

## Assessment Authors and Year

Hall, K.C. 2023. NSW Stock Status Summary 2022/23 – Southern Calamari (*Sepioteuthis australis*). NSW Department of Primary Industries, Fisheries NSW, Coffs Harbour. 12 pp.

## Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Southern Calamari is currently assessed as <b>Sustainable</b> for the NSW component of the stock.
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## Stock structure & distribution

The Southern Calamari (*Sepioteuthis australis*) is found in estuarine and inshore coastal waters around southern Australia from Brisbane in Queensland to Perth in Western Australia (WA), and including Tasmania. It also occurs in coastal waters of northern New Zealand. Across this broad species distribution, the stock structure is quite complex and potentially changing. A molecular study using allozyme markers identified three genetic types with overlapping distributions and identified separate stocks off WA, South Australia (SA), New South Wales (NSW) and Tasmania (data were not available for Victoria) (Triantafillos & Adams, 2001). A more recent study using microsatellite markers found little genetic differentiation between seven study sites across WA, Victoria, Tasmania and SA (Smith *et al.*, 2015); whereas, life history variations, movement patterns and statolith microchemistry all provide evidence of some localised structuring in Tasmanian waters and a possible division between northern NSW populations and more widely distributed southern populations (Pecl *et al.*, 2011).

In the absence of conclusive evidence on biological stock boundaries, stock status is currently assessed at the jurisdictional level. The data presented in this summary relate to the NSW jurisdiction.

## Biology

The biology of Southern Calamari has been extensively studied off southern Australia, where large, targeted jig fisheries operate. It is a fast-growing, short-lived species, with a maximum age of less than 1 year (Triantafillos, 2004). In southern Australian waters, males reach a maximum size of over 50 cm mantle length (ML) and females 40 cm ML (Pecl, 2004). Large squid measuring around 30–35 cm ML were also reported from NSW waters during research trawl surveys by the FRV *Kapala* (Hall, 2015).

In southern states, adults attain maturity at a wide range of ages (females 117 to 263 days) and sizes (12–26 cm ML) (Pecl, 2001). Females mate with multiple males and store sperm before spawning in relatively shallow (3–5 m) depths mainly during the spring and summer (Jantzen & Havenhand, 2002). They produce multiple batches of eggs (numbering up to several hundred), which are laid in long coated strings attached to seagrass, macro-algae, hard reef and sandy substrates (Steer & Moltschaniwskyj, 2007).

### FISHERY STATISTICS

#### Catch information

##### Commercial

Annual commercial catches of Southern Calamari in NSW state waters were consistently above 50 tonnes (t) per annum until the mid-2000s, with a peak of 145 t in 1997/98. Since 2006/07, commercial catches have been lower, at around 30–50 t per annum (Fig. 1). In 2021/22 the commercial catch of Southern Calamari from NSW waters was 27.7 t.

Most of commercial catch of Southern Calamari from NSW waters is taken as byproduct in the Ocean Trawl Fishery (OTF), particularly by the fish trawl sector off the central and southern coasts in ocean zones 5 and 6 and south of Barrenjoey Point (Figs 2 and 3).

Southern Calamari are also commercially harvested in larger quantities by targetted squid jigging and hauling in other southern Australian jurisdictions. Catches from NSW account for only 6.4% of the total Australian harvest of 430.8 t in 2021/21, with 278.3 t reported from South Australia, 86.3 t from Tasmania, 36.8 t from Victoria and a negligible amount (1.7 t) from Commonwealth fisheries (Krueck *et al.*, in prep). The total catch has declined steadily over the last six years from 658 t in 2017 (Moore *et al.*, 2018). Given the uncertain stock structure and unknown dispersal and adult movement patterns it is not known what affect the larger catches in southern jurisdictions might have on stocks in NSW waters, which is at the northern end of the species’ distribution.

