Stock Status Summary – 2021/22

NSW Stock Status Summary – Silver Trevally (*Pseudocaranx georgianus*)

Assessment Authors and Year

Fowler, A.M., Liggins, G., and Chick, R. C. 2021. NSW Stock Status Summary 2021/22 – Silver Trevally (*Pseudocaranx georgianus*). NSW Department of Primary Industries, Fisheries. 11 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. 2021a). Acknowledging this, the 2021/22 NSW stock assessment for Silver Trevally is conducted at the jurisdictional level, although the production modelling component incorporates both reported catch and discards from the Commonwealth Trawl Sector (CTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF). Catch from NSW and the CTS were combined because: 1) the two jurisdictions likely share the same stock of Silver Trevally, given they are adjacent to each other and primarily separated in an on-offshore direction, 2) some CTS catch was reported as NSW catch between 1985-2000.

This report provides a stock status summary from a more detailed NSW stock assessment report (Fowler et al. 2021b).

Biology

Silver Tevally 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

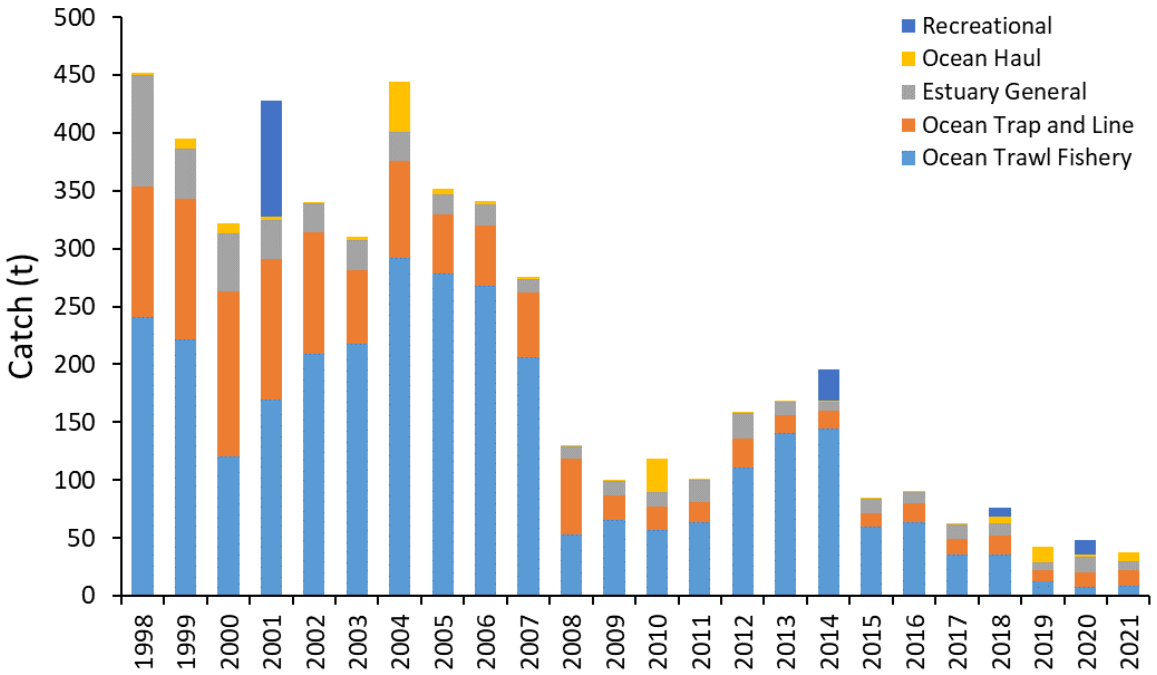
Commercial

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 (OH). During the period 1998–2021, the OTF accounted for 59% of landings by weight (inter-annual range: 22–86%), with landings in the OTLF and EGF accounting for 24% (range: 9–50%) and 13% (range: 4–36%), respectively (Figure 1).

Total catch, including commercial landings from NSW and the CTS, trawl discards, and recreational harvest in NSW, was generally < 200 t during1950-1970. Catch then increased rapidly to >1400 t during the early 1980's, after which it has declined substantially to present day.

