## Assessment Authors and Year

Fowler, A.M., Liggins, G., and Chick, R. C. 2023. Stock assessment report 2022/23 - Silver Trevally (*Pseudocaranx georgianus*). NSW Department of Primary Industries - Fisheries: 53 pp.

## Stock Status

| Current stock status | On the basis of the evidence contained within this assessment, Silver Trevally are currently assessed as **depleted**. |
|---|---|
| | |

## Stock structure & distribution

Silver Trevally in NSW comprises a single species revised in 2006 as *Pseudocaranx georgianus* (previously considered *P. dentex*; Smith-Vaniz and Jelks 2006, Bearham et al. 2019). The species is distributed throughout NSW and also occurs in southern Queensland, Victoria, Tasmania, South Australia and southern Western Australia.

Stock structure of Silver Trevally in NSW is uncertain, with no investigations of potential genetic structure within the state or neighbouring jurisdictions. Investigations of population connectivity and post-settlement movement are also limited, although tag-recapture studies in NSW, Western Australia and New Zealand indicate restricted post-settlement movement over moderate (100s of km) spatial scales (James 1980; Fairclough et al. 2011; Fowler et al. 2018).

Silver Trevally is assessed at a jurisdictional level in the national Status of Australian Fish Stocks (SAFS) reports, due to the complex of *Pseudocaranx* species harvested in some states, and the uncertainty in stock structure (Fowler et al. 2021). Acknowledging this, the production modelling component of the current assessment incorporates data from NSW, the Commonwealth Southern and Eastern Scalefish and Shark Fishery (SESSF) and Victoria. This was done because the jurisdictions likely share the same stock of Silver Trevally given adjacent borders, contiguous coastline, dynamic environment and broadcast spawning behaviour of the species.

## Biology

Silver Trevally is a medium-bodied bentho-pelagic carnivore inhabiting a broad range of habitats, from shallow estuaries through to the outer continental shelf. The species is relatively long-lived and slow growing, attaining a maximum age in excess of 25 years (Rowling and Raines 2000). However, Silver Trevally are moderately fecund and mature at a relatively early age (2–4 years). The species is a broadcast spawner, with pelagic eggs and larvae distributed by currents prior to settlement on soft sediment habitat.

## FISHERY STATISTICS

## Catch information

Commercial

Silver Trevally are predominantly caught in three commercial fisheries within NSW; the Ocean Trawl Fishery (OTF), the Ocean Trap and Line Fishery (OTLF) and the Estuary General Fishery (EGF). Substantial catches are also occasionally taken in the Ocean Hauling Fishery (OHF). During the period 1998–2022, the OTF accounted for 58% of landings by weight (inter-annual range: 22–86%), with landings in the OTLF and EGF accounting for 24% (range: 9–49%) and 13% (range: 4–36%), respectively (Figure 1).

The fish trawl sector of the OTF has two endorsements that are spatially separated; Ocean Trawl – Fish Northern Zone (OTFN) and Southern Fish Trawl (SFT). During the period 2010–2022, the OTFN accounted for 47% of Silver Trevally catch by weight (range: 16–84%) while the SFT accounted for 53% of catch (range: 16–84%). Landings were greater in the SFT between 2012 and 2014; however, more recent landings (2015 onward) have been similar between the two endorsements.

