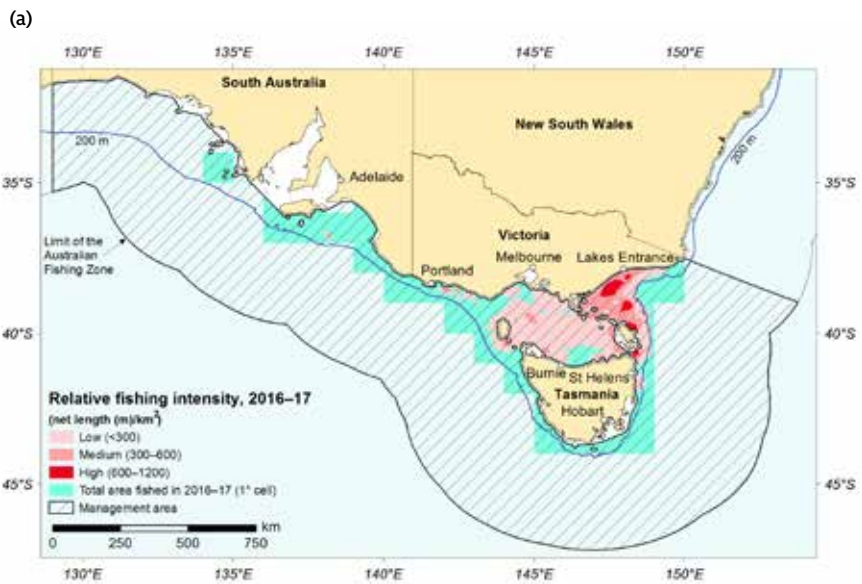# Chapter 12
Shark Gillnet and Shark Hook sectors

N Marton and A Koduah

FIGURE 12.1 Relative fishing intensity in (a) the Shark Gillnet Sector and (b) the Shark Hook Sector of the Southern and Eastern Scalefish and Shark Fishery, 2016–17 fishing season

(a)

FIGURE 12.1 Relative fishing intensity in (a) the Shark Gillnet Sector and (b) the Shark Hook Sector of the Southern and Eastern Scalefish and Shark Fishery, 2016–17 fishing season continued
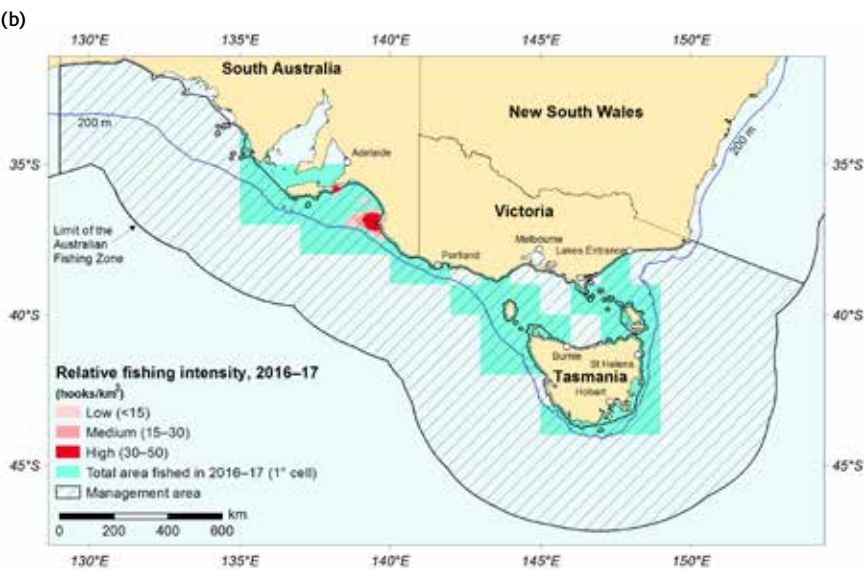
Gillnet vessel
AFMA

TABLE 12.1 Status of the Shark Gillnet and Shark Hook sectors

Status	2015		2016		Comments
Biological status	**Fishing mortality**	**Biomass**	**Fishing mortality**	**Biomass**	
Elephantfish (*Callorhinchus milii*)	🟩	🟩	🟩	🟩	CPUE is above target; catch is below RBC.
Gummy shark (*Mustelus antarcticus*)	🟩	🟩	🟩	🟩	Catch is below RBC. Estimates of pup production are close to or above the target.
Sawshark (*Pristiophorus cirratus, P. nudipinnis*)	🟩	🟩	🟩	🟩	CPUE is above target; catch is below RBC.
School shark (*Galeorhinus galeus*)	🟨	🟥	🟨	🟥	Uncertain if total mortality will allow recovery in required time frame. Estimate of pup production is below 20% of unexploited levels.
Economic status a	NER were −$2.9 million in 2012–13. Preliminary estimates for 2013–14 indicate that NER are likely to remain negative. Although gummy shark biomass is not constraining NER, the management of non-target species and marine mammal interactions has likely contributed to a fall in NER in recent years.				

a NER refer to the entire Gillnet, Hook and Trap Sector; therefore, this figure includes scalefish. Shark species account for around 70 per cent of total Gillnet, Hook and Trap Sector gross value of production.
Notes: **CPUE** Catch-per-unit-effort. **NER** Net economic returns. **RBC** Recommended biological catch.

Fishing mortality	🟩 Not subject to overfishing	🟥 Subject to overfishing	🟨 Uncertain
Biomass	🟩 Not overfished	🟥 Overfished	🟨 Uncertain

12.1 Description of the fishery

Area fished

The Shark Gillnet and Shark Hook sectors (SGSHS) extend south from the New South Wales – Victoria border, around Tasmania, and west to the South Australia – Western Australia border. Most fishing occurs in waters adjacent to the coastline and throughout Bass Strait (Figure 12.1).

Fishing methods and key species

The SGSHS uses demersal gillnet and longline to target gummy shark (*Mustelus antarcticus*). School shark (*Galeorhinus galeus*), elephantfish (*Callorhinchus milii*) and sawsharks (*Pristiophorus cirratus* and *P. nudipinnis*) are byproducts from the gummy shark fishery. School shark was historically the primary target species in the fishery, but biomass was reduced below the limit reference point around 1990. It remains an important byproduct species and is the second most economically important species in the fishery.

Other important byproduct species (by weight) are snapper (*Pagrus auratus*), whiskery shark (*Furgaleus macki*), broadnose sevengill shark (*Notorynchus cepedianus*), bronze whaler (*Carcharhinus brachyurus*), draughtboard shark (*Cephaloscyllium laticeps*) and blue morwong (*Nemadactylus valenciennesi*).

Management methods

The fishery is managed using a combination of input controls (gear restrictions and closed areas) and output controls (individual transferable quotas and limits on the proportion of school shark to gummy shark catch). The four key commercial stocks taken in the SGSHS are managed under the Southern and Eastern Scalefish and Shark Fishery (SESSF) harvest strategy framework (AFMA 2009). The harvest strategy is summarised in Chapter 8. School shark is subject to incidental catch limits, and other measures to reduce targeting and catch for a number of seasons. Additional current measures include closure of waters deeper than 183 m to gillnet fishing, closure of waters shallower than 183 m to auto-longline fishing (except in South Australia for shark), and various spatial closures to protect pupping areas.

A number of gear and area closures (primarily off South Australia) have been introduced in the SGSHS to reduce the risk of interactions with Australian sea lions and dolphins. These have changed the fishing areas and targeting behaviour of fishers, influenced the take of target species and consequently affected catch-per-unit-effort (CPUE). These and other key wildlife bycatch issues are discussed further in Chapter 8.

In response to the gillnet spatial closures, a recent project looked at increasing the use of demersal longlines instead of using gillnets to target gummy shark (Knuckey et al. 2014). However, this is still an experimental fishery, with temporary hook permits being made available for holders of gillnet statutory fishing rights operating in South Australian waters (AFMA 2015a).

From 1 July 2015, electronic monitoring (e-monitoring) has been mandatory for all full-time vessels in the SGSHS. Video footage of at least 10 per cent of all recorded hauls is reviewed to verify the accuracy of logbooks. In addition, gillnet boats operating off South Australia's Australian Sea Lion Zones are subject to 100 per cent review of video footage for interactions with protected species. Logbooks must be completed for 100 per cent of shots.