Substantial discarding has been observed within the OTF following the introduction of the minimum legal length (MLL) in 2007 (NSW DPI, unpublished). Discards were estimated between 16 and 38% of landed catch by onboard observers within the Commercial Fisheries Observer Program (CFOP) during 2015 and 2016 (NSW DPI, unpublished).

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 2021.



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 (NSW DPI unpublished). 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.

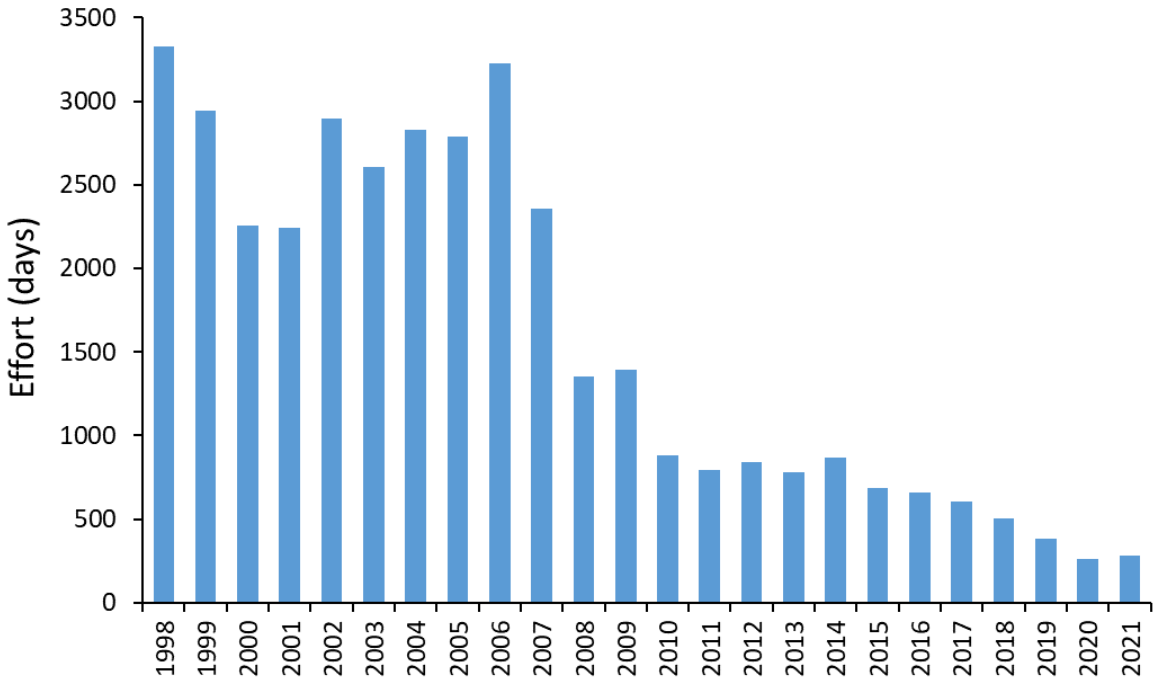
Illegal, Unregulated and Unreported

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 264 days in 2020. Effort during the most recent reporting year was slightly higher at 281 days.

Figure 2. Annual trawl effort (days) for Silver Trevally from 1998-2021. Note: days of effort for the period 2010-2021 were estimated from the number of distinct fishing dates in each month.

