Department of Primary Industries
Department of Regional NSW

NSW Stock Status Summary – 2023/24

Bluespotted Flathead (*Platycephalus caeruleopunctatus*)

Karina Hall (2024)

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

Hall, K. C. (2023) Stock assessment report 2023/24 – Bluespotted Flathead (*Platycephalus caeruleopunctatus*). NSW Department of Primary Industries, Fisheries Research: 65 pp.

Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Bluespotted Flathead is currently assessed as a **sustainable stock**.

Stock structure & distribution

Bluespotted Flathead (*Platycephalus caeruleopunctatus*, CAAB 37 296007) occurs in estuarine and coastal waters to depths of 80 m from southern Queensland to eastern Victoria. The stock structure of Bluespotted Flathead has not been formally investigated and remains unknown. However, a review of the species' taxonomy that examined specimens from along the NSW coast and Lakes Entrance, Victoria, identified no significant variation in morphological characters within the species (Imamura, 2015). Limited tagging data also suggest that, while some individuals show high site fidelity in estuarine habitats, other individuals move large distances in coastal waters within a short period (Fetterplace *et al.*, 2016). Therefore, some longshore mixing of populations is possible.

On the basis of this evidence, assessment of the stock status of Bluespotted Flathead is presented at the biological stock level – Eastern Australia.

Scope of this assessment

This report provides a determination of stock status for Bluespotted Flathead (*Platycephalus caeruleopunctatus*, CAAB 37 296007) according to the Status of Australian Fish Stocks (SAFS) framework (Piddocke *et al.*, 2021), using data up to and including 2022/23. Only data from NSW are used to assess the stock status. While the species' distribution extends into Commonwealth, Queensland and Victorian waters, separate historical landings data are only available for NSW waters. Bluespotted Flathead is listed among the combined species taken under the basket Tiger Flathead TAC of the Commonwealth Southern and Eastern Scalefish and Shark Fishery (SESSF) in offshore waters south of Barrenjoey Point; however, recent landings data suggest that the species comprises a negligible (2.3–9.5 t) component of the total catch (AFMA unpub. data).

A total allowable catch (TAC) of 108.1 tonnes (t) was introduced for Bluespotted Flathead in the NSW Ocean Trawl Fishery in state waters north of Barrenjoey Point for the 2019-20 fishing season (1 May 2019 to 30 April 2020) and has remained in place in all subsequent years (Mapstone *et al.*, 2020; NSW TAF Committee, 2021). No catch quota was implemented for the Southern Fish Trawl Restricted Fishery in state waters south of Barrenjoey Point; however, those catches have been restricted by a combined flathead trip limit of 200 kg since 1996. Recreational and charter boat catches are limited by a daily bag limit of 10 (in total with Tiger Flathead, *Platycephalus richardsoni*) or 20 in possession, and all fisheries are restricted by a size limit of 33 cm total length (TL).

Biology

Bluespotted Flathead reaches a maximum size of about 68 cm TL and 3 kg in weight, with a pronounced sexual dimorphism. Females attain larger sizes than males at equivalent ages (Barnes *et al.*, 2011). Males mature at about 1 year of age and 21 to 23 cm TL; while females mature later than males at 2 years of age and 28 cm TL in northern NSW and at 3 years of age and 35 cm TL in central NSW (Barnes *et al.*, 2022). The species is relatively fast growing and short-lived, reaching a maximum recorded age of just 9 years.

Fishery statistics

Catch information

Commercial

Total annual reported commercial catches of Bluespotted Flathead in NSW are available since 1947/48 to present (Fig. 1). Early commercial catches fluctuated considerably and then stabilised during the 1990s and 2000s at around 100–200 t per annum. Over recent years, catches decreased from 210 t in 2010/11 to 95 t in 2014/15, and then increased again to 137.2 t in 2017/18 and 124.6 t in 2018/19 before a TACC was introduced for the northern part of the fishery. In the three years since quota introduction, catches have decreased to historic lows of 63.3 t in 2021/22 and 65.8 t in 2022/23 (Fig. 1). Recent estimates of recreational catches from 2019/20 and 2021/22 surveys were also much smaller than previous estimates (Fig. 1).

Most of commercial catch of Bluespotted Flathead from NSW waters is taken by fish and prawn trawling in the Ocean Trawl Fishery (OTF) (Fig. 2). Since 1997/98, the proportion of Bluespotted Flathead commercial catch taken by the OPT has gradually decreased relative to that of the NFT (Fig. 2). However, the decrease in commercial catches between 2010/11 and 2014/15 and then increases during recent years have been primarily due to fluctuations in the NFT sector, which accounted for 71.2% of the OTF catch in 2018/19. Catches along the south coast (OZ6–OZ10) by the Southern Fish Trawl Restricted Fishery have remained relatively stable, and only account for on average 10.6% of the total commercial catch (Figs 2 and 3).

