

Eastern School Whiting (*Sillago flindersi*)

Karina Hall (2024)

This stock status summary report, summarises information from the combined Trawl Whiting stock assessment report:

Hall, K. C. 2024. Stock assessment report 2023/24 – Eastern School Whiting (*Sillago flindersi*) and Stout Whiting (*Sillago robusta*). NSW Department of Primary Industries, Fisheries Research: 89 pp.

Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Eastern School Whiting is currently assessed as a sustainable stock for the NSW part of the stock.
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Stock structure & distribution

Eastern School Whiting (*Sillago flindersi*, CAAB 37 330014) is a temperate inshore demersal finfish species that occurs in oceanic waters to a depth of about 100 m, from southern Queensland to South Australia, and including north-eastern Tasmania. The species is currently considered and assessed as a single, genetically diverse panmictic stock on the Australian mainland, with some genetic differentiation of Tasmanian populations (Hall *et al.*, 2021).

Scope of this assessment

This assessment of the stock status of Eastern School Whiting was completed according to the Status of Australian Fish Stocks (SAFS) criteria (Pidcocke *et al.*, 2021), using data up to and including 2022 (and 2023 in some analyses) in calendar years. Where necessary data for Eastern School Whiting were adjusted or combined with data for Stout Whiting (*Sillago robusta*), to support determination of a combined trawl whiting total allowable catch (TAC) in New South Wales (NSW) for the 2024-25 fishing season (1 May to 30 April). The assessment refers to the NSW Trawl Whiting Harvest Strategy (NSW DPI, 2022). For the 2023-24 fishing season, the combined NSW TAC for trawl whiting was set at 1,066 t.

The Eastern School Whiting stock is shared with Commonwealth, Victorian, Tasmanian and South Australian fisheries, with an independently managed Commonwealth TAC in place since 1993 and managed according to the Harvest Strategy Framework for the Southern and Eastern Scalefish and Shark Fishery (SESSF) (AFMA, 2021). For the 2023-24 fishing season (1 May to 30 April), the Commonwealth TAC for Eastern School Whiting was set at 914 t.

A quantitative stock assessment of the entire biological Eastern School Whiting stock is completed by Commonwealth agencies every 3-5 years, with a significant input of NSW data, including two standardised CPUE series, historical length and age data and discard rate estimates (Day *et al.*, 2020). The most recent update of the full assessment was completed in 2020 using data up to 2019, so the current year was considered an 'interim

year' for stock assessment purposes. This report summarises existing information on primary indicators and updates fisheries statistics and data for a range of secondary indicators according to the NSW harvest strategy.

The assessment results for Eastern School Whiting are presented here at the biological stock level – south-eastern Australia; however, the conclusions and stock status are derived independently by NSW DPI to support catch quota setting and management for the NSW part of the stock and do not reflect a cross-jurisdictional consensus (as for the national SAFS assessments). The most recent update of the national SAFS assessment occurred in 2023, with Eastern School Whiting assessed as a **sustainable stock** (Hall *et al.*, in press).

Biology

Eastern School Whiting is a relatively fast-growing and short-lived species, reaching a maximum recorded age of 9 years (Day, 2017). While it reaches a maximum size of about 32 cm fork length (FL), few individuals in commercial catches exceed 25 cm FL (Gray *et al.*, 2014a). Maturity occurs at about 2 years of age and 15 cm in length (Gray *et al.*, 2014b), although age and size at maturity and spawning season may show some latitudinal variation (Day, 2017).

Fishery statistics

Catch information

Commercial

Annual commercial catches of Eastern School Whiting in NSW state waters (following adjustment for inaccurate species reporting in northern NSW) peaked at 1,167 t in 1998 and remained above 700 t until 2012, after which catches decreased to a recent minimum of 494 t in 2014 (Fig. 1). Over subsequent years, catches rapidly increased to above 1,100 t in the three years leading up to quota introduction, and then have decreased to 507 t in 2021 and 578 t in 2022 following quota introduction. A catch of 761 t has already been reported in 2023, before the year has finished, so a larger total is expected this year (Fig. 1).

Most of commercial catch of Eastern School Whiting from NSW waters is taken by fish and ocean prawn trawlers in the Ocean Trawl Fishery (OTF) and Southern Fish Trawl Restricted Fishery (SFT) (Fig. 2). A small number of NSW Danish seine operators have also targeted trawl whiting in NSW since 2010 and these catches have been those from the fish trawlers are collectively referred to as the 'fish trawl sector'. Historically, Eastern School Whiting catches were larger for the ocean prawn trawl sector than the fish trawl sector and showed latitudinal variation across ocean zones (OZ1 to OZ10, north to south along the coastline), with larger catches in the north (OZ1 to OZ4) where the prawn trawl sector mainly operates (Figs 2 and 3). However, since 2007 this trend has gradually reversed, with recent fluctuations in the commercial catches largely influenced by northern fish trawl catches from OZ5 (Figs 2 and 3).

Eastern School Whiting is also targeted by Danish seine and trawl vessels in the Commonwealth SESSF in offshore waters (>3 nm from the coastline) south of Barrenjoey Point (Fig. 4). Total Commonwealth catches (based on CDR data, not including discards) were 550.3 t in 2020, 497.2 t in 2021 and 456.6 t in 2022 (Burch *et al.*, 2023). Recent Commonwealth TACs have been considerably under-caught. Much smaller commercial catches are also taken by trawl vessels in Victorian and Tasmanian state waters that on average account for less than 2% of the total catch (Burch *et al.*, 2023).

Total commercial discards across all jurisdictions are estimated as part of the Commonwealth Tier 1 stock assessment modelling, which was updated in 2020 using data up to and including 2019 (Day *et al.*, 2020). Total discards were estimated to be 388 t in 2020 assuming a total catch of 1,752 t (actual catch was 1,379 t) and 370 t in 2021 assuming the estimated recommended biological catch (RBC) of 2,140 t was fully caught.