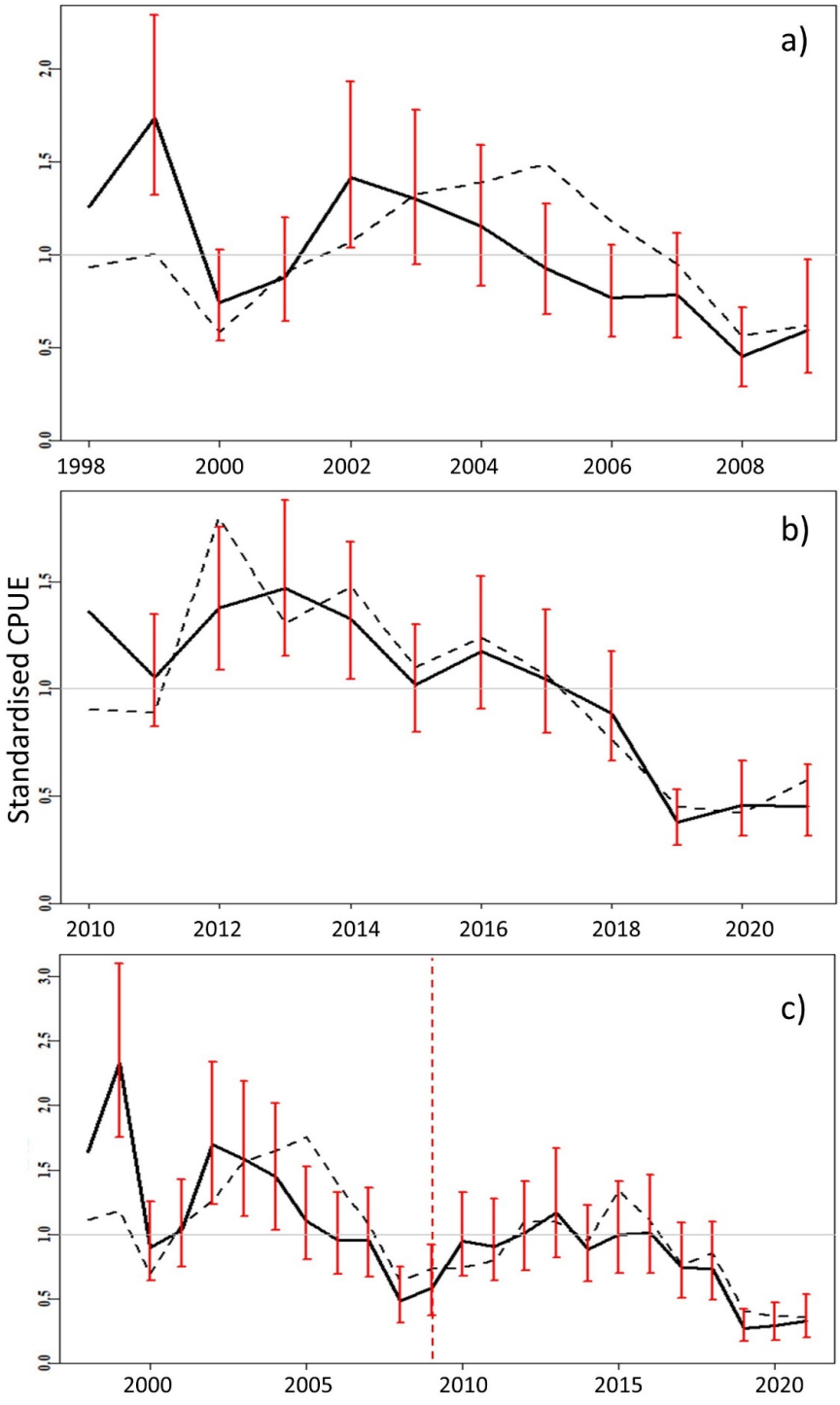


Catch Rate information

Standardised catch rates (kg.day^{-1}) from commercial fish trawling and fish trapping during 1998-2021 were examined. Catch rates during 1998-2009 were examined separately from those in 2010-2021 due to a reporting change in 2009/10. The entire period was also examined in a third analysis. Catch rates were standardised for a range of variables that may spuriously influence trends (see Key model structure and assumptions).

Catch rates for fish trawl declined during both the 1998-2009 and 2010-2021 periods (Figures 3a and b). Catch rates across the entire period also showed the initial decline, but then increased after 2008, and remained relatively stable between 2011 and 2016. Catch rates then declined again, with the most recent three years the lowest ever recorded (Figure 3c). Catch rates for fish trapping showed an earlier (pre-2005) and more substantial decline than those for trawling, followed by relatively low and stable catch rates to present day.

