# Stock Status Summary – 2022/23

NSW Stock Status Summary – Hammer Octopus
(*Octopus australis)*

## Assessment Authors and Year

Hall, K.C. 2023. NSW Stock Status Summary 2022/23 – Hammer Octopus (*Octopus australis).* NSW Department of Primary Industries, Fisheries NSW, Coffs Harbour. 13 pp.

## Stock Status

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| Current stock status | On the basis of the evidence contained within this assessment, Hammer Octopus is currently assessed as **Sustainable** for the NSW stock. |

## Stock structure & distribution

The Hammer Octopus (*Octopus australis*) has a limited east coast distribution, from central Queensland to southern New South Wales (NSW) (Reid, 2016). The stock structure of Hammer Octopus is currently unknown. However, on the basis of the large size of mature eggs (8–12 mm) relative to dorsal mantle length (13.7–21.4% of DML) the species is likely to be holobenthic (Boletzky, 1974; Stranks & Norman, 1992). Holobenthic octopuses typically have relatively large benthic rather than pelagic hatchlings, with limited dispersal capacity. Most holobenthic species show finer scale population structuring across the species distribution (e.g., Pale Octopus, *Octopus pallidus)* (Doubleday *et al.*, 2008; Higgins *et al.*, 2013). Therefore, it is unlikely that Hammer Octopus form a single biological stock across the species distribution. Furthermore, there is currently no joint stock assessment for this species, so stock status is reported here at the jurisdictional level.

The data presented in this summary relate to the NSW part of the stock.

## Biology

The Hammer Octopus is found in coastal waters and bays on sand or mud substrates in depths between 3 and 140 m (Stranks & Norman, 1992). It is a relatively small species reaching a maximum total length (TL) of 49.9 cm, dorsal mantle length (DML) of 10.6 cm and total weight of 408 g (Nuttall, 2009). Recent aging via growth increments in thin sections of stylets suggest that the Hammer Octopus has a lifespan of up to 11 months in NSW waters (Nuttall, 2009). Males have a modified arm shaped like a club or hammer that is used to transfer sperm to females during mating (Stranks & Norman, 1992). Mature females are found in May to October in NSW (Nuttall, 2009), but a more detailed assessment of the reproductive biology is required to ascertain whether there is a distinct peak in spawning or year-round reproduction.

# FISHERY STATISTICS

## Catch information

### Commercial

In NSW, total annual commercial catches of combined octopus are available from 1979/80 to 2008/09 and for separate species from 2009/10 to present (Fig. 1). Commercial catches of combined octopus steadily increased from around 200 tonnes (t) in the late 1970s to a peak of 783 t in 1997/98. Catches then rapidly declined over 2 years to 277 t in 1999/00, briefly returned to over 500 t in 2000/01 and have fluctuated at lower levels (76–256 t) since 2004/05 (Fig. 1).

The species compositions of catches since 2009/10, suggest that Hammer Octopus typically dominates the catches (Fig. 1), and accounted for 84.2–94.6% of the total catches between 2009/10 and 2015/16 (Hall, 2018). Over the last six years, catches of Maori Octopus (*Macroctopus maorum*) and Gloomy Octopus (*Octopus tetricus*) have also increased (Fig. 1). The total commercial catch of Hammer Octopus in 2021/22 was 65.8 t, the lowest on record.

Most of the historical combined octopus catches were taken by the Ocean Trawl Fishery (OTF) with a recent increase in Ocean Trap and Line Fishery (OTLF) catches (Fig. 2). These latter predominantly comprise Maori and Gloomy octopuses. Most of the commercial catch of Hammer Octopus since 2009/10 has been taken by the ocean prawn trawl sector of the OTF, with smaller quantities reported from the fish trawl sector (Fig. 3). Most of the catch is taken north of Barrenjoey Point, and in particular in northern ocean zones 2 and 3 (Fig. 4).

Combining information regarding the breakdown of historical catches by fishing method and recent catches by species for each fishing method, there is strong evidence to suggest that the bulk of the historical catches by the OTF are likely to have comprised Hammer Octopus. This assumes that current species identification and reporting are accurate and that the species composition of historical catches has not changed considerably over time. By making this assumption, it allows a longer time series of catch and effort data to be constructed to assess the status of Hammer Octopus using historical ocean trawl catch-rate series.

