Stock Status Summary – 2022/23

NSW Stock Status Summary – Bluespotted Flathead
(Platycephalus caeruleopunctatus)

Assessment Authors and Year

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Stock Status

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

Stock structure & distribution

The Bluespotted Flathead 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 stock assessment report provides a determination of the stock status for Bluespotted Flathead (*Platycephalus caeruleopunctatus*, CAAB 37 296007) according to the Status of Australian Fish Stocks (SAFS) framework, using data up to and including 2021/22. 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 commercial catch (TACC) was first introduced for Bluespotted Flathead for the NSW Ocean Trawl Fishery in state waters north of Barrenjoey Point in May 2019 and has been set at 108.1 t in the following four fishing seasons (Mapstone et al. 2020; NSW TAF Committee 2021; NSW TAF Committee 2022). 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. The species is relatively fast growing and short lived, reaching a maximum recorded age of just 9 years.

Life history characteristics of Bluespotted Flathead vary significantly with water depth and latitude (Barnes 2012; Barnes et al. 2011; Liggins 1996). Juveniles (<25 cm total length, TL) are more common in inshore waters that are shallower than 30 m depth; while mature adults occur in deeper waters to 80 m depth. Because the shape of the continental shelf varies from wide and shallow along the north coast to narrow and steep along the south coast, the distribution and size structure of Bluespotted Flathead also varies, which in turn influences catches and discard rates along the NSW coast (Barnes 2012; Barnes et al. 2011; Liggins 1996).

FISHERY STATISTICS

Catch information

Commercial

Annual commercial catches of Bluespotted Flathead in NSW state waters are available from 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 146.2 t in 2017/18 and 123.5 t in 2018/19 before the TACC was introduced. In the three years since quota introduction, catches have been much smaller at 89.6 t in 2019/20, 78.3 t in 2020/21 and 57.5 t in 2021/22 (Fig. 1). While the latter is likely to be incomplete due to outstanding logbook returns, corresponding quota usage data suggest that the 2021/22 total catch is likely to remain the smallest ever reported. Recent recreational catch estimates from the 2019/20 survey period were also smaller than previous estimates (Fig. 1). The prawn trawl component of 'Flathead unspecified' data are also included in the historical catch series, because anecdotal evidence from fishers suggest that these likely comprise mostly Bluespotted Flathead (Hall 2018).

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 1998, the proportion of catch taken by the prawn trawl sector in northern NSW (OZ1 to 3) has gradually decreased relative to that of the fish trawl sector in central NSW (OZ4 to 6) (Figs 2 and 3). Recent fluctuations in commercial catches have been mostly due to changes in the fish trawl 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).

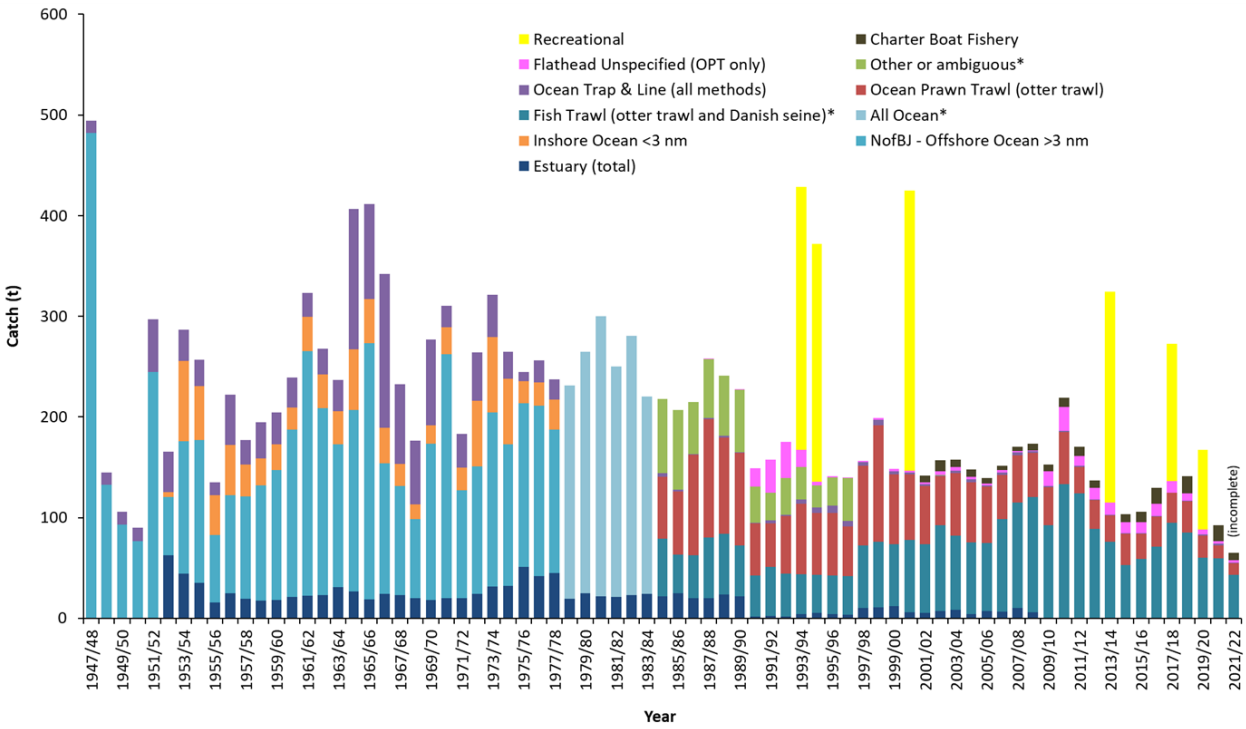

Figure 1 **Annual total catch (tonnes) of Bluespotted Flathead for all sectors in NSW waters between 1947/48 and 2021/22. Data from 2021/22are likely to be incomplete. Offshore catches are only included north of Barrenjoey Point (NofBJ) and data in some sectors (*) and years (1978/79–1989/90) have been adjusted. Recreational catch data are available from five surveys and are adjusted to statewide estimates. Charter boat data are only available since 2000/01 and included in recreational estimates in surveyed years. OPT=Ocean Prawn Trawl.**

