

## Assessment Authors and Year

Hall, K. C. 2021. NSW Stock Status Summary 2021/22 – Eastern School Whiting (*Sillago flindersi*). NSW Department of Primary Industries, Fisheries. 19 pp.

## Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Eastern School Whiting is currently assessed as <b>sustainable</b> for the NSW part of the stock.
----------------------	--

## Stock structure & distribution

Eastern School Whiting is a temperate inshore demersal 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 stock structure is currently unknown. Some historic genetic and growth data suggests there may be separate northern and southern stocks, with a division around Forster (Dixon et al. 1987). However, the power of the methods used to detect a difference was limited, and the results were difficult to interpret, with no clear geographic pattern in the genetic variation detected. Overall, the hypothesis of a single, genetically diverse panmictic stock could not be rejected, and the species has been assessed as a single south-eastern Australia biological stock (Conron et al. 2018). However, due to divergent fishing effort and assessment results between the northern and southern parts of the stock in recent years and ongoing uncertainty regarding the stock structure, stock status was reported according to management units in 2020.

## Scope of this assessment

The data presented in this summary relate to the NSW part of the stock (reproduced from Hall 2021). This was an interim stock assessment for Eastern School Whiting, and summarises the primary biomass indicator results from the most recent 2020 Commonwealth Tier 1 assessment (based on data up to and including 2019) and updates NSW fisheries statistics and secondary indicator information (for data up to and including 2020). The NSW part of the stock was assessed according to the *Status of Australian Fish Stocks* criteria (Pidcocke et al. 2021) and with reference to the *Draft NSW Trawl Whiting Harvest Strategy* (NSW DPI 2021).

A basket total allowable commercial catch (TACC) for 'Trawl Whiting' (combined Eastern School Whiting and Stout Whiting, *Sillago robusta*) was introduced in May 2019 for the Ocean Trawl Fishery in NSW waters north of Barrenjoey Point. It was initially set at 1,189 t for the 2019-20 fishing season (1 May 2019 to 30 April 2020) and was subsequently adjusted to 898 t for 2020-21 and 1,066 t for 2021-22 fishing seasons (Mapstone et al. 2020; NSW TAF Committee 2021).

## Biology

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

Distribution and size composition data from independent trawl surveys using the *FRV Kapala* in the early 1990s found larger Eastern School Whiting in offshore waters (60–80 m depth), while smaller juveniles mainly occurred in inshore waters (10–30 m depth) (Graham et al. 1993a; Graham et al. 1993b; Graham and Wood 1997). Similar patterns were found during a chartered prawn trawl survey in 2006–2007 (Gray et al. 2014b). Overall, greater numbers of Eastern School Whiting are caught in offshore waters than in inshore waters, particularly in the mid-depth strata of 37–55 m (Graham and Wood 1997; Gray et al. 2014b).

## FISHERY STATISTICS

### Catch information

#### Commercial

Annual commercial catches of Eastern School Whiting in NSW state waters (following adjustment for species misreporting 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 the last six years catches rapidly increased to 1,187 t in 2017, 1,155 t in 2018 and 1,219 t in 2019, but have decreased to 803 t in 2020 (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. Danish seine and SFT catches have been combined with northern fish trawl (NFT) catches and 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, and the large increases in the commercial catch over the last 3 years were mostly taken by the northern fish trawl sector from OZ5 (Figs 2 and 3).

Eastern School Whiting is also targeted by Danish seine and trawl vessels in the Commonwealth Southern and Eastern Scalefish and Shark Fishery (SESSF) in offshore waters (>3 nm from the coastline) south of Barrenjoey Point (Fig. 1). Total Commonwealth catches (based on CDR data, not including discards) were 767.7 t in 2017, 602.8 t in 2018, 505.6 t in 2019 and 550.3 t in 2020 (Althaus et al. 2020, CSIRO unpub. data), with TACs in each year 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 (Conron et al. 2018).

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 RBC of 2,140 t is fully caught.

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

Figure 1. Annual adjusted commercial catches (tonnes) of Eastern School Whiting (ESW) for all jurisdictions combined (1947–1997) and for sectors of the NSW Ocean Trawl Fishery relative to the combined catches other jurisdictions (1998–2020), including the Commonwealth (Cwth), and Victorian (Vic) and Tasmanian (Tas) state waters. Data for other jurisdictions from Day et al. (2020) and CSIRO unpub. data.