Data collected from port monitoring of commercial catches in 2004/05, suggest that that Hammer Octopus accounted for only 45.7% of the total catch and Gloomy Octopus accounted for approximately 43.3% (Nottage et al. 2007). Insufficient detail is provided in the methods to determine how port monitoring data were scaled up to produce statewide species composition estimates (e.g., whether they were weighted according to the proportion of catch taken by different fishing methods across different ocean zones), but other data from the same study suggest that Hammer Octopus dominated catches from northern fishing zones, which is where the bulk of the prawn trawl landings are taken. Given the dominance of the prawn trawl sector as the main method of capture, it seems reasonable to assume that Hammer Octopus would be the main species landed by commercial fishers from NSW waters.

Octopus are also a permitted byproduct species of prawn trawling in Queensland, although catches are not separated according to species. In 2022, 23.5 t of undifferentiated octopus was reported taken from Queensland waters (QDAF unpublished data), of which some is likely to comprise Hammer Octopus, because the species' distribution extends well into southern Queensland and bycatch surveys indicate the species is common in east coast prawn trawl catches (Courtney *et al.*, 2007).

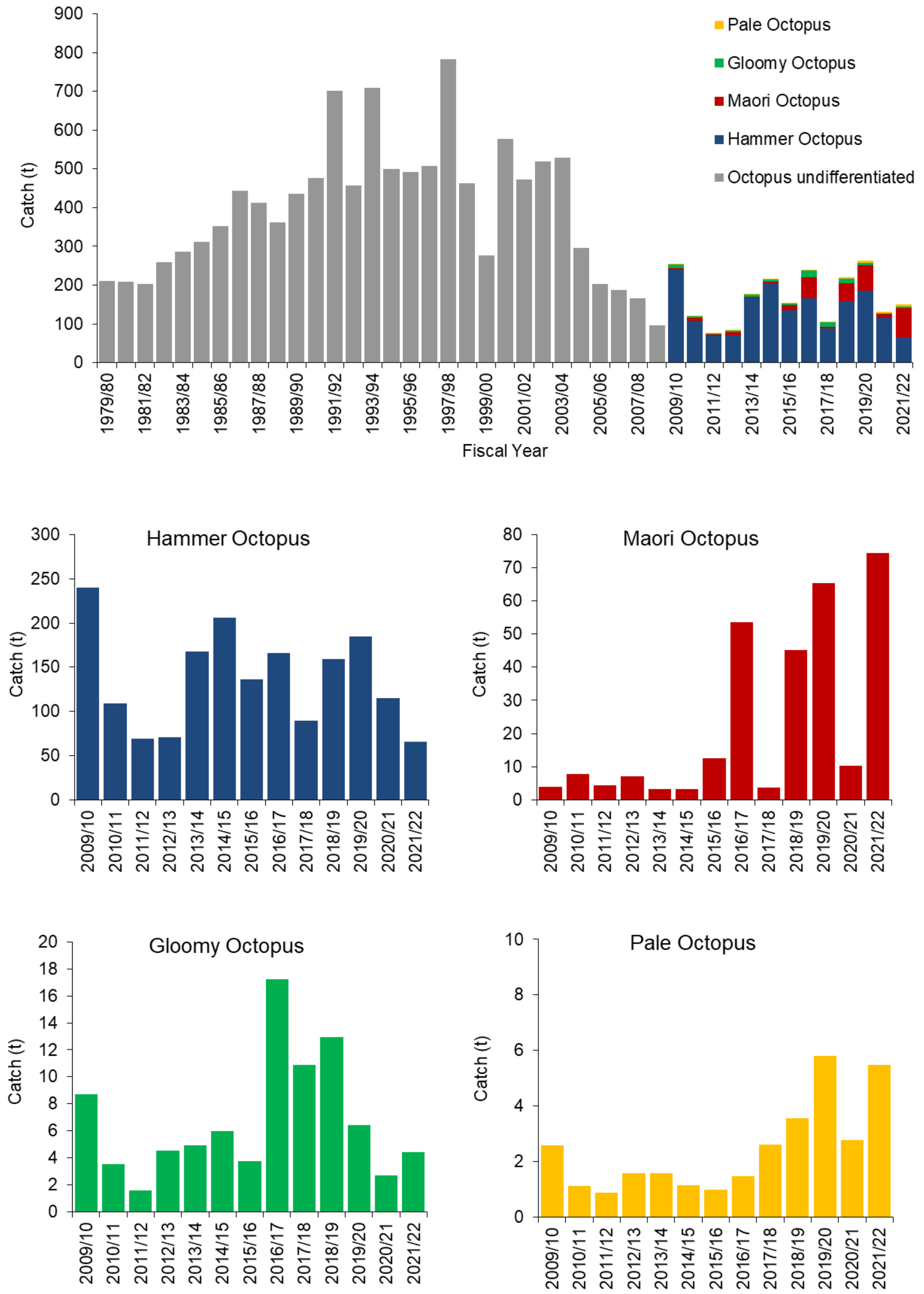


Figure 1. Annual commercial landings (tonnes) of combined octopus species for NSW waters from 1979/80 to 2008/09 for all fishing methods, and then by separate species from 2009/10 to 2021/22 (top graph). Separate trends in landings for individual octopus species since separate reporting started in 2009/10 are provided in the bottom four graphs.

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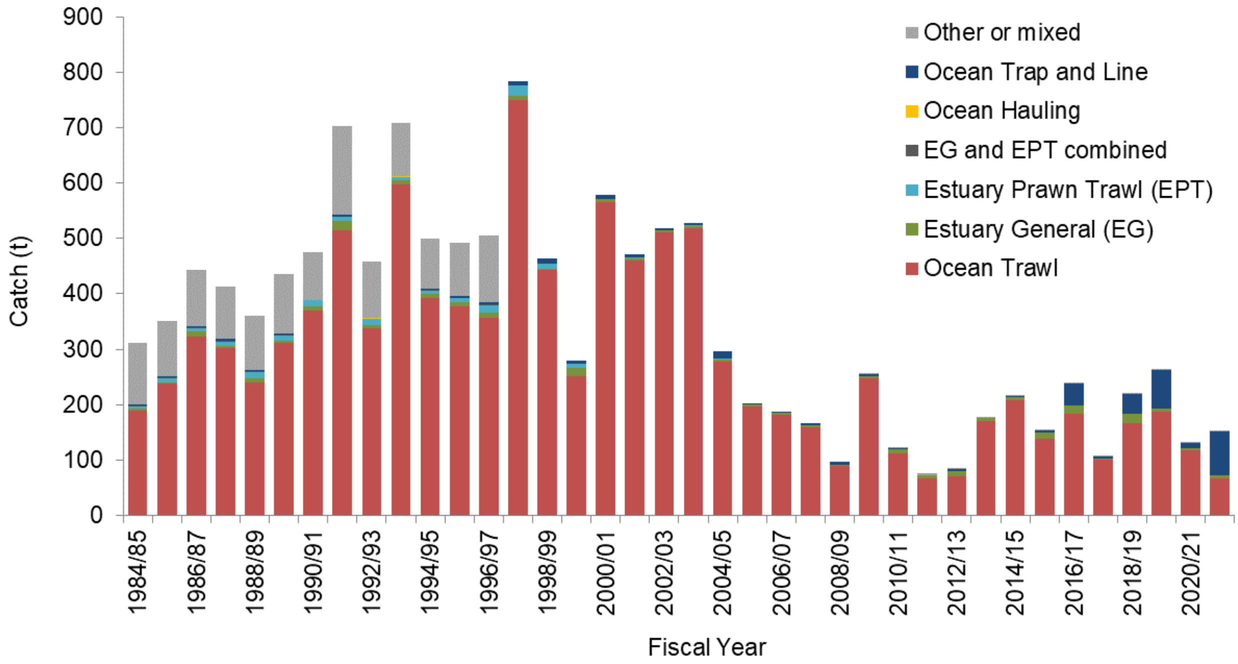


Figure 2. Annual commercial catches (tonnes) of combined octopus species by fisheries for NSW waters from 1984/85 to 2021/22. EG = Estuary General, EPT= Estuary Prawn Trawl.