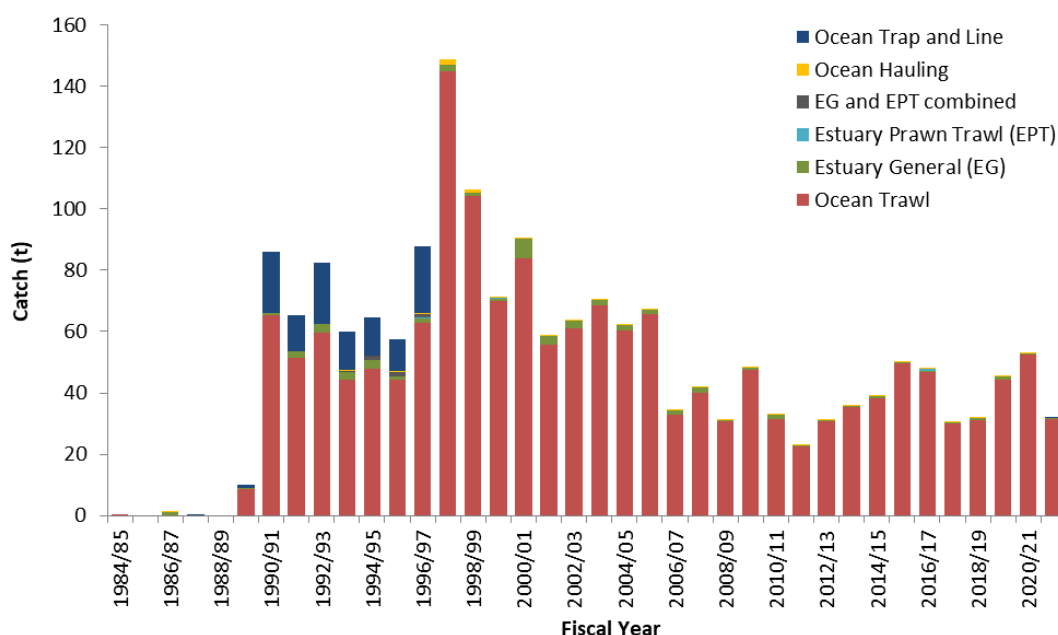


Figure 1. Annual commercial catches (tonnes) of Southern Calamari by fishery for NSW waters (1997/98–2021/22).

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## NSW Stock Status Summary – Southern Calamari (*Sepioteuthis australis*)

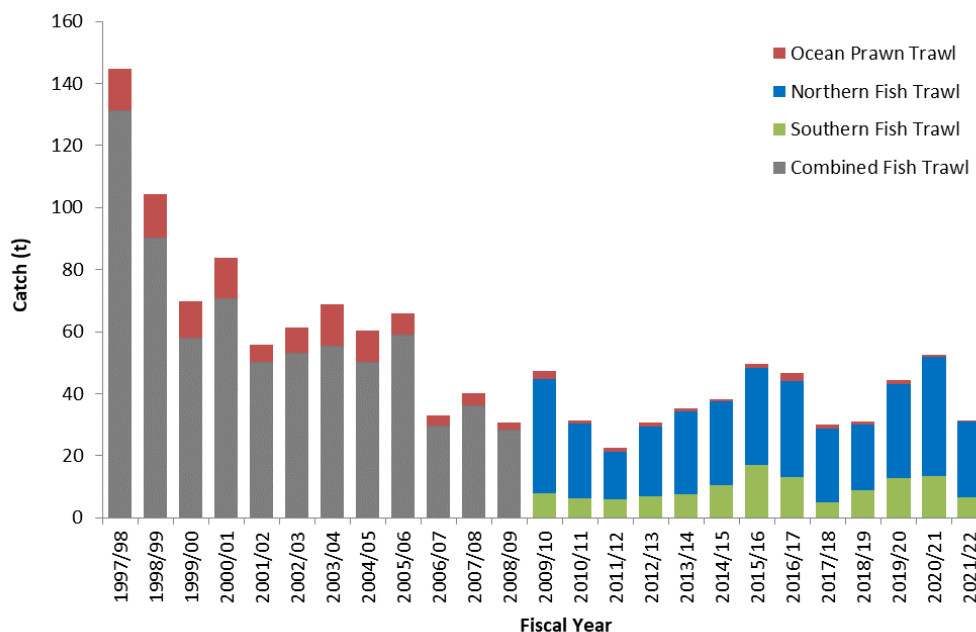


Figure 2. Annual commercial catches (tonnes) of Southern Calamari by the prawn trawl and fish trawl sectors of the NSW Ocean Trawl Fishery (1997/98–2018/19).

