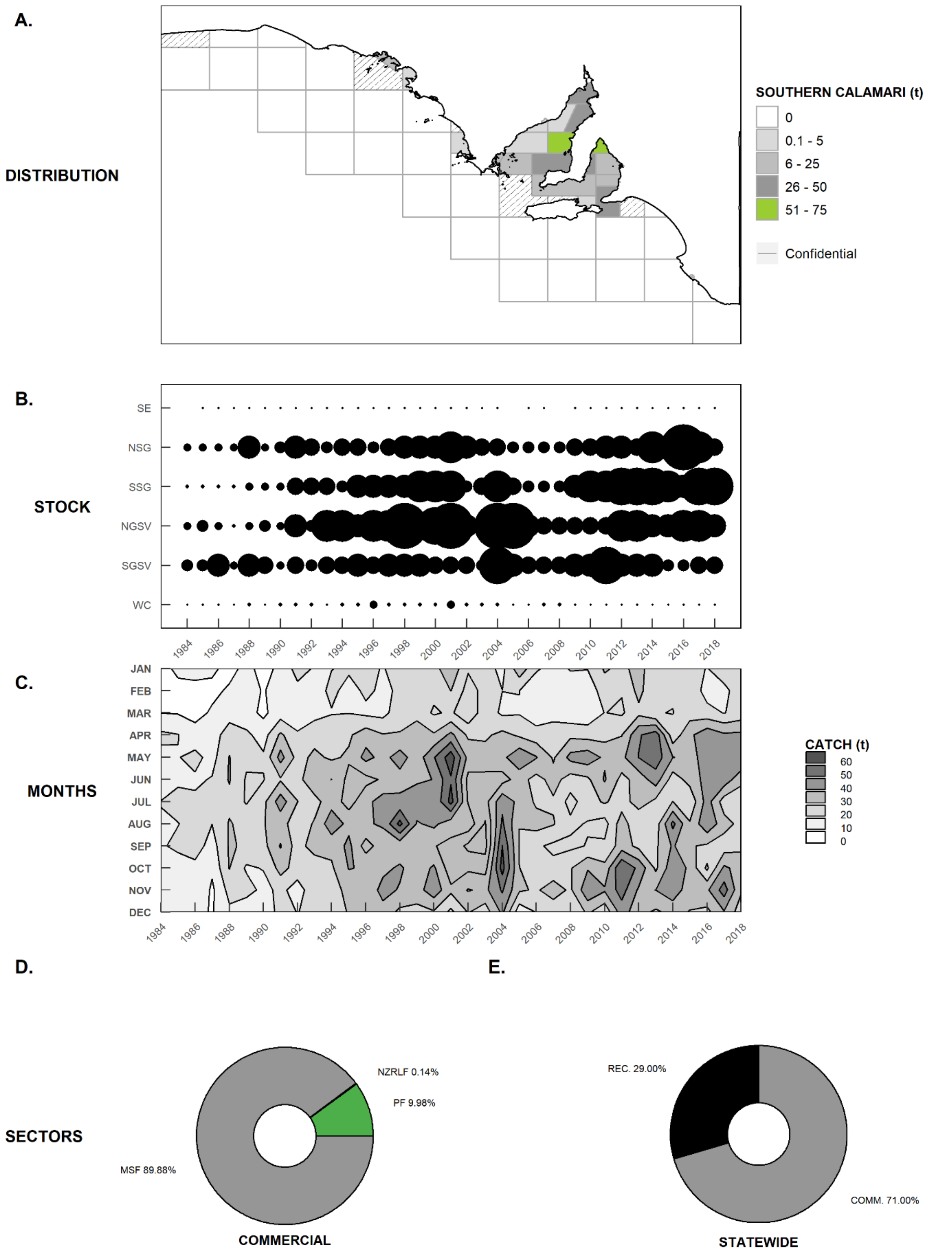

Figure 3-20. Southern Calamari. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t); (D) The proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

West Coast

The annual commercial catch of Southern Calamari from the WC has rarely exceeded 10% of the State's catch. Total catches declined from a peak of 37.2 t in 1996 to 5.2 t in 2014 (Figure 3-21a). Annual catch of Southern Calamari decreased from 9.6 t in 2016 to 8.4 t in 2018 on the WC. Targeted jig effort in this region declined from a historic peak of 1,343 fisher-days in 2001 to 277 fisher-days in 2009, decreasing at rate of 94 fisher-days.year^{-1} over eight years. (Figure 3-21c) Targeted jig effort levels have remained below 430 fisher-days.year^{-1} since 2014, and declined from 415 days in 2017 to 375 days in 2018. Most of the fishing for Southern Calamari in this region has been targeted using jigs. The number of licences targeting Southern Calamari using jigs has ranged from 32 to 55 over the past decade, and was 35 in 2018. (Figure 3-21e).

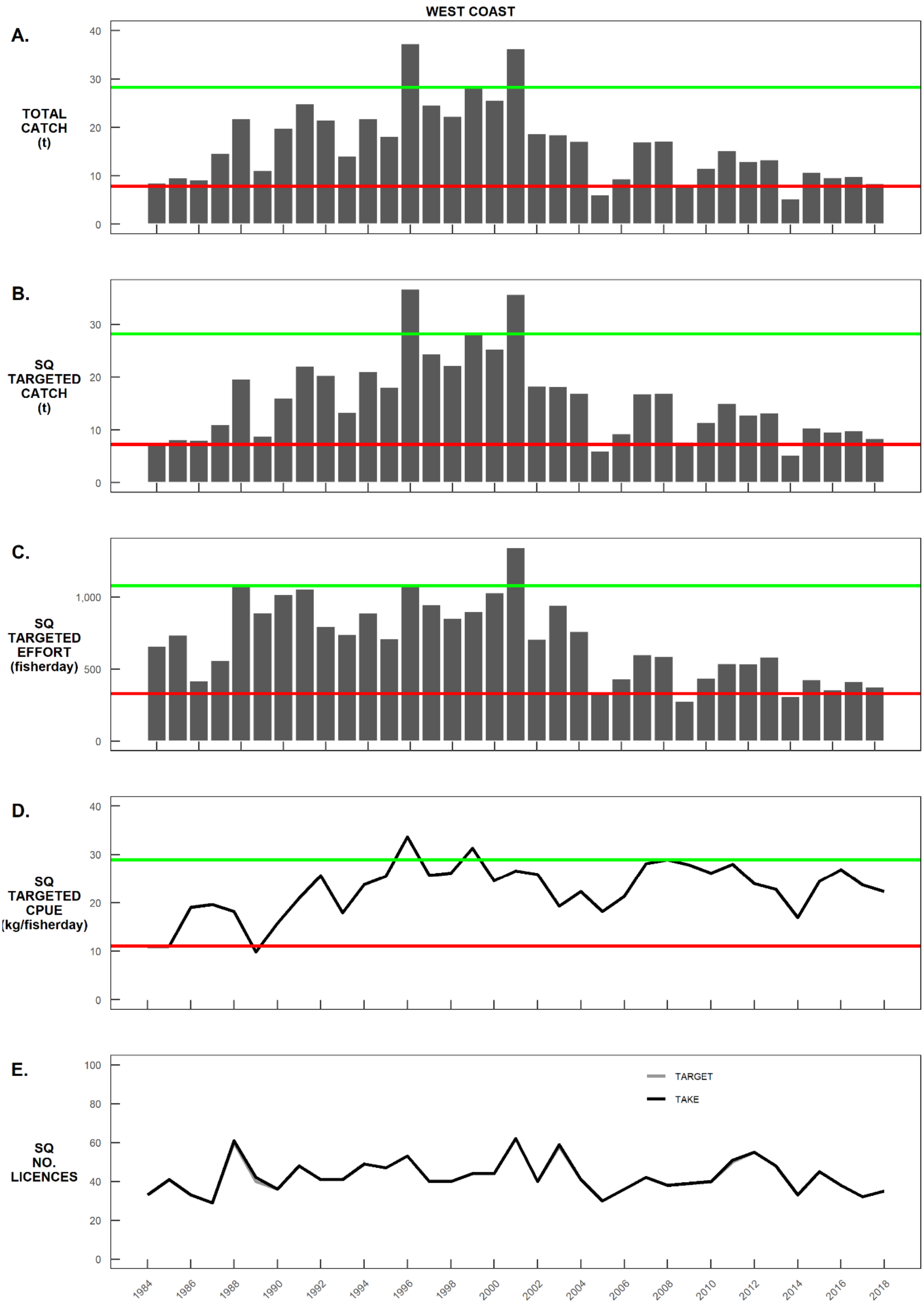

Figure 3-21. Key fishery statistics used to inform the status of Southern Calamari in the West Coast. Long-term trends in (A) total catch; (B) targeted squid jig catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3.9.

Northern Spencer Gulf

Total catch of Southern Calamari in NSG has typically accounted for 25% of the State's catch. The annual catch of 76.8 t in 2018 decreased from the previous year by 24% (Figure 3-22a). The targeted hauling net catch had increased from 6.5 to 7.9 t, whereas, historical catches taken using this gear were rarely >3 t per year (Figure 3-22c). Targeted jig effort in NSG decreased by 19.7% from 2,101 fisher-days in 2017 to 1,687 fisher-days in 2018. Targeted jig catch rate in 2018 was the lowest recorded over the past decade at 23.2 fisher-day^{-1} (*c.f.* 28.8 kg fisher-day^{-1} in 2017) (Figure 3-22d). The number of licence holders targeting Southern Calamari using jigs has declined from a peak of 45 fishers in 2011 to 34 in 2018 (Figure 3-22e).

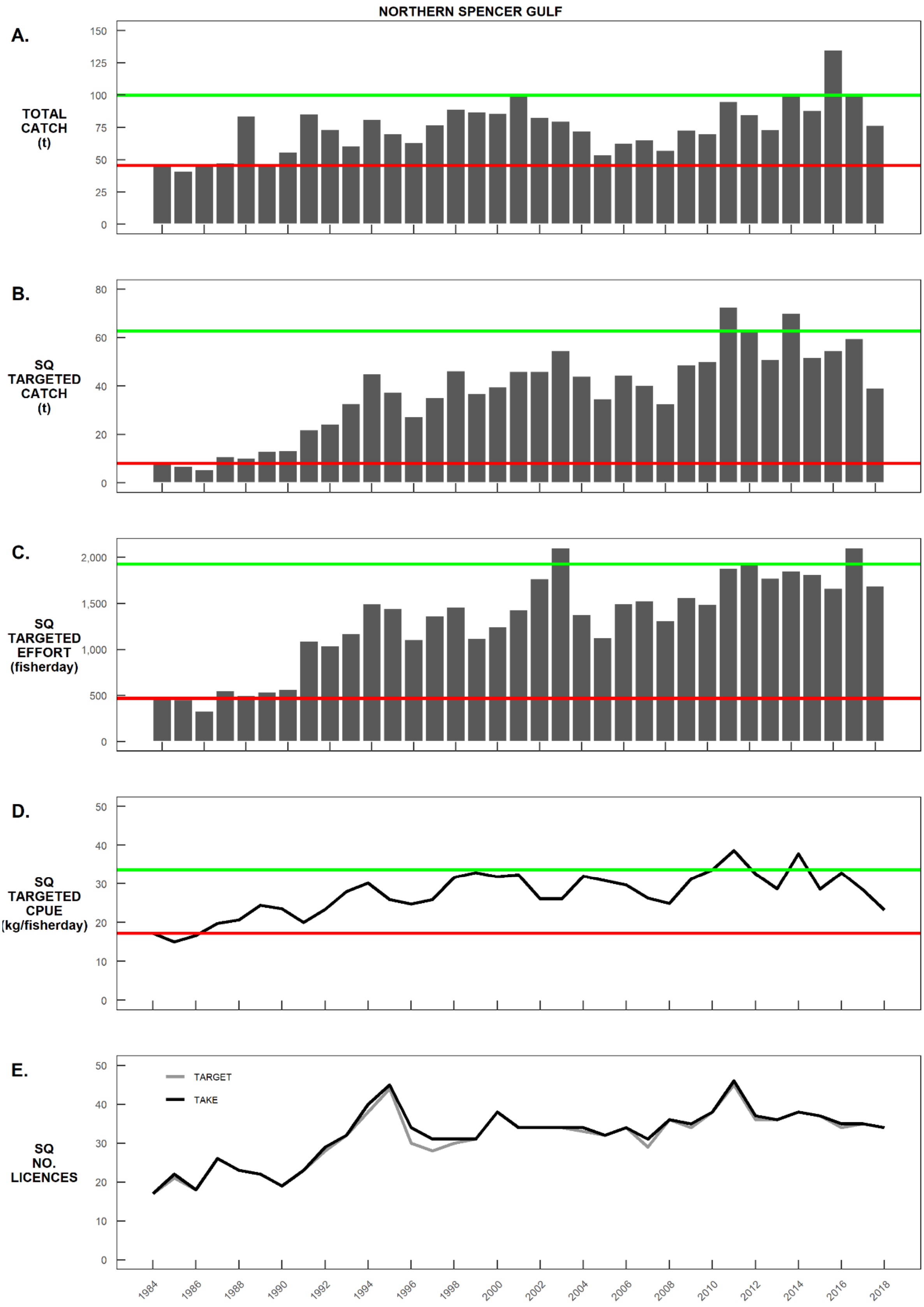

Figure 3-22. Key fishery statistics used to inform the status of Southern Calamari in Northern Spencer Gulf. Long-term trends in (A) total catch; (B) targeted squid jig catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-9.

Southern Spencer Gulf

Total catch of Southern Calamari in the MSF in SSG has accounted for 30% of the State-wide MSF catch. It peaked at 123 t in 2012 and declined to 93 t in 2016. Total catches reached a record high of 123.7 t in 2017, before stabilising at 120.8 t in 2018 (Figure 3-23a). Effort levels followed a similar trend, rising to a peak of 3,749 fisher-days in 2012. Total effort then decreased to 2,918 fisher-days in 2016 before peaking at 4,146 fisher-days in 2018 (Figure 3-23c). Almost all fishing of Southern Calamari in SSG consisted of jigs, as area available for hauling netting is limited. Catch rates in this sector peaked at 36.3 kg.fisher-day^{-1} in 2013, remained above 32 kg.fisher-day^{-1}.year^{-1} until 2017 and was 29.6 kg.fisher-day^{-1}.year^{-1} in 2018 (Figure 3-23d). The number of licence holders using jigs to target Southern Calamari in this region remained relatively stable since 1992, averaging 88 licences per year (Figure 3-23e).

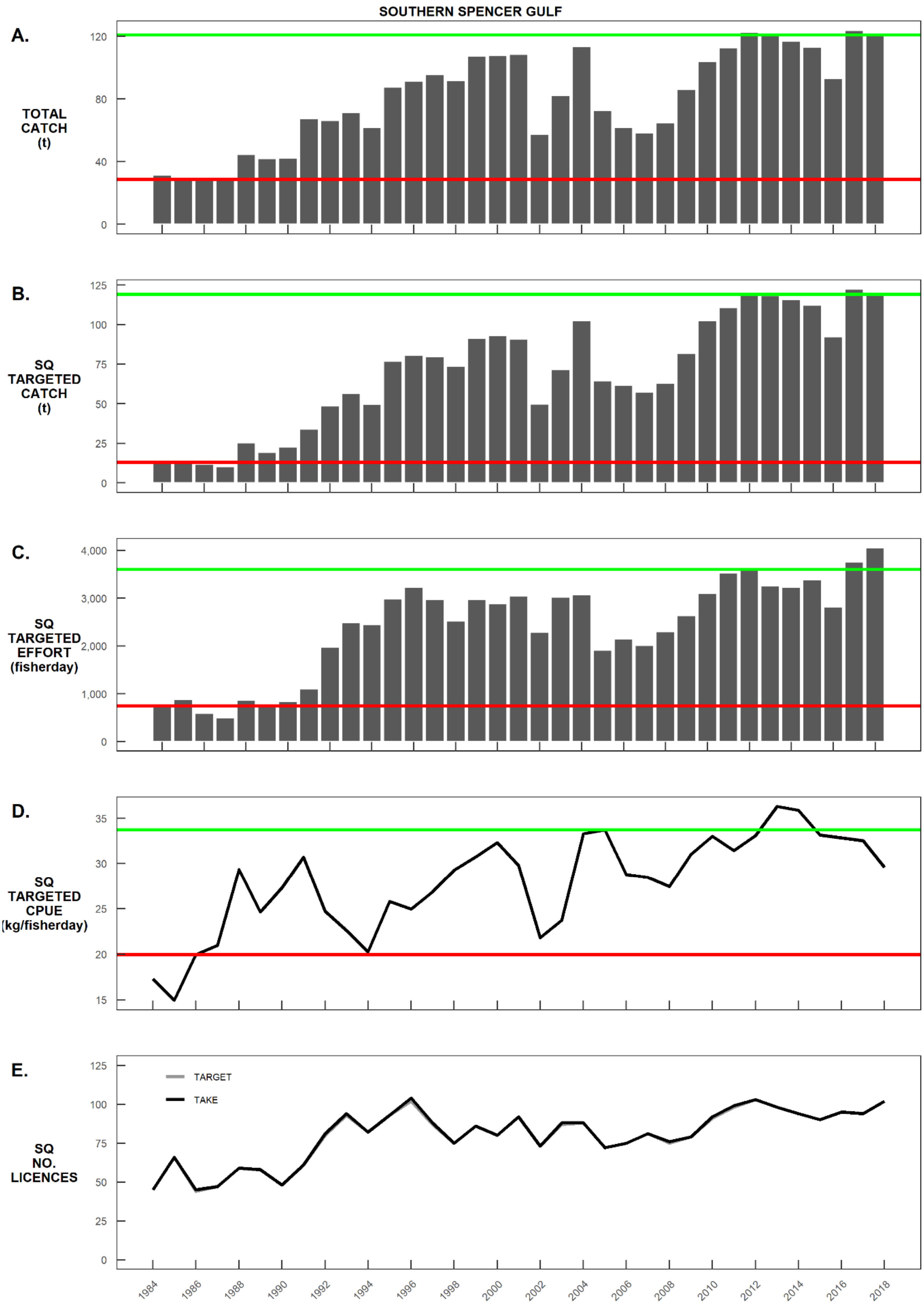

Figure 3-23. Key fishery statistics used to inform the status of Southern Calamari in Southern Spencer Gulf. Long-term trends in (A) total catch; (B) targeted squid jig catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-9.

Northern Gulf St. Vincent

The relative contribution of the commercial Southern Calamari catch from NGSV to the annual State-wide total is ~25%. Annual catches have decreased from a peak of 148 t in 2004 to the most recent low of 69 t in 2009 (Figure 3-24a). Since then, annual total catch has remained relatively stable at 92 t per year. A total of 58% of the catch is targeted, of which 39% and 61% are taken using haul nets and jigs, respectively. Targeted jig effort fluctuated annually following an increasing trend that ranged from 503 to 1,546 fisher-days.year^{-1} from 1984 to 2012 (Figure 3-24c). Target effort then increased sharply, ranging between 1,409 and 2,207 fisher-days.year^{-1} between 2012 and 2017. Targeted jig effort decreased and stabilised at 1,733 fisher-days.year^{-1} in 2018 (Figure 3-24c). Catch rates between 2014 and 2018 ranged from 28.5 to 32.9 kg.fisher-day.year^{-1} (Figure 3-24d). The number of licence holders using jigs to target Southern Calamari in NGSV was stable with a slightly upward trend since 1992, averaging 43 per year (Figure 3-24e).

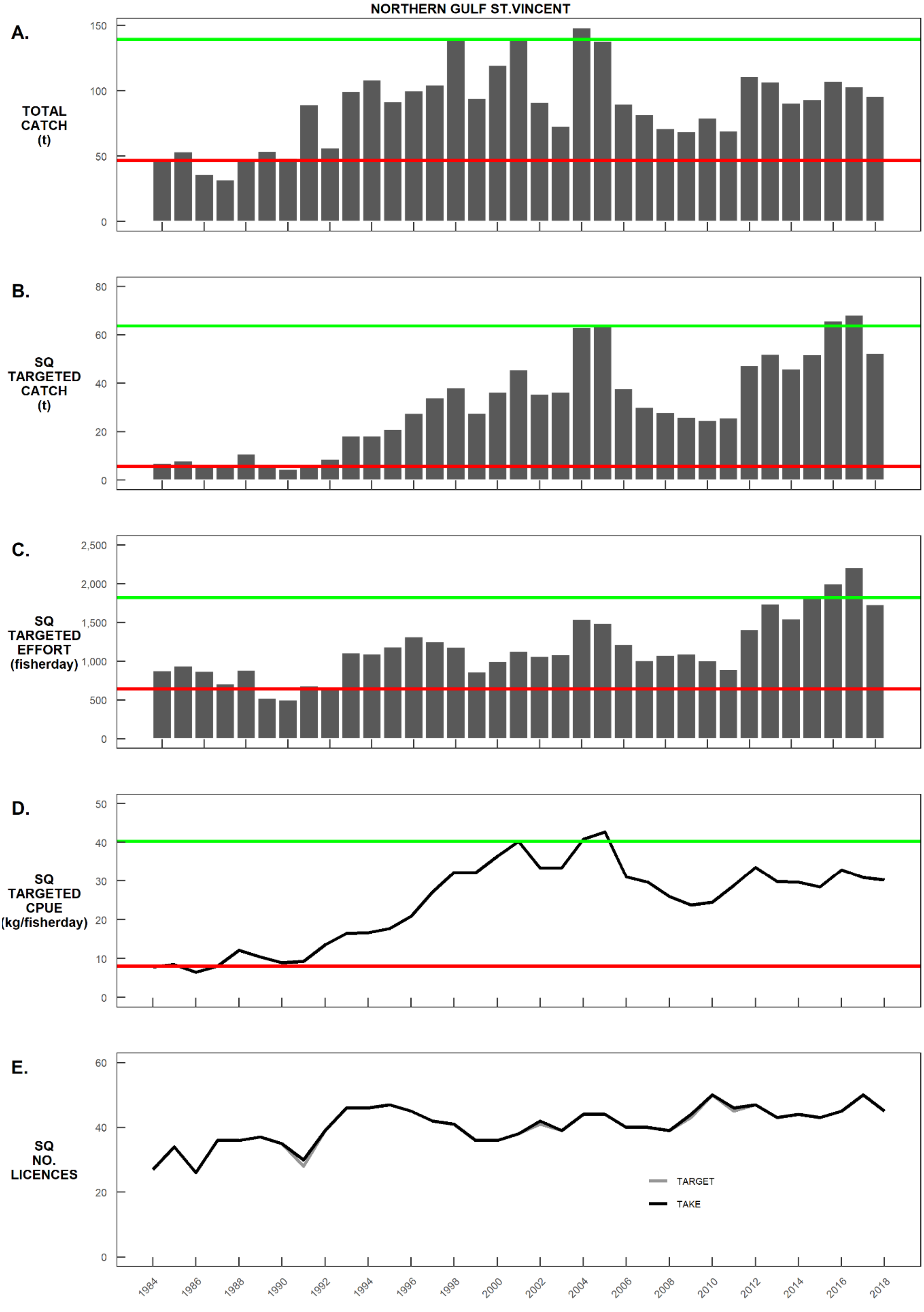

Figure 3-24. Key fishery statistics used to inform the status of Southern Calamari in Northern Gulf St. Vincent. Long-term trends in (A) total catch; (B) targeted squid jig catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-9.

Southern Gulf St. Vincent

Southern Gulf St. Vincent accounts for ~20% of the State-wide catch of Southern Calamari, in the MSF with almost all (>98%) of it targeted by jig fishers. Total catch peaked at 122.7 t in 2011 (Figure 3-25a). Total catch of southern calamari in SGSV was 69 t in 2018, representing a decrease in total catch of ~23.5% in the last 5 years (Figure 3-25a). This decreasing trend has been driven by a concomitant decrease in targeted jig effort, declining from 3,683 fisher-days in 2011 to a record low of 1,857 fisher-days in 2016 (Figure 3-25c). Targeted jig effort levels increased to 2,176 fisher-days in 2018. Targeted jig CPUE has been moderate and relatively consistent since 1984, averaging 28.5 kg.fisher-day.year^{-1} (Figure 3-25d). The number of licence holders using jigs to target Southern Calamari in this region peaked at 69 in 1996, and remained stable between 42 and 47 in the past 5 years (Figure 3-25e).

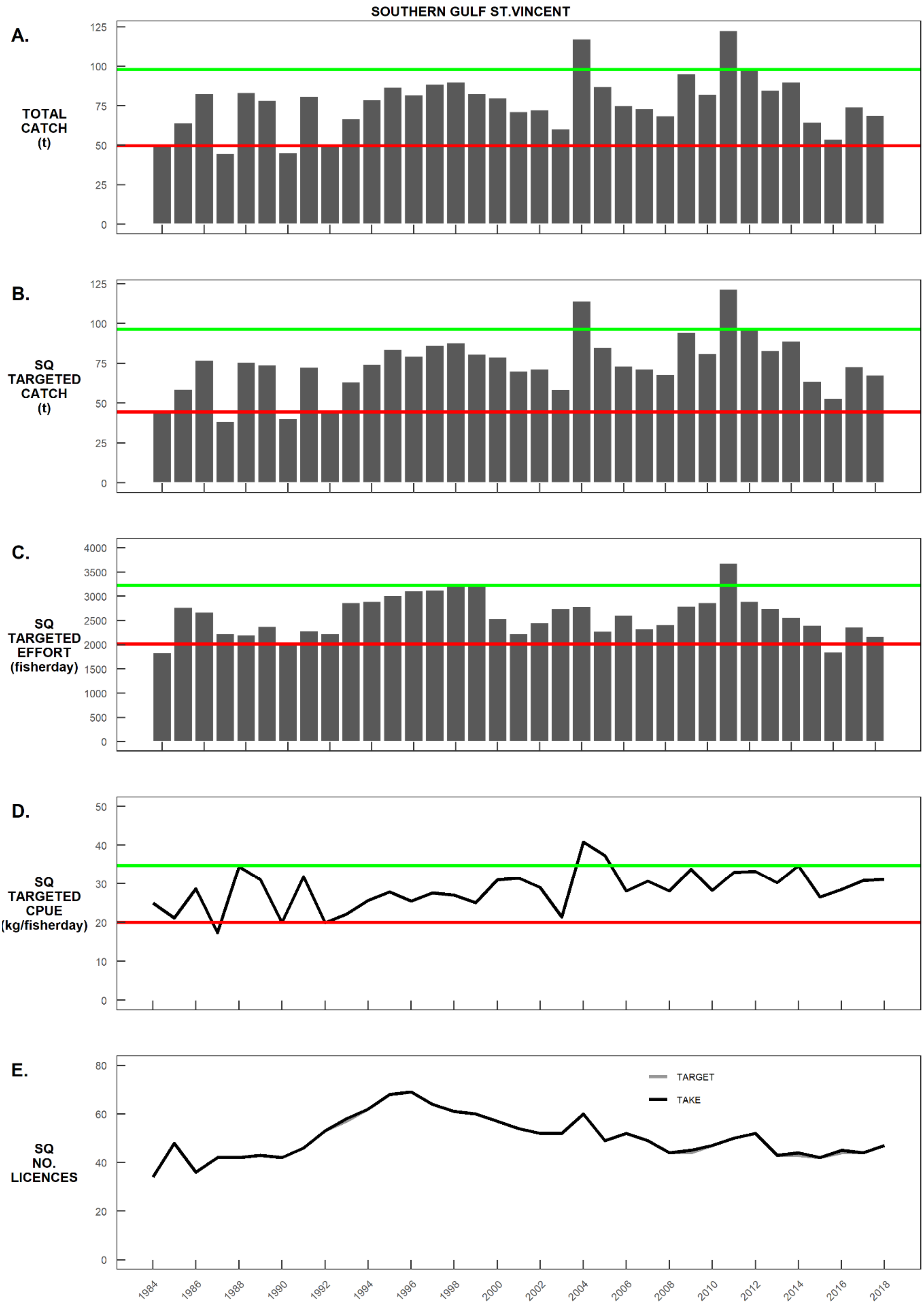

Figure 3-25. Key fishery statistics used to inform the status of Southern Calamari in Southern Gulf St. Vincent. Long-term trends in (A) total catch; (B) targeted squid jig catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-9.

South East

A negligible proportion of the catch (<1%) of Southern Calamari in the MSF was landed in the SE.

Fishery Performance

No trigger limits associated with the relative proportion of commercial catch shares were breached (Table 3-8). The general performance indicators were assessed at the regional scale for 2018. There were three breaches of trigger reference points (Table 3-9) that all related to SSG. This region yielded the third highest catch in 2018, the highest targeted jig effort and declines in catch rate over five consecutive years.

Table 3-8. Results from consideration of commercial catches of Southern Calamari by fishery against their allocation percentages and trigger reference points. MSF = Marine Scalefish, NZRL = Northern Zone Rock Lobster, GSVP = Gulf St. Vincent Prawn Fishery; SGP = Spencer Gulf Prawn Fishery; WCP = West Coast Prawn Fishery. Green colour – allocation not exceeded.

COMMERCIAL ALLOCATION	MSF 90.91%	SZRL n/a	NZRLF 0.73%	GSVP 0.73%	SGP 7.47%	WCP 0.16%
TRIGGER 2	92.70%	-	1.46%	1.46%	8.20%	0.75%
TRIGGER 3	95.40%	-	2.19%	2.19%	11.20%	1.00%
2013	91.98%	-	0.66%	0.00%	7.23%	0.13%
2014	91.89%	-	0.34%	0.04%	7.60%	0.12%
2015	93.98%	-	0.21%	0.51%	5.22%	0.07%
2016	89.14%	-	0.34%	0.77%	9.69%	0.06%
2017	88.60%	-	0.11%	0.88%	10.33%	0.08%
2018	89.88%		0.14%	1.01%	8.86%	conf.

Table 3-9. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the regional spatial scales for Southern Calamari in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	WC	NSG	SSG	NGSV	SGSV	SE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×	×	3rd HIGHEST	×	×	conf.
	G	Greatest % interannual change (+/-)	×	×	×	×	×	conf.
	G	Greatest 5 year trend	×	×	×	×	×	conf.
	G	Decrease over 5 consecutive years	×	×	×	×	×	conf.
TARGET JIG EFFORT	G	3rd Lowest / 3rd Highest	×	×	HIGHEST	×	×	conf.
	G	Greatest % interannual change (+/-)	×	×	×	×	×	conf.
	G	Greatest 5 year trend	×	×	×	×	×	conf.
	G	Decrease over 5 consecutive years	×	×	×	×	×	conf.
TARGET JIG CPUE	G	3rd Lowest / 3rd Highest	×	×	×	×	×	conf.
	G	Greatest % interannual change (+/-)	×	×	×	×	×	conf.
	G	Greatest 5 year trend	×	×	×	×	×	conf.
	G	Decrease over 5 consecutive years	×	×	✓	×	×	conf.

Stock Status

In the absence of conclusive evidence on the biological stock boundaries of Southern Calamari throughout its geographical range the assessment of stock status is ascertained at the State-wide level. The primary measure for biomass and fishing mortality is targeted CPUE from jig and hauling net fishers. The total reported commercial catch of Southern Calamari in 2018, combined across all fisheries was 412.1 t in 2018, with 371 t taken in the MSF (*c.f.* 412.7 t in 2017). Commercial CPUE has remained relatively high in both the jig and the hauling net sectors of the fishery.

Southern Calamari has established itself as an alternate target species as fishers have shifted their effort away from other primary species (Figure 2-4). Although the biological stock of Calamari encompasses the State, there appears to be evidence of regional depletion. This is particularly evident in SSG where catch rates have consistently declined over the past 5 years, reducing from a peak of 36.3 kg.fisherday^{-1} in 2013 to 29.6 kg.fisherday^{-1} in 2018, representing an 18% reduction, and breaching the associated trigger point. Northern SG has displayed similar reductions with targeted jig catch rates in 2018 being the lowest recorded over the past decade. The sharp declines in catch rates over the past three to five years in Spencer Gulf raises uncertainty about the sustainability of increased effort on regional populations. There are also concerns within industry regarding local productivity with anecdotal reports suggesting that some areas are displaying signs of localised depletion. These inferences have been based on Southern Calamari being 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. This declining trend was not evident in either northern or southern GSV as target catch rates in both regions have remained relatively stable over the past decade.

There now appears to be regional impacts on the sustainability of the resource and this is likely a result of increased pressure from both commercial and recreational fishers. Although localised depletion can occur through intense fishing pressure on spawning aggregations, the species' high paced life-history, dynamic spawning behaviour, and movement potential, favours population replenishment at the broader biological stock level (Pecl et al. 2006).

The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired at the biological stock level. However, there are concerns regarding levels of fishing activity on regional populations, particularly within Spencer Gulf. That withstanding, the current level of fishing mortality is unlikely to cause the biological stock to become recruitment impaired. On this basis, South Australia's Southern Calamari stock is classified as **sustainable**.

3.3.5. YELLOWFIN WHITING

Biology

The Yellowfin Whiting (*Sillago schomburgkii*) is endemic to Australian coastal waters from Dampier to Albany in Western Australia and in the gulf waters of South Australia (Kailola et al. 1993). There is some uncertainty about the continuity of distribution through the remote coastal waters of Western Australia and South Australia (Kailola et al. 1993).

Fishery catches indicate that in South Australia, Yellowfin Whiting occur in highest abundances in the two northern gulfs, with lower abundances in the southern gulfs and the west coast of Eyre Peninsula. The life history of this species appears particularly adapted to habitation of relatively protected, shallow, near-shore gulf and coastal waters. Adults are generally associated with shallow, tidal creeks and coastal sand flats 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). Yellowfin Whiting demonstrate different growth patterns between the sexes that culminates in females reaching larger sizes-at-age than males (Ferguson 1999). Furthermore, market sampling of commercial catches has demonstrated considerable bias in sex ratios towards females. Age estimation of Yellowfin Whiting using otoliths has indicated a longevity of ~12 years, although most fish taken in the commercial fishery were 2 to 4 years old (Ferguson 1999).

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. This remains to be resolved.

Fishery

Yellowfin Whiting is one of the more valuable ‘secondary’ species of South Australia’s MSF (PIRSA 2013). The ‘secondary’ classification might reflect that its catches have been variable, reflecting that in the past it was targeted when demand for, or availability of, primary species was low (Jones 1981, Ferguson 1999). As the Yellowfin Whiting is a schooling species that occupies sandy, shallow habitats predominantly in the northern gulfs, it is particularly vulnerable to net gear types used in the MSF. As such, historically the commercial catches have been dominated by the net sector, with hauling nets the predominant gear followed by bottom-set gillnets. Yellowfin Whiting is a popular target species of boat- and shore-based recreational fishers who target them using hook and line. In 2013/14, this sector took an estimated 174,264 Yellowfin Whiting, equating to an estimated catch of 45.3 t (Giri and Hall 2015).

Management Regulations

There is a minimum size limit of 240 mm TL for Yellowfin Whiting that applies to the commercial and recreational sectors. A bag limit of 20 fish and boat limit of 60 fish is in place for the recreational sector. Furthermore, for the commercial sector, the many regulations that are input controls for the net gear types contribute to minimising fishing effort directed at Yellowfin Whiting. These include restrictions to net lengths and mesh sizes, extensive spatial closures and temporal restrictions that limit net fishing activities.

Commercial Fishery Statistics

State-wide

Estimates of State-wide commercial catches of Yellowfin Whiting ranged from 14.5 t in 1988 to 179 t in 2001 (Figure 3-26a). In 2018, the total catch was 140.2 t. The economic value of the commercial catch of Yellowfin Whiting in 2018 was approximately $ 1.1 M (*c.f.* $ 1.1 M in 2017) (Figure 3-26a). Total catches followed an increasing trend over the past five years. Hauling net and gillnet effort have declined considerably since 2002, with the former gear type contributing most of the catches (Figure 3-26b). State-wide estimates of CPUE of Yellowfin Whiting taken using hauling nets have been highly variable, with an increasing trend from 1984 to 2018 (Figure 3-26c). Over the same period, the total number of licence holders who reported taking Yellowfin Whiting exhibited a long-term decreasing trend from 129 to 47 licence holders per year (Figure 3-26d).

Regional

Although the annual catches of Yellowfin Whiting in NSG have been variable since 1984, they have always been higher than in the other SA regions (Figure 3-27a, b). Since the early 1990s, NGSV has been the second most productive region, whilst lower catches have come from the southern gulfs. Only incidental catches have been recorded from the SE and WC.

Northern Spencer Gulf continues to be the region where most of the State's commercial catch of Yellowfin Whiting comes from (Figure 3-27b). In 2018, MSF fishers accounted for the entire commercial catch. In 2013/14, the recreational sector accounted for ~31.5% of the State-wide catch (Figure 3-27d).