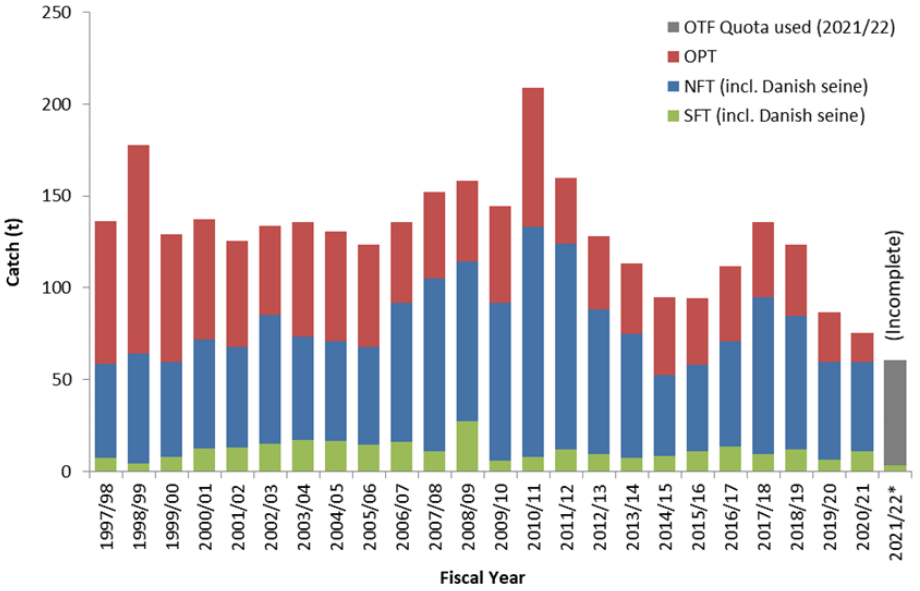

Figure 2 **Annual commercial catches (tonnes) of Bluespotted Flathead in NSW waters (1997/98–2021/22) for different sectors of the NSW Ocean Trawl Fishery. OPT=ocean prawn trawl, NFT=northern fish trawl, SFT=southern fish trawl.**

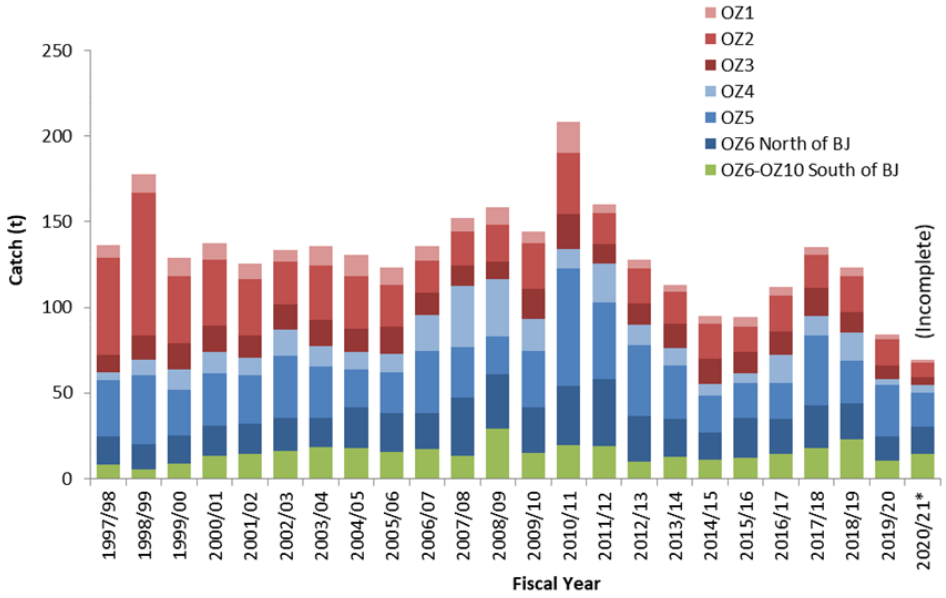

Figure 3 **Annual commercial catches (tonnes) of Bluespotted Flathead from the NSW Ocean Trawl Fishery reported in different fishing zones (OZ1–OZ10), with catches in OZ6 divided into amounts taken from north and south of Barrenjoey Point (BJ) and zones south of BJ aggregated for confidentiality reasons.**

Recreational & Charter boat

The most recent estimate of the recreational harvest of Bluespotted Flathead (combined with other sand flatheads) in NSW was approximately 158,386 fish or around 72 t during 2019/20 (Murphy et al. 2020). 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. This was 45% smaller than the equivalent estimated harvest in 2017/18 of around 363,949 fish or 129 t and 64% smaller than the estimated harvest in 2013/14 of around 416,195 fish or 199 t (Fig. 4) (Murphy et al. 2020). Relative to the commercial catch, the estimated statewide harvest of 210 t in 2013/14 accounted for approximately 64.6% of the total harvest of Bluespotted Flathead from NSW waters and 71.6% when catches by interstate fishers were also included; whereas, the commercial catch was marginally larger than the recreational harvest in 2019/20 (Hall 2018b).

