Stock Status Summary – 2022/23

NSW Stock Status Summary – Giant Australian Cuttlefish (*Sepia apama*)

Assessment Authors and Year

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Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Giant Australian Cuttlefish is currently assessed as **Undefined** for the NSW stock.

Stock structure & distribution

The Giant Australian Cuttlefish (*Sepia apama*) is an endemic species distributed throughout southern Australia from central New South Wales (NSW) to Western Australia (WA), and including Tasmania (Reid 2016). The stock structure of *Sepia apama* has been investigated using genetic methods (allozymes, mitochondrial DNA and microsatellites), and comprised three stocks: NSW populations formed one, South Australia (SA) and Victoria (VIC) combined in another and WA was distinct as a third (Kassahn *et al.*, 2003). Results indicated NSW populations had a different evolutionary history from the rest of the species range, but it was not clear whether they were sufficiently diverged to constitute a separate species.

The data presented in this summary relate to the NSW stock of the Giant Australian Cuttlefish.

Biology

The Giant Australian Cuttlefish is the largest cuttlefish species in the world, with a maximum recorded size of 520 mm mantle length, ML (Gales & Pemberton, 1990) and over 12 kg weight (Kassahn *et al.*, 2003). The biology of Giant Australian Cuttlefish has been studied in southern Australian waters, where it is targeted by jig fishing (Hall & Fowler, 2003). The species has two alternative life cycles and lifespans (of 1 or 2 years) but all only breed once during the final 3 months of life (Hall *et al.*, 2007). Consequently, age and size at maturity vary considerably. Giant Australian Cuttlefish have complex reproductive behaviours and mating systems, with males competing for access to females and females storing and using sperm from multiple males to internally fertilise and lay each egg individually (Hall & Hanlon, 2002). Egg size is large (approximately 1 cm diameter) and fecundity is low (about 500 eggs per female) and both vary positively with female size (Hall & Fowler, 2003). The species migrates between deeper waters where they feed, grow and mature during spring and summer and then concentrate in shallower, rocky reef areas during the autumn and winter for spawning (Hall *et al.*, 2017).

Other cuttlefish species that make up the bulk of commercial catches from NSW waters are much smaller bodied than the Giant Australian cuttlefish, with maximum sizes of the less than 250 mm ML and 300 g in weight (Beasley *et al.*, 2018). Nevertheless, the three main species—Rosecone Cuttlefish (*S. rozella*), Mourning Cuttlefish (*S. plangon*) and Magnificent Cuttlefish (*S. opipara*)—have similar alternative life cycles, lifespans of up to 18 months (Beasley, 2017) and breed only once at the end of their life with a range of ages and sizes at maturity (Beasley, 2017).

FISHERY STATISTICS

Catch information

Commercial

In NSW, total annual commercial catches of combined cuttlefish are available from 1975/76 to 2008/09 and for Giant Australian Cuttlefish as a separate species from 2009/10 to present (Fig. 1). Commercial catches of combined cuttlefish steadily increased from around 11 tonnes (t) in the mid 1970s to a peak of 457 t in 1994/95. Catches then fluctuated around a declining trend until 2008/09, when catches reached a historic low of 60 t. It is not known what proportion of these historic catches comprised Giant Australian Cuttlefish. Since 2009/10, catches of combined cuttlefish have remained below 100 t, with reported Giant Australian catches fluctuating between 10 and 33 t (Fig. 1). Giant Australian catches over the last two years have been the lowest on record at 14.1 t in 2020/21 and 10 t in 2021/22.