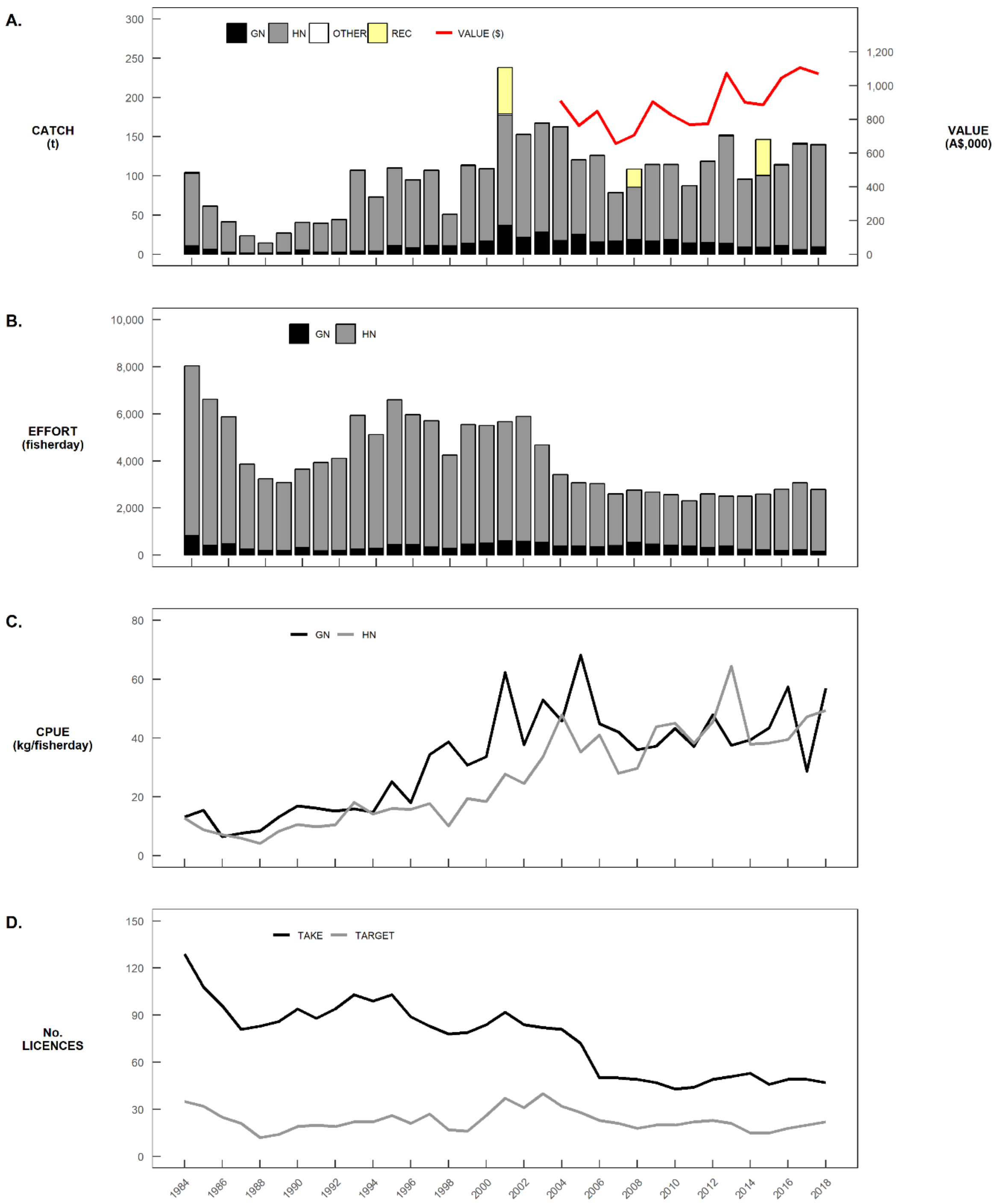

Figure 3-26. Yellowfin Whiting. Long-term trends in: (A) total catch of the main gear types (hauling and gillnets), estimates of recreational catch and gross production value; (B) total effort for hauling and set nets; (C) total catch per unit effort (CPUE) for hauling and dab nets; and (D) the number of active licence holders taking or targeting the species.

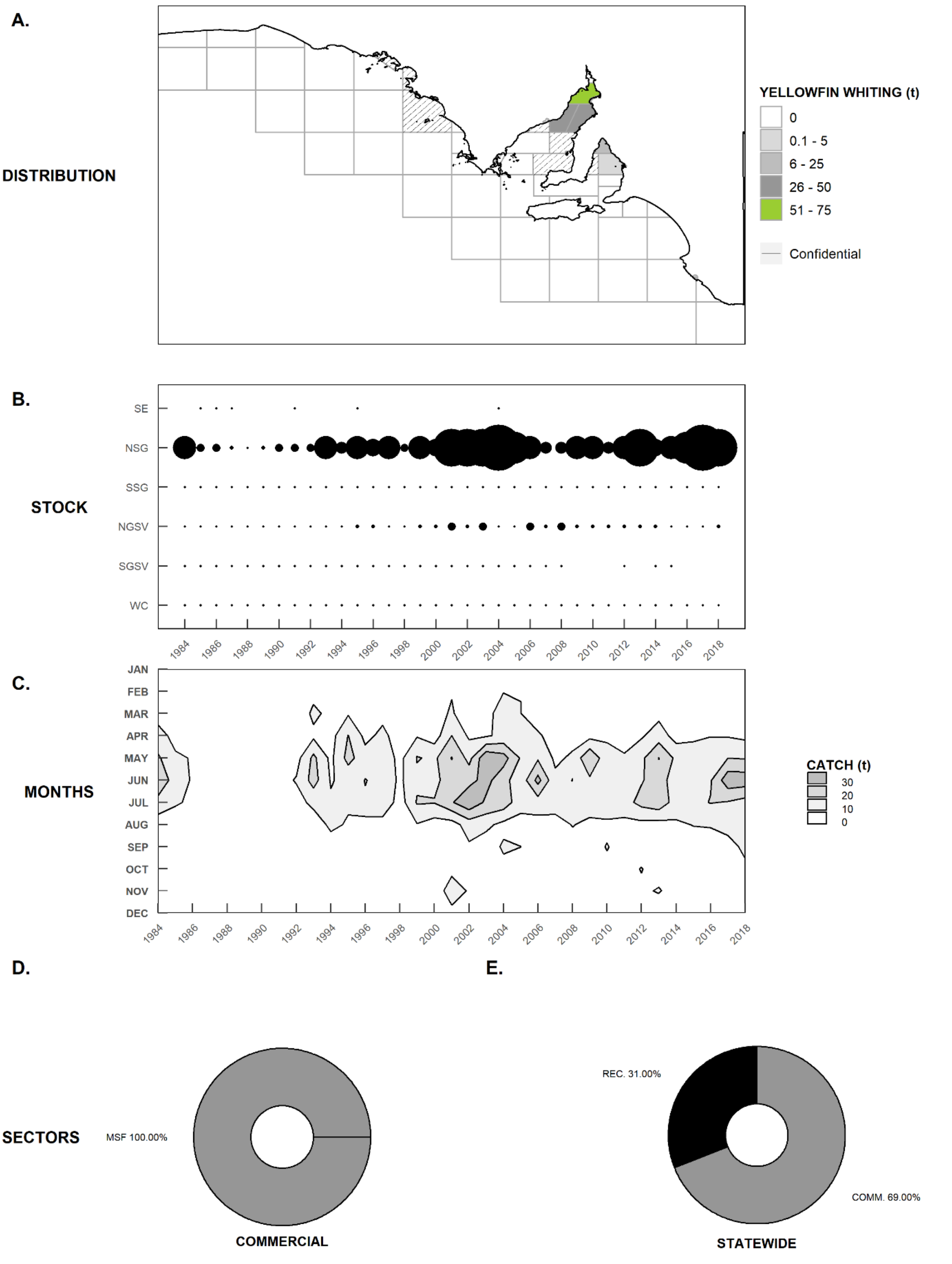

Figure 3-27. Yellowfin Whiting. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t). The proportion of catch distributed among the commercial sector in 2018 (D); and among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Northern Spencer Gulf / West Coast Stock

Total catch of Yellowfin Whiting from NSG/WC has varied considerably over the years. The lowest catch of 13.4 t was taken in 1988 and the highest of 145 t was taken in 2004. The total catch of 121 t in 2018 was the sixth highest reported since 1984 (Figure 3-28a).

Targeted hauling net catches have been highly variable, with the highest catches taken between 2001 and 2004 (Figure 3-28b). Targeted hauling net effort also peaked at 812 fisher-days in 2004, but subsequently decreased to 159 fisher-days in 2014, prior to reaching 394 days in 2018 (Figure 3-28c). Targeted hauling net CPUE has varied considerably, with no obvious long-term trend, peaking in 2013 and 2014 at 175 and 172 kg.fisher-day.year^{-1}, respectively (Figure 3-28d). In 2018, the hauling net CPUE stabilised at 116 kg.fisher-day^{-1}. The number of licence holders who took Yellowfin Whiting with hauling nets was highest at 59 in 1984 and by 2018 had declined to 21. The number of fishers who targeted this species with hauling nets has been variable and ranged from 8 to 23. A total of 12 licences targeted the species with hauling nets in 2018 (Figure 3-28e).

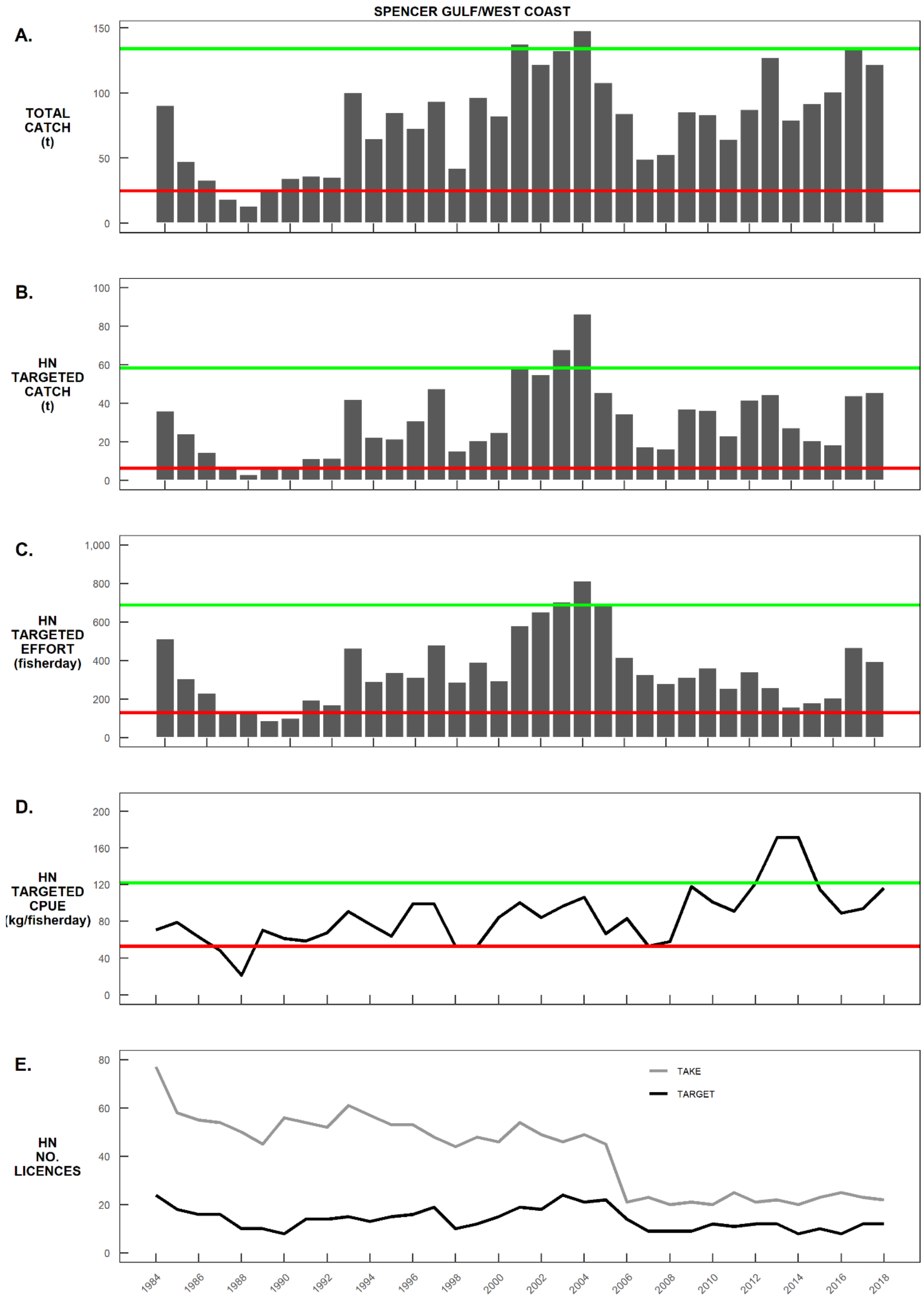

Figure 3-28. Key fishery statistics used to inform the status of Yellowfin Whiting in Spencer Gulf / West Coast. Long-term trends in (A) total catch; (B) targeted hauling net catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3.10.

Gulf St Vincent Stock

In NGSV, total annual catches of Yellowfin Whiting were highest between 2002 and 2012, ranging between 20 and 40 $t.yr^{-1}$ (Figure 3-29a). They have subsequently declined to 18.2 t in 2018. The effort levels associated with these catches were higher during the 1980s and 1990s, and declined considerably through the 2000s.

Targeted hauling net catches have been <5 $t.yr^{-1}$ in the past five years (Figure 3-29b). Such low levels of targeted catch and effort have led to variable estimates of targeted CPUE (Figures 3-29c, d). Relatively few fishers that took Yellowfin Whiting with hauling nets in NGSV targeted this species. Confidentiality issues prevent presenting the full time-series of commercial catch and effort data (Figure 3-29e).

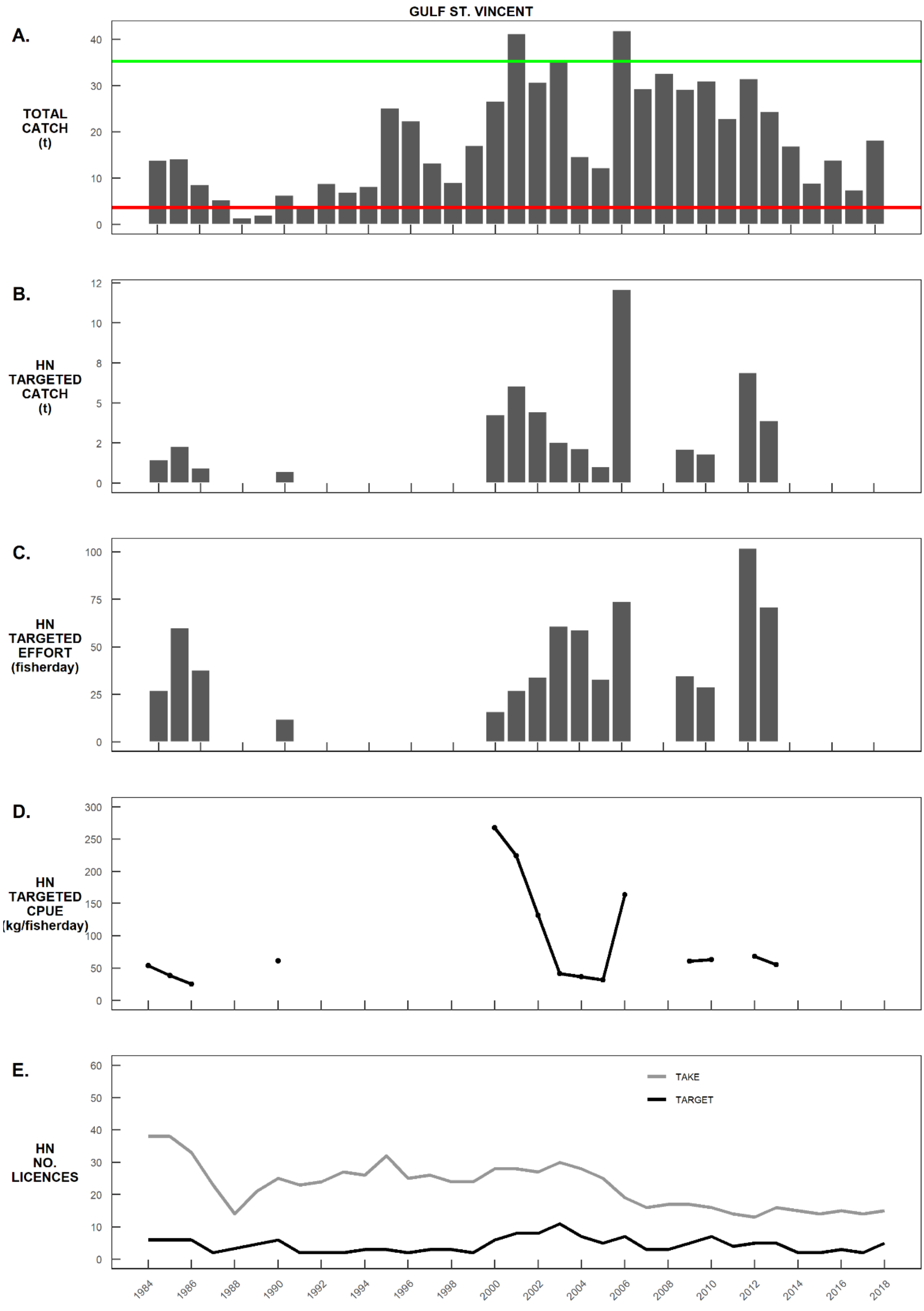

Figure 3-29. Key fishery statistics used to inform the status of Yellowfin Whiting in Gulf St. Vincent. Long-term trends in (A) total catch; (B) targeted hauling net catch; (C) effort; (D) catch rate; and (E) the number of active licence holders taking and targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-10.

Fishery Performance

The general fishery performance indicators for Yellowfin Whiting were assessed for 2018 for both NSG and NGSV. For NSG, no trigger reference points were breached (Table 3-10). The resolution of the targeted effort and associated catch rates for hauling net fisher in GSV were confidential due to the <5 fisher rule.

Table 3-10. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the regional spatial scales for Yellowfin Whiting in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	NSG	NGSV
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×	×
	G	Greatest % interannual change (+/-)	×	×
	G	Greatest 3 year trend	×	×
	G	Decrease over 5 consecutive years	×	×
TARGET HAULING NET EFFORT	G	3rd Lowest / 3rd Highest	×	CONF.
	G	Greatest % interannual change (+/-)	×	CONF.
	G	Greatest 3 year trend	×	CONF.
	G	Decrease over 5 consecutive years	×	CONF.
TARGET HAULING NET CPUE	G	3rd Lowest / 3rd Highest	×	CONF.
	G	Greatest % interannual change (+/-)	×	CONF.
	G	Greatest 3 year trend	×	CONF.
	G	Decrease over 5 consecutive years	×	CONF.

Stock Status

The South Australian catches of Yellowfin Whiting were dominated by those from Spencer Gulf, although the fishery performance indicators for this region are characterised by high levels of variability. This may reflect the transient nature of targeted fishing effort, with fishers either opportunistically targeting Yellowfin Whiting due to market demands, or when the availability of higher value species is low. There was a long-term declining trend in fishing effort for Yellowfin Whiting until 2017 and 2018. The decline in effort was not reflected in total catch, targeted catch or targeted CPUE. The higher effort in the last two years was associated with increases in total catch, targeted catch and CPUE. The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. Furthermore, the above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment-impaired. On this basis, the Spencer Gulf population is classified as a **sustainable** stock.

The Gulf St. Vincent population has produced considerably lower annual catches than those from Spencer Gulf. The targeted catches from the netting sector in this region have been variable over time reflecting variable effort. Estimates of CPUE have been relatively stable throughout the 2000s. The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. Furthermore, the above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired. On the basis of the evidence provided above, the Gulf St. Vincent stock is classified as a **sustainable** stock.

3.3.6. WESTERN AUSTRALIAN SALMON

Biology

The Western Australian Salmon (*Arripis truttaceus*) (hereafter referred to as 'Salmon') comprises a migratory biological stock that extends from southern Western Australia to the east coast of Tasmania, with each State jurisdiction harvesting different life-history stages. Western Australian Salmon intermix with Eastern Australian Salmon (*A. trutta*) in eastern Victorian waters and around Tasmania. The Western Australian fishery typically targets adult fish that aggregate around the south-western coastline, 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).

Salmon form large spawning schools in coastal waters between Cape Leeuwin and Busselton, Western Australia, during late autumn and early winter when the eastward flow of the Leeuwin Current is strongest. Developing larvae settle along the entire southern coastline of Australia, with the main nursery grounds located along the south-eastern coast. Juveniles 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 and Australian anchovies. Salmon attain a maximum age of ~12 years and can reach a maximum size of 850 mm FL (Cappo 1987).

Fishery

Historically, the harvest of Salmon in South Australia has been confined to gulf and coastal waters and targeted by hauling net fishers and dedicated seine net fishers within the MSF. The Southern and Northern Zone Rock Lobster fisheries and Miscellaneous Fishery have reported negligible catches of Salmon over many years.

Salmon is an iconic recreational fishery species in South Australia and is targeted with rod and line. The product is used or lobster bait and human consumption. The State-wide recreational survey in 2013/14 estimated that 220,332 Salmon were captured, of which 148,361 fish were harvested (Giri and Hall 2015). The estimated total recreational harvest weight was 56.2 t, which was ~48% of the State's total catch in 2013/14.

Management Regulations

Since 1984, the commercial harvest of Salmon in South Australia has been managed through the implementation of a 1,100 t catch limit with varying entitlements allocated to individual licence holders on the basis of their net endorsements. Despite this capacity, the annual State-wide commercial catch has rarely exceeded 600 t (Fowler et al. 2016b). Other regulations that are in place for this sector include temporal and spatial netting closures, and restrictions to net lengths and mesh sizes, and a minimum legal size of 210 mm TL (PIRSA 2016).

There are multiple management regulations in place for Salmon in the recreational sector. Input and output controls ensure the total catch is maintained within sustainable limits and that access is distributed equitably among fishers. The minimum legal length of 210 mm (TL) applies for recreational fishers. Daily size, bag and boat limits were implemented for the recreational sector in 1995. For fish from 210 to 350 mm TL, the bag and boat limits are 20 and 60 fish, respectively. For fish >350 mm TL, the limits are 10 and 30 fish.

Commercial Fishery Statistics

State-wide

Historically, the commercial MSF for Salmon has involved a hauling net component and a specialist purse seine (i.e. Salmon net) component. From 1984 to 2003, the annual commercial catches fluctuated around 600 t per year, with most taken by a small number of purse seiners operating throughout the West Coast and Kangaroo Island/Investigator Strait of Southern Gulf St. Vincent (SGSV) (Figure 3-30a). From 2004 to 2013, catch was considerably lower, ranging from 59–262 $t.yr^{-1}$, as purse seiners exited the fishery. During that period, hauling net fishers accounted for most (up to 90%) of the annual catch. Since 2013, catch has progressively increased in response to a developing market. A total catch of 156.3 t was taken in 2018, representing a 58% reduction from the catch of 374 t in the previous year, which was the highest catch since 2003. The total commercial catch of Salmon taken in the Lakes and Coorong was negligible. The economic value of the commercial catch of Salmon in 2018 was approximately $ 584 K (*c.f.* $ 496 K in 2017) (Figure 3–30a).

Targeted effort levels in the hauling net sector have remained relatively stable at ~57 fisher-$days.yr^{-1}$ since 2008 (Figure 3-30b). Prior to this, fishing activity has steadily declined from a peak of 807 fisher-days in 1992. Associated catch rates peaked at 1,721 $kg.fisher\text{-}day.year^{-1}$ in 2009 (Figure 3-30c). This peak was uncharacteristically high as catch rates have rarely exceeded 450 $kg.fisher\text{-}day.yr^{-1}$, and have typically ranged between 100 and 500 kg.fisher-$day.year^{-1}$. Hauling net catch rate had increased to 303 $kg.fisher\text{-}day^{-1}$ in 2018 (*c.f.* 194 $kg.fisher\text{-}day^{-1}$ in 2017).

Regional

Up to the early 2000s, the highest catches were recorded from the West Coast or SGSV, with intermediate contributions from Southern Spencer Gulf (SSG) (Figure 3-31b). From 2004 to 2013, the highest catches were taken in SSG. However, since 2013, the contributions from the West Coast and SGSV have increased, with catches from SSG remaining relatively stable. Most of the catch taken in each year has been landed throughout spring and summer (Figure 3-31c). In 2018, Salmon catches taken by MSF fishers accounted for 99.7% of the State-wide commercial catch of the species. In 2013/14, the recreational sector accounted for ~48% of the State-wide catch (Figure 3-31d).

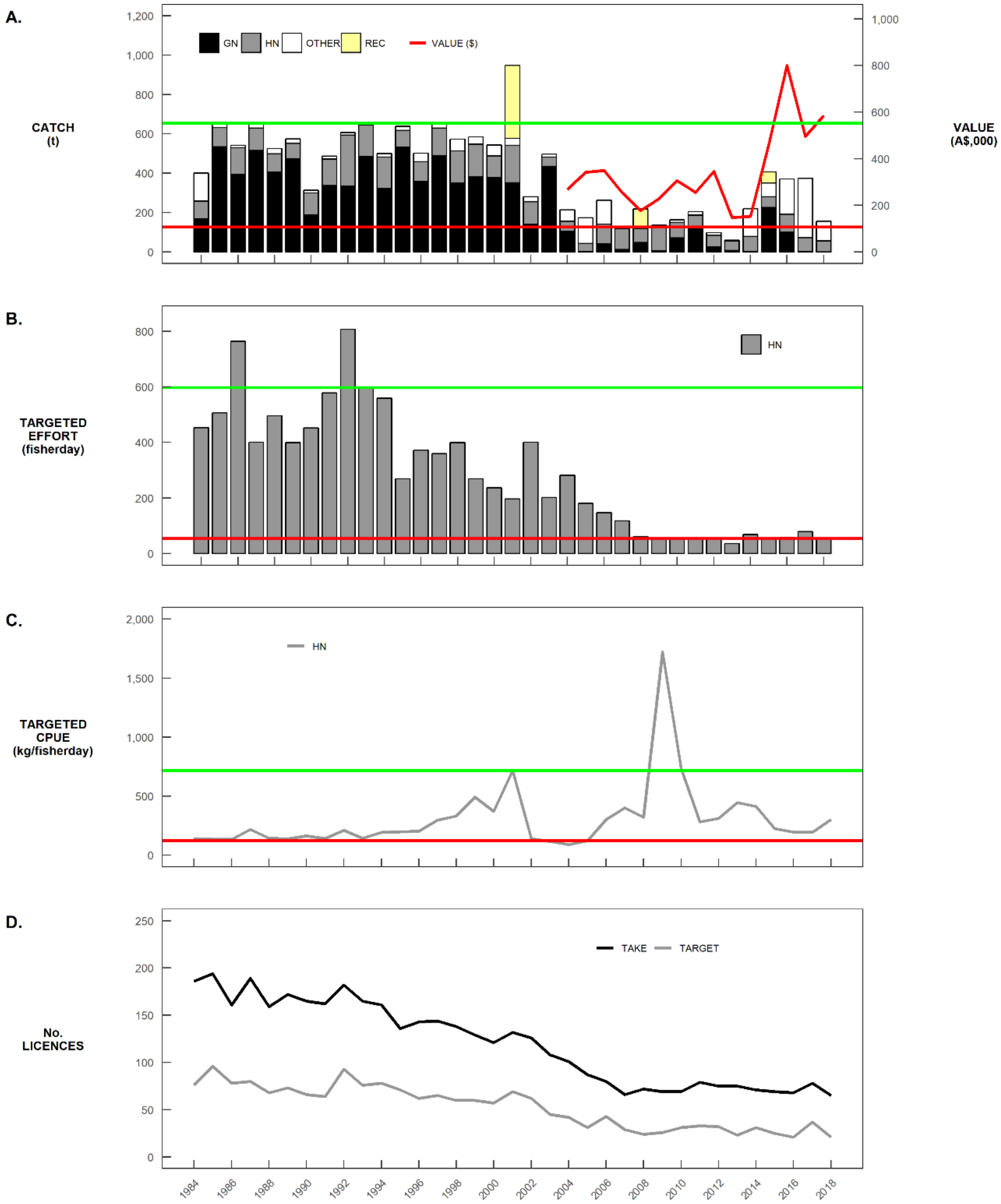

Figure 3-30. Salmon. Long-term trends in: (A) total catch of the main gear types (hauling and set nets), estimates of recreational catch, and gross production value; (B) targeted effort for hauling nets; (C) total catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-11.

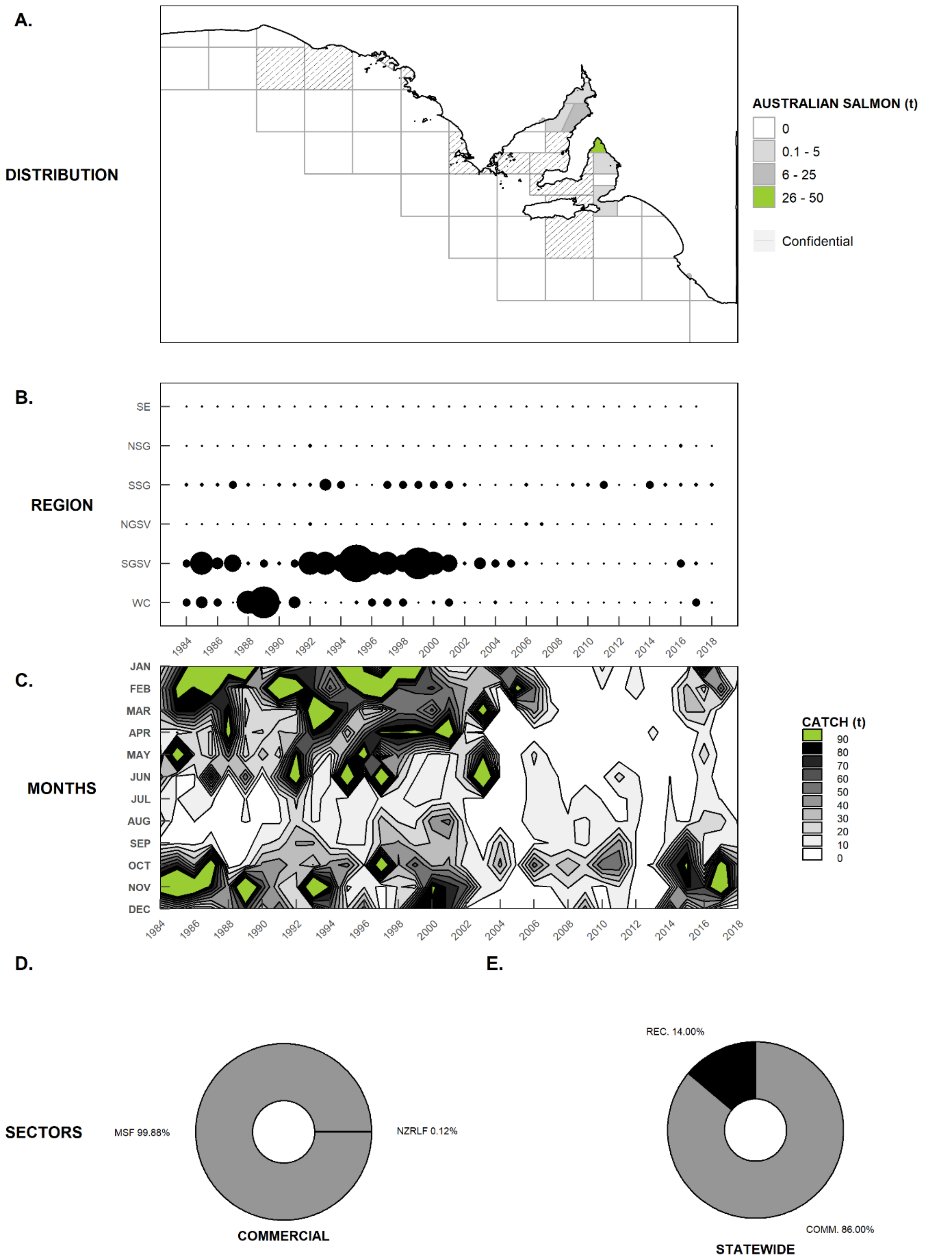

Figure 3-31 Salmon. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Fishery Performance

The general performance indicators for Salmon were assessed for 2018 at the State-wide scale. The single trigger reference point that was activated was the greatest negative inter-annual change in total catch (Table 3-11).

Table 3-11. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Salmon in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	✓
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET HAULING NET EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET HAULING NET CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

Given the shared nature of the Salmon biological stock across southern Australia it is important that each jurisdiction has adequate management in place to ensure that their respective fisheries do not compromise the overall sustainability of the resource. Currently the stock is considered to be 'sustainable' as the fishery has been relatively inactive due to weak market demand and low wholesale prices (Stewart et al. 2016). Trends in catch and effort of Salmon also reflect this inactivity and have been further restricted as a consequence of a series of netting closures that were implemented in 2005. Similarly, the relative inactivity of key purse seiners is indicative of a weak market; however, the increase in annual catches from 2015 to 2017 and escalating value suggest new, emerging markets for this species. Total catch in 2018 declined by 58% compared with the previous year, representing the greatest annual decline on record. This reduction is most likely in response to market demands. The recent medium-level catches and associated catch rates indicate that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. On this basis, the Salmon fishery is classified as **sustainable**.

3.3.7. AUSTRALIAN HERRING

Biology

Australian Herring (*Arripis georgiana*) (hereafter referred to as 'Herring') is distributed in coastal marine and estuarine waters between Shark Bay, Western Australia, and Port Phillip Bay, Victoria, and are considered to constitute a single biological stock (Ayvazian et al. 2000). Herring 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 relates to the relative strength of the Leeuwin Current which transports warm tropical water southward in the Indian Ocean and eastward along Australia's southern coastline during autumn and winter. Juveniles settle in inshore waters throughout this eastward distribution, some in close proximity to the spawning grounds, whereas others extend as far as Victoria. Juveniles prey upon small epibenthic crustaceans associated with shallow seagrass beds and as they mature switch their diet to include small fish (i.e. juvenile Australian Sardines and Blue Sprats), larger crustaceans and surface insects. Herring attain sexual maturity at two to three years of age and ~200 mm in length and typically return to southwestern Australia where they contribute to the spawning population (Smith et al. 2013).

Fishery

The schooling behaviours of Herring have made them a particularly important secondary species within the hauling net sector of the MSF, whereas they constitute a minor catch for the line sector. The majority of Herring caught in South Australia has been for human consumption, and given its relatively low value they are typically caught as a by-product when hauling net fishers target more valuable species, such as King George Whiting or Southern Garfish. Set and gill nets are also used to catch Herring for bait for either commercial longlining or Rock Lobster fishing operations. The Northern and Southern Zone Rock Lobster licence holders and Miscellaneous Fishery licence holders have reported negligible catches of Herring over many years. The species is a popular target within the State's recreational fishing sector. These fishers capture Herring using rod and line from boat and shore-based platforms. The latest estimate of catch from the recreational sector was 157.2 t (Giri and Hall 2015).

Management Regulations

Generic netting restrictions that have been implemented since the 1950s have affected many species within the MSF, including Herring. In 1983, the legal minimum length of 150 mm (TL) that applied to the recreational fishing sector was abolished. A recreational bag limit of 60 fish per person and a boat limit of 180 fish per vessel was introduced in July 2001. This was reduced to 40 and 120 fish, respectively, in December 2016.

Commercial Fishery Statistics

State-wide

The total State-wide commercial catch of Herring in 2018 was 104.5 t, which represented an increase of 41% from the previous year (*c.f*. 61 t in 2017) (Figure 3-32a). Annual catches have remained below 200 t since 2003. The economic value of the commercial catch of Australian Herring in 2018 was approximately $ 307 K (*c.f.* $ 337 K in 2017) (Figure 3-32a).

Netting closures have contributed to reductions in fishing effort, where hauling net fishers have rarely exceeded 80 fisher-days.year^{-1} targeting Herring since 2005. Prior to this, total targeted effort for the hauling net sector declined from a peak of 738 fisher-days in 1992 to 182 fisher-days in 2005 (Figure 3-32b).

Target catch rates of Herring in the hauling net sector have been highly variable over the past 35 years ranging from 53.4 kg.fisher-day^{-1} in 2003 to 216.5 kg.fisher-day^{-1} in 1999 (Figure 3-32c). Targeted hauling net catch rate of Herring in 2018 is confidential. Despite such high variability, the long term trend has been relatively stable. Approximately 20% of fishers that take Herring actively target the species, and this has remained relatively consistent over the last 35 years (Figure 3-32d).

Regional

Prior to the implementation of the netting closures in 2005, the highest catches for Herring were shared amongst NSG, SSG, and NGSV (Figure 3-33b). Since then, most of the catch from SSG has reduced. Similar reductions were evident in NGSV but only lasted approximately six years before returning back to moderate levels. The relative proportion of catch from NSG has remained relatively unchanged (Figure 3-33b). Most of this catch has been historically landed throughout spring and autumn (Figure 3-33c). In 2018, MSF licences took all of the commercial catch, with none taken in the Lakes and Coorong Fishery or the Rock Lobster fisheries. In 2013/14, the recreational sector accounted for ~52% of the State-wide catch (Figure 3-33d).