Bluespotted Flathead are 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 and although smaller again in 2021/22, these data are likely to be incomplete at the time of analyses (Fig. 5).

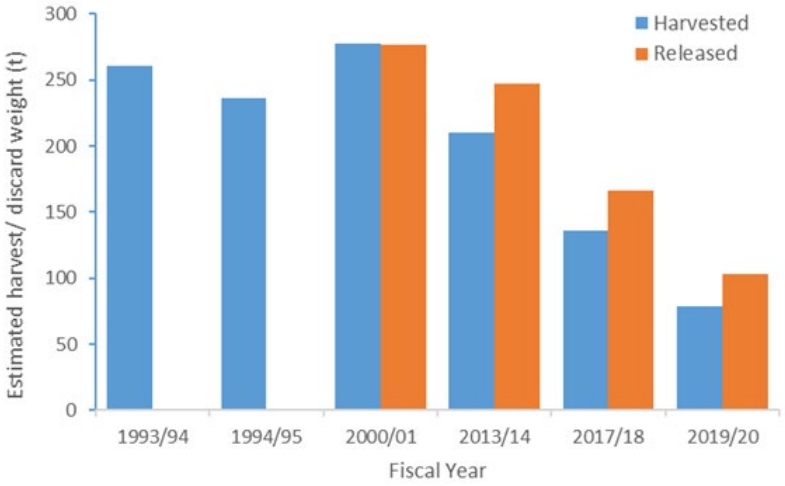

Figure 4 **Estimated NSW statewide recreational harvest and discard weights of Bluespotted Flathead from surveys of recreational fishers between 1993/94 and 2019/20. Data sources and treatment are outlined in (Hall 2022).**

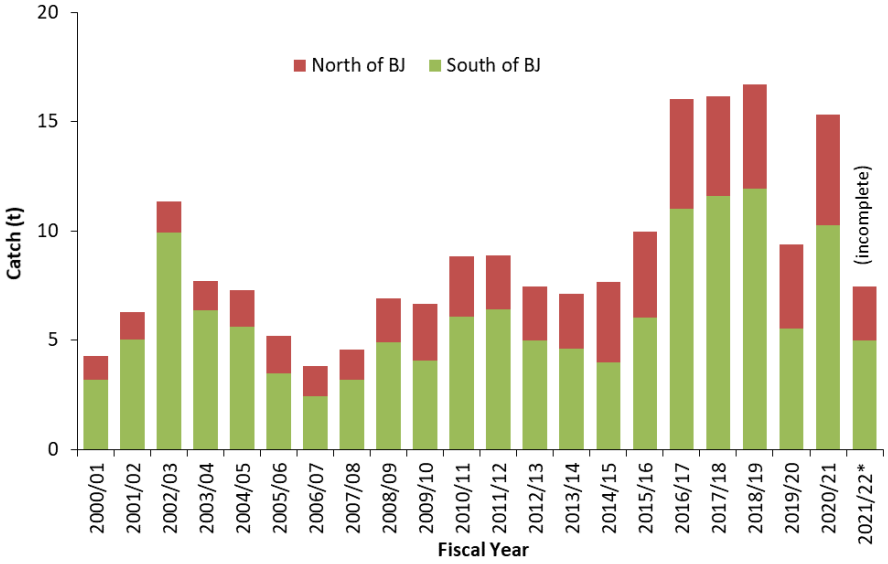

Figure 5 **Estimated annual catches (tonnes) of Bluespotted Flathead in the NSW Charter Boat Fishery north and south of Barrenjoey Point (BJ) (2000/01–2021/22). Catch weights were estimated from the numbers of fish reported multiplied by the estimated mean weight of fish (0.462 kg in ocean and 0.409 kg in estuaries). *Data from 2021/22 are likely to be incomplete.**

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 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 Bluespotted Flathead 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.

Reported effort in the prawn trawl sector for Bluespotted Flathead rapidly decreased during the mid-2000s, and then remained more stable between 2009/10 and 2018/19 (Fig. 6). However, effort has rapidly decreased again following quota introduction. The reported effort in 2021/22 was 1,980 days fished and 20,385 hours trawled, which represents just 14.9% and 14.8%, respectively, of the peak effort reported in 2002/03. Reported effort in the fish trawl sector has declined more evenly over time, but has also declined more rapidly over the last 3 years since quota introduction than in the prawn trawl sector (Fig. 7). The reported effort for the fish trawl sector in 2021/22 was just 399 days fished and 3,242 hours trawled.