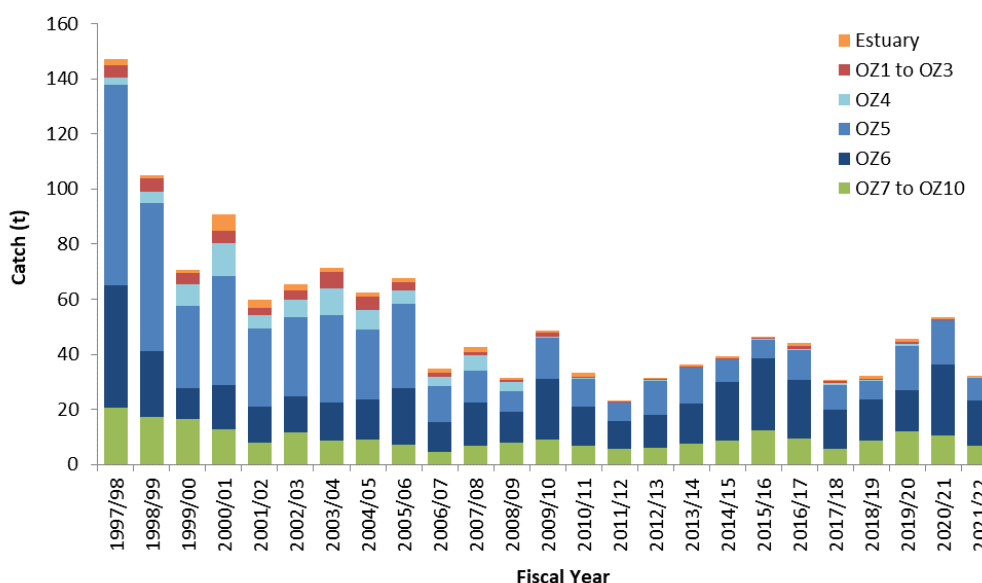


Figure 3. Annual commercial catches (tonnes) of Southern Calamari in different ocean zones and combined estuaries (1997/98–2021/22).

### Recreational & Charter boat

The most recent estimate of the recreational harvest of Southern Calamari in NSW was approximately 30,403 squid during 2019/20 (Murphy *et al.*, 2022). This estimate was based on a survey of Recreational Fishing Licence (RFL) Households, comprised of at least one fisher possessing a long-term (1 or 3 years duration) fishing licence and any other fishers resident within their household. The equivalent estimates from previous surveys in 2017/18 and 2013/14 were

smaller at around 15,247 and 13,087 mixed squid, respectively (Murphy *et al.*, 2020). Relative to the commercial catch, these recreational catches are small, comprising approximately 9.5% of the total harvest from NSW waters in 2013/14.

Recreational catches in other southern Australian jurisdictions tend to be larger than those from NSW, with 219 t reported from South Australia in 2021/22 and 31 t from Tasmania in 2017/18 (Krueck *et al.*, in prep).

### Aboriginal cultural fishery

A survey of Aboriginal cultural fishing in the Tweed River catchment identified squid as a common component of the marine invertebrate catches (Schnierer & Egan, 2016); however, statewide estimates of the annual Aboriginal harvest of Southern Calamari in New South Wales are unknown.

### Illegal, Unregulated and Unreported

The amount of illegal, unregulated and unreported catches of Southern Calamari in New South Wales are unknown.

### Fishing effort information

Commercial fishing effort for Southern Calamari was collected as number of days fished on monthly records prior to July 2009 and as numbers of hours fished per daily event after July 2009. To form a longer time series of effort, recent daily events were re-aggregated, with effort in days fished estimated from the number of fishing events entered for each fisher in each month where Southern Calamari was reported on at least one day.