Fishing effort

Before spatial closures, which have been progressively implemented since 2003, effort in the SGSHS was spread across the waters of South Australia and eastern Victoria. However, the spatial closures discussed above have resulted in gillnet effort being concentrated off Victoria (Figure 12.1). Effort in the gillnet sector peaked in 1987 at 99,000 km of gillnet hauled, but has decreased to around one-third of this level in recent years.

Catch history

Fishing for sharks in the waters off southern Australia began in the 1920s, using longlines. During the 1970s and 1980s, the sector mainly targeted school shark (Figure 12.2). Adoption of monofilament gillnets and concern about mercury content in large school sharks, coupled with declining school shark catches, resulted in gummy shark becoming the principal target species from around 1986 (Figures 12.2 and 12.3). This transition occurred in the early 1970s in Bass Strait, and later in the waters off South Australia and Tasmania. Recent catch records indicate that trawl operations in the SESSF are now landing as much sawshark as gillnet operations. Most of the landed catch of elephantfish is taken using gillnets in eastern Bass Strait.

FIGURE 12.2 Annual landings and effort in the SGSHS, by species, 1970 to 2016
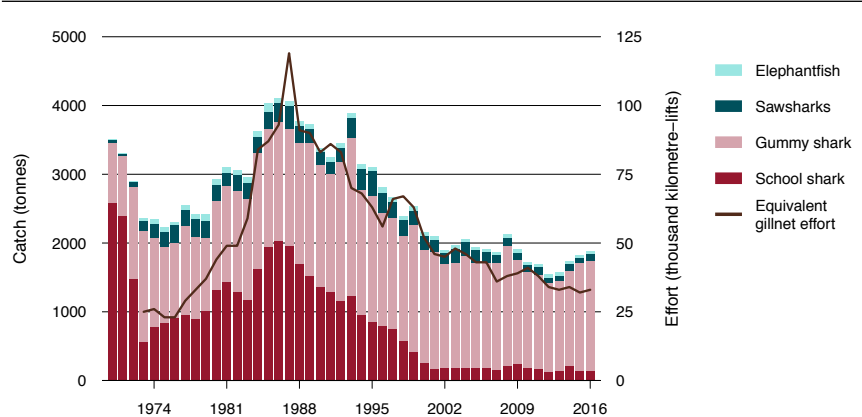
Note: 'Equivalent gillnet effort' is an estimate of total effort after converting hook effort to the equivalent gillnet effort using the methods in Walker et al. (1994).

FIGURE 12.3 Annual landings in the CTS, by species, 2001 to 2016
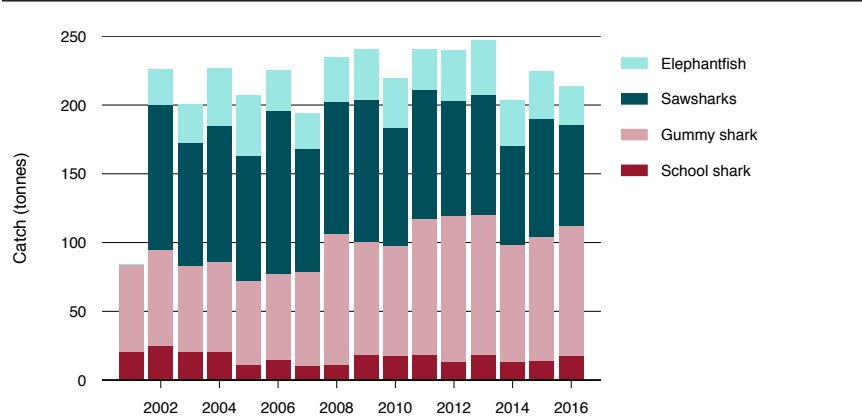
TABLE 12.2 Main features and statistics for the SGSHS

Fishery statistics a	2015–16 fishing season			2016–17 fishing season	
Stock	TAC (t)	Catch (t) (GHTS, CTS)	Real value (2015–16) (GHTS, CTS)	TAC (t)	Catch (t) (GHTS, CTS)
Elephantfish	163	67 (35, 32)	<$0.10 million (<$0.10 million, <$0.10 million)	163	76 (45, 31)
Gummy shark	1,836	1,798 (1667, 131)	$16.31 million ($15.46 million, $0.85 million)	1,836	1,669 (1526, 143)
Sawsharks	482	187 (93, 94)	$0.48 million ($0.26 million, $0.22 million)	482	200 (112, 88)
School shark	215 b	181 (165, 16)	$1.58 million ($1.44 million, $0.14 million)	215 b	173 (149, 24)
Total fishery	**2,696**	**2,233 (1,960, 273)**	**$18.42 million ($17.21 million, $1.22 million)**	**2,696**	**2,118 (1832, 286)**

Fishery-level statistics

Effort	Gillnet: 29,876 km of net hauled Hook: 1,695,313 hooks set	Gillnet: 31,814 km of net hauled Hook: 1,103,912 hooks set
Fishing permits c	Gillnet: 61 Hook: 13	Gillnet: 61 Hook: 13
Active vessels	Gillnet: 37 Hook: 26	Gillnet: 36 Hook: 26
Observer coverage d	Gillnet: 10% Hook: 10%	Gillnet: 10% Hook: 10%
Fishing methods	Demersal gillnet, demersal longline, dropline, mechanised handline, auto-longline	
Primary landing ports	Adelaide, Port Lincoln, Robe (South Australia); Devonport, Hobart (Tasmania); Lakes Entrance, San Remo, Port Welshpool (Victoria)	
Management methods	Input controls: gear restrictions, closed areas Output controls: ITQs, school shark/gummy shark catch ratio restriction, size limits, trip limits	
Primary markets	Domestic: Melbourne, Adelaide and Sydney—fresh and frozen	
Management plan	*Southern and Eastern Scalefish and Shark Fishery Management Plan 2003*	

a Fishery statistics are provided by fishing season, unless otherwise indicated. Fishing season is 1 May to 30 April. Real-value statistics are by financial year and were not available for the 2016–17 financial year at the time of publication. Components of catch may not sum to total due to rounding. b Incidental catch allowance. c In the GHTS, additional permit types limit gear use and access to state waters. d Numbers of hooks observed relate only to the Shark Hook Sector. d From 1 July 2015, e-monitoring is mandatory for all full-time vessels in the SGSHS. Video footage of at least 10% of all recorded hauls is reviewed to verify the accuracy of logbooks. In addition, gillnet boats operating off South Australia's Australian Sea Lion Zones are subject to 100% review of video footage for interactions with protected species.
Notes: **CTS** Commonwealth Trawl Sector. **GHTS** Gillnet, Hook and Trap Sector. **ITQ** Individual transferable quota. **TAC** Total allowable catch (for the entire Southern and Eastern Scalefish and Shark Fishery).

12.2 Biological status

Elephantfish (*Callorhinchus milii*)
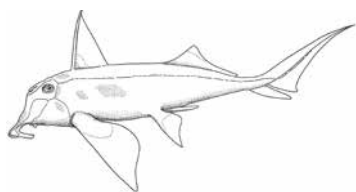
Line drawing: Karina Hansen

Stock structure

Stock structure of elephantfish is not known, and populations are considered to constitute a single stock for management purposes.

Catch history

Elephantfish contribute a small component (<5 per cent) of landed catch in the SGSHS. Catch of elephantfish in the SGSHS increased during the 1970s and peaked at almost 120 t in 1985 (Figure 12.4). Catch has since declined, and has been relatively stable at 30–60 t in recent years. Combined catch in 2016–17 in the Gillnet, Hook and Trap Sector (GHTS) and the Commonwealth Trawl Sector (CTS) increased slightly to 75 t (Table 12.2). The four-year rolling average (2012 to 2015) of elephantfish discards for state fisheries and the SGSHS was 140.9 t. In 2015, discards from the SGSHS only were 180.4 t, which is more than double the 2014 estimate (Thomson & Upston 2016). There is some uncertainty about the level of discards, especially for earlier years (AFMA 2012a). Discarding can be high in some areas of the fishery at certain times of the year. There is little information on recreational catches. The most recent stock assessment scenario accepted by the Shark Resource Assessment Group (SharkRAG) assumes that recreational catches increased from 29 t in 2002 to 45 t in 2008 and then remained at 45 t per year from 2008 to 2014 (Sporcic & Thomson 2015).