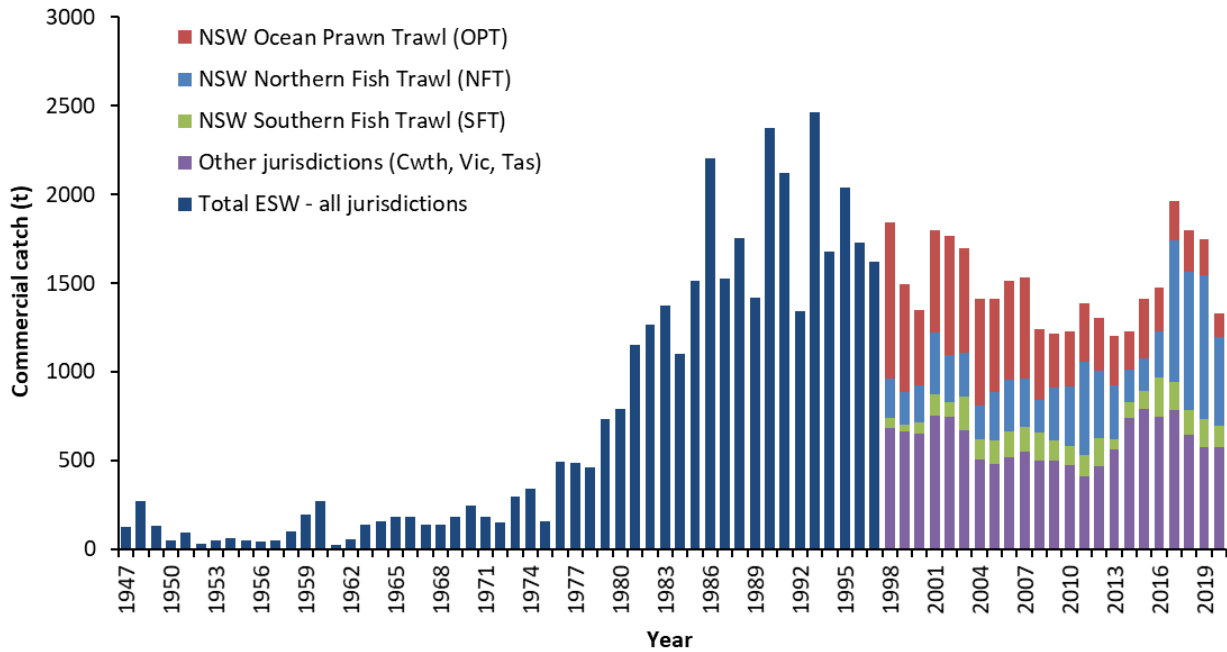
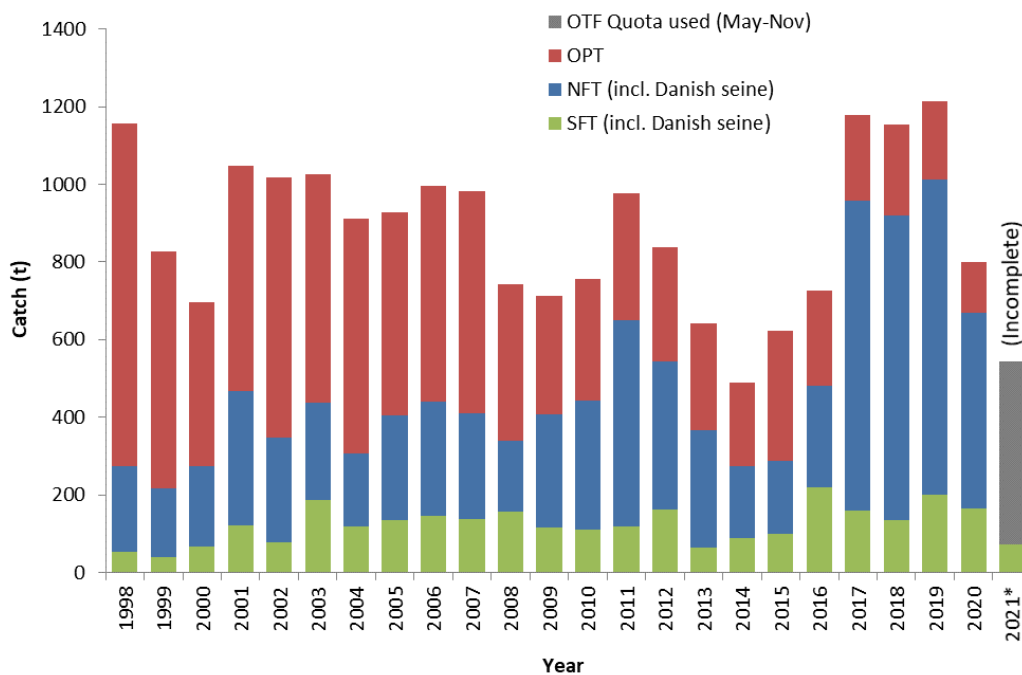


Figure 2. Annual adjusted commercial catches (tonnes) of Eastern School Whiting in NSW waters (1998–2020) for different sectors and endorsements in the NSW Ocean Trawl Fishery. OPT=ocean prawn trawl, NFT=northern fish trawl, SFT=southern fish trawl.

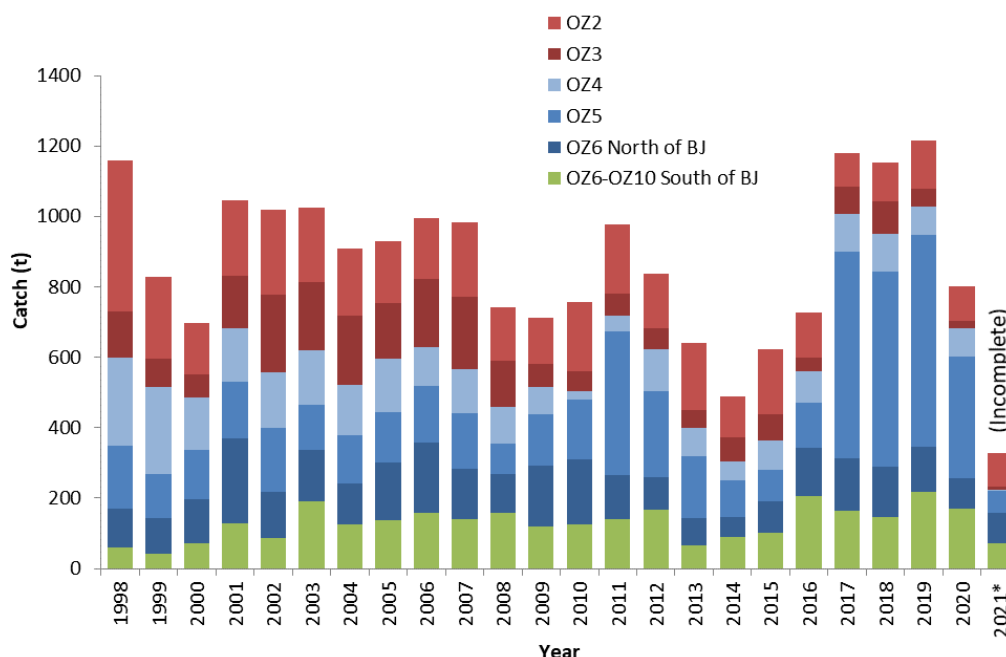


# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

Figure 3. Annual adjusted commercial catches (tonnes) of Eastern School Whiting from the NSW Ocean Trawl Fishery (1998–2020) reported in different fishing zones (OZ1–OZ10), with catches in OZ6 divided into amounts taken from north and south of Barrenjoey Point (BJ) and zones south of BJ aggregated for confidentiality reasons.



### Recreational & Charter boat

The most recent estimate of the recreational harvest of combined trawl whiting (Eastern School Whiting and Stout Whiting) in NSW was approximately 9,882 fish or around 1.4 t during 2019/20 (Murphy et al. in prep.). This 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, excluding other long-term licence holders. However, because these catches are so small the reliability of the estimates is questionable. Nevertheless, relative to the commercial catch, recreational catches are clearly negligible, and comprise approximately 0.1% of the total harvest from NSW waters.