The lower commercial landings of Southern Calamari since 2006/07 coincided with a concurrent decrease in effort in the prawn and fish trawl sectors of the OTF. In the prawn trawl sector, reported effort for Southern Calamari declined rapidly from 8,116 days fished in 1997/98 to 1,703 days fished in 2006/07. Since then, effort declined more gradually during the 2010s, but has rapidly decreased again over the last two years to an estimated 252 days fished in 2021/22 (Fig. 4). However, most of the decline in effort occurred prior to the catch reporting change in 2009. Over the same period, reported effort for Southern Calamari in the fish trawl sector has declined more gradually from 3,402 days fished in 1997/98 to 749 days fished in 2021/22 (Fig. 4).

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## NSW Stock Status Summary – Southern Calamari (*Sepioteuthis australis*)

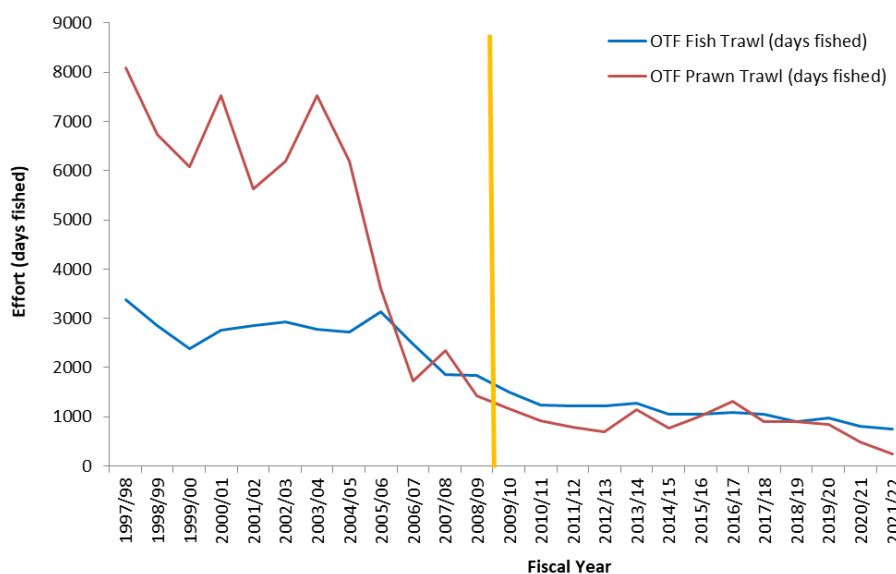


Figure 4. Annual adjusted effort (days and hours fished) for fish trawl and prawn trawl fishers of the NSW Ocean Trawl Fishery that reported landing Southern Calamari on at least one day in each month (1997/98–2021/22). The gold vertical line indicates the change from monthly to daily catch reporting in July 2009.

### Catch Rate information

Historical catch rates (catch-per-unit-effort, CPUE in kg per day fished) for Southern Calamari taken by the fish trawl and prawn trawl sectors were compiled from monthly records between 1998 and 2009 and standardized for month, ocean zone and fishing business using the r-package 'rforcue' (Haddon, 2023). Recent catch rates (CPUE in kg per hour trawled) were compiled from daily fishing event records from 2010 to 2023 and standardised for month, ocean zone, fishing business and capture depth (taken from the mean depth of the reported c-square).

The mean standardized catch rates of Southern Calamari have been consistently lower for the prawn trawl sector relative to the fish trawl sector (Figs 5 and 6). The two sectors operate in mostly different ocean zones, use different gears and vary in their targeted fishing practices, which would account for these differences. In particular, the prawn trawl sector fishes the northern extremity of the species distribution.

Standardised catch rates for the two sectors indicate differing historical trends, with mean monthly CPUE for the prawn trawl sector decreasing by over 80% in the early 1990s and continuing to trend downwards until 2014 (Fig. 5). Since, then daily catch rates have improved slightly to be above the more recent long-term average over the last three years. As mentioned above, this sector fishes the northern extremity of the species distribution, and any depletion due to fishing is likely to be exacerbated by any southerly species range shifts in response to climate change.