FIGURE 12.4 Annual elephantfish catch and fishing season TAC in the SGSHS, 1970 to 2016
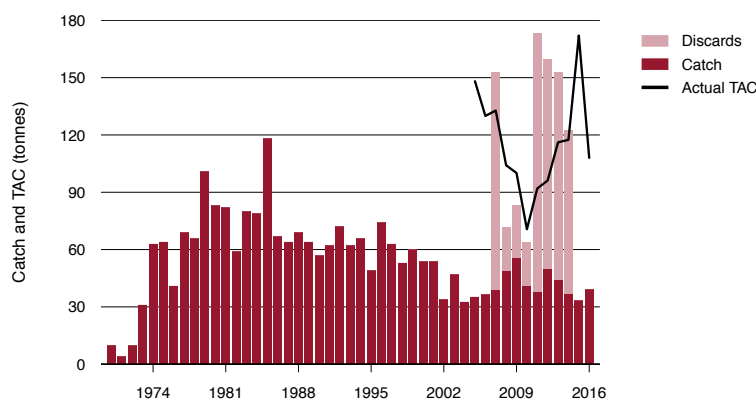
Notes: **TAC** Total allowable catch. Actual TAC includes carryover from previous season (undercatch/overcatch). Discard data are only available by calendar year and for the period 2007 to 2014.

Stock assessment

Elephantfish has been assessed as a tier 4 stock under the SESSF harvest strategy framework since 2009. The tier 4 assessment framework uses standardised CPUE. The tier 4 assessment was revised in 2015 (Sporcic & Thomson 2015).

In 2014, SharkRAG recommended a decrease in the biomass target (B_{TARG}) from 48 per cent to 40 per cent of unfished biomass (AFMA 2014a). In recommending the decrease in B_{TARG}, SharkRAG noted that elephantfish was a byproduct species in the gillnet sector and that commercial catch largely depended on effort targeted at gummy shark (AFMA 2014a). As such, catch of elephantfish was not a key driver of the economics of the fishery, so a B_{MEY} (biomass at maximum economic yield) proxy (B_{48}) was not appropriate. SharkRAG further noted that they were not concerned about the sustainability of elephantfish. SharkRAG recommended the lower B_{TARG} in 2015 (AFMA 2015a).

The most recent assessments of elephantfish (four alternative tier 4 assessments) in 2015 used data up to 2014. These assessments used scenarios including and excluding discards, and either constant recreational catches of 29 t or increased from 29 t in 2002 to 45 t in 2008 and then a constant 45 t per year from 2008 to 2014 (Sporcic & Thomson 2015). Trawl data were not analysed because of limited catch data, so only CPUE data from gillnet fishing were used. Concerns about the data used have been raised previously; the inclusion of discards was thought to bias estimates high, and the exclusion of discards was thought to bias estimates low (AFMA 2014b). All four assessments in 2015 estimated CPUE to be above the target (Sporcic & Thomson 2015).

Although the tier 4 assessment that included discards is thought to bias estimates high (AFMA 2014b), it was thought to more closely reflect the fishery dynamics (Sporcic & Thomson 2015). SharkRAG recommended using the tier 4 assessment that included discards in the CPUE with a B_{TARG} of $0.4B_0$ (Figure 12.5) and the updated estimate of recreational catches to develop a recommended biological catch (RBC), since this was thought to be more conservative than other scenarios (AFMA 2015b). This resulted in an RBC of 306 t. TAC was constrained by the large change rule (which limits increases in TAC to 1.5 times the previous year's TAC). SharkRAG recommended a multiyear TAC for the 2015–16 to 2017–18 seasons of 163 t. In comparison, the landed catch of elephantfish in the 2016–17 season was 76 t.

FIGURE 12.5 Standardised gillnet CPUE index (including discards) for elephantfish in the SGSHS, 1997 to 2014
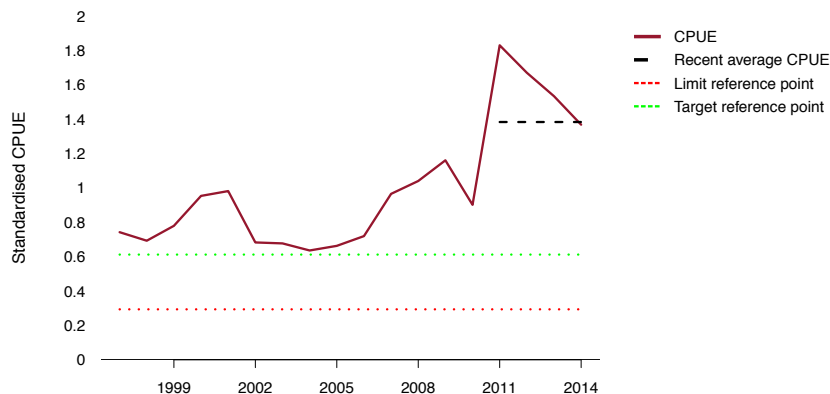
Notes: **CPUE** Catch-per-unit-effort. Discard data are only available by calendar year and for 2007 to 2014.
Source: Sporcic & Thomson 2015

Stock status determination

The average recent CPUE for elephantfish was estimated to be above the target and well above the limit reference points. On this basis, the stock is assessed as **not overfished**. Catch (excluding discards) in the 2016–17 season was below the TAC and below the RBC from the 2015 stock assessment. On this basis, the stock is assessed as **not subject to overfishing**.

Gummy shark (*Mustelus antarcticus*)
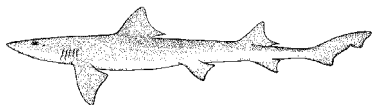
Line drawing: Karina Hansen

Stock structure

The most recent research on stock structure for gummy shark indicates that there are most likely two stocks in Australian waters: one in southern Australia, extending from Bunbury in Western Australia to Jervis Bay in New South Wales, and another in eastern Australia, extending from Newcastle to the Clarence River in New South Wales (White & Last 2008). The southern Australian biological stock is split into four populations for modelling purposes: the continental shelf of Bass Strait, Tasmania, South Australia and Western Australia. The first three are assessed together by the Commonwealth (Punt et al. 2016) and are reported here. The fourth is assessed separately by Western Australia (Braccini et al. 2013).

Catch history

Catch of gummy shark in the SGSHS increased after 1970, initially as byproduct in the school shark fishery, and then increasingly as a target as school shark catches decreased from 1986 (Figure 12.6). Catch in the SGSHS reached a peak of around 2,300 t in 1993. Catch dropped to a low of 1,288 t in 2012, before increasing since then to 1,667 t in 2015 and then decreasing slightly to 1,526 t in 2016 (Figure 12.6). Total Commonwealth catch (including from the CTS) in 2016–17 was 1,669 t. Estimates of discards have been stable in recent years, at 3–6 per cent of total catch. The four-year rolling average (2012 to 2015) of gummy shark discards for state fisheries and the SGSHS was 96 t (Thomson & Upston 2016).

FIGURE 12.6 Annual gummy shark catch and fishing season TAC in the SGSHS, 1970 to 2016
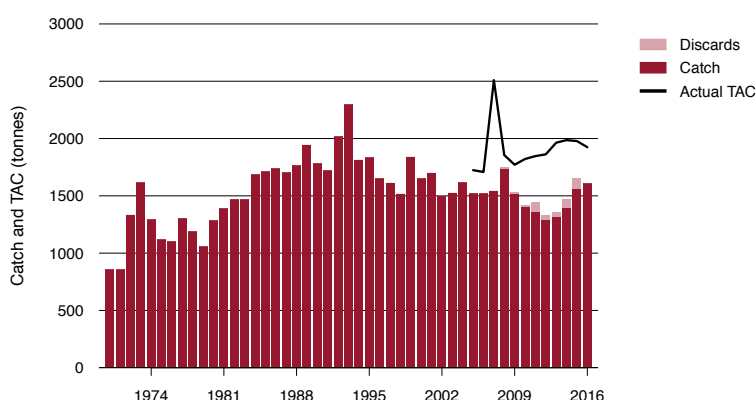
Notes: **TAC** Total allowable catch. Actual TAC includes carryover from previous season (undercatch/overcatch). Discard data are only available by calendar year and for 2007 to 2015.

