Stock Status Summary 2021

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

Assessment Authors and Year

Hall, K.C. 2020. NSW Stock Status Summary 2018/19 – Hammer Octopus (*Octopus australis).* NSW Department of Primary Industries, Fisheries NSW, Coffs Harbour. 10 pp.

Stock Status

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

Stock Structure

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 and 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 and 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 and 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.

Stock Status – New South Wales

Catch Trends - Commercial Fisheries

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 and then returned

to over 500 t in 2000/01. Since 2004/05, catches have remained at a consistently lower level (76–256 t, 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 three years, catches of Maori Octopus (*Macroctopus maorum*) and Gloomy Octopus (*Octopus tetricus*) have also increased. The total commercial catch of Hammer Octopus in 2018/19 was 169.7 t.

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 (Hall 2018). 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 2014, 21 t of undifferentiated octopus was reported taken from Queensland waters (www.daf.qld.gov.au), 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).

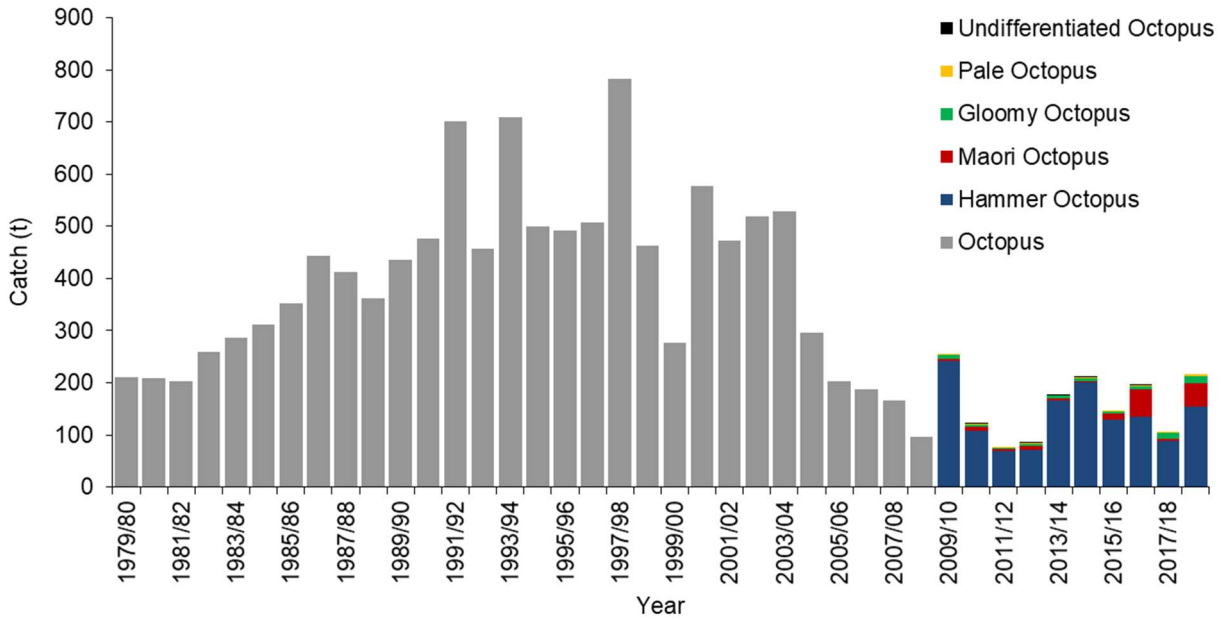

Figure 1. Annual commercial landings (tonnes) of combined octopus species for NSW waters from 1972/73 to 2009/10 for all fishing methods, and then by separate species from 2009/10 to 2018/19.