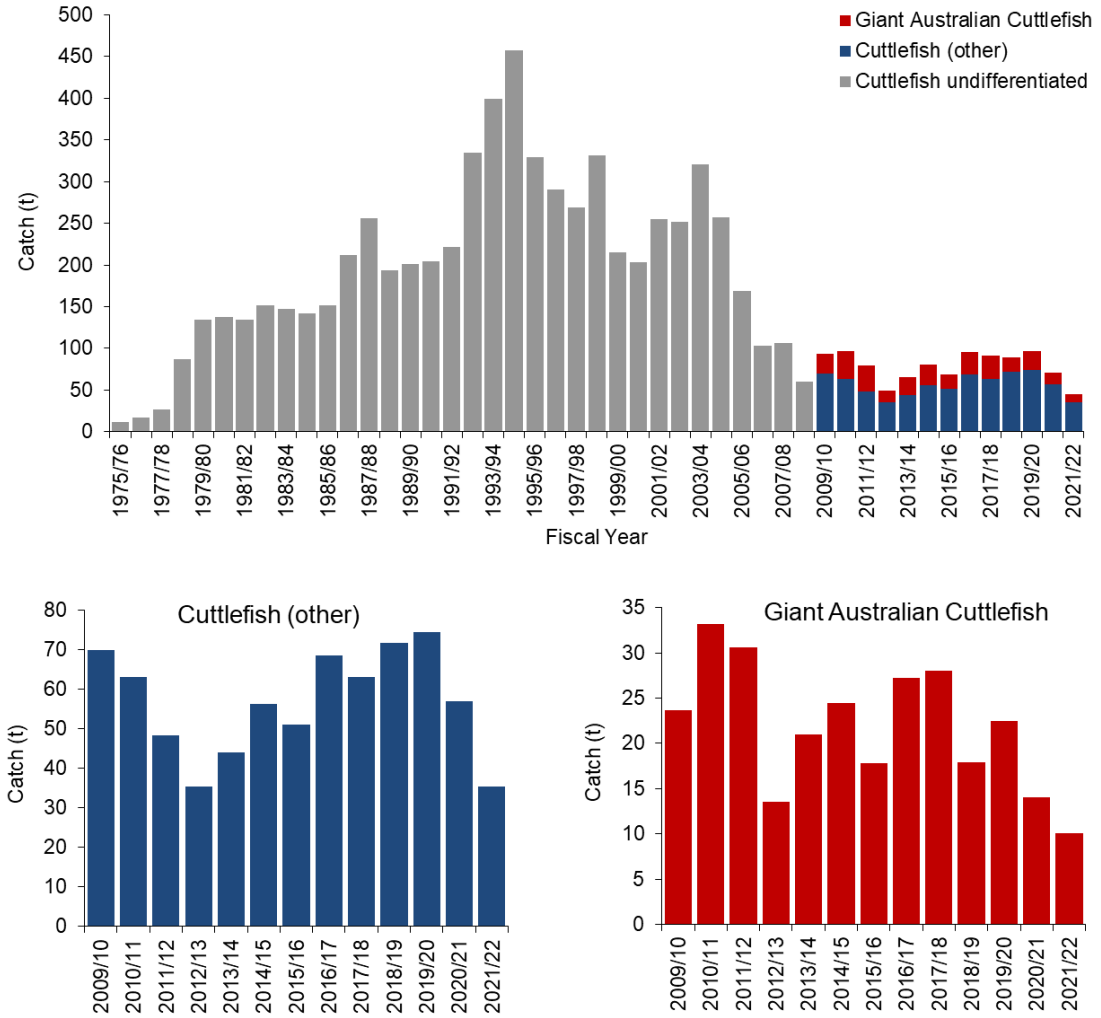

Figure 1. Annual commercial landings (tonnes) of combined cuttlefish species for NSW waters from 1975/76 to 2008/09 for all fishing methods, and then by separate species from 2009/10 to 2021/22 (top graph). Separate trends in landings for the Cuttelfish (other) mixed species group and Giant Australian Cuttlefish (*Sepia apama*) are provided in the bottom two graphs.

In NSW, cuttlefish are almost exclusively caught by the ocean prawn trawl and fish trawl fleets in coastal waters to a depth of 350 m (Fig. 2). The considerable decline in NSW catches during the early 2000s was largely driven by reduced landings (and fishing effort) in the ocean prawn trawl sector, which operates in northern and central NSW at the northern extremity of the species distribution. The fish trawl sector account for a greater proportion of the Giant Australian Cuttlefish catch (over years for which separate species data are available) with approximately half of the catch taken by each sector in most years (Fig. 3). Catches of Giant Australian Cuttlefish are taken in all ocean zones, especially along the mid north and central coasts (Fig. 4).