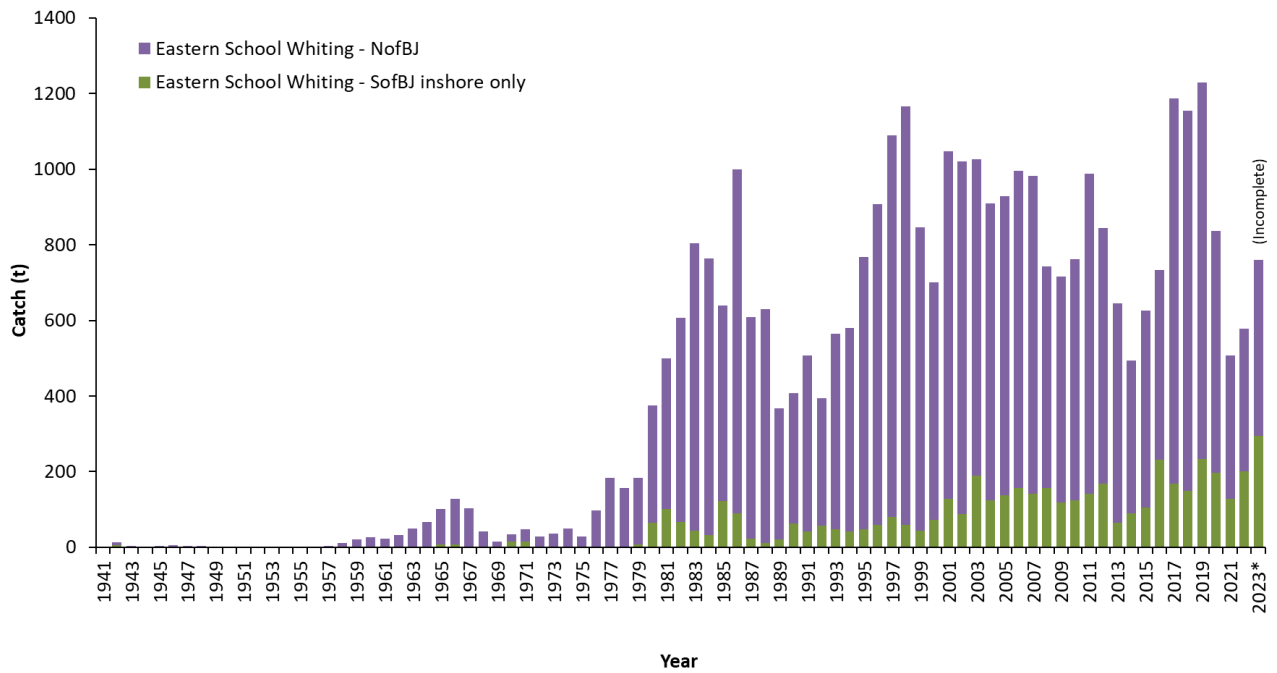


Figure 1 Annual adjusted commercial catches (tonnes) of Eastern School Whiting in NSW state waters (1941–2023). Estimated amounts taken north and south of Barrenjoey Point (NofBJ, SofBJ) are indicated. Catches have been adjusted for inaccurate species reporting in northern NSW and only oceanic ‘mixed whiting’ catches have been included. *Data for 2023 are incomplete.

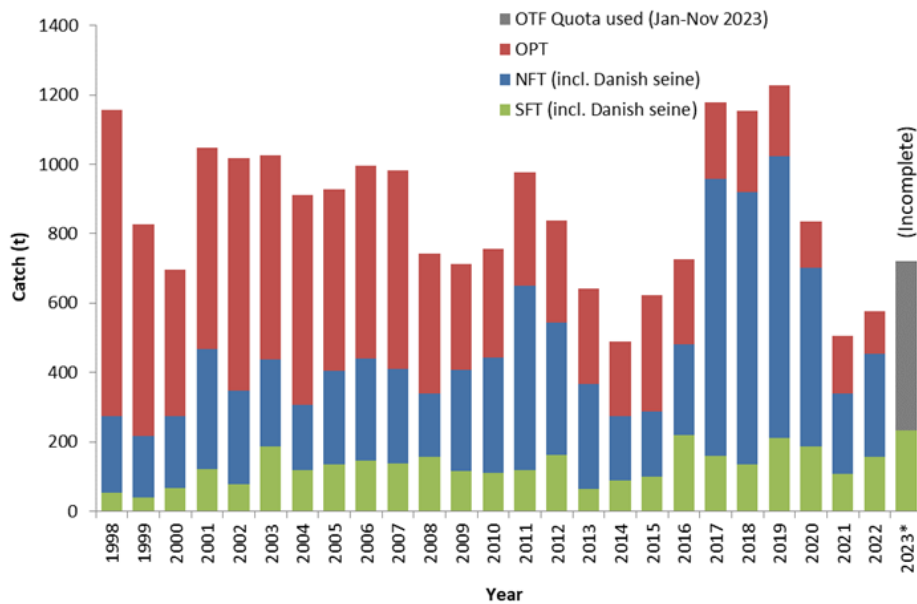


Figure 2 Annual adjusted commercial catches (tonnes) of Eastern School Whiting in NSW waters (1998–2023) for different sectors and endorsements in the NSW Ocean Trawl Fishery (OPT=ocean prawn trawl, NFT=northern fish trawl, SFT=southern fish trawl). *Data for 2023 are incomplete and the estimated quota used north of Barrenjoey Point for January to November is indicated instead (grey bar).

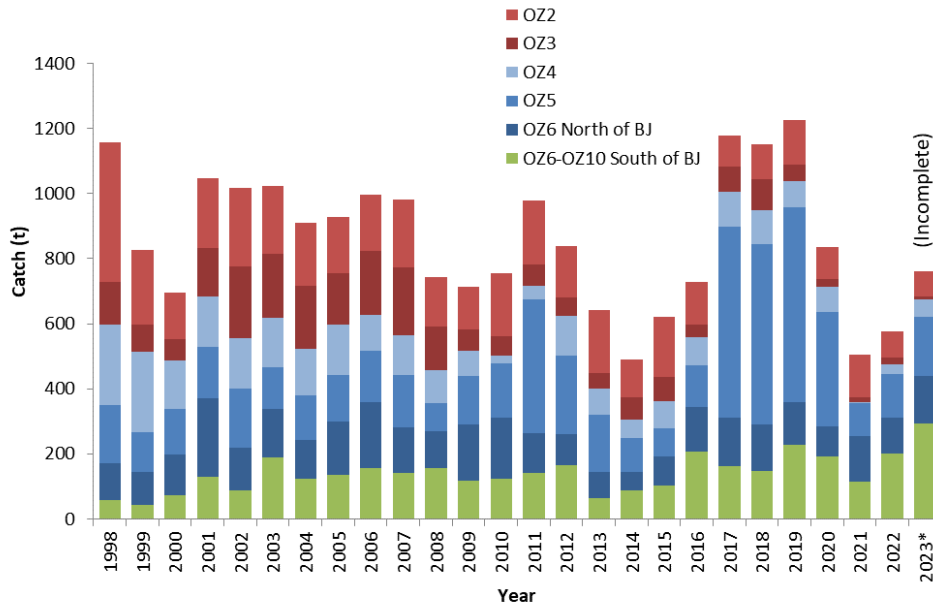


Figure 3 Annual adjusted commercial catches (tonnes) of Eastern School Whiting from the NSW Ocean Trawl Fishery (1998–2023) reported in different fishing zones (OZ1–OZ10) covering one degree of latitude each from north to south. Catches in OZ6 were divided into amounts taken from north and south of Barrenjoey Point (BJ) and for zones south of BJ data were aggregated for confidentiality reasons. *Data for 2023 are incomplete.