Stock assessment

The most recent update of the integrated stock assessment model for gummy shark was in 2016, using data to the end of 2015 (Punt et al. 2016). Updated inputs to the assessment included landings data from 2013–15, revisions to earlier catch and length-frequency data, new age-frequency data and updated CPUE indices. Some changes to the model structure were also made, with catches by the different gear types now assumed to occur simultaneously, rather than sequentially; the 'hook fleet' separated into its components; and made allowances for age-reading errors. As in previous assessments, Bass Strait, South Australian and Tasmanian stocks were treated as three separate populations, with no movement of animals between these regions and no density-dependent effects of one population on another. However, the stocks have a number of common biological parameters, including age–length and length–weight relationships, fecundity, gear selectivity, and overall availability as a function of age. The assessment uses pup production as an indicator of biomass because of the close relationship between pup production and female spawning biomass.

The gillnet closures off South Australia have influenced catch and CPUE of gummy shark in this area. When the 2014 update was run, there was concern that the South Australian CPUE data were less reliable as an index of abundance in recent years (Thomson & Sporcic 2014). Consequently, South Australian CPUE data after 2009 were not included in the 2014 update, a change that has been retained for the 2016 update.

The model treats the three regions separately and develops RBCs and pup production relative to P_0 for each. These RBCs are then summed to an overall RBC. In addition, different gear types are known to have different selectivities, which result in differences in the average size of sharks caught. Consequently, a range of RBCs are calculated, based on different catch proportions taken by line and gillnet, which can be assessed against their impact on pup production at a regional level (Punt et al. 2016).
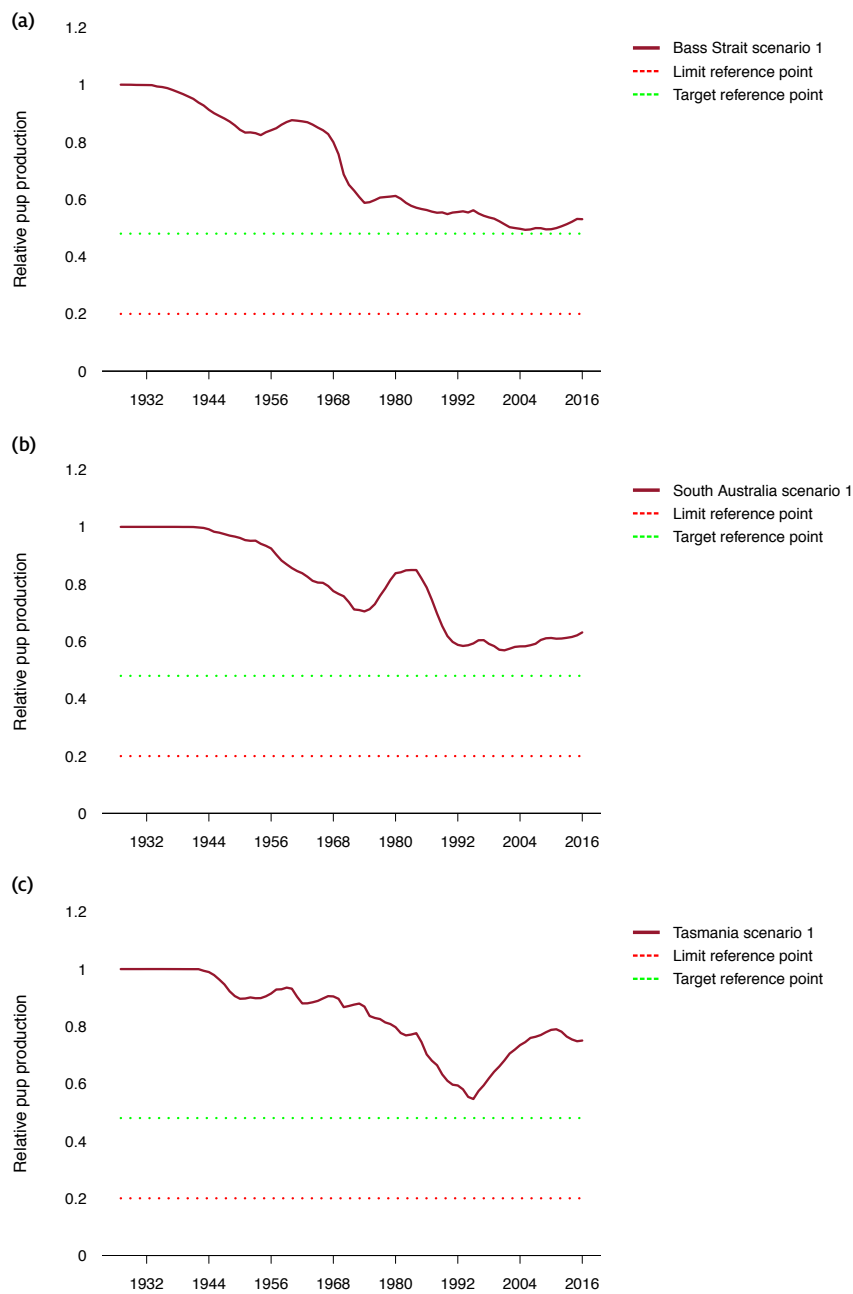
The base-case assessment estimated 2016 pup production as a proportion of the unfished level of pup production (1927) to be above $0.48P_0$ (48 per cent of virgin pup production) for all three gummy shark populations: $0.53P_0$ for Bass Strait (Figure 12.7a), $0.63 P_0$ for South Australia (Figure 12.7b) and $0.75 P_0$ for Tasmania (Figure 12.7c). These are all slightly reduced from the 2014 updated assessment (Thomson & Sporcic 2014). The sensitivities of the model to density dependence were examined through nine alternative models. Seven of the nine alternative models estimated pup production to be below $0.48P_0$ in Bass Strait (range $0.31P_0$ to $0.57P_0$), while the other models were all above $0.48P_0$ for South Australia (range $0.52P_0$ to $1.00P_0$) and Tasmania (range $0.59P_0$ to $0.79P_0$).

The three-year RBC for the base-case assessment resulted in an initial increase in RBC followed by reductions in each of the two following years. SharkRAG noted the importance of stable TACs for industry (AFMA 2016a) and requested that three additional scenarios be explored: the continuation of the current TAC, the average RBC when the base-case model is run to 2035, and the three-year average RBC from the base-case model (that is, when it is run to 2019). All three scenarios resulted in the Bass Strait population decreasing to below the target reference point by 2021 at the latest (continuation of the current TAC resulted in $P_{2019} = 0.471P_0$ and was therefore discounted as an option). SharkRAG recommended that either the 2016–35 average RBC (1,961 t) or the 2016–19 average RBC (1,922 t) be applied as a three-year TAC. The group noted that, while either of these would provide stability for industry to 2019, the RBC would likely decrease when a new assessment is run in 2019 following fishing down to the target reference point (AFMA 2016b). The 2016–35 average RBC (1,961 t) was agreed to by the Australian Fisheries Management Authority (AFMA) Commission as the basis for a three-year TAC for the 2017–18 to 2019–20 seasons.

State allocations are deducted from the RBC (2.9 per cent of the RBC for catches in South Australian internal waters and 1.7 per cent of the RBC for catches in Victorian bays and inlets [AFMA 2013a]).

The Commonwealth catch of gummy shark in 2016–17 was 1,673 t, below the 2016–17 TAC. The catch was also below the 2017–18 RBC generated by the updated model.