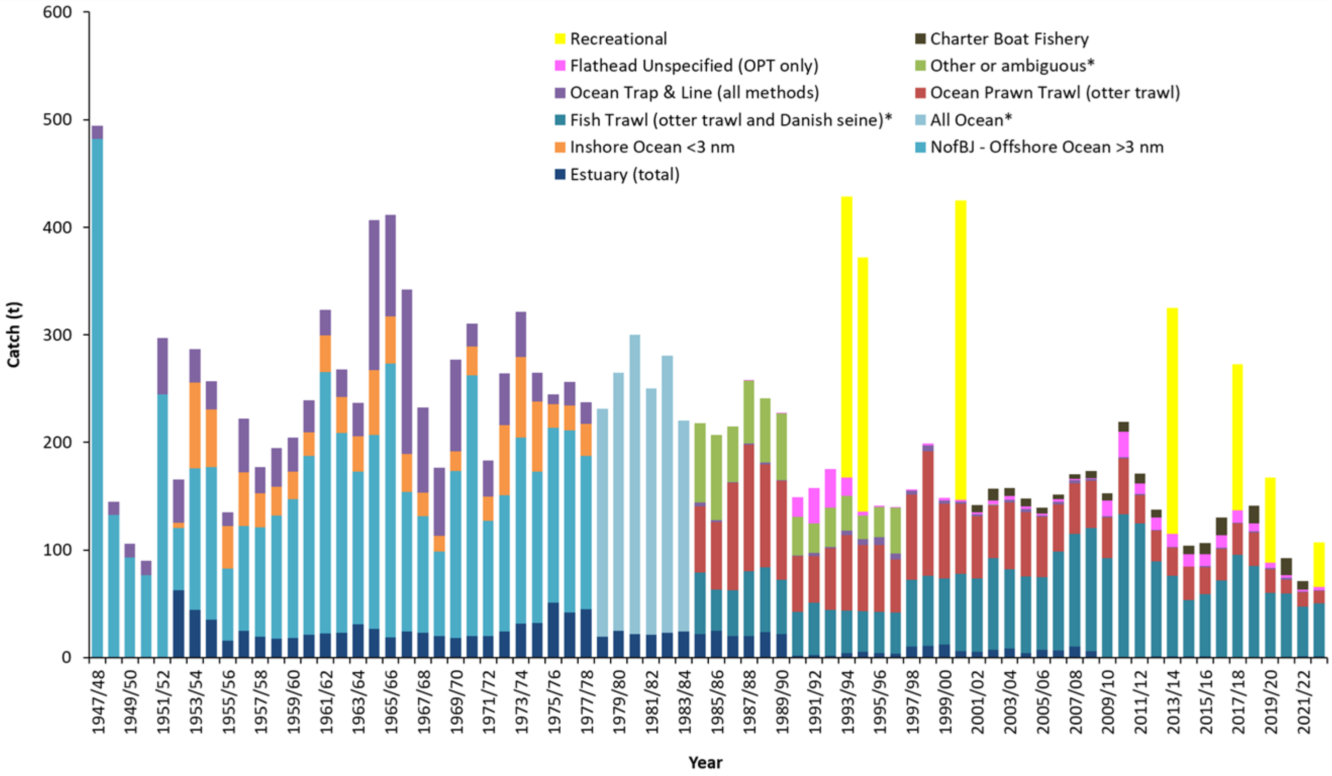

Figure 1 Annual total catches (tonnes) of Bluespotted Flathead for all sectors in NSW waters between 1947/48 and 2022/23. Data for 2022/23 are preliminary and may not be complete. Offshore catches are only included north of Barrenjoey Point (NofBJ) and data in some sectors (*) and years (1978/79–1989/90) have been adjusted south of BJ to remove suspected Commonwealth catches. Recreational catch data are available from six surveys, with results adjusted to statewide estimates. Charter boat data are only available since 2000/01 and are included in recreational estimates in surveyed years. OPT=Ocean Prawn Trawl.

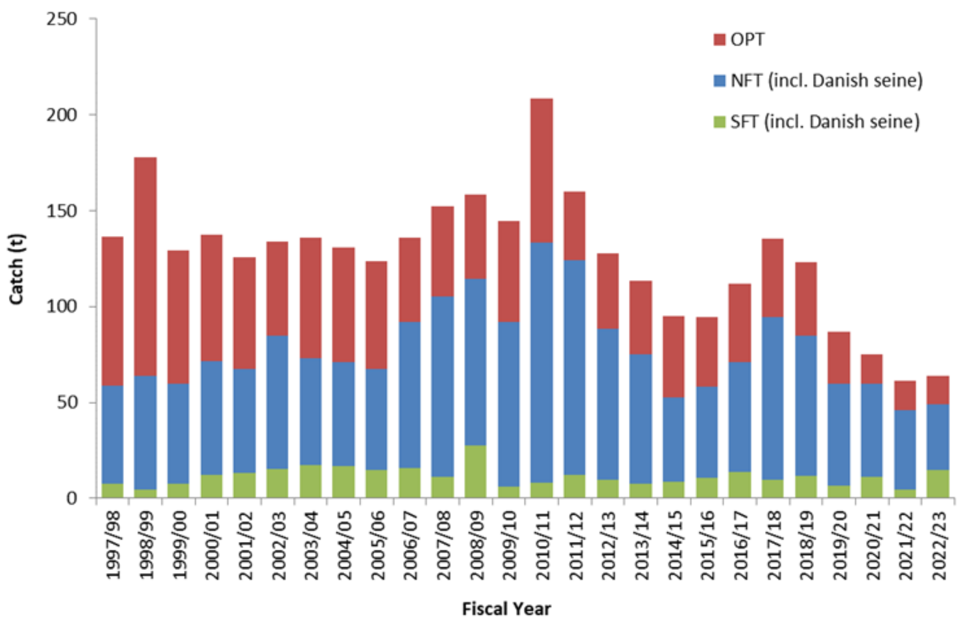

Figure 2 Annual commercial catches (tonnes) of Bluespotted Flathead in NSW waters (1997/98–2022/23) for different sectors of the NSW Ocean Trawl Fishery (OPT=ocean prawn trawl, NFT=northern fish trawl, SFT=southern fish trawl). *Data for 2022/23 are preliminary and may not be complete.