Historical catch rates in the fish trawl sector increased by over 80% in the early 1990s to a distinct peak of 57.4 kg per day in 1998, followed by a rapid decline by over 50% until 2002. Since then, catch rates have been more stable and were above the recent long-term average of 7 kg per hour trawled over the last three years (Fig. 6). The fish trawl sector accounts for most of the catch of Southern Calamari in NSW waters.

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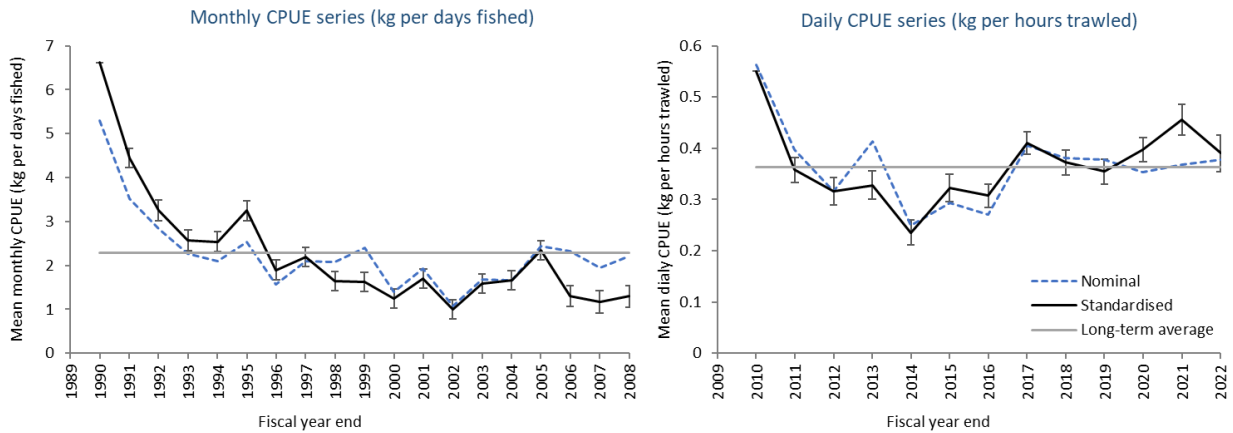


Figure 5. Mean standardised catch rates (catch-per-unit-effort, CPUE) of Southern Calamari for the prawn trawl sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1990–2009) in kg per days fished (left graph) and from daily fishing event records (2010–2022) in kg per hours trawled (right graph). The dashed and solid lines indicate the nominal and standardised mean CPUE, respectively and the grey horizontal line indicates the long-term average for each series.