A historical series of catch, including commercial landings from NSW, the Commonwealth SESSF and Victoria, showed catch was initially low (1950-1970), then increased rapidly to >1500 t during the mid-1980's, after which it has declined substantially to present day.
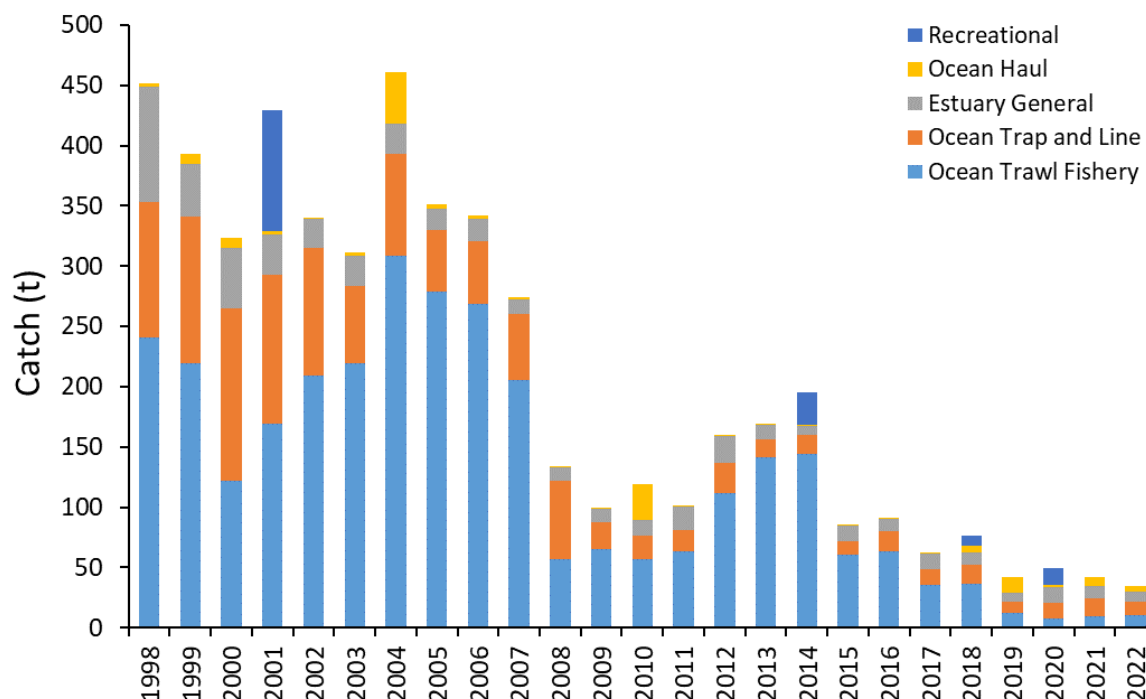


**Figure 1** **Annual reported landings (t) of Silver Trevally from NSW Ocean Trawl, Ocean Trap and Line, Estuary General, Ocean Hauling and Recreational fisheries from 1998 to 2022. Years are fiscal.**

## Recreational & Charter boat

Four surveys of recreational fishing have been conducted at the state-wide level in NSW. Retained landings by recreational fishers resident in NSW have generally decreased over time, with landings estimated from off-site telephone/diary surveys declining from approximately 140,000 fish during 2000/01 (Henry and Lyle 2003) to around 49,000 individuals during 2013/14 (West et al. 2015) and around 15,000 fish in 2017/18 (Murphy et al. 2020). The most recent estimate in 2019/20 is slightly higher, at 24,000 individuals (Murphy et al. 2022). Estimated harvest weights made from the number of individuals are 100 t during 2000/01, 27 t during 2013/14, 8 t in 2017/18, and 13 t in 2019/20 (Figure 1), based on average body weight of fish caught by recreational fishers (NSW DPI, unpublished). The 2017/18 and 2019/20 surveys sampled one- and three-year licence holders present in the NSW Recreational Fishing Fee (RFF) Licence database, whereas the previous NSW survey in 2013/14 sampled households from the White Pages (West et al. 2015). The extent to which differences in the sampling frames between the 2013/14 and later surveys have influenced catch estimates is unknown.

## Indigenous

Aboriginal cultural catch of Silver Trevally has not been quantified in NSW.

## Illegal, Unregulated and Unreported

The level of Illegal, Unregulated and Unreported (IUU) fishing has not been quantified.