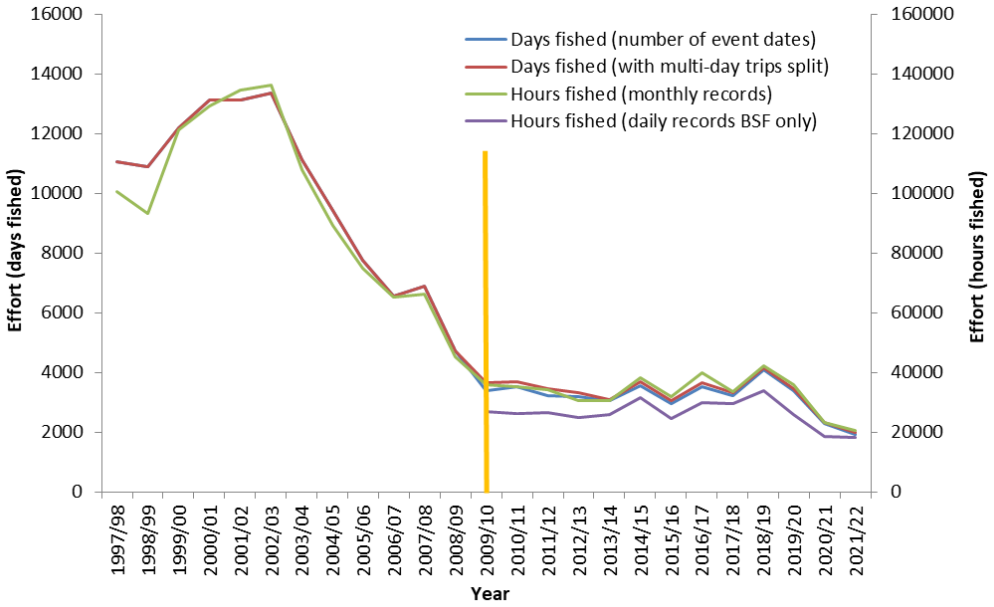

Figure 6 **Annual adjusted effort (days and hours fished) for prawn trawl fishers that reported landing Bluespotted Flathead on at least one day in each month. The vertical gold line indicates the change from monthly to daily event reporting.**

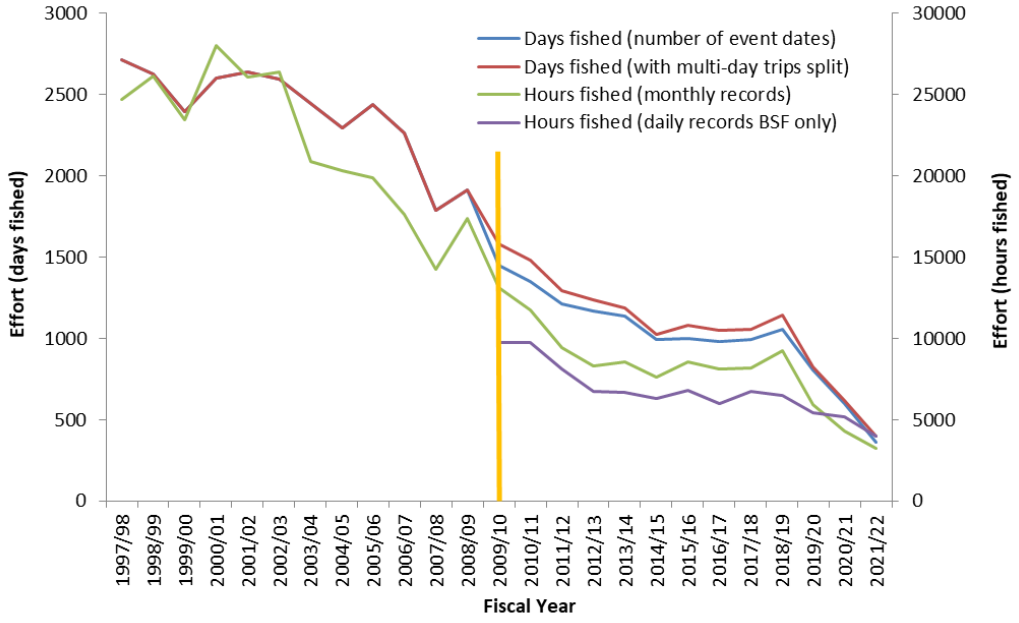

Figure 7 **Annual adjusted effort (days and hours fished) for fish trawl (including Danish seine) fishers that reported landing Bluespotted Flathead on at least one day in each month. The vertical gold line indicates the change from monthly to daily event reporting.**

Catch Rate information

Monthly catch rates (catch-per-unit-effort, CPUE in kg per day fished) for Bluespotted Flathead taken by the ocean prawn trawl and fish trawl (excluding Danish seine) 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 fish trawl sector consistently achieved higher mean catch rates (average of 77.8 kg per day) than the prawn trawl sector (average of 9.1 kg per day) when pooled across the entire state (Figs 8 and 9). The two sectors operate in different ocean zones, use different gears and vary in their targeted fishing practices, which account for these differences.

Standardised catch rates for the ocean prawn trawl sector show similar patterns across both monthly and daily CPUE series (Fig. 9). Catch rates rapidly declined by over 50% from 1998 to an historic minimum in 2002 and then gradually increased again between 2007 and 2010 up to a peak of 12 kg day^{-1}. Following a rapid decrease in 2011, catch rates remained steady near the long-term average until 2019 when quota was introduced. Over the last 3 years, catch rates have fallen rapidly to well below the long-term average (Fig. 9).

In contrast, standardised catch rates of the fish trawl sector generally increased from 1998 to a peak in 2011, before undergoing a steady decline to remain below the long-term average between 2014 and 2017. After that, recent catch rates have fluctuated near the long-term average (Fig. 10).

Anecdotal evidence from industry members suggests that the decline in prawn trawl catch rates may relate to increased discarding following quota introduction, with some large operators not securing sufficient flathead quota to cover incidental catches while targeting other species like whiting and prawns (that co-occur over similar grounds in northern NSW).

Catch rates for the Charter Boat Fishery (in number of fish per angler hour) have fluctuated around a steadily increasing trend between 2001 and 2018; however, over the last 3 years these have also decreased back toward the long-term average (Figure 12). Catch rates in this sector were unlikely to be influenced by the introduction of quota in OTF in 2019, 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.