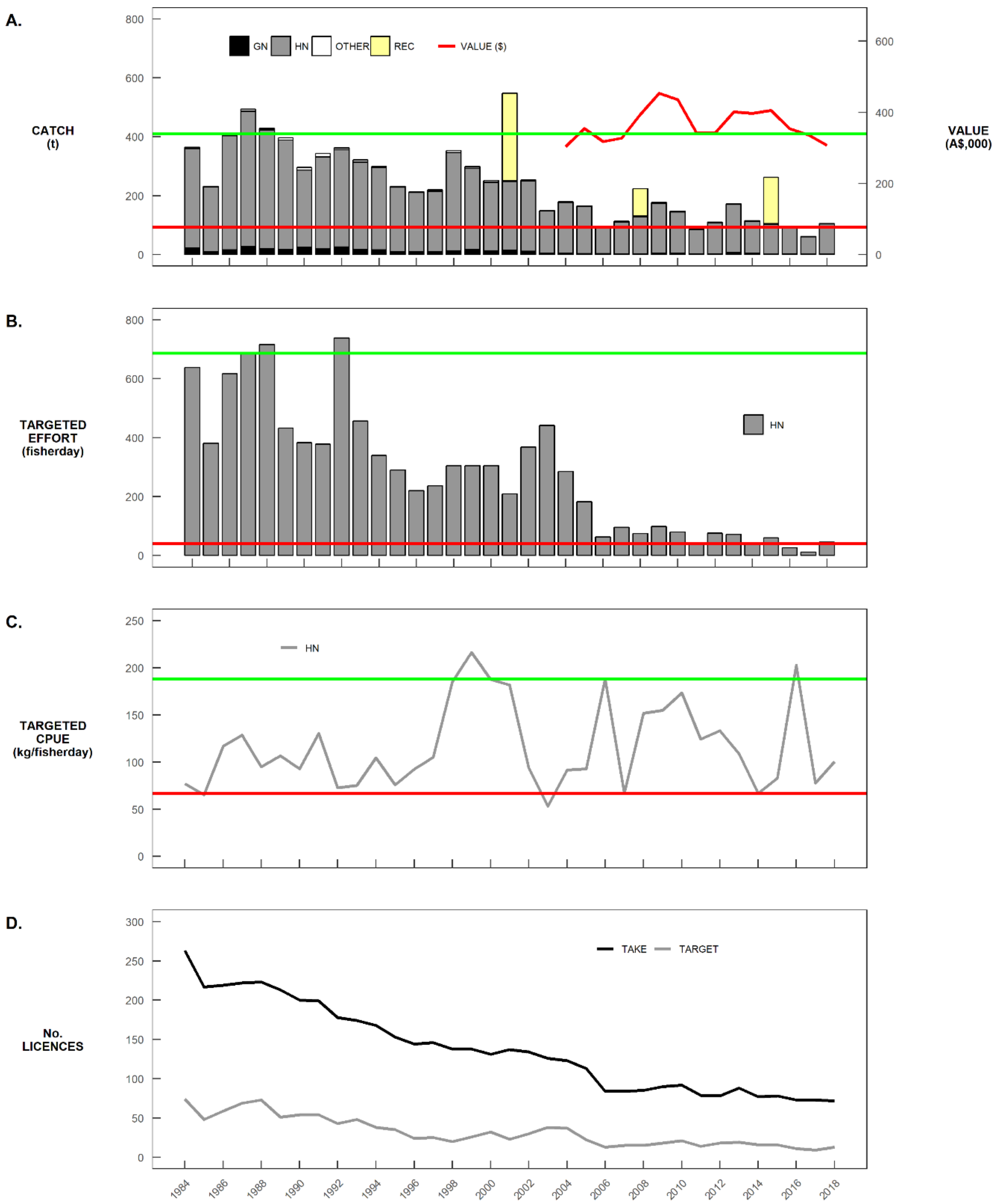

Figure 3-32. Australian Herring. Long-term trends in: (A) total catch of the main gear types (hauling and set nets), estimates of recreational catch, and gross production value; (B) targeted effort for hauling nets; (C) total catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-12.

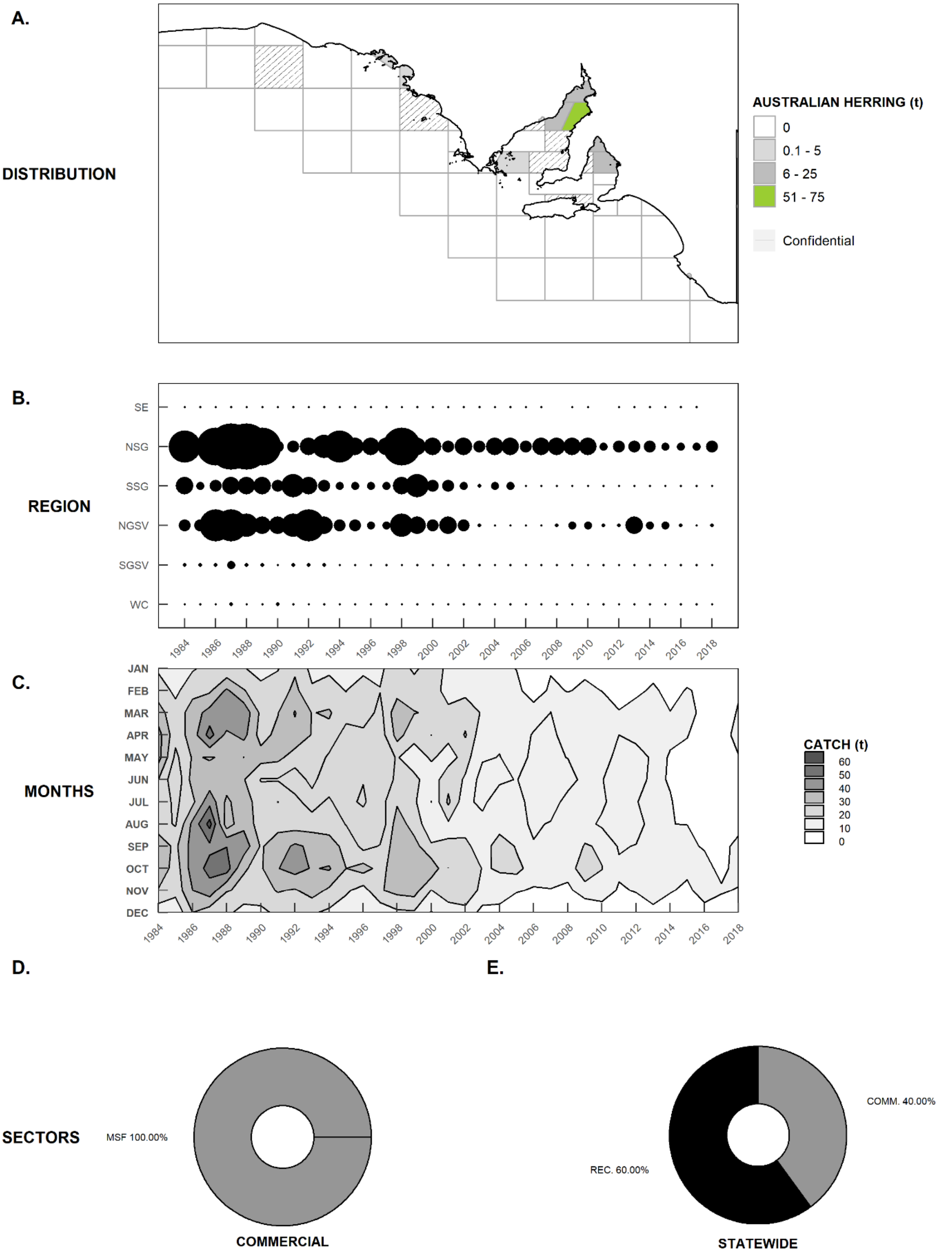

Figure 3-33. Australian Herring. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall 2015).

Fishery Performance

The general performance indicators for Herring were assessed for 2018 at the State-wide scale, using the reference period 1984 to 2018. The resolution of the targeted effort and associated catch rates for hauling net fishers were confidential due to the <5 fisher rule. No trigger reference points were breached (Table 3-12).

Table 3-12. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State scale for Australian Herring in 2018. CONF. denotes confidential data, <5 fishers.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	reatest % interannual change (+/	×
	G	Greatest 3 year trend	×
	G	ecrease over 5 consecutive year	×
TARGETED HAULING NET EFFORT	G	3rd Lowest / 3rd Highest	CONF.
	G	reatest % interannual change (+/	CONF.
	G	Greatest 3 year trend	CONF.
	G	ecrease over 5 consecutive year	CONF.
TARGETED HAULING NET CPUE	G	3rd Lowest / 3rd Highest	CONF.
	G	reatest % interannual change (+/	CONF.
	G	Greatest 3 year trend	CONF.
	G	ecrease over 5 consecutive year	CONF.

Stock Status

The levels of fishing effort and subsequent catch of Herring in South Australia have declined over the past 35 years, which was partly due to implementation of a series of netting closures in 2005. During 2018, total catch of Herring remained low, yet had increased from the previous year and was 104.5 t, reflecting continuing low effort levels. Catch rates within the hauling net sector remained highly variable with no clear, long-term trend. This is most likely due to this species being infrequently targeted by the commercial sector. The species is a popular target within the State's recreational fishing sector.

The productivity of the species and the management arrangements introduced in WA in 2015, has contributed to the recovery of the resource (DPIRP 2017). Consequently the status of the South Australian Herring Fishery should reflect the Western Australian assessment.

The current level of fishing mortality of Herring in South Australia is unlikely to cause the stock to become recruitment impaired. On the basis of the evidence provided above, the Australian Herring biological stock is classified as **sustainable**.

3.3.8. VONGOLE

Biology

South Australia has three Vongole (Mud Cockles) species that are commercially harvested. These include ‘greys’ (*Katelysia scalarina*), ‘yellows’ (*K. rhytiphora*) and ‘whites’ (*K. peronii*) (Dent et al. 2016a). All three species inhabit shallow estuarine and marine embayments and are broadly distributed along the temperate coastline from Augusta, Western Australia to Port Jackson, New South Wales (Roberts 1984).

The stock structures of these species have not been resolved, but given the short larval periods of the genus (Gluis and Li 2014) individual bays are predicted to constitute separate stocks (Dent et al. 2015). In South Australia, three putative biological stocks have been identified as separate management zones, including the West Coast, Coffin Bay, and Port River. Vongole reach a maximum age of 29 years and attain sizes of 55 mm shell length (SL). Size and age at maturity have been estimated at 23-31 mm SL and 4 years, respectively (Riley et al. 2005).

Fishery

Vongole have been commercially harvested in South Australia since the early 1960s with the majority of catch taken from the Port River and Kangaroo Island and sold as bait. Since the mid-1980s there has been an increasing demand for this species for human consumption, particularly driven by Melbourne-based markets. Commercial MSF licence holders typically use hand-held cockle rakes to target Vongole in shallow, sand/mud substrates, although there are some records where they have been harvested by hand. These rakes can only be used if they are specifically endorsed on the commercial licence. In 2013/14, an estimated 12,805 Vongoles, weighing ~0.14 t, were harvested by the recreational sector (Giri and Hall 2015).

Management Regulations

Take of Vongole is managed separately from other MSF species. In October 2008 the fishery transitioned to an individual transferable quota (ITQ) management system. A total allowable commercial catch (TACC) was established as the principal output control for South Australia’s commercial Vongole Fishery in 2008/09. This was initially set at 195 t for all zones on the basis of catch history, partitioned amongst the three zones: 100 t Port River, 70 t Coffin Bay, and 25 t West Coast. A fishery-independent program that estimated the harvestable biomass was developed in 2010 (Gorman et al. 2010). This program provides survey-based estimates of biomass and size-at-maturity in each of the three fishing zones. The subsequent estimates of harvestable biomass provide the key performance indicator for determining the TACC. The TACC is determined as a fraction of the biomass estimate (at 80% confidence), up to a maximum of 7.5%. All licensed MSF fishers that do not own quota can harvest 10 kg per day of Vongole for bait. A size limit of 35 mm maximum shell width is current for Vongole (Whites and Yellows) within the Coffin Bay Cockle Fishing Zone, outside of this zone the size limit is lower at 30 mm for all three species. Recreational size limits for Vongole are 38 mm within Coffin Bay, and 30 mm outside of the bay. They are further restricted to a personal bag limit of 300 cockles. The Port River Cockle Fishing Zone was closed in 2011, and continues to be closed, due to sustainability concerns. SARDI is currently undertaking a research project to inform a potential re-stocking program.

Commercial Fishery Statistics

From 2005 until 2007, this fishery peaked above 300 t, and the gross value was ~AUD$1 M per annum. Given the majority of the Vongole catch is managed under a TACC since 2008/09, annual catches have been relatively stable since 2010. The total State-wide commercial catch of Vongole species was 68.6 t in 2018 (*c.f.* 61.7 t in 2017) with an estimated gross production value of $1 M (*c.f.* $961 K in 2017) (Figure 3-34a). In the past five years, the total catch (all species combined) has increased marginally from 66.1 t in 2014.

Vongole are almost exclusively harvested using cockle rakes, with the majority of the catch taken from Coffin Bay on the West Coast. Given the highly selective nature of the gear, the long-term trend in rake effort which have been ~60–100 fisher days per year in the past decade, generally reflects the catch (Figure 3-34b). Catch rates of Vongole declined from a peak of 177 kg.fisher-day^{-1} in 2002 to 58.4 kg.fisher-day^{-1} in 2011, and increased to 104 kg.fisher-day^{-1} in 2018 (Figure 3-34c). The number of licence holders targeting Vongole using rakes has declined from 38 in 2007 to 17 in 2018 (Figure 3-34d).

Regional

The West Coast and NGSV regions have historically accounted for most of the State-wide catch, supporting the establishment of the three management zones (Figure 3-35a, b). The closure of the Port River Cockle Fishing Zone in 2011 led to cessation of the fishing production of the species in NGSV. During the peak of the fishery in the late 1990s and 2000s most of the catch was harvested in late winter and spring (Figure 3-35c). Marine Scalefish licence holders accounted for almost 100% of the commercial catch in 2016. The recreational sector accounted for <0.2% of the State-wide catch in 2013/14 (Figure 3-35d).

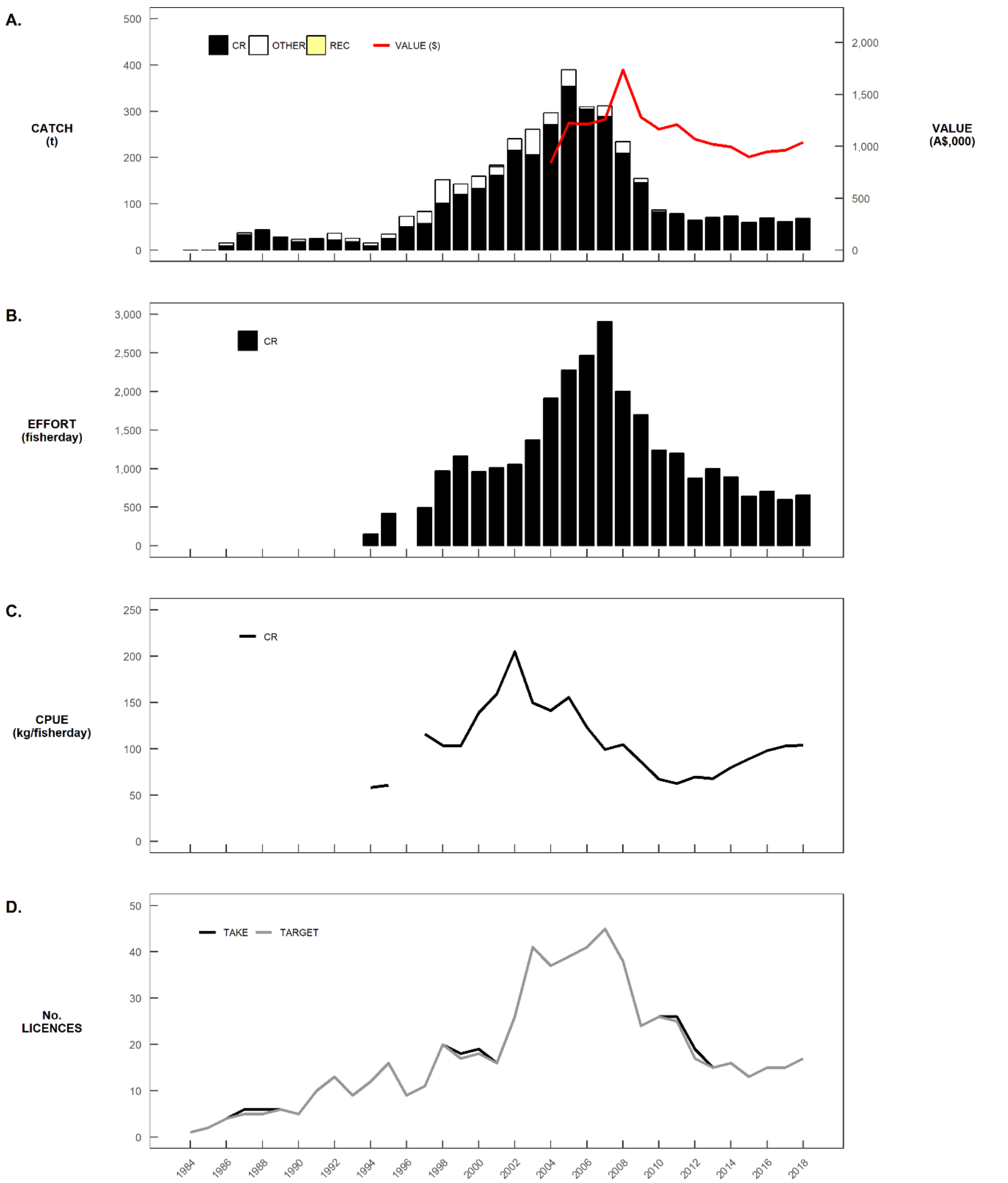

Figure 3-34. Vongole. Long-term trends in: (A) total catch of the main gear types (cockle rake and other), estimates of recreational catch, gross production value, and total allowable commercial catch (TACC); (B) total effort for cockle rakes; (C) total catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species.

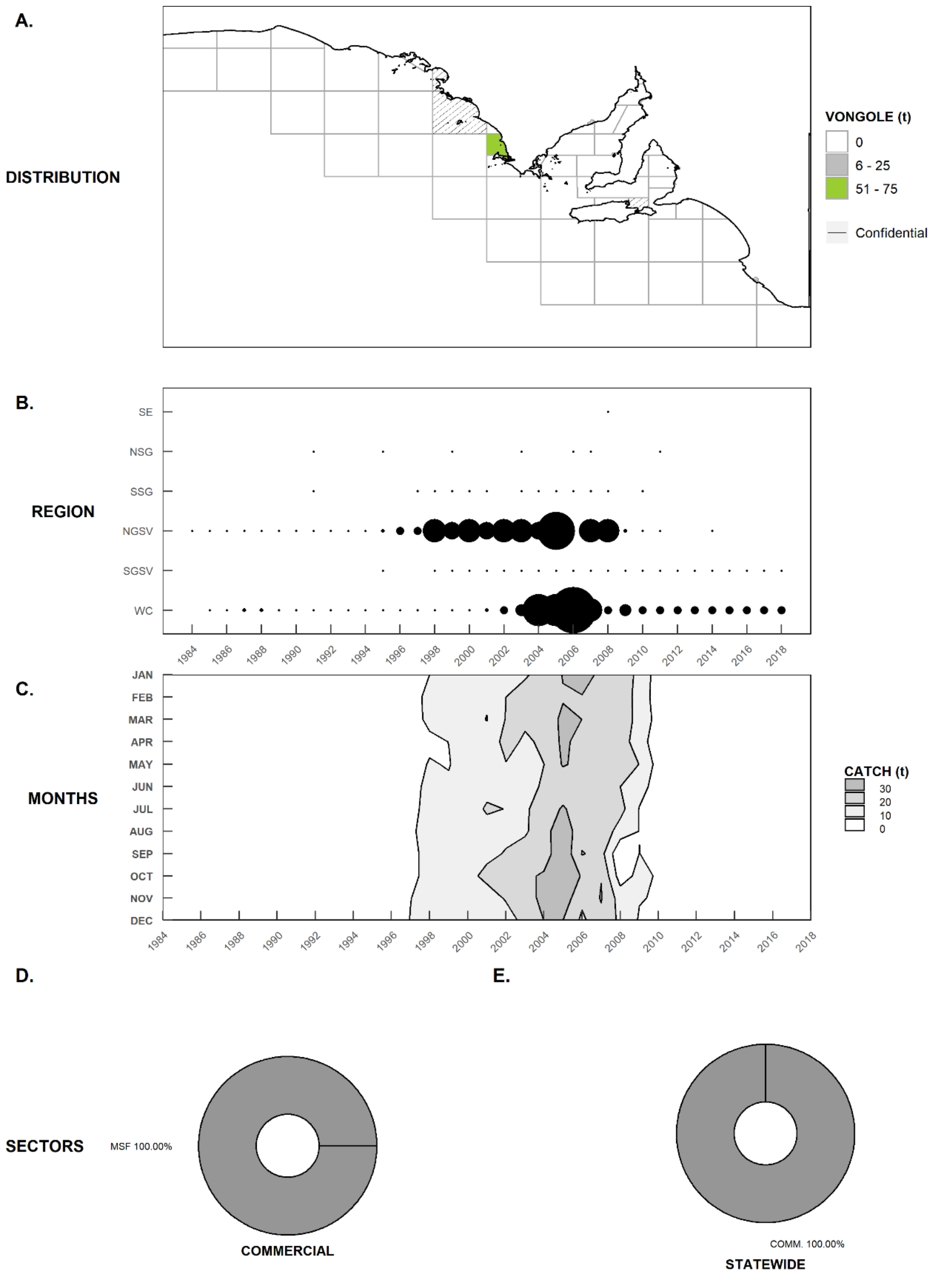

Figure 3-35. Vongole. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Fishery Performance

The MSF performance indicators and associated reference limits do not apply for Vongole, which PIRSA manage by TACC (PIRSA 2013).

Stock Status

The status of South Australia's Vongole Fishery is determined via a fishery-independent research program that undertakes structured surveys to determine the relative density and size structure of Vongole populations within West Coast, Coffin Bay and Port River Cockle Fishing Zones (Gorman et al. 2010, Dent et al. 2016a).

The most recent assessment of the status of Vongole stocks in the three management zones was for 2017. As 2018 stock status has not yet been determined (Held and Mayfield in review), the stock status of Vongole has not been updated in this report.

3.3.9. SNOOK

Biology

Snook (*Sphyraena novaehollandiae*) are elongate predators that are found over seagrass beds and kelp reefs in inshore and offshore waters (Emery et al. 2016). They prey on pelagic and demersal teleost fishes, crustaceans and cephalopods (Bertoni 1994). The species is distributed across southern Australia from Perth to Sydney, including Tasmania as well as New Zealand (Gomon et al. 2008). There is little information available on stock structure of Snook throughout this broad Australasian distribution (Emery et al. 2016).

A study in northern Gulf St. Vincent and Spencer Gulf during 2002 (O'Sullivan and Jones 2003) found that the largest fish was 820 mm TL, although most were from 300 to 500 mm TL. The modal age was 2+ years and the oldest fish were 12 years of age. Males and females demonstrated similar growth patterns, with strong biases in the sex ratio towards females. Snook were reproductively active during late spring-summer (Bertoni 1994). Snook are multiple batch spawners with indeterminate fecundity. The size at first maturity (L_{50}) is 391 mm and 403 mm for males and females, respectively, at two years of age.

Fishery

Snook are taken by both the commercial and recreational sectors of the MSF. In the former sector, they are generally taken with hauling nets and gill nets when commercial net fishers target higher value species such as King George Whiting, Southern Garfish, Southern Calamari and Yellowfin Whiting. Snook are also targeted using lures by commercial troll line fishers. Recreational fishers target Snook with rods and lines. The State-wide recreational survey done in 2013/14 estimated that 187,165 Snook were captured, of which 12,941 were released, leaving 174,224 fish retained (Giri and Hall 2015). The latter provided an estimated State-wide recreational harvest of 126.3 t.

Management Regulations

For the commercial sector, the many input controls for the netting gear types contribute to limiting fishing effort. The minimum size limit for Snook was increased from 360 to 450 mm TL in July 2001. A reduction in size limit to 410 mm TL came into effect in 2017, to align with the estimated size-at-maturity (Bertoni 1994). For the recreational sector, the size limit remains at 450 mm TL, with a bag limit of 20 fish and a boat limit of 60 fish. These regulations remained the same after the recent review of the recreational fishery (PIRSA 2016).

Commercial Fishery Statistics

State-wide

Estimates of annual, State-wide commercial catches of Snook increased to the highest recorded level of 147.3 t in 1995, before declining to the lowest level of 38.9 t in 2017 (Figure 3-36a). In 2018, the annual commercial catch increased marginally to 43.2 t. The economic value of the commercial catch of Snook in 2018 was approximately $ 231 K (*c.f.* $ 240 K in 2017) (Figure 3-36a).

Hauling nets have generally accounted for at least half of the annual catches, whilst troll lines and gill nets have been the second and third most important gear types. Targeted hauling net fishing effort has declined since 2005 to the lowest recorded level in 2010, after which it has increased slowly to 81 kg.fisher-day^{-1} in 2018 (Figure 3-36b). Targeted hauling net CPUE has been highly variable, often fluctuating by >30 kg.fisher-day^{-1} between years. During the 1980s and 1990s annual targeted catch rates ranged from 14 to 62.1 kg.fisher-day^{-1}. Through the 2000s, catch rates have generally been >50 kg.fisher-day^{-1}. The catch rate in 2018 was 53.0 kg.fisher-day^{-1} (Figure 3-36c). The number of MSF fishers taking Snook decreased from 318 in 1984 to 128 in 2005, and then stabilised at 107 in 2018 (Figure 3-36d).

Regional

Catches of Snook have been reported from all six geographic regions of South Australia's marine waters (Figure 3-37a). The highest regional catches were mainly taken from NSG and NGSV during the 1990s, with intermediate catches from SSG and the WC (Figure 3-37b). Catches from all regions have been lower during the 2000s. The fishery is seasonal with highest catches generally taken between July and November. Marine Scalefish Fishery licence holders accounted for all of the State-wide commercial catch in 2018 (Figure 3-37c). The MSF landed 27% of the total State-wide catch in 2013/2014 with the recreational sector accounting for the remaining 73% (Figure 3-37d).

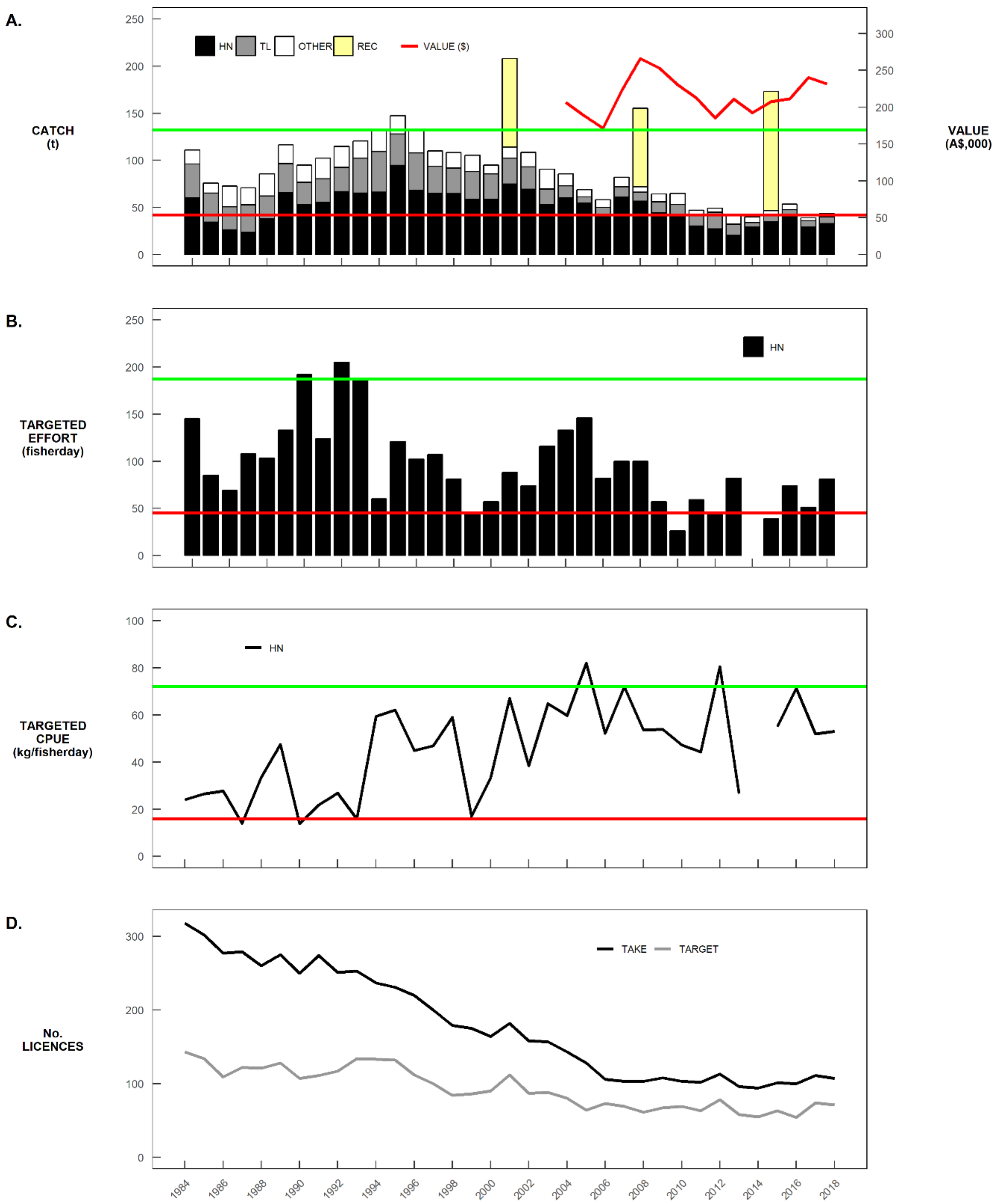

Figure 3-36. Snook. Long-term trends in: (A) total catch of the main gear types (hauling net and troll line), estimates of recreational catch, and gross production value; (B) targeted effort for hauling nets; (C) total catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-13.

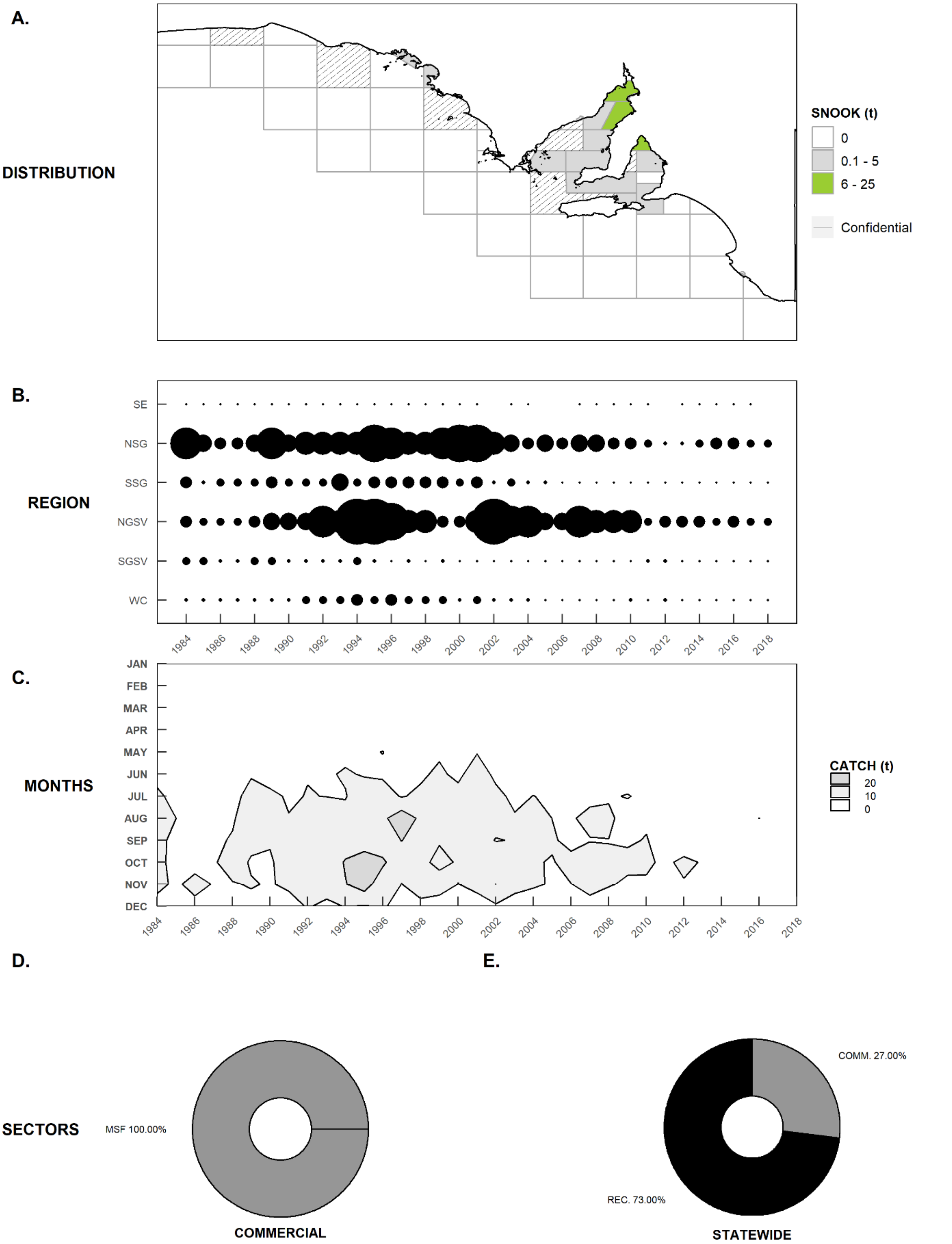

Figure 3-37. Snook. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Fishery Performance

The general fishery performance indicators for Snook were assessed for 2018 at the State-wide scale. There were no breaches of any trigger reference points (Table 3-13).

Table 3-13. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State-wide scale for Snook in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET HAULING NET EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET HAULING NET CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

The primary measures for biomass and fishing mortality are targeted catch rates using troll lines and hauling nets. Approximately 25% of the annual total catches come from targeted fishing effort using troll lines and hauling nets, with the remaining 75% landed as by-product when fishers target other, higher-value species. Targeted catch rates for both gear types are typically variable for troll lines and hauling nets. Total annual commercial catches have declined from a peak of 147 t in 1995 to 43.2 t in 2018, driven by a 72% reduction in fishing effort. This reduction largely reflects the removal of hauling net fishers through the implementation of a voluntary buy-back scheme and spatial netting closures in 2005. During this time, catch rates have been highly variable, but have not shown any long-term decline. The recent medium-level catches and associated catch rates indicate that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. On this basis, Snook in South Australia is classified as a **sustainable** stock.

3.3.10. BLUE CRAB

Biology

The Blue Crab (*Portunus armatus*) is distributed within near-shore, marine bays and estuarine systems in Australia and New Caledonia (Lai et al. 2010). The species occurs in a wide range of inshore habitats to a depth of at least 50 m (Williams 1982; Edgar 1990). Blue Crabs generally reach sexual maturity at carapace widths of between 70 and 90 mm (Smith 1982).

The spawning season lasts for three to four months over the summer/autumn period (Kumar et al. 2000). In South Australian waters, Blue Crabs near the Minimum Legal Size (MLS = 110 mm carapace width) have reached sexual maturity and are ~14 to 18 months old. Females produce at least two batches of eggs within a single season. Fecundity of females is size-dependent, increasing up to a carapace width of 134 mm and decreasing thereafter. Between 650,000 and 1,760,000 eggs are produced per spawning event (Kumar et al. 2000; 2003). Using allozyme markers, Bryars and Adams (1999) determined that the populations of *P. armatus* within Spencer Gulf, Gulf St Vincent and West Coast regions of South Australia represented separate sub-populations with limited gene flow.

Fishery

Blue Crabs were first harvested as by-product in South Australian Prawn and Marine Scalefish Fisheries in the 1970s. In 1981, an experimental trawl fishery with four licensed fishers was established in northern Spencer Gulf. This approach was later abandoned, and in 1983, six experimental pot fishing permits were offered to licence holders in the MSF. In 1985/86 the number of experimental licences was increased to 12, i.e. four on the West Coast, six in Spencer Gulf, and two in Gulf St Vincent. In 1986, the West Coast fishery declined and the four licence holders surrendered their entitlements. Also during 1986, the sale of Blue Crabs as by-product from the prawn fishery was prohibited.

During the early years the fishery was primarily based on the use of specialised crab pots. However, from 1998, crab pots were no longer used by the MSF as effort was transferred to the pot fishing sector of the BCF.