## Fishing effort information

Fishing effort (days) in the OTF was relatively high but variable during 1998-2007, then declined rapidly until 2010 (Figure 2). Effort has subsequently remained low, with a gradual decline to 272 days in 2020. Effort during the most recent reporting year was similar at 274 days.
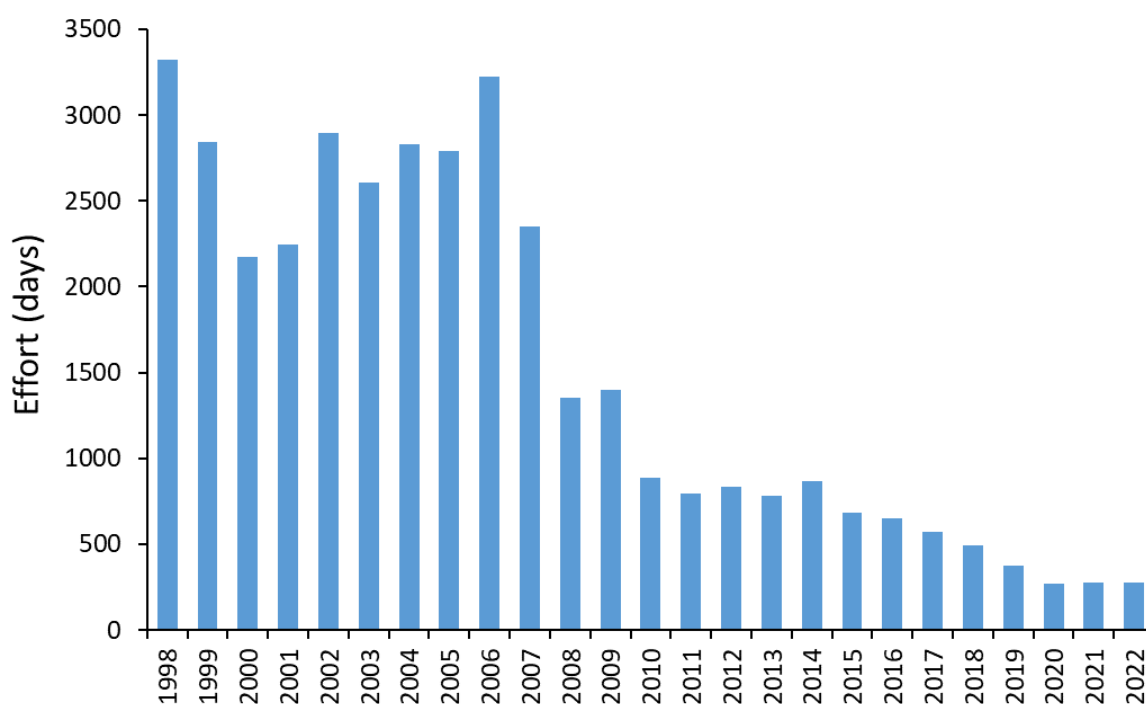


**Figure 2    Annual trawl effort (days) for Silver Trevally from 1998-2022. Note: days of effort for the period 2010-2022 were estimated from the number of distinct fishing dates in each month.**

## STOCK ASSESSMENT

### Stock Assessment Methodology

Year of most recent assessment:

2022/23 (using data to 2021/22)

Assessment method:

A weight-of-evidence approach has been used to classify the biological status of the NSW Silver Trevally stock based on:

1) Bayesian state-space surplus production modelling (JABBA, Winker et al. 2018)

2) Length-only modelling (SS-LO, Rudd and Thorson 2018);

3) A time-series of length compositions from ocean fish trawlers in NSW.

Main data inputs:

Production model

- Historical catch series, comprising:
    - Commercial landings reported to NSW from 1945-2021 from all fisheries;
    - Landings reported from the Commonwealth SESSF Trawl Sector (CTS) from 1986-2021;
    - Landings reported from the Commonwealth non-trawl sector from 2001-2021;
    - Commercial landings reported to Victoria from 1979-2021;
    - Imputed commercial landings in Victoria during 1945-1978 based on the mean ratio of Victorian to NSW commercial landings during 1979-1985;
    - Annual estimates of recreational harvest in NSW from 2000 onward imputed from four available harvest estimates from state-wide telephone diary surveys;
    - Annual estimates of recreational harvest in NSW during 1945-1999 imputed from the ratio of Silver Trevally harvest in NSW during the year 2000 to total Australian recreational harvest (Kleisner et al. 2015);
    - Annual estimates of Victorian recreational harvest during 1945-2021 imputed from the ratio of Victorian to NSW recreational catch of Silver Trevally during 2000/01 (Henry and Lyle, 2003).
- Commercial catch rates (CPUE) – five series of standardised CPUE were used to calibrate the model:
    - NSW fish trawl during 1998-2006;
    - NSW fish trawl during 2010-2022;
    - NSW fish trap during 1998-2006;
    - NSW fish trap during 2010-2022;
    - Commonwealth trawl during 1986-2020.