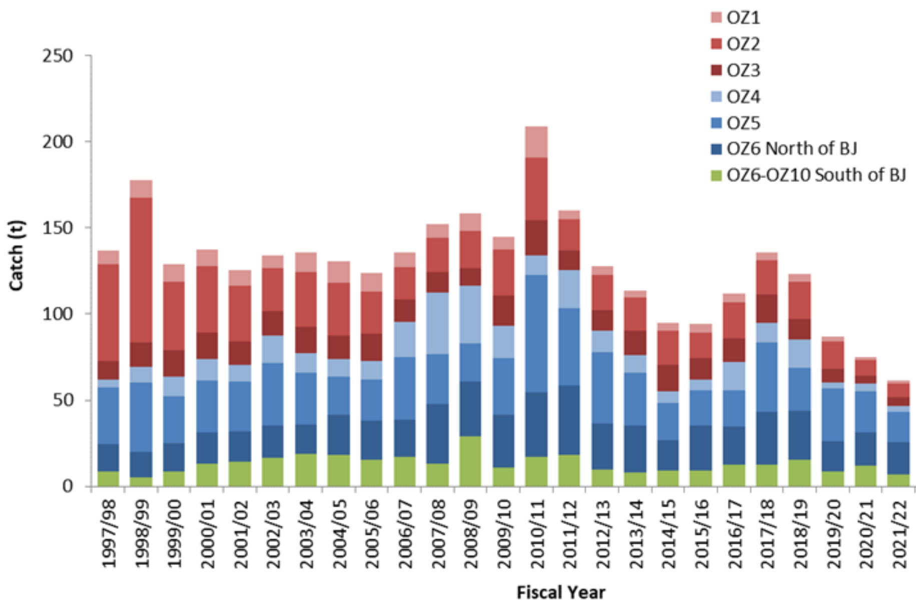

Figure 3 Annual commercial catches (tonnes) of Bluespotted Flathead from the NSW Ocean Trawl Fishery reported in different fishing zones (OZ1–OZ10), with catches in OZ6 divided into amounts taken from north and south of Barrenjoey Point (BJ) and zones south of BJ aggregated for confidentiality reasons. Data for 2022/23 are preliminary and may not be complete.

Recreational & Charter boat

Bluespotted Flathead is an important species for recreational fishers in NSW and historical harvests often far exceeded commercial catches (Fig. 1). Recent estimates of recreational catches of Bluespotted Flathead 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. The most recent estimate of the recreational harvest of Bluespotted Flathead in NSW was approximately 89,530 (± 15,502 SE) fish or around 42 t during 2021/22 (Murphy et al., unpub. data), which was considerably smaller than previous similar estimates: 416,195 (± 69,315) fish in 2013/14 (equivalent to 199 t), 281,844 (± 46,361) fish (129 t) in 2017/18 and 158,386 (± 32,788) fish (72 t) in 2019/20 (West et al., 2015; Murphy et al., 2020, 2022) (Fig. 4). In November 2014, the bag limit changed from 20 to 10 flathead in total per person, which may have contributed towards some of the decrease in subsequent catches. However, historical recreational catches in 2000/01 were estimated to represent 72% of the total NSW harvest of Bluespotted Flathead (when catches by interstate fishers and commercial catches were also included) (Hall, 2022); whereas, the equivalent estimate from the most recent survey in 2021/22 represented only 49% of total catches.

Bluespotted Flathead are also one of the main target species in the NSW Charter Boat Fishery (Hughes *et al.*, 2021). Reported catches from this sector are available from logbook reporting from 2000/01 to present (Fig. 5). Catches remained at <10 t in most years since 2000/01, until recent increases to 15.2–16.7 t between 2016/17 and 2018/19. The catch in 2019/20 was considerably lower (9.4 t) than in the preceding three years, which may reflect the influence of Covid-19 on tourism operations during the end of the 2019/20 financial year. Catches increased again in 2020/21 to 15.3 t, but were smaller again in 2021/22 and 2022/23, which may reflect the recent economic downturn (Fig. 5).

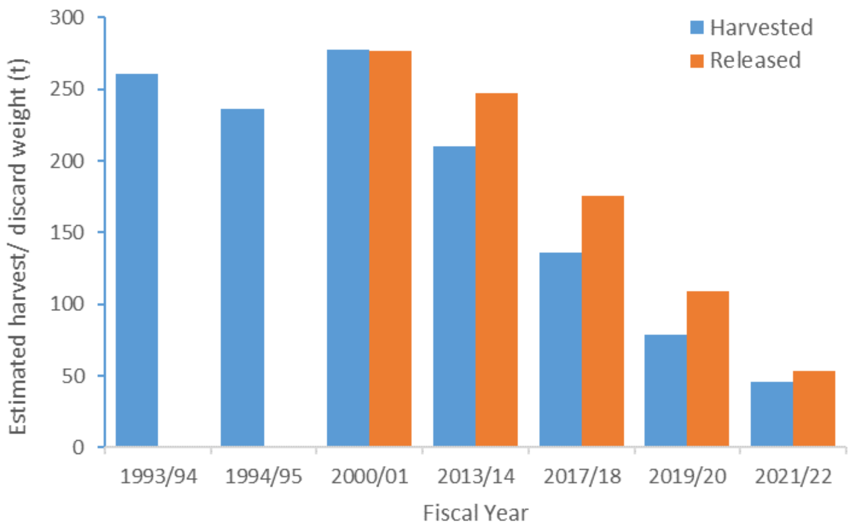

Figure 4. Estimated NSW statewide recreational harvest and discard weights of Bluespotted Flathead from surveys of recreational fishers between 1993/94 and 2021/22. Data sources and treatment are outlined in Hall (2022).

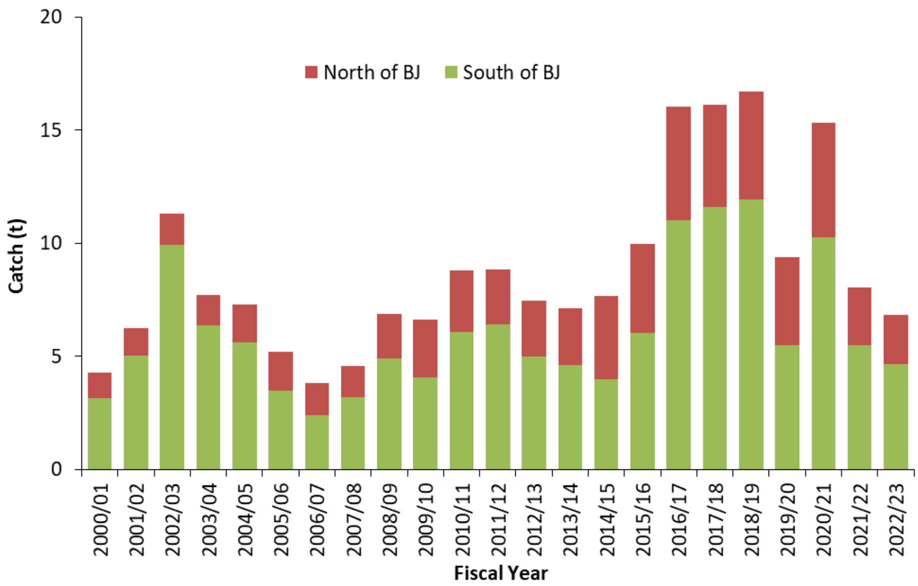

Figure 5. Estimated annual catches (tonnes) of Bluespotted Flathead in the NSW Charter Boat Fishery north and south of Barrenjoey Point (BJ) (2000/01–2022/23). Catch weights were estimated from the numbers of fish reported (see below). *Data for 2022/23 are preliminary and may not be complete.