Eastern School Whiting are also rarely reported in logbook catches and observer surveys of the NSW Charter Boat Fishery and catches are 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 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 significant misreporting of Stout Whiting as Eastern School Whiting on catch returns, particularly in northern

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

NSW waters since July 2009, when separate species reporting was first introduced for trawl whiting. A large quantity of trawl whiting catch in 2016–2018 was reported without accurate location information and other large catches in 2019 and 2020 on the south coast were deemed invalid, which contribute towards greater uncertainty in total catch data.

### 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 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 Eastern School Whiting 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.

The reported effort for Eastern School whiting (in total days fished) by the prawn trawl sector declined rapidly from around 12,000 days fished and 120,000 trawl hours in the early 2000s to 4,270 days fished and 39,125 hours trawled in 2009 (Fig. 4). Effort was more stable between 2010 and 2018, after which it has declined rapidly again over the last two years in response to the recent structural reforms and introduction of quota. Prawn trawl effort for Eastern School Whiting was just 2,321 days fished and 23,552 hours trawled in 2020 (Fig. 4). In contrast, reported effort for Eastern School Whiting in the fish trawl sector was initially more variable and continued to decline after the reporting change in 2009 from 2,029 days fished and 18,537 hours trawled to 786 days fished and 5,257 hours trawled in 2020 (Fig. 5).

Figure 4. Annual adjusted effort (days and hours fished) for prawn trawl fishers that reported landing Eastern School Whiting (ESW) on at least one day in a given month.

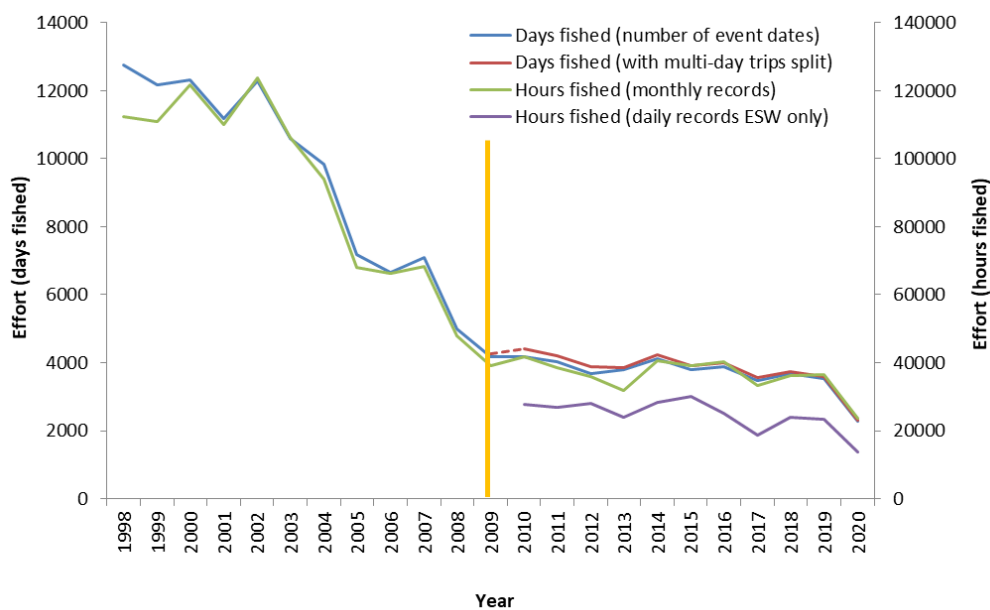
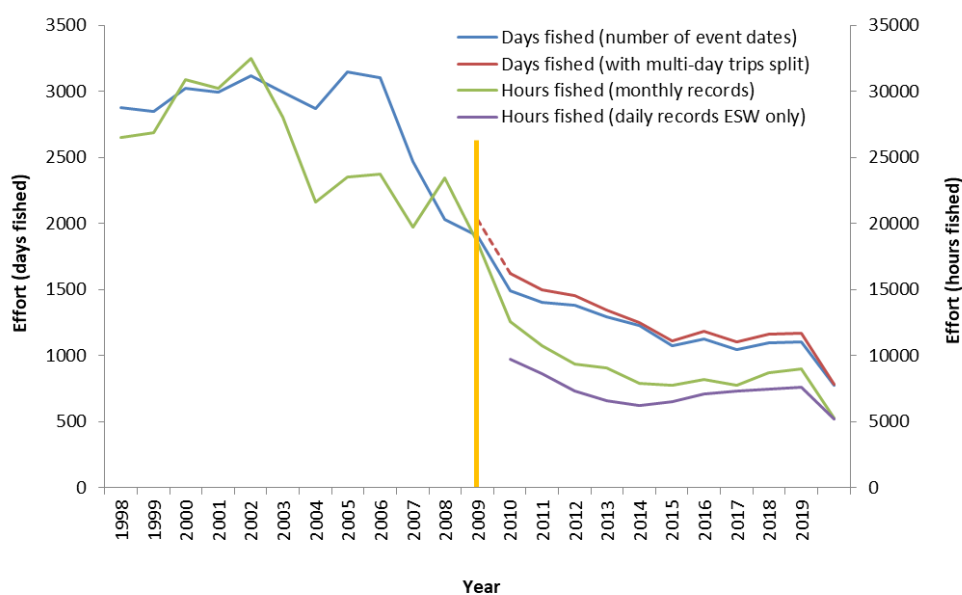


Figure 5. Annual adjusted effort (days and hours fished) for fish trawl (including Danish seine) fishers that reported landing Eastern School Whiting (ESW) on at least one day in a given month.



### Catch Rate information

Monthly catch rates (catch-per-unit-effort, CPUE in kg per day fished) for Eastern School Whiting taken by the fish trawl (excluding Danish seine) and ocean prawn trawl sectors were compiled from monthly records between 1998 and 2008 and re-aggregated daily records between 2010 and 2020. 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) were also compiled from daily fishing event records from 2010 to 2020 and standardised for month, ocean zone, vessel and capture depth (taken from the mean depth of the reported c-square).

The mean standardized catch rates of Eastern School Whiting have been consistently lower for the prawn trawl sector compared to the fish trawl sector (Figs 5 and 6). 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.

Historic monthly catch rates of the prawn trawl sector 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. 5). This suggests the stock in northern NSW may have initially declined following the peak catches in the late 1990s, but then recovered. Trends in both the re-aggregated monthly and daily event series show a decrease from 2010 to 2014, a

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

spike in 2015 and then a return to levels near the 12-year average over the last 5 years (Fig. 5). These recent series diverge over the last 2 years, with the monthly re-aggregated series declining slightly between 2018 and 2020, while the daily event CPUE has continued to rise above the 12-year average.