Length-only model

- Length-composition data from NSW commercial fish trawl during 1987-2007;
- Length-composition data from a trawl observer program during 1994;
- Length-composition data from a fishery-independent trawl survey during 1994;

- Biological parameters, including natural mortality and von Bertalanffy growth parameters;

## Key model structure & assumptions:

### Production model

The JABBA (Just Another Bayesian Biomass Assessment) Bayesian state-space surplus production model (Winker et al. 2018) was used to estimate trajectories of annual biomass (B), fishing mortality (F) and fractions of B and F relative to their equilibrium values associated with Maximum Sustainable Yield (MSY). The model was conditioned on catch and calibrated using times-series of indices of abundance (standardised CPUE from 5 fleets), prior probability distributions for the intrinsic rate of population increase ($r$), carrying capacity ($K$, i.e. $B_0$), depletion of the stock at the start of the catch time-series (*psi*), process error and catchabilities for each abundance time-series.

Raw catch rates were standardised using general linear models in the R package 'cede' (v. 0.0.4; Haddon, 2019) using variables of month of capture, ocean zone, fishing business, authorised fisher, depth and the interaction between month and ocean zone.

The base-case model assumed a Pella and Tomlinson production function with $B_{msy}$ occurring at 40% of $B_0$ ($K$). The time-series of catch was assumed to be accurate, and changes in CPUE were assumed to reflect changes in stock abundance.

### Length-only model

Length-only modelling was conducted to provide a complementary assessment method that does not rely on catch or CPUE data. The model is an age-structured population dynamics model that accounts for variable fishing mortality and recruitment (Rudd and Thorson 2018). It integrates length composition data across multiple years to estimate a time series of biomass depletion. The model was run using the Stock Synthesis Data-limited (SS-DL) Tool in R which uses the Stock Synthesis framework (Methot and Wetzel 2013).

Modelling was conducted on data from 1987 to 2007 only, due to the introduction of the MLL and the resulting change in commercial length compositions after that time. Depletion after 2007 was inferred from the proportion of large (>30 cm FL) individuals in trawl catches relative to those during the modelling period.

Length data were assumed to arise from a Dirichlet-multinomial probability distribution. Other assumptions include instantaneous length sampling, logistic selectivity, adequate description of growth by the von Bertalanffy equation, and that both sexes have the same growth.

## Sources of uncertainty evaluated:

### Production model

Sensitivity of the model to a range of alternative assumptions and model inputs was evaluated by implementing 15 additional model scenarios, including those that varied CPUE inputs, NSW commercial catch during an uncertain reporting period (1986-2000), recreational harvest estimates from NSW, and added trawl discard estimates in NSW after the introduction of the minimum legal length (MLL) in 2007.

### Length-only model

Sensitivity of the model to natural mortality, steepness of the stock-recruitment relationship and growth parameters was evaluated by implementing additional model scenarios that varied each parameter while holding the others constant. A two-fleet scenario was also investigated to explicitly include non-targeted sampling from the fishery-independent trawl survey.

## Status Indicators - Limit & Target Reference Levels

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| Biomass indicator or proxy | $B/B_0$ |
| Biomass Limit Reference Point | $B_{20}$ (20% of pre-exploitation spawning biomass), through adoption of the Australian standard in national SAFS reporting |
| Biomass Target Reference Point | NA |
| Fishing mortality indicator or proxy | $F/F_{msy}$ |
| Fishing mortality Limit Reference Point | NA |
| Fishing Mortality Target Reference Point | NA |

## Stock Assessment Results

The NSW Silver Trevally stock is classified as **depleted**. The status is based on:

1) Prediction that current biomass is <20% of unfished biomass in most scenarios of the production model (Figure 3).