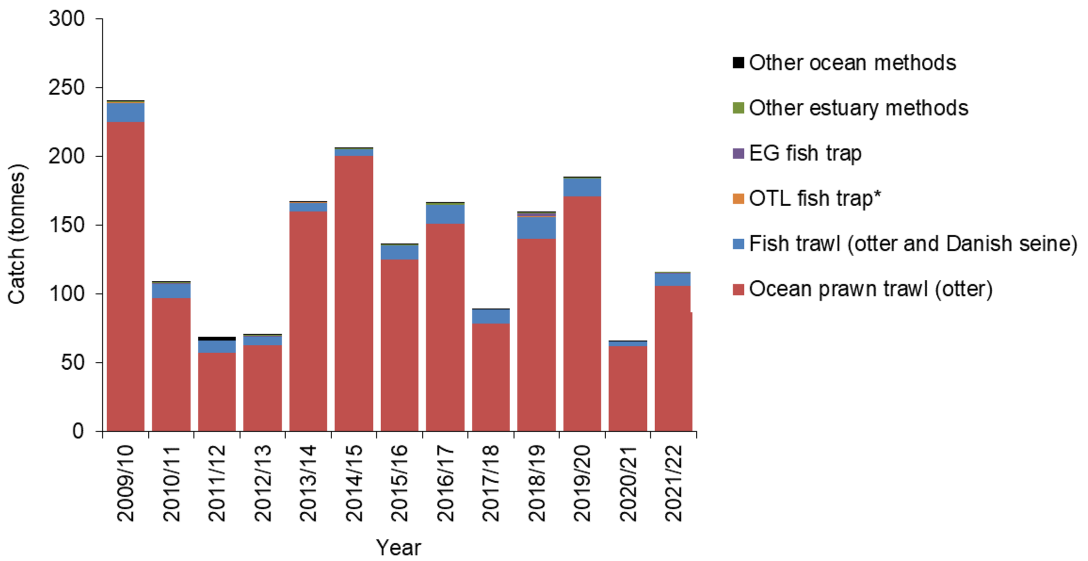


Figure 3. Annual commercial catches (tonnes) of Hammer Octopus by fishing sectors for NSW waters for years that separate species data are available (2009/10 to 2021/22). EG = Estuary General , OTL = Ocean Trap and Line.