FIGURE 12.7 Estimated pup production as a proportion of unfished level of pup production for gummy shark in (a) Bass Strait, (b) South Australia and (c) Tasmania, 1927 to 2016


Note: Scenario 1 refers to base-case scenario from the 2016 assessment.
Source: Punt et al. 2016

Stock status determination

The results of the 2016 stock assessment estimate that 2015 pup production (used as the index of gummy shark biomass) for each of the three subpopulations is above the target reference point ($0.48P_0$) and well above the limit reference point. As a result, gummy shark is classified as **not overfished**. Since catch was less than the RBC generated by both the 2014 and 2016 models and the 2016–17 TAC, the stock is classified as **not subject to overfishing**.

Sawshark (*Pristiophorus cirratus, P. nudipinnis*)
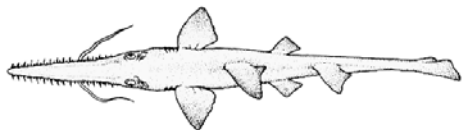
Line drawing: FAO

Stock structure

Three species of sawshark (common sawshark—*Pristiophorus cirratus,* southern sawshark—*P. nudipinnis,* and eastern sawshark—*P. peroniensis*) are caught in southern Australian waters. Little is known about the stock structure or movements of sawshark. Two species dominate reported sawshark catches in this sector: common sawshark and southern sawshark. For assessment purposes, all sawsharks found south of the Victoria – New South Wales border are assumed to be common or southern sawshark, and those found north of that border are assumed to be eastern sawshark (AFMA 2014c). Around 90 per cent of the total sawshark catch from southern Australia is taken from Bass Strait (AFMA 2011a). All sawshark catch in the SESSF is managed under a single TAC, and the status assessment is reported for the multispecies stock.

Catch history

Catch of sawshark in the SGSHS increased in the early 1970s to around 200 t by 1974, and then fluctuated between about 170 and 350 t per year until the early 2000s. Catch in the SGSHS declined steadily after 2004 and has remained below 100 t since 2012 (Figure 12.8). Combined catch in the SGSHS and the CTS in 2016–17 was 200 t (Table 12.2). The four-year rolling average (2012 to 2015) of sawshark discards for state fisheries and the SGSHS was 43.5 t. In 2015, discards from Commonwealth waters only were 35.4 t (Thomson & Upston 2016).

FIGURE 12.8 Sawshark catch and TAC in the SGSHS, 1970 to 2016
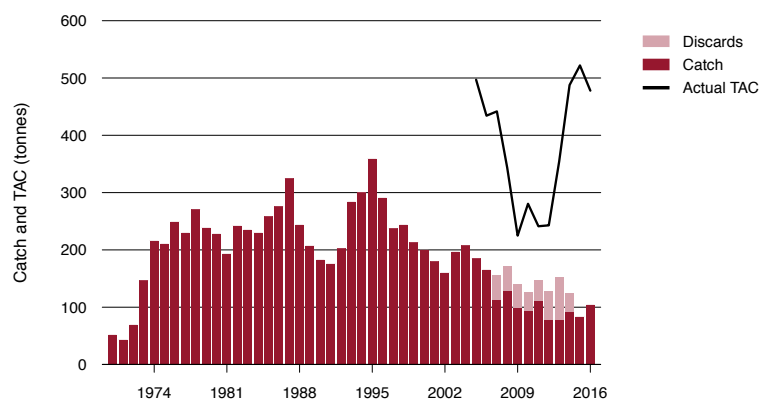
Notes: **TAC** Total allowable catch. Actual TAC includes carryover from previous season (undercatch/overcatch). Discard data are only available by calendar year and for the period 2007 to 2015.

Stock assessment

Sawshark has been assessed as a tier 4 stock under the SESSF harvest strategy framework since 2009. The most recent assessments of sawshark (four alternative tier 4 assessments) were conducted in 2015. The assessments used scenarios including and excluding discard estimates, and using either trawl or gillnet data. The assessments used data to 2014. The CPUE derived from the gillnet data was considered to be less reliable because of anecdotal reports of gillnet fishers actively avoiding sawshark (AFMA 2015b). The assessments based on trawl data have been used in recent years because they are considered to be less affected by avoidance (AFMA 2014b, 2015d). The assessment that excluded discard data was used for status determination because the uncertainty in discard data was thought to result in an overestimate of CPUE (AFMA 2015d).

In 2014, SharkRAG recommended a decrease in the biomass target (B_{TARG}) from 48 per cent to 40 per cent of unfished biomass. Since sawshark is currently a byproduct species in the gillnet sector, SharkRAG noted that commercial catch largely depends on effort targeted at gummy shark (AFMA 2014a). As such, catch of sawshark was not a key driver of the economics of the fishery, so a B_{MEY} proxy (B_{48}) was not appropriate. SharkRAG further noted that it was not concerned about the sustainability of sawshark and recommended a decrease in B_{TARG} for the species (AFMA 2014a). SharkRAG recommended retaining the biomass target of $0.4B_0$ in 2015 (AFMA 2015a). The tier 4 assessment based on trawl data, excluding discards with a B_{TARG} of $0.4B_0$, gave an RBC of 535 t before the tier 4 discount factor (15 per cent discount) was applied (Sporcic & Thomson 2015).

SharkRAG recommended a TAC for the 2015–16 to 2017–18 seasons of 482 t. In comparison, the landed catch of sawshark in the 2016–17 season was 200 t.

Stock status determination

The average recent CPUE for sawshark was estimated to be above the target reference point and well above the limit reference point (Figure 12.9). On this basis, the stock is assessed as **not overfished**. Catch in the 2016–17 season was below the TAC and below the RBC from the 2015 stock assessment. On this basis, the stock is assessed as **not subject to overfishing**.

FIGURE 12.9 Standardised CPUE index for sawshark in the CTS, 1997 to 2014 (trawl)

Note: **CPUE** Catch-per-unit-effort.
Source: Haddon 2014

School shark (*Galeorhinus galeus*)
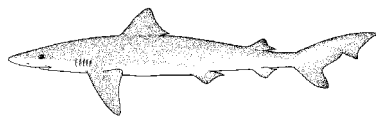
Line drawing: Karina Hansen

Stock structure

School shark has a broad distribution throughout temperate waters of the eastern North Atlantic, western South Atlantic, and north-eastern and south-eastern Pacific oceans; and temperate waters off South Africa, New Zealand and southern Australia. A single genetic stock exists in Australian waters, and school shark is managed as a single stock in the SESSF area.

Catch history

Catch of school shark in the SGSHS peaked at more than 2,500 t in 1970 and then declined rapidly to around 500 t in 1973. Catch in the sector again increased, to around 2,000 t in 1986, before declining steadily through the late 1980s and 1990s, and then stabilising from 2000 onwards at around 200 t per year (Figure 12.10). In 2009, the species was listed as conservation dependent under the *Environment Protection and Biodiversity Conservation Act 1999* and has been subject to other measures to reduce catch, including the implementation of a catch ratio of 20 per cent school shark to gummy shark—whereby a fisher must hold five times more gummy shark quota than their school shark catch (2011–12 season)—and the requirement that all live caught school shark be released (2014–15 season). Catch in 2016–17 was 173 t. The four-year rolling average (2012 to 2015) of school shark discards for both state and Commonwealth waters was 34.4 t. In 2015, discards from Commonwealth waters only were 32.7 t, a decrease of 10 t from 2014 (Thomson & Upston 2016).

FIGURE 12.10 Annual school shark catch and fishing season TAC in the SGSHS, 1970 to 2016
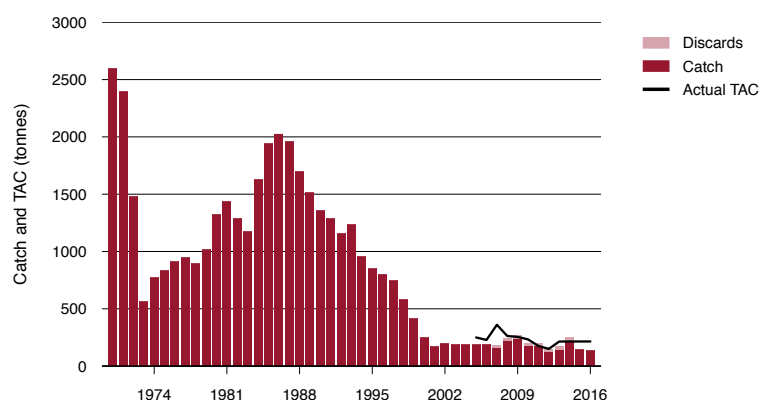
Notes: **TAC** Total allowable catch. Actual TAC includes carryover from previous season (undercatch/overcatch). Discard data are only available by calendar year and for 2007 to 2015.