2) Prediction from length-only modelling that biomass declined below 5% of unfished biomass by the year 2000 and remained low until the end of the series (2007, Figure 4), with all scenarios indicating the biomass fraction in 2007 was ≤5.1%.

3) No increase in the proportion of large size-classes in trawl catches between 2007 and 2022 (Figure 5).

Results of uncertainty evaluation

Sensitivity scenarios run for the production model consistently estimated the current depletion of biomass to be close to, or below, the limit reference point of 20% $B_0$. Median estimates from the base-case and 11 sensitivity scenarios were less than 20% and 4 sensitivity scenarios produced median estimates slightly greater than 20%.

The declining trajectory of predicted biomass was consistent across all sensitivity scenarios of the length-only model, including the two-fleet scenarios with non-targeted trawl data. Final biomass fractions in 2007 were ≤5.1% in all cases.
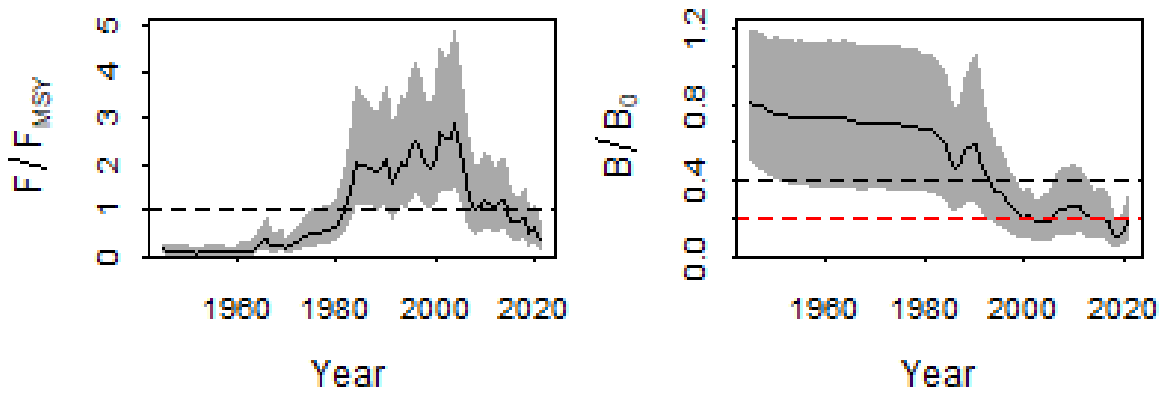
**Figure 3** Estimates of $B/B_0$ and $F/F_{msy}$ from the base-case JABBA production model during the period 1945 – 2021. The dashed black horizontal lines indicate values at MSY. The dashed red horizontal line indicates levels of biomass at 20% of $B_0$. The grey shading indicates the 90% credibility intervals around the estimates.
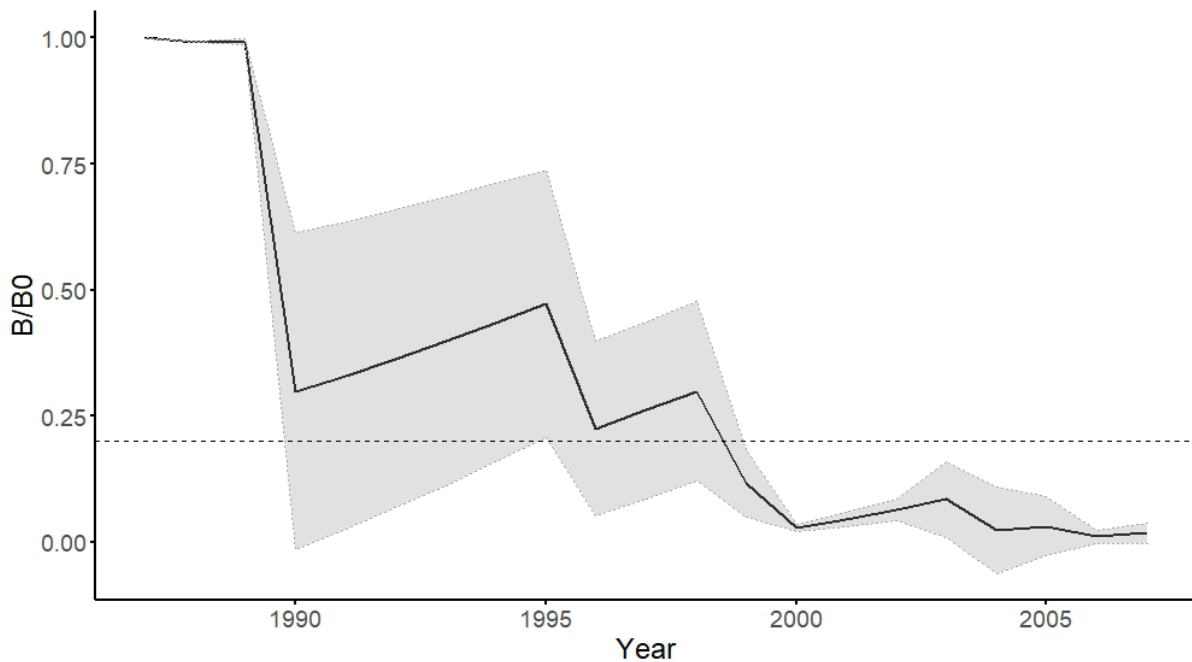


