Stock Status Summary – 2022/23

NSW Stock Status Summary – Gould's Squid
(*Nototodarus gouldi*)

Assessment Authors and Year

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Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Gould's Squid is currently assessed as **Sustainable** for the NSW component of the stock.

Stock structure & distribution

Gould's Squid (*Nototodarus gouldi*) is widely distributed in temperate waters of southern Australia from Moreton Bay in Queensland to Geraldton in Western Australia, and including Tasmania (Nowara & Walker, 1998). It also occurs in New Zealand waters (Smith *et al.*, 1987).

Genetic studies using allozyme electrophoresis supported the hypothesis of a single biological stock of Gould's Squid throughout south-eastern Australian waters (Triantafillos *et al.*, 2004). While a detailed analysis of statolith (earbone) shape of adults collected from two locations (Victoria and the Great Australian Bight) provided evidence for separate stocks, the elemental compositions of the statoliths suggested they derived from multiple locations throughout the species distribution (Green *et al.*, 2015). Thus, egg mass and juvenile drift via longshore currents were postulated to sustain the genetic homogeneity of the species rather than large-scale adult migrations between regions, with greater drift occurring from Victoria to the Great Australian Bight than in the opposite direction (Green *et al.*, 2015). Until more information can be collected from other parts of the species distribution, the stock status of the Gould's Squid is assessed as a single biological stock—South-Eastern Australia (Noriega *et al.*, 2021).

The data in this summary relate to the New South Wales (NSW) part of the stock and include data up to and including the 2021/22 financial year.

Biology

Gould's Squid is a sexually dimorphic oceanic species, with females reaching larger maximum sizes (up to 393 mm dorsal mantle length [DML] and 1,655 g) and ages (360 days) than males (366 mm DML, 1057 g and 325 days) (Jackson *et al.*, 2003). Growth rates, and consequently age and size at maturity, varied significantly across the species distribution in relation to water temperatures and ocean productivity. Squid collected from NSW were typically smaller, younger and had smaller gonads than squid collected from Victoria and Tasmania, while those off South Australia were of intermediate size and age, but more variable. Growth rates also varied between years within a given location. Maturity was reached within 6–9 months and at 170–300 mm ML (Jackson *et al.*, 2003). Spawning apparently occurs year-round, with eggs internally fertilised and then released into large gelatinous, pelagic egg masses that drift on ocean currents (McGrath & Jackson, 2002; O'Shea & Bolstad, 2004).

FISHERY STATISTICS

Catch information

Commercial

Annual commercial catches of Gould's Squid in NSW state waters steadily declined from a peak of 59.8 t in 1997/98 to a minimum catch of 4.9 t in 2010/11 (Fig. 1). Over the last 10 years catches have remained steady at an average of 8 t per annum, with a slight increase to 11.6 t in 2018/19.

Most of commercial catch of Gould's Squid from NSW waters is taken by fish and prawn trawling in the Ocean Trawl Fishery (including data from the Southern Fish Trawl Restricted Fishery in all analyses) (Fig. 2). In most years the catch is fairly evenly split between the fish and prawn trawl sectors. Most of the historical catch was taken from ocean zone 2 in northern NSW by the prawn trawl sector and from ocean zones 6 to 10 by the southern fish trawl sector (Fig. 3).

Catches of Gould's Squid in NSW waters are insignificant relative to the much larger, but highly variable catches taken by fisheries in other jurisdictions along the east coast and in Bass Strait and the Southern Ocean (Noriega et al. 2018). Historically, large catches were taken by distant-water fleets, with the largest reported catch of 7,914 t taken by Japanese jig vessels in 1979/80 (Kailola *et al.*, 1993). In 2022, 394 t of Gould's Squid was landed across three Commonwealth sectors: the Southern Squid Jig Fishery (146 t), the Commonwealth Trawl Sector (204 t) and Great Australian Bight Trawl Sector (44 t) (Noriega & Curtotti, 2023). The combined catch was smaller than that reported by these sectors in 2021 (982 t). The total catch of Gould's Squid from Tasmanian waters was also smaller in 2022 (192 t) than in 2021 (269 t) (Noriega & Curtotti, 2023).