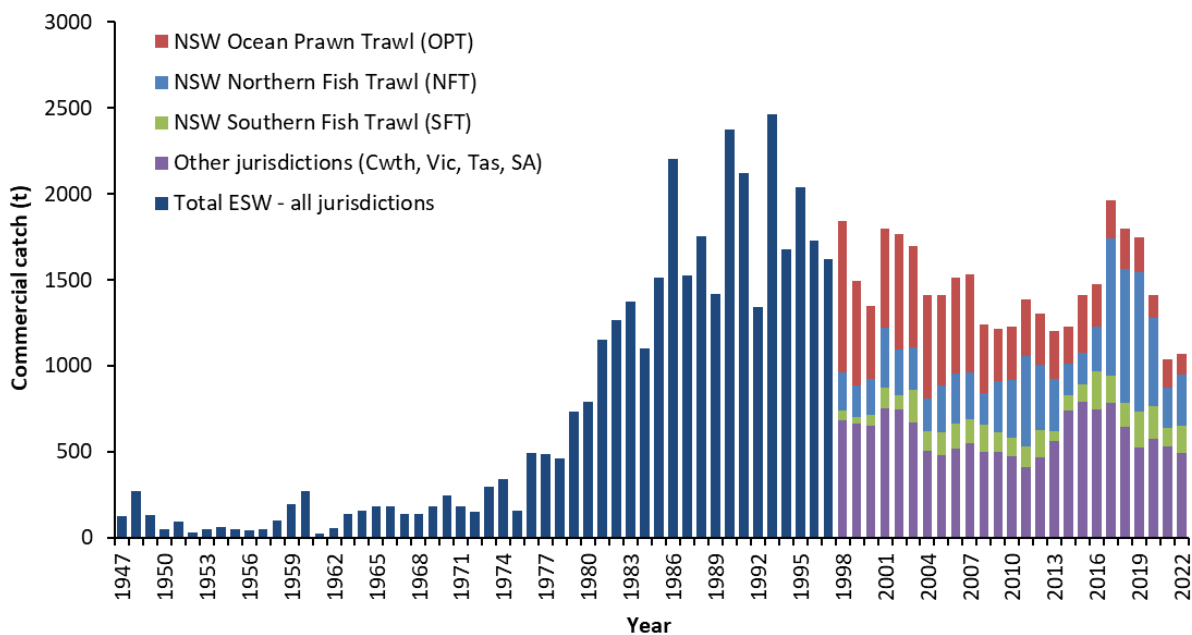


Figure 4 Annual adjusted commercial catches (tonnes) of Eastern School Whiting (ESW) for all jurisdictions combined (1947–1997) including Commonwealth (Cwth), Victorian (Vic), Tasmanian (Tas) and South Australian (SA) waters. NSW data are separated by sectors of the NSW Ocean Trawl Fishery relative to the combined catches of other jurisdictions (1998–2022). Data for other jurisdictions are from Day et al. (2020) and Burch et al. (2023).

Recreational & Charter boat

Estimates of recreational catches of combined trawl whiting (Eastern School Whiting and Stout Whiting) from NSW waters are based on biennial telephone surveys 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, excluding other long-term licence holders. In all recent surveys, reports of trawl whiting catches have been rare (~0.1% of surveyed households reported trawl whiting catches in the most recent survey) and consequently estimates have a high standard error (SE) and questionable reliability. The most recent estimate of the recreational harvest of combined trawl whiting in NSW was approximately 259 (± 257 SE) fish or around 0.04 t during 2021/22 (Murphy et al., unpub. data), which was considerably smaller than in previous surveys: 9,882 ($\pm 4,040$) fish in 2019/20, 10,933 ($\pm 8,016$) fish in 1917/18 and 4,995 ($\pm 2,078$) fish in 2013/14 (West et al., 2015; Murphy et al., 2020, 2022). Irrespective of the data quality, recreational catches are clearly negligible relative to commercial catches, comprising approximately 0.1% of the total harvest of trawl whiting from NSW waters.

Eastern School Whiting and Stout Whiting are also rarely reported in logbook catches of the NSW Charter Boat Fishery and these catches are similarly considered insignificant in comparison with commercial catches (Gray and Kennelly, 2016; Hughes *et al.*, 2021).

Indigenous

The annual Aboriginal harvest of Eastern School Whiting in NSW waters is currently unknown, but is also assumed to be small and to have a negligible impact on the stock biomass.

Illegal, Unregulated and Unreported

The level of illegal, unregulated and unreported fishing is unknown; however, there is considerable inaccurate reporting to individual trawl whiting species on catch returns, particularly in northern NSW waters. Data in OZ1 and OZ2 have been adjusted accordingly, which affects total catch amounts for each species. In addition, large quantities of trawl whiting catches in 2016–2018 were reported without accurate location information and other large catches in 2019 and 2020 on the south coast in OZ8 were deemed invalid and have been partially removed from total catches.

Fishing effort information

Commercial fishing effort for Eastern School Whiting was collected as number of days fished on monthly records prior to July 2009 and as number 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 fisher days estimated from the number of fishing events entered for each fisher in each month where Eastern School Whiting was reported on at least one day.

The annual reported effort for Eastern School whiting by the prawn trawl sector declined rapidly from 12,467 fisher days in 1998 to 4,023 fisher days in 2009 (Fig. 5). After the reporting change to daily event records in July 2009, effort became more stable between 2010 and 2018, after which it declined rapidly following structural reforms and quota introduction in 2019. Prawn trawl effort for Eastern School Whiting was 2,074 fisher days and 12,193 fisher hours in 2022 (Fig. 5). In contrast, reported effort for Eastern School Whiting in the fish trawl sector remained fairly stable during the early 2000s with a peak of 3,025 fisher days in 2002, but declined rapidly between 2006 and 2010 (Fig. 6). Following a slight increase just prior to quota introduction, fish trawl effort rapidly declined again to just 735 fisher days and 4,937 fisher hours in 2022. Although data are still incomplete for 2023, fish trawl effort appears to have increased to 5,865 fisher hours; whereas, prawn trawl effort has declined further to 9,780 fisher hours (Figs 5 and 6).