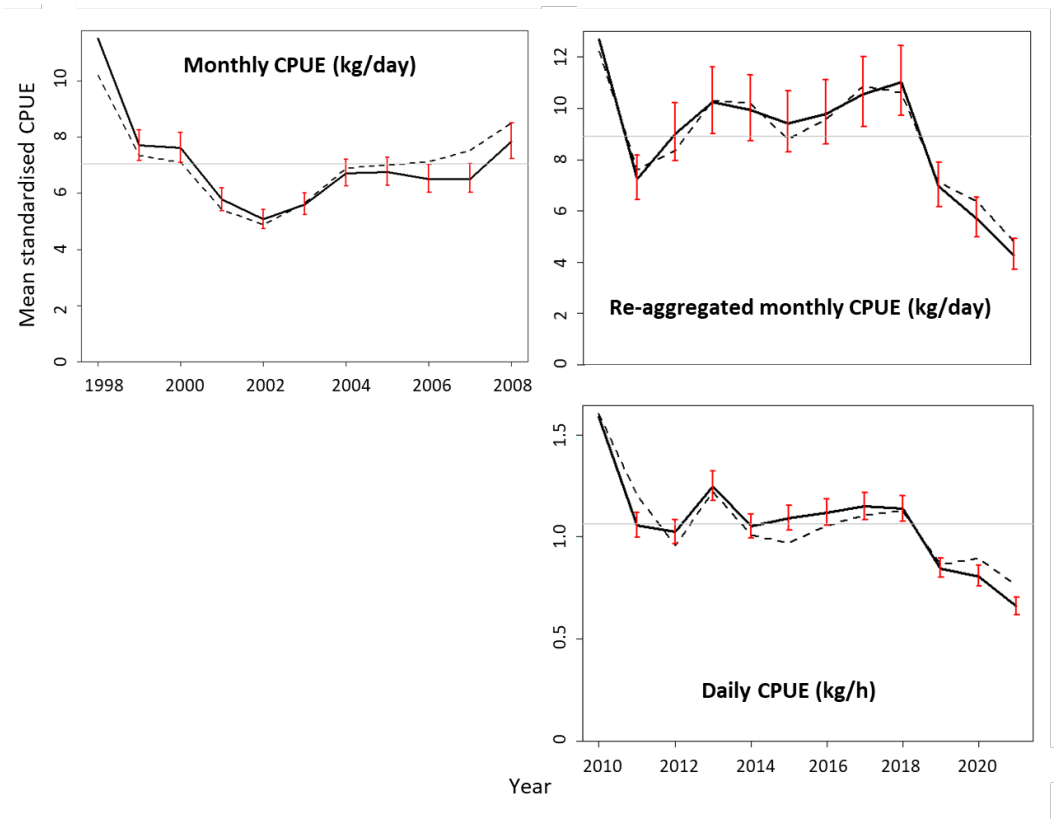

Figure 8 **Mean standardised catch rates (catch-per-unit-effort, CPUE) of Bluespotted Flathead for the ocean prawn trawl sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1998–2009) and re-aggregated daily records (2010–2021) in kg per days fished and from daily fishing event records in kg per hour trawled. The dashed and solid lines indicate the nominal and standardised mean CPUE (± 95% confidence intervals), respectively and the grey horizontal line indicates the long-term average for each series.**

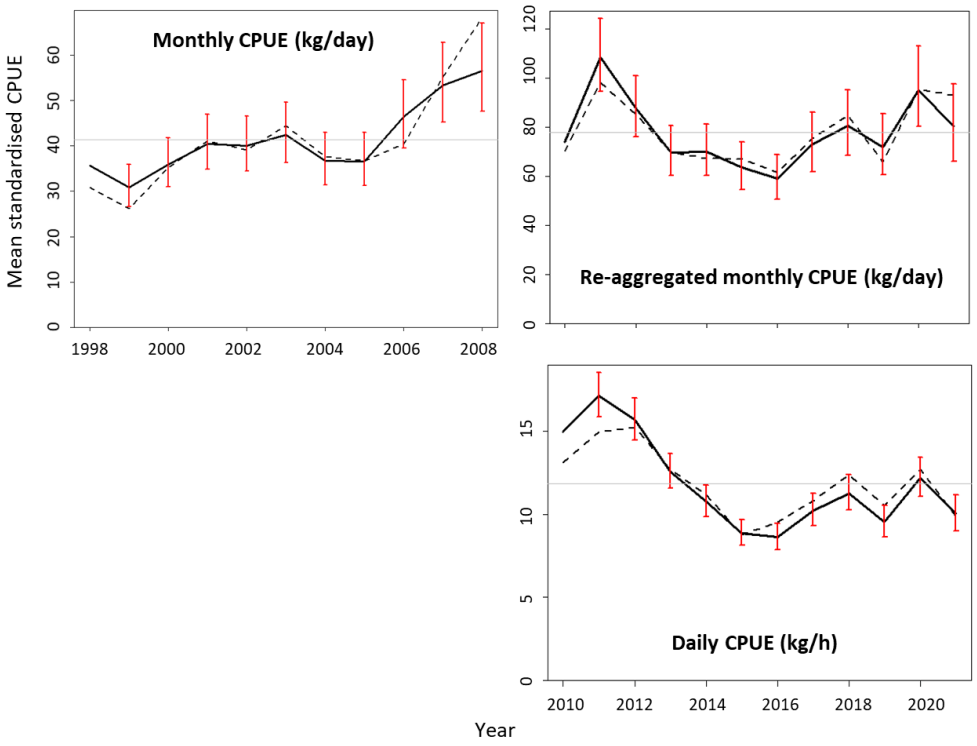

Figure 9 **Mean standardised catch rates (catch-per-unit-effort, CPUE) of Bluespotted Flathead for the fish trawl (excluding Danish seine) sector of the NSW Ocean Trawl Fishery, estimated from monthly records (1998–2009) and re-aggregated daily records (2010–2021) in kg per days fished and from daily fishing event records in kg per hour trawled. The dashed and solid lines indicate the nominal and standardised mean CPUE (± 95% confidence intervals), respectively and the grey horizontal line indicates the long-term average for each series.**