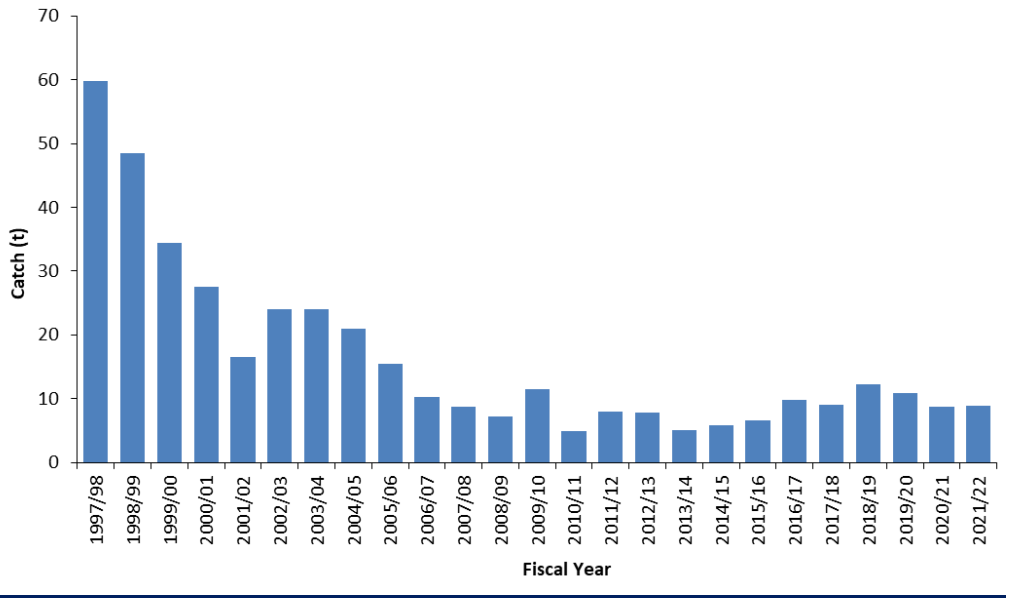

Figure 1. Annual commercial landings (tonnes) of Gould's Squid for NSW waters (1997/98–2021/22) for all fishing methods combined.

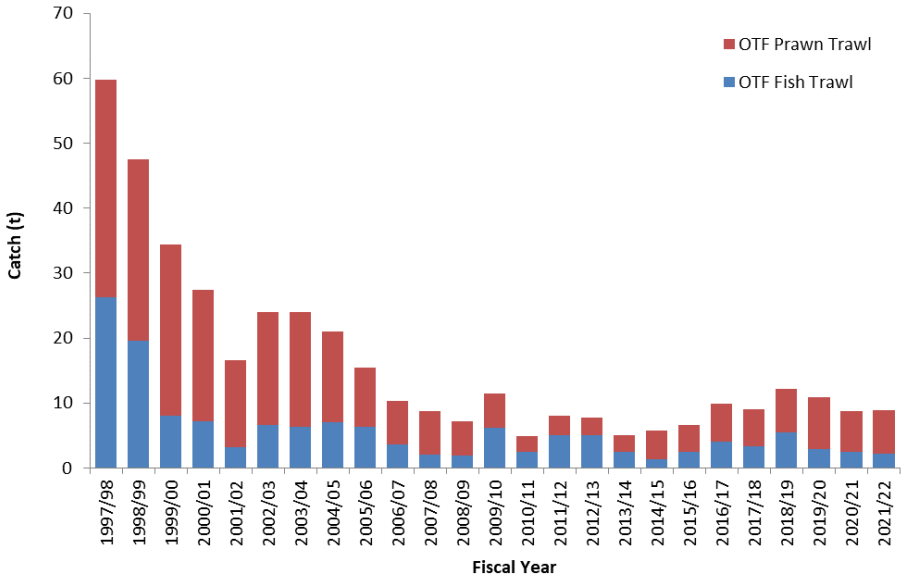

Figure 2. Annual commercial catches (tonnes) of Gould's Squid by sector for NSW Ocean Trawl Fishery (1997/98–2021/22).