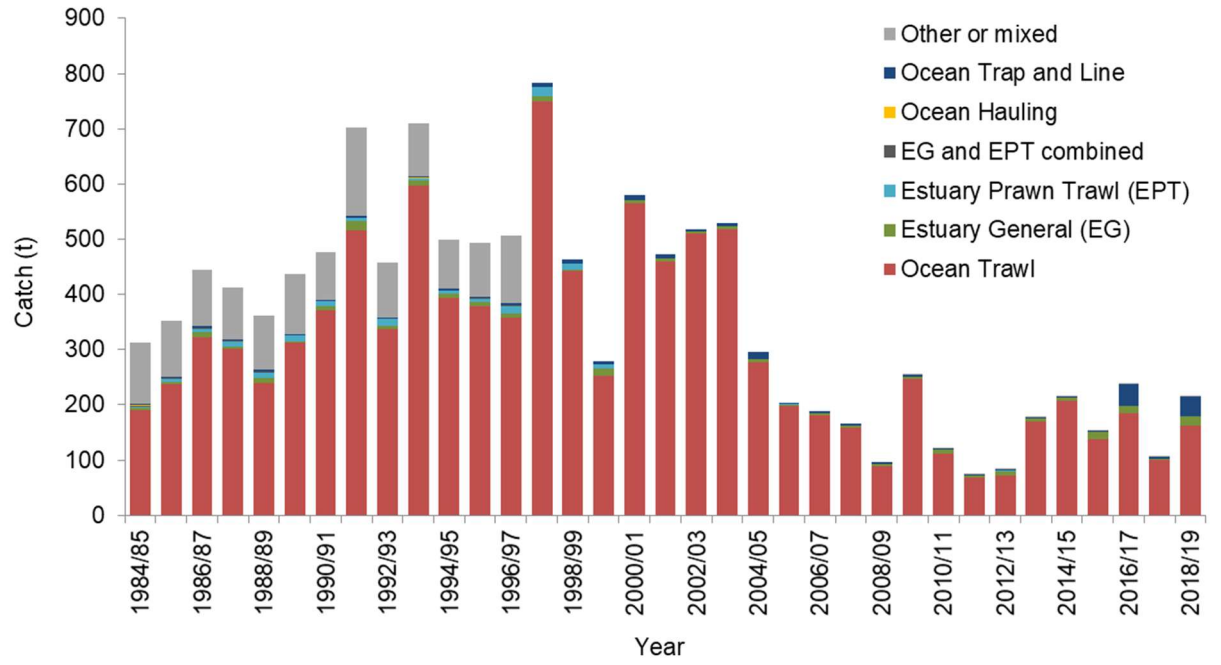

Figure 2. Annual commercial catches (tonnes) of combined octopus species by fisheries for NSW waters from 1972/73 to 2009/10. EG = Estuary General, EPT= Estuary Prawn Trawl.

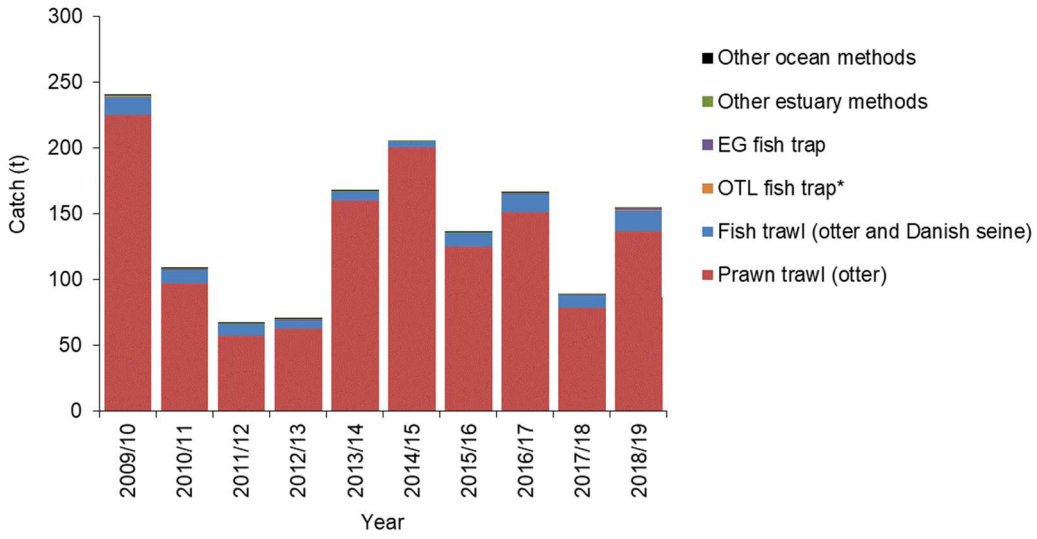

Figure 3. Annual commercial catches (tonnes) of Hammer Octopus by fishery sectors for NSW waters since separate species reporting of octopus began (2009/10 to 2018/19). EG = Estuary General , OTL = Ocean Trap and Line.