Indigenous

The annual Aboriginal harvest of Bluespotted Flathead in NSW waters is currently unknown, but is assumed to be significant and requires quantification.

Illegal, Unregulated and Unreported

The level of illegal, unregulated and unreported (IUU) fishing is unknown; however, there is likely to be significant misreporting of Bluespotted Flathead as 'Unspecified Flathead' or 'Flathead (other)' in NSW waters (Hall 2018). To partially account for this discrepancy, the prawn trawl component of these unspecified catches has been included in the historical catch series. In 2019/20 this equated to 4.8 t, but has been as high as 24 t in 2010/11 and 35.4 t in 1992/93.

Fishing effort information

Commercial fishing effort for Bluespotted Flathead 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 Stout Whiting was reported on at least one day.

Reported effort for Bluespotted Flathead in the prawn trawl sector decreased rapidly during the mid-2000s, and then has remained more stable between 2009/10 and 2022/23 (Fig. 6). The reported effort in 2022/23 was 2,668 fisher days and 24,432 fisher hours, which represented just 12.4% and 17.9%, respectively, of the peak effort reported in 2002/03. Reported effort in the fish trawl sector has continued to decline since 2009/10 to reach a minimum in 2021/22 and rose slightly over the last year to 724 fisher days and 5,050 fisher hours in 2022/23 (Fig. 7).

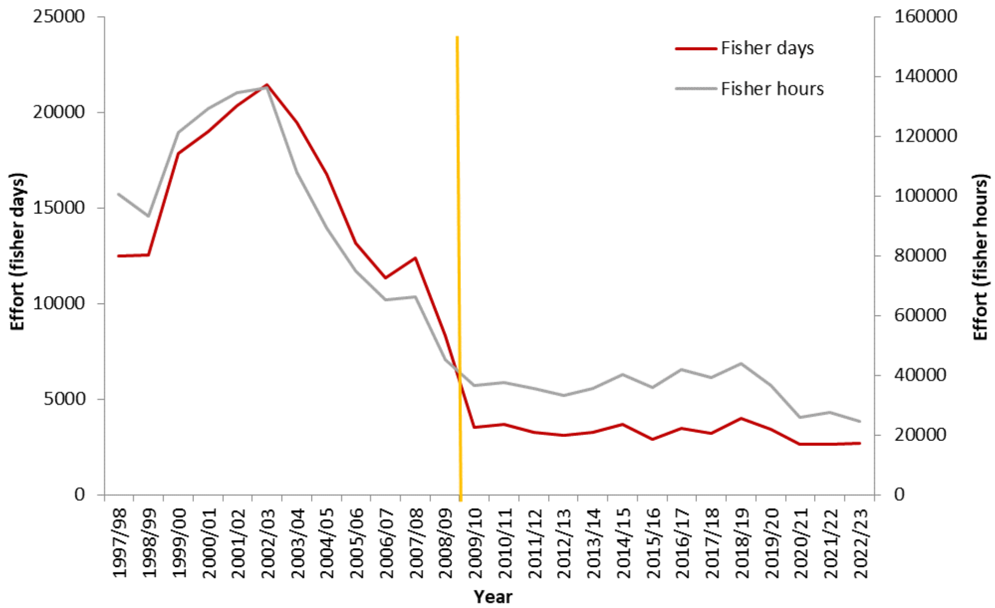

Figure 6 Annual total effort (fisher days and fisher hours) for prawn trawl fishers that reported landing Bluespotted Flathead on at least one day in any given month. The vertical gold line indicates the change from monthly to daily event reporting. Data for 2022/23 may be incomplete.

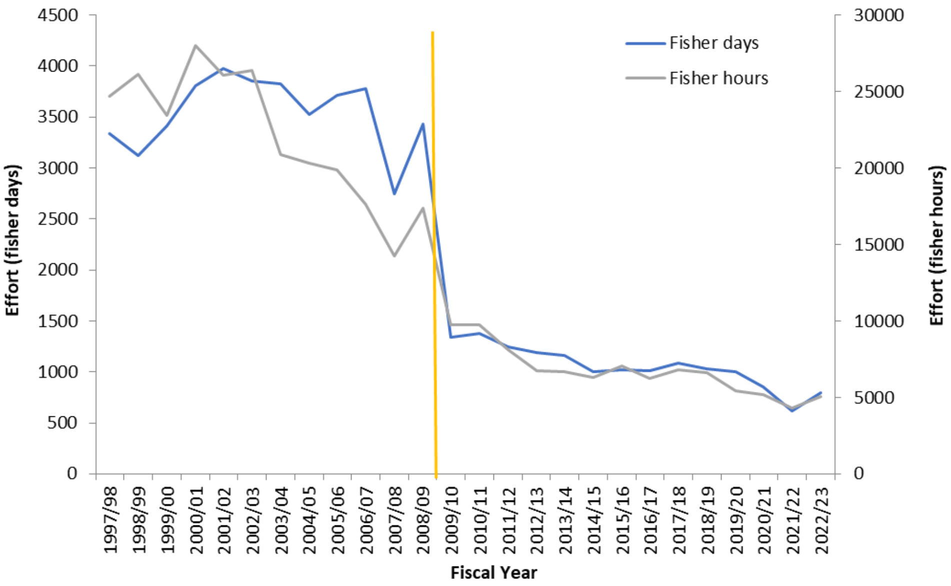

Figure 7 Annual total effort (fisher days and fisher hours) for fish trawl fishers (including Danish seine) that reported landing Bluespotted Flathead on at least one day in any given month. The vertical gold line indicates the change from monthly to daily event reporting. Data for 2022/23 may be incomplete.