The statistics in this report refer to the MSF component of the Blue Crabs catch and exclude the BCF catches from 1996 onwards. In June 1996, management arrangements for a separate commercial Blue Crab Fishery (BCF) in South Australia were established. The BCF is based on the capture of a single species (*P. armatus*), although other crab species may also be landed. The BCF comprises two fishing zones, i.e. the Spencer Gulf and Gulf St Vincent fishing zone. An annual total allowable commercial catch (TACC) or 'quota' is determined for the BCF for the 12-month period from 1 July to 30 June, with separate quota units allocated for each fishing zone. Almost all of the TACC (99%) is allocated among the BCF licence holders (also referred to as 'pot fishers'), with the remainder allocated to some MSF licence holders. Following this, crab nets became the predominant gear type used in the MSF. Fishery-independent surveys are conducted to inform stock assessment of the BCF with the most recent report classifying the Gulf St Vincent and Spencer Gulf biological stocks as sustainable (Beckmann and Hooper 2018).

Management Regulations

Current output controls for Blue Crabs caught in South Australia include restrictions on the total commercial catch through a quota system (BCF), spatial and temporal commercial closures, bag and boat limits for recreational fishers, a minimum legal size limit (MLS) of 110 mm carapace width measured from the anterior base of the first spine, and restrictions on taking berried females.

The *Fisheries Management (General) Regulations 2007* state that Blue Crabs may also be taken from State waters within three nautical miles of the coast west of longitude 135°E, although this WC region of South Australia is not subject to quota management arrangements. Commercial pot fishers generally haul their gear once or twice every 24 hours using specifically designed crab pots covered with mesh. MSF fishers use either hoop or drop nets hauled every 20-30 minutes. Recreational fishers target Blue Crabs mostly using hoop/drop nets or hand held rakes. The most recent estimate of recreational catch was 376 t between December 2013 and November 2014 (Giri and Hall 2015).

Formalised management arrangements for the BCF include pot dimension restrictions, pot to quota unit ratios, delineation of two fishing zones in SG and GSV, and a single TACC with quota units allocated separately for each zone. Quota is transferable between the pot fishers of the BCF and eligible MSF licence holders, but only within the same zone.

The State-wide TACC for the BCF was initially set at 520 t for the 1996/97 fishing season (325 t in SG and 194 t GSV). Over the following four quota years the TACC was gradually increased to 627 t (382 t in SG and 245 t in GSV) in 2000/01, where it remained until 2012/13. In 2013/14 and 2014/15, the TACC for the GSV zone was reduced to 196 t due to stock sustainability concerns. A voluntary commercial closure in GSV was also implemented from 1 July 2013 to 15 January 2014. From 2015/16, the TACC for the GSV zone was increased to 245 t, resulting in an overall TACC of 627 t (382 t in SG and 245 t in GSV).

Since December 2016, recreational fishers have been restricted to a bag limit of 20 crabs (Blue Crabs and/or Sand Crabs combined) per person per day and a boat limit of 60 crabs per day (where 3 or more people are on board).

Commercial Fishery Statistics

State-wide

Estimates of annual, State-wide commercial catches of Blue Crabs have been variable since the fishery commenced in 1984 (Figure 3-38a). Annual catches were comparatively low until 1988. Catches then increased between 1989 and 1995 and reached a peak of 692.9 t, before falling to 74.3 t in 1998. The total annual catch then increased to 123.9 t in 1999, declined to a minimum of 31.2 t.yr^{-1} in 2016, before stabilising at 35.6 t in 2018 (*c.f.* 51.7 t in 2017). The economic value of the commercial catch of Blue Crabs in the MSF in 2018 was approximately $ 307 K (*c.f.* $ 409 K in 2017) (Fig. 3-38a).

Targeted crab net effort peaked at 5,000–7,000 fisher-days during the 90s. In the past decade, targeted effort ranged between 556 fisher-days in 2016 and 1,106 in in 2013. In 2018, target effort for Blue Crabs was 688 fisher-days (*c.f.* 895 in 2017) (Figure 3-38b).

Targeted crab net CPUE has increased from approximately 40 kg.fisher-day^{-1} in 1985 to 94.8 kg.fisher-day^{-1} in 1995, before declining to 51.8 kg.fisher-day^{-1} in 2000 (Figure 3-38c). Since then, CPUE has remained relatively stable and was 51.7 kg.fisher-day^{-1} in 2018 (*c.f.* 56.8 kg.fisher-day^{-1} in 2017). Since 1989, the numbers of fishers taking and targeting Blue Crabs have been closely linked, which indicates that this species is specifically targeted rather than being a by-product species. The number of fishers targeting Blue Crabs using pots and nets peaked in 1988, and has declined to 28 in 2018.

Regional

From 1985 to 2005, Blue Crabs were primarily harvested from NSG and NGSV (Figure 3-39a, b). Catch in NSG was highest from 1985–1997, while NGSV was highest from 1998–1997. Outside of this region, the highest catches have been taken from the WC and from 2006 onwards, a majority of the catch was harvested from this region. Lower annual catches occurred in SSG and SGSV, while no catch has been recorded the SE. From 1984–1996, the Blue Crabs were harvested all year round, with highest catches during February and March (Figure 3-39c). Since 1997 Blue Crabs harvests have been seasonal with highest catches taken between January and March.

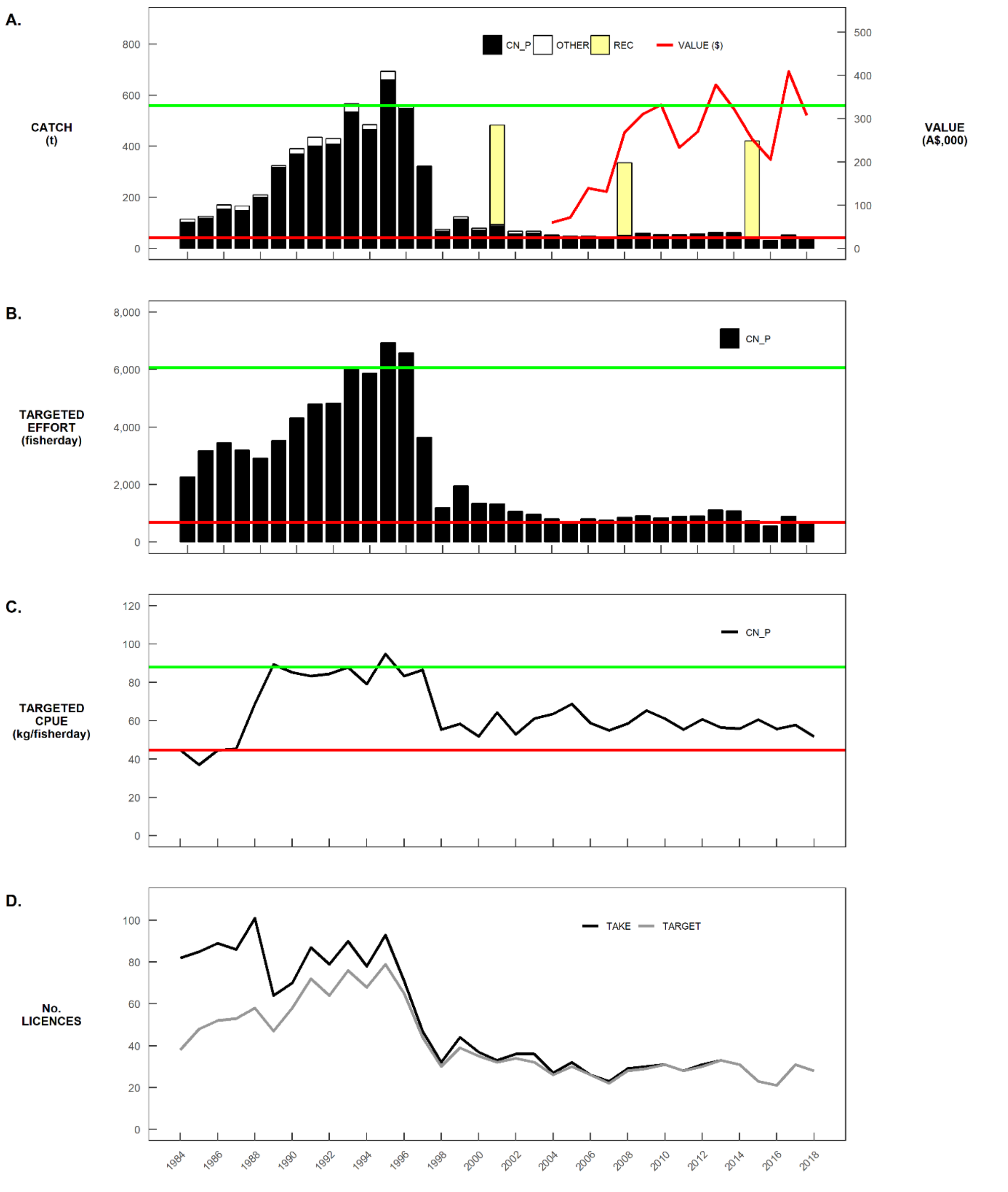

Figure 3-38. Blue Crabs. Long-term trends in: (A) total catch of the main gear types (crab net/pot and other), estimates of recreational catch, and gross production value; (B) targeted effort crab net/pots; (C) total catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-14.

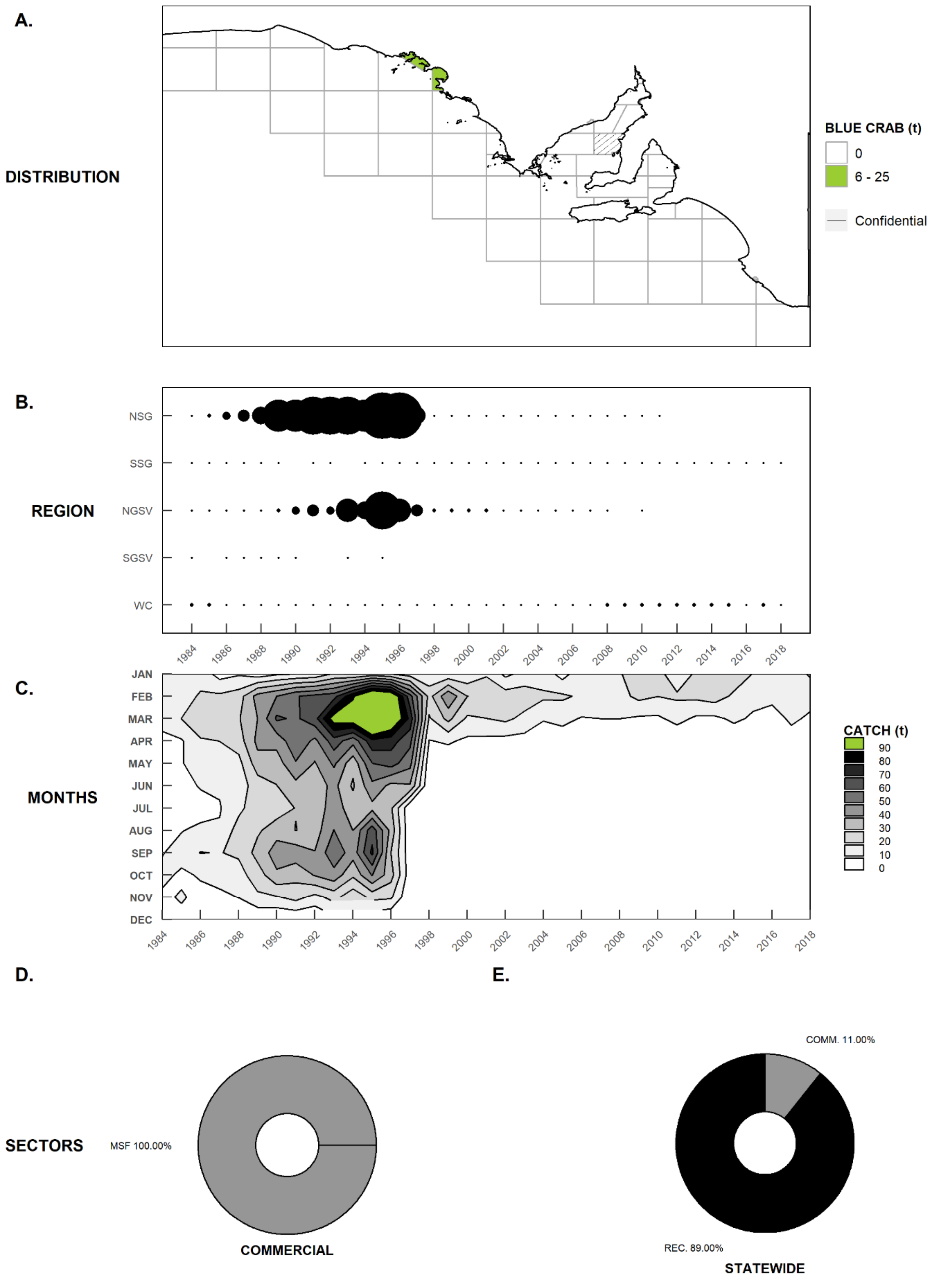

Figure 3-39. Blue Crabs. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t); and (D) the proportion of catch distributed among the commercial sector in 2018.

Fishery Performance

The general fishery performance indicators for Blue Crabs were assessed for 2018 at the State-wide scale. One trigger reference point (2nd lowest catch) was activated by the downward trend in total catch (Table 3-14).

Table 3-14. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State-wide scale for Blue Crab in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	2nd lowest
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET CRAB NET EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET CRAB NET CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

The Blue Crab resource is accessed by specialist fishers that require endorsed net or pot types on their MSF licences to target the species. Consequently, the fishery statistics considered here at State-wide scale related to targeted fishing effort. Nevertheless, the interpretation of such data is complicated by the transfer of MSF effort to the pot fishing sector in the gulfs. This is reflected by low catches from the Spencer Gulf and Gulf St Vincent since 2008. For the WC zone, recent catches and targeted crab net effort levels are relatively high compared to those in the past. Relatively stable CPUE and consistent catches over the past decade indicate that the biomass of this management unit (stock) is unlikely to be depleted and that recruitment is unlikely to be impaired. On this basis, the Blue Crab stock available to the MSF, is classified as **sustainable**.

3.3.11. SAND CRAB

Biology

The Sand Crab (*Ovalipes australiensis*) is a medium-sized crab species with a broad distribution across southern Australia from Wide Bay in Queensland, to Rottnest Island in Western Australia, including Tasmanian waters (Kailola et al. 1993). They occur along surf beaches, in sandy bays and inlets, and in offshore waters to ~100 m depth. In South Australia, they occur in most inshore waters except the northern gulfs and west coast bays (Jones 1995), where Blue Crabs are most abundant. The stock structure of Sand Crabs is unknown.

A study into the reproductive biology of Sand Crabs in Coffin Bay determined that they are winter spawners for which reproductive activity peaks in July, with berried females present until late August (Deakin 1996). Female Sand Crabs attain sexual maturity at a smaller size than males. A measuring program undertaken in Coffin Bay during the late 1990s determined that all sampled females were below the minimum legal size or 100 mm, indicating that the regional Sand Crab fishery was essentially based on males (Jones and Deakin 1997, Jones 2000).

Fishery

In South Australia, the commercial fishery for Sand Crabs initially developed in Coffin Bay in 1982 and subsequently extended to southern coastal areas. It started as an experimental trap or pot fishery. The fishery expanded outside of Coffin Bay as fishers began using more efficient hoop and drop nets, actively targeted Sand Crabs during the night, and implemented mechanical net haulers (Jones 1995, Jones and Deakin 1997).

Recreational fishers target Sand Crabs using hoop or drop nets from jetties along the southern metropolitan Adelaide coast, and from small vessels in southern coastal waters. Approximately 52,557 Sand Crabs were captured by the recreational sector in 2013/14, of which 48.1% were released, resulting in a harvest of 27,277 animals, with an estimated total weight of 9.9 t (Giri and Hall 2015).

Management Regulations

A minimum legal size of 100 mm carapace width (measured across the widest point) was introduced in 1992 for market purposes (Jones 1995). Commercial fishers require a specific licence endorsement to target Sand Crabs and are restricted to a nominated quantity of crab net/pots. Within the MSF there are four dedicated Sand Crab licence holders who have a combined access to 400 crab net/pots. Recreational fishers have a combined Sand/Blue Crab bag and boat limit of 20 and 60 crabs, respectively (PIRSA 2016b).

Commercial Fishery Statistics

State-wide

Estimates of annual, State-wide commercial catches of Sand Crabs have been variable since the fishery commenced in 1984 (Figure 3-40a). Annual catches were comparatively low until 1988. They then increased considerably between 1989 and 1990 reaching a peak of 152 t, before dropping to a minimum of 40.1 t in 1994. Since then, total catch increased again to the highest recorded level of 177 t in 2005, but has since declined over the long-term to 44.2 t in 2018. During the early years the fishery was based on the use of crab pots. However, in 1989, crab nets (hoop and drop nets) were more prevalent. In the following years, the use of crab nets gradually increased, and since 1991 have dominated the fishery. The economic value of the commercial catch of Sand Crabs in the MSF in 2018 was approximately $ 261 K (*c.f.* $ 337 K in 2017) (Fig. 3-40a).

There have been three peaks in targeted fishing effort on Sand Crabs that exceeded 1,000 fisher-days.yr^{-1} (Figure 3-40b). These were in 1989-1991, 1997-2000, and in 2005 and 2006. Since 2006, there has been a gradual decline in targeted effort, which dropped to 335 fisher-days in 2018.

Targeted crab net and pot CPUE has been variable but nevertheless demonstrated a gradual, long-term increase from 76.5 kg.fisherday^{-1} in 1992 to 131.0 kg.fisherday^{-1} in 2018 (Figure 3-40c). The numbers of fishers taking and targeting Sand Crabs are closely linked, which indicates that this species is specifically targeted rather than being a by-product species. The numbers of fishers increased up to 45 in 1997, but have since declined to 14 in 2018.

Regional

The fishery has been heavily concentrated in and around Coffin Bay on the West Coast (Figure 3-41a). Outside of this region, the highest catches have been taken from SSG. Lower annual catches have occurred in SGSV and NGSV (Figure 3-41b), with only incidental catches ever recorded from NSG and the SE. The Sand Crab fishery has been seasonal with highest catches being taken between October and March (Figure 3-41c).

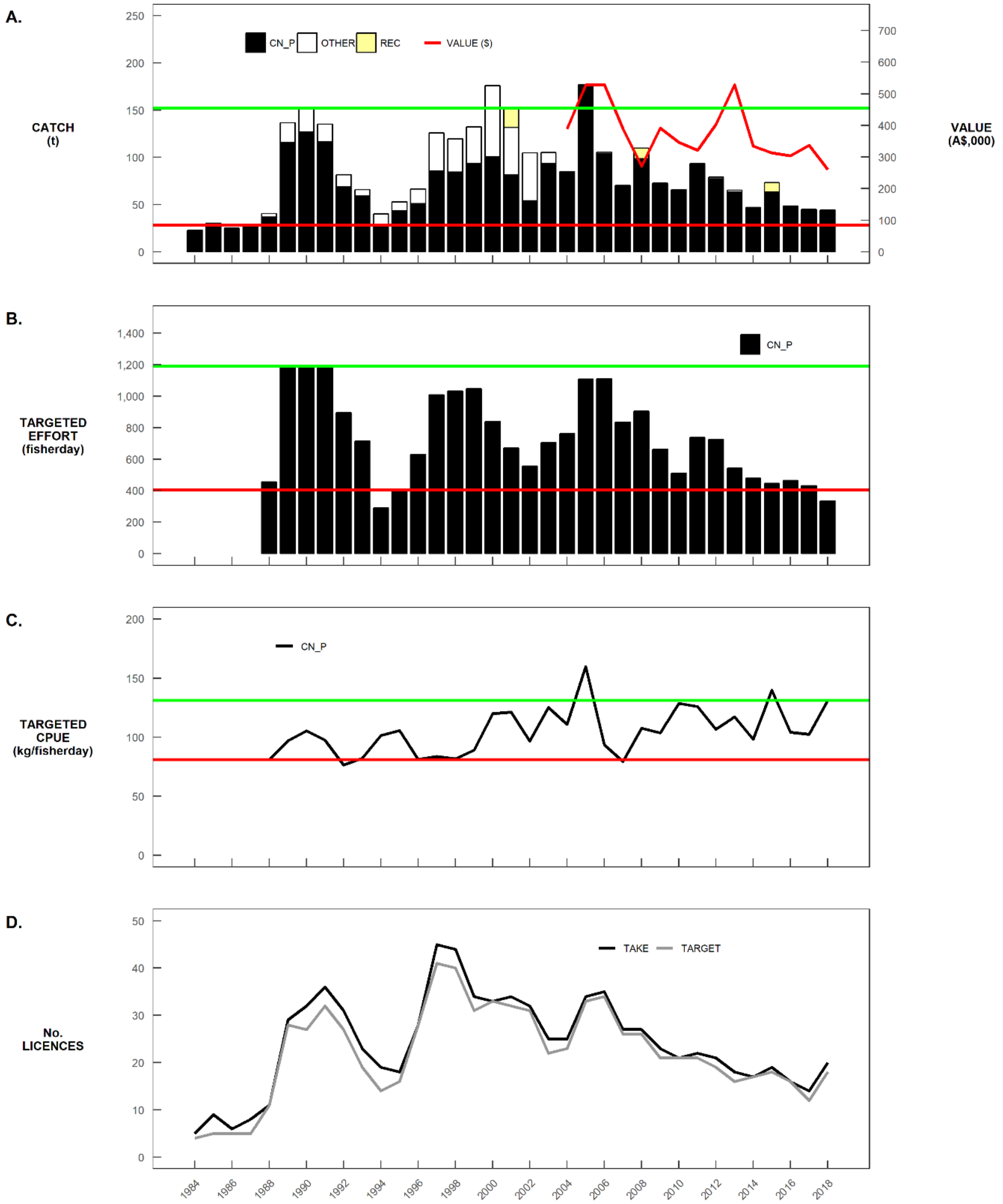

Figure 3-40. Sand Crab. Long-term trends in: (A) total catch of the main gear types (crab net/pot and other), estimates of recreational catch, and gross production value; (B) targeted effort crab net/pots; (C) targeted catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-15.

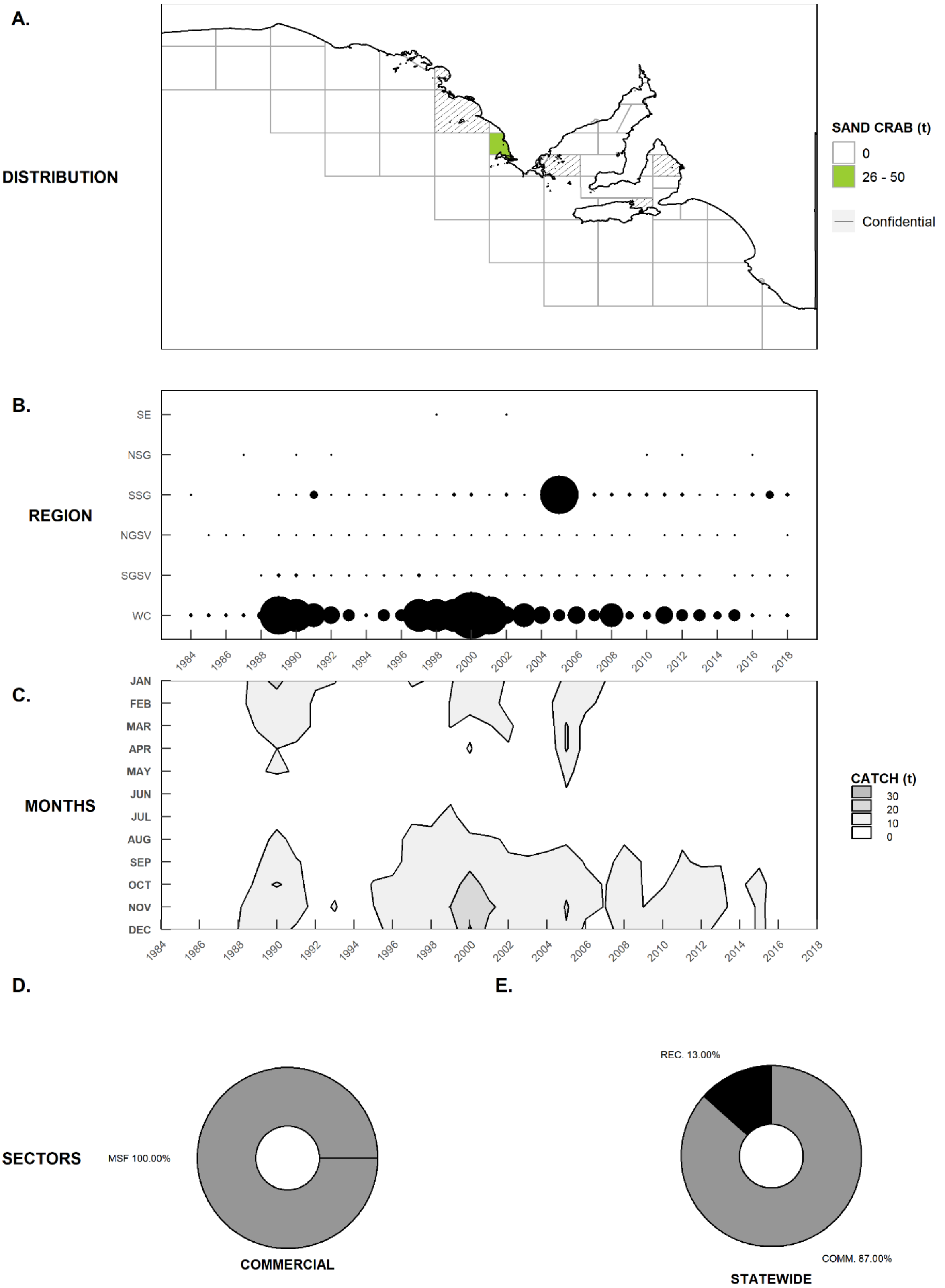

Figure 3-41. Sand Crab. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Fishery Performance

The general fishery performance indicators for Sand Crabs were assessed for 2018 at the State-wide scale. The reference period was from 1989 onwards, when the fishers starting to target Sand Crabs with crab nets. Two trigger reference points were activated. In 2018, the 2nd lowest crab net effort was recorded, whilst targeted crab net CPUE was the third highest yet recorded (Table 3-15).

Table 3-15. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State-wide scale for Sand Crab in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET CRAB NET EFFORT	G	3rd Lowest / 3rd Highest	2nd lowest
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET CRAB NET CPUE	G	3rd Lowest / 3rd Highest	3rd HIGHEST
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

The Sand Crab fishery consists of specialist fishers that require endorsed net or pot types on their licences to target the species. Consequently, the fishery statistics considered here at the State-wide scale related to targeted fishing effort. Nevertheless, the interpretation of such data is complicated by the development of the fishery since 1982/83 that resulted in improvements in fishing efficiencies (Jones 1995, Jones and Deakin 1997, Jones 2000). The early fishery involved a few fishers that primarily used crab pots. Then, as the number of operators increased, they began to use hoop nets, which were later replaced with more effective drop nets. Furthermore, fishers started to work at night when the crabs were more active, and to use portable, mechanical net haulers, allowing further modifications to net design. The commercial fishery statistics for Sand Crabs are characterised by significant inter-annual variability, although with long-term trends apparent. The trends in State-wide catch statistics are largely driven by those from the West Coast, which was dominated by the Coffin Bay fishery. The recent catches and targeted crab net effort levels are relatively low compared to those in the past, whilst targeted catch rates have generally increased over time. As such, these data show evidence of the increases in efficiencies in the fishery but no indication that it is becoming recruitment limited. On the basis of these data, South Australia's Sand Crab fishery is classified as **sustainable**.

3.3.12. YELLOWEYE MULLET

Biology

The Yelloweye Mullet (*Aldrichetta forsteri*) is a small, schooling species that inhabits estuaries and nearshore coastal waters along Australia's southern coast from Kalbarri in Western Australia to the Hunter River in New South Wales, and around Tasmania (Gomon et al. 2008; Earl et al. 2016a). Yelloweye Mullet occur over sandy and muddy substrates to depths of 20 m, and are often abundant in estuaries (Kailola et al. 1993). This species is considered a marine estuarine-opportunist, i.e. spawns at sea; regularly enters estuaries, particularly as juveniles, but also uses coastal marine waters as alternative nursery areas (Potter et al. 2015).

The biological stock structure of Yelloweye Mullet throughout southern Australia is poorly understood. Available data suggest the populations in this geographic region form two discrete biological stocks, i.e. the Western and Eastern Stocks. The South Australian populations on the Far West Coast are thought to contribute to the Western Stock (Smith et al. 2008), while populations in Spencer Gulf, Gulf St Vincent and the South East are thought to be part of the Eastern Stock (Thomson 1954; Pellizzari 2001).

In South Australia, the Yelloweye Mullet is a fast growing, short-lived species that attains a maximum length of 440 mm and maximum age of 10 years. Females mature at around 240 mm TL, while males mature at around 250 mm TL (Earl and Ferguson 2013). They have a protracted spawning season from winter to early autumn, with spawning most frequent during December–February.

Fishery

Yelloweye Mullet are taken by both the commercial and recreational sectors of the MSF. In the commercial sector, they are targeted and taken as by-product with hauling nets and set nets. However, 80–90% of annual State-wide commercial catches over the past decade have been taken by the Lakes and Coorong Fishery, which is not considered in this report (Earl 2019).

Recreational fishers target Yelloweye Mullet with rod and line. The State-wide recreational survey in 2013/14 estimated that 100,876 Yelloweye Mullet were captured, of which 29,598 fish were released, leaving 71,278 fish retained (Giri and Hall 2015). This provided a total estimated State-wide recreational harvest of 19.4 t.

Management Regulations

Mullet spp. are considered a secondary taxa of the commercial MSF, being of medium value and making a relatively small contribution to the total production value of the fishery (PIRSA 2013). For the commercial sector, regulations are in place to manage fishing effort and limit the take of Mullet spp. These include temporal and spatial netting closures, restrictions to net lengths and mesh sizes, and a minimum legal size of 210 mm TL (PIRSA 2016).

There are multiple management regulations in place for Mullet spp. in the recreational sector. Input and output controls ensure the total catch is maintained within sustainable limits and that access is distributed equitably among fishers. These include a daily recreational bag limit of 60 fish and boat limit of 180 fish, and gear restrictions. The minimum size limit of 210 mm TL also applies to this sector.

Commercial Fishery Statistics

State-wide

The total commercial catch of Yelloweye Mullet peaked at 175 t in 1990, before declining to an historic low of 12.5 t in 2016. Catch increased to 19.7 t in 2018 (*c.f.* 22 t in 2017). The economic value of the commercial catch of Yelloweye Mullet in 2018 was approximately $ 130 K (*c.f.* $ 91 K in 2017) (Fig. 3-42a). In recent years, most catch has been taken using hauling nets, with set nets making the second largest contribution. Annual estimates of total fishing effort that produced catches of Yelloweye Mullet have been dominated by hauling nets. Total haul net fishing effort declined from a peak of almost 6,000 fisher-days in 1984 to <500 fisher-days in 2009 (Figure 3-42b). Haulnet effort has been low yet stable and ranged between 400 and 694 fisher-days between 2014 and 2018, with 658 fisher-days recorded in 2018 (*c.f.* 694 in 2017).

Hauling net CPUE was relatively stable in the 1980s and 1990s, before it increased substantially from 22 to 50 kg.fisher-day^{-1}between 2003 and 2005 (Figure 3-42c). It remained high (30 55 kg.fisherday^{-1}) until 2012 with that period including the highest value on record (55 kg.fisherday^{-1}) in 2011. The hauling net CPUE had decreased to 26 kg.fisher-day^{-1} in 2018 (*c.f.* 28.4 kg.fisher-day^{-1} in 2017). The numbers of fishers who reported taking and targeting Yelloweye Mullet have both decreased (< 60 in 2018) over the time-series.

Regional

Historically, catches of Yelloweye Mullet have been reported from each of the six geographic regions of South Australia's marine waters Figure 3-43a, b). Between 1984 and 1992, the highest catches were taken in Northern and Southern Gulf St Vincent, the former remaining the major contributor since 2003. Catches in the other five regions have been low over the past decade.

Prior to 2005, the fishery was seasonal, with most catches taken between January and April of each year. There has been no clear seasonality of Yelloweye Mullet catches by the MSF during the past decade (Figure 3-43c). In 2018, MSF licence holders accounted for 98.6% of the commercial catch, with the remainder taken by SZRLF licence holders (Figure 3-43d, e).

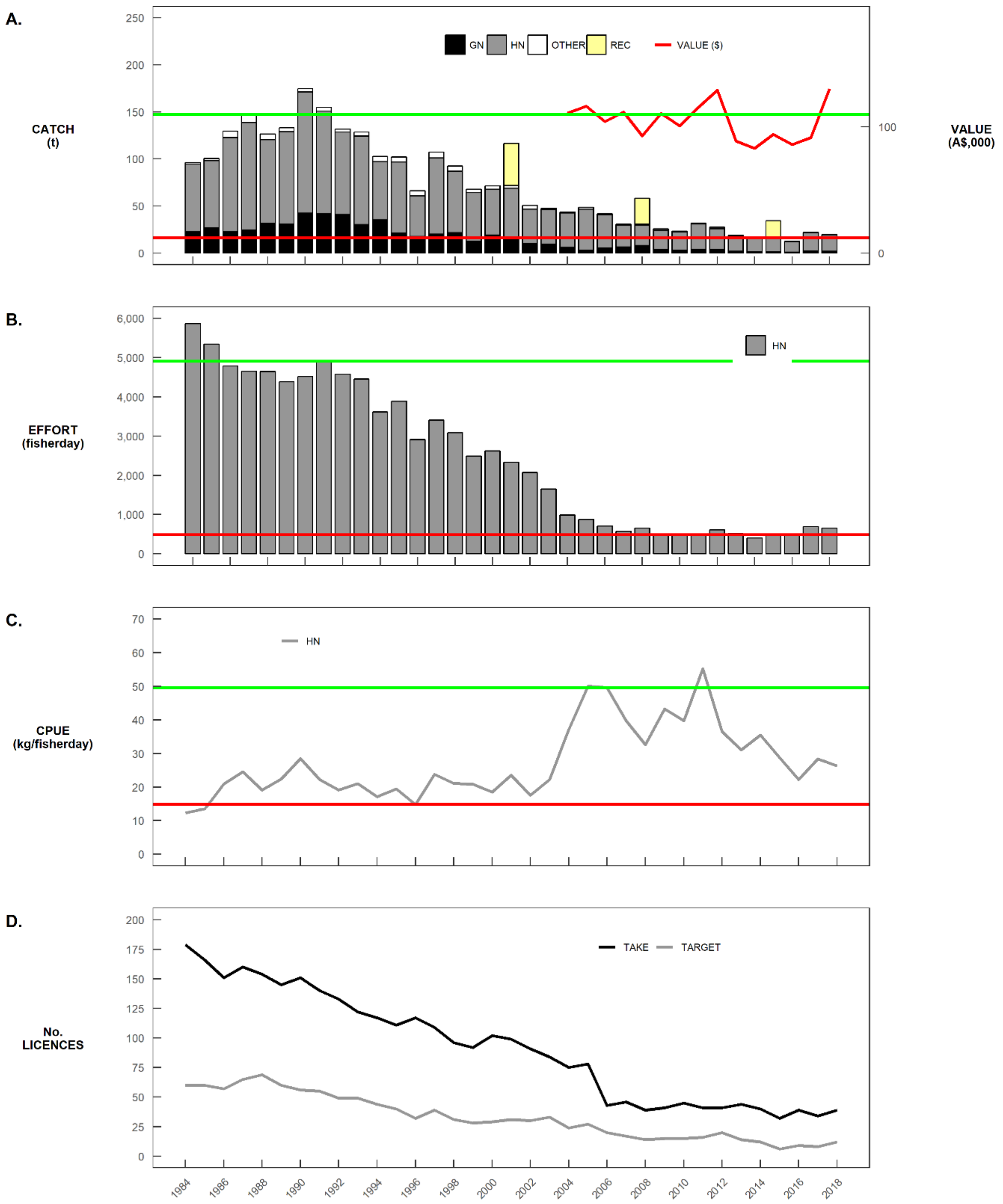

Figure 3-42. Yelloweye Mullet. Long-term trends in: (A) total catch of the main gear types (hauling net and set net), estimates of recreational catch, and gross production value; (B) total effort hauling net; (C) total catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-16.