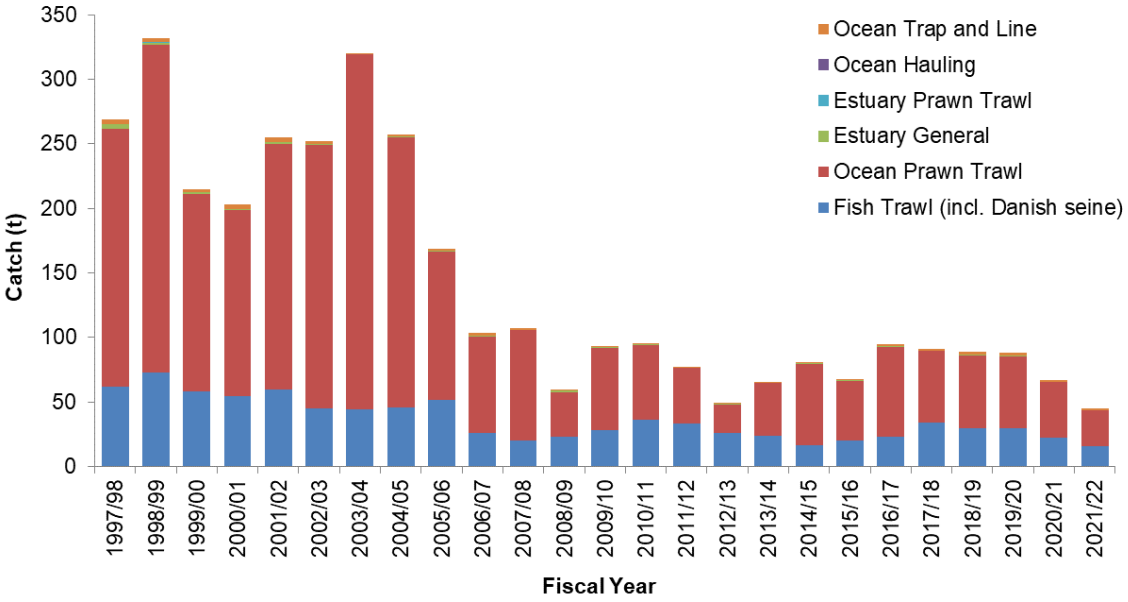

Figure 2. Annual commercial catches (tonnes) of combined cuttlefish species by fisheries for NSW waters from 1997/98 to 2021/22.

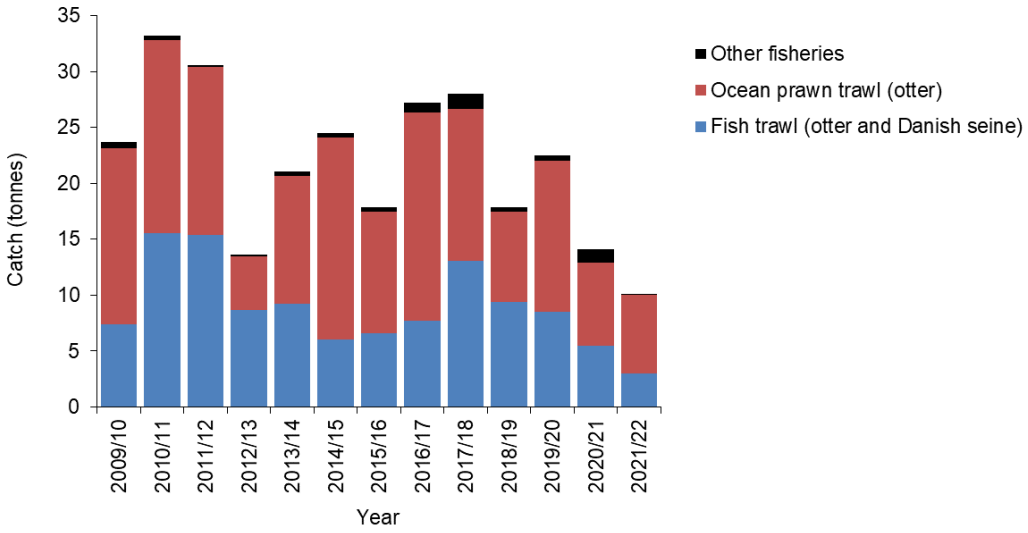

Figure 3. Annual commercial catches (tonnes) of Giant Australian Cuttlefish by fishing sector for years that separate species data are available (2009/10 to 2021/22).