Catch-rate information

Standardised catch rates (catch-per-unit-effort, CPUE) for Bluespotted Flathead taken by the ocean prawn and fish trawl (otter trawl only) sectors were compiled from monthly records (in kg per day) between 1997/98 and 2008/09 and daily event records (in kg per hour) between 2009/10 to 2022/23.

Historical mean standardised catch rates for the ocean prawn trawl sector declined by over 50% from 1997/98 to a minimum in 2001/02 and then gradually increased again between 2006/07 and 2009/10 to near the long-term average (Fig. 6). Following a rapid decrease in 2010/11, recent catch rates have remained steady near the long-term average until 2018/19 when quota was introduced. Over the last five years, prawn trawl catch rates have fallen rapidly to a level well below the long-term average in 2022/23 (Fig. 6). In contrast, standardised catch rates of the fish trawl sector showed an increasing trend from 1997/98 to a peak in 2010/11, before undergoing a steady decline to remain below the long-term average between 2013/14 and 2016/17, and since then have returned to and remained stable near the long-term average (Fig. 7). Anecdotal evidence from industry members suggests that the decline in prawn trawl catch rates may relate to increased discarding following quota introduction.

Mean standardised catch rates for the Charter Boat Fishery (in kg per angler hour) fluctuated around a steadily increasing trend between 2000/01 and 2018/19; however, over the last four years have also decreased back toward the long-term average (Fig. 8). Catch rates in this sector were unlikely to be influenced by the introduction of quota in the OTF in 2018/19, but also need to be interpreted with caution. Catch rates are typically small because total effort for each trip is used in their calculation, and flathead may be targeted for only part of the entire trip. Most of the charter catch derives from the south coast, where fish trawl catch rates have remained relatively stable (Hall, 2024).

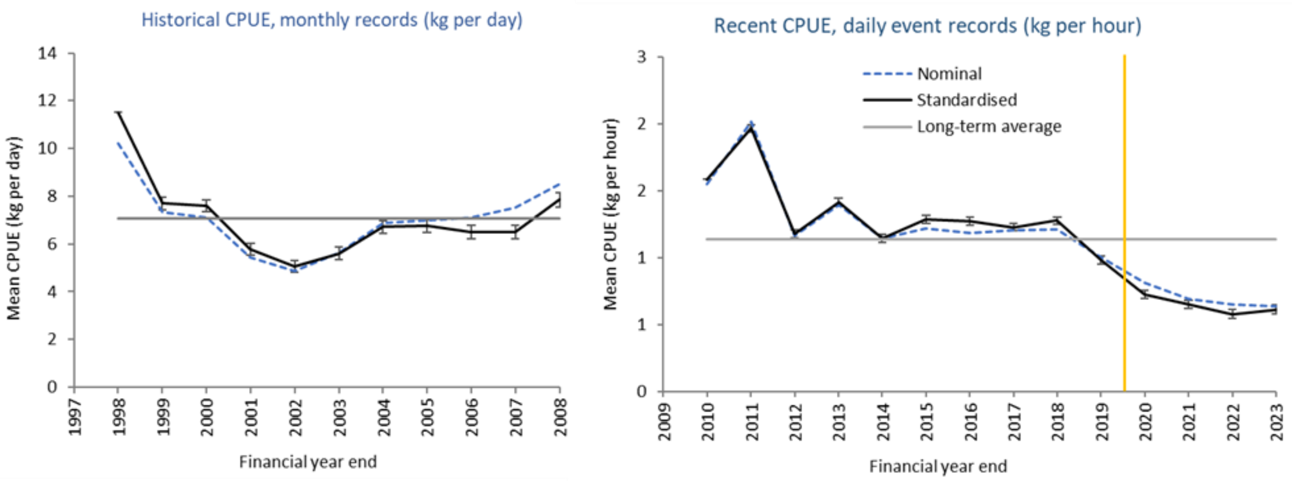

Figure 6 Mean standardised catch rates (catch-per-unit-effort, CPUE) of Bluespotted Flathead for the ocean prawn trawl sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1997/98–2008/09) in kg per day and from daily event records (2009/10–2022/23) in kg per hour. The dashed and solid lines indicate the nominal and standardised mean CPUE (± 95% confidence intervals), respectively; the grey horizontal line indicates the long-term average for each series; and vertical gold line indicates the introduction of quota.

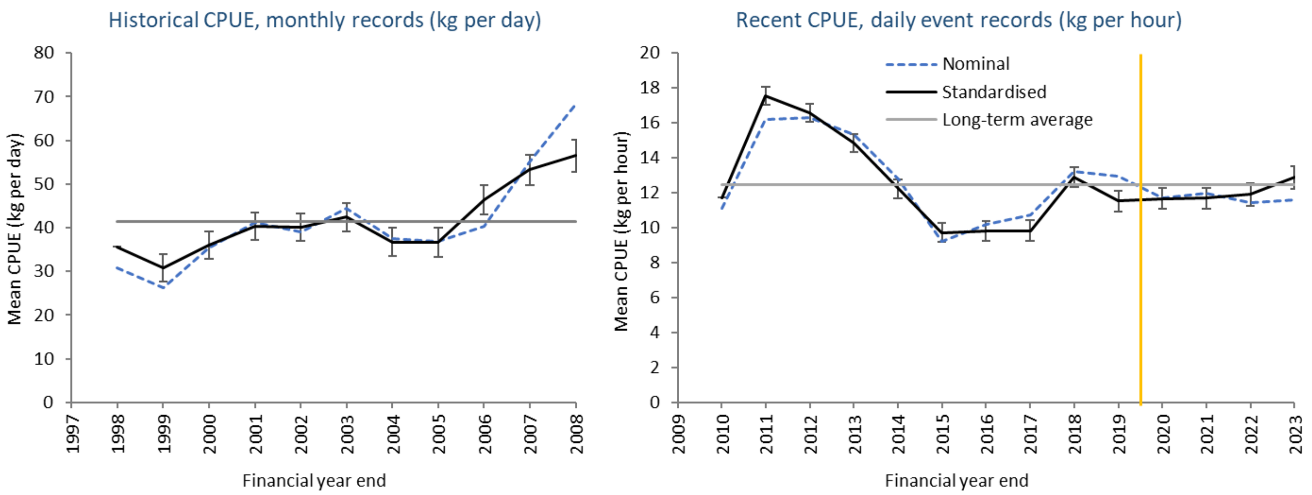

Figure 7 Mean standardised catch rates (catch-per-unit-effort, CPUE) of Bluespotted Flathead for the fish trawl sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1997/98–2008/09) in kg per day and from daily event records (2009/10–2022/23) in kg per hour. The dashed and solid lines indicate the nominal and standardised mean CPUE (± 95% confidence intervals), respectively; the grey horizontal line indicates the long-term average for each series; and vertical gold line indicates the introduction of quota.