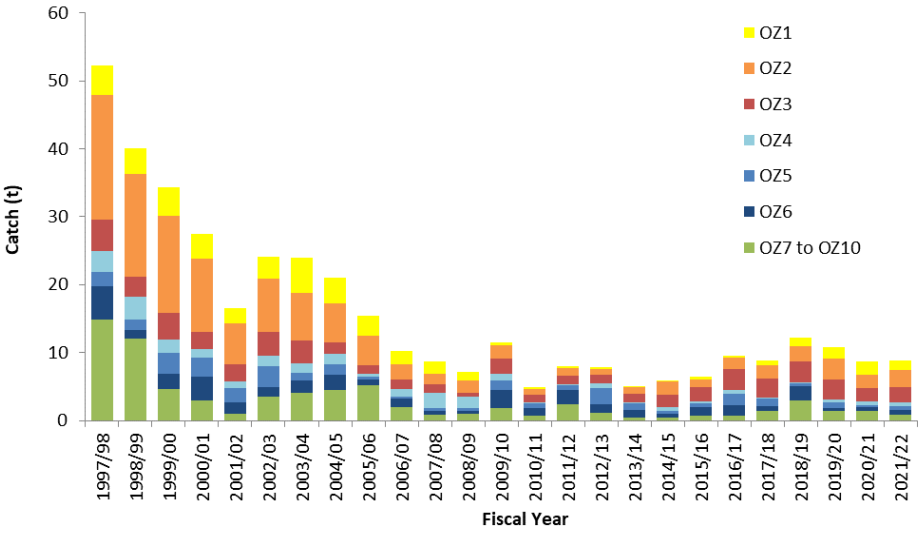

Figure 3. Annual commercial catches (tonnes) of Gould's Squid in different ocean zones (OZs) spanning one degree of latitude from the Queensland to Victorian borders (1997/98–2021/22).

Recreational & Charter boat

The most recent estimate of the recreational harvest of combined squid species (excluding Southern Calamari) was 117,714 squid (Murphy *et al.*, 2022); however, very little of this is thought to be Gould's Squid because of the generally deep offshore habitat of the species. 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 slightly smaller at around 108,213 and 79,819 mixed squid, respectively (Murphy *et al.*, 2020).

Aboriginal cultural fishery

There are no data on the Aboriginal harvest of Gould's Squid, but these catches are assumed to be negligible.

Illegal, Unregulated and Unreported

There are no data on the illegal, unregulated and unreported harvests of Gould's Squid, but these catches are also assumed to be negligible.

Fishing effort information

Commercial fishing effort for Gould's Squid was collected as number of days fished on monthly records prior to July 2009 and as numbers of hours trawled 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 Gould's Squid was reported on at least one day.

In the prawn trawl sector, reported effort for Gould's Squid declined rapidly from around 9,905 days fished in 1997/98 to a minimum of 1,172 days fished in 2012/13 (Fig. 4). Since then effort has increased slightly and was 2,578 days fished in 2021/22. Most of the decline in effort occurred prior to the catch reporting change in 2009. In contrast, reported effort for the fish trawl sector has remained relatively steady, but at a consistently lower level (Fig. 4). Reported effort for the fish trawl sector was 268 days fished in 2021/22.

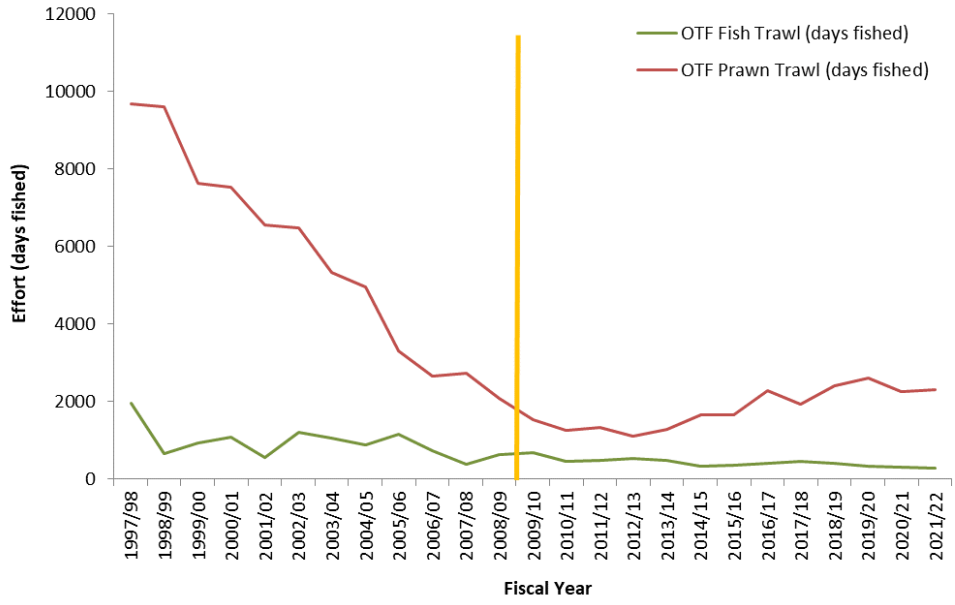

Figure 4. Annual effort (days fished) of prawn trawl and fish trawl fishers of the NSW Ocean Trawl Fishery that reported landing Gould's Squid on at least one day in each month (1997/98–2021/22). The gold vertical line indicates the change from monthly to daily catch reporting in July 2009.