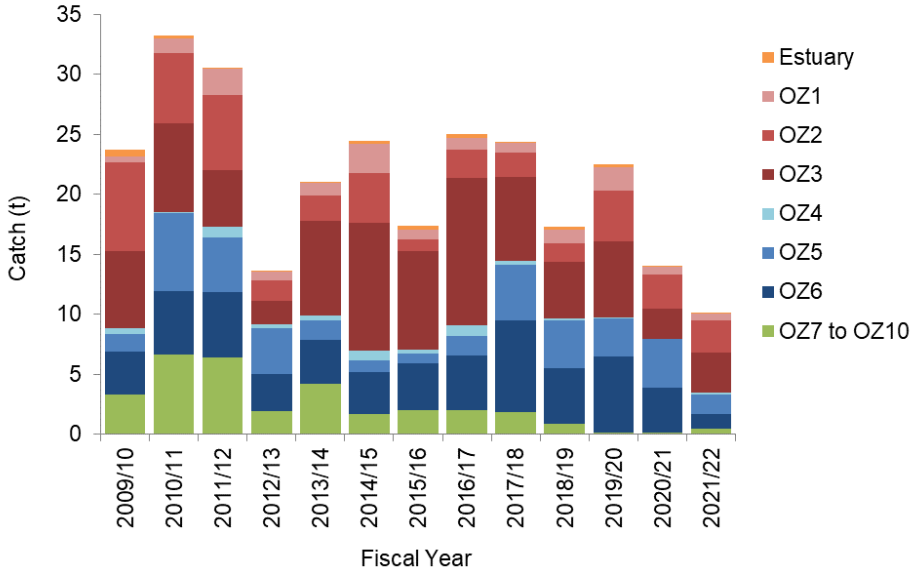

Figure 4. Annual commercial catches (tonnes) of Giant Australian Cuttlefish by ocean zone (OZ) covering 1 degree of latitude from OZ1 in the north near the Queensland border to OZ10 in the south near the Victorian border for years that separate species data are available (2009/10 to 2021/22).

Recreational & Charter boat

The most recent estimate of the recreational harvest of combined cuttlefish species in NSW was approximately 841 cuttlefish during 2019/20 (Murphy *et al.*, 2022). The proportion of Giant Australian cuttlefish in this estimate is unknown. The 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 quite varied at 1,611 and 115 cuttlefish, respectively (Murphy *et al.*, 2020). Relative to the commercial catch, these recreational catches are estimated to be small (<1% of the total NSW harvest).

Aboriginal cultural fishery

Statewide estimates of the annual Aboriginal harvest of Giant Australian Cuttlefish in NSW waters are unknown.

Illegal, Unregulated and Unreported

The amount of illegal, unregulated and unreported catches of Giant Australian Cuttlefish in New South Wales are unknown.

Fishing effort information

Commercial fishing effort for combined cuttlefish 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 cuttlefish were reported on at least one day; and were adjusted for multi-day trips reported as a single fishing event by dividing the total number of hours by 12.

In the ocean prawn trawl sector, reported effort for combined cuttlefish declined rapidly from 15,029 days fished in the early 2000s to 5,132 days fished in 2008/09. Since then effort has declined more gradually to an estimated 3,113 days fished in 2021/22 (Fig. 5). Therefore, most of the decline in effort occurred prior to the catch reporting change in 2009. In contrast, reported effort for combined cuttlefish in the fish trawl sector has decreased more gradually from 3,639 days fished in 1997/98 to 700 days fished in 2021/22 (Fig. 5). Overall current levels of fishing effort reported for combined cuttlefish are well below historical levels reported prior to 2009/10.