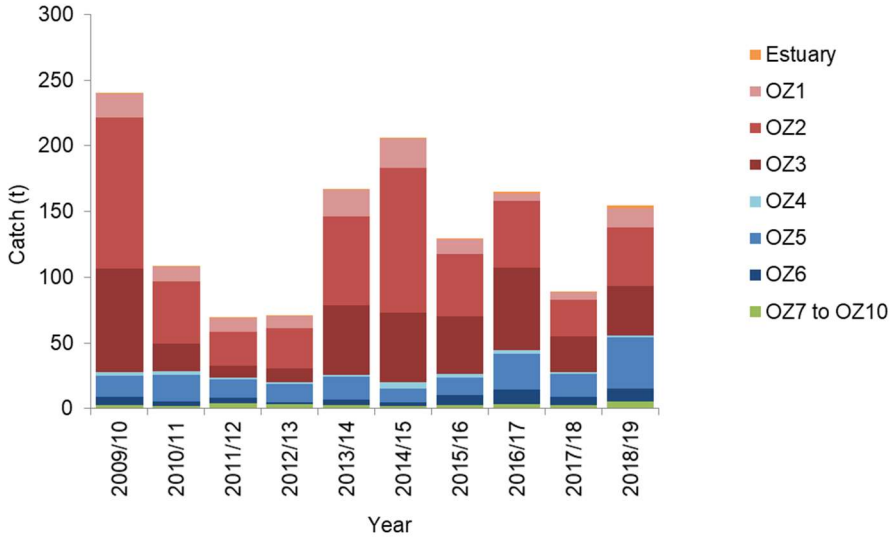

Figure 4. Annual commercial catches (tonnes) of Hammer Octopus in different ocean zones and combined estuaries (2009/10–2018/19).

Catch Trends - Recreational and Indigenous

The most recent estimate of the recreational harvest of combined octopus species in NSW was approximately 1,145 octopus during 2017/18, with an additional 2,700 octopus caught and released (Murphy et al. 2020). 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 estimated recreational harvest in 2013/14 was 1.6 times larger at around 1,877 octopus, with an additional 5,227 octopus caught and released (Murphy et al. 2020). Relative to the commercial catch, these recreational catches are estimated to be small (<1% of the total NSW harvest).

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 and 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.

Fishing Effort Trends - Commercial Fisheries

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; 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 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 5,518 days fished in 2018/19 (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 3,054 days fished in 1997/98 to 810 days fished in 2018/19 (Fig. 5). Overall current levels of fishing effort are well below historical levels reported prior to 2009/10.

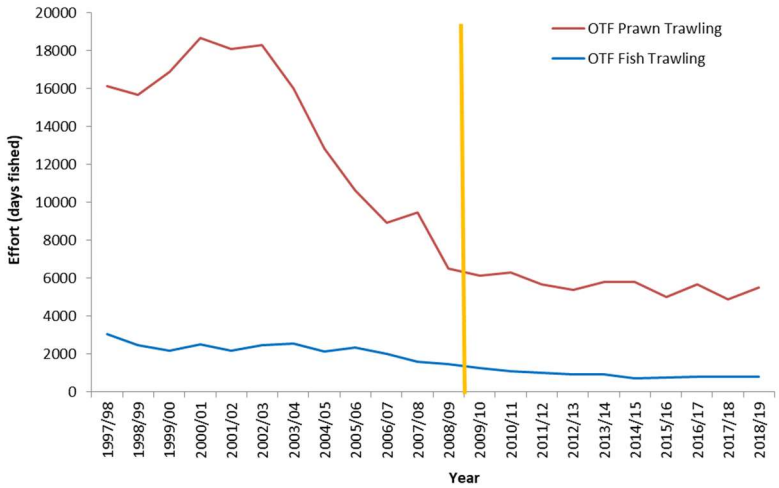

Figure 5. Annual adjusted effort (days fished) for ocean prawn trawl and fish trawl fishers of the NSW Ocean Trawl Fishery that reported landing Hammer Octopus on at least one day in each month. The gold vertical line indicates the change from monthly to daily catch reporting.