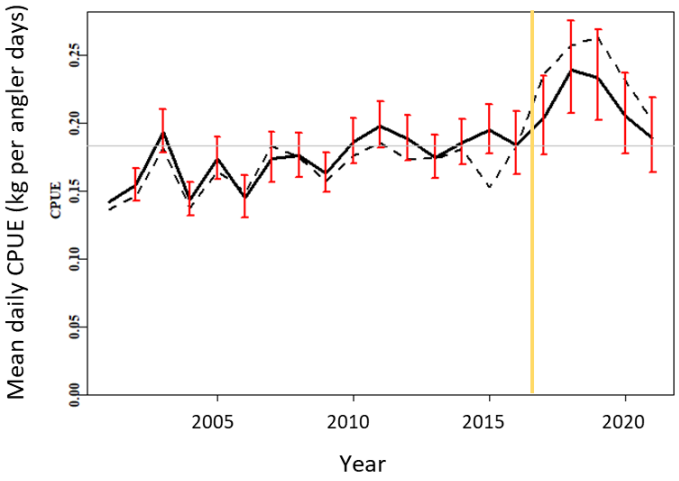

Figure 10 **Mean standardised catch rates (fish per angler hour) of Bluespotted Flathead in the NSW Charter Boat Fishery (2001–2021). The dashed and solid lines indicate the nominal and standardised mean CPUE (± 95% confidence intervals), respectively and the grey horizontal line indicates the long-term average for each series, and the vertical gold line indicates the recent catch reporting change.**

STOCK ASSESSMENT

This current assessment updates standardised catch rates for the two main NSW commercial fishing fleets, but otherwise relies on the results of data-limited stock assessment approaches completed in previous assessments between 2018 and 2021 (Hall 2018; Hall 2020; Hall 2021b; Hall 2022).

Stock Assessment Methodology

Year of most recent assessment:

2022 using data up to 2021/22 (Hall 2022; Hall 2023).

Assessment method:

A weight-of-evidence approach was used for this stock assessment of Bluespotted Flathead in NSW waters. It incorporated the results from three different analyses:

1. Standardised monthly catch rates and daily catch rates for the two main commercial fishing fleets, fish trawl (otter trawl, excluding Danish seine) and prawn trawl (otter trawl), analysed by whole fleet and ocean zones, and the handline and rod (and including baitfishing and jigging) sectors of the Charter Boat Fishery;
2. Catch-curve analyses of age-structure data derived from length frequency data from 33 years to estimate fishing mortality levels – last updated in 2021/22 (Hall 2022), with analyses of historical data in previous assessments (Hall 2018; Hall 2020; Hall 2021b); and
3. Catch-MSY and Bayesian state-space production model (BSM) analyses (Froese et al. 2017) of 10 different historical catch and CPUE time series (1948/49 to 2019/20), comprising varying commercial, discard, recreational catch scenarios and CPUE time series for comparison – last updated in 2021/22 (Hall 2022).

Main data inputs:

Monthly catch rates (catch-per-unit-effort, CPUE in kg per days fished) calculated from commercial logbook data provided by fishers of the OTF for two methods – prawn trawl (otter trawl) and fish trawl (otter trawl) by calendar years (1998–2021).

Daily catch rates (CPUE in kg per hour trawled) calculated from commercial logbook data provided by fishers of the OTF for two methods – prawn trawl (otter trawl) and fish trawl (otter trawl) by calendar years (2010–2021).

Daily catch rates (CPUE in fish per angler hour) calculated from reported catch-and-effort data provided by fishers of the Charter Boat Fishery for the handline and rod fishing method by calendar years (2001–2021).

Length compositions - commercial catch samples via port monitoring (1969-1975 and 1999-2020, some years missing), onboard observer surveys (1990-1995 and 2014-2019) and independent trawl surveys by FRV Kapala (1990-1997).

Numbers-at-age data from the re-weighted length frequencies (as above).

Age–length keys developed from sectioned otoliths collected during onboard observer surveys (2014–2016) and fish sampled during port monitoring at seven locations (2016–2019) along the NSW coast.

Natural mortality estimates were derived using the updated Hoenig and Pauly equations recommended in Then (2014), a maximum age of 9 years and von Bertalanffy growth parameters

determined from a reanalysis of data from Barnes et al. (2011) for both sexes combined. The updated Hoenig equation provided an estimate of M=0.33 and the updated Pauly equation an estimate of M=0.65. Given the disparity in these estimates, the average of M=0.49 was also used in analyses to provide a third comparison.

A resilience level of 'medium' was selected for Bluespotted Flathead on the basis of its life-history characteristics (i.e., maximum age of 9 years, early age-of-maturity and average natural mortality estimate of M=0.49, Froese et al. 2002)

Key model structure & assumptions:

The CPUE standardisations and analyses assume that the annual catch rates are a relative index of abundance and are not unduly influenced by other factors that are not accounted for through standardisation.

Fishing mortality estimates derived from catch-curve analyses are highly dependent on the availability of a sound estimate for natural mortality, which in the absence of alternative information is generally assumed to remain constant across years.