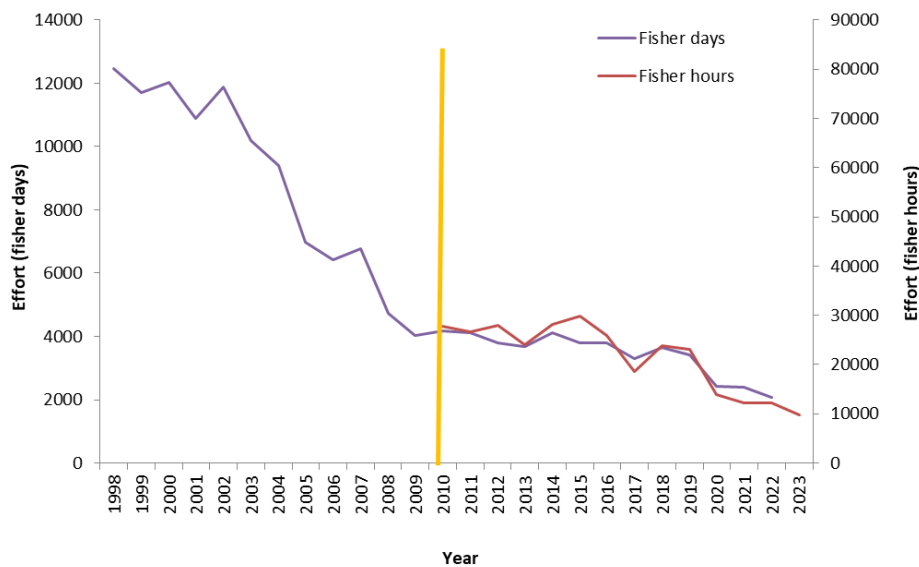


Figure 5 Annual adjusted effort (fisher days and fisher hours) for all prawn trawl fishers that reported landing Eastern School Whiting (ESW) on at least one day in any given month. *Data for 2023 are incomplete.

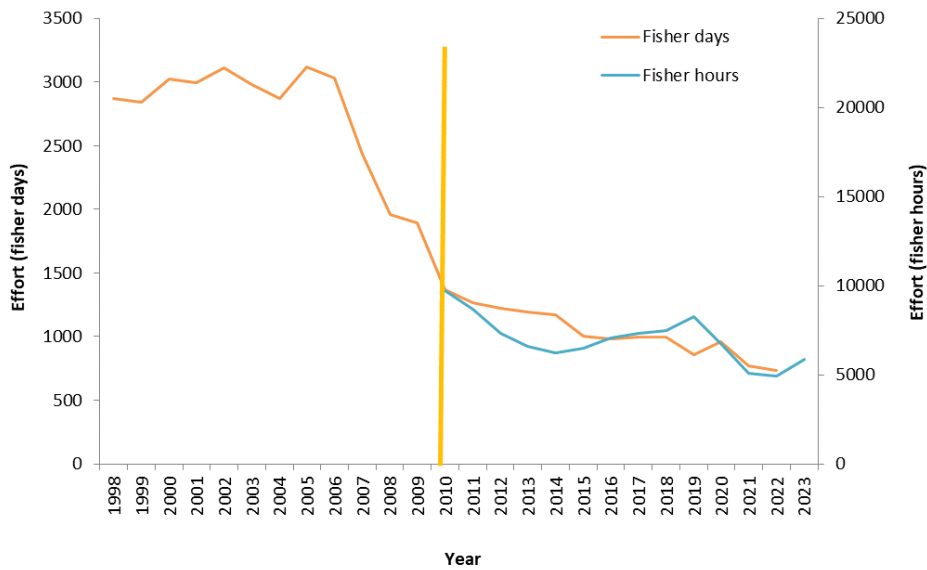


Figure 6 Annual adjusted effort (fisher days and fisher hours) for all fish trawl fishers that reported landing Eastern School Whiting (ESW) on at least one day in any given month. *Data for 2023 are incomplete.

Catch-rate information

Standardised catch rates (catch-per-unit-effort, CPUE) for Eastern School Whiting taken by the fish trawl (excluding Danish seine) and ocean prawn trawl sectors were compiled from monthly records (in kg per day) between 1998 and 2008 and daily event records (in kg per hour) between 2010 to 2023.

The mean standardized catch rates of Eastern School Whiting are consistently lower in the prawn trawl sector compared to the fish trawl sector (Figs 7 and 8). The two sectors operate in mostly different ocean zones, use different gears and vary in their targeted fishing practices, which account for these differences. The temporal trends in the two series over the last 22 years also vary.

Historical catch rates of the prawn trawl sector (averaged across the State) rapidly declined between 1998 and 2000 to more than 50% below the long-term average, then steadily increased over the next 8 years to be well above the historic average in 2008 (Fig. 7). This suggests that the stock in northern NSW may have initially declined following the peak catches in the late 1990s, but then recovered. However, during the 2000s, changes to legislated whiting codend configurations may have also influenced catch rates (Graham *et al.*, 2009). Trends in more recent mean CPUE show a decrease from 2010 to 2014, a spike in 2015 and then a return to above-average levels between 2019 and 2021. Over the last 2 years, however, catch rates have decreased to end below average in 2023 (Fig. 7).

Historical catch rates of the fish trawl sector (averaged across the State) fluctuated around the long-term average in the early 2000s and then steadily increased after 2004 to a peak in 2008 (Fig. 8). More recent mean CPUE decreased between 2011 and 2013, followed by an upward trend and has been above average over the last 4 years (Fig. 8).

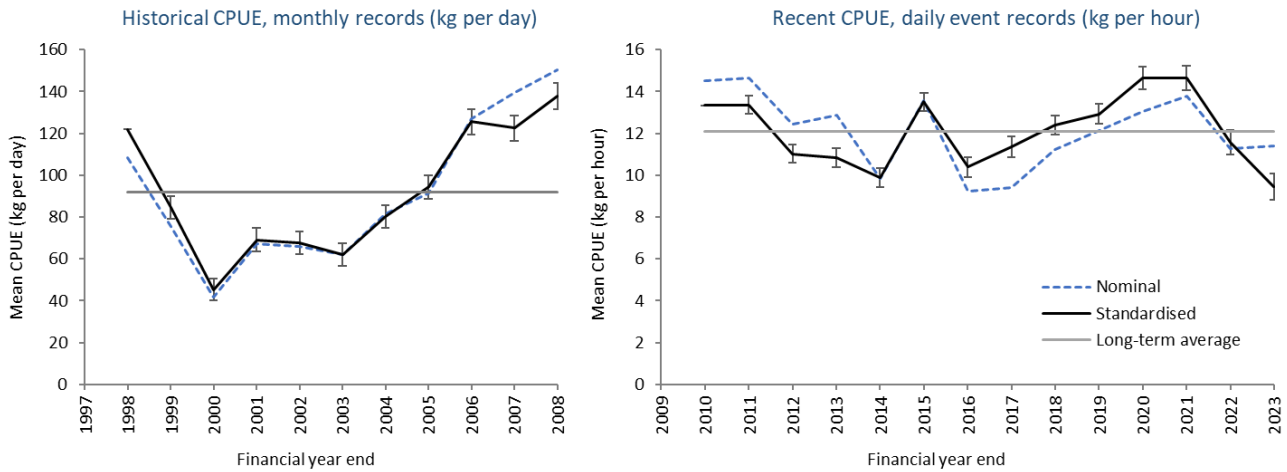


Figure 7 Mean standardised catch rates (catch-per-unit-effort, CPUE) of Eastern School Whiting for the ocean prawn trawl sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1998–2009) in kg per day and from daily event records (2010–2023) in kg per hour. Data for 2023 are incomplete. The dashed and solid lines indicate the nominal and standardised mean CPUE (\pm 95% confidence intervals), respectively; and the grey horizontal line indicates the long-term average for each series.