Monthly catch rates of the fish trawl sector fluctuated around the long-term average in the early 2000s and then steadily increased after 2004 to a peak in 2008 (Fig. 6). Monthly re-aggregated and daily event CPUE series over the last 12 years show a similar trend with a steady decline between 2011 and 2013 and then recover from 2016 to above or near the 12-year trend. Both indices also show a strong increase in 2020, with monthly re-aggregated series ending up slightly higher than the daily CPUE series (Fig. 6).

Mean annual prawn trawl and fish trawl catch rates of Eastern School Whiting in each ocean zone (for which sufficient data are available) show some latitudinal variation in magnitude and temporal trends (Hall 2022). This spatial variation suggests that some finer scale population dynamics may be occurring.

Figure 6. 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) and re-aggregated daily records (2010–2020) in kg per days fished and from daily fishing event records (2010–2020) in kg per hours trawled. 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 averages for each series.

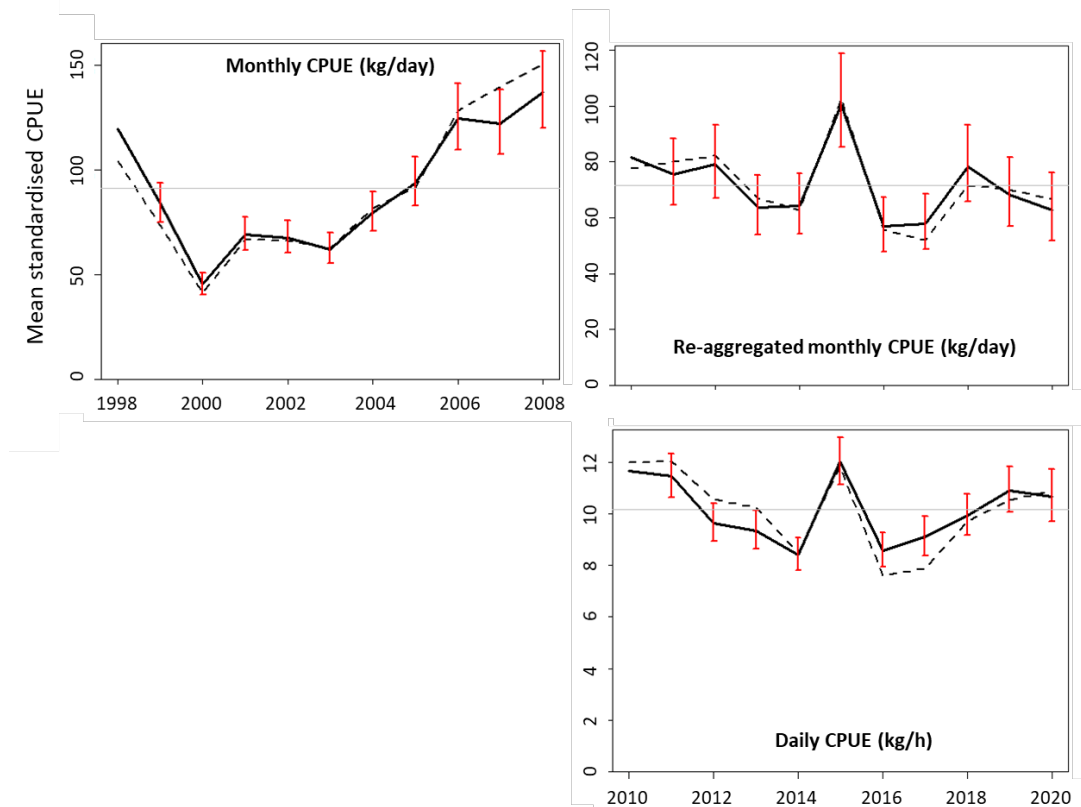
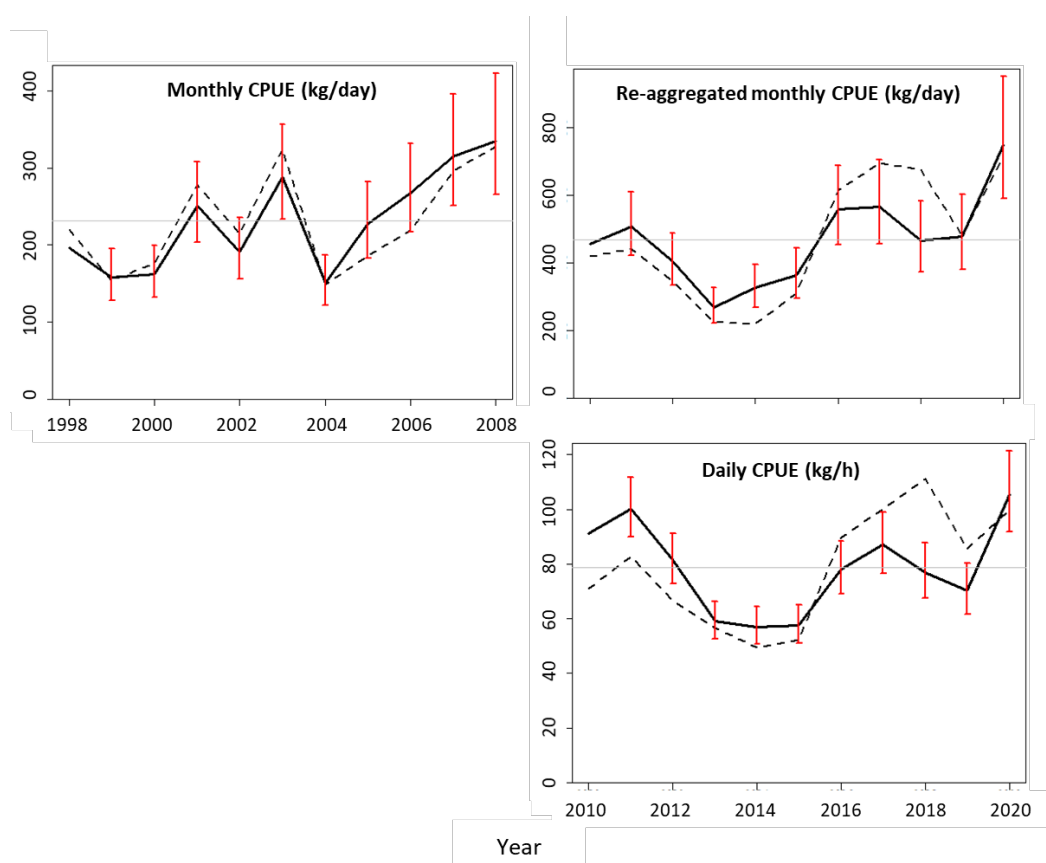


Figure 7. Mean standardised catch rates (catch-per-unit-effort, CPUE) of Eastern School Whiting for the fish trawl sector (excluding Danish seine) of the NSW Ocean Trawl Fishery, estimated from monthly records (1998–2009) and re-aggregated daily records (2010–2020) in kg per days fished and from daily fishing event records (2010–2020) in kg per hours trawled. 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 averages for each series.