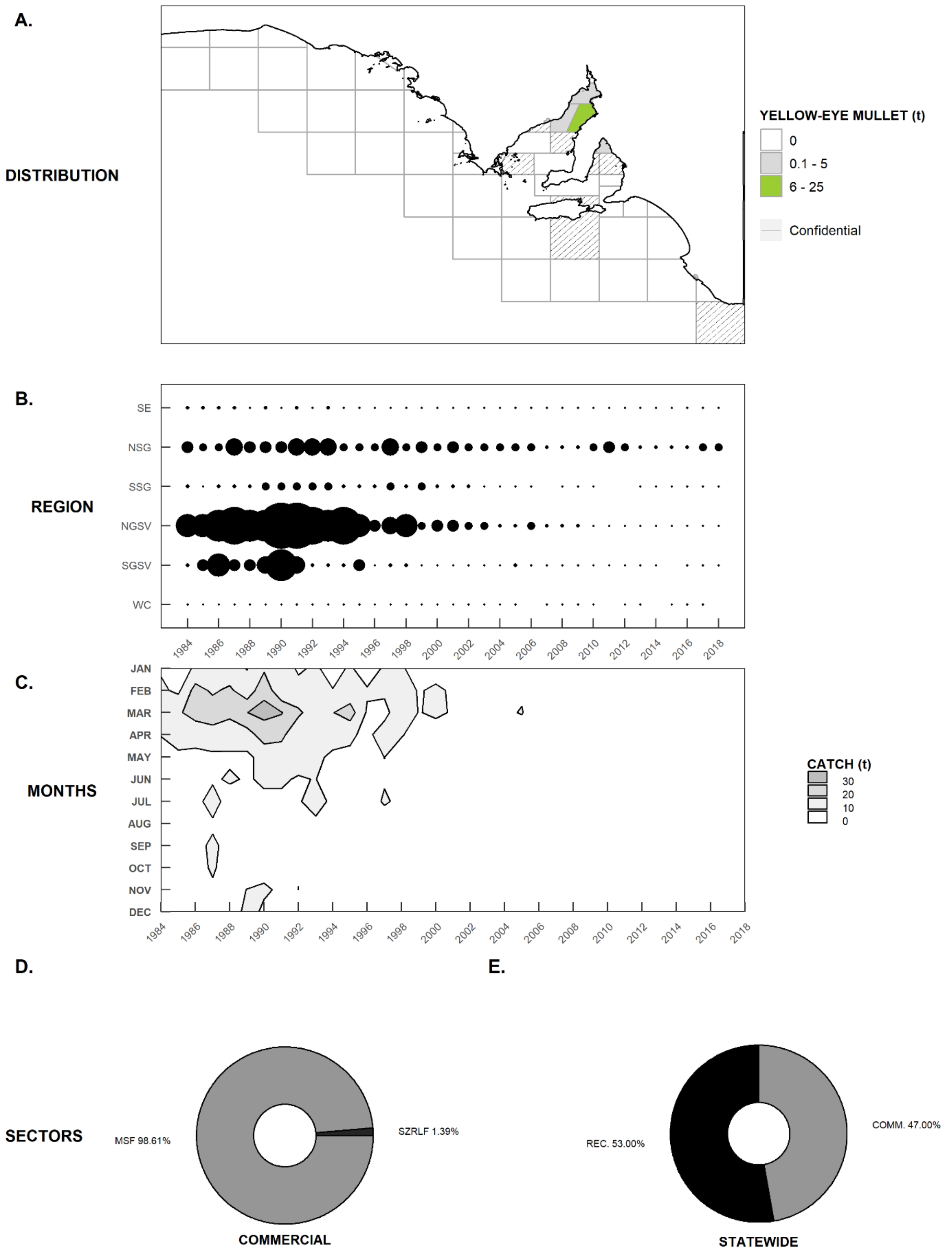

Figure 3-43. Yelloweye Mullet. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t); (D) the proportion of catch distributed among the commercial sector in 2018, and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Fishery Performance

The general fishery performance indicators for Yelloweye Mullet were assessed for 2018 at the State-wide scale. No trigger reference points were breached (Table 3-16).

Table 3-16. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Yelloweye Mullet in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAULING NET EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTALHAULING NET CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

Yelloweye Mullet is predominantly taken as by-product within the hauling net sector of the MSF when other species are targeted. Annual catches of Yelloweye Mullet have been low and stable for a considerable period, which reflects the declines in fishing effort in the hauling net sector of the fishery. The long-term decline in fishing effort likely relates to the relatively low value of Yelloweye Mullet on the domestic market, rather than a declining biomass, as hauling net CPUE over recent years has been above the long-term average for the fishery. The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. On this basis, the Yelloweye Mullet fishery is classified as **sustainable**.

3.3.13. MULLOWAY

Biology

Mulloway (*Argyrosomus japonicus*) is a large, schooling species that inhabits estuaries and nearshore coastal waters in subtropical to temperate regions of the Atlantic, Pacific and Indian Oceans including around southern Australia, Africa and India (Silberschneider and Gray 2008; Gomon et al. 2008). In Australia, Mulloway occur from North West Cape, Western Australia, to the Burnett River, Queensland, excluding Tasmania (Kailola et al. 1993). Juveniles are often abundant in estuaries, while adults are predominantly found in nearshore coastal waters, including the surf zone and around the mouths of rivers (Griffiths 1997).

Mulloway is a late-maturing species that can attain a maximum age of 42 years and maximum length of 2000 mm TL. In South Australia, Mulloway mature at ~780 mm TL and five years of age for males and 850 mm TL and six years of age for females (Ferguson et al. 2014). Spawning occurs from October to January each year (Ferguson et al. 2014). Regional differences in otolith morphology and chemistry, and genetic characteristics suggest distinct populations of Mulloway along the eastern and western coasts of South Australia (Ferguson et al. 2014; Barnes et al. 2015).

Fishery

In South Australia, most of the commercial catch of Mulloway is taken by the Lakes and Coorong Fishery (Earl and Ward 2014; Earl 2019), which is not considered in this report. However, this species is also taken by the commercial and recreational sectors of the MSF. In the commercial sector, Mulloway are taken with multiple gear types that include set nets, fishing rods and hand lines. For the recreational sector, Mulloway is an iconic species that is targeted with rod and line. The State-wide recreational survey in 2013/14 estimated that 47,238 Mulloway were captured by the recreational sector of which 37,354 fish were released, leaving 9,833 fish harvested (Giri and Hall 2015). The estimated total harvest weight was 59.5 t, which was considerably higher than the annual catches of the commercial sector.

Management Regulations

Mulloway can be taken by the commercial MSF fishers in all coastal waters of South Australia, except those accessible to the commercial Lakes and Coorong Fishery (PIRSA 2014). No specific harvest strategy exists for Mulloway in the MSF (PIRSA 2013). However, multiple management regulations are used to ensure the sustainable harvest of the species. For the commercial sector, temporal and spatial netting closures are used to manage fishing activity and effort. Restrictions to gear including net lengths and mesh sizes, and a minimum size limit of 820 mm TL applies for both sectors. For the recreational sector, a bag limit of two fish and boat limit of six fish applies in marine waters.

Commercial Fishery Statistics

State-wide

During the mid-1980s and early 1990s, total annual commercial catch of Mulloway by the MSF fluctuated between 7–15 $t.yr^{-1}$ with a peak of 24.2 t in 1995 (Figure 3-44a). Catches declined during the late 1990s, remained low during the 2000s, and then declined to a low of 1.1 t in 2016. The total commercial MSF catch of Mulloway of 9 t in 2018 was the highest since 1997. The economic value of the commercial catch of Mulloway in 2018 was approximately $ 51 K (*c.f.* $ 42 K in 2017) (Figure 3-44a).

From 1984 to 2001, total catch was dominated by set nets and handlines. Since then, hauling nets have accounted for proportionally higher catches (Figure 3-44b). Catch rates for set nets were relatively stable between 2000 and 2009, but were then highly variable between 2010 and 2018 (Figure 3-44c). Catch rates for handlines have shown no long-term trend from 1984 to 2018. In 2018, the catch rates for set nets and handlines were 36.1 $kg.fisher\text{-}day^{-1}$ and 22.9 $kg.fisher\text{-}day^{-1}$, respectively.

The number of licence holders who reported taking Mulloway has declined over the long-term at a faster rate than the lower number of fishers who reported targeting the species (Figure 3-44d). The higher numbers of fishers taking Mulloway compared to those targeting the species, suggests it is largely a by-product when fishing for more valuable species.

Regional

Historically, catches of Mulloway have been reported from each of the six geographic regions of South Australia's marine waters, with most having been taken in the South East (Figure 3-45a, b). In 2018, most of the commercial catches were taken in Northern Gulf St Vincent. There is no clear seasonality for Mulloway catches by the MSF (Figure 3-45c). In 2018, all commercial catches of Mulloway in marine waters were taken by MSF licence holders (Figure 3-45d, e).

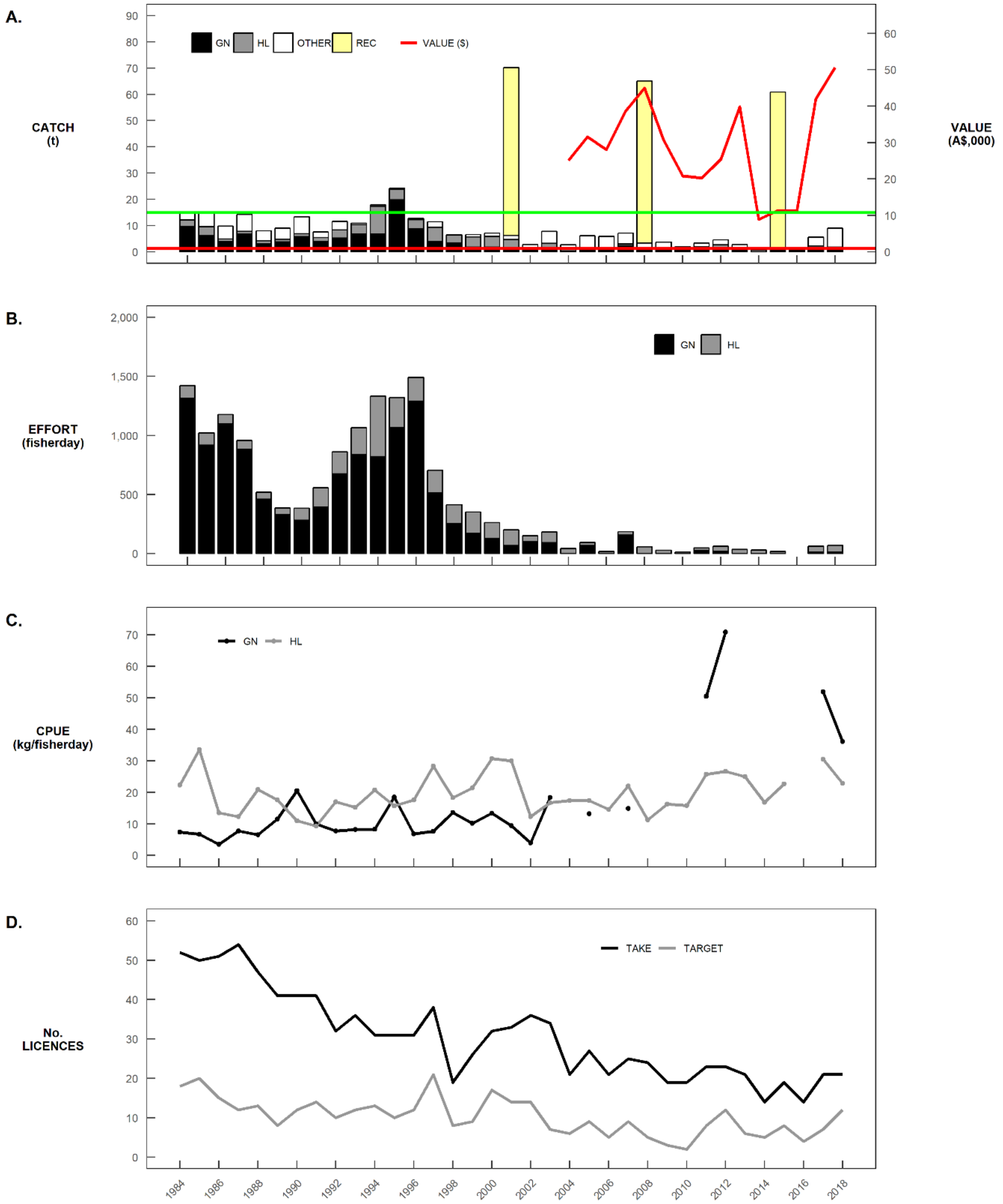

Figure 3-44. Mulloway. Long-term trends in: (A) total catch of the main gear types (handline and set net), estimates of recreational catch, and gross production value; (B) total effort; (C) total catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-17.

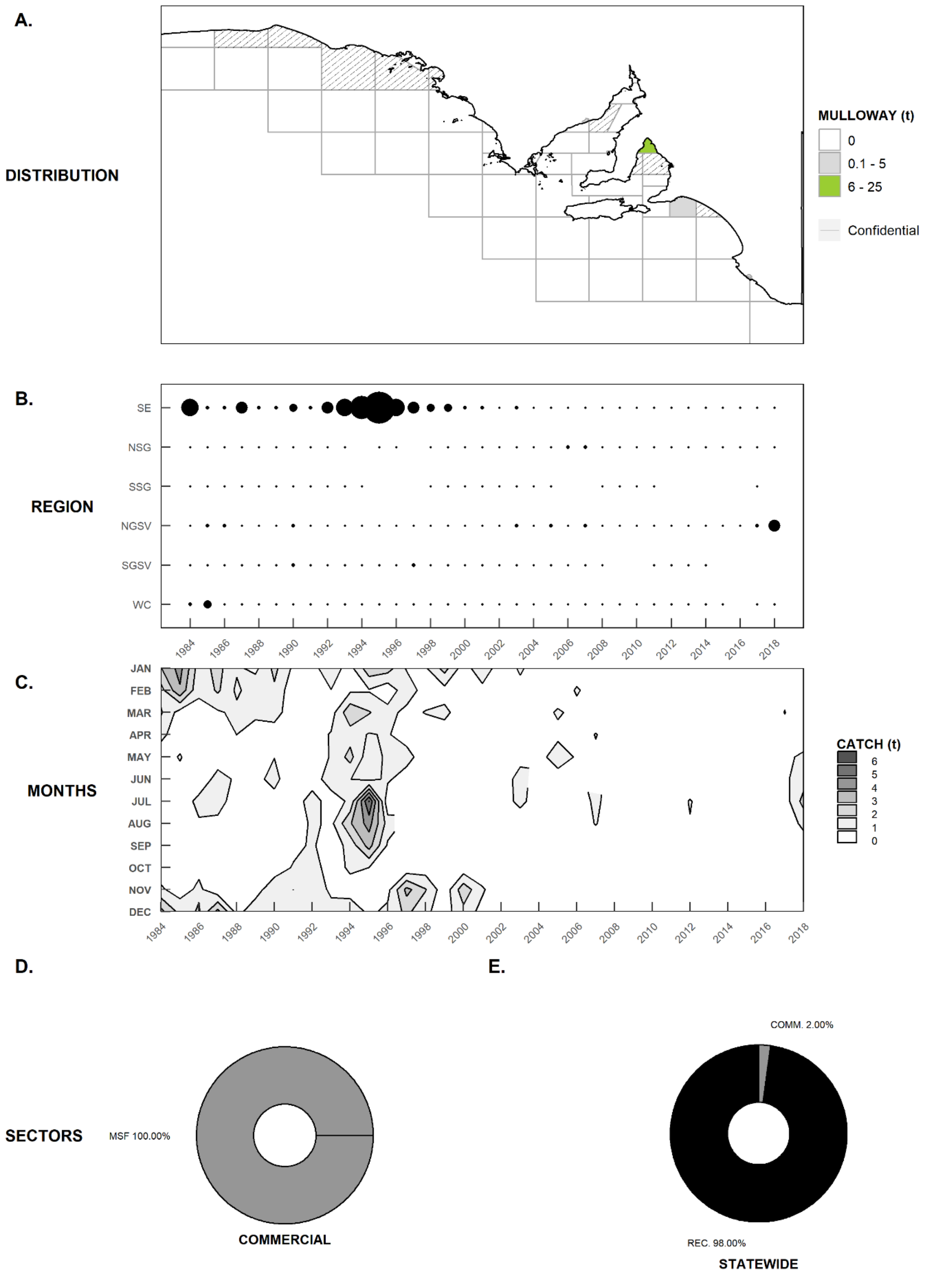

Figure 3-45. Mulloway. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Fishery Performance

The general fishery performance indicators for Mulloway were assessed for 2018 at the State-wide scale. No trigger reference points were breached (Table 3-17).

Table 3-17. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State-wide spatial scale for Mulloway in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAND LINE EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAND LINE CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL SET NET EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL SET NET CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

Mulloway is of medium-high value but makes a relatively minor contribution to the commercial MSF total production value because of the low volume taken. Whilst the species is taken as targeted catch, the higher numbers of fishers who reported taking Mulloway suggest it is taken predominantly as by-product. Total commercial catch of Mulloway has shown a long-term decline since the peak in the mid-1990s. This likely reflects the long-term reduction in fishing effort, rather than a decline in fishable biomass, as catch rates have generally remained consistent over the same period. The recent high CPUE indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. On this basis, the Mulloway fishery is classified as **sustainable**.

3.3.14. WHALER SHARKS

Biology

Two species of 'Whaler Sharks' including the Bronze Whaler (*Carcharhinus brachyurus*) and the Dusky Shark (*C. obscurus*) are taken in the MSF. The species can be differentiated by their physical characteristics. Bronze Whalers are copper coloured, have non-serrated teeth and lack an inter-dorsal ridge, whereas Dusky Sharks are dark brown in colour, have serrated teeth and an inter-dorsal ridge located between the first and second dorsal fin.

Female Bronze Whalers live for 31 years and males have similar lifespans of 25 years. Males and females both reach sexual maturity at 16 years of age at lengths of 2.2 and 2.7 m TL, respectively (Drew et al. 2016). The breeding frequency of Bronze Whalers is poorly understood in Australian waters, yet females produce 20–24 pups per litter. Dusky Sharks are long-lived (max ~50 years), slow growing, have a 3-year breeding frequency and only produce 3–12 pups per litter (Romine et al. 2009; McAuley et al. 2007). Large juvenile Dusky Sharks (>2.0 m) migrate between Western Australia and South Australian waters (Rogers et al. 2012). Similarly, there is preliminary evidence of east-ward and west-ward movements of Bronze Whalers between state jurisdictions (Rogers et al. 2012; 2013; Drew et al. 2019).

Fishery

The MSF mostly uses longlines to target Whaler Sharks and in the last decade 70–90% of the total annual catches taken using that gear type. During the years prior to the Offshore Constitutional Settlement with AFMA (pre-1999), a larger proportion (45–92%) of the catch of Whaler Sharks was taken using demersal-set gillnets.

Preliminary data suggest catch contributions of the two Whaler Shark species are spatially and temporally variable, and MSF longline catches are mostly comprised of juvenile Bronze Whalers (>90%). Catches of Whaler Sharks are not currently resolved to the species level in the MSF log-books.

The MSF predominantly targets Whaler Sharks during spring–autumn using floating and demersal set longlines in Spencer Gulf, Gulf St Vincent and the West Coast.

Recreational fishers target Whaler Sharks during spring and summer from boats, jetties and the shore in South Australia (Jones 2008). A small number (<40 per annum) are also taken by recreational fishers in the South Australian Charter Boat Fishery (Rogers et al. 2017), and by fishers targeting Mulloway from the shore on the West Coast (Rogers et al. 2014).

Given the Dusky Shark stock (early juveniles and adults) is mostly distributed off Western Australia, the status is determined from assessments during the National Status of Australian Fish Stocks (SAFS) process for the Western jurisdiction. In contrast, the Bronze Whaler stock is not assessed at the single species level in SAFS and the stock has been assessed at the state level (Steer et al. 2018a, b).

Management Regulations

Whaler Sharks in the MSF are managed under input controls on longlines, set nets, droplines and handlines. There is no commercial size limit. Management measures aimed at limiting fishing effort and mortality of larger mature individuals include, limits on the daily number of hooks that can be set (n = 200), limits on hook leader diameter (2 mm) for longlines, and mesh size restrictions (150 mm) for demersal gill nets. South Australian recreational fishery regulations for Whaler Sharks (combined) include a daily bag limit of one shark per fisher and a daily boat limit of three sharks, when there are three or more fishers on-board.

Commercial Fishery Statistics

State-wide

Annual patterns in catches of Whaler Sharks have been highly variable since 1983. Prior to 2016, peaks in total annual catches ranged between 77 and 121 t per annum and followed a 6-year cycle that started in 1990 (Fig. 3-46a). The annual total commercial catch stabilised at 45.1 t in 2018 (*c.f.* 61.8 t in 2017). The economic value of the commercial catch of Whaler Sharks in 2018 was approximately $ 213 K (*c.f.* $ 184 K in 2017) (Fig. 3-46a).

Catch trajectories were stable in the last five-year period, yet trending downward from the last peak in 2010 (Fig. 3-46a). Longlines have been the dominant gear type for taking these shark species since 2000 and comprised ~90% (40–56 t) of annual catches between 2015 and 2018. Catches taken using the net gear types have been < 6 t in the past 5 years. As with the other species assessed in this report, available data on the recreational component of the catch are scant and were based on two surveys.

Annual targeted longline effort was highly variable and increased from 35 fisher-days in 1993 to a peak of 535 fisher-days in 2010 (Figure. 3-46b). Since 2014, target effort has stablised between ~150 and 220 fisher-days, and was 153 fisher-days in 2018. Targeted longline catch rates were relatively stable at 122 to 173 kg.fisher-day^{-1} in the past 5 years to 2018 (5-year average = 155 kg.fisher-day^{-1}) (Figure. 3-46c). In 2018, the targeted longline catch rate was 173 kg.fisher-day^{-1}. The number of licences taking and targeting Whaler Sharks have each remained relatively stable since 2002 and have followed the same trajectories (Fig. 3-46d).

Regional

The commercial catch of Whalers Sharks was mostly distributed in southern and central Spencer Gulf and Investigator Strait, Gulf St Vincent, and the West Coast (Fig. 3-47a). A high proportion of the catch was landed on the West Coast in the 1980s and 1990s, the 2000s and more recently in 2017 (Fig. 3-47a, b). Marine Fishing Areas (MFAs) in southern and central Spencer Gulf, supported either a greater or similar proportion of the catch between 2003 and 2012 (Figure 3-47a, b), with a notable peak in Spencer Gulf occurring in 2010. Subsequent to that period, the distribution of the catch mostly included the West Coast, Southern Spencer Gulf, northern and southern Gulf St. Vincent between 2014 and 2018. Limited catches were taken in the South-east region in the past decade. Catches mostly occurred between spring and autumn with only sporadic catches during the winter months in three years since 1984 (Fig. 3–47c). The MSF licence holders accounted for 99.2% of the catch of Whaler Sharks. Of the remaining catch, only 0.7% and 0.1%, respectively, were landed by NZRLF and SZRLF licence holders in 2018 (Fig. 3–47d, e).

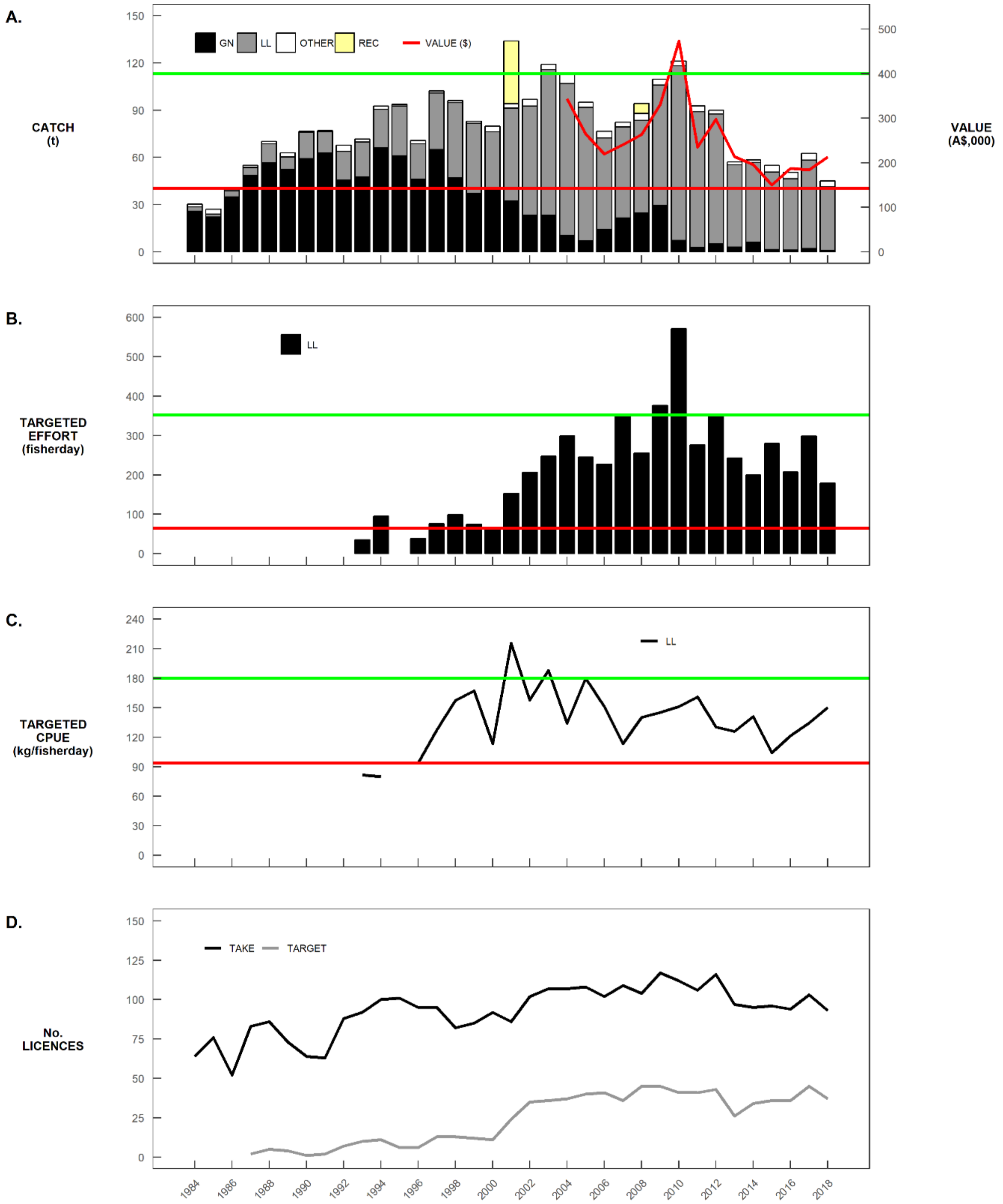

Figure 3-46. Whaler Shark. Long-term trends in: (A) total catch of the main gear types (longline and set net), estimates of recreational catch, and gross production value; (B) total effort longline; (C) catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-18.

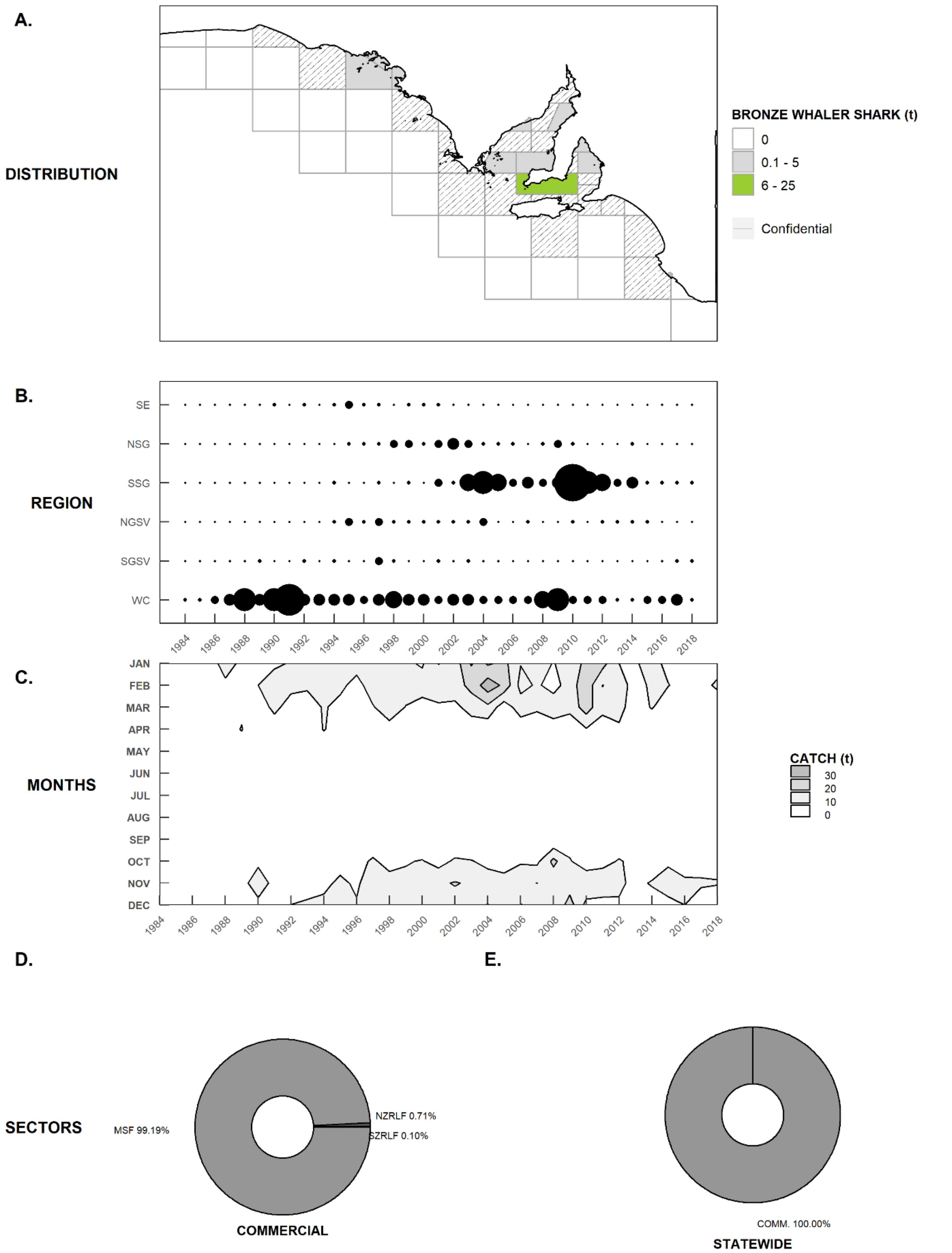

Figure 3-47. Whaler Shark. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t); and (D) the proportion of catch distributed among the commercial sector in 2018.

Fishery Performance

The general fishery performance indicators for Whaler Shark species combined were assessed for 2018 at the State-wide scale. No trigger reference points were breached (Table 3-18).

Table 3-18. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Whaler Sharks in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGETED LONGLINE EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGETED LONGLINE CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

Available data suggest the commercial catch composition is skewed towards Bronze Whalers. Recent demographic models suggest the current catch levels of Bronze Whaler are likely to be sustainable (Bradshaw et al. 2018). However, the fundamental need to differentiate the two species within MSF log-books, and the lack of understanding of the magnitude of the recreational catch of both species remain the key uncertainties in estimating current levels of fishing mortality.

The western Australian Dusky Shark stock was classified as ‘recovering’ following the most recent SAFS assessment in 2018 (Braccini et al. 2018).

Relatively stable annual trends in longline targeted catch rates for Whaler Sharks in the MSF, stabilising effort and CPUE, suggest the fishery is likely to be sustainable at the current low levels. However, in light of the species identification issues, the status of the fishery is classified as **undefined**.

3.3.15. OCEAN JACKETS

Biology

The Ocean Jacket (*Nelusetta ayraudi*) is the largest species of Leatherjacket of southern Australia that can reach 700 mm in length (Gomon et al. 2008). It is a demersal, schooling species that is distributed from central Queensland southwards, along the southern coastline and continental shelf and then up to the central coast of Western Australia (Kailola et al. 1993, Gomon et al. 2008). The species occurs across a wide depth range from very shallow to >350 m, due to off-shore movement associated with ontogenetic development. The juvenile Ocean Jackets occur in shallow, coastal bays whilst the adults are located over flat, sandy bottom in offshore, continental shelf waters >60 m in depth (Grove-Jones and Burnell 1991). Stock structure throughout the broad distribution is unknown, but must be influenced by off-shore, ontogenetic migration, and the capacity of adults for significant long-distance movement (Grove-Jones and Burnell 1991).

The Ocean Jacket is a dichromatic species of leatherjacket that is fast-growing and short-lived, as determined from ageing work from rings in vertebrae (Grove-Jones and Burnell 1991). Most fish from the commercial fishery were 3 – 6 years of age, whilst the oldest male was seven years and oldest female was nine years old (Grove-Jones and Burnell 1991). Reproductive maturity was attained from 2 – 4 years of age, associated with size-at-first-maturity of 310 mm, and corresponded with the timing of off-shore migration. In South Australia, spawning occurs in April and early May in waters >85 m depth in off-shore waters.

Fishery

Because adult Ocean Jackets occur in deep, off-shore waters, the fishery is essentially a commercial one, although juveniles are likely to be taken incidentally by recreational fishers in shallow, near-shore coastal waters (Grove-Jones and Burnell 1991). The commercial fishery commenced in 1984/85 in continental shelf waters off Streaky and Venus Bays on Eyre Peninsula. It commenced as, and has remained, a targeted, baited fish trap fishery. The catches rose very quickly until 1988/89, as new entrants came into the fishery and the geographic range of fishing activity spread throughout the Great Australian Bight (Grove-Jones and Burnell 1991). At that time, discussions commenced about regulating the fishery to control this expansion and to prevent catches from exceeding the long-term sustainable yield. As a result, regulations were introduced to: restrict access to Ocean Jackets to a limited number of MSF fishers; reduce the numbers of fish traps per licence; and regulate the dimensions of the fish traps (Grove-Jones and Burnell 1991). These regulations largely curtailed the expansion of the fishery.

Management Regulations

There are defined regulations for Ocean Jacket traps that differ from those for fish traps, as specified on the fishery licences. Currently there are four MSF licences with Ocean Jacket trap endorsements. Each licence holder has access to 20 traps, equating to a total of 80 Ocean Jacket traps that can be used by South Australia's MSF. Such traps can only be used in depths >60 m, and to target Ocean Jackets. Other fish traps can only be used in waters <60 m depth to target any species.

Commercial Fishery Statistics

State-wide

The reported catch for Ocean Jackets in 1990 was 930 t (Figure 3-48a). This related to a total fishing effort of 2,095 fisher-days by 11 licence holders, and a relatively high fish trap CPUE of 444 kg.fisher-day^{-1}. In the following few years, catch and effort increased to their maxima (Figure 3-48b). Total catch was highest in 1991 at 977 t, whilst effort was highest in the following year at 3,103 fisher-days, of which most related to fish traps. Total catch and effort declined between 1991 and 2000 before stabilising for several years. Catch and effort have subsequently declined to and remained at low levels. There were noticeable increases in catch and effort in 2016, but these declined again in 2017. Since 2008, the numbers of fishers who took and targeted Ocean Jackets in each year have generally been less than five (Figure 3-48d). CPUE for fish traps has been variable, shown a number of modes, ranged between 191 and 544 kg.fisher-day^{-1}, but nevertheless showed no long-term trend. There was a considerable increase in fish trap CPUE between 2013 and 2017 from 197 to 544 kg.fisher-day^{-1} (Figure 3-48c). The economic value of the commercial catch of Ocean Jackets in 2018 was approximately $ 298 K (*c.f.* $ 536 K in 2017) (Figure 3-48a).

Regional

Two regions have contributed the most to catches of Ocean Jackets in South Australia. High catches reported from the 'Other' region between 1989 and 1998 came from MFAs 37, 38, and 39, located off-shore from southern Eyre Peninsula (Figure 3-49a). Subsequently, these declined to moderate to low levels. Very high catches were reported from the WC in MFAs 24, 25, and 26 between 1989 and 1993. Catches declined before increasing to high levels again between 1998 and 2007. After this, they declined back to moderate levels before increasing again in 2016 and 2017. There have only ever been incidental catches of Ocean Jackets reported from the gulf regions and the SE (Figure 3-49b). Throughout the higher catch years of 1989 to 2006, commercial catches of Ocean Jackets were distributed throughout the year, although the highest catches were taken between September and March (Figure 3-49c).