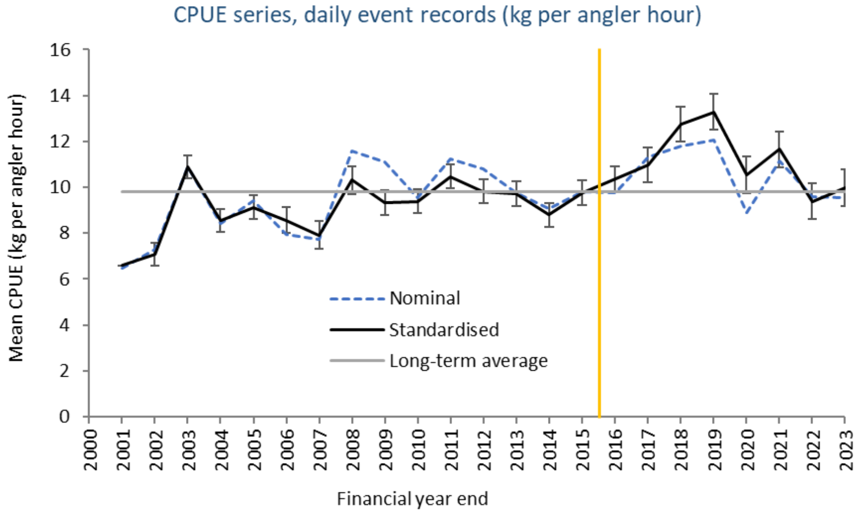

Figure 8 Mean standardised catch rates (kg per angler hour) of Bluespotted Flathead in the NSW Charter Boat Fishery (2000/01–2022/23). The dashed and solid lines indicate the nominal and standardised mean CPUE (± 95% confidence intervals), respectively; the grey horizontal line indicates the long-term average for each series; and the vertical gold line indicates the recent catch reporting change.

Stock Assessment

Stock Assessment Methodology

Year of most recent assessment:

2023 using data up to 2022/23 (Hall, 2024).

Assessment method:

This current stock assessment applied a weight-of-evidence approach to determine stock status of Bluespotted Flathead and included: (1) updated information for NSW fisheries statistics; (2) updated standardised catch rates for the fish and prawn trawl sectors of the commercial OTF and handline sector of the Charter Boat Fishery, standardised using the r-package 'rforcpue' (Haddon, 2023); and (3) two data-limited surplus production modelling (SPM) approaches, including a Bayesian state-space Schaefer production model (BSM, Froese *et al.*, 2017) that models a single CPUE series at a time that has been applied in previous assessments and a new more generalized Bayesian state-space estimation framework (JABBA) that allows for alternative models and multiple or split relative abundance indices. The models were applied to three historical catch series (spanning 1948/49 to 2022/23that included all commercial catches and discard estimates, but varied in the way historical recreational catches were estimated, combined with differing combinations of the three statewide CPUE indices (from 1997/98).

Previous catch-curve analyses of conditional age-structure data derived from age-length keys and length frequency data to estimate fishing mortality levels were also considered. These were last updated in 2021/22 (Hall, 2022) and historical data were analysed in previous assessments (Hall, 2018, 2020, 2021).

Main data inputs:

Historical standardised catch rates (CPUE in kg per day) - from commercial logbook data provided in monthly records for the prawn trawl (otter trawl) and fish trawl (otter trawl) sectors of the OTF by fiscal years (1997/98–2008/09).

Recent standardised catch rates (CPUE in kg per hour) - from commercial logbook data provided in daily event records for the prawn trawl (otter trawl) and fish trawl (otter trawl) sectors of the OTF by fiscal years (2009/10–2022/23).

Recent catch rates (CPUE in kg per angler hour) - from reported catch-and-effort data provided in daily event records for the handline and rod fishing sectors of the Charter Boat Fishery by fiscal years (2000/01–2022/23).

Commercial landings – reported annual commercial catches for all sectors north of Barrenjoey Point and for inshore waters south of Barrenjoey Point aggregated by fiscal years (1947/48–2019/20).

Estimated discards and rates – added to the catch in each year by applying the discard rates estimated from observer programs for the prawn trawl (1990–1992 and 2017–2019) and fish trawl (1993–1995 and 2014–2016) sectors to the catches for each sector.

Commercial catch rates – reported annual catch-and-effort data for two fleets – Queensland Finfish mixed Danish seine and otter trawl fleet in catch-per-hour and catch-per-shot from daily records (1990–2016); NSW OTF prawn and fish trawl fleet (combined Danish seine and otter trawl methods in Queensland analyses, Danish seine excluded in NSW analyses) in catch-per-day from monthly records (1998–2008) and daily event records (2010–2023).

Recent recreational catch data – estimated from six surveys, including ocean trailer-boat surveys (1993/94 and 1994/95), the national recreational and Indigenous fishing survey (2000/01), NSW statewide survey (2013/14) and NSW recreational fishing licence holder household surveys (2017/18, 2019/20 and 2021/22); proportionally adjusted to include catches for both NSW and interstate fishers and then interpolated across intervening years (between 1993/94 and 2022/23).