The modified Catch-MSY method is a model-assisted data-poor method that does not statistically fit an index of relative abundance to model the underlying population biomass. Rather it uses a form of stock reduction analysis and pre-determined parameter ranges for r and K and historical catches. The model is dependent on the resilience level and hence lower bound of r selected. Both modelling methods are subject to many other assumptions associated with the use of the simple Schaefer surplus production model, such as no variation in many parameters over time (Froese et al. 2017; Haddon et al. 2018; Martell and Froese 2013).

Sources of uncertainty evaluated:

Three different natural mortality estimates were used for the catch curve analyses.

Five different historical catch series were analysed for the modified Catch-MSY method, that differed with respect to whether or not estimated discards were included, and the temporal variation of recreational catch histories (Table 1). Two different CPUE series were analysed with the different historical catch series to provide 10 scenarios for the BSM analyses.

Table 1 **Summary of the four catch and three catch-rate (CPUE) series used to construct 10 scenarios for Catch-MSY and BSM analyses of Bluespotted Flathead historical data.**

No	Catch series	CPUE series
1	Comm	Separate monthly
2	Comm + discards	pooled average
3	Comm + discards + rec constant	
4	Comm + discards + rec scaled to NSW population size	
5	Comm + discards + rec scaled to historical effort	
6	Comm	Separate monthly
7	Comm + discards	and daily series
8	Comm + discards + rec constant	
9	Comm + discards + rec scaled to NSW population size	
10	Comm + discards + rec scaled to historical effort	

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	None specified in a formal harvest strategy. In the interim, a weight-of-evidence approach was used, which included: the estimated biomass depletion (as a percentage of the estimated unfished biomass, K) from Catch-MSY analyses and BSM analyses; and annual standardised catch rates from the fish trawl (otter trawl) and ocean prawn (otter trawl) sectors of the Ocean Trawl Fishery and handline sector of the Charter Boat Fishery.
Biomass Limit Reference Point	None specified in a formal harvest strategy. In the interim, a default Blim of 20% of unfished spawning stock biomass was selected in line with the current NSW Harvest Strategy Policy. Current catch rates are compared against long-term averages.
Biomass Target Reference Point	None specified in a formal harvest strategy. In the interim, a Btarg of 48% of unfished spawning stock biomass was selected as a proxy for MEY in line with the current NSW Harvest Strategy Policy (NSW DPI 2022).
Fishing mortality indicator or proxy	None specified in a formal harvest strategy. In the interim, a weight-of-evidence approach was used, which included: the estimated annual relative fishing mortality from Catch-MSY and BSM analyses, and fishing mortality estimates from catch-curve analyses using length and age data sampled from commercial fisheries catches.
Fishing mortality Limit Reference Point	None specified in a formal harvest strategy. In the interim, the level of fishing mortality (Flim) above which overfishing is occurring and biomass is depleting toward Blim was selected.
Fishing Mortality Target Reference Point	None specified in a formal harvest strategy. In the interim, the level of fishing mortality (Ftarg) that would result in a spawning stock biomass of Btarg was selected.

Stock Assessment Results

Standardised catch rates

The standardised CPUE analyses produced some conflicting results, with prawn trawl catch rates in northern NSW declining substantially over the last three years, while fish trawl catch rates have remained relatively stable. These fleet and spatial differences may relate to increased discarding among the prawn trawl fishers following quota introduction in May 2019, but need to be carefully monitored. Especially given that recent recreational catches and charter boat fishery catch rates have also declined, which are unlikely to be influenced by quota introduction. Some spatial variation in catch rates across different ocean zones may also indicate some localised depletion is occurring (Hall 2022).

Size-structures, age-structures and catch-curve analyses

The length frequencies and mean lengths of Bluespotted Flathead sampled from NSW commercial catches have varied little over the 50-year period over which the historical data span (Hall 2020; Hall 2022). Recent data from the charter onboard observer program in 2017/18 and 2019/20 also show similar size structures to the commercial catches (Hughes et al. 2021).

Among the historical data, estimates of total mortality have also shown little variation across years (ranging from 0.86 to 1.07). However, catch-curve analyses of the most recent port monitoring samples produced slightly higher estimates of total mortality, and consequently fishing mortality (F=0.69 and 0.64 in 2019/20 and 2020/21), than in previous years that were above the average natural mortality estimate (M=0.49) (Fig. 11). However, interpretation of these results is sensitive to the assumed value of natural mortality selected and some hyperstability in the age structures may be resulting from the use of forward age-at-length analytic approaches for historical samples.

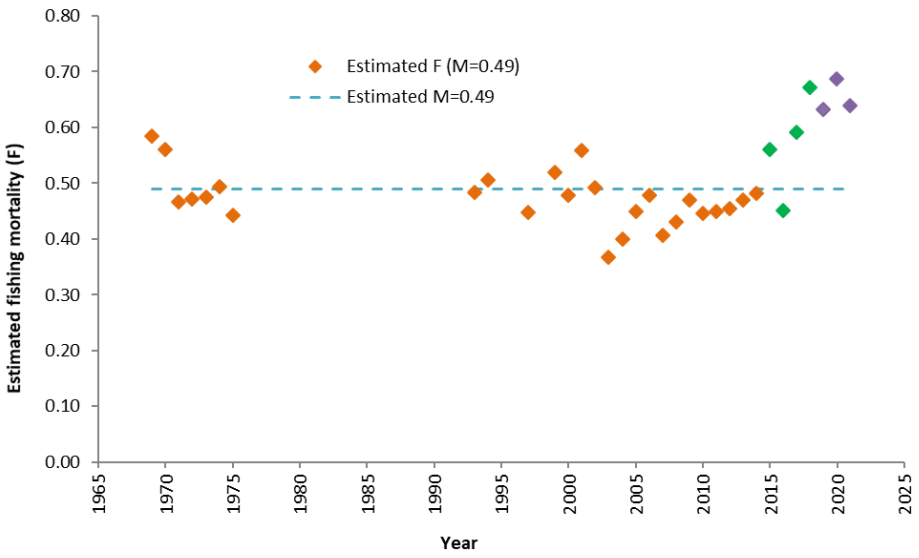

Figure 11 **Estimated fishing mortality (F) from catch curves for Bluespotted Flathead in each calendar year (orange dots), recent observer surveys (green dots) and port monitoring fiscal years (purple dots), using an average natural mortality level (M=0.49). Sample numbers and sizes and fishing methods and locations have varied among years.**