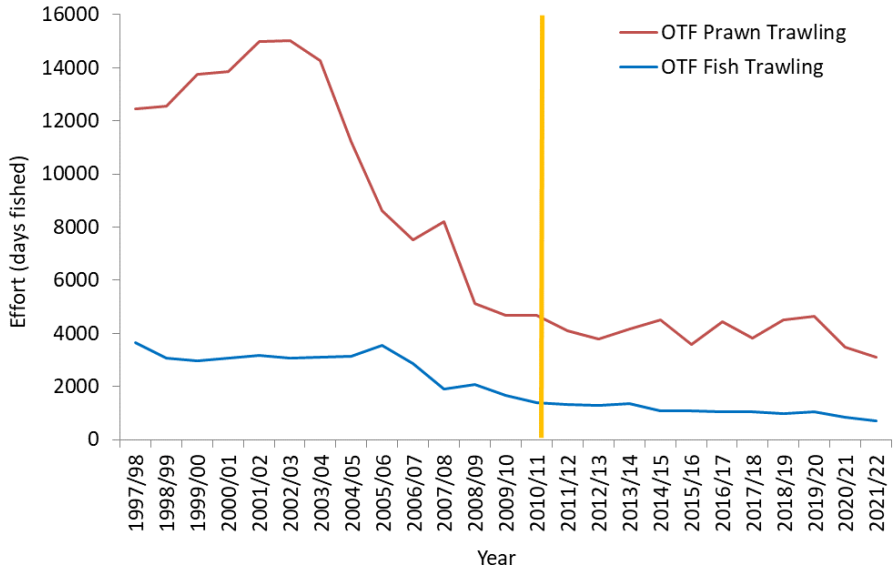

Figure 5. Annual adjusted effort (days fished) for ocean prawn trawl and fish trawl fishers of the NSW Ocean Trawl Fishery (including Southern Fish Trawl Fishery) that reported landing cuttlefish on at least one day in each month. The gold vertical line indicates the change from monthly to daily catch reporting.

Catch Rate information

Monthly catch rates (catch-per-unit-effort, CPUE in kg per days fished) for combined cuttlefish taken by the fish trawl and ocean prawn trawl sectors were compiled from monthly records between 1997/98 and 2008/09 and standardized for month, ocean zone and fishing business using the r-package 'rforcpue' (Haddon, 2023). Any continuity of the time series across the catch reporting change in July 2009 must be interpreted with caution. Daily catch rates (CPUE in kg per hour trawled) for Giant Australian Cuttlefish were also compiled from daily fishing event records from 2009/10 to 2021/22 and standardised for month, ocean zone, fishing business and capture depth (taken from the mean depth of the reported c-square).

Monthly catch rates of the ocean prawn trawl sector indicate some significant declines in the late 1990s and 2000s to finish below the long-term average in 2008/09 (Fig. 6). More recent daily

catch rates for Giant Australian Cuttlefish, decreased initially between 2009/10 and 2012/13, but then rapidly increased over the next two years and have fluctuated near the recent-average over the eight years (Fig. 6).

Historical monthly catch rates of the fish trawl sector, which operates in central and southern NSW, showed a consistently declining trend from 1998/99 to 2008/09 (Fig. 7). More recent daily catch rates for Giant Australian Cuttlefish increased between 2009/10 and 2011/12 and then declined to below average until 2015/16, but have fluctuated near the average for the last six years.