Stock assessment

School shark has been considered to be below the $0.2B_0$ limit since about 1990. The base case of the most recent full stock assessment in 2009, using data to 2008, estimated the biomass at $0.12B_0$ (Thomson & Punt 2009). In 2012, the 2009 assessment was re-run with additional catch data for 2009 to 2012 (Thomson 2012), specifically to estimate recovery time frames for the stock under a range of future incidental catch levels and to investigate the impact of a proposed auto-longline shark fishery in South Australia. Under a zero catch scenario, the stock was projected to rebuild to $0.2B_0$ within 23 years. At a constant catch of 250 t, the stock was projected to rebuild to $0.2B_0$ in 80 years, and a constant catch of 275 t was projected to collapse the stock. These projections were based on assumptions that the gear selectivity, and spatial and temporal distribution of catches remain similar to those in 2011. Uncertainties around these median projections were not provided by the assessment. The school shark rebuilding strategy was revised in 2015 to explicitly specify a recovery time frame of 66 years to the $0.2B_0$ limit (AFMA 2015c), based on advice from SharkRAG.

The reliability of the current school shark stock assessment model to estimate the state of the stock is limited, as a result of increasingly uncertain input data over the past decade. The low TACs in recent years and the reported avoidance behaviour of gillnet fishers have meant that the CPUE index for that sector has potentially become less reliable as an index of abundance. The coefficient of variance associated with the fishery-independent survey data is also very high.

There are indicators that school shark biomass may be increasing. These include a preliminary index of abundance based on trawl CPUE, which estimates a generally increasing trend (Sporcic 2016). Trawl CPUE data may be a better representation of biomass than CPUE from other methods, because trawl does not target, nor can it avoid, school shark (AFMA 2016c); however, it is unclear how reliable an index of abundance trawl CPUE is, because the trawl fishery primarily operates outside the main part of the gummy shark fishery (AFMA 2016a). Data from the Integrated Scientific Monitoring Program (ISMP) show an increase in the catch of small school sharks (Thomson et al. 2015). Preliminary results of survey work by the Institute for Marine and Antarctic Studies (IMAS) in school shark pupping areas off Tasmania indicate higher numbers of pups than during the 1990s (McAllister et al. 2015). Industry participants on SharkRAG have reported signs of increasing availability of school shark, including increasing presence of juvenile school shark and increasing difficulty in avoiding school shark (AFMA 2014a, c; 2013b).

A project to develop a fishery-independent index of abundance using close-kin genetic approaches is currently underway, and should further inform rebuilding targets and time frames when results become available (by the end of 2017) (AFMA 2013c, 2016a). A new stock assessment will be run after results from the close-kin genetics project are finalised (likely in 2018) (AFMA 2016a).

The reported landed catch in the SGSHS in 2016–17 was 173 t, a decrease from the 2015–16 catch of 181 t and below the incidental catch allowance of 215 t. State catches and discards are not available by season; however, in the 2015 calendar year, discards from the SGSHS were 15 per cent of catch (32.7 t; Thomson & Upston 2016). Overall, state catches in 2015 were higher than in 2014 (24 t in 2015; 22 t in 2014), with South Australia reporting most (17 t) of this. South Australia's catch continues to exceed its allocation of 6.2 t under the Offshore Constitutional Settlement.

Stock status determination

The last full stock assessment of school shark, undertaken in 2009, estimated the 2008 biomass to be below the limit reference point. Projections of this model undertaken in 2012 indicate that the stock was likely to recover to a level above the limit reference point in 2035 if the catch was zero. School shark catches have been between 129 t and 230 t in each year since these analyses were run. The stock therefore remains classified as **overfished.**

Commonwealth discards and state catches are only available for the 2015 calendar year. Additionally, state discards are not known. If state catches in 2016–17 were similar to those in recent years, and similar to discards from the SGSHS, total catch (retained and discarded) from the SGSHS and state fisheries may have been around 230 t. A constant catch of 250 t was estimated to enable recovery to the limit reference point within 80 years, while a catch of 275 t was projected to collapse the stock.

Some evidence indicates that the stock may be rebuilding under current catches (for example, trawl CPUE, IMAS surveys, ISMP data and anecdotal reports from industry). However, there is uncertainty around total catch estimates for the 2016–17 season, because South Australian catch has consistently increased in recent years, and the latest available state and discarding data relate to the 2015 calendar year. In addition, there is uncertainty around the rebuilding projections resulting from uncertainty in the stock assessment. Given these issues, whether the level of fishing mortality will enable rebuilding within the time frame is uncertain, and school shark is therefore classified as **uncertain** with regard to the level of fishing mortality.

12.3 Economic status

Key economic trends

The real gross value of production (GVP) in the SGSHS, which reflects the four shark species taken in the GHTS, declined from a peak of $26.74 million in 2008–09 to $18.42 million in 2015–16 (Figure 12.11). This long-term fall is primarily the result of a 27 per cent fall in the price of gummy shark, despite experiencing a slight (2 per cent) increase in volume. Since 2013–14, GVP for the SGSHS has trended upwards, largely as a result of higher volumes of gummy shark landings. Gummy shark accounts for the majority of GVP in the SGSHS (89 per cent in 2015–16).

FIGURE 12.11 Real GVP for the SGSHS, by key species, and real price for gummy shark, 2005–06 to 2015–16
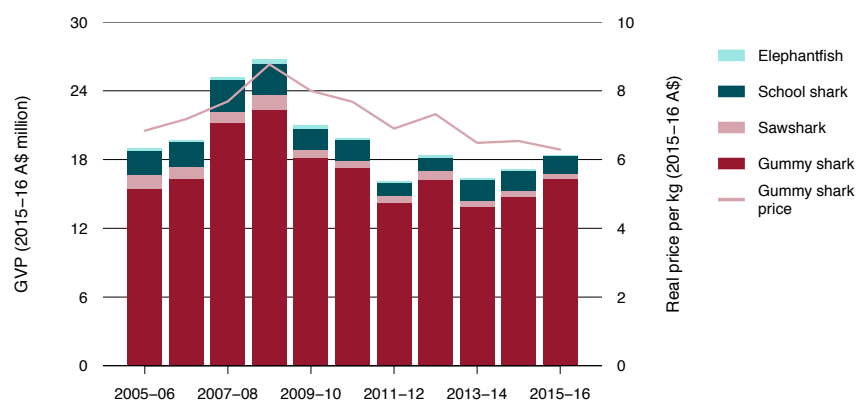
Note: **GVP** Gross value of production.

The four shark species that make up the SGSHS—gummy shark, school shark, sawshark and elephantfish—account for around 77 per cent of the GHTS GVP, with scalefish species making up the remainder. Therefore, overall economic performance in the GHTS may contribute to an understanding of economic status in the SGSHS.

Survey-based estimates of revenue, costs and net economic returns (NER) in the GHTS are available for 2012–13, and preliminary estimates are available for 2013–14 (Figure 12.12). NER in the GHTS were positive between 2003–04 and 2008–09, peaking at $7.04 million in 2008–09 (Figure 12.13). NER reached a low of –$5.55 million in 2011–12. Preliminary estimates for 2013–14 indicate that NER are likely to remain negative. The falling price of fuel is unlikely to improve NER, as the price of fuel is not a significant input in gillnet and hook fisheries, unlike in trawl fisheries.