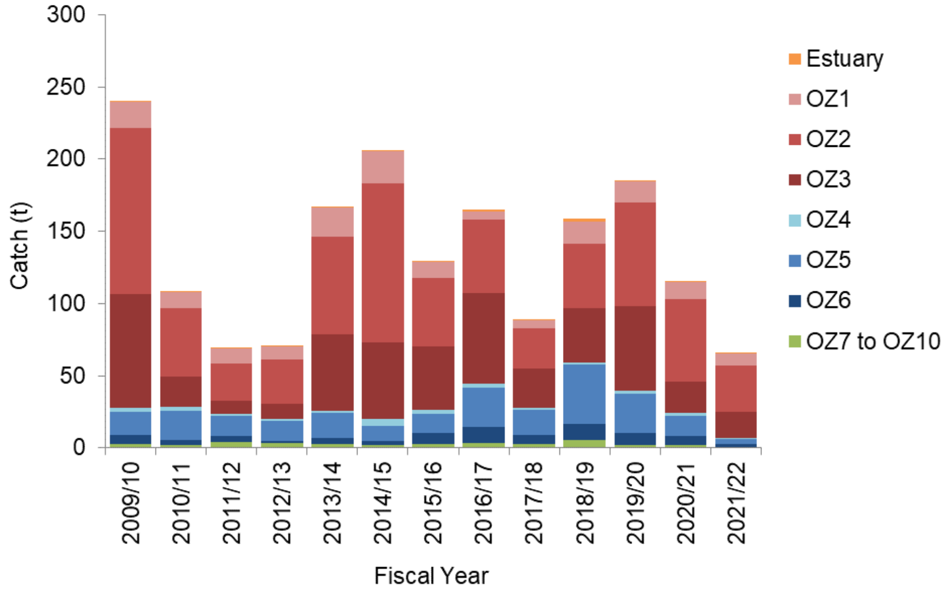


Figure 4. Annual commercial catches (tonnes) of Hammer Octopus by ocean zone (OZ) covering 1 degree of latitude from OZ1 in the north near the Queensland border to OZ10 in the south near the Victorian border, and combined estuary catches, for years that separate species data are available (2009/10 to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

## Recreational & Charter boat

The most recent estimate of the recreational harvest of combined octopus species in New South Wales was approximately 1 634 octopus during 2019–20, with an additional 2 241 octopus caught and released (Murphy *et al.*, 2022). The proportion of Hammer Octopus 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 larger at around 1 634 and 1 877 octopus harvested, with an additional 2 241 and 5 227 octopus caught and released, respectively (Murphy *et al.*, 2020). Relative to the total commercial catch, these recreational catches are very small (<1 per cent of the total state harvest).

## Aboriginal cultural fishery

A survey of Aboriginal cultural fishing in the Tweed River catchment identified octopus as a common component of the marine sub-littoral benthic invertebrate catches (Schnierer & Egan, 2016). However, it only accounted for 0.4% of the total Aboriginal catch from the area (Schnierer, 2011). Total catches in the region were estimated to range between 38–200 octopus per annum for combined octopus species (Schnierer, 2011). Statewide estimates of the annual Aboriginal harvest of octopus in NSW waters are unknown.

## Illegal, Unregulated and Unreported

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

## Fishing effort information

Commercial fishing effort for Hammer Octopus 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 Hammer Octopus was reported on at least one day.

In the ocean prawn trawl sector, reported effort for Hammer Octopus declined rapidly from over 18,000 days fished in the early 2000s to 6,499 days fished in 2008/09. Since then effort has declined more gradually to an estimated 3,916 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 Hammer Octopus in the fish trawl sector has decreased more gradually from 3,054 days fished in 1997/98 to 502 days fished in 2021/22 (Fig. 5). Overall current levels of fishing effort are well below historical levels reported prior to 2009/10.

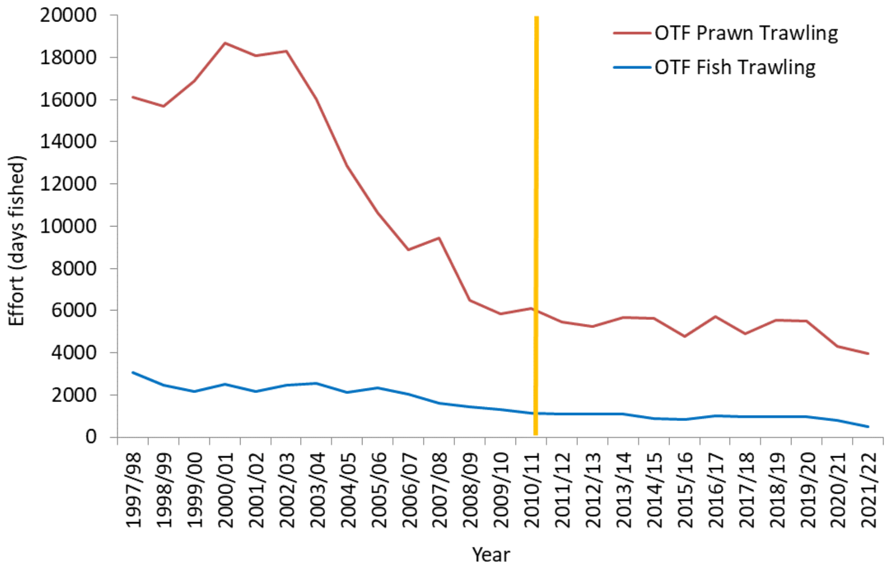


Figure 5. Annual adjusted effort (days fished) for ocean prawn trawl and fish trawl fishers of the NSW Ocean Trawl Fishery (including Southern Fish Trawl Fishery) that reported landing octopus on at least one day in each month (1997/98 to 2021/22). The gold vertical line indicates the change from monthly to daily catch reporting.