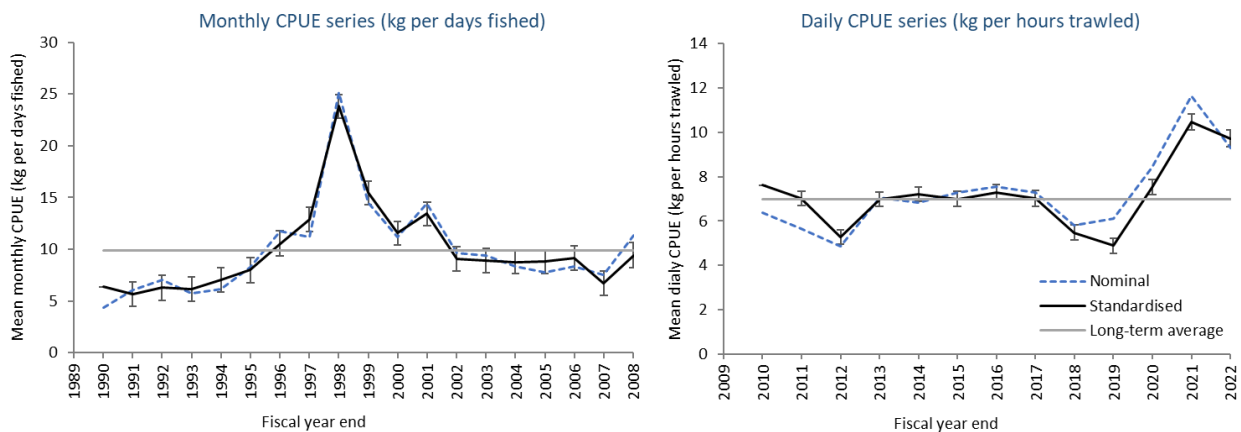


Figure 6. Mean standardised catch rates (catch-per-unit-effort, CPUE) of Southern Calamari for the fish trawl sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1989/90–2008/09) in kg per days fished (left graph) and from daily fishing event records (2009/10–2021/22) in kg per hours trawled (right graph). The dashed and solid lines indicate the nominal and standardised mean CPUE, respectively and the grey horizontal line indicates the long-term average for each series.

## STOCK ASSESSMENT

### Stock Assessment Methodology

Year of most recent assessment:

2020

No quantitative joint stock assessment of the entire biological stock is undertaken.

Assessment method:

A weight-of-evidence approach was used for this stock status assessment of Southern Calamari in NSW waters. It relies on analyses of standardised catch rates for the two main fishing fleets of the OTF, fish trawl (otter trawl, excluding Danish seine) and prawn trawl (otter trawl), across all ocean zones.

Main data inputs:

Commercial catch and effort data – for all NSW commercial fisheries by fiscal years (1984/85–2021/22).

Recreational catches – estimated annual catches from four periods – national recreational and indigenous fishing survey (2000/01) and NSW recreational fishing surveys (2013/14, 2017/18 and 2019/20).

Commercial catch rates historical – reported annual CPUE data for the ocean prawn trawl and fish trawl sectors of the OTF in kg per days fished (1989/90–2008/09) from monthly records – standardised.

Commercial catch rates recent – reported annual CPUE data for the ocean prawn trawl and fish trawl sectors of the OTF by calendar years in kg per hours trawled (2009/10–2021/22) from daily records – standardised.

Key model structure & assumptions:

The CPUE standardisations and analyses assume that the annual catch rates are a relative index of abundance and are not unduly influenced by other factors that are not accounted for through standardisation.

Catch rates were standardised for the influences of different months, ocean zones, fishing businesses and capture depths (daily records only).

Using fishing effort as an indicator of relative fishing pressure assumes that fish catchability and fishing power have not changed significantly over the monitoring period.

Sources of uncertainty evaluated:

None assessed.



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(*Sepioteuthis australis*)

## Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	None specified in a formal harvest strategy. In the interim, the trend in commercial catch rates of the ocean prawn trawl and fish trawl sectors of the OTF were selected as indices of relative abundance.
Biomass Limit Reference Point	None specified in a formal harvest strategy. In the interim, current catch rates were assessed relative to long-term averages of each time series.
Biomass Target Reference Point	None specified.
Fishing mortality indicator or proxy	None specified in a formal harvest strategy. In the interim, the trend in annual total commercial fishing effort for the prawn trawl and fish trawl sectors of the OTF were selected as indicators of relative fishing pressure.
Fishing mortality Limit Reference Point	None specified in a formal harvest strategy. In the interim, current fishing effort levels were compared against historic levels.
Fishing Mortality Target Reference Point	None specified.

## Stock Assessment Results

### Stock Assessment Result Summary

Biomass status in relation to Limit	Current standardised catch rates for the ocean prawn trawl and fish trawl sectors of the NSW OTF were above average for the last two year and near or above long-term averages over the last 11 years. Historical trends in catch rates between the fish trawl and prawn trawl sectors show opposing trends, with a considerable decline in catches and catch rates in northern NSW during the 1990s. However, these longer-term catch rates must be interpreted with caution due to the potential influence of catch reporting changes in July 2009. Aside from some possible localised population contraction in northern NSW, the weight of evidence indicates that the biomass is unlikely to be depleted and that recruitment is unlikely to be impaired.
Biomass status in relation to Target	Not assessed.