Catch-MSY and Bayesian state-space production models

Results of the Catch-MSY and Bayesian state-space production model (BSM) analyses completed in 2021/22 produced varying biomass depletion estimates (26 to 72% of unfished biomass) depending on the catch history scenario and CPUE series combination selected, but all were above the limit nominated limit reference point of 20% of unfished biomass (Hall 2022). The most likely scenario, involving commercial catches and discards, and recreational catches scaled to past NSW population sizes or recreational participation rates, combined with historical monthly catch rates and recent daily catch rates for the fish trawl sector, produced recent biomass depletion estimates of around 40% of unfished biomass, with lower confidence bounds well above the limit reference point. In all cases, the lower confidence bound of the biomass depletion estimate were at or above the limit reference point.

Irrespective of the analytic method or historical catch and CPUE series selected, all results suggested that the current harvest rate of Bluespotted Flathead in NSW waters is below that required to maintain the biomass at the level for MSY. Relative fishing mortality estimates (F/Fmsy) ranged between 0.23 and 0.72 depending on the historical catch and CPUE series combination selected, and were estimated at 0.42 for the most likely scenario (Hall 2022).

Stock Assessment Result Summary

Biomass status in relation to Limit	Results from the 2021/22 stock assessment that used two data-limited stock assessment analyses (Catch-MSY and Bayesian state-space surplus production models, BSM) and the most likely historical catch and CPUE series combinations provided spawning stock biomass estimates for Bluespotted Flathead of around 40% of unfished biomass, with lower confidence bounds well above the nominated limit reference point of 20% of unfished biomass (Hall 2022). For all scenarios analysed, the lower confidence bound of the biomass depletion estimate was at or above the limit reference point. The updated standardised CPUE analyses produced some conflicting results, with prawn trawl catch rates in northern NSW declining substantially over the last three years, while statewide fish trawl catch rates have remained stable, albeit with a slight downturn in 2021 and considerable spatial variation across ocean zones. Charter boat catch rates from the south coast also show a significant decline over the last three years. The size and age structures of fish sampled from the commercial catches over a period spanning 52 years have remained relatively stable. Overall, the weight-of-evidence indicates that the biomass of the stock is unlikely to be recruitment impaired; however, there is a high level of uncertainty in the assessment.
Biomass status in relation to Target	Relative biomass estimates varied widely with some results above or near the nominated reference point of 48%. All scenarios resulted in model outputs that suggested the biomass had decreased substantially between 1960 and 2000 and again more recently between 2010 and 2015. Results from the most likely historical

	scenarios, suggest that some stock rebuilding may be required to bring the stock back up to the potential target reference point.
Fishing mortality in relation to Limit	Results of model scenarios suggest that the current harvest rate of Bluespotted Flathead in NSW waters is below that required to maintain the biomass at the level for MSY. Relative fishing mortality estimates (F/Fmsy) ranged between 0.23 and 0.72 depending on the historical catch and CPUE series combination selected. 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. While no updated estimates are available for the current stock assessment, 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.
Current SAFS stock status	Bluespotted Flathead was assessed as **sustainable** under the SAFS framework in 2020 (Hall 2021a).

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. 1999 ; Broadhurst et al. 1996 ; Broadhurst et al. 1997; Broadhurst et al. 2006; Broadhurst et al. 2005).

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

The following are important points regarding this stock assessment to consider with respect to TACC determination:

- The modified Catch-MSY and BSM modelling approaches used to assess Bluespotted Flathead in NSW rely on simplistic and generic surplus production models, and results should be interpreted with caution.
- Future harvest rates should be set to allow for the high uncertainty in this assessment and ensure recovery of the biomass toward Btarg.
- Recent rapid decreases in prawn trawl catch rates on the north coast and charter boat catch rates on the south coast need to be carefully monitored.
- Nevertheless, the stable size and age structures and fishing mortality estimates spanning 52 years suggest that current harvest rates are sustainable.
- The potential influence of catch reporting changes on commercial catch rates (especially during the transition from monthly to daily reporting around July 2009 and recently following quota introduction), complicates their use as an index of relative abundance.
- Recreational harvests of Bluespotted Flathead are significant and typically comprise over 50% of total landings from NSW waters.
- The uncertainty regarding the magnitude of, and temporal variation in, historical removals by the recreational sector increases the level of uncertainty in the Catch-MSY and BSM results.
- Likewise, the uncertainty around the accuracy of historical commercial catch data (especially prior to July 1990) and unknown temporal variation in discards should be considered when interpreting the Catch-MSY and BSM results.
- Discarding practices and rates are likely to have changed following the introduction of catch quota in May 2019 and the observer surveys for the OTF have now ceased. Increased discarding may be contributing towards the rapid decrease in commercial catch rates and catches observed over the last two years, particularly for the prawn trawl sector.
- There may also be unknown quantities of catch taken in other jurisdictions that overlap with the species' distribution that are reported in mixed species groupings.

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