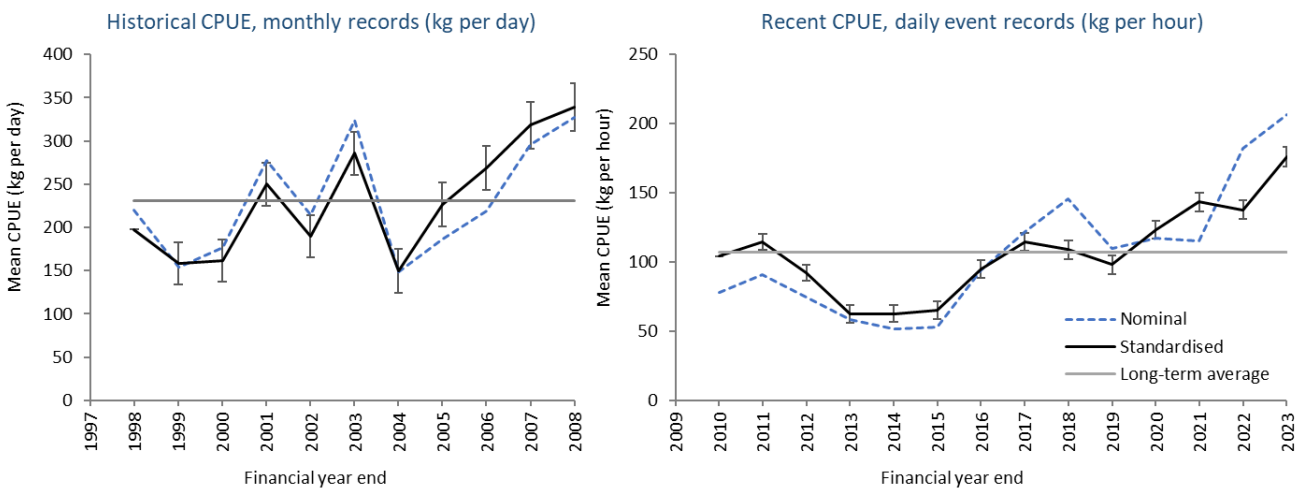


Figure 8 Mean standardised catch rates (catch-per-unit-effort, CPUE) of Eastern School Whiting for the fish trawl sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1998–2009) in kg per day and from daily event records (2010–2023) in kg per hour. Data for 2023 are incomplete. The dashed and solid lines indicate the nominal and standardised mean CPUE (\pm 95% confidence intervals), respectively; and the grey horizontal line indicates the long-term average for each series.

Stock Assessment

Stock Assessment Methodology

The NSW Trawl Whiting Harvest Strategy outlines primary indicators of spawning stock biomass depletion relative to unfished spawning stock biomass for each species, and also includes a range of secondary indicators that are to provide supplementary information to apply decision rules in interim years (NSW DPI, 2022). The most recent quantitative stock assessment for Eastern School Whiting was completed in 2020, so this year is considered an interim year for stock assessment purposes. Therefore, the following assessment summarises available information on the primary spawning stock biomass indicators and assesses updated information for the above secondary indicators.

Year of most recent assessment:

2020 using data up to 2019, for the Commonwealth Tier 1 stock assessment completed by CSIRO on behalf of AFMA (Day, 2020); and 2023 using data up to 2022, for this NSW assessment of primary and secondary indicators as outlined in the NSW harvest strategy for an interim year (Hall 2024).

Assessment method:

In 2020, a five-fleet integrated age-structured population dynamics model was fitted using Stock Synthesis SS-V3.30.16 (Methot et al., 2020); and in 2023, weighted-average percent changes in catch rates of the prawn and fish trawl sectors of the NSW Ocean Trawl Fishery, standardised using the r-package 'rforcpue' (Haddon, 2023).

Main data inputs:

Commercial landings – reported annual catch, taken from fisher logbooks of various sources compiled into five fleets – Commonwealth Danish seine (combined with Tasmanian and Victorian); Commonwealth otter trawl (combined with Victorian and NSW Southern Fish Trawl); NSW Danish seine, NSW fish trawl (north of Barrenjoey Point) and NSW prawn trawl; 1942–2021. For the model estimated RBC projections, the 2020 total catch was assumed to be equivalent to the 2019 catch.

Estimated discards and rates – from an onboard observer program for four fleets (excluding NSW Danish seine fleet, which was assumed to have no discarding); Commonwealth data available 1994–2019, with some years missing; NSW data for two time periods.

Commercial catch rates – reported annual CPUE data for four fleets – Commonwealth Danish seine (in kg per shot, 1986–2019), Commonwealth trawl (in kg per hour, 1995–2019), NSW fish trawl and prawn trawl (in kg per day from monthly records, 1998–2008 and kg per hour from daily events, 2010–2021).

Standardised catch rates for NSW data were split into three series for the current interim year analyses: (1) prawn trawl catch rates north of Barrenjoey Point excluding data from OZ2 (i.e., OZ3–OZ6), which was the CPUE series considered least likely to be influenced by overlap with and adjustment for Stout Whiting catches further north and was used in the full assessment; (2) fish trawl catch rates for data north of Barrenjoey Point only (i.e., OZ4–OZ6), which was considered the CPUE series least likely to be influenced by Commonwealth trawling to the south of Barrenjoey Point and used in the full assessment; and southern fish trawl catch rates south of Barrenjoey Point (i.e., OZ7–OZ10) which were combined with the Commonwealth Trawl catch rates in the full assessment.

Length compositions – from Commonwealth and NSW fleets for retained and discarded catches from onboard observer programs (weighted by number of shots, 1990–2019); and for retained catches from port monitoring (weighted by number of trips, 1951–2019, many early years missing).