## STOCK ASSESSMENT

The *Draft NSW Trawl Whiting Harvest Strategy* (NSW DPI 2021) outlines separate decision rules for primary biomass indicators in years when a quantitative stock assessment is available for Eastern School Whiting (typically completed every 3 to 5 years) and a range of secondary indicators to be monitored in interim years. The most recent quantitative stock assessment for Eastern School Whiting was completed in 2020, so 2021 was considered an interim year for stock assessment purposes. The following stock assessment section summarises available information for the primary spawning stock biomass indicators (from the quantitative stock assessment) and updates information for the range of secondary indicators used in interim years.



## Stock Assessment Methodology

### Year of most recent assessment:

2020 using data up to 2019, Commonwealth Tier 1 stock assessment completed by CSIRO on behalf of AFMA (Day et al. 2020); and 2021 using data up to 2020, NSW assessment of primary and secondary indicators outlined in the draft NSW harvest strategy for an interim year (Hall 2022).

### Assessment method:

2020, a five-fleet integrated age-structured population dynamics model fitted using Stock Synthesis SS-V3.30.16 (Methot et al. 2020); and 2021, 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 'cede' (Haddon 2018)..

### 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; 1942–2020. 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 catch-per-shot, 1986–2019), Commonwealth trawl (in catch-per-h, 1995–2019), NSW fish trawl and prawn trawl (in catch-per-day from monthly records, 1998–2008 and catch-per-h from daily events, 2010–2020).

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  $b=2.93$ ).

### 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–

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

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 (x 2 or x 0.5), age (x 2 or x 0.75) and survey CPUE data (x 1.5 or x 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 *Draft NSW Trawl Whiting Harvest Strategy* (NSW DPI, in prep).

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; and

# Stock Status Summary – 2021/22



NSW Stock Status Summary – Eastern School  
Whiting (*Sillago flindersi*)

	fishing mortality estimates from catch-curve analyses of age structures from commercial catches in interim years.
Fishing mortality Limit Reference Point	Level of fishing mortality (F <sub>lim</sub> ) above which overfishing is occurring and biomass is depleting toward B <sub>lim</sub> .
Fishing Mortality Target Reference Point	Level of fishing mortality (F <sub>targ</sub> ) that would result in a spawning stock biomass of B <sub>targ</sub> .

## 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 2017) that has also been adopted in the Draft 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 Commonwealth Tier 1 assessment in 2017 estimated an average RBC of 1,615 t for the whole stock for the 3 years from 2018 to 2020 (Day 2017). The total combined catches over this period were 1,701 t in 2017, 1,916 t in 2018 and 1,743 t in 2019 (catch chart). When combined with the weighted average discards (estimated as 103.9 t for the 2018–19 year, ABARES 2019) the total mortality substantially exceeded the estimated RBC over those three years. Furthermore, the partial update of the assessment in 2019 revised the predicated RBC under an average recruitment scenario to 1,165 t for 2020 (Day 2019).

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting *Sillago flindersi*

Results of the updated Commonwealth Tier 1 assessment in 2020 indicated through the spawning potential ratio, that the target fishing mortality had exceeded the target mortality in each of the last 3 years (Day et al. 2020). However, the stock overall was modelled as a more productive system, which increased the estimated RBC for 2021 to 2,140 t. Therefore, the current level of fishing pressure is unlikely to exceed this new RBC estimate.

The New South Wales basket TAC was reduced from 1,189 t in 2018-19 to 898 t for the 2019-20 fishing season, and although this was readjusted to 1,066 t for the 2020–21 fishing season, total Eastern School Whiting catches from NSW waters were substantially smaller in 2020 at 802.9 t.

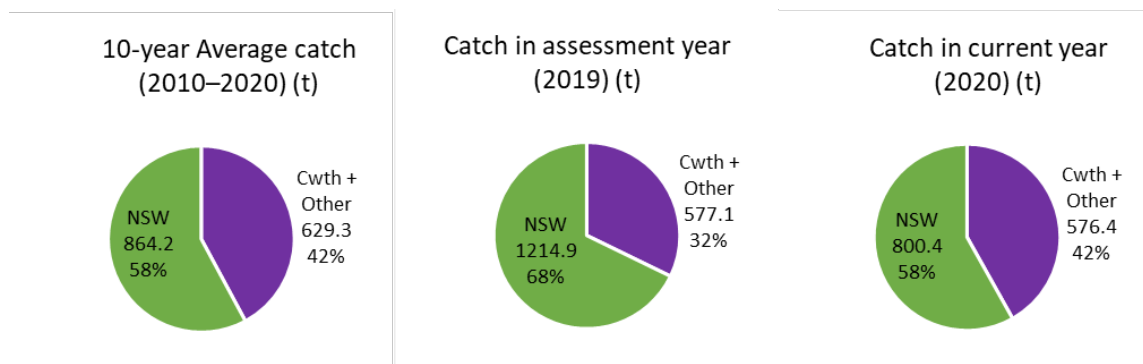
- Annual total catches and discards in NSW and other jurisdictions

Forward projections in the Commonwealth Tier 1 assessment to estimate an RBC for Eastern School Whiting assumed a 2020 catch equivalent to the 2019 total catch (combined across all fleets and jurisdictions) of 1,752 t. The realised total Eastern School Whiting catch across all jurisdictions in 2020 was much lower at 1,379.4 t. Overall, there was a weighted average percent decrease in Eastern School Whiting catches of 19.4% between 2019 and 2020. The model also estimated combined discards of 370 t for 2020, however, this was based on the assumed higher total catch for 2020. Therefore, realised discards may also have been lower than the model estimates.