Catch Rate information

Monthly catch rates (catch-per-unit-effort, CPUE in kg per day fished) for Gould's Squid 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 'rforcpue' (Haddon, 2023). Daily catch rates (CPUE in kg per hour trawled) were also compiled from daily fishing event records from 2010 to 2022 and standardised for month, ocean zone, fishing business and capture depth (taken from the mean depth of the reported c-square).

The historic mean standardized monthly catch rates of Gould's Squid for the commercial prawn trawl sector fluctuated around an overall declining trend from 1998 to 2008 to end the series below the long-term average (Fig. 5, left graph). Recent daily catch rates also declined in the early 2010s, but have steadily increased since then and were above-average in 2021 and 2022 (Fig. 5, right graph).

Mean standardized catch rates for the commercial fish trawl sector show greater variation, with a fairly steep decline in the early 2000s and sudden back to near the long-term average in 2007 and 2008 (Fig. 6, left graph). Recent daily catch rates of the fish trawl sector increased from 2011 to 2013, decreased rapidly during the following two years and have then increased to be above-average over the last two years (Fig. 6, right graph).

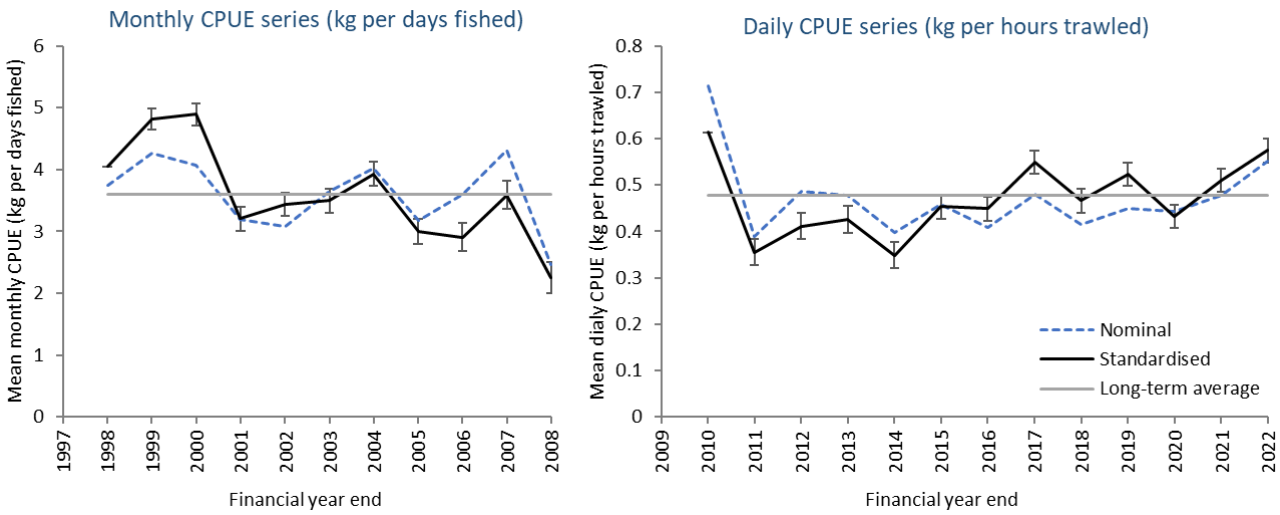

Figure 5. Mean standardised catch rates (catch-per-unit-effort, CPUE) of Gould's Squid for the prawn trawl sector in the NSW Ocean Trawl Fishery, estimated from monthly records in kg per days fished (1998–2008, left graph) and daily fishing event records in kg per hours trawled (2010–2022, right graph). The dashed blue and solid black lines indicate the nominal and standardised mean CPUE, respectively; and the grey horizontal line indicates the long-term averages for each series.