Age-at-length and ageing error data – from sectioned otoliths processed by Fish Ageing Services Pty Ltd for fish sampled from the Commonwealth Danish seine fleet (1991–2019) and trawl fleet (2001–2019, with some years missing); and processed by the NSW DPI ageing laboratory for the NSW fish and prawn trawl fleets for two time periods.

Life-history parameters – many were estimated from the modelling (e.g., all four von Bertalanffy growth parameters, recruitment and selectivity parameters for each fleet); others were taken from relevant literature (e.g., age and size at sexual maturity of 2 years and 16 cm FL, fecundity assumed to be proportional to spawning biomass, natural mortality fixed to $M=0.6$, steepness of the stock-recruitment relationship was set at $h=0.75$ and length–weight relationship parameters of $a=1.32 \times 10^{-5}$ and $b=2.93$) (Day *et al.*, 2020).

Key model structure & assumptions:

- **Population dynamics modelling**

Assumptions: a single-sex model (length data are not available by sex); single season of spawning assumed across the whole stock; the population was at an unfished biomass and equilibrium age-structure at the start of 1942; population abundance is proportional to standardised catch rates; the selectivity of fleets, rate of natural mortality and growth (mean size-at-age) are constant over time; selectivity is logistic for all fleets; and average annual recruitment follows a Beverton–Holt stock–recruitment relationship. For more details on model assumptions see Day (2020) and Methot and Wetzel (2013).

- **Standardised catch rates**

Assumptions: annual catch rates are a relative index of abundance and not unduly influenced by other factors that are not accounted for through standardisation.

Sources of uncertainty evaluated:

Twenty-five different model sensitivities were tested in the 2020 Tier 1 assessment (Day *et al.*, 2020), including the effects of:

- varying the stock–recruitment steepness parameter (from $h=0.75$ to 0.65 or 0.85);
- varying the natural mortality (from $M=0.6$ to 0.5 or 0.75 per year);
- varying the age at 50% maturity (from 16 to 14 or 18 cm FL);
- varying the recruitment process error (from $\sigma_R=0.7$ to 0.6 or 0.8);
- placing different weightings on length ($\times 2$ or $\times 0.5$), age ($\times 2$ or $\times 0.75$) and survey CPUE data ($\times 1.5$ or $\times 0.5$);
- excluding each CPUE series in turn or including only that CPUE series; and
- reverting to the original 3-fleet, base-case model from 2017.

In addition, likelihood profiles of key parameters, retrospective analyses and jitter analyses were run as additional diagnostic tools to assess the model fits obtained from both the updated three-fleet model and new five-fleet model, along with assessment of the effects of a low-recruitment scenario on the estimated spawning biomass and forward catch projections (Day *et al.*, 2020).

Status Indicators - Limit & Target Reference Levels

The stock status of Eastern School Whiting was assessed against the following performance indicators and reference points outlined in the NSW Trawl Whiting Harvest Strategy (NSW DPI, 2022).

Biomass indicator or proxy	Spawning stock biomass depletion (as a percentage of the estimated unfished spawning stock biomass) estimated every 3–5 years from population biomass modelling; and standardised CPUE-based reference points in interim years.
Biomass Limit Reference Point	Blim of 20% of unfished spawning stock biomass. Current catch rates are assessed relative to long-term averages and levels in the last full assessment year.

Biomass Target Reference Point	Btarg of 48% of unfished spawning stock biomass, with a trigger reference point of 35% of unfished spawning stock biomass.
Fishing mortality indicator or proxy	Spawning potential ratio (1-SPR) as a proxy for fishing mortality that integrates fishing mortality across all fleets in the fishery, estimated every 3-5 years from population biomass modelling; fishing mortality estimates from catch-curve analyses and total catches and discards relative to estimated RBCs in interim years.
Fishing mortality Limit Reference Point	Level of fishing mortality (F _{lim}) above which overfishing is occurring and biomass is depleting toward B _{lim} .
Fishing Mortality Target Reference Point	Level of fishing mortality (F _{targ}) that would result in a spawning stock biomass of B _{targ} .

Stock Assessment Results

Primary indicators

- **Spawning stock biomass**

The 2020 Commonwealth Tier 1 stock assessment (using data up to and including 2019), developed a five-fleet base-case model that included an increased amount of NSW fisheries and biological data, including two CPUE series from NSW waters. The model estimated the spawning stock biomass of Eastern School Whiting was at 33% of unfished biomass in 2020 and will recover to 41% in 2021 assuming average recruitment (Day *et al.*, 2020). Development of the five-fleet model with additional NSW data improved the uncertainty in the biomass depletion estimate (95% asymptotic intervals of 35–45%).

Under the agreed 20:35:48 harvest control rule for a Commonwealth Tier 1 assessment (AFMA, 2021) that has also been adopted in the NSW Trawl Whiting Harvest Strategy, an RBC of 2,140 t for 2021 was estimated for the entire eastern Australian stock of Eastern School Whiting, with a long-term yield of 2,448 t, assuming average recruitment into the future. The RBC estimate for the five-fleet model included a larger combined jurisdictional discard estimate of 370 t for 2021, but overall suggested the stock was more productive.

The results of the 25 sensitivity analyses suggested that changes to some of the fixed parameters had a significant influence on the model fits and stock status estimates. Results were particularly sensitive to adjustments in the recruitment steepness parameter, h , natural mortality estimates, M , and the size at 50% maturity, with estimates of spawning stock biomass ranging between 31% and 57% (Day *et al.*, 2020). This range is well above the adopted limit reference point of 20% depletion.

Secondary indicators

- **Fishing mortality**

The spawning potential ratios in the updated Commonwealth Tier 1 assessment in 2020 suggested that fishing mortality between 2017 and 2019 had exceeded the target mortality (Day *et al.*, 2020). Since then, the NSW basket TAC for trawl whiting was reduced from 1,189 t in 2018–19 to 898 t for the 2019–20 fishing season and 1,066 t in all subsequent seasons, of which an estimated 70% was expected to comprise Eastern School Whiting. Total NSW catches of Eastern School Whiting, including the SFT catches not under quota management, have subsequently decreased from 1,300 t in 2019 to 837 t in 2020, 507 t in 2021 and 578 t in 2022.

Other changes to the base-case model in the 2020 assessment, which included two extra fleets and higher discard rates applied to NSW catches, also resulted in a more productive system overall and increased RBC estimates of 2,140 t for 2021 and a 5-year average of 2,295 for 2021–2025 (Day *et al.*, 2020). While these also included increased discard estimates of 370–386 t, the combined catches and discards across all jurisdictions have been consistently below the RBC estimates in all years, with total removals estimated at 1,767 t in 2020, 1,408 t in 2021 and 1,450 t in 2022 (Hall, 2024). Therefore, the current level of fishing pressure on Eastern School Whiting is below the RBC estimates derived from the most recent full assessment.