FIGURE 12.12 Real revenue and costs for the GHTS, 2003–04 to 2013–14
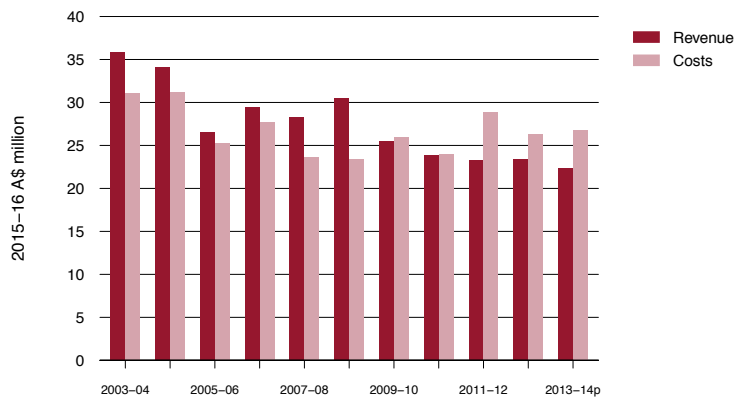
Note: Data for 2013–14 are preliminary.
Source: Skirtun & Green 2015

FIGURE 12.13 Real NER for the GHTS, 2003–04 to 2013–14

Notes: **NER** Net economic returns. NER estimates for 2013–14 are preliminary non–survey based estimates.
Source: Skirtun & Green 2015

A profit decomposition of the gillnet sector of the GHTS (Skirtun & Vieira 2012) showed that the key driver of profitability in the sector in the period 2006–07 to 2008–09 was productivity growth. This was linked to the Securing our Fishing Future structural adjustment package (completed in 2006–07), which is considered to have removed the least efficient vessels from the sector (Vieira et al. 2010). The decline in NER in recent years can be partly linked to falls in the price of fish within the fishery. Productivity has improved recently, but this has been offset by falls in the terms of trade for fishers, providing downward pressure on NER (Skirtun & Green 2015). Factors related to recent management changes in the fishery (discussed below) are also likely to have played a role.

Management arrangements

Significant spatial closures have been implemented in recent years to reduce the catch of protected species, primarily in South Australian waters (see Chapter 8). This started with voluntary closures in 2009–10, followed by mandatory closures in 2010–11. As a result, it is likely that fisher incentives have changed, leading to a relocation of fishing intensity to other areas, particularly for operators where closures have covered the full extent of their usual fishing grounds. Some South Australian gillnet fishers also operate in the South Australian Rock Lobster Fishery, which is considered to be profitable (Econsearch 2014) and could have supported some SGSHS operators affected by the closures. However, these changes would have reduced the profitability of gillnet operations in South Australia, contributing to the negative NER in the GHTS following the closures.

South Australian gillnet operators (subject to specific qualification criteria) are allowed to use hook methods in areas where gillnetting is prohibited (or restricted), so that fishers can continue to operate. However, anecdotal reports from industry suggest that vessel-level economic efficiency is lower using this hook method (AFMA 2011b). Anecdotal information also indicates that allowing gillnet permit holders to use hooks has had a negative impact on the value of hook permits in the sector, as rights provided by hook permits have become less exclusive. One adaptive management zone (zone C) was closed in 2016 (reopened 18 June 2017).

School shark biomass remains below the limit reference point, and stock rebuilding measures are likely to be affecting sector profitability. These measures include low incidental catch allowances and the prohibition of targeted fishing. Given the relatively high beach prices of school shark, changes in its catch allowance can have a relatively large influence on the revenue of the sector. Additionally, school shark is often caught with gummy shark, the main target species of the sector. Operators who do not hold quota for school shark, or actively avoid it when targeting gummy shark, are forfeiting a potential means of profit. The substantial time projected for school shark stock rebuilding means that it may be some time before these issues are resolved.

Trials to test the efficiency of longer gillnets (4,200–6,000 m) have been undertaken; SharkRAG, in January 2016, considered the preliminary results inconclusive (AFMA 2016d). Giving fishers the option to use longer nets provides them with greater flexibility to operate under individual transferable quotas, potentially improving efficiency and NER. However, some industry members previously expressed concerns about introducing larger nets at a time when the sector is already facing significant challenges to reduce bycatch (AFMA 2011b). The AFMA Commission has since approved the removal of net length restrictions, subject to the roll-out of dolphin management arrangements across the fishery.

Performance against economic objective

Additional information on the economic status of the SGSHS is possible by comparing the biomass levels of key species with harvest strategy targets. Gummy shark is the primary driver of economic performance in the SGSHS, accounting for 89 per cent of the SGSHS GVP in 2015–16. The target reference point for gummy shark is the B_{MEY} proxy of $0.48P_0$ (48 per cent of virgin pup production). The results of the 2013 stock assessment indicate that the biomass for gummy shark stocks is likely to be above the target reference point. If the proxy accurately reflects B_{MEY} for this species, the results indicate that biomass is not currently constraining NER and that there may be potential for expansion in the sector.

The SGSHS is a multispecies fishery, and its economic performance must also be interpreted in terms of the other species caught in the fishery. The incidental catch allowance for school shark makes it the second most valuable species in the sector, accounting for 9 per cent of SGSHS GVP in 2015–16. The school shark to gummy shark quota restriction implemented in 2011–12 may have reduced gummy shark catch and therefore current GVP (AFMA 2014d). Efforts to rebuild the school shark stock towards target levels should lead to future increases in NER.

The challenge of reducing marine mammal interactions may affect the degree to which economic performance can be improved in the short term. Recent closures to mitigate interactions are likely to have contributed to the recently observed declines in the GHTS NER and may be related to increased gummy shark quota latency since 2009. The falling price of gummy shark is another contributor to the reduced gummy shark catch since 2009.

Demersal longline hooks
AFMA

12.4 Environmental status

The SESSF was accredited against parts 13 and 13A of the *Environment Protection and Biodiversity Conservation Act 1999* in February 2016. Conditions associated with the accreditation relate to the impact of fishing on bycatch species, particularly Australian sea lions (*Neophoca cinerea*), dolphins, seals and seabirds. Further recommendations associated with the accreditation relate to requirements for ecological risk assessment, and monitoring of bycatch and discarding.

A level 2 ecological risk assessment of 329 species resulted in 21 assessed as being at high risk (16 chondrichthyans and 5 marine mammals; Walker et al. 2007). A level 3 Sustainability Assessment of Fishing Effects (SAFE) assessment was completed for all 195 chondrichthyan and teleost species identified in the shark gillnet fishery, regardless of their level 2 Productivity Susceptibility Analysis (PSA) risk score. The assessment found seven species (all chondrichthyan) to be at high risk (Zhou et al. 2012). One species (common sawshark—*Pristiophorus cirratus*) was removed during the residual risk analysis (AFMA 2014e). The remaining six species considered to be at high risk are all sharks: bronze whaler (*Carcharhinus barchyurus*), white shark (*Carcharodon carcharias*), whiskery shark (*Furgaleus macki*), smooth hammerhead shark (*Sphyrna zygaena*), school shark (*Galeorhinus galeus*) and broadnose sevengill shark (*Notorynchus cepedianus*). A 2010 residual risk assessment of PSA results for non-teleost and non-chondrichthyan species identified five marine mammal species as high risk (AFMA 2010). A subsequent residual risk analysis removed two species (as a result of no interactions being recorded in the fishery) and included one further species (as a result of higher than expected interactions), resulting in four marine mammal species considered to be at high risk in the fishery: Australian fur seal (*Arctocephalus pusillus doriferus*), Australian sea lion, New Zealand fur seal (*A. forsteri*) and common dolphin (*Delphinus delphis*) (AFMA 2012b). The results of the ecological risk assessments have been consolidated to form a priority list in an ecological risk assessment strategy for the SESSF (AFMA 2015d).

AFMA publishes quarterly reports of logbook-reported interactions with protected species on its website. Reports for the GHTS in the 2016 calendar year indicate 349 interactions: 76 with mammals, 143 with seabirds, and the remainder with sharks. The mammal interactions comprised 37 interactions with dolphins (2 alive; 34 dead; 1 in unknown condition), 10 with Australian fur seals (all dead), 2 with Australian sea lions (1 dead), 6 with New Zealand fur seals (all dead), 1 with a killer whale (dead) and 20 with seals (3 unclassified; 17 dead). In 2016, 143 seabirds (21 of which were released alive) were caught, including albatrosses, cormorants, petrels, prions and shearwaters, and gannets.