Figure 3. Standardised catch rate (solid line) of Silver Trevally for fish trawl method in NSW during: a) 1998 - 2009, b) 2010 - 2021 and c) 1998 - 2021. Units for Panels a and c are kg.day^{-1}, whereas the unit for Panel b is kg.h^{-1}. The dashed black line indicates the geometric mean catch rate. Red bars indicate 95% confidence intervals. The dashed red line indicates the reporting discontinuity.



STOCK ASSESSMENT

Stock Assessment Methodology

Year of most recent assessment:

2021/22 (using data to 2020/21)

Assessment method:

A weight-of-evidence approach based on standardised catch rates, production modelling, spawning potential ratio modelling, modelling of fishing mortality relative to natural mortality (F/M).

Main data inputs:

- Commercial landings –
    - Landings (t) reported in NSW during 1950-2021. These include landings from the OTF, OTLF, EGF, and OHF.
    - Landings (t) reported in the Commonwealth Trawl Sector (CTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF) during 1985-2020.
- Commercial trawl discards – estimates of commercial trawl discards in NSW from an on-board observer study conducted during 1993-1995 (Liggins 1996) and the NSW CFOP during 2015 and 2016. Estimates of commercial trawl discards from the CTS during 1998-2015.
- Commercial catch rates (CPUE) – standardised CPUE for fish trawl (kg.day^{-1}, kg.hour^{-1}; OTF) and fish trap (kg.day^{-1}, kg.trap^{-1}; OTLF) methods in NSW during 1998-2021.
- Recreational harvest – four estimates of recreational harvest (t) in NSW obtained by converting estimated numbers caught from statewide telephone-diary surveys (2000/01, 2013/14, 2017/18, and 2019/20) to weight using average catch weights from the recreational sector.
- Length composition data – Lengths of individuals sampled from commercial catches in NSW between 1993 and 2021. Data during 1993-1995 were obtained from an observer study conducted on board commercial trawl vessels in NSW, and separately from a fishery-independent survey conducted using commercial trawl gear. Data during 2005-2021 was obtained from commercial trawl, trap and line catches sampled in fish markets.

Key model structure & assumptions:

Catch rate (CPUE) standardisations

Raw catch rates were standardised using general linear models in the R package ‘cede’ (v. 0.0.4, Haddon 2018). Standardising variables included month of capture, ocean zone, fishing business (as a proxy for ‘vessel’ in the trawl fishery, and the trap fishery prior to 2010), authorised fisher (as a proxy for ‘vessel’ in the trap fishery from 2010 onward), and an interaction between month and ocean zone.

Assumptions of CPUE analyses include accurate catch and effort data, and that changes in CPUE reflect changes in stock abundance.

Production model

A Bayesian space-state surplus production model (BSM) was used to estimate biomass (B/B_{msy}) and fishing mortality (F/F_{msy}) fractions (Froese et al. 2017). The model is fitted using both catch and CPUE, and sets bounds for *r*, *k*, and start, intermediate, and final year saturation by deriving density distributions. The model also adds a prior for catchability, q.

The base-case historical catch series used in the BSM was comprised of: 1) landings reported to NSW from 1950-2021 from all fisheries, 2) half the landings reported from the Commonwealth Trawl Sector (CTS) from 1985-2000, 3) all landings reported from the CTS from 2001-2021, 4) trawl discard estimates from NSW (intermediate-level [27%] estimates from 2008 onward) and discard estimates from the CTS, and 5) estimates of recreational fishing harvest from NSW during 1950-2021.The BSM was run separately for fish trawl and fish trap CPUE series spanning 1998 to 2021. A resilience input of "low" was used, based on the maximum recorded age of Silver Trevally in NSW.

The approach assumes accurate catch and effort reporting, discard estimates, and recreational harvest, along with no effect of reporting changes on CPUE trends during 1998-2021. The model assumes that *k* was log-normally distributed and that the mean of the *k*-ranges provided a reasonable central value.