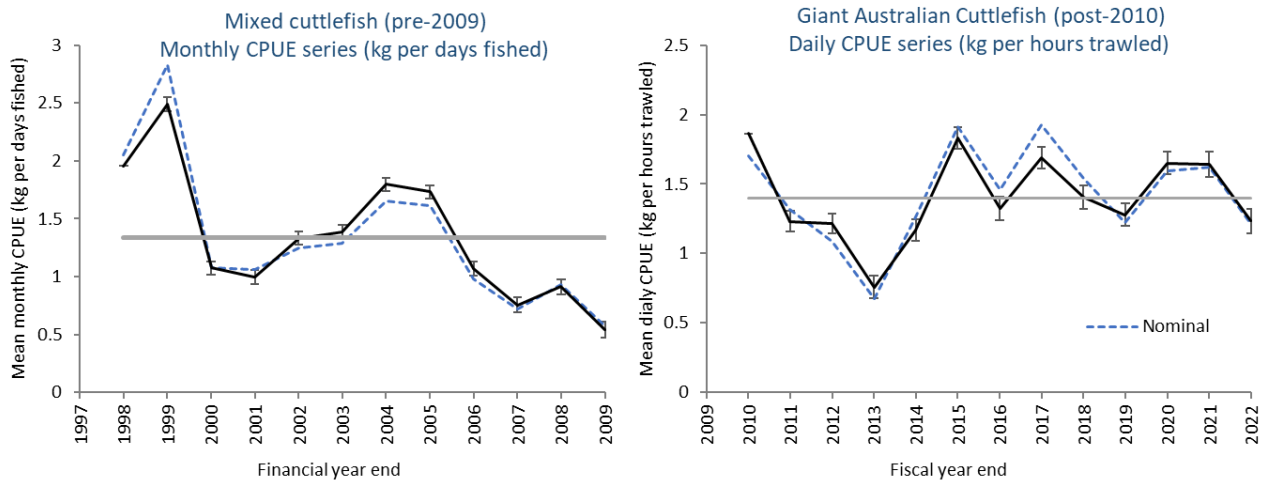

Figure 6. Mean standardised catch rates (catch-per-unit-effort, CPUE) for the ocean prawn trawl sector in the NSW Ocean Trawl Fishery, of combined cuttlefish from monthly records (1997/98–2008/09) in kg per days fished (left graph) and Giant Australian Cuttlefish from daily fishing event records (2009/10–2021/22) 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 averages for each series.

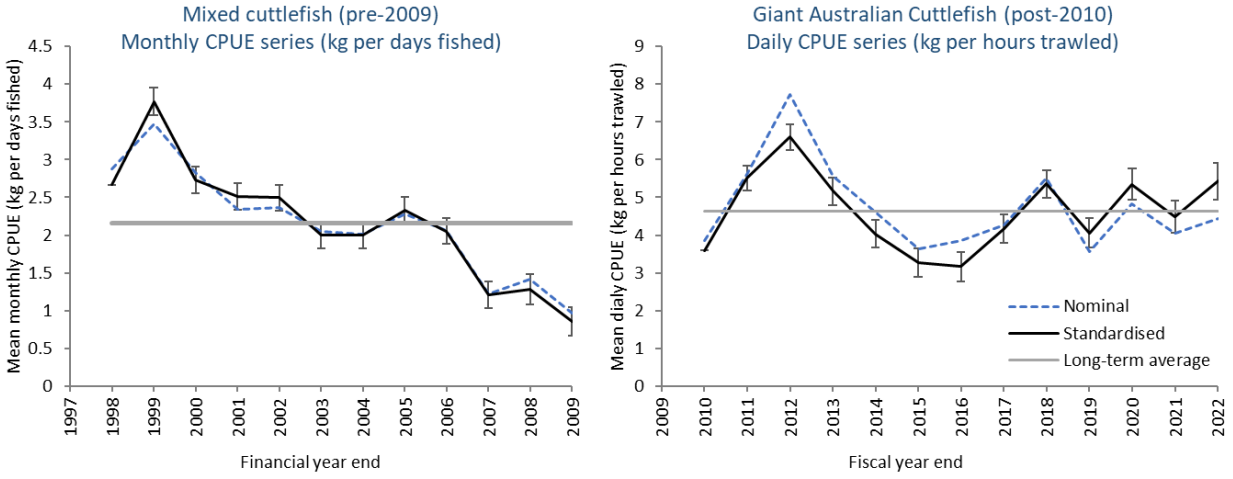

Figure 7. Mean standardised catch rates (catch-per-unit-effort, CPUE) for the fish trawl sector in the NSW Ocean Trawl Fishery, of combined octopus from monthly records (1998–2009) in kg per days fished (left graph) and Hammer Octopus from daily fishing event records (2010–2022) in kg per hours trawled (right graph). The dashed and solid lines indicate the nominal and standardised mean CPUE, respectively; and the grey horizontal line indicates the long-term averages for each series.

STOCK ASSESSMENT

Stock Assessment Methodology

Year of most recent assessment:

2023

Assessment method:

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

Main data inputs:

Commercial catch and effort data – for all NSW commercial fisheries by fiscal years for combined cuttlefish species (1975/76–2008/09) and Giant Australian Cuttlefish as a separate species (2009/10–2021/22).

Recreational catches – estimated annual catches for combined cuttlefish species from three periods – 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 by calendar years in kg per days fished (1997/98–2008/09) 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.

This assessment also assumes that historical catch and effort data for combined cuttlefish species reported by the commercial OTF between 1997/98 and 2008/09 reflect trends in the Giant Australian Cuttlefish populations during that period, and that the species composition has not changed significantly over time.