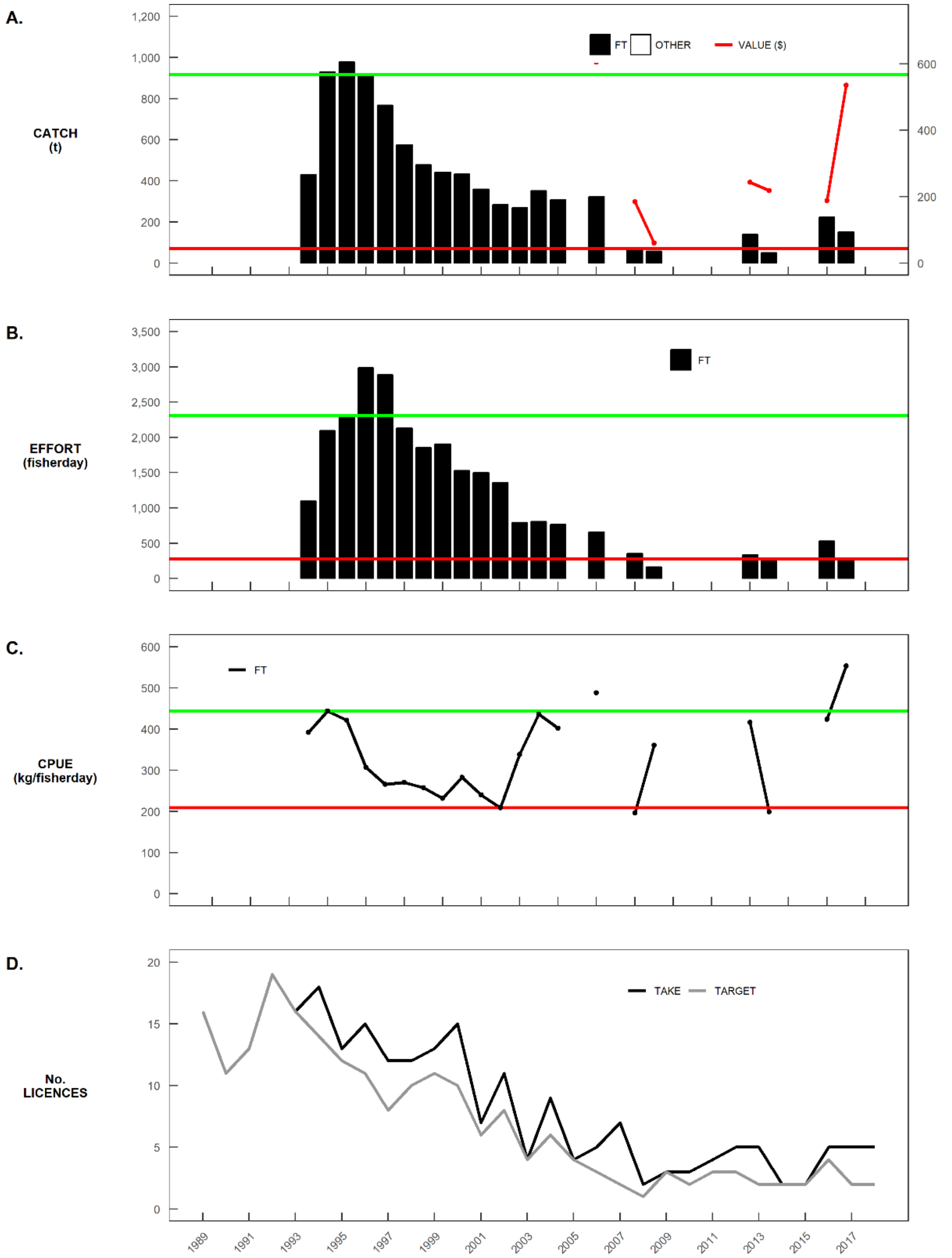

Figure 3-48. Ocean Jacket. Long-term trends in: (A) total catch of the main gear types (fish trap and other), and gross production value; (B) total effort; (C) catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-19.

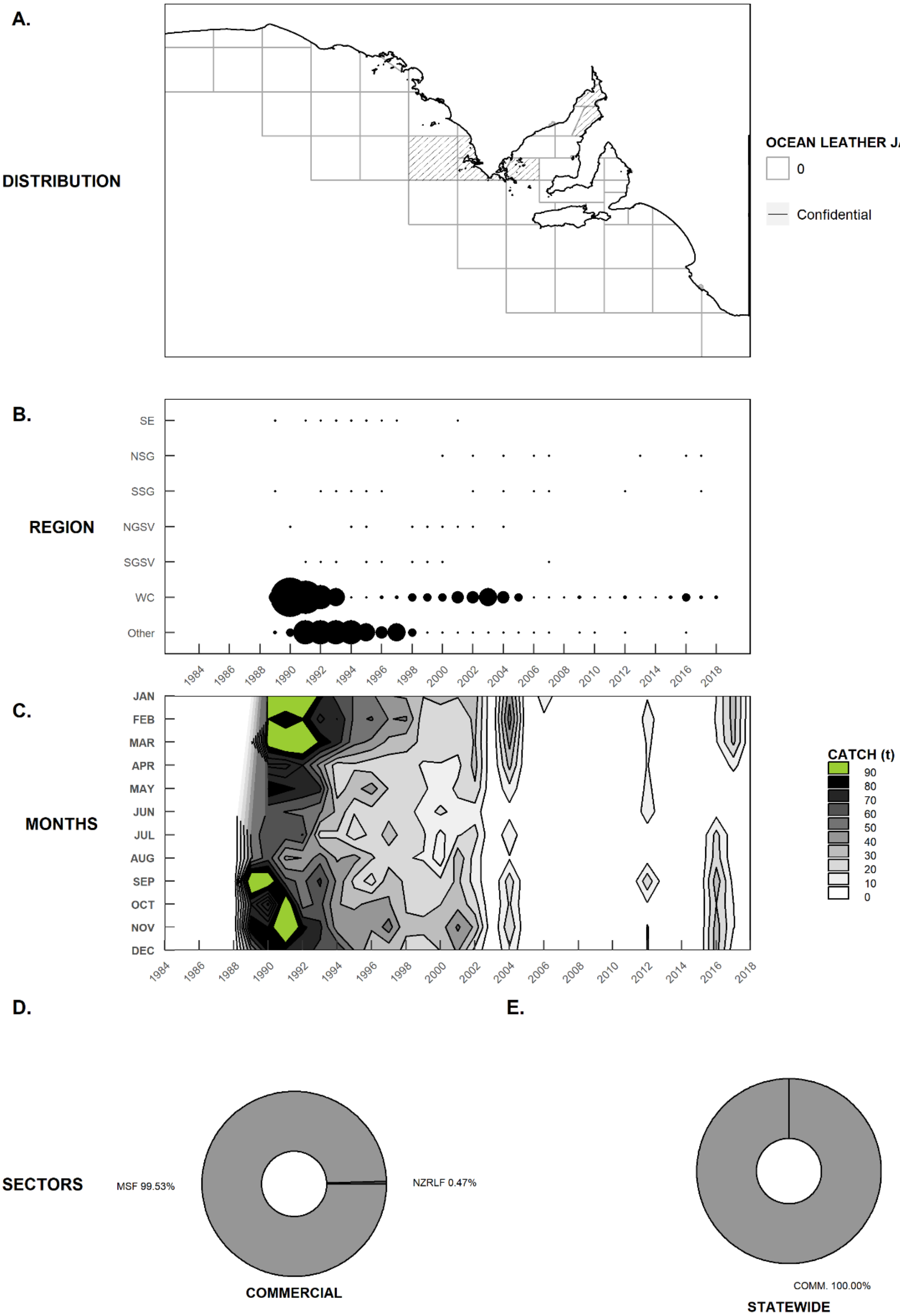

Figure 3-49. Ocean Jacket. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t); and (D) the proportion of catch distributed among the commercial sector in 2018.

Fishery Performance

The general fishery performance indicators for Ocean Jackets were assessed for 2018 at the State-wide scale. No trigger reference points were activated (Table 3-19).

Table 3-19. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Ocean Jacket in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET FISH TRAP EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TARGET FISH TRAP CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

The Ocean Jacket fishery developed very quickly between 1984 and 1988 resulting in an exponential increase in total annual catch that reflected both an increase in effort as new entrants came into the fishery and the geographic expansion of the fishery (Grove-Jones and Burnell 1991). The fast rate of fishery development caused concerns about sustainability, which soon led to the introduction of regulations to limit the numbers of fishers and fishing effort. As a result, the fishery attained its highest productivity in the early 1990s. Since then, the fishery statistics have been dominated by declining levels of catch, effort, and numbers of specialist fishers. These declines are also likely to relate to the perception that developed early amongst some fishers that the Ocean Jacket fishery was not worthwhile due to the marginal economics associated with high fishing costs relative to low price in return (Grove-Jones and Burnell 1991). The relatively low fishery catches, low level of targeted fishing effort and the recent high catch rates are unlikely to cause the stock to become recruitment impaired. As such, South Australia’s Ocean Jacket fishery is classified as **sustainable**.

3.3.16. BLUETHROAT WRASSE

Biology

There are several temperate Wrasse species (Family Labridae) that occur in South Australian waters (Gomon et al. 2008, Shepherd and Baker 2008). They are associated with shallow, near-shore reef habitats, making them particularly vulnerable to line fishing. Only the Bluethroat Wrasse (*Notolabrus tetricus*) is recognised as a legitimate commercial species for the MSF (PIRSA 2013). Bluethroat Wrasse is the largest of the labrids, reaching a maximum size of 420 mm TL (Gomon et al. 2008). Its distribution includes the coastal waters of New South Wales, Victoria, Tasmania and extends as far west as central South Australia (Gomon et al. 2008, PIRSA 2016). The Bluethroat Wrasse occupies algal beds and reefs through the depth range of 0–50 m. It is a significant predator of benthic invertebrates that include crustaceans and molluscs (Shepherd and Baker 2008).

Bluethroat Wrasse are highly territorial and display long-term residency of their home-ranges (Barrett 1995, Shepherd and Baker 2008). Their strong site attachment is associated with their complex social structure and reproductive biology. The species is a monandric, sequential, protogynous hermaphrodite, i.e. the adult males only originate through sex change from a female fish (Smith et al. 2003). The social structure is based around the male that defends a territory, which includes a harem of numerous females that have overlapping home ranges. This social structure is size-dependent, i.e. if the male is removed, its hierarchical position is quickly replaced by the largest female which transitions into the territorial male within a few weeks. This complex social and reproductive strategy complicates managing the fishery because of concerns about localised depletion and the need to maintain sufficient males in the population to ensure reproductive output (Shepherd et al. 2010).

Fishery

The Bluethroat Wrasse has historically been used as bait to target Southern Rock Lobster, but is also a commercially targeted species in the MSF (PIRSA 2013). Other labrid species are also taken in lower numbers and are reported as Bluethroat Wrasse. Consequently, it is not possible to differentiate the fishery statistics amongst the wrasse species, although it is likely that since the Bluethroat Wrasse is the most abundant species, it has historically dominated the fishery catches (Saunders et al. 2010). For the commercial sector there is a relatively small targeted fishery for which the captured fish are sold either as fresh or as live product by the Sydney Fish Market. Alternatively, they are captured as by-product when other more valuable species are targeted. As such, there are considerable discrepancies between the numbers of fishers who report taking Bluethroat Wrasse, and those who specifically target it.

For the recreational sector, Bluethroat Wrasse is not a prized target species. Rather, they are often taken as by-catch when more desirable species are targeted, which can result in a high discard rate. In 2013/14, there was an estimated 22,073 Bluethroat Wrasse captured by the recreational sector, of which 68.7% were released (Giri and Hall 2015). No estimated harvest weight was provided.

Management Regulations

Prior to 01 December 2016 there was no size limit nor were there recreational bag and boat limits for the Bluethroat Wrasse. In the review of the recreational sector undertaken in 2016, there was concern about size-selective harvesting that related to its hermaphroditic reproductive mode (PIRSA 2016). In response, a slot limit of 250 – 350 mm TL was introduced in order to maintain some males in the population to ensure the reproductive output. Given the complexity in identifying Bluethroat Wrasse, these regulations apply to all wrasse species with the exception of Blue Groper. Also, a bag limit of 5 fish and boat limit of 15 fish was introduced for the recreational sector.

Commercial Fishery Statistics

State-wide

Between 1984 and 1996, the reported commercial catch of Bluethroat Wrasse was relatively low at <10 $t.yr^{-1}$ (Figure 3-50a). In 1997 it increased considerably after which it remained at >20 $t.yr^{-1}$ until 2004. Since then it has fallen and generally been <20 $t.yr^{-1}$, with considerable decline between 2012 and 2018. The total catch of 7.9 t in 2018 was the lowest since 1996. The economic value of the commercial catch of Bluethroat Wrasse in 2018 was approximately $ 78 K (*c.f.* $ 52 K in 2017) (Figure 3-50a). Up to 2004, the catch was dominated by that taken on handlines. Subsequently, the proportion taken on longlines increased considerably, although in 2018 this proportion was relatively low.

Between 1984 and 1991, total line effort was low, before it increased considerably up to 1997. Since then it has been highly variable (Figure 3-50b). From 2005, the proportion of total line effort accounted for by longlines has increased considerably. In 2010, the highest level of effort and the highest proportional contribution from longlines were recorded. Since 2010, effort has declined, as has the proportional contribution from longlines. Between 1984 and 1996, total line CPUE was low, before it increased considerably up to 2000 (Figure 3-50c). Over the following nine years there was a gradual decline in CPUE before it stabilised between 2009 and 2017. There was a considerable drop in CPUE in 2018.

Since 1984, there has been a disparity between the high numbers of fishers who reported taking Bluethroat Wrasse and those who targeted it (Figure 3-50d). The former increased up to 2013, after which there has been considerable decline. The numbers who targeted this species have been relatively constant since 1997.

Regional

Since 1997, the WC has provided the highest catches of Bluethroat Wrasse with SSG as the next most significant region. Only incidental catches have been reported from the other four regions (Figure 3-51a). Catches have not been concentrated in any season but have been distributed throughout the year. In 2018, the MSF fishers accounted for 96.6% of the commercial catch, with Southern Rock Lobster fishers accounting for the remainder (Figure 3-51d). There was no estimate of the total weight of the recreational catch from 2013/14 to compare against that from the commercial sector (Giri and Hall 2013).

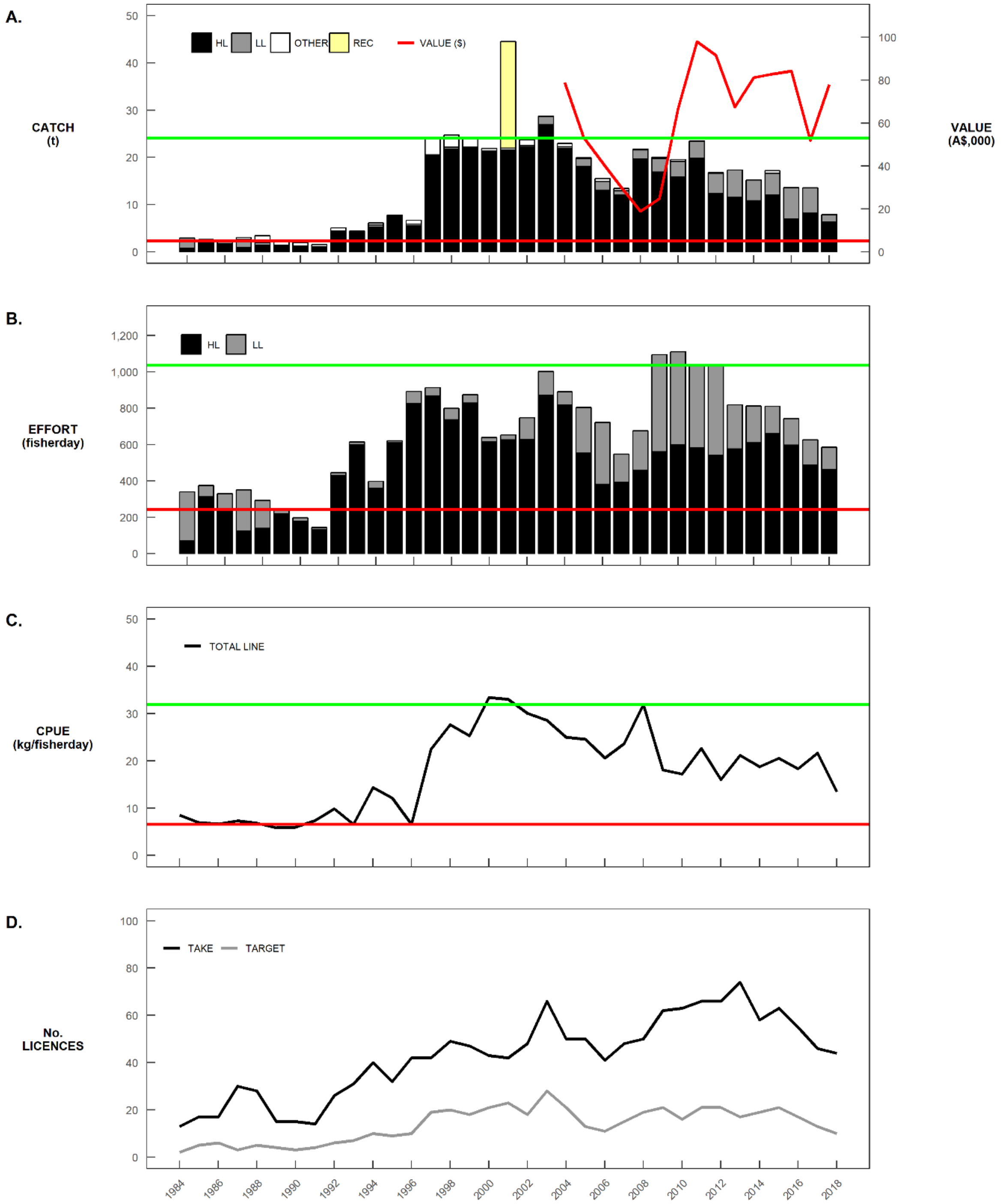

Figure 3-50. Bluethroat Wrasse. Long-term trends in: (A) total catch of the main gear types (handline and longline), estimate of recreational catch, and gross production value; (B) total line effort; (C) catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-20.

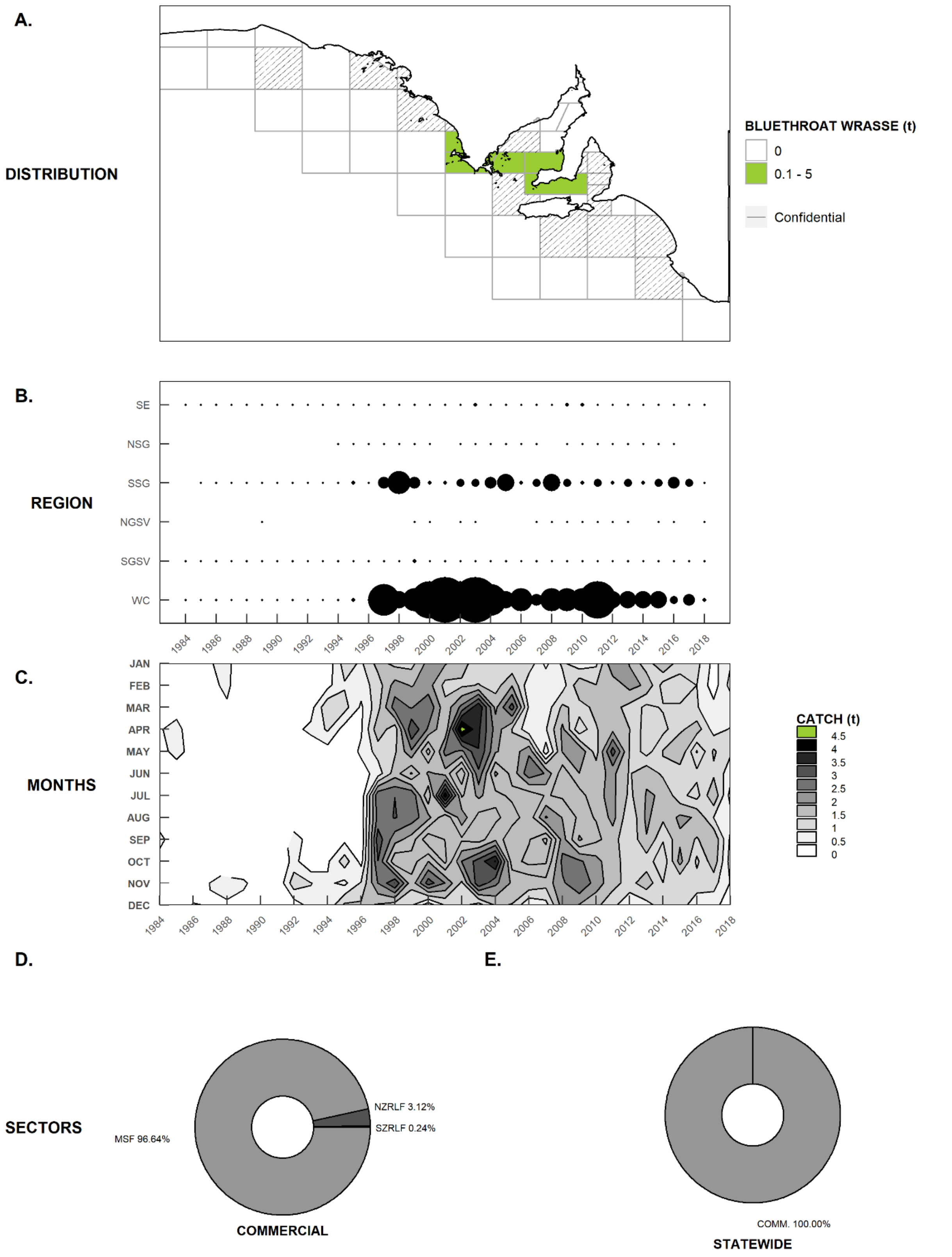

Figure 3-51. Bluethroat Wrasse. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t); and (D) the proportion of catch distributed among the commercial sector in 2018.

Fishery Performance

The general fishery performance indicators for Bluethroat Wrasse were assessed for 2018 at the State-wide scale. Total effort combined across hand line and longline fishing methods consistently declined over five consecutive years, breaching the associated trigger reference point (Table 3-20).

Table 3-20. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State-wide spatial scale for Bluethroat Wrasse in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL LINE EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	✓
TOTAL LINE CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

There is a small targeted fishery for the Bluethroat Wrasse with the product directed towards the live fish trade, which accounts for considerable proportions of the total annual catches. The remaining catch is taken as by-product when other more valuable species are targeted. The tendency towards higher longline catches after 2004, might reflect the development of the longline fishery for Snapper in Southern Spencer Gulf. The later decline in longline effort that produced catches of Bluethroat Wrasse may well correspond with the decline in the Snapper fishery that occurred in that region.

Total catch of Bluethroat Wrasse has declined since 2011, corresponding with a general decline in longline effort. The latter decline is evident as the single trigger reference point that was activated. From 2011 to 2017, annual catch rates were relatively stable at medium levels. However, in 2018, there were notable declines in both total catch and catch rate. As such, the recent estimates of catch and catch rate are considerably lower than the high values recorded through the peak period of the early 2000s, but nevertheless remain higher than the low levels of the 1980s and 1990s. The declines in commercial catch and catch rate in 2018 are not yet sufficient to indicate that a change in stock status is warranted. As a result, the Bluethroat Wrasse stock is classified as **sustainable**.

3.3.17. SILVER TREVALLY

Biology

The Silver Trevally (*Pseudocaranx georgianus*) is distributed from Coffs Harbour in New South Wales (NSW) across southern Australia to Perth in Western Australia (Stewart 2015). It forms schools over sandy bottom in estuaries, as well as gulf, nearshore coastal and shelf waters, where it feeds on small fish, benthic and pelagic invertebrates.

The population biology of Silver Trevally in South Australian waters is poorly understood. They are slow-growing and live up to 25 years in NSW waters (Stewart 2015), and 33 years in New Zealand waters (Langley 2004). Spawning occurs between spring and autumn, with the larvae occurring in coastal waters, which may enter estuaries before settling out as juveniles.

Fishery

Silver Trevally are taken by both the commercial and recreational sectors of the Marine Scalefish Fishery (MSF). In South Australia, the commercial catches have been dominated by MSF fishers, with only incidental catches reported by the Northern Zone Rock Lobster Fishery (NZRLF). Hand line catches account for the majority of commercial catches, with smaller contributions taken using net gear types.

The recreational catch is taken using rods and lines and is substantial relative to the commercial catch. The State-wide recreational survey in 2013/14 estimated that 73,924 Silver Trevally were captured by the recreational sector, of which 57,140 were harvested. The estimated total recreational harvest weight was 14.6 t (Giri and Hall 2015).

Management Regulations

Silver Trevally is considered a tertiary species of the commercial MSF, being of low-medium value and making a minor contribution to the total production value of the fishery (PIRSA 2013). For the commercial sector, regulations are in place that manage fishing effort and limit the take of this species. These include temporal and spatial netting closures, restrictions to net lengths and mesh sizes, and a minimum legal size of 240 mm TL (PIRSA 2016).

For the recreational sector, there are multiple management regulations in place for Silver Trevally. Input and output controls ensure that the total catch is maintained within sustainable limits and that access is distributed equitably among fishers. These include a daily bag limit of 20 fish and boat limit of 60 fish, as well as gear restrictions. The minimum size limit of 240 mm TL also applies to the recreational sector.

Commercial Fishery Statistics

State-wide

Total annual commercial catch of Silver Trevally has been highly variable, ranging from 2.1 t in 1985 to 21 t in 2000 (Figure 3-52a). From 1984 to 1991, catches were low and rarely exceeded 4.5 $t.yr^{-1}$. Since then, they have ranged from 5–15 $t.yr^{-1}$, except for the peak catch of 21 t taken in 2000. The total catch of 4.6 t in 2018 was a considerable drop from the 10.5 t taken in 2017. The economic value of the commercial catch of Silver Trevally in 2018 was approximately $ 53 K (*c.f.* $ 71 K in 2017) (Figure 3-52a).

Since 1992, handline catches have contributed most to annual catches, with the remainder taken using various net types. Hand line fishing effort that produced catches of Silver Trevally has varied cyclically since the mid-1980s (Figure 3-52b). It was 129–395 $fisher\text{-}days.yr^{-1}$ during the 1980s, increased to a peak of 1167 fisher-days in 1993, and declined to 261 fisher-days in 2001. It increased to a further peak of 802 fisher-days in 2015, before declining to 486 fisher-days in 2018. Hand line catch per unit effort (CPUE) has increased slowly over the long-term. The high catch in 2000 was associated with uncharacteristically high CPUE. Catch rate declined the following year and has remained relatively flat since 2004 (Figure 3-52c). Historically, there has been a considerable difference between the numbers of licence holders who take Silver Trevally compared with those who target this species. The former has often been >50 $fishers.yr^{-1}$, whilst the latter have generally been <10 $fishers.yr^{-1}$ (Figure 3-52d). This suggests that for many fishers, Silver Trevally was taken as by-product when they fished for more valuable species.

Regional

Catches of Silver Trevally have been reported from each of the six regions in most years since 1984 (Figure 3-53a). Since 2000, the majority of catches have been taken from Southern Spencer Gulf during May, June and July. In 2018, MSF fishers took 95.1% of the commercial catch with the NZRL fishers taking the remaining 4.9% (Figure 3-53c,d). In 2013/14, the recreational sector accounted for around 57% of the total State-wide catch of Silver Trevally (Figure 3-53e).

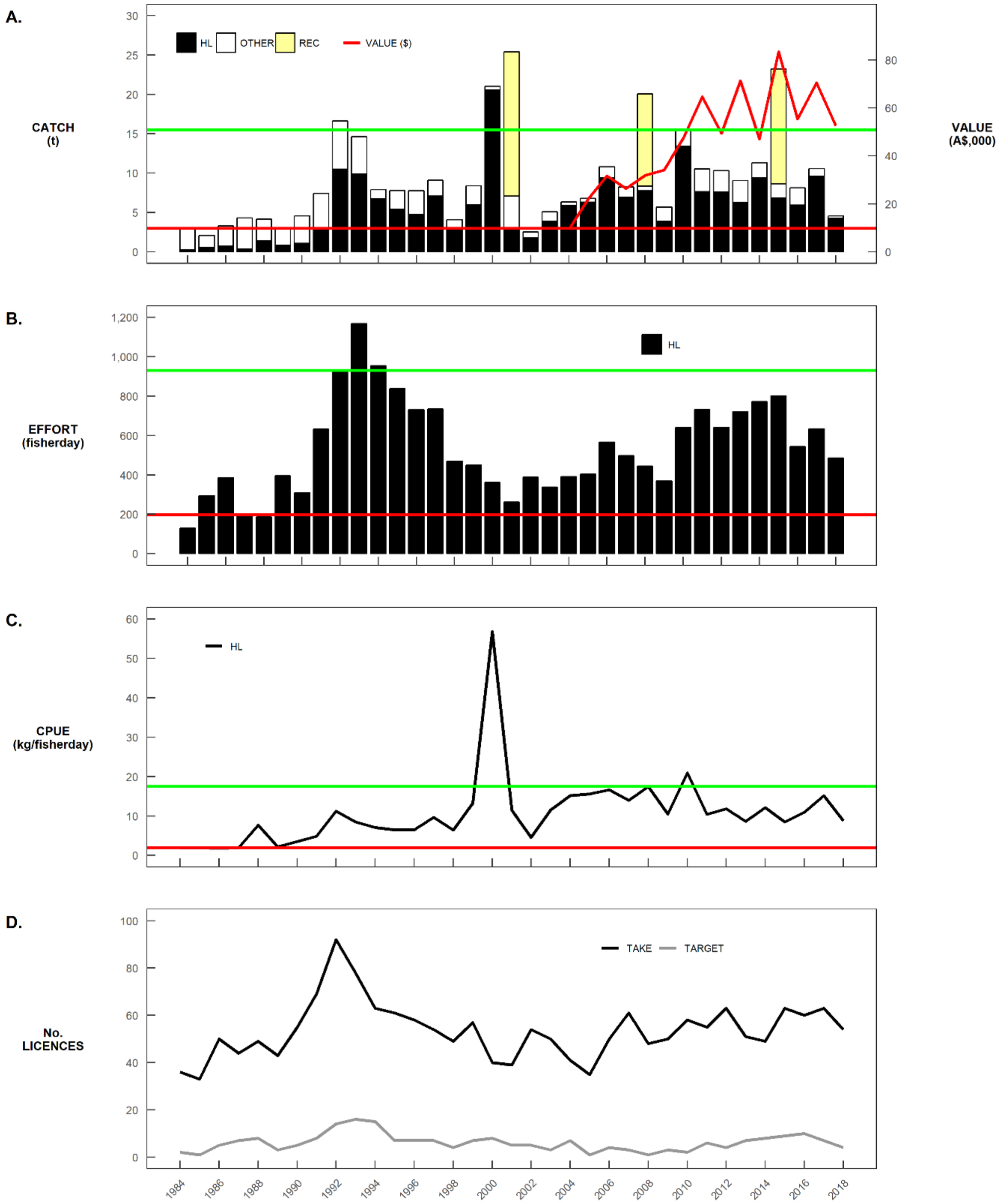

Figure 3-52. Silver Trevally. Long-term trends in: (A) total catch of the main gear types (handline and other), estimates of recreational catch, and gross production value; (B) total handline effort; (C) catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-21.

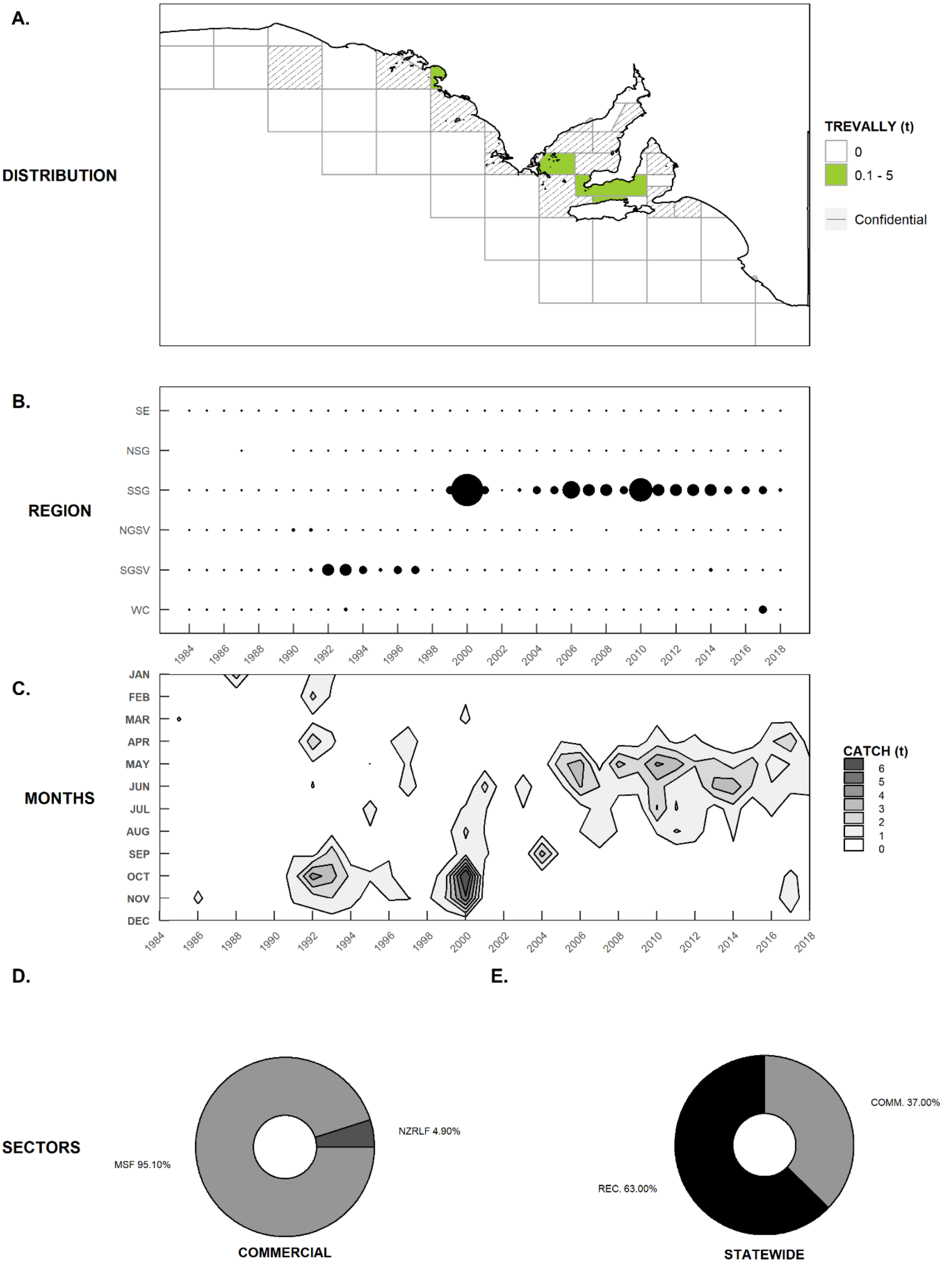

Figure 3-53. Silver Trevally. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), (D) the proportion of catch distributed among the commercial sector in 2018; and (E) among the State-wide MSF in 2013/14 ascertained from the latest recreational fishing survey (Giri and Hall, 2015).

Fishery Performance

The general fishery performance indicators for Silver Trevally were assessed for 2018 at the State-wide scale. No trigger reference points were breached (Table 3-21).

Table 3-21. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State-wide spatial scale for Silver Trevally in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAND LINE EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAND LINE CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

Silver Trevally make a minor contribution to the total production value of the commercial sector of the MSF. Relatively few fishers actively target this species. Nevertheless, the targeted catch accounts for a considerable proportion of the total line catch. The remaining catch is taken as by-product by a considerably larger number of fishers when they target more valuable species such as King George Whiting and Snapper. Over the past decade prior to 2018, estimates of total catch, hand line effort and hand line CPUE for Silver Trevally were stable at moderate levels. In 2018, each of these performance indicators showed a downturn. Nevertheless, they still remained above the values of the 1980s, whilst no trigger reference points were breached. The declines in commercial fishery statistics in 2018 from the previous year are not yet sufficient to indicate that a change in stock status is warranted. At present, the stock status for Silver Trevally in South Australia is classified as **sustainable**.

3.3.18. LEATHERJACKETS

Biology

Of 19 species of Leatherjackets (Monacanthidae) that occur in the waters of southern Australia, at least six species inhabit coastal reef habitats in South Australia. Leatherjacket species are characterised by having a compressed, deep body, prominent dorsal spine above the eyes and leathery skin (Gomon et al. 2008). Most are sexually dimorphic in body shape and colouration. They are omnivores that feed on small invertebrates, algal turfs and seagrass (Shepherd and Baker 2008).

For South Australia's MSF, anecdotal evidence suggests that the Horseshoe Leatherjacket (*Meuschenia hippocrepis*) and the Sixspine Leatherjacket (*M. freycineti*) are the dominant species taken. Nevertheless, mixed species catches are reported collectively as Leatherjackets and recorded in the Marine Scalefish Fishery Information System as such. Consequently, it is not possible to differentiate the fishery statistics amongst species.

Fishery

In South Australia, Leatherjacket species are taken in the commercial and recreational sectors of the MSF. For the commercial sector, Leatherjackets are predominantly taken as by-product when more valuable species are targeted; however, a small number of fishers also target these species. Leatherjackets are mostly caught using hauling nets or hand lines, but are also susceptible to fish traps.

Leatherjacket species are taken with rod and line by recreational fishers. In 2013/14, an estimated 121,962 Leatherjackets were captured by this sector of which 75,787 fish were released, and 46,175 fish retained (Giri and Hall 2015). No estimate of total State-wide harvest weight is available for Leatherjacket spp. taken for the recreational sector.

Management Regulations

All species of Leatherjackets are permitted in the commercial sector of the MSF (PIRSA 2014). They are classified as tertiary taxa in the commercial MSF Management Plan as they have low-medium value and make a minor contribution to the total production value of the commercial fishery (PIRSA 2013). There is no size limit nor bag or boat limit for either the commercial or recreational fishing sectors.

Commercial Fishery Statistics

State-wide

The State-wide, annual commercial catches for Leatherjackets were highest during the early 1990s when they varied between 50–70 t. Total catch declined regularly over the long-term to the lowest recorded level of 10.5 t in 2014 (Figure 3-54a). It subsequently increased to 29.5 t in 2018. The economic value of the commercial catch of Leatherjackets in 2018 was approximately $ 107 K (*c.f.* $90 K in 2017) (Figure 3-54a).