**Figure 4** Estimates of $B/B_0$ from the base-case length-only (SS-LO) model during the period 1987 – 2007. The grey shading indicates the 95% confidence intervals around the estimates.
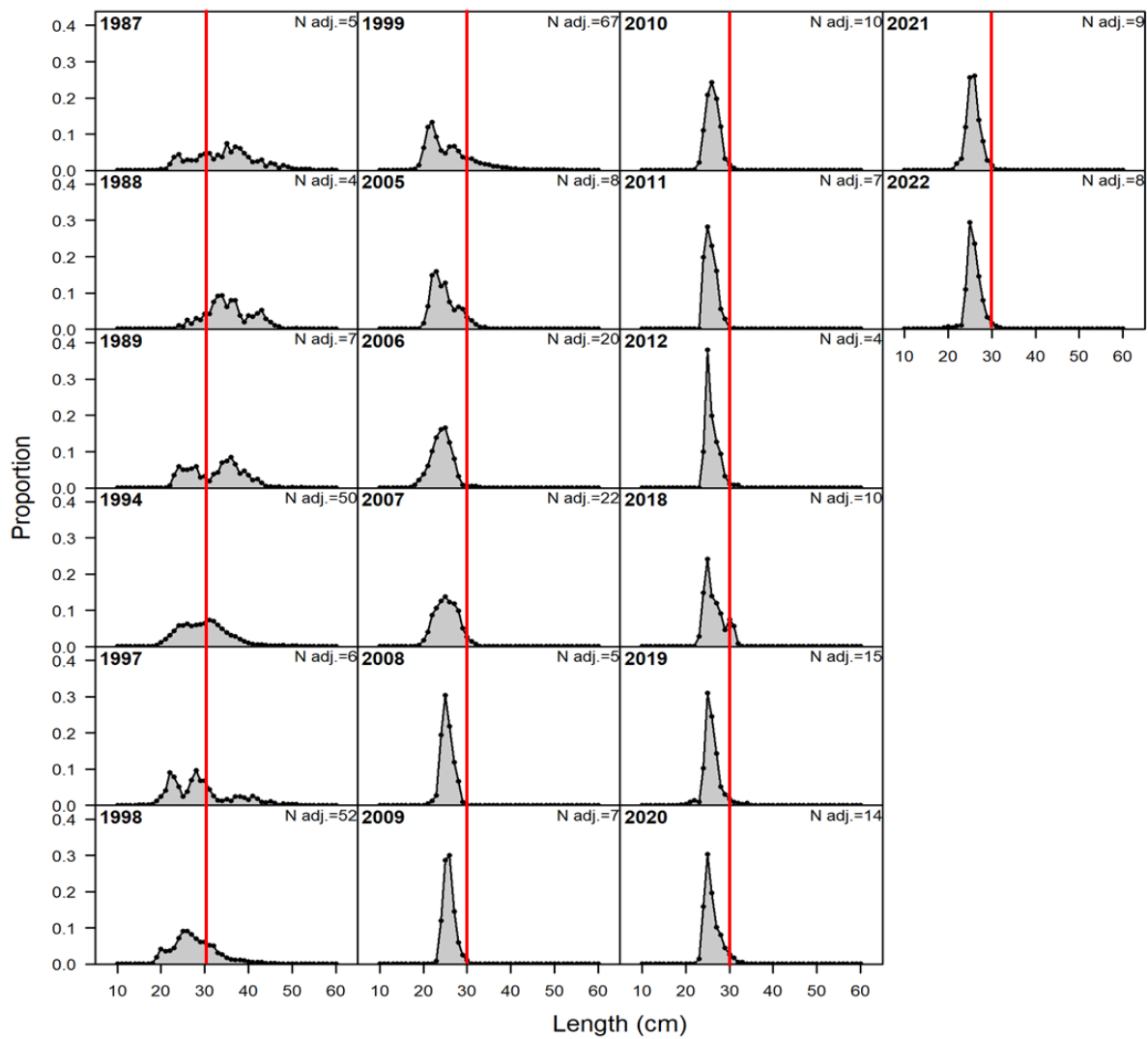
**Figure 5** Length compositions of Silver Trevally from trawl catches in NSW during 1987 and 2022, including an onboard observer study (1994). The red line indicates a fork length of 30 cm.