Spawning potential ratio and F/M

Length Based – Spawning Potential Ratio (LB-SPR) modelling was conducted to provide a complimentary assessment that does not rely on commercial catch data (Hordyk et al. 2015). The LB-SPR approach draws on size structure and SPR in harvested populations, being a function of relative fishing pressure (F/M) and life history ratios. A maximum likelihood approach is used to estimate selectivity, F/M and SPR with a smoother function used to reduce noise in multi-year estimates. Life-history input parameters were obtained from Rowling and Raines (2000), with natural mortality (*M*) of 0.10 used as a base case.

Model assumptions include normal distribution of length-at-age, logistic selectivity, adequate description of growth by the von Bertalanffy equation, and that both sexes have the same growth curve and sex ratio of catch at parity.

Sources of uncertainty evaluated:

Standardised CPUE

Discarding has been observed within the OTF following the introduction of the MLL in 2007. To examine the potential effect on CPUE trends, discard estimates were added to catch data from 2008 onward and catch rates were re-standardised. A range of discard adjustments were examined (16%, 27% and 38%), spanning the range of discard rates in the OTF recorded by onboard observers within the Commercial Fisheries Observer Program (CFOP) during 2015 and 2016 (NSW DPI, unpublished).

Production model

Three components of the base case catch series were varied to examine model sensitivity: 1) landings reported in the CTS during 1985-2000, 2) NSW trawl discards from 2008 onward, and 3) recreational harvest. High and low scenarios were developed for each component while holding the rest of the base case constant, resulting in six additional catch series. Each of these were combined with both trawl and trap CPUE series, generating 14 model runs in total, including the base case.

Spawning potential ratio and F/M

The sensitivity of model outputs to the natural mortality input (M) was examined by rerunning the LB-SPR model with a low (M=0.05) and high (M=0.15) value.

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	Standardised CPUE, B/B_{msy}, SPR
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}, F/M
Fishing mortality Limit Reference Point	NA
Fishing Mortality Target Reference Point	NA

Stock Assessment Results

The status of the NSW Silver Trevally stock is classified as **depleted**, with most model outputs indicating that current depletion is below 20% of unfished biomass. Specific lines of evidence include:

1) Historically low standardised catch rates in two NSW fisheries (OTF and OTLF);
2) Truncation (fewer large fish) of commercial length structure, from 72% of fish > 30 cm fork length (FL) in 1993 to 2% of fish > 30 cm FL in 2019-2021;
3) Historical decline of B/B_{msy} estimates from production models that has been maintained to the current assessment period (Figure 4). Note that B/B_{msy} is double the value of B/B_0, indicating current stock biomass is < B_{20}.
4) Historical increase of F/F_{msy} estimates from a production model using fish trawl CPUE (OTF) that has been maintained to the current assessment period, noting that a model using fish trap CPUE (OTL) suggests F/F_{msy} has recently returned below 1 (Figure 4).
5) Low SPR (<15%) and increasing F/M estimates after 1993-1995 from LB-SPR models conducted on commercial length samples from 1993 to 2021. SPR is similar to B/B_0.