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

The proportion of the total catch taken by NSW fisheries (58%) versus that taken by other jurisdictions (42%) in 2020, differed from that in the previous assessment year, when unusually large catches were being taken from NSW waters in the lead up to quota introduction (Fig. 8). However, the percentage breakdown was almost identical to the 10-year average catch breakdown.

Figure 8. 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 TACC 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 2020 (after data adjustments in OZ1 and OZ2 for species misreporting) were 270.5 t (or 29.9%) of Stout Whiting and 635.2 t (or 70.1%) of Eastern School Whiting (Fig. 9).

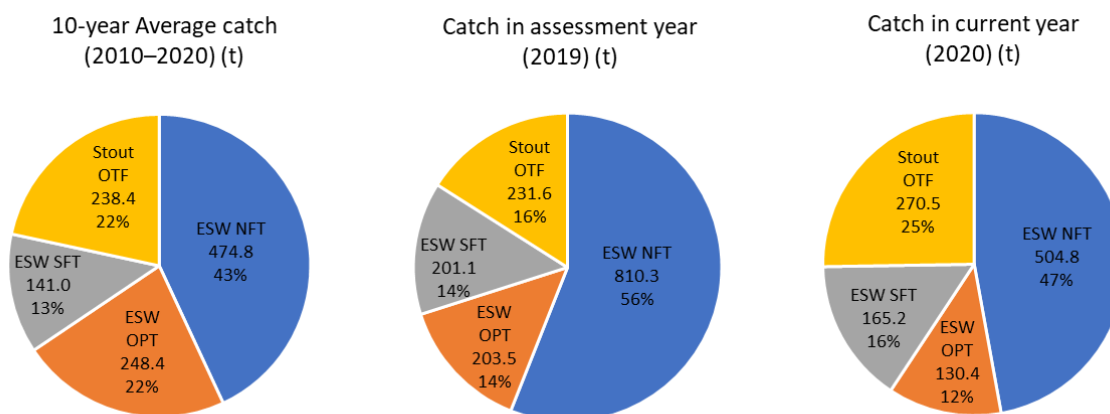
# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting Whiting (*Sillago flindersi*)

Therefore, Stout Whiting comprised a greater percentage of the harvest under the combined TAC in 2020 than predicted.

Figure 9. 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

Over the last 12 months since the most recent full stock assessment was completed for each stock, catch rates for the NSW prawn trawl fleet were relatively stable, while those of the fish trawl fleet increased by over 50%. Overall, there was a weighted average percent increase of 31.6% in the CPUE indices of NSW Ocean Trawl Fishery sectors that target trawl whiting. This may have resulted from the reduced fishing pressure on the NSW part of the stock over the last two years when the TAC was reduced in the 2020–21 fishing season.

In comparison, recent catch rates in the two main Commonwealth sectors show opposing trends over recent years. The Danish seine series consistently declined over the last five years to over 50% below the long-term average, while the trawl sector catch rates have increased rapidly over the last two years.

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

Information on the projected catch rates from the quantitative stock assessment were not available to inform the current stock assessment. However, since the stock was estimated to be at around 41% of unfished biomass levels in 2020 and harvesting according to the predicted RBCs should rebuild the stocks towards the target of 48% of unfished biomass, catch rates would be expected to increase over subsequent years. As detailed above, NSW catch rates for Eastern School Whiting in the fish trawl and prawn trawl sectors both increased by 56.2% and 22.7%, respectively. However, the increases in the NSW trawl catch rates were somewhat offset by further decreases in catch rates of the Commonwealth Danish seine sector.

- Size and age-structure of the catch

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

No new data on the size and age-structure of Eastern School Whiting were available in 2020 due to delays in collection and processing of samples associated with covid-19 lockdowns in NSW and Victoria. However, earlier data collated and analysed in 2019, suggested that the mean lengths and size distributions of Eastern School Whiting in recently retained catches, while variable, had not changed significantly from historical catches in the 1950s and 1970s (Hall 2021).

### Stock Assessment Result Summary

<p>Biomass status in relation to Limit</p>	<p>The 2020 five-fleet base-case model estimated that the spawning stock biomass of Eastern School Whiting was at 33% of unfished biomass in 2020 and would recover to 41% in 2021 (with 95% asymptotic intervals of 35–45%), assuming average recruitment (Day et al. 2020). These estimates are well above the nominated limit reference point of 20% of unfished biomass.</p> <p>Current data from NSW suggest that standardised prawn trawl catch rates are stable and fish trawl catch rates had substantially increased between 2019 and 2020. Overall, there was a 31.6% weighted average increase in NSW CPUE indices in 2020, but these are somewhat offset by declining trends in the Commonwealth Danish seine CPUE indices.</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 (41% of unfished biomass) suggests that the stock has recovered substantially from the low of 33% of unfished biomass in 2020, but that it is still below the target reference point of 48% of unfished biomass. Model projections under a fixed average recruitment scenario and assuming the full RBC is harvested each year, predict the spawning stock biomass will approach the target reference point by 2026. However, if a low recruitment scenario prevails between 2017 and 2023 (with average recruitment thereafter), the spawning stock biomass is not expected to reach the target reference point until after 2040 (Day et al. 2020).</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 the target fishing mortality had exceeded the target mortality during the 3 years 2017 to 2019 (Day et al. 2020). However, the stock was modelled as a more productive system overall, with the estimated RBC for 2021 increasing from 1,610 t to 2,140 t. Therefore, the current level of fishing pressure is unlikely to exceed this new RBC estimate.</p> <p>The New South Wales basket TAC was reduced from 1,189 t in 2018-19 to 898 t for the 2019-20 fishing season, and although this was readjusted to 1,066 t for the 2020–21 fishing season, total Eastern School Whiting catches from NSW waters were substantially smaller in 2020 at 802.9 t.</p>

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

	On the basis of the above evidence, the current level of fishing mortality is considered unlikely to cause the biomass to become recruitment impaired.
Fishing mortality in relation to Target	Combined total catches and discards across all jurisdictions in 2020 were 1,767 t, which was well below the estimated RBC of 2,140 t. Therefore, the current combined level of fishing mortality should permit further rebuilding of the stock towards the target reference point.
Current SAFS stock status	Eastern School Whiting was assessed as a <b>sustainable stock</b> under the SAFS framework in 2020 (Hall et al. 2021)
Current Commonwealth stock status	The Commonwealth part of the stock was assessed as <b>not overfished and not subject to overfishing</b> in 2021 based on the update of the Tier 1 stock assessment in 2020 (Emery et al. 2021).