Since 1990, generally >50% of the annual catches were taken with hauling nets. The second major gear type that contributed to catches of Leatherjackets was handlines, for which the annual catches peaked at 5.5 t in 1997. Annual estimates of total fishing effort that produced catches of Leatherjackets have always been dominated by hauling nets. Hauling net effort has consistently declined from its peak of 4,860 fisher-days in 1992 to 676 fisher-days in 2014 before increasing in recent years, attaining 1,224 fisher-days in 2018 (Figure 3-54b).

Between 1990 and 2001, hauling net CPUE was relatively consistent until it declined in 2002 to its lowest recorded level of 6 kg.fisher-day^{-1} (Figure 3-54c). Nevertheless, it increased to 18.1 kg.fisher-day^{-1} in 2004 and since then has remained relatively high, i.e. between 12–19 kg.fisher-day^{-1}. Hauling net CPUE peaked at 22.3 kg.fisher-day^{-1} in 2018.

The number of fishers who reported taking Leatherjackets has declined from 141 in 1990 to 75 fishers in 2014, before increasing to 89 fishers in 2018. An average of 12 fishers.yr^{-1} reported that they actively targeted these species since 1984, with ≤5 licence holders taking this fishing approach since 2014. The higher numbers of fishers who took Leatherjackets compared to those who targeted it suggests that this taxon has largely been a by-product when more valuable species were targeted (Figure 3-54d).

Regional

Between 1990 and 2018, NSG and NGSV provided the highest catches of Leatherjackets. Incidental catches were taken from the other four regions (Figure 3-55a). Historically, catches have been highest between March and October. In 2018, the MSF fishers accounted for 99.8% of the commercial catch, whilst the Northern and Southern Zone Rock Lobster fishers accounted for the remainder (Figure 3-55d).

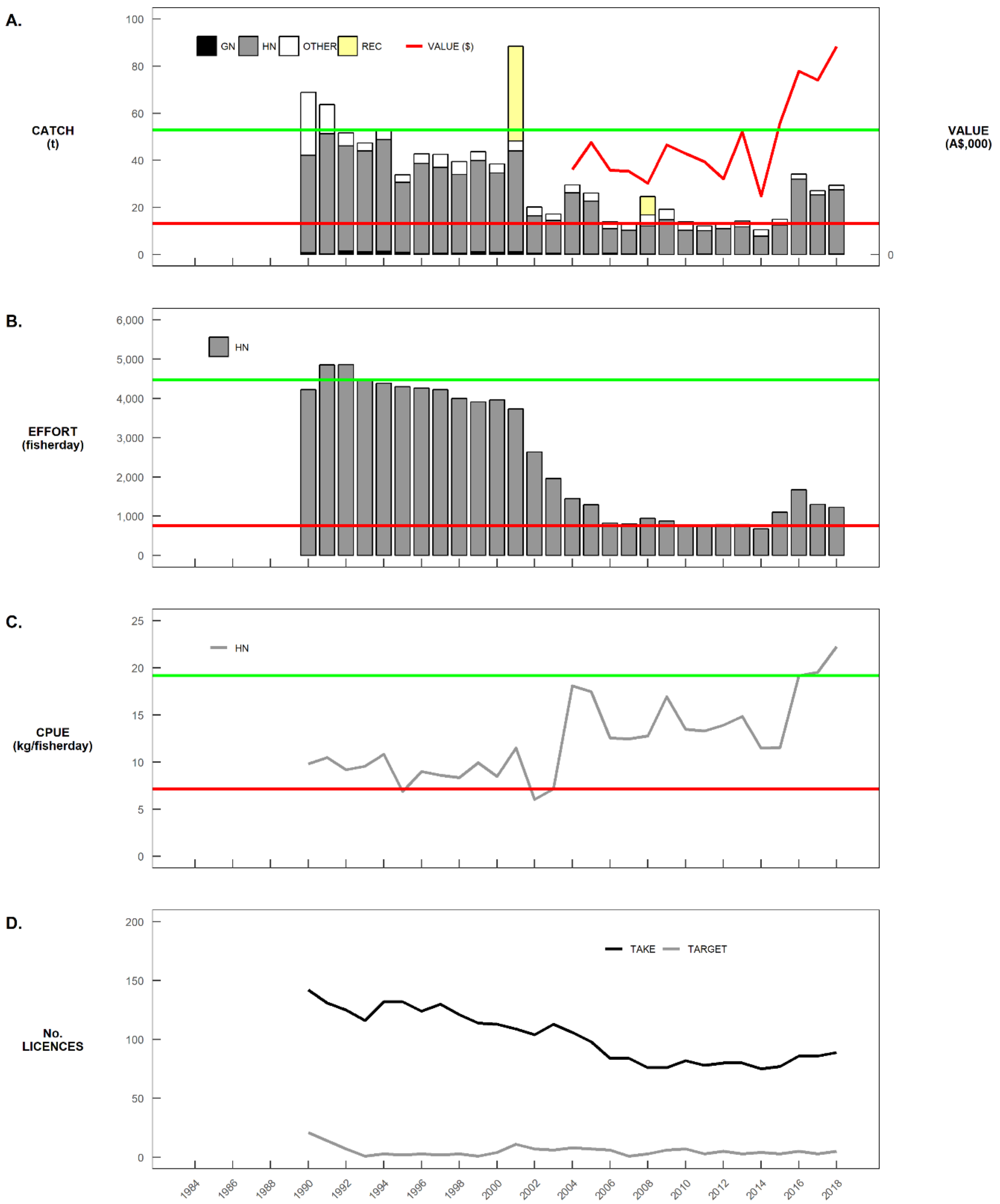

Figure 3-54. Leatherjackets. Long-term trends in: (A) total catch of the main gear types (hauling net and gillnets), estimates of recreational catch, and gross production value; (B) total hauling net effort; (C) catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-22.

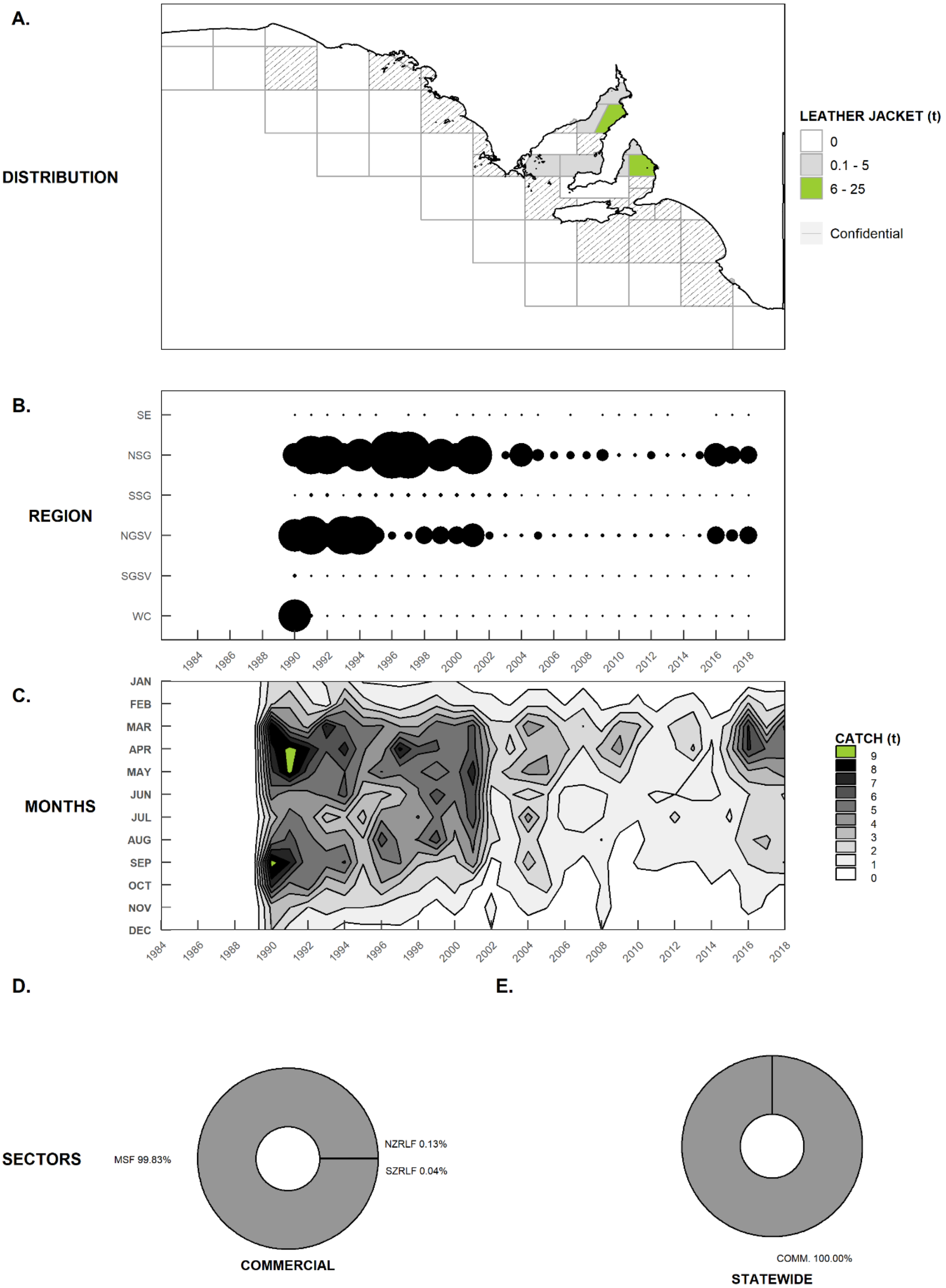

Figure 3-55. Leatherjacket. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), and (D) the proportion of catch distributed among the commercial sector in 2018.

Fishery Performance

The general fishery performance indicators for Leatherjackets were assessed for 2018 at the State-wide scale, using the reference period of 1990 to 2018. One trigger reference point was activated (Table 3-22). Targeted hauling net CPUE in 2018 was the highest recorded.

Table 3-22. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Leatherjacket in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAULING NET EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAULING NET CPUE	G	3rd Lowest / 3rd Highest	HIGHEST
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

Although some catch is targeted, Leatherjackets are predominantly taken as by-product when more valuable species are targeted. As such, there have been consistently higher numbers of fishers who reported taking Leatherjackets than those that targeted these species. Until 2015, the overwhelming trend was one of declining annual catches for Leatherjackets. This largely reflected the significant declines in effort in the net sector of the MSF. However, hauling net CPUE increased in 2018 resulting in a breach of this trigger reference point. This reflected increases in both hauling net catch and effort, although they remained lower than those up to the early 2000s. The relatively low levels of catch and effort, but high hauling net CPUE indicated that changes in the status were not warranted. On this basis, South Australia's Leatherjacket fishery is currently classified as **sustainable**.

3.3.19. RAYS AND SKATES

Biology

Rays and Skates that are common in South Australian waters belong to several Families, including the Myliobatiae (e.g. Southern Eagle Ray), Dasyatidae (e.g. Smooth Stingray) and Rajidae (e.g. Bight Skate). The catch of Rays and Skates in the MSF is not differentiated by species in the fishery log-books. Products from Southern Eagle Rays (*Myliobatis tenuicaudatus*) are regularly identified during market sampling, and hence, it is likely this species comprises a prominent proportion of the Ray and Skate landings in the MSF.

The Southern Eagle Ray is distributed from Jurien Bay in Western Australia to Moreton Bay in Queensland. The species is also found in South Australia, Victoria, Tasmania and New Zealand (Last and Stevens 2009). Southern Eagle Rays reach a maximum size of up to 1.6 m disc width (>3.0 m TL) (Last and Stevens 2009). Age and growth studies suggest the species reaches a maximum age of >15 years for males and >26 years for females in New Zealand (Hartill 1989).

Fishery

Rays and Skates are mostly taken as bycatch in the MSF when fishers use large-mesh hauling nets and longlines to target higher value species (Fowler et al. 2009). The most recent recreational fishing survey estimated that 9,489 Southern Eagle Rays were captured by recreational fishers in South Australia, and all were released (Giri and Hall 2015).

Management Regulations

Rays and Skates of all species are permitted to be taken by the MSF (PIRSA 2014). No commercial harvest strategy has been developed for this species group (PIRSA 2013). There is currently no size, daily bag or boat limits for Ray and Skate species taken in the commercial or recreational fishing sectors in South Australian State-managed waters.

Commercial Fishery Statistics

State-wide

The total state-wide catch of Rays and Skates was 10.2 t in 2018 (*c.f.* 13.0 t in 2017). Total annual catches were relatively stable between 2014 and 2018 and averaged 12.8 t per year (Figure 3-56a). The economic value of the commercial catch of Rays and Skates in 2018 was approximately $ 27 K (*c.f.* $ 26 K in 2017) (Figure 3-56a).

Rays and Skates were predominantly taken using longlines (72%), hauling nets (16%), and handlines (4%). The total annual catches using longlines, hauling nets and handlines were 4.5 t, 4.6 t and 0.6 t, respectively during 2018. Annual trends in longline effort in the MSF related to Skates and Rays showed a steady decline from 1,306 to 223 fisher-days between 1992 and 2018. Longline effort increased moderately from 172 fisher-days in 2016, and averaged 233 fisher-days per annum in the past 5 years. (Figure 3-56b). Annual trends in hauling net effort when Rays and Skates were retained ranged between 185 and 301 fisher days between 2014 and 2018. Longline CPUE when Rays and Skates were taken has ranged between 20–36 kg.fisher-day^{-1} in the past 5 years, and was 20.2 kg.fisher-day^{-1} in 2018, which was the third lowest on record (Figure 3-56). Hauling net CPUE for Rays and Skates ranged between 14–20 kg.fisher-day^{-1} in the past 5 years, and was 17 kg.fisher-day^{-1} in 2018 (Figure 3-56c). The number of licences taking (<75) and targeting (<25) Rays and Skates has been stable over the past decade.

Regional

The largest annual catches of Rays and Skates occurred off the West Coast between 1988 and 2005. Southern GSV was the second most significant region until 2003, with NSG and the SE also supporting significant annual catches in some years (Figure 3-57a). In the past five years, catches have been homogeneously distributed, albeit at low levels, with fishers from the WC and NSG maintaining the highest catches. Catches of Rays and Skates are generally more frequent between spring and autumn. In 2018, the MSF accounted for ~98.4% of the commercial catch of Rays and Skates, with and Northern Zone Rock Lobster fishers taking 1.6% of the total catch (Figure 3-57d).

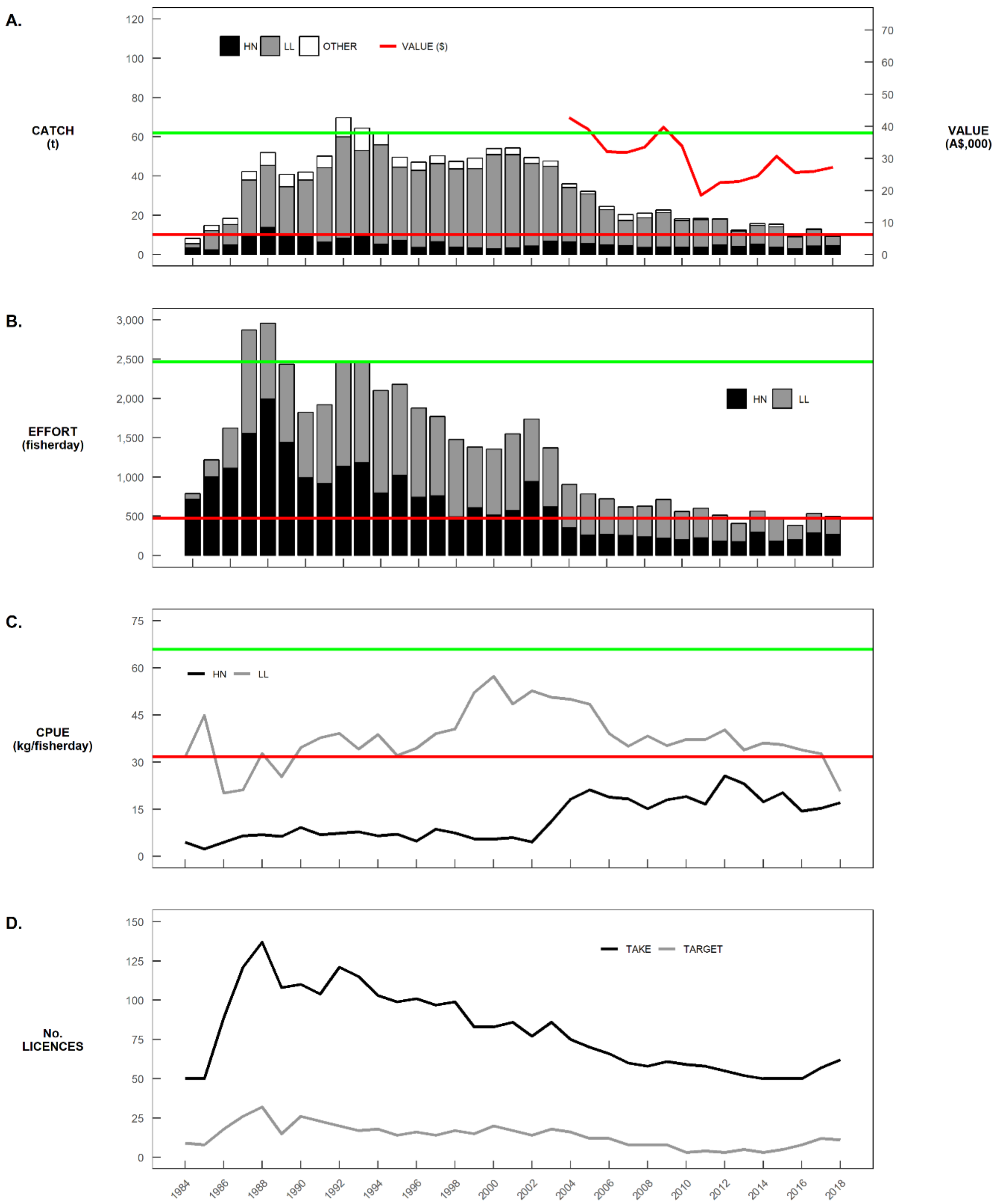

Figure 3-56. Rays and Skates. Long-term trends in: (A) total catch of the main gear types (longline and hauling net), and gross production value; (B) total effort; (C) catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-23.

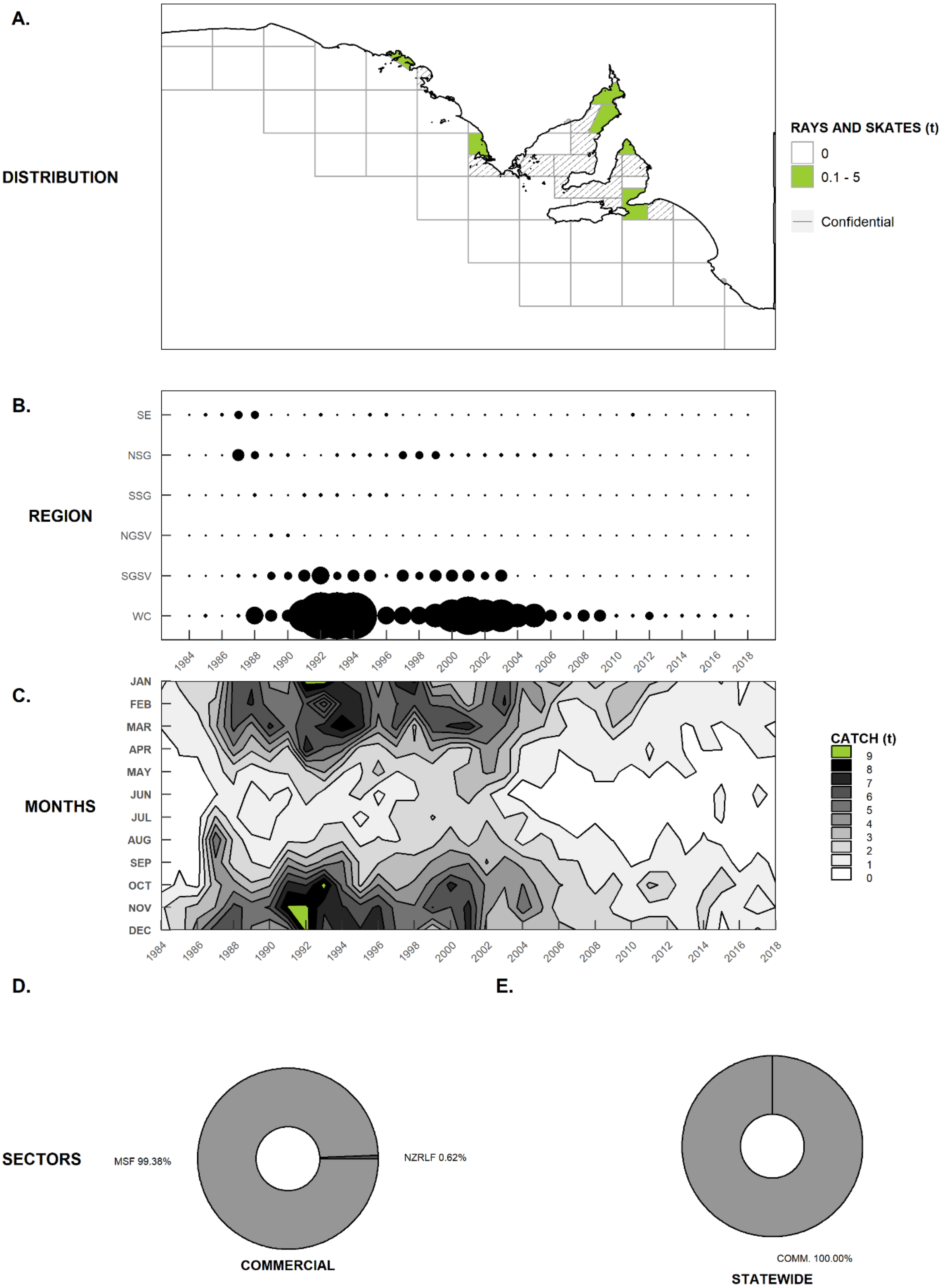

Figure 3-57. Rays and Skates. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), and (D) the proportion of catch distributed among the commercial sector in 2018.

Fishery Performance

The general fishery performance indicators for Rays and Skates were assessed for 2018 at the State-wide scale. A single trigger reference point for the third lowest longline CPUE was breached (Table 3-23), reflecting a downward trend in catch rates since 2012.

Table 3-23. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Rays and Skates in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAULING NET EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL HAULING NET CPUE	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL LONGLINE EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL LONGLINE CPUE	G	3rd Lowest / 3rd Highest	✓
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

Based on the long-term annual trends in MSF catch, effort and CPUE data this combined species stock would be classified as depleting. However, recent information suggests there is a need to differentiate Rays and Skates by species in MSF log-books. There is also a lack of information on the magnitude of annual recreational catches. Together, these represent key uncertainties in assessing the current levels of fishing mortality, and the status of the fishery is classified as **undefined**.

3.3.20. CUTTLEFISH

Biology

Giant Australian Cuttlefish (*Sepia apama*) and Nova's Cuttlefish (*S. novaehollandiae*), are commercially harvested in the MSF. The Giant Australian Cuttlefish is the largest and most abundant local cuttlefish species (Edgar 2000) reaching a maximum size of 500 mm mantle length and weighing up to 10.5 kg (Jereb and Roper 2005). This species is endemic to Australia, broadly distributed around the southern coastline from Point Cloates, Western Australia to Moreton Bay, Queensland, including Tasmania (Edgar 2000). Giant Australian Cuttlefish are generally found over seagrass beds and rocky reef habitats in waters of up to 100 m depth (Jereb and Roper 2005).

Two populations of Giant Australian Cuttlefish have been identified in South Australia, (Gillanders et al. 2016). While the Cuttlefish stock in southern Spencer Gulf extends into Gulf St. Vincent, the northern stock is restricted to northern Spencer Gulf (NSG) with individuals returning to the site of hatching to breed at either one or two years of age. The NSG population forms a breeding aggregation at Point Lowly (Steer et al. 2013, Steer 2015, Gillanders et al. 2016) during late autumn and early winter each year. The species is semelparous, dying soon after spawning (Hall and Fowler 2003).

Fishery

Cuttlefish species are taken in the commercial and recreational sectors of the Marine Scalefish Fishery. Handlines and jigs are used in the commercial sector where they are either targeted or taken as by-product whilst fishing for Southern Calamari. Historically, Cuttlefish were retained by commercial fishers as bait for Snapper.

Recreational fishers mostly take Cuttlefish using jigs when they are targeting Southern Calamari. In 2013/14, the State-wide recreational survey estimated that 2,648 Cuttlefish were captured, of which 1,217 were released, leaving 1,431 retained (Giri and Hall 2015). This provided a total estimated recreational catch of 0.34 t, which was considerably lower than the estimated commercial catch of 2 t during the survey period.

Management Regulations

Cuttlefish species are permitted to be taken by the commercial sector of the MSF (PIRSA 2014). There is no size limit for either the commercial or recreational fishing sectors. However, for the recreational sector, there is a combined Cuttlefish/Squid bag limit of 15 fish and boat limit of 45. A cephalopod fishing closure, that aimed to protect the Giant Australian Cuttlefish spawning population in False Bay, Northern Spencer Gulf was implemented in 1998. This area was extended in 2012 to offer greater protection to the spawning population. An additional temporary closure was implemented in 2013 to prohibit the targeting and retention of Giant Australian Cuttlefish to the north of Wallaroo, Spencer Gulf, and remains current.

Commercial Fishery Statistics

State-wide

Between 1994 and 1997, the reported commercial catch of Cuttlefish increased from 12.3 t.yr^{-1} to a peak at 262 t.yr^{-1} (Figure 3-58a) corresponding with an increase in both targeted and untargeted effort. Total catch declined but remained high in 1998 at 150 t, and then averaged ~19.6 t over the four year period between 1999 and 2002. Between 2003 and 2016 the total catches of Cuttlefish decreased further, and ranged from 10.5 t in 2007 to 1.3 t in 2016. The total catch of 0.9 t in 2017 was the lowest since 1987, and had only increased marginally to 1.3 t in 2018. The economic value of the commercial catch of Cuttlefish in 2018 was approximately $ 12 K (*c.f.* $ 7 K in 2017) (Figure 3-58a).

Until 1994, total jig effort was <350 fisher-days.year^{-1}, before peaking at 1,477 fisher-days in 1997 (Figure 3-58b). Since then, it has fluctuated between 600 and 900 fisher-days.yr^{-1} before dropping to 373 fisher-days in 2018 (*c.f.* 358 fisher-days in 2017). Jig CPUE followed a similar trend and increased from >50 kg.fisher-day^{-1} to 173 kg.fisher-day^{-1} in 1997, and subsequently declining to <15 kg.fisher-day^{-1}.year^{-1} since 2007. The short-term expansion of the fishery between 1994 and 1997 reflects the fleet's concentration of fishing effort on the spawning aggregation in north-western Spencer Gulf. The fishery's take of Cuttlefish was reduced considerably by the False Bay spawning closure, which accounted for >90% of the State-wide catch.

During the late 1990s and early 2000s up to 56% of the fishers catching Cuttlefish were actively targeting them. The number of fishers actively targeting Cuttlefish has rarely exceeded 20% since 2010, indicating that the majority of Cuttlefish landed are incidentally caught (Figure 3-58 c,d).

Regional

Between 1994 and 2002, NSG has provided the highest catches of Cuttlefish with only incidental catches from the other regions (Figure 3-59a). During these years, the seasonality of catches aligned with the timing of the spawning aggregation between April and August. In 2018, the MSF fishers accounted for 99.15% of the commercial catch, and the majority of this was landed in the south eastern corner of Spencer Gulf (Figure 3-59a). The remaining 0.85% was taken by the NZRLF (Figure 3-59d).

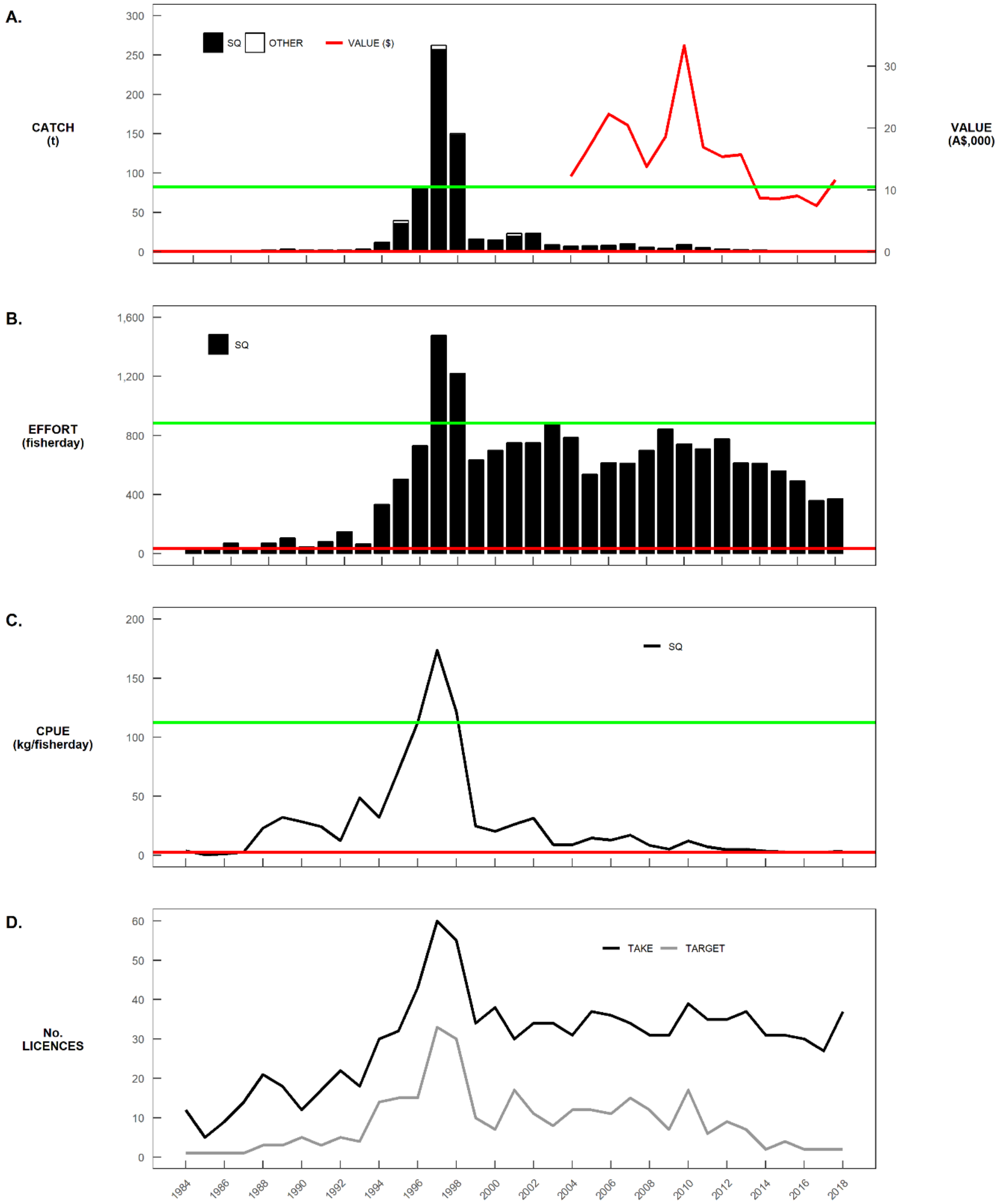

Figure 3-58. Cuttlefish. Long-term trends in: (A) total catch of the main gear types (squid jig and other), and gross production value; (B) total effort; (C) catch per unit effort (CPUE); and (D) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-24.

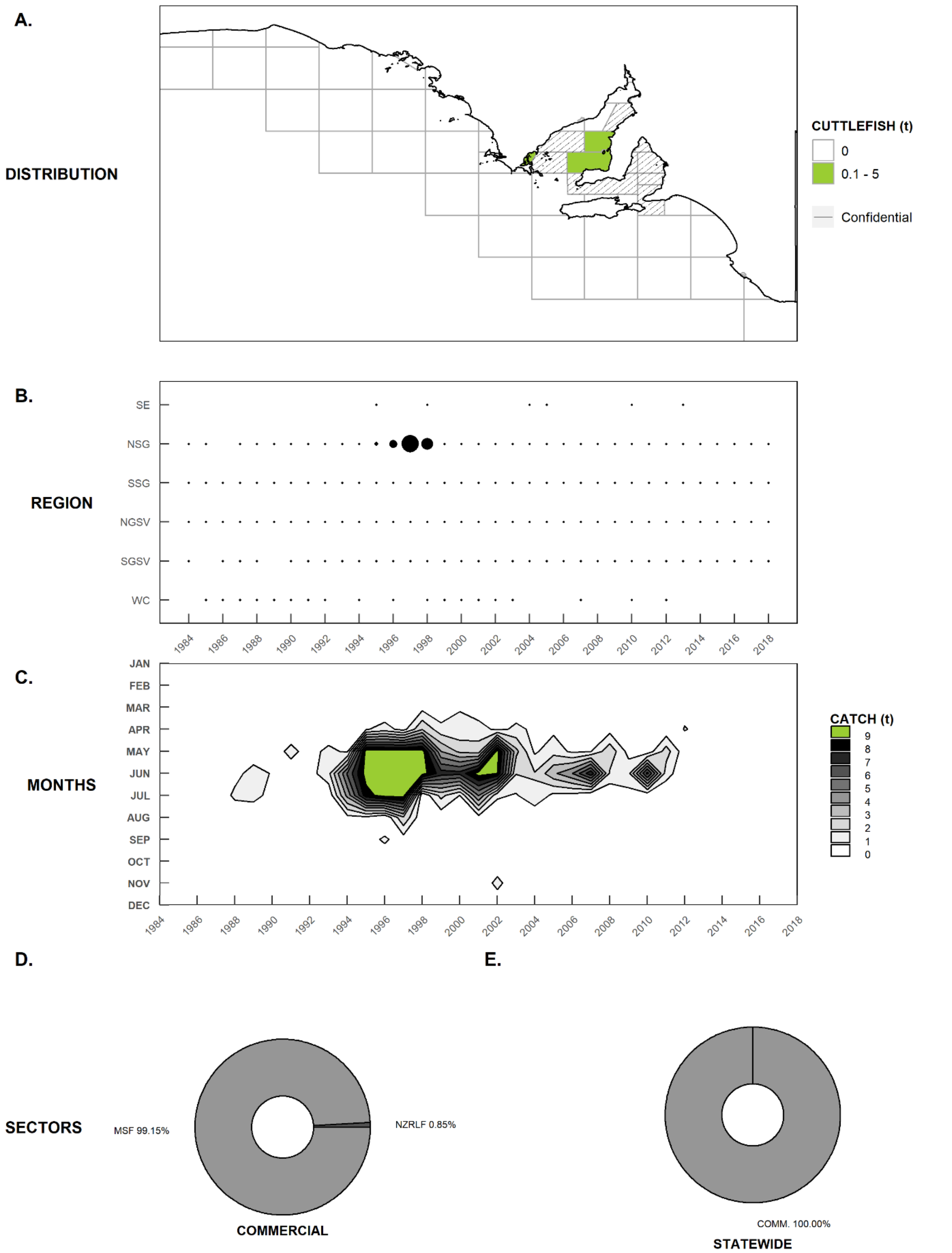

Figure 3-59. Cuttlefish. (A) Catch distribution for 2018. Long term trends in: (B) the annual distribution of catch among regions, (C) months of the year (t), and (D) the proportion of catch distributed among the commercial sector in 2018.

Fishery Performance

The general fishery performance indicators for Cuttlefish were assessed for 2018 at the State-wide scale. Four trigger reference points were activated in 2018 (Table 3-24). Total catch, jig effort and jig CPUE declined over 5 consecutive years, while total jig CPUE was the third lowest recorded since 1984.

Table 3-24. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Cuttlefish in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×
TOTAL JIG EFFORT	G	3rd Lowest / 3rd Highest	×
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	✓
TOTAL JIG CPUE	G	3rd Lowest / 3rd Highest	3rd LOWEST
	G	Greatest % interannual change (+/-)	×
	G	Greatest 3 year trend	×
	G	Decrease over 5 consecutive years	×

Stock Status

There is a minor targeted fishery for this species although it is primarily taken as by-product when other more valuable species, such as Southern Calamari, are targeted. As such, there were a large number of fishers who reported taking Cuttlefish compared to those who reported targeting it. Total catch of Cuttlefish has generally declined since 1997, corresponding with the implementation of spatial and temporal closures (Steer 2015). In 2018, the catch rate was the third lowest level recorded since 1984. This was considerably lower than the high catch rates recorded through the peak period of the mid to late 1990s, and only slightly higher than the lowest level recorded in 1985–87. There were two trigger reference points breached for the data from 2018 reflecting low targeted jig CPUE and declines in total catch over 5 consecutive years. However, fishery independent surveys of abundance in the Point Lowly closure area showed consecutive annual increases from 2014 and 2015, and relatively high abundance in 2018 (Steer, unpublished data). This, in addition to the low recent catches and decrease in effort, suggests that the fishery is unlikely to become recruitment overfished at the current level of fishing pressure. On this basis, South Australia's Cuttlefish fishery is currently classified as **sustainable**.