Catch Rate Trends - Commercial Fisheries

Monthly 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 1998 and 2009 and re-aggregated daily records for Hammer Octopus as a separate species between 2010 and 2019. Catch rates were standardized for month, ocean zone and vessel using the r-package 'cede' (Haddon 2018). 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 Hammer Octopus were also compiled from daily fishing event records from 2010

to 2019 and standardised for month, ocean zone, vessel and capture depth (taken from the mean depth of the reported c-square).

Monthly catch rates of the ocean prawn trawl sector indicate a widely fluctuating trend, with gradual increases in catch rates over many years, followed by sudden rapid decreases 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. All CPUE time series, monthly and daily, suggest that recent catch rates rapidly decreased between 2010 and 2013, increased significantly in 2014, then gradually decreased until 2018 and have increased again in 2019 to near the long-term averages (Fig. 6).

Monthly catch rates of the fish trawl sector fluctuated below the long-term average prior to 2009, and then have fluctuated near or above the long-term average since (Fig. 7). However, when analysed as a separate series, recent catch rates show a similar trend to those for the ocean prawn trawl sector, with catch rates decreasing between 2010 and 2013, increasing until 2016, decreasing for the following two years and increasing again in 2019 to be currently near the long-term average (Fig. 7). While there are some specific differences evident in the historical series, the overall temporal trends in troughs and peaks in the catch rates are aligned between the two sectors.