## 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 ; Broadhurst et al. 1997; Broadhurst et al. 1999 ; Broadhurst et al. 2005; Broadhurst et al. 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.

## Qualifying Comments

While current stock assessment results indicate no concerns for the current 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 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, likely to be in response to greater industry awareness of species reporting issues. Only catches in northern NSW are currently adjusted for species misreporting issues. These discrepancies suggest that a greater proportion of Stout Whiting may have been previously caught in the central region than reported, and there may be implications for the accuracy of the catch series for each species used in the current biomass models.
- (2) The stock structure of Eastern School Whiting also remains uncertain, which may influence the relevance of the current biomass modelling. This issue is currently being addressed by an FRDC funded project that is applying modern molecular and otolith chemistry techniques to clarify the stock structure prior to the next update of the Tier 1 Commonwealth assessment.
- (3) The latter is especially pertinent given the sustained decline in Danish seine catches off the Victorian coast over recent years, and any possible longer-term influences of the seismic testing in that region on NSW populations if Eastern School Whiting is determined to be a single biological stock.
- (4) The recent increase in frequency of poor recruitment years and their strong influence on spawning stock biomass of Eastern School Whiting is 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 were well below the estimated RBC, which should help to rebuild the stock further and offset any variation due to poor recruitment.
- (5) And last but not least, current discard rates are unquantified and may be in excess of the recent observer survey estimates that were used in the biomass modelling. These were collected prior to quota introduction and anecdotal evidence from fishers suggests that discard rates have changed since then.

## References

- AFMA. 2017. Harvest Strategy Framework for the Southern and Eastern Scalefish and Shark Fishery. Australian Fisheries Management Authority [Available at [www.afma.gov.au](http://www.afma.gov.au)], Canberra, ACT.
- Althaus, F., P. Burch, and R. Thomson. 2020. Southern and Eastern Scalefish and Shark Fishery catches and discards for TAC purposes using data until 2019 DRAFT. Report prepared for Australian Fisheries Management Authority, revised after the SESSFRAG Data Meeting, 25-26 August 2020, Hobart. Commonwealth Scientific Industrial and Research Organisation, Hobart, Tasmania.



- Broadhurst, M. K., and S. J. Kennelly. 1996. Effects of the circumference of codends and a new design of square-mesh panel in reducing unwanted by-catch in the New South Wales oceanic prawn-trawl fishery, Australia. *Fisheries Research* 27:203-214.
- Broadhurst, M. K., S. J. Kennelly, and S. Eayrs. 1999. Flow-related effects in prawn-trawl codends: potential for increasing the escape of unwanted fish through square-mesh panels. *Fishery Bulletin* 97:1-8.
- Broadhurst, M. K., S. J. Kennelly, and G. O'Doherty. 1996. Effects of square-mesh panels in codends and of haulback delay on bycatch reduction in the oceanic prawn-trawl fishery of New South Wales, Australia. *Fishery Bulletin* 94:412-422.
- Broadhurst, M. K., S. J. Kennelly, and G. O'Doherty. 1997. Specifications for the construction and installation of two by-catch reducing devices (BRDs) used in New South Wales prawn-trawl fisheries. *Marine and Freshwater Research* 48:485- 489.
- Broadhurst, M. K., R. B. Millar, M. E. L. Wooden, and W. G. Macbeth. 2006. Optimising codend configuration in a multispecies demersal trawl fishery. *Fisheries Management and Ecology* 13:81-92.
- Broadhurst, M. K., D. J. Young, C. A. Gray, and M. E. L. Wooden. 2005. Improving selection in south eastern Australian whiting (*Sillago* spp.) trawls: effects of modifying the body, extension and codend. *Scientia Marina* 69:301-311.
- Conron, S., K. Hall, F. Helidoniotis, J. Lyle, and B. Moore. 2018. Eastern School Whiting *Sillago flindersi*. C. Stewardson, and coeditors, editors. *Status of Australian Fish Stocks Reports 2018*. Fisheries Research and Development Corporation, Canberra, ACT.
- Day, J. 2017. School Whiting (*Sillago flindersi*) stock assessment based on data up to 2016. Pages 588-663 in G. N. Tuck, editor. *Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery 2016 and 2017, Part 2*. Australian Fisheries Management Authority and CSIRO Oceans and Atmosphere, Hobart, Tasmania, Australia.
- Day, J. 2020. School whiting (*Sillago flindersi*) projections based on CPUE updates to 2018, estimated catch to 2019 and projected catch scenarios to 2021. Technical report prepared for SERAG Meeting, December 2019. Pages 6-34 in G. N. Tuck, editor. *Stock assessment for the Southern and Eastern Scalefish and Shark Fishery 2018 and 2019. Part 1, 2019*. Australian Fisheries Management Authority and CSIRO Oceans and Atmosphere, Hobart, Tasmania, Australia.
- Day, J., K. Hall, P. Bessell-Browne, and M. Sporcic. 2020. School whiting (*Sillago flindersi*) stock assessment based on data up to 2019. Technical report prepared for SERAG Meeting, December 2020. Commonwealth Scientific and Industrial Research Organisation, Hobart, Tasmania, Australia.
- Dixon, P. I., R. H. Crozier, M. Black, and A. Church. 1987. Stock identification and discrimination of commercially important whittings in Australian waters using genetic criteria (FIRTA 83/16). University of New South Wales, Sydney, NSW, Australia.
- Emery, T., J. Woodhams, and R. Curlotti. 2021. Chapter 9. Commonwealth Trawl and Scalefish hook sectors. Pages 121-226 in H. Patterson, and coeditors, editors. *Fishery Status Reports 2021*. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, ACT.
- Fletcher, M., and G. Fisk. 2017. New South Wales marine estate threat and risk assessment report. Marine Estate Management Authority, Sydney, NSW.
- Graham, K. J., G. W. Liggins, J. Wildforster, and S. J. Kennelly. 1993a. Kapala Cruise Report No. 110. NSW Fisheries, Cronulla, NSW, Australia.
- Graham, K. J., G. W. Liggins, J. Wildforster, and S. J. Kennelly. 1993b. Kapala Cruise Report No. 112. NSW Fisheries, Cronulla, NSW, Australia.
- Graham, K. J., and B. J. Wood. 1997. The 1995-96 survey of Newcastle and Clarence River prawn grounds. Kapala Cruise Report No. 116. NSW Fisheries, Cronulla, NSW, Australia.