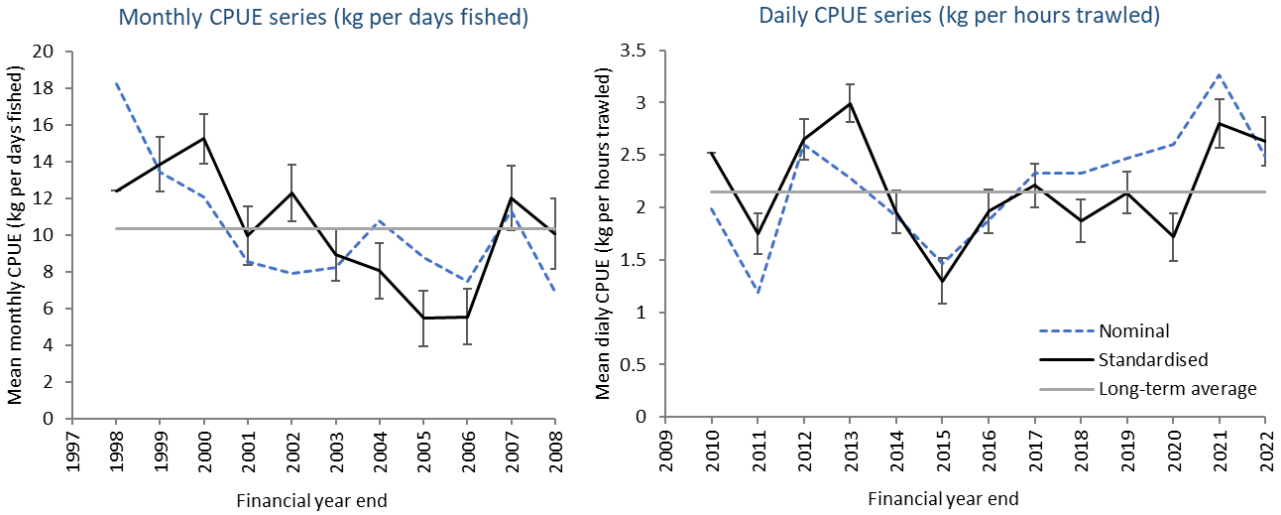

Figure 6. Mean standardised catch rates (catch-per-unit-effort, CPUE) of Gould's Squid for the fish trawl sector in the NSW Ocean Trawl Fishery, estimated from monthly records in kg per days fished (1998–2008, left graph) and daily fishing event records in kg per hours trawled (2010–2022, right graph). The dashed blue and solid black 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:

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

A weight-of-evidence approach was used for this stock status assessment of Gould's Squid 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 (1997/98–2021/22).

Recreational catches – estimated annual catches for combined squid species 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 by calendar years in kg per days fished (1998–2008) 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 (2010–2022) 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.

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	Not assessed.
Fishing mortality indicator or proxy	None specified in a formal harvest strategy. In the interim, 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, for the purposes of this stock assessment current fishing effort levels were compared against historic levels.
Fishing Mortality Target Reference Point	Not assessed.

Stock Assessment Results

Stock Assessment Result Summary

Biomass status in relation to Limit	Recent standardised catch rates in both the ocean prawn trawl and fish trawl sectors of commercial Ocean Trawl Fishery have shown an increasing or stable trend over the last 8 to 9 years, and were above average over the last 2 years. While there is considerable uncertainty in interpreting earlier trends in these data due to catch reporting changes from monthly to daily in July 2009, the weight of evidence suggests that the biomass of the stock is unlikely to be recruitment overfished and that current harvest rates are permitting some biomass recovery following declining catch rates in the early 2000s.
Biomass status in relation to Target	Not assessed
Fishing mortality in relation to Limit	Fishing effort has slightly increased over the last 8 years, but is still well below the levels reported in the 2000s that preceded the decreasing catch rates. Fishing levels in NSW waters are insignificant relative to removals from the stock in other jurisdictions. The weight of evidence indicates that the current level of fishing pressure is unlikely to cause the stock in NSW to become recruitment overfished.
Fishing mortality in relation to Target	Not assessed
Current SAFS stock status	Gould's Squid is currently assessed as a **sustainable stock** under the SAFS framework in 2023 (Noriega *et al.*, 2023).

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 2018/19 and consequently fishing pressure on Gould's Squid.
- Recent increasing or stable trends in catch rates and slightly lower fishing mortality estimates suggest that current harvest rates are sustainable and may be permitting some recovery of biomass.
- The potential 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 an index of relative abundance.
- Ongoing misreporting of multi-day trips as single fishing events further compromise the accuracy of current catch-rate data.
- Variation in discard rates for this species is unknown, but is likely to be significant given that retention of this species can be market driven based on anecdotal reports from fishers.
- Squid species misidentification by fishers is also suspected, given that some catches of Gould's Squid are also reported from estuaries where the species is unlikely to occur, leading to greater uncertainty in the logbook data. Catch records from ocean zones only were included in the current stock assessment.
- Data assessed in this report date only as far back as 1997/98. Trawl fishing in NSW waters is known to have occurred since at least 1920. Even if Gould's Squid were not retained from trawling before 1997/98, they are still likely to have been caught by trawl gears as by-catch. Any potential historical discard or targeted mortality prior to 1997/98 has not been considered in this stock assessment.

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