## Stock Assessment Result Summary

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|---|---|
| Biomass status in relation to Limit | **B/B$_0$ < 20% in most model scenarios**<br><br>Production model (base-case, last series value [2021]): B/B$_0$ = 18.2%<br><br>Length-only model (base case, last series value [2007]): B/B$_0$ = 1.9%.<br><br>No recovery of large size classes between 2007 and 2022. |
| Biomass status in relation to Target | NA |
| Fishing mortality in relation to Limit | NA |
| Fishing mortality in relation to Target | NA |
| Current SAFS stock status | Depleted (NSW) |
| Current Commonwealth stock status | Not overfished<br>Not subject to overfishing |

## Fishery interactions

Silver Trevally are fished in the adjacent Commonwealth Trawl Sector (CTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF), as well as in Victoria and Queensland.

## Stakeholder engagement

NSW DPI Fisheries presented the current stock assessment to stakeholders in the Ocean Trawl Fishery on the 18th January, 2023, to outline the assessment process and provide an opportunity for feedback.

Two stakeholders provided comment on the current assessment. One stakeholder noted that trawl fishers were actively avoiding areas known for Silver Trevally due to the undesirability of small fish, and that this may have affected CPUE values. The other stakeholder noted the larger catches historically taken in the OTFN, and that the current status of the stock was concerning.

DPI expressed to stakeholders that the current assessment uses numerous types of data in addition to CPUE, and that the model based on length data supports the results of the model based on catch and CPUE. More recent events in the fishery cannot account for the steep decline in biomass estimates from the mid-1980s to the early 2000s, nor the long-term truncation in length structure.

## Qualifying Comments

NSW catch and effort logbook data vary spatially and temporally across different eras, delineated by changes in fisher reporting requirements and other management changes. The change in the method of effort reporting during 2009/10 limits the certainty with which conclusions can be made regarding shifts in effort and catch rates around that time. The establishment of the Batemans Bay Marine Park may also have affected trends in fishery metrics, potentially reducing catches and catch rates following 2007, however these are likely to be restricted to that area of the coast. Lastly, the introduction of the MLL likely reduced landings across the state after 2007.

Results from data-limited assessment methods must be interpreted with caution, given the limited information used to model population parameters and stock status.

Factors other than fishing, including climate change and other environmental processes, may affect changes in the abundance and biological functioning of the Silver Trevally stock through time.

## References

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