- **Annual total catches and discards in NSW and other jurisdictions**

Forward projections in the 2020 Commonwealth Tier 1 assessment to estimate an RBC for Eastern School Whiting assumed future catches would remain equivalent to the 2019 total catch of 1,752 t (combined across all fleets and jurisdictions) (Day *et al.*, 2020). The realised total Eastern School Whiting catches across all jurisdictions since 2019 have been much lower at 1,414 t in 2020, 1,039 t in 2021 and 1,071 t in 2022. Overall, there was a weighted average percent decrease in Eastern School Whiting catches of 49.4% between 2019 and 2022 for NSW catches, or 34.7% when combined with Commonwealth catches (Hall, 2024). The model also estimated combined discards of between 388 t and 379 t across the same period, based on assumed higher total catches equivalent to the RBC in each year. Therefore, realised discards may also have been lower than model estimates (although refer to industry feedback and qualifying comments below).

- **Proportion of total catch caught by each jurisdiction for each species**

The proportion of the total Eastern School Whiting catch taken by NSW fisheries (54%) versus that taken by other jurisdictions (46%) in 2022, differed from that in the full assessment year (2019), when unusually large catches were taken from NSW waters in the lead up to quota introduction (Fig. 9). However, the recent percentage breakdown is more equivalent to the 10-year average catch breakdown.

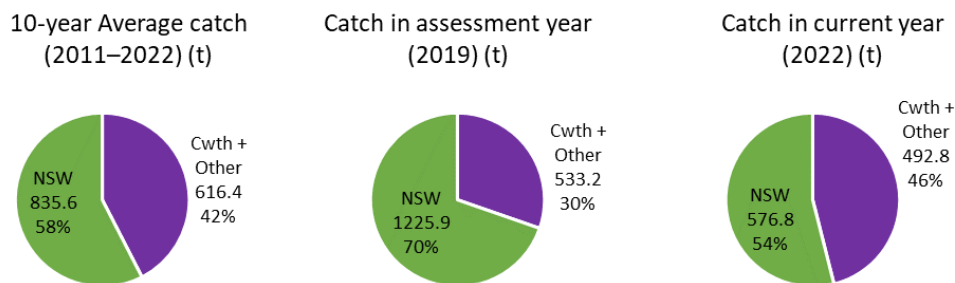


Figure 9 Breakdown of Eastern School Whiting total catches according to jurisdictions.

- **Species composition of NSW catch relative to predicted species composition from the preliminary TACs**

The preliminary TACs for each species used to derive the NSW basket Trawl Whiting TAC of 1,066 t for the 2021-22 fishing season, were reported by the TAF Committee as 217 t of Stout Whiting and 848 t of Eastern School Whiting (NSW TAF Committee, 2021). These equate to 20.4% Stout Whiting and 79.6% of Eastern School Whiting. The species composition of reported landings that was realised during 2022 (after data adjustments in OZ1 and OZ2 for inaccurate species reporting) were 190 t (or 25%) of Stout Whiting and 578 t (or 75%) of Eastern School Whiting (Fig. 10). Therefore, Stout Whiting comprised a marginally larger percentage of the harvest under the combined TAC in 2022 than predicted.

The higher catch of Stout Whiting was possibly due to a shift in catch reporting by some fishers in the NFT sector to start reporting their species compositions more accurately, with greater catches of Stout Whiting being report further south than in previous years.

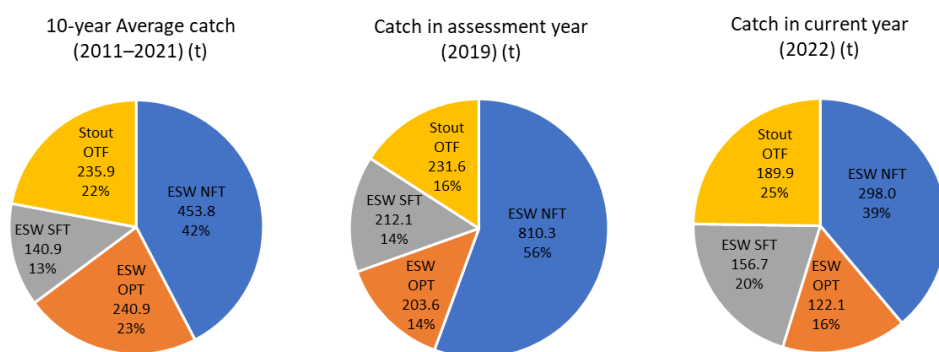


Figure 10 Breakdown of the NSW Ocean Trawl Fishery commercial catches of Eastern School Whiting (ESW) and Stout Whiting (Stout) according to species and sector. NB: Danish seine catches are included within the Northern Fish Trawl (NFT) and Southern Fish Trawl (SFT) sectors. OPT = Ocean Prawn Trawl.

- ### Standardised catch rates by fleet and weighted averages in NSW and in other jurisdictions

The last full stock assessment for Eastern School Whiting was completed in 2020, using data up to 2019. Since then, catch rates in the NSW OPT sector increased and then decreased to end up near the long-term average, while those in the NFT and SFT increased by 38.2% and 74.4%, respectively. Overall, there has been a weighted average percent increase of 32.3% in the CPUE indices of Eastern School Whiting by sectors in the NSW Ocean Trawl Fishery (Hall, 2024).

Recent Eastern School Whiting catch rates for the two main Commonwealth sectors also show differing trends over recent years (Sporcic, 2023). The Danish seine catch rates consistently declined between 2014 and 2020, but recovered slightly in 2021 and 2022 to end up near the 2019 level (slight 1.4% increase). Meanwhile the trawl sector catch rates have increased rapidly by 109% over the last 3 years. Overall, this has resulted in a weighted average percent increase of 11.7% in Commonwealth CPUE indices, given that the bulk of the catch (on average 90%) is taken by the Danish seine fleet (Hall, 2024).

- ### Catch rates for the most recent fishing period relative to projected catch rates from the quantitative stock assessment

Information on projected catch rates were not available from the quantitative stock assessment to inform this current stock assessment. However, given that the model estimated the spawning stock biomass of Eastern School Whiting would recover from 33% of unfished biomass in 2020 to 41% in 2021 assuming average recruitment and rebuild towards the target of 48% of unfished biomass if harvested according to predicted RBCs (Day *et al.*, 2020), catch rates would be expected to increase over subsequent years. As detailed above, NSW catch rates for Eastern School Whiting increased by a weighted average of 32.3% and Commonwealth catch rates have shown an estimated 11% weighted average percent increase over the last 3 years. Combined, these results suggest that the biomass of the stock may be recovering towards the target; however, there is some regional variation evident.