Sources of uncertainty evaluated:

None assessed.

Status Indicators - Limit & Target Reference Levels

There is no harvest strategy in place for cuttlefish in NSW, so a weight-of-evidence approach has been applied in this stock assessment with nominated indicators and reference points in line with the current NSW Harvest Strategy Policy (NSW DPI, 2021).

Biomass indicator or proxy	Trends in annual standardised catch rates of the ocean prawn trawl and fish trawl sectors of the commercial OTF were used as indices of relative abundance.
Biomass Limit Reference Point	Current catch rates were compared to the long-term averages of each time series.
Biomass Target Reference Point	None specified.
Fishing mortality indicator or proxy	Trends in the total fishing effort of the ocean prawn trawl and fish trawl sectors of the commercial OTF were used as indicators of relative fishing pressure.
Fishing mortality Limit Reference Point	Current 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	Commercial catches of combined cuttlefish peaked in the 1990s at 457 t and then declined considerably during the 2000s. Recent catches since 2009/10 have been below 100 t. Long-term trends in catch rates of the fish trawl and prawn trawl sectors of the OTF for combined cuttlefish show considerable declines during the late 1990s and 2000s, particularly in the fish trawl sector, which is more likely to comprise a greater proportion of Giant Australian Cuttlefish, because the species is more common along the central and southern coasts of NSW. The integrity of these indices as a proxy for relative abundance of Giant Australian Cuttlefish is questionable, however, because of the unknown species composition of historical data prior to 2009. Recent catch rates for Giant Australian Cuttlefish from daily records for both the fish trawl and prawn trawl sectors of the OTF have been more stable and

	have fluctuated around the recent long-term average over the last 6 to 8 years. Given the uncertainty with respect to possible historical declines in Giant Australian Cuttlefish abundances during the period when data for separate species were not collected, it is not possible determine whether the current spawning biomass is above or below the limit reference point. Given that recent catch rates have stabilised, however, no further declines in population levels are apparent during the last 6 to 8 years.
Biomass status in relation to Target	Not assessed.
Fishing mortality in relation to Limit	Current levels of fishing effort in the prawn trawl and fish trawl sectors of the OTF are much lower than historical levels, such that current fishing pressure is considered unlikely to cause any further declines to the stock abundance.
Fishing mortality in relation to Target	Not assessed.
Current SAFS stock status	On the basis of the evidence above, Giant Australian Cuttlefish is currently assessed as an **Undefined** stock.

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

- Given the short period of separate species catch-rate data available and the use of combined cuttlefish data prior to 2009, there is high uncertainty in these stock assessment results.
- The data collated in this stock assessment suggest that the input controls used to manage effort in the NSW commercial fisheries have proved effective at reducing effort levels between 1997/98 and 2020/21 and consequently fishing pressure on cuttlefish.
- Estimates of catches for the recreational sector are only available for combined cuttlefish species.
- The undue influence of catch 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.
- Data assessed in this report date only as far back as 1975/76. Trawl fishing in NSW waters is known to have occurred since at least 1920. Even if cuttlefish were not retained from trawling before 1975/76, they are still likely to have been caught by trawl gears as bycatch. Any potential historical discard or targeted mortality prior to 1975/76 has not been considered in this stock assessment.

References

Beasley, A. (2017). Life-history characteristics of three subtropical cuttlefishes: reproduction, growth, life span and behaviour. School of Environment, Science and Engineering, Southern Cross University, Coffs Harbour, NSW, 170 pp.

Beasley, A. L., Hall, K. C., Latella, C. I., Harrison, P. L., Morris, S. G., & Scott, A. (2018). Reproductive characteristics of three small-bodied cuttlefish in subtropical waters. *Marine and Freshwater Research*, *69*, 403–417.

Broadhurst, M. K., Kennelly, S. J., & Eayrs, S. (1999). Flow-related effects in prawn-trawl codends: potential for increasing the escape of unwanted fish through square-mesh panels. *Fishery Bulletin*, *97*, 1–8.