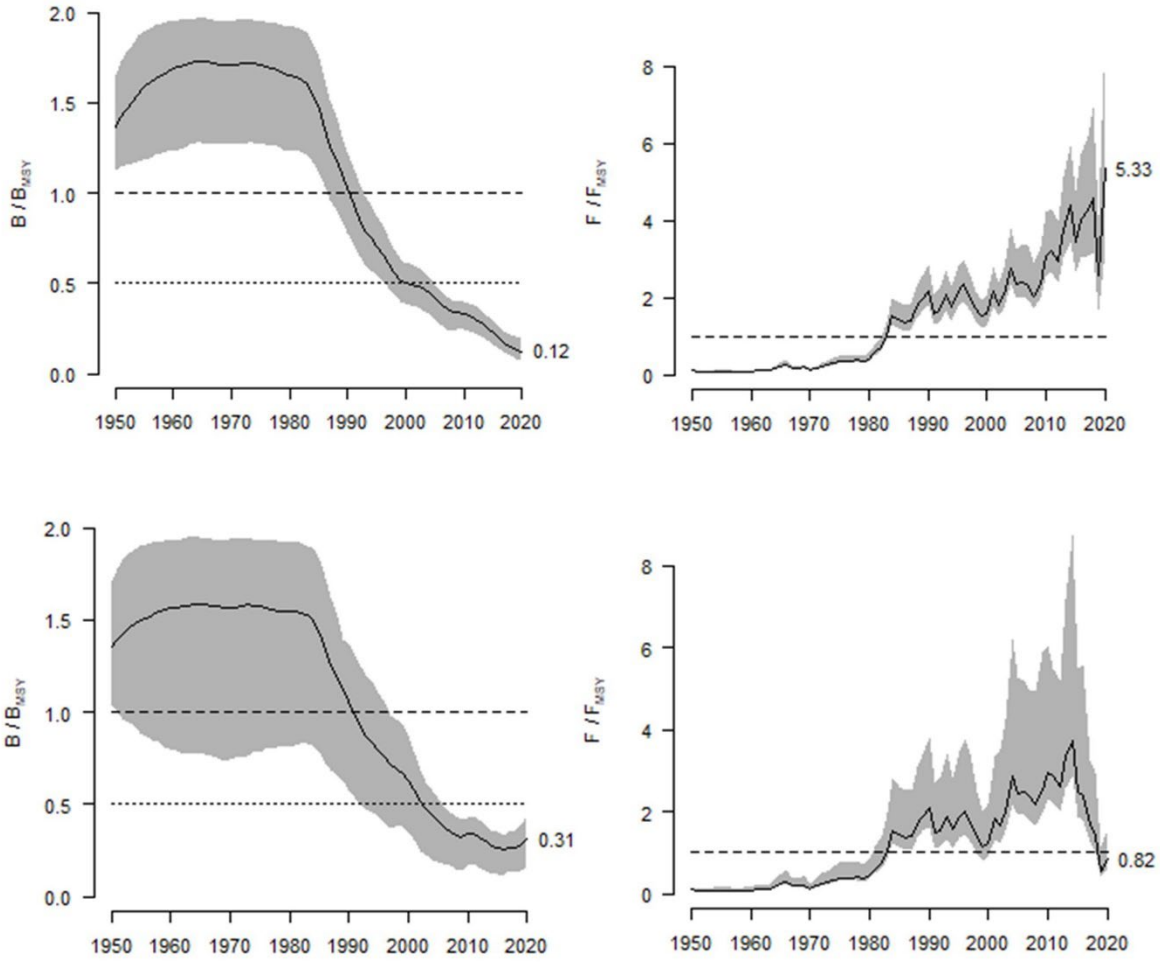
<u>Results of uncertainty evaluation</u>

Standardised CPUE for fish trawl increased from 2008 when discard estimates were added to catch; however CPUE for the last three years remained the lowest in the series (1998-2021)

Biomass fractions from the BSM differed between trawl and trap CPUE series, but were below B_{20}. Outputs were not sensitivie to variations in the historical catch series.

SPR and F/M were sensitive to the value of natural mortality (M) used in the LB-SPR model. SPR in the most recent period (2019-2021) was 4 and 24% for M of 0.05 and 0.15, respectively. F/M was 7.3 and 2.4 for M of 0.05 and 0.15, respectively.

Figure 4. Estimates of B/B_{msy} and F/F_{msy} from the BSM using the base case catch series from 1950-2021. The top panels indicate model outputs when a fish trawl CPUE series from 1998-2021 was used, the bottom panels indicate model outputs when a fish trap CPUE series over the same period was used. Note that B/B_{msy} is double the value B/B_0.



Stock Assessment Result Summary

Biomass status in relation to Limit	**B and SPR < 20% of B_0 (or equivalent)** Production model (base-case, 2020 values): B = 6% (trawl CPUE) and 16% (trap CPUE) of B_0 LB-SPR model (base case, 2019-2021 values): SPR (B equivalent) = 12%
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	Sustainable • Not overfished • 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 Victorian and Queensland fisheries.

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.

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