- **Size and age-structure of the catch**

No new size and age-structure data for the commercial catches of Eastern School Whiting were analysed for the current assessment. Otoliths were collected as part of the current FRDC project and will be compiled for the next update of the full stock assessment planned for 2024.

Stock Assessment Result Summary

<p>Biomass status in relation to Limit</p>	<p>The full stock assessment in 2020 (using data up to 2019) developed a five-fleet base-case model that estimated the spawning stock biomass of Eastern School Whiting was at 33% of unfished biomass in 2020 and would continue to recover to 41% in 2021 (with 95% asymptotic intervals of 35–45%) and beyond, assuming average recruitment (Day <i>et al.</i>, 2020). These estimates are all well above the nominated limit reference point of 20% of unfished biomass.</p> <p>Since 2020, standardised catch rates for the NSW prawn trawl sector have decreased slightly between 2019 and 2022, but NSW fish trawl and Commonwealth trawl catch rates have substantially increased (Sporcic, 2023). Commonwealth Danish seine catch rates have stabilised at a level well below the long-term average, but still near the 2019 level that was used in the last full assessment. Overall, there has been a 32.3% weighted average increase in NSW CPUE indices and 11.7% increase in Commonwealth CPUE indices since the last full assessment.</p> <p>On the basis of the above evidence, the biomass of the Eastern School Whiting stock is unlikely to be recruitment impaired.</p>
<p>Biomass status in relation to Target</p>	<p>The most recent estimate of current spawning stock biomass depletion in 2021 (41% of unfished biomass) suggested that the stock had recovered substantially from the low of 33% of unfished biomass in 2020, but that it was still below the target reference point of 48% of unfished biomass. Model projections under a fixed average recruitment scenario and assuming the full RBC was harvested each year, predicted the spawning stock biomass would approach the target reference point by 2026. However, if a low recruitment scenario prevailed between 2017 and 2023, with average recruitment thereafter, the spawning stock biomass was not expected to reach the target reference point until after 2040 (Day <i>et al.</i>, 2020). The increasing catch rate trends across several sectors and spatial zones and total catch levels well below the RBC in all years since suggest that the biomass is likely to be increasing towards the target under the current management arrangements.</p>
<p>Fishing mortality in relation to Limit</p>	<p>Results of the updated Commonwealth Tier 1 assessment in 2020 indicated through the spawning potential ratio, that fishing mortality had exceeded the target mortality in the preceding 3 years (Day <i>et al.</i>, 2020). However, the stock overall was modelled as a more productive system, which increased the estimated RBC for 2021 from 1,610 t to 2,140 t and predicted 3-year average of 2,237 t. Estimates of total removals over the last 4 years suggest that the current level of fishing pressure is unlikely to have exceeded the RBC estimates.</p> <p>The New South Wales basket TAC north of Barrenjoey Point has been set at 1,066 t since the 2020–21 fishing season. Over this period Eastern School Whiting catches from NSW waters have decreased from above 1,000 t in the 4</p>

	years preceding quota introduction to 507 t in 2021 and 578 t in 2022. Although, NSW catches have increased again in 2023, with an increased catch south of Barrenjoey Point, the current level of fishing mortality is still considered unlikely to cause the biomass to become recruitment impaired.
Fishing mortality in relation to Target	Combined total catches and discards across all jurisdictions over the last 3 years were 1,767 t in 2020, 1408 t in 2021 and 1,450 t in 2022, which were all well below the estimated three-year average RBC of 2,237 t. Therefore, the current combined level of fishing mortality across the entire stock should permit further rebuilding towards the target reference point. This is reflected in the increasing catch rates for sectors fishing the central distribution of the stock, while there may be some contraction at the northern and southern extremities.
Current SAFS stock status	Eastern School Whiting was assessed as a sustainable stock under the SAFS framework in 2023 (Hall <i>et al.</i> , in press).
Current Commonwealth stock status	The Commonwealth part of the stock was also assessed as not overfished and not subject to overfishing in 2023 based on the Tier 1 stock assessment results from 2020 (Emery <i>et al.</i> , 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 and Kennelly, 1996; Broadhurst *et al.*, 1996, 1997, 1999, 2005, 2006).

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 the 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 and Fisk, 2017). The OTF was considered a moderate threat to ETP species along the north coast and a low threat to ETP species along the south coast. Interactions with grey nurse sharks and sygnathids were identified as the main concerns.

Compulsory reporting in commercial logbooks of all interactions with ETP species was mandated for the OTF 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.

Stakeholder engagement

Results of the current stock assessment were presented to industry members via video conference on 15 December 2023. Feedback suggested that: discarding had increased in the prawn trawl sector since quota introduction, due to migration of quota southwards to the fish trawl sector; prawn catch rates and prices had been strong over recent years, leading to decreased targeting of whiting by the prawn trawl sector; and that data adjustments that allocate 100% of combined trawl whiting catches in OZ1 to Stout Whiting may be flawed because schools of spawning Eastern School Whiting are encountered there at certain times of the year and any fishing in deeper waters is likely to be taking Eastern School Whiting. This feedback will be incorporated into future stock assessments, but should be considered while interpreting current results.

Qualifying Comments

While current stock assessment results indicate no concerns for the status of the stock, it is pertinent to raise the following issues that should be considered when interpreting these results.

- (1) There remains ongoing uncertainty with respect to the species composition of trawl whiting catches in northern and now central NSW, which in turn increases the uncertainty in the data inputs that underpin the current biomass models. Especially given the sudden increase in Stout Whiting catches reported for the fish trawl sector in central NSW in 2020, that are possibly related to greater industry awareness of species reporting issues. Only catches in northern NSW are currently adjusted for inaccurate species reporting and these recent discrepancies suggest that a greater proportion of Stout Whiting may have been previously caught in the central region than reported. This has implications for the accuracy of the catch series for each species used in the current biomass models.
- (2) Some spatial variation in indicators was evident, with substantial declines in Danish seine catch rates off the Victorian coast over recent years, that are inconsistent with a single biological stock structure.
- (3) The recent increase in frequency of poor recruitment years and their strong influence on spawning stock biomass of Eastern School Whiting is also concerning. The current model predicts that the stock biomass will only increase from 33% in 2020 to 41% in 2021 under an average recruitment scenario and under a low recruitment scenario would not rebuild to target levels until 2040. Current RBC predictions are also based on the stock reaching 41% of unfished biomass by 2021. Fortunately, catches in 2020 and 2021 were well below the estimated RBC, which should help to rebuild the stock further and offset any variation due to poor recruitment.
- (4) Current discard rates in NSW waters have not been assessed since quota was introduced and may be exceeding those estimated from the observer survey that were used in the biomass modelling. Anecdotal information from fishers suggests that discard rates may have changed since quota introduction.

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