Broadhurst, M. K., & Kennelly, S. J. (1996). Effects of the circumference of codends and a new design of square-mesh panel in reducing unwanted by-catch in the New South Wales oceanic prawn-trawl fishery, Australia. *Fisheries Research*, *27*, 203–214.

Broadhurst, M. K., Millar, R. B., Wooden, M. E. L., & Macbeth, W. G. (2006). Optimising codend configuration in a multispecies demersal trawl fishery. *Fisheries Management and Ecology*, *13*, 81–92.

Broadhurst, M. K., Kennelly, S. J., & O'Doherty, G. (1996). Effects of square-mesh panels in codends and of haulback delay on bycatch reduction in the oceanic prawn-trawl fishery of New South Wales, Australia. *Fishery Bulletin*, *94*, 412–422.

Broadhurst, M. K., Kennelly, S. J., & O'Doherty, G. (1997). Specifications for the construction and installation of two by-catch reducing devices (BRDs) used in New South Wales prawn-trawl fisheries. *Marine and Freshwater Research*, *48*, 485–489.

Broadhurst, M. K., Young, D. J., Gray, C. A., & Wooden, M. E. L. (2005). Improving selection in south eastern Australian whiting (*Sillago* spp.) trawls: effects of modifying the body, extension and codend. *Scientia Marina*, *69*, 301–311.

Fletcher, M., & Fisk, G. (2017). *New South Wales marine estate threat and risk assessment report*. Sydney, NSW: Marine Estate Management Authority. p. 251.

Gales, R., & Pemberton, D. (1990). Seasonal and local variation in the diet of the Little Penguin, *Endyptula minor*, in Tasmania. *Wildlife Research*, *17*, 231–259.

Haddon, M. (2023). *rforcpue: functions to assist with the analysis of CPUE data. R package version 0.0.0.3000.*

Hall, K. C., & Fowler, A. J. (2003). *The fisheries biology of the cuttlefish* Sepia apama *Gray, in South Australian waters.* FRDC Final Report, Project No. 98/151. Adelaide, South Australia: FRDC Final Report Project No. 98/151, South Australian Research and Development Institute. p. 277.

Hall, K. C., Fowler, A. J., & Geddes, M. C. (2007). Evidence for multiple year classes of the giant Australian cuttlefish *Sepia apama* in northern Spencer Gulf, South Australia. *Reviews in Fish Biology and Fisheries*, *17*, 367–384.

Hall, K. C., & Hanlon, R. T. (2002). Principal features of the mating system of a large spawning aggregation of the giant Australian cuttlefish *Sepia apama* (Mollusca: Cephalopoda). *Mar. Biol.*, *140*, 533–545.

Hall, K. C., Fowler, A. J., Geddes, M. C., & Taylor, J. (2017). Predictable spatiotemporal dynamics of a dense cuttlefish spawning aggregation increases its vulnerability to exploitation. *ICES Journal of Marine Science*, *75*, 221–234.

Kassahn, K. S., Donnellan, S. C., Fowler, A. J., Hall, K. C., Adams, M., & Shaw, P. W. (2003). Molecular and morphological analyses of the cuttlefish *Sepia apama* indicate a complex population structure. *Mar. Biol.*, *143*, 947–962.

Murphy, J. J., Ochwada-Doyle, F. A., West, L. D., Stark, K. E., & Hughes, J. M. (2020). *The NSW Recreational Fisheries Monitoring Program - survey of recreational fishing, 2017/18. Fisheries Final Report Series No. 158.* p. Wollongong, NSW.

Murphy, J. J., Ochwada-Doyle, F. A., West, L. D., Stark, K. E., Hughes, J. M., & Taylor, M. D. (2022). *Survey of recreational fishing in NSW, 2019/20 – Key Results. Fisheries Final Report Series No. 161.* Nelson Bay, NSW. p. 80.

NSW DPI. (2004). *Ocean Trawl Fishery Environmental Impact Statement. Public Consultation Document.* Cronulla, NSW: NSW Department of Primary Industries. p. 428 pp.

NSW DPI. (2017). *Assessment of the NSW Ocean Trawl Fishery. Prepared for the Department of Environment and Energy for the purpose of assessment under Part 13 and 13(A) of the Environment Protection and Biodiversity Act 1999*. Coffs Harbour, NSW: NSW Department of Primary Industries. p. 25 pp.