## Catch Rate information

Historical catch rates (catch-per-unit-effort, CPUE in kg per days fished) for combined octopus taken by the fish trawl and ocean prawn trawl sectors were compiled from monthly records between 1984/85 and 2008/09 and standardized for month, ocean zone and fishing business using the r-package ‘rforcpue’ (Haddon, 2023). Recent catch rates (CPUE in kg per hour trawled) for Hammer Octopus 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).

Historical catch rates of the ocean prawn trawl sector indicate a widely fluctuating trend, with gradual increases in catch rates over many years, followed by a sudden rapid decrease over one or a few years (Fig. 6). This pattern of abundance corresponds to anecdotal evidence from fishers, indicating that octopus catches suddenly decrease in trawl landings. Recent catch rates from daily records rapidly decreased between 2010 and 2013, increased significantly in 2014 and 2015, then decreased again until 2018 and have increased again until 2021. Current catch rates in 2022 were just below average (Fig. 6).

Standardised catch rates of the fish trawl sector show similar cyclical fluctuations, with recent catch rates decreasing between 2010 and 2013, increasing until 2016, decreasing for the following two years and increasing again until 2021 to be currently near the long-term average (Fig. 7). While there are some specific differences evident, the overall temporal trends in troughs and peaks in catch rates are roughly aligned between the two sectors.

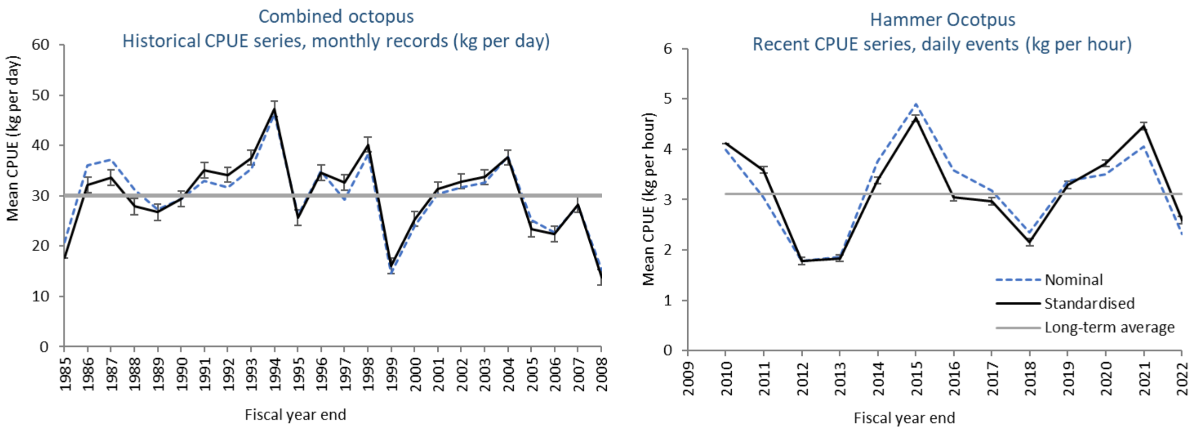


Figure 6. Mean standardised catch rates (catch-per-unit-effort, CPUE) for the ocean prawn trawl sector in the NSW Ocean Trawl Fishery, of combined octopus from monthly records (1984/85–2008/09) in kg per days fished (left graph) and Hammer Octopus from daily fishing event records (2009/10–2021/22) in 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.