Logbooks reported that 101 shortfin mako sharks (3 alive; 89 dead; 7 injured; 2 unknown condition), 17 porbeagle sharks (6 injured; 11 dead), 1 grey nurse shark (dead) and 11 great white sharks (9 alive; 1 dead; 1 unknown condition) were caught during 2016. Measures to reduce interactions with Australian sea lions and dolphins are discussed in Chapter 8.

12.5 References

AFMA 2009, *Harvest strategy framework for the Southern and Eastern Scalefish and Shark Fishery*, version 1.2, September 2009, Australian Fisheries Management Authority, Canberra.

—— 2010, *Residual risk assessment of the level 2 ecological risk assessment species results: report for the gillnet sector of the Gillnet, Hook and Trap Fishery*, AFMA, Canberra.

—— 2011a, *SharkRAG species summaries 2010*, AFMA, Canberra.

—— 2011b, 'South East Management Advisory Committee (SEMAC), chair's summary, meeting 7, 19 September 2011', AFMA, Canberra.

—— 2012a, 'Shark Resource Assessment Group (SharkRAG) meeting record, 13–14 November 2012', AFMA, Canberra.

—— 2012b, *Residual risk assessment of the level 2 productivity susceptibility assessment: report for the shark gillnet method of the Gillnet, Hook and Trap sector*, AFMA, Canberra.

—— 2013a, 'South East Management Advisory Committee (South East MAC) teleconference minutes, 18 March 2013', AFMA, Canberra.

—— 2013b, 'Shark Resource Assessment Group (SharkRAG) meeting record, 8 March 2013', AFMA, Canberra.

—— 2013c, 'Shark Resource Assessment Group (SharkRAG) meeting record, 2–3 October 2013', AFMA, Canberra.

—— 2014a, 'Shark Resource Assessment Group (SharkRAG) meeting record, 15–16 October 2014', AFMA, Canberra.

—— 2014b, 'Shark Resource Assessment Group (SharkRAG) meeting record, 20 November 2014', AFMA, Canberra.

—— 2014c, *Species summaries for the Southern and Eastern Scalefish and Shark Fishery: for stock assessments completed in 2013 in preparation for the 2014–15 fishing season*, AFMA, Canberra.

—— 2014d, *Southern and Eastern Scalefish and Shark Fishery management arrangements booklet 2014*, AFMA, Canberra.

—— 2014e, *Residual risk assessment: report for the shark gillnet method of the Gillnet, Hook and Trap sector*, AFMA, Canberra.

—— 2015a, 'Shark Resource Assessment Group (SharkRAG) meeting minutes, 18–19 November 2015', AFMA, Canberra.

—— 2015b, 'Shark Resource Assessment Group (SharkRAG) meeting minutes, 8 October 2015', AFMA, Canberra.

—— 2015c, *School shark* Galeorhinus galeus *stock rebuilding strategy: revised 2015*, AFMA, Canberra.

—— 2015d, *Ecological risk management: strategy for the Southern and Eastern Scalefish and Shark Fishery*, AFMA, Canberra.

—— 2016a, 'Southern and Eastern Scalefish and Shark Fishery Shark Resource Assessment Group (SharkRAG) meeting minutes, 22–23 November 2016', AFMA, Canberra.

—— 2016b, 'Southern and Eastern Scalefish and Shark Fishery Shark Resource Assessment Group (SharkRAG) meeting minutes, 7 December 2016', teleconference, AFMA, Canberra.

—— 2016c, 'Shark Resource Assessment Group (SharkRAG) meeting no.1 2016 meeting minutes, 13–14 October 2016', AFMA, Canberra.

—— 2016d, 'Shark Resource Assessment Group (SharkRAG) out of session teleconference, meeting minutes, 28 January 2016', AFMA, Canberra.

Braccini, M, McAuley, R & Rowland, F 2013, 'Temperate Demersal Gillnet and Demersal Longline fisheries status report', in WJ Fletcher & K Santoro (eds), *Status reports of the fisheries and aquatic resources of Western Australia 2012/13*, Department of Fisheries, Perth.

Econsearch 2014, *Economic indicators for the SA Southern Zone Rock Lobster Fishery 2012/13*, report prepared for Primary Industries and Resources South Australia, Econsearch, Adelaide.

Haddon, M 2014, *SESSF saw shark and elephantfish tier 4 analyses (data from 1986–2013)*, CSIRO, Hobart.

Knuckey, I, Ciconte, A, Koopman, M, Hudson, R & Rogers, P 2014, *Trials of longlines to target gummy shark in SESSF waters off South Australia: FRDC project 2011/068*, Fishwell Consulting, Queenscliff.

McAllister, JD, Barnett, A, Lyle, JM & Semmens, JM 2015, 'Examining the functional role of current area closures used for the conservation of an overexploited and highly mobile fishery species', *ICES Journal of Marine Science*, vol. 72, no. 8, pp. 2234–44.

Punt, A, Thomson, R & Sporcic, M 2016, *Gummy shark assessment update for 2016, using data to the end of 2015*, report presented to the SharkRAG meeting, CSIRO Marine and Atmospheric Research, Hobart.

Skirtun, M & Vieira, S 2012, *Understanding the drivers of profitability in Commonwealth fisheries*, ABARES technical report 12.4, ABARES, Canberra.

—— & Green, R 2015, *Australian fisheries economic indicators report 2015: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery*, ABARES, Canberra.

Sporcic, M & Thomson, R 2015, *Tier 4 analyses for elephant fish and sawshark in the SESSF: (data to 2014)*, CSIRO Marine and Atmospheric Research, Hobart.

—— 2016, CPUE standardization for selected shark SESSF species (data to 2015): Draft, SharkRAG Meeting 1: 13–14 October, 2016, CSIRO Marine and Atmospheric Research, Hobart.

Thomson, R 2012, *Projecting the school shark model into the future: rebuilding timeframes and auto-longlining in South Australia*, CSIRO Marine and Atmospheric Research, Hobart.

—— & Punt, AE 2009, *Stock assessment update for school shark* Galeorhinus galeus *based on data to 2008*, report presented to the SharkRAG meeting, 17–18 November, CSIRO Marine and Atmospheric Research, Hobart.

—— & Sporcic, M 2014, *Gummy shark assessment update for 2013, using data to the end of 2012 (draft)*, CSIRO Marine and Atmospheric Research, Hobart.

——, Sporcic, M, Klaer, N, Fuller, M, Krucic-Golub, K & Upston, J 2015, *Data summary for the Southern and Eastern Scalefish and Shark Fishery: logbook, landings and observer data to 2014 (draft)*, CSIRO Marine and Atmospheric Research, Hobart.

—— & Upston, J 2016, *SESSF catches and discards for TAC purposes*, CSIRO Marine Resources and Industries, Hobart.

Vieira, S, Perks, C, Mazur, K, Curtotti, R & Li, M 2010, *Impact of the structural adjustment package on the profitability of Commonwealth fisheries*, Australian Bureau of Agricultural and Resource Economics research report 10.01, ABARE, Canberra.

Walker, T, Stone, T, Battaglene, T & McLoughlin, K 1994, *The southern shark fishery 1994*, fisheries assessment report compiled by the Southern Shark Fishery Assessment Group.

——, Dowdney, J, Williams, A, Fuller, M, Webb, H, Bulman, C, Sporcic, M & Wayte, S 2007, *Ecological risk assessment for the effects of fishing: report for the shark gillnet component of the Gillnet, Hook and Trap Sector of the Southern and Eastern Scalefish and Shark Fishery*, report for AFMA, Canberra.

White, WT & Last, PR 2008, 'Description of two new species of gummy sharks, genus *Mustelus* (Carcharhiniformes: Triakidae), from Australian waters', in PR Last, WT White & JJ Pogonoski (eds), *Descriptions of new Australian chondricthyans*, CSIRO Marine and Atmospheric Research paper 22, CSIRO Marine and Atmospheric Research, Canberra.

Zhou, S, Fuller, M & Daley, R 2012, *Sustainability assessment of fish species potentially impacted in the Southern and Eastern Scalefish and Shark Fishery: 2007–2010*, CSIRO, Canberra.