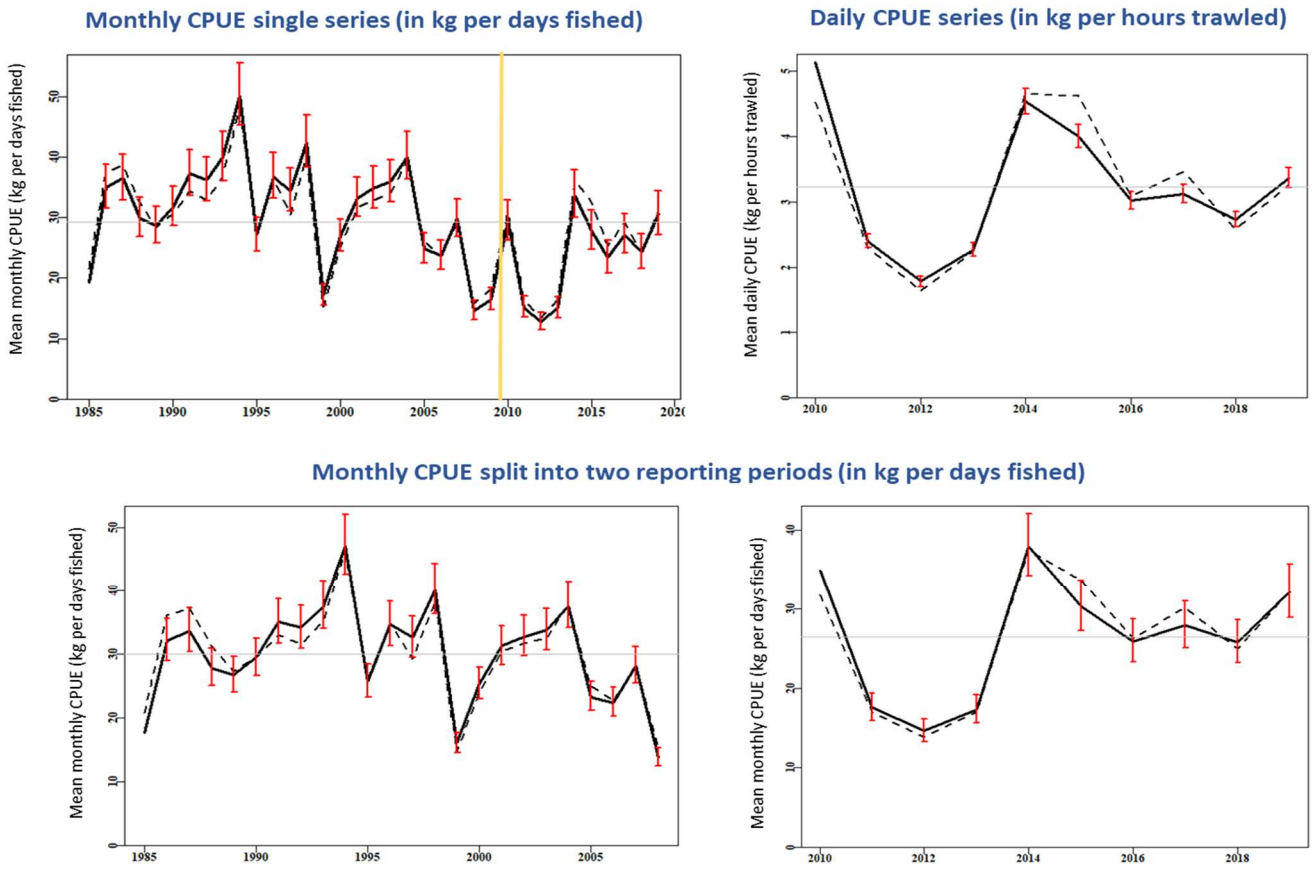

Figure 6. Mean standardised catch rates (catch-per-unit-effort, CPUE) for the ocean prawn trawl sector in the NSW Ocean Trawl Fishery, of combined octopus from monthly records (1998–2009) and Hammer Octopus from re-aggregated daily records (2010–2019) in kg per days fished (top left and bottom) and Hammer Octopus from daily fishing event records in kg per hours trawled (top right). The dashed and solid lines indicate the nominal and standardised mean CPUE, respectively; the gold vertical line indicates the change from monthly to daily catch reporting and the grey horizontal line indicates the long-term averages for each series.