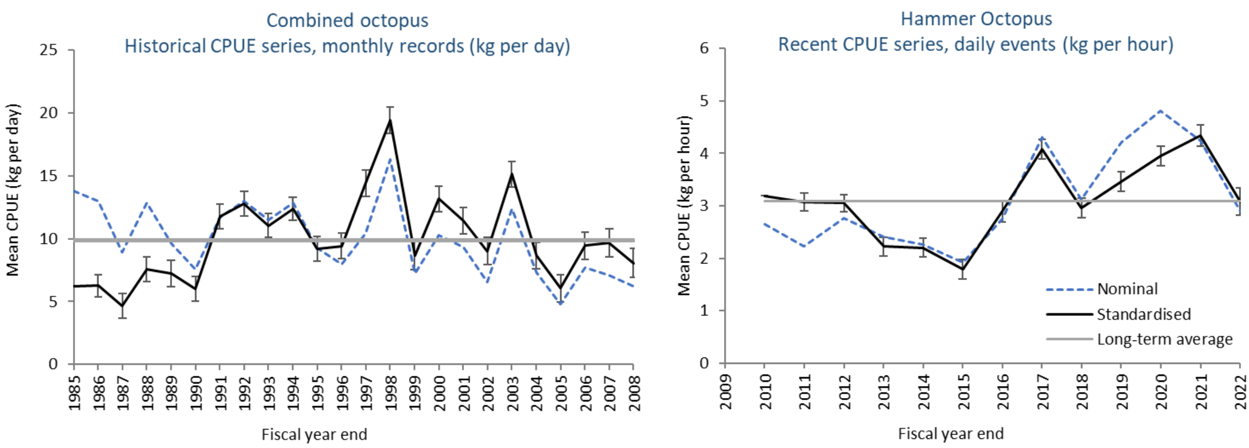


Figure 7. Mean standardised catch rates (catch-per-unit-effort, CPUE) for the fish trawl sector in the NSW Ocean Trawl Fishery, of combined octopus from monthly records (1984/85–2008/09) in kg per days fished (left graph) and Hammer Octopus from daily fishing event records (2009/10–2021/22) in kg per 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.

## STOCK ASSESSMENT

### Stock Assessment Methodology

Year of most recent assessment:

2023

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 Hammer Octopus 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 octopus species (1979/80–2008/09) and Hammer Octopus as a separate species (2009/10–2021/22).

Recreational catches – estimated annual catches for combined octopus 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 (1984/85–2008/09) 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 octopus species reported by the commercial OTF between 1997/98 and 2008/09 reflect trends in the Hammer Octopus 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

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| Biomass indicator or proxy | None specified in a formal harvest strategy.<br>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.<br>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.<br>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.<br>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

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| Biomass status in relation to Limit | Commercial catches of combined octopus steadily increased from around 200 tonnes (t) in the late 1970s to a peak of 783 t in 1997/98, but have fluctuated at much lower levels (76–256 t) since 2004/05.<br>Long-term trends in combined octopus catch rates of the fish trawl and prawn trawl sectors of the OTF suggest that catch rates have fluctuated considerably over the 22-year period. The integrity of these indices as a proxy for relative abundance is questionable because of the undue influence of catch reporting changes in July 1997 and July 2009 and the unknown species composition of historical data prior to 2009.<br>Recent catch rates for Hammer Octopus from daily records for both the fish trawl and prawn trawl sectors of the OTF have returned to levels near the |

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| | long-term average following four years of increasing catch rates between 2018 and 2021. Combined these data suggest that the abundance of octopus fluctuates considerably, but the current level of biomass of Hammer Octopus is unlikely to be recruitment impaired. |
| 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 the stock to become recruitment impaired. |
| Fishing mortality in relation to Target | Not assessed. |
| Current SAFS stock status | On the basis of the evidence above, Hammer Octopus is currently assessed as a **sustainable** 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 octopus 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 2021/22 and consequently fishing pressure on octopus.
- Comparison of species compositions in recent data as reported by commercial fishers and earlier port monitoring suggest there may be some ongoing species misreporting.
- Estimates of catches in other jurisdictions and for the recreational sector are only available for combined octopus 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 an index of relative abundance.
- Data assessed in this report date only as far back as 1979/80. Trawl fishing in NSW waters is known to have occurred since at least 1920. Even if octopus were not retained from trawling before 1979/80, they are still likely to have been caught by trawl gears as bycatch. Any potential historical discard or targeted mortality prior to 1979/80 has not been considered in this stock assessment.

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