# Stock Status Summary – 2021/22



## NSW Stock Status Summary – Eastern School Whiting (*Sillago flindersi*)

- Gray, C., and S. Kennelly. 2016. First implementation of an independent observer program for the charter boat industry of NSW: data for industry-driven resource sustainability. FRDC Final Report Project No. 2014/036. WildFish Research, 1365-2400, Sydney, Australia.
- Gray, C. A., L. M. Barnes, F. A. Ochwada-Doyle, D. E. van der Meulen, B. W. Kendall, and W. D. Robbins. 2014a. Age, growth and demographic characteristics of *Sillago flindersi* exploited in a multi-species trawl fishery. *Fisheries Science* 80:915-924.
- Gray, C. A., L. M. Barnes, D. E. van der Meulen, B. W. Kendall, F. A. Ochwada-Doyle, and W. D. Robbins. 2014b. Depth interactions and reproductive ecology of sympatric Sillaginidae: *Sillago robusta* and *S. flindersi*. *Aquatic Biology* 21:127-142.
- Haddon, M. 2018. cede: functions for fishery data exploration and CPUE Standardization. R package version 0.0.4.
- Hall, K., T. Emery, N. Krueck, and Victorian Fisheries Authority. 2021. Eastern School Whiting *Sillago flindersi*. T. Piddocke, and coeditors, editors. Status of Australian Fish Stocks Reports 2020. Fisheries Research and Development Corporation, Canberra, ACT.
- Hall, K. C. 2021. NSW stock assessment and status summary report 2020 – Ocean Trawl Fishery (Inshore Prawn, Offshore Prawn, Deepwater Prawn and Northern Fish Trawl) – Eastern School Whiting and Stout Whiting (*Sillago flindersi* and *Sillago robusta*). NSW Department of Primary Industries, Coffs Harbour, NSW, Australia.
- Hall, K. C. 2022. NSW Stock assessment report 2021 – Ocean Trawl Fishery (Inshore Prawn, Offshore Prawn, Deepwater Prawn and Northern Fish Trawl) – Eastern School Whiting and Stout Whiting (*Sillago flindersi* and *Sillago robusta*). NSW Department of Primary Industries, Coffs Harbour, NSW, Australia.
- Hughes, J. M., D. D. Johnson, J. J. Murphy, and F. A. Ochwada-Doyle. 2021. The NSW Recreational Fisheries Monitoring Program - Charter Fishery Monitoring 2017/18. NSW DPI - Fisheries Final Report Series No. 159. NSW Department of Primary Industries, Mosman, NSW, Australia.
- Mapstone, B., A. McDonald, R. Little, and S. Pascoe. 2020. Report and Determinations for the 2020–21 Fishing Period - -NSW Ocean Trawl Fishery: Blue-spotted Flathead, Tiger Flathead, Silver Trevally, and Eastern School Whiting and Stout Whiting. NSW Total Allowable Fishing Committee, Coffs Harbour, NSW.
- Methot, R., C. Wetzel, I. Taylor, and K. Doering. 2020. Stock Synthesis User Manual Version 3.30.16. NOAA Fisheries, Seattle, Washington, USA.
- Methot, R. D. J., and C. R. Wetzel. 2013. Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management. *Fisheries Research* 142:86-99.
- Murphy, J. J., F. A. Ochwada-Doyle, L. D. West, K. E. Stark, and J. M. Hughes. in prep. The NSW Recreational Fisheries Monitoring Program - survey of recreational fishing, 2019/20. Fisheries Final Report Series No. XXX.
- NSW DPI. 2004. Ocean Trawl Fishery Environmental Impact Statement. Public Consultation Document. NSW Department of Primary Industries, Cronulla, NSW.
- NSW DPI. 2017. Assessment of the NSW Ocean Trawl Fishery. Prepared for the Department of Environment and Energy for the purpose of assessment under Part 13 and 13(A) of the Environment Protection and Biodiversity Act 1999. NSW Department of Primary Industries, Coffs Harbour, NSW.
- NSW DPI. 2021. Draft NSW Trawl Whiting Harvest Strategy. NSW Department of Primary Industries, Orange, NSW.
- NSW TAF Committee. 2021. Determination for the 2021/22 fishing period - -NSW Ocean Trawl Fishery: Eastern School Whiting, Stout Whiting, Bluespotted Flathead and Silver Trevally. NSW Total Allowable Fishing Committee, Coffs Harbour, NSW.
- Piddocke, T., C. Ashby, K. Hartmann, A. Hesp, P. Hone, J. Klemke, S. Mayfield, A. Roelofs, T. Saunders, J. Stewart, B. Wise, and J. Woodhams. 2021. Status of Australian Fish Stocks

Reports 2020, Available: <https://www.fish.gov.au/> [Accessed 29 June 2021] edition. Fisheries Research and Development Corporation, Canberra, ACT.

## Appendix 1

### Reliability and Relevance of the Commonwealth Assessment to assessment of stock status in NSW

The principal source of information available to assess the current spawning stock biomass of Eastern School Whiting is the most recent Tier 1 Commonwealth stock assessment (Day et al. 2020). The most recent update of the Commonwealth Tier 1 assessment in 2020 (using data up to and including 2019), developed a five-fleet base-case model that included increased NSW fisheries and biological data, including two CPUE series (fish trawl and prawn trawl indices for north or Barrenjoey Point), lengths, ages and discard rates. Outcomes from this updated assessment are considered particularly relevant for determining the stock status of the NSW part of the stock and informing TAC determination in NSW waters.

Furthermore, NSW prawn trawl and fish trawl catch rates show similar trends to the Commonwealth otter trawl fleet in many years, although during some periods with an apparent 1 or 2-year lag effect. However, neither of the NSW series match the recent gradually declining trend in the Commonwealth Danish seine series (Fig. 10).

Figure 10. Standardised annual catch rates (CPUE) of Eastern School Whiting taken by the Commonwealth Danish seine fleet (red) from 1986 to 2019 and otter trawl fleet (orange) fleet from 1995 to 2019. The standardised annual catch rates for the NSW fish trawl (blue) and prawn trawl (green) fleets derived from monthly records between 1998 and 2008 and daily records between 2010 and 2019 are also indicated. All series have been plotted on a normalised scale (mean of each series equals 1) to enable comparison. Figure reproduced from Day et al. (2020).