3.3.21. BLACK BREAM

Biology

Black Bream (*Acanthopagrus butcheri*) occurs in estuaries and nearshore coastal waters across southern Australia from the Murchison River in Western Australia, to Myall Lake in New South Wales, including Tasmania (Norriss et al. 2002; Gomon et al. 2008). It is a medium-bodied, slow-growing species that can grow to 600 mm TL and live to 32 years of age. In South Australia, Black Bream mature at 289–340 mm TL (Ye et al. 2015).

Unlike most Sparids, the Black Bream is an estuarine-dependent species, completing much of its life-cycle within a single estuary (Chaplin et al. 1998). Tagging studies in estuaries in South Australia (Hall 1984), Western Australia (Norriss et al. 2002) and Victoria (Butcher and Ling 1962; Hindell et al. 2008) found limited or no evidence of migration among estuaries. Spawning is usually confined to estuaries and occurs from August to December each year.

Fishery

Black Bream are taken by the commercial and recreational sectors of the MSF. In the commercial sector, the species is targeted and taken as by-product using hauling nets and set nets. However, in most years during the past decade around 70% of annual State-wide commercial catches have been taken by the Lakes and Coorong Fishery, which is not considered in this report (Earl 2019).

Recreational fishers target the species using rod and line in coastal waters and estuaries (Kailola et al. 1993). The State-wide recreational survey in 2013/14 estimated that 197,848 Black Bream were captured, of which 180,869 were released (Giri and Hall 2015). A total of 16,979 fish were retained and contributed to an estimated harvest weight of 4.97 t.

Management Regulations

Black Bream is a tertiary species of the commercial MSF, being of low-medium value and making a minor contribution to the total production value of the fishery (PIRSA 2013). For the commercial sector, regulations are in place to manage fishing effort and limit the take of Black Bream. These include temporal and spatial netting closures, restrictions to net lengths and mesh sizes, and a minimum legal size of 300 mm TL (PIRSA 2016).

There are multiple management regulations in place for Black Bream in the recreational sector. Input and output controls ensure the total catch is maintained within sustainable limits and that access is distributed equitably among fishers. These include gear restrictions and a daily bag limit of 10 fish and boat limit of 30 fish. The minimum size limit of 300 mm TL also applies to the recreational sector. A spatial and temporal closure prohibits the take of Black

Bream from 1 September to 30 November in the area upstream of the Main South Road Bridge in the Onkaparinga River at Noarlunga.

Commercial Fishery Statistics

State-wide

Total annual commercial catches of Black Bream have averaged <1 t per year since 1984 (Figure 3-60a). Total catch peaked at 3.9 t in 2007 and was 3.8 t in 2018. By comparison, only 0.5 t was taken in the Lakes and Coorong Fishery in 2018. The economic value of the commercial catch of Black Bream in the MSF during 2018 was approximately $ 32 K (*c.f.* $40 K in 2017) (Figure 3-60a). Catch and effort data for Black Bream in the MSF were confidential for several years (2011, 2013–15 and 2017) during the last decade, hence, substantially reducing the timeframe of this assessment (Figure 3-60b).

Estimates of total annual fishing effort Black Bream have been highly variable since 1984. Effort declined to 8 fisher-days.yr^{-1} in 1996, before increasing to an historic peak of 253 fisher-days in 2003 (Figure 3-60c). From then until 2010, effort was highly variable ranging from 11 to 82 days per year, with additional peaks of 84 days per year in 2016 and 101 days per year in 2018. Total CPUE fluctuated between 3–21 kg.fisher-day^{-1} until 2007 when it increased to a peak of 47 kg.fisher-day^{-1} (Figure 3-60c). In the past decade, for the reportable years the CPUE has ranged between 13.8 and 38.1 kg.fisher-day^{-1}. The numbers of fishers who reported taking and targeting Black Bream were variable over time, suggesting the catch is largely by-product when other species are targeted (Figure 3-60d).

Regional

Confidentiality constraints (<5 fisher rule) prevented an interrogation of the commercial catch and effort data at regional scales.

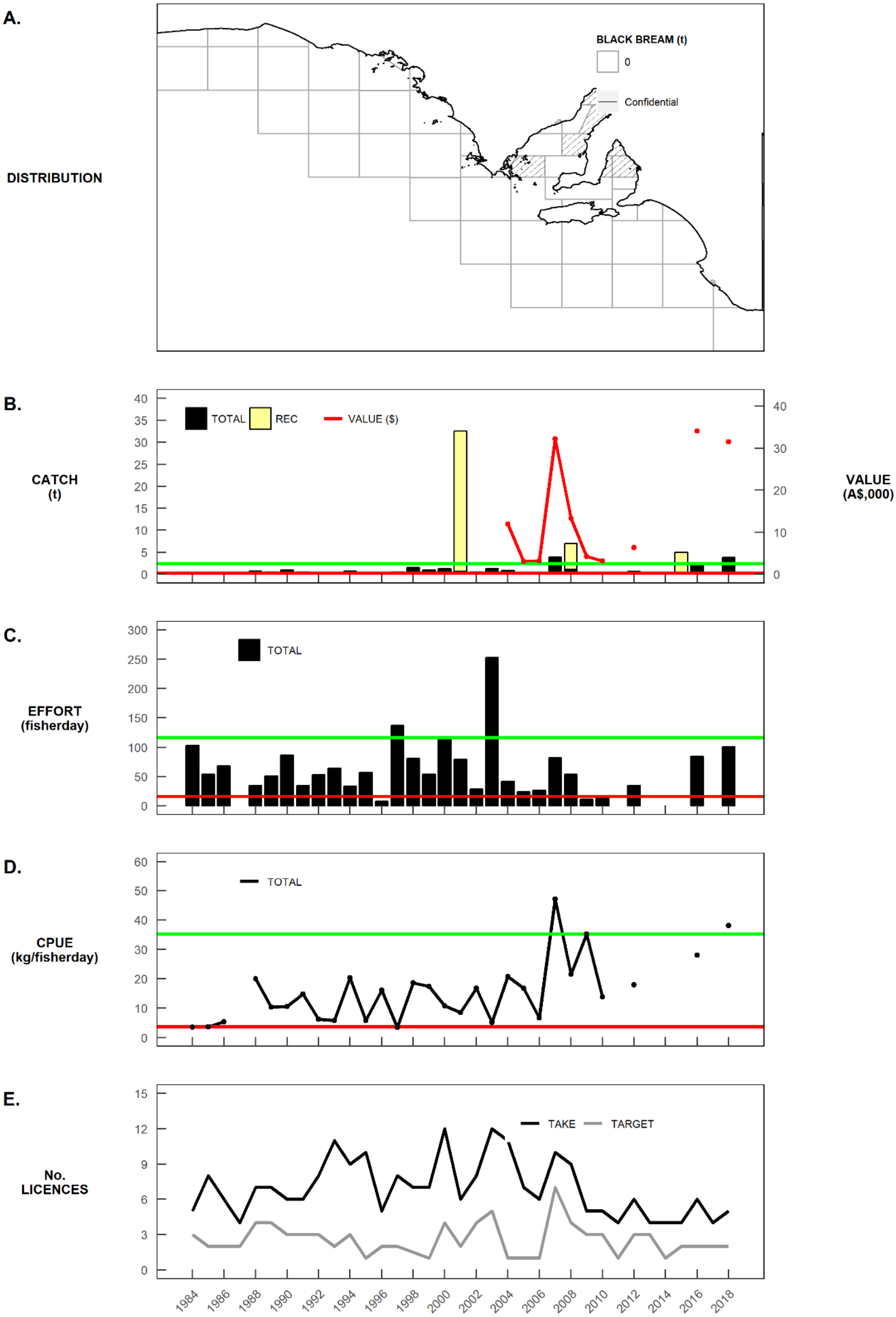

Figure 3-60. Black Bream: (A) Catch distribution for 2018. Long-term trends in (B) total catch, and estimates of recreational catch; (C) total effort; (D) catch per unit effort (CPUE); and (E) the number of active licence holders taking or targeting the species. Green and red lines represent the upper and lower reference points identified in Table 3-25.

Fishery Performance

Confidentiality constraints prevented the assessment of the 2018 catch and effort data against the general performance indicators (Table 3-25).

Table 3-25. Results of the assessment of the general (G) fishery performance indicators against their trigger reference points at the State spatial scale for Black Bream in 2018.

PERFORMANCE INDICATOR	TYPE	TRIGGER REFERENCE POINT	STATE
TOTAL CATCH	G	3rd Lowest / 3rd Highest	CONF.
	G	Greatest % interannual change (+/-)	CONF.
	G	Greatest 3 year trend	CONF.
	G	Decrease over 5 consecutive years	CONF.
TOTAL EFFORT	G	3rd Lowest / 3rd Highest	CONF.
	G	Greatest % interannual change (+/-)	CONF.
	G	Greatest 3 year trend	CONF.
	G	Decrease over 5 consecutive years	CONF.
TOTAL CPUE	G	3rd Lowest / 3rd Highest	CONF.
	G	Greatest % interannual change (+/-)	CONF.
	G	Greatest 3 year trend	CONF.
	G	Decrease over 5 consecutive years	CONF.

Stock Status

Black Bream is a tertiary species for the commercial sector of the MSF (PIRSA 2013). This reflects low annual catches and its minor contribution to the total production value of the sector. Catches of Black Bream were low from 1984 to 2006, as a result of low targeted effort and low CPUE. Between 2014 and 2018, catches increased slightly and estimates of CPUE were > 80% higher than the long-term average catch rate. The recent increases in total catch and CPUE indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. On this basis, at the state scale, the Black Bream stock is classified as **sustainable**.

4. DISCUSSION

This report assessed the fishery performance of 21 species/taxonomic groups taken in the MSF based on data available until the end of 2018. Collectively, these taxa were considered across 33 management units, at a resolution that aligned with either the biological stock, State-wide or regional level. Of these, 26 (79%) stocks were classified as sustainable, three (9%) were classified as depleted, one (3%) was classified as depleting, one (3%) was classified as recovering, and the remaining two (6%) were classified as undefined as there was insufficient information to assign a stock status.

The four primary species, including King George Whiting, Snapper, Southern Garfish, and Southern Calamari have consistently accounted for more than half of the State-wide total commercial catch in the MSF over the last decade, which emphasises their collective importance to the local economy. Previous stock assessments for King George Whiting (Steer et al. 2018a), Southern Garfish (Steer et al. 2018b) and Snapper (Fowler et al. 2019) have identified different levels of concern regarding the sustainability of some stocks. All three King George Whiting stocks remain sustainably fished in 2018, with the GSV/KI improving from a depleting status in 2016 on the basis of increasing catch rates, relatively stable catch and effort trends, and consistent recruitment. The statuses of the Southern Garfish stocks remain unchanged from the previous assessment (Steer et al. 2018b), with the NSG stock classified as recovering and NGSV as depleted. For Snapper, the SG/WC Stock remains depleted, whereas the Gulf St. Vincent stock has deteriorated from sustainable to a depleting classification. This reflects a significant reduction in the spawning biomass, as well as declining catches and catch rates, and recent poor recruitment (Fowler et al. 2019). In each case, the stock status classifications have supported the development and implementation of specific management arrangements to recover each stock.

The improvement in the status of the GSV/KI stock of King George Whiting appears to be unrelated to the changes in management arrangements that were implemented in December 2016, as the recovery occurred within a year of their implementation. The changes included: a spatial closure to protect spawning grounds; and an increase in the legal minimum length. Nevertheless, the spatial spawning closure that has now been implemented during May in 2017 and 2018 may have provided additional benefit particularly since the recent advancement of fishing technologies. Increased vessel power and engine reliability, affordable electronic fish-finding equipment, improved fishing gear and communication has increased the fleet's capacity to extend their fishing effort into offshore areas that have been difficult to access in the past. A project is currently underway to identify the key spawning areas of King George Whiting throughout the southern gulfs and to understand their role in replenishing local stocks (FRDC 2016/003). It is anticipated that the results of that study will contribute to improving the assessment and management of this important resource.

The short lifespan and rapid generation turnover of Southern Garfish increases the capacity of the population to respond rapidly to effective management arrangements. This was apparent for the NSG Southern Garfish stock, which was classified as recovering in 2017, based on promising signs of improvement in biomass, exploitation rates, egg production, and population age structure (Steer et al. 2018b). Targeted catch rates in the hauling net sector for NGSV have increased; however, harvest fraction has trended downwards; and fishable biomass, egg production and recruitment have remained relatively stable. This indicates that current fishing mortality is constrained by management to a level that should allow the stock to recover from its recruitment-impaired state. Nevertheless, measurable improvements are yet to be detected. Although adequate management may now be in place to recover this stock, more time is required to determine the relative effects of the 2017 and 2018 management arrangements, which included an extended closure and increased hauling net mesh sizes. The next full stock assessment for Southern Garfish is scheduled for 2021. Furthermore, a dedicated research project (FRDC Project 2015/018) was completed in 2019, which provided important insights into the population biology and ecology of Southern Garfish throughout Gulf St. Vincent (Fowler 2019). The project demonstrated that there were complex spatial patterns in the dispersion of Southern Garfish at different life history stages, with the abundances and biomass of adult fish being highest in the northern gulf and declining southward down the eastern and western sides of the gulf. These findings are useful in the interpretation of spatially-limited, fishery-dependent data in terms of stock status.

The recent performances of the SG/WC and GSV Snapper stocks have deteriorated despite considerable management interventions aimed at reducing exploitation rates and enhancing reproductive output and recruitment (Fowler et al. 2013, 2016, Steer et al. 2018b). Despite these changes, commercial fishery statistics for the SG/WC stock up to 2018 show no improvements, with estimates of catch and gear-specific effort and CPUE, remaining at or around historically low levels, and daily egg production method-based (DEPM) estimates indicating significant declines in recent estimates of spawning biomass in key fishing areas (Fowler et al. 2019). Furthermore, commercial statistics for the GSV stock have declined considerably since 2015, and fishery-independent estimates of spawning biomass indicated relative declines of 23% for Spencer Gulf and 87% for Gulf St. Vincent over the past five years (Fowler et al. 2019). The population age structures derived from commercial catch sampling also provided evidence to suggest that recruitment has been relatively low (Fowler et al. 2019). Considerable changes to management arrangements have occurred in the past decade, and further restrictions will be implemented to address the concerning statuses of these two

Snapper stocks. These arrangements include: an extensive state-wide Snapper fishing closure over a 3.25 year period (from 1 November 2019 until 31 January 2023); with the exception of the South East region which will be opened to restricted fishing from 1 February to 31 October in each year.

Declines in the 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 Southern Calamari. This change has most likely been driven by economics where it has become more cost-effective to target the latter species based on their relative abundance, catchability, low set-up and vessel running costs and high market value. Targeted jig effort for Southern Calamari has remained high in 2018, for NSG, SSG, and NGSV. This trend reaffirms Southern Calamari as an established opportunistic target species for commercial fishers. Furthermore, it has now surpassed Snapper and King George Whiting as the most valuable commercial MSF species in SA, in terms of gross production value. Although the resource is considered sustainable at the biological stock level, targeted catch rates have declined in particular regions, i.e. SSG and NSG, suggesting that increased fishing pressure in these regions may have contributed to localised depletion. These concerns regarding regional declines in productivity have also been raised by industry, who have reported, anecdotally: Southern Calamari have become increasingly difficult to catch in areas that were previously highly productive; there is now a lack of eggs in known spawning areas; and there is a notable absence of large animals. Although localised depletion can occur through intense fishing pressure on spawning aggregations, Southern Calamari's high-paced life history, dynamic spawning behaviour and movement potential favours population replenishment at the broader biological stock level (Pecl et al. 2006).

The long-term decline in fishing effort through reduction in numbers of licence holders is a distinct feature of the MSF. Since 1984, 555 MSF licences have been removed, representing an overall reduction of 64%, and translating to a 58.2% reduction in total fishing effort. Furthermore, industry and government have recently committed to a structural reform of the fishery to ensure its long-term sustainability and economic viability. This reform aims to address the inherent complexities of the fishery by reviewing its overall structure and function, refining its future management, and developing a mechanism to further rationalise the fleet. Aspects of this reform will be informed by a current research project that aims to firstly disentangle and understand the fleet dynamics of this complex, multi-species, multi-gear fishery, then explore the implications of strategic management options (e.g. regionalisation, unitisation) on the future structure and viability of the MSF from resource sustainability, economic and social perspectives (FRDC 2017/014).

The multi-species nature of the MSF can be considered a strength of this fishery, as it provides considerable flexibility in the fishing dynamics of the fleet. As seen with the recent increase in effort targeted towards Southern Calamari, there is also evidence of other, relatively low value, secondary and tertiary species becoming more prominent within the fishery. Snook and Leatherjackets have been increasingly targeted by hauling net fishers and there has been a resurgence in catches of Ocean Jackets and Salmon over the past five years. For some species, increases in effort have presumably been in response to developing markets, whereas others have arisen out of the need for fishers to counteract diminishing access to more valuable species as a consequence of management arrangements, sustainability concerns or competitive interactions. Reducing the MSF's reliance on the four primary species through the development of 'lesser-known' (or 'under-utilised') species has been identified by industry and government as a means of redirecting effort away from compromised stocks to facilitate their recovery, and to increase the overall productivity and profitability of the fishery. A study is currently being done to explore the MSF's potential to diversify by increasing production of these lower value, 'lesser-known' species, whilst conforming to the principles of ecologically sustainable development (FRDC 2017/023).

A number of species considered in this report constitute by-product for the hauling net sector, where they are incidentally caught when fishers target more valuable species. Of these, Yellowfin Whiting, Australian Herring, Snook, Leatherjackets and Yelloweye Mullet are of medium value, with moderate market appeal. These species share similar commercial catch and effort trends for which fishing effort within the hauling net sector has declined due a reduction in net endorsements as a function of the licence amalgamation scheme implemented in 1994, and two net buy-backs associated with increased netting closures introduced in 2005 and 2014. These management arrangements have effectively constrained the fishing capacity of the hauling net sector to predominantly target premium MSF species (i.e. Southern Garfish, King George Whiting and Southern Calamari). Nominal catch rates for the by-product species have trended upwards, suggesting that they are relatively abundant and being harvested at sustainable levels.

The MSF continues to demonstrate its capacity to respond to productivity levels and market demands. The rapid growth of Southern Calamari, coupled with its high market value, has effectively counteracted the decline in Snapper productivity. Similar opportunities exist for some lesser-known species, such as Western Australian Salmon, Ocean Jackets and Snook, which may contribute to distributing fishing pressure more widely throughout the fishery and to reducing target effort on key species.

4.1. Challenges and Uncertainties in the Assessment

Determining stock status through the weight-of-evidence approach for the numerous MSF stocks considered in this report has relied heavily on fishery-dependent statistics. Given the diverse structure and function of the fishery, these data sources will continue to form the basis of both quantitative and qualitative assessments. This is particularly relevant for the secondary and tertiary species for which fewer data are available and there are limited resources for developing more sophisticated fishery-independent assessment programs.

The most significant gap in our knowledge for assessing the status of the stocks that support the MSF is determining the relative contribution of the State-wide catch of the recreational fishing sector. This sector's total harvest has traditionally been determined through telephone/diary surveys that are undertaken on a five-year cycle (Henry and Lyle 2003, Jones 2009, Giri and Hall 2015). Although these surveys adopt a standard methodology that allows the results to be compared through time, their estimates of catch and effort are typically imprecise. This imprecision has implications for the assessments of King George Whiting and Snapper, for which the recreational contribution is significant. Improving the precision of the estimates of the recreational catches, either through more frequent surveys or increased participation rates, will benefit the assessment and subsequent management of the MSF.

In recent years, it has become increasingly evident that the fishing behaviour of the MSF fleet has changed, and, in some cases, these changes have compromised the reliance on fishery-dependent information to determine stock status. For example, changes in fishing efficiency combined with new management arrangements for Snapper reduced the reliability of CPUE as a suitable index of stock biomass and performance, and led to the development and evaluation of an alternate fishery-independent indicator (Steer et al. 2017, Fowler et al. 2019). Similarly, the issue of advancing fishing technologies and improved efficiency was identified as a key concern for King George Whiting.

4.2. Research Priorities

The poor status of Snapper stocks in SA and the significant response of the government has directed considerable research focus towards this species. Considerable funding has been directed towards addressing a suite of research topics to support the recovery of the SG/WC and GSV Snapper stocks. These include: undertaking an annual stock assessment for Snapper during the 3.25 year closure period, including DEPM-based surveys of spawning biomass; developing a cost-effective method for monitoring the numbers of juvenile Snapper to provide an early indication of recruitment strength (FRDC 2019/046) and quantifying post-release mortality rates across all sectors of the Snapper fishery (FRDC 2019/044).

Assessing new technologies and techniques that could improve the cost-effectiveness and robustness of recreational fishing surveys was the central focus of an FRDC-funded (Project 2017/198) national recreational fisheries science workshop hosted by SARDI (Aquatic Sciences) in July 2018 (Beckmann et al. 2019). It is anticipated that outcomes of this workshop will be integrated into future recreational fishing surveys and contribute to the development of cross-jurisdictional research collaborations that aim to improve our understanding of Australia's recreational fishing dynamics.

For the primary species, for which there are dedicated quantitative stock assessment models, there is a need to explore the relative effects of nominal increases in effective effort, and to determine whether greater influence should be placed on biological metrics, or if fishery-independent data streams (such as spawning biomass estimates, pre-recruit information, or recreational fishing data) can be used to 'ground-truth' model-derived estimates of biomass. For the other lower-value species, there may be a need to revisit whether nominal estimates of targeted CPUE are the most informative metric of relative abundance, as opposed to standardised catch rates. New statistical and modelling methods are emerging for 'data-limited' fisheries. The aim is to deliver the most robust, transparent and defensible fishery assessments possible to support sustainable resource management. The MSF is currently undergoing considerable transition through the structural reform, development of new harvest strategies and pending review of the Management Plan. An FRDC project that will provide statistical support to this structural reform will review current fishery assessment methods and consider the implementation of data-limited approaches to optimise its sustainable utilisation of the resource.

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Appendix 1. Annual commercial catches (t) of 21 species and species groups taken in the Marine Scalefish Fishery between 1984 and 2018. Crosses indicate confidential data (<5 fishers) and dashes indicate no data.

	Garfish	KGW	Snapper	Calamari	YFW	A. Salmon	A. Herring	Vongole	Snook	B. Crab	S. Crab	Y.eye Mullet	Mulloway	W. Sharks	Ocean Jacket	Wrasse spp.	S. Trevally	L.Jackets.	Rays & Skates	Cuttlefish	Bream
1984	441.9	636.0	451.1	183.9	104.5	400.2	364.2	0.2	110.9	114.7	22.8	96.0	14.8	30.1	–	2.9	3.0	X	8.2	0.3	0.4
1985	438.4	597.0	457.9	196.2	61.4	659.6	231.2	0.3	75.6	126.1	30.4	100.5	14.7	27.0	–	2.6	2.1	X	14.9	0.1	0.2
1986	449.1	693.2	427.2	201.7	41.7	541.7	409.2	15.2	72.5	170.1	25.0	129.4	9.8	40.2	–	2.3	3.3	X	18.4	0.3	0.4
1987	382.4	602.1	364.5	168.2	23.8	650.6	493.8	37.0	70.8	165.6	28.0	147.0	14.2	54.8	–	3.0	4.3	X	42.3	0.2	X
1988	391.0	586.6	409.8	281.3	14.5	524.9	427.7	43.9	85.5	209.4	40.5	126.3	8.1	70.0	–	3.4	4.2	X	51.9	2.3	0.7
1989	513.7	638.0	423.3	231.6	26.9	573.3	396.2	28.6	116.4	323.6	136.5	133.3	9.0	62.8	429.4	2.5	3.0	X	40.8	3.5	0.5
1990	527.7	683.8	453.1	212.1	40.8	313.6	296.0	23.4	94.8	390.5	151.9	174.7	13.4	76.6	930.0	1.9	4.6	68.9	42.0	2.0	0.9
1991	422.5	678.0	419.5	348.5	39.9	486.5	342.8	24.4	102.3	434.6	135.2	154.8	7.6	76.9	977.3	1.6	7.4	63.7	50.1	2.1	0.5
1992	492.8	776.3	383.1	268.3	44.4	607.2	362.1	36.2	114.7	429.1	81.6	131.8	11.6	67.7	916.8	5.0	16.6	51.6	69.6	2.1	0.3
1993	531.5	668.8	358.2	312.9	107.4	658.7	321.2	25.5	120.5	566.3	65.9	128.6	10.9	71.6	766.3	4.4	14.6	47.3	64.4	3.3	0.4
1994	469.0	635.0	242.1	352.5	73.3	500.1	299.9	15.1	132.6	484.3	40.1	102.5	17.9	92.4	575.3	6.1	7.9	52.9	61.8	12.3	0.7
1995	401.9	565.0	260.3	355.2	110.3	638.0	231.5	34.9	147.3	692.9	53.0	102.1	24.2	93.6	477.0	7.8	7.8	33.9	49.5	39.8	0.3
1996	503.9	579.1	310.2	374.5	95.4	500.9	212.9	73.1	131.8	559.6	66.5	66.0	12.7	70.7	441.7	6.7	7.8	42.8	46.9	82.5	0.1
1997	546.4	570.6	362.4	390.7	107.0	653.5	219.1	83.1	110.1	320.9	125.9	107.3	11.4	102.2	433.0	23.9	9.1	42.5	50.3	262.0	0.5
1998	447.2	562.3	398.2	433.2	51.2	572.7	353.1	151.8	108.3	74.3	119.5	92.2	6.5	96.1	359.6	24.7	4.1	39.4	47.4	150.1	1.5
1999	452.2	602.1	572.9	400.4	113.7	584.7	298.3	142.4	105.4	123.9	132.1	67.8	6.6	82.8	284.1	24.1	8.4	43.7	49.0	16.3	0.9
2000	517.4	440.7	571.5	419.3	109.3	542.1	250.7	159.2	94.9	78.5	175.7	71.3	7.1	79.7	269.2	21.9	21.0	38.4	54.0	15.0	1.3
2001	522.8	449.1	661.5	455.6	178.9	576.4	250.9	179.7	113.9	92.9	131.7	71.6	6.2	93.9	352.1	21.9	7.1	48.1	54.2	23.3	0.7
2002	419.9	370.7	545.0	323.3	152.9	279.7	252.9	240.7	108.4	66.7	104.7	50.8	2.7	96.9	308.0	23.7	2.5	20.2	49.4	23.8	0.5
2003	295.7	381.8	412.0	314.5	167.7	496.3	149.4	261.0	90.4	66.2	104.9	47.7	7.8	119.1	X	28.8	5.1	17.1	47.6	8.9	1.3
2004	327.3	345.7	449.9	468.8	162.9	213.8	178.8	296.7	85.6	51.9	84.9	43.4	2.6	113.2	322.7	22.9	6.3	29.5	36.1	7.1	0.9
2005	390.6	348.0	529.6	357.9	120.5	173.5	165.4	389.5	69.0	47.8	177.0	48.5	6.1	94.8	X	19.9	6.8	26.1	32.2	7.9	0.4
2006	350.0	348.0	613.6	299.3	126.1	262.5	93.2	309.5	58.1	47.6	105.5	41.6	5.9	76.5	69.2	15.5	10.8	14.0	24.5	8.0	0.2
2007	264.5	351.7	745.4	295.9	78.8	126.3	112.6	311.5	82.0	41.8	70.2	30.5	7.2	82.4	57.7	13.4	8.2	13.3	20.3	10.5	3.9
2008	277.1	313.3	719.7	279.1	85.7	126.7	130.0	233.6	72.1	51.0	98.5	30.5	3.3	87.9	X	21.7	8.4	16.8	21.0	6.0	1.2
2009	316.7	358.5	818.5	331.0	114.7	136.1	176.7	154.5	64.3	60.4	72.7	25.6	3.7	109.5	X	20.0	5.7	19.2	22.7	4.5	0.4
2010	254.9	326.7	1034.5	347.9	114.4	163.5	147.1	86.6	64.9	54.2	65.7	23.3	2.0	121.1	X	19.5	15.5	14.0	18.3	9.1	0.2
2011	291.7	328.2	945.0	415.4	87.5	204.0	86.4	78.5	46.8	53.6	93.2	31.8	3.3	92.6	X	23.5	10.5	12.1	18.3	5.2	X
2012	238.9	310.9	642.7	429.4	119.0	98.0	109.7	64.1	49.2	56.6	79.0	27.5	4.5	90.0	138.6	16.7	10.3	13.2	18.3	3.8	0.6
2013	250.4	292.5	519.4	399.0	152.0	59.4	172.1	70.7	41.9	62.5	65.0	18.9	2.8	57.2	50.2	17.3	9.1	14.2	12.4	3.1	X
2014	264.0	280.6	534.4	402.5	96.2	220.1	114.5	73.6	40.3	60.9	46.9	16.0	1.3	58.3	X	15.2	11.3	10.5	15.7	2.2	X
2015	163.3	288.5	512.4	370.3	101.0	349.5	104.3	60.0	46.7	45.0	63.2	16.1	1.3	54.8	X	17.2	8.7	15.0	15.4	1.5	X
2016	155.2	287.3	386.8	398.8	114.6	370.1	93.5	69.5	53.5	31.2	48.4	12.5	1.1	50.4	224.2	13.6	8.1	34.1	9.6	1.3	2.4
2017	183.5	244.8	339.7	412.7	141.6	374.1	61.2	61.7	38.9	51.7	44.7	22.1	5.6	62.5	151.2	13.6	10.6	27.1	13.1	0.9	X
2018	176.2	250.2	281.3	371.0	140.2	156.3	104.5	68.6	43.2	35.6	44.2	19.7	9.0	45.1	X	7.9	4.6	29.5	10.2	1.3	3.8

Appendix 2. Annual commercial catches (t) of remaining permitted species and species groups taken in the Marine Scalefish Fishery between 1984 and 2018. These species were not considered in detail in this report. Crosses indicate confidential data (<5 fishers).

	Annelids	Goolwa Cockle	Mussel	Octopus	Oyster	Scallop	Gould's squid	Anchovy	Barracouta	Cod	Dories	Flathead	Flounder	Goatfish	Yellowtail Kingfish	Pink Ling	Blue Mackerel	Jack Mackerel	Morwong	Other Mullet	Bight Redfish	Sweep	Swallowtail	Blueeye Trevalla	School Whiting	Other Shark
1984	13.9	X	X	X	X	X	X	X	76.1	0.4	X	4.6	0.3	2.5	0.7	X	X	2.1	10.8	X	5.1	3.5	X	X	X	21.1
1985	14.6	X	X	0.2	X	X	X	X	24.0	X	X	3.2	1.0	2.6	X	X	X	X	13.4	X	8.9	3.1	X	3.6	X	25.8
1986	15.2	X	X	0.1	X	X	X	X	7.6	X	X	3.4	1.2	3.7	X	0.1	X	3.0	19.5	X	16.3	1.7	X	24.6	X	27.7
1987	11.8	X	X	1.4	X	X	X	X	5.8	X	X	3.3	0.5	3.3	X	1.1	3.7	X	24.4	X	13.8	1.8	X	153.4	X	80.7
1988	11.3	X	X	3.1	X	X	X	X	12.2	0.4	X	5.1	0.3	4.0	X	0.4	0.8	37.4	22.7	X	14.7	2.7	X	81.8	X	83.6
1989	13.7	X	X	2.6	X	X	X	X	9.1	0.2	X	4.0	0.3	4.7	X	0.2	1.3	X	28.7	X	22.0	9.6	0.2	54.9	X	72.5
1990	15.9	X	X	3.9	X	X	X	X	12.9	X	X	5.6	X	6.3	X	0.2	0.6	X	28.3	X	15.6	10.5	0.3	84.3	0.1	73.5
1991	15.8	X	X	6.2	X	X	X	X	5.2	X	X	6.9	0.2	3.9	0.4	0.1	1.4	0.3	20.5	X	9.4	7.0	0.4	70.6	X	102.8
1992	17.0	366.1	X	9.7	X	X	X	X	2.5	X	X	5.9	0.2	4.8	2.5	0.4	0.7	0.4	16.3	X	10.4	3.2	0.3	49.0	X	260.2
1993	13.7	X	X	6.5	X	X	X	X	2.0	X	X	4.5	0.1	4.6	1.7	2.1	0.5	0.4	13.6	X	13.5	4.8	0.4	54.5	0.1	352.0
1994	13.7	X	X	5.3	X	X	X	X	0.5	X	X	3.9	0.1	4.9	0.7	0.7	6.7	0.0	20.1	X	13.7	8.9	0.5	35.8	0.1	135.5
1995	13.9	X	X	6.8	X	X	X	X	X	X	X	2.8	0.5	4.1	0.5	0.6	5.0	0.3	25.8	X	18.2	5.8	0.1	17.9	0.0	114.6
1996	14.1	436.1	X	11.4	X	X	X	X	0.9	X	X	2.3	0.2	4.9	X	1.3	5.7	X	29.8	X	11.9	5.9	0.4	6.6	0.1	135.4
1997	11.6	362.6	X	5.9	X	X	X	X	X	X	X	2.2	0.1	3.5	X	1.6	4.0	X	14.1	X	9.3	8.7	0.1	4.5	X	78.5
1998	11.3	X	X	X	X	X	X	X	0.3	X	X	2.5	X	4.6	X	X	4.6	X	8.6	X	4.6	5.9	0.1	X	X	61.1
1999	11.5	340.7	X	7.4	X	X	X	X	X	X	X	2.8	0.2	4.7	X	X	2.4	X	3.7	X	5.5	2.6	X	X	X	54.9
2000	14.5	332.0	X	7.5	X	X	X	X	X	X	X	2.1	0.0	3.7	X	X	3.6	X	1.6	X	3.0	1.4	X	X	X	56.0
2001	10.8	338.7	X	X	X	X	X	X	X	X	X	2.1	X	4.8	X	X	0.4	X	0.5	X	1.6	1.8	X	X	X	75.6
2002	8.3	273.5	X	5.5	X	X	X	X	2.0	X	X	2.1	X	3.6	0.2	X	5.1	X	1.5	X	3.6	2.0	X	X	X	46.8
2003	7.1	X	X	5.1	X	X	X	X	2.4	0.0	X	2.2	X	3.4	0.4	X	1.5	X	2.6	X	3.4	2.0	X	X	0.1	36.2
2004	7.3	X	X	X	X	X	X	X	5.5	X	X	2.1	X	3.8	0.1	0.1	3.6	X	3.0	X	4.7	1.7	X	X	X	31.3
2005	7.5	34.3	X	X	X	X	X	X	4.3	X	X	2.2	X	3.7	0.4	X	0.8	X	3.8	0.2	7.5	1.4	X	X	X	24.8
2006	7.5	2.2	X	8.1	X	X	X	X	0.9	X	X	1.7	X	4.6	X	X	2.3	X	2.0	X	3.9	1.4	0.0	X	X	25.3
2007	6.6	X	X	18.9	X	X	X	X	X	X	X	2.1	X	5.8	X	X	3.6	X	2.3	X	4.6	0.8	0.1	X	X	19.5
2008	7.6	X	X	23.3	X	X	X	X	X	X	X	2.4	X	4.5	0.5	X	3.5	X	1.8	X	3.3	1.2	0.1	X	0.1	12.1
2009	6.1	X	X	X	X	X	X	X	2.2	0.4	X	3.3	X	4.9	0.1	X	2.1	X	2.6	2.4	6.8	2.5	0.4	X	X	16.4
2010	5.8	X	X	X	X	X	X	X	X	X	X	4.2	X	4.3	0.3	X	1.9	X	3.4	0.2	8.9	2.2	0.5	X	X	19.4
2011	5.9	X	X	14.6	X	X	X	X	X	X	X	5.7	X	3.3	X	X	X	X	2.9	X	14.2	3.1	0.2	X	X	23.0
2012	6.5	X	X	X	X	X	X	X	X	X	X	2.6	X	3.3	0.2	X	0.3	X	1.2	X	10.7	3.1	0.3	X	X	12.9
2013	5.4	X	X	7.6	X	X	X	X	X	X	X	1.6	X	5.2	X	X	X	X	1.0	X	10.0	2.4	0.2	X	0.0	8.4
2014	5.0	X	X	11.4	X	X	X	X	X	X	X	2.0	X	4.3	2.8	X	X	X	0.6	X	8.3	2.0	0.1	X	0.2	7.5
2015	5.2	X	X	10.6	X	X	X	X	X	X	X	2.0	X	3.5	1.3	X	X	X	0.9	X	12.6	1.1	0.1	X	X	7.1
2016	4.3	X	X	X	X	X	X	X	X	X	X	0.8	X	3.5	2.0	X	X	X	0.9	X	12.2	0.9	0.1	X	X	4.4
2017	4.7	X	X	14.4	X	X	X	X	X	X	X	1.1	X	3.3	2.1	X	X	X	1.2	X	19.8	0.7	0.2	X	X	6.1
2018	3.8	X	X	X	X	X	X	X	X	X	X	1.1	X	4	1.9	X	X	X	1.1	6.2	20.7	1.6	1.9	X	X	3.9