Historical recreational catch data - hindcast for years prior to 1993/94 via three different methods: (1) constant proportion (72%) of historic commercial catches based on survey results from 1993/94; (2) scaled in proportion to historic changes in the NSW population size (sourced from the Australian Bureau of Statistics, www.abs.gov.au); and (3) scaled in proportion to estimates of national recreational marine fishing effort derived from coastal population statistics and snapshot estimates of past participation rates (Kleisner *et al.*, 2015).

Key model structure & assumptions:

- **Standardised catch rates**

These analyses rely on the assumption that annual catch rates are a relative index of abundance that is not unduly influenced by other factors that are not accounted for through the standardisation process. Factors included in CPUE standardisations included year, month, fishing business ID, ocean zone (for pooled statewide analyses) and capture depth (assigned from the mean depth of the C-square grid code for daily event data).

- **Surplus production modelling**

The BSM analyses applied a simple discrete Schaefer SPM to describe the underlying dynamics of the stock in a Bayesian state-space model framework and Markov Chain Monte-Carlo (MCMC) simulation along with random observation and process error to produce likely trajectories of biomass depletion for the given catch and CPUE indices included (Froese et al., 2017). The Schaefer SPM assumes a symmetrical relationship with a biomass corresponding to MSY of 50% of unfished biomass (i.e., *BmsyK*=0.5). The JABBA modelling allows alternative SPM models (Pella-Tomlinson and Fox), in addition to the standard Schaefer model, to be fitted. The Pella-Tomlinson model assumes a range of surplus production shapes and for these analyses a *BmsyK*=0.4 was applied.

The base-case in all analyses comprised the catch scenario considered most likely (recreational catches estimated via the Kleisner approach) and the fish trawl CPUE series only, given that it accounts for most of the commercial catches. Priors for the base-case (for both modelling methods, BSM and JABBA) assumed a 'medium' level of resilience (productivity, *r,* prior range of 0.2 to 0.8), and an initial biomass level equivalent to *K* (i.e., initial depletion, ψ=1). A medium resilience for Bluespotted Flathead was selected, based on the species' short generation time (maximum age of 12 years and early age-at-maturity) and average mortality level of 0.45 (Froese *et al.*, 2019). Other parameters for the base-case JABBA model included a fixed observation error of 0.1 and a process error conforming to an inverse gamma distribution on a log scale with both scaling parameters set to 0.001.

Sources of uncertainty evaluated:

Nine different combinations of the three historical catch series with recreational catches hindcast using three methods and three different CPUE indices (from the statewide ocean prawn trawl, fish trawl and charter boat fleets) were analysed by the BSM and JABBA methods. The BSM could only consider a single CPUE series at a time, while the JABBA modelling allowed the integration of different combinations of the CPUE indices within the same model.

Given the large influence of the prior resilience level on model outputs, all models were also rerun using a 'low' resilience level (r prior range of 0.05 to 0.5) for sensitivity analyses. In addition, the JABBA models were rerun using a Pella-Tomlinson SPM for comparison with the standard Schaefer base-case. Other sensitivities explored included altering the fixed observation error from 0.1 to 0.2 and changing the initial biomass depletion from 1 to 0.9 and 0.75. Overall, 26 BSM and 18 JABBA model scenarios were run (Hall, 2024).

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	Estimated relative spawning biomass depletion (as a percentage of unfished biomass, K) from data-limited modelling approaches; and trends in annual standardised catch rates.
Biomass Limit Reference Point	Nominated Blim of 20% of unfished spawning stock biomass; and current catch rates are compared against long-term averages.
Biomass Target Reference Point	Nominated Btarg of 48% of unfished spawning stock biomass as a proxy for MEY.
Fishing mortality indicator or proxy	Estimated annual relative fishing mortality from data-limited modelling approaches; and fishing mortality estimates from catch-curve analyses of fishery-dependent age structures.

Fishing mortality Limit Reference Point	Level of fishing mortality (Flim) above which overfishing is occurring and biomass is depleting toward Blim; and fishing mortality estimates are compared against natural mortality estimates.
Fishing Mortality Target Reference Point	Level of fishing mortality (Ftarg) that would result in a spawning stock biomass of Btarg.

Stock Assessment Results

Standardised catch rate analyses

Trends in standardise catch rates diverged in recent time series, depending on sector. Recent catch rates in the fish trawl sector have remained stable near the long-term average; whereas, prawn trawl catch rates have decreased substantially over the last six year and particularly since quota was introduced in 2019. Charter boat catch rates have also decreased over the last three years, but remain near the long-term average.

Surplus production modelling

BSM analyses

Results from the BSM analyses produced a wide range of r and K parameter estimates (Table 8) and current relative spawning biomass estimates of between 24% and 88%, depending on the series analysed (Hall, 2024). In all cases, the current relative fishing mortality estimates (F/Fmsy) were well below the level required for MSY (Hall, 2024). The combination considered the most likely catch scenario and most reliable CPUE index (hereafter referred to as the 'base-case'), included all commercial catches and discard estimates and recreational catches scaled to the past participation rates (labelled 'rec Kleisner'), combined with CPUE series for the fish trawl sector. This base-case combined with an r prior for medium resilience (0.2–0.8) produced a current relative spawning biomass estimate of 62% of unfished biomass, with lower confidence bounds well above the limit reference point (Hall, 2024). The predicted MSY for this base-case scenario was 722 t. The second base-case considered, as above with an r prior for low resilience (0.05–0.5), resulted in a lower estimated r and higher estimated K, but similar current biomass depletion of 0.68% and MSY of 722 t.

Among the sensitivity analyses, all combinations that included the prawn trawl CPUE series (even with the last four years of data removed) produced lower relative spawning biomass estimates, with some lower confidence limits below the limit reference point of 20% of unfished biomass; whereas, all other combinations produced estimates above the limit reference point and near or above the nominated target reference point of 48% of unfished biomass (Hall, 2024). In all cases, other than those including the prawn trawl CPUE series, the lower confidence bounds of the current relative spawning biomass estimate were above the limit reference point. Changing the prior resilience level from medium to low, resulted in smaller posterior r estimates and much larger K estimates, and in many cases (but not all) a lower relative spawning biomass estimate for 2023 (Hall, 2024). Overall, however, changing the underlying catch and CPUE series had a much greater influence on model outputs than changing the other model parameter priors (Hall, 2024).