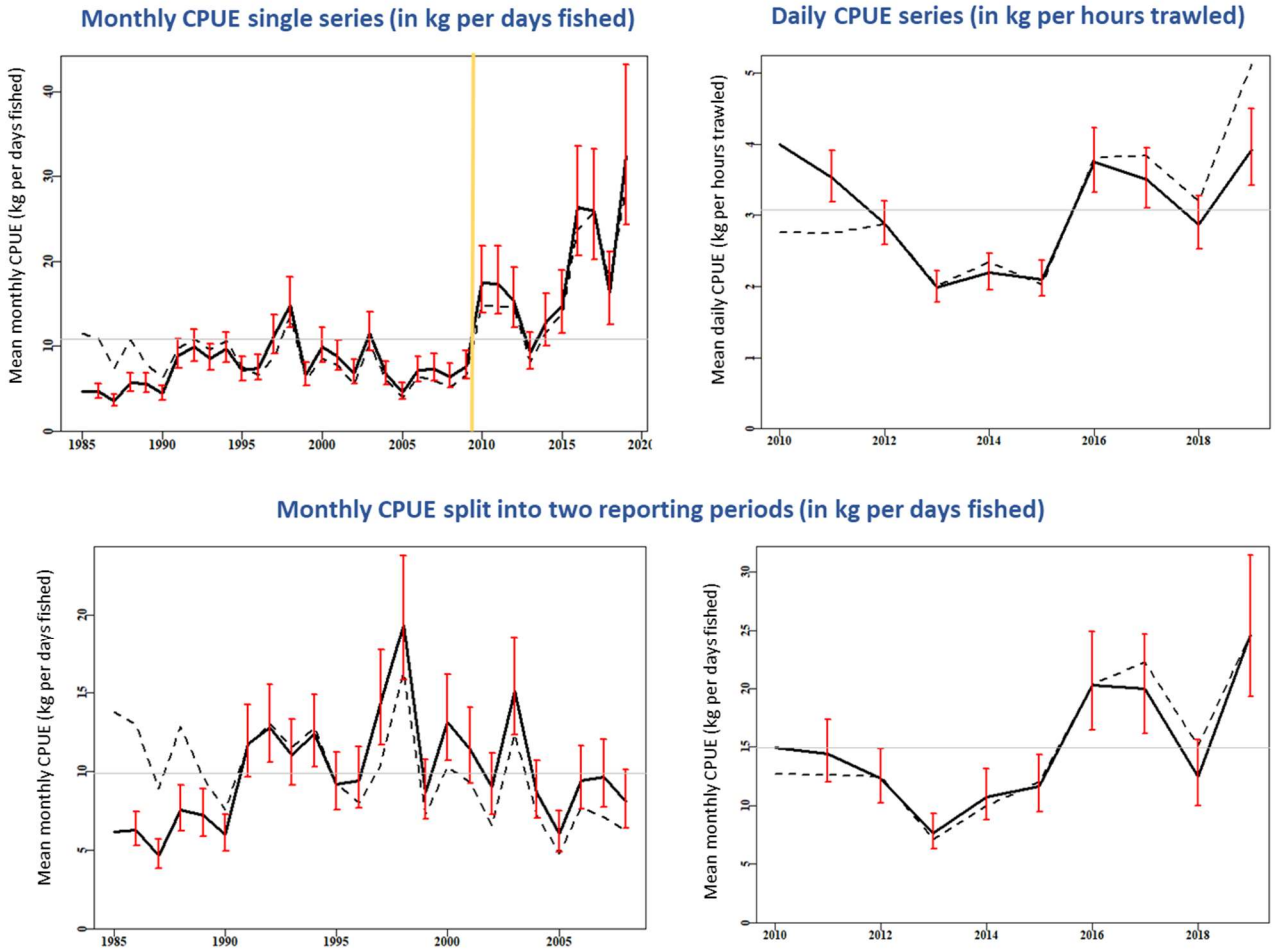

Figure 7. Mean standardised catch rates (catch-per-unit-effort, CPUE) for the fish trawl sector in the NSW Ocean Trawl Fishery, of combined octopus estimated from monthly records (1998–2009) and Hammer Octopus from re-aggregated daily records (2010–2019) in kg per days fished (top left and bottom) and Hammer Octopus from daily fishing event records in kg per hours trawled (top right). The dashed and solid lines indicate the nominal and standardised mean CPUE, respectively; the gold vertical line indicates the change from monthly to daily catch reporting and the grey horizontal line indicates the long-term averages for each series.

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 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 (1984/85–2008/09) and Hammer Octopus as a separate species (2009/10–2018/19). Recreational catches – estimated annual catches for combined octopus species from three periods – national recreational and indigenous fishing survey (2000/01) and NSW recreational fishing surveys (2013/14 and 2017/18). 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 (1985–2019) 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 (2010–2019) from daily records – standardised.
Key model structure and 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, vessels 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 1984/85 and 2008/09 comprised mostly Hammer Octopus, and that the species composition has not changed significantly over time.
Sources of uncertainty evaluated	Changes in fishing effort distribution following catch reporting changes from monthly to daily event reporting in July 2009.

Status Indicators and Limit Reference Levels

Biomass indicator or proxy	None specified in a formal harvest strategy. In the interim, for the purposes of this assessment 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 Level	None specified in a formal harvest strategy. In the interim, for the purposes of this stock assessment current catch rates were assessed relative to long-term averages of each time series.

Fishing mortality indicator or proxy	None specified in a formal harvest strategy. In the interim, for the purposes of this assessment 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 Level	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.

Stock Assessment Results

Biomass status in relation to limit	Long-term trends in 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, but are currently near the long-term average. 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. Recent catch rates for Hammer Octopus from daily records for both the fish trawl and prawn trawl sectors of the OTF have recently returned to levels near the long-term average after a significant decrease between 2010 and 2013. Combined these data suggest that the current level of biomass of Hammer Octopus is unlikely to be recruitment impaired.
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.
Previous SAFS stock status	Hammer Octopus was previously assessed in NSW as a **sustainable stock** using the same criteria as the SAFS framework in 2018 (Hall 2018).
Current stock status	On the basis of the evidence above, Hammer Octopus is currently assessed as a **sustainable** stock.

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 2018/19 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.
- 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 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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