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Fishing mortality in relation to Limit	Fishing effort in both the prawn trawl and fish trawl sectors of the OTF have decreased substantially relative to historical levels in the late 1990s.  The weight of evidence indicates that the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished.
Fishing mortality in relation to Target	Not assessed.
Current SAFS stock status	On the basis of the evidence above, which includes stable trends in standardised catch rates over the last 11 years and current low levels of fishing effort, Southern Calamari is currently assessed as a <b>sustainable stock</b> .

## Fishery interactions

The OTF trawl fishing gears interact with other commercial and non-commercial by-catch marine species, a range of endangered, threatened and/or protected (ETP) species and marine habitats. The OTF share management plan mandates that otter trawl nets must be fitted with at least one BRD of an approved design to reduce the by-catch of small prawns and juvenile fish. Mesh size and other gear restrictions are regulated to increase the target species selectivity of otter trawl and Danish seine nets and cod ends. Research results to date suggest that these measures significantly decrease the levels of by-catch associated with these fishing gears (Broadhurst *et al.*, 1999, 2006, 1996, 1997, 2005; Broadhurst & Kennelly, 1996).

Interactions with animals protected under the *Environment Protection and Biodiversity Conservation Act* 1999 include marine mammals (dolphins, seals and sea lions), seabirds, some shark species, and seahorses and pipefish (sygnathids). The ETP species that interact with the OTF were subjected to a detailed risk assessment in an environmental impact statement (EIS) for the fishery (NSW DPI, 2004). All 11 ETP species identified in the EIS were considered to be at moderate/low or low risk. An updated threat and risk assessment for all components of the NSW marine estate was completed in 2017 (Fletcher & Fisk, 2017). The OTF was considered a moderate threat to ETP species along the north coast and a low threat along the south coast. Interactions with grey nurse sharks and sygnathids were identified as the main concerns.

Compulsory logbook reporting of all interactions with ETP species was mandated in 2005 and these are reported annually to the Department of Environment and Energy (NSW DPI, 2017). Data on incidental interactions with by-catch, ETP species and associated mortalities were also collected during a recent fish trawl (2014–2016) and prawn trawl (2017–2019) observer surveys.

The majority of available trawl ground in NSW waters is likely to be dominated by sandy habitat with little reef structure, and fishers typically try to avoid high topography, hard, structured habitats to prevent net damage. Large areas within NSW marine parks are closed to trawling and provide areas for habitat protection. The use of bobbins on ground ropes of fish trawl nets is prohibited north of Seal Rocks and the maximum size of bobbins is limited south of Seal Rocks to minimise damage to reef habitats. More information on the potential effects of trawl gears on the soft seabed biota is warranted, as impacts to these less protected habitats are likely to be more significant.

## Qualifying Comments

- Overall, the data collated in this stock assessment suggest that the input controls used to manage effort in the commercial OTF have proved effective at reducing effort levels between 1997/98 and 2021/22 and consequently fishing pressure on Southern Calamari.
- Recent stable trends in catch rates of both ocean trawl sectors suggest that current harvest rates are sustainable. However, some possible localised depletion of the stock in northern ocean zones (as indicated by declines in prawn trawl catch rates during the 1990s) needs to be monitored, as status assessments in other jurisdictions indicate that this species can be subject to localised depletions (Moore et al. 2018).
- The potential influence of reporting changes on commercial catch rates (especially during the transition from monthly to daily reporting around July 2009) limits their application as a long-term index of relative abundance.
- Ongoing misreporting of multi-day trips as single fishing events further compromise the accuracy of current catch-rate data.
- Data assessed in this report date only as far back as 1990/91. Trawl fishing in NSW waters is known to have occurred since at least 1920. Even if Southern Calamari were not retained from trawling before 1990/91, they are still likely to have been caught by trawl gears as by-catch. Any potential historical discard or targeted mortality prior to 1990/91 has not been considered in this stock assessment.

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