JABBA analyses

Results from the JABBA analyses produced lower *r* and higher *K* estimates for a given scenario relative to the BSM analyses, but more optimistic current relative spawning biomass estimates in most cases (between 49 and 88%). Changing the assumed resilience level *r* prior from medium to low resulted in a large decrease in estimated current relative spawning biomass (from 84% to 49%) and estimated MSY (912 t to 557 t) for the two base-case scenarios (Hall, 2024).

Among the sensitivity analyses, when combined with other CPUE series in the JABBA models, the negative influence of the prawn trawl series was minimised by the other positive indices, but their integration ultimately resulted in poorer fits to all indices (Hall, 2024). Similar to the results of the BSM analyses, varying the composition of the catch and CPUE series had a greater influence on the model outputs than altering the model input parameters (Hall, 2024). Likewise, changing the underlying SPM from a Schaefer to Pella-Tomlinson model had very little effect on the model outputs. The sensitivity that produced the greatest effect in the JABBA analyses was changing the resilience (*r* priors) from medium to low, which in most cases resulted in a lower MSY and biomass depletion estimate for 2023.

The large estimates of current relative spawning biomass for 2023 that were near the virgin biomass for many of the medium resilience scenarios in the JABBA modelling were considered unrealistic given the long history of large catch removals on this species. Therefore, despite the recommendation for a medium resilience level for Bluespotted Flathead based on the life history characteristics (Froese *et al.*, 2019), in the lower productivity of southern oceans relative to the higher productivity northern oceans where these methods were developed, our results suggest a low resilience prior may be more appropriate for this species.

Stock Assessment Result Summary

Biomass status in relation to Limit	The updated standardised catch rate (catch-per-unit-effort, CPUE) analyses produced some conflicting results, with fish trawl and charter boat catch rates in central and southern NSW remaining stable over the last five years, while prawn trawl and charter boat catch rates in northern NSW have declined substantially over the same period. Furthermore, there has been a significant decrease in recreational catches over the last three surveys that have used consistent methods. This suggests some localised depletion or contraction of the population at the northern end of its distribution may be occurring. Alternatively, anecdotal evidence suggests that the lower prawn trawl catch rates may be resulting from increased discarding or active avoidance of flathead in northern NSW following quota introduction. Results from the data-limited modelling approaches also varied according to the input catch and CPUE series, modelling assumptions and prior parameter estimates. The low resilience base-case surplus production models (using all commercial catches and discards, recreational catches estimated according to past participation rates and the fish trawl CPUE series), predicted that the current spawning biomass in 2023 was between 49–62% of unfished biomass, with lower confidence intervals that were above the limit reference point. However, production models that included the prawn trawl catch rates (even with the last four years of data removed) produced lower estimates of current spawning biomass, but these were still above the limit reference point of 20% of unfished biomass. The size and age structures of fish sampled from the commercial catches over a period spanning 52 years have remained stable. Overall, the weight-of-evidence indicates that the biomass of the stock is unlikely to be recruitment impaired; however, there is considerable uncertainty in the assessment and several conflicting signals in the data that need to be carefully monitored.
Biomass status in relation to Target	Relative biomass estimates varied widely with most results above or near the nominated reference point of 48%. All scenarios resulted in model outputs that suggested the biomass had decreased following the peak

	catches in the 1960s and again more recently in the 1980s and 1990s. Results from the two base-case scenarios, suggest that the stock has rebuilt, and that current stock spawning biomass is above the target reference point of 48% of unfished biomass.
Fishing mortality in relation to Limit	Results of model scenarios suggest that the current harvest rate of Bluespotted Flathead in NSW waters is lower than that predicted to maintain the biomass at the level for MSY and should allow for further stock rebuilding. Relative fishing mortality estimates (F/Fmsy) ranged from <0.1 to 0.32 for all analyses, even those that included the recent prawn trawl CPUE series. The fishing mortality estimates from the length-converted catch-curve analyses spanning 52 years suggest that current levels are slightly higher than historic levels and slightly higher than natural mortality. Collectively, the weight-of-evidence suggests that the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished.
Fishing mortality in relation to Target	The stock assessment outcomes were uncertain with respect to where current fishing mortality levels are relative to the nominated target, given the discrepancy in recent catch-rate series.
Current SAFS stock status	Bluespotted Flathead was assessed as **sustainable** under the SAFS framework in 2023 using data up to and including 2021/22 (Hall, in press).

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 this 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 southward to the fish trawl sector and small size of fish relative to the size limit; and prawn catch rates and prices had been strong, leading to decreased targeting of flathead by the prawn trawl sector. This feedback will be incorporated into future stock assessments, but should be considered while interpreting current results.

Qualifying Comments

While the current stock assessment results are mostly positive, with stable catch rates in the fish trawl sector and stable size structures and fishing mortality estimates over five decades. However, there were some inconsistencies that should be monitored carefully. Catches and catch rates in the prawn trawl sector have decreased substantially over the last five years since quota was introduced. Anecdotal evidence from industry suggests that this may relate to some operators receiving lower quota than historic catches with an increase in discarding. This also suggests that this catch rate series may now be compromised and not be a reliable indicator of stock abundance. Consequently, sensitivity analyses for the population modelling involved different combinations of CPUE indices that included or excluded the recent prawn trawl series with the most recent four years removed.

While excluding the recent prawn trawl series from analyses may seem an obvious and acceptable solution, especially given the relatively small catches taken by the sector; however, the situation in northern NSW should be monitored carefully. Recreational catch estimates have also decreased over the last three surveys and charter fishery catch rates in northern and central NSW have also decreased over the last four years, and these are unlikely to be influenced by the introduction of quota in the commercial sector. These sectors may have been influenced by other factors unrelated to fisheries management, such as COVID-19 and subsequent economic downturn, but have no obvious explanation. The wide ranges in parameter estimates from the various modelling methods while using similar combinations of inputs also indicate there is considerable uncertainty inherent in these data-limited assessment methods and the data inputs.

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