Department of Primary Industries
Department of Regional NSW

NSW Stock Status Summary – 2023/24

Dusky Flathead (*Platycephalus fuscus*)

Assessment Authors and Year

Schilling, H. T., Helidoniotis F. 2024. Stock assessment report 2023/24 – Dusky Flathead (*Platycephalus fuscus*). NSW Department of Primary Industries - Fisheries: 41 pp.

Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Dusky flathead are currently assessed as **sustainable**.

Stock structure & distribution

Dusky Flathead are a ubiquitous species in the estuarine and inshore waters of south-eastern Australia. Tagging data shows that individuals move from estuaries to nearshore coastal waters, as well as move among estuaries (Gray & Barnes, 2015). The stock structure for Dusky Flathead was investigated in 2018 using microsatellite markers and mitochondrial DNA, and showed strong evidence for panmixia within NSW waters (Taylor *et al.*, 2020). There was evidence, however, for some localised stock structure *within* one of the sampled estuaries that had very poor connectivity with the coast. While there may be sufficient genetic connectivity, the fact that there is some localised structure suggests there may be regional differences in demography.

Scope of this assessment

The aims of the current report are to: 1) summarise the biology and stock structure of the species within NSW; 2) summarise fishery statistics and additional data sources to inform the assessment; 3) assess and determine the biological status of the NSW stock; 4) outline data limitations and uncertainty in the assessment; 5) indicate future research and assessment directions; and 6) inform determination of the 2024-25 TAE.

The current report represents the first assessment for Dusky flathead in NSW and will be incrementally improved in future years.

Biology

Dusky flathead are a top estuarine predator. Spawning is thought to occur around the mouths of estuaries and in close-inshore waters, and mesoscale currents likely disperse larvae along the coastline with recruitment into estuaries influenced by coastal winds (Schilling *et al.*, 2022). Estuaries with expansive shallow sandy flats and seagrass beds are known to be ideal habitat for Dusky Flathead (Gray *et al.*, 2005). Dusky Flathead can live for 10 to 16 years, and may reach legal size by 2 years of age. There is sex-based size dimorphism in the species, with

females maturing later (L_{50} at ≈4 years) and growing to larger sizes than males, who reach L_{50} at ≈1.2 years (Gray & Barnes, 2015). Despite its importance and ubiquity, there is great uncertainty surrounding early life history processes in the species, as early juveniles are rarely encountered.

Fishery statistics

Catch information

Commercial

Dusky Flathead are predominantly caught in Estuary General fishery within NSW. During the 1998 – 2023 period, total landings in this fishery have ranged from 111.1t in 2010 to 235.7t in 2000. The majority of landings come from Estuary General Region 4 and have done so since the 1950s (Figure 1). The commercial catch across NSW was approximately stable from the 1950s until the early 2000s (Figure 2). It has since declined which was likely at least partially driven by a general reduction in fishing effort across this fishery and the introduction of recreational fishing havens which either partially or wholly removed commercial fishing from 30 estuaries. In 2004, the minimum mesh size on overnight set nets used in the estuary general fishery was increased from 82mm to 100mm which had substantial impacts on the selectivity of the fishery (Broadhurst *et al.*, 2003).

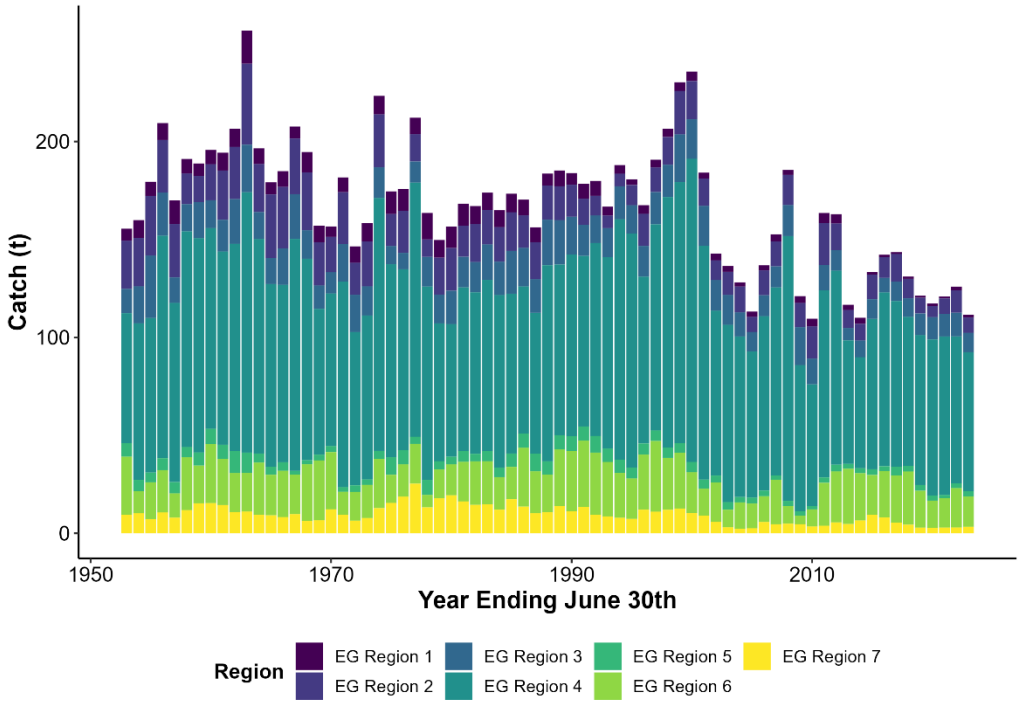

Figure 1 Annual commercial catch (t) of Dusky flathead from the NSW Estuary General Fishery by region from 1953 to 2023. Years shown are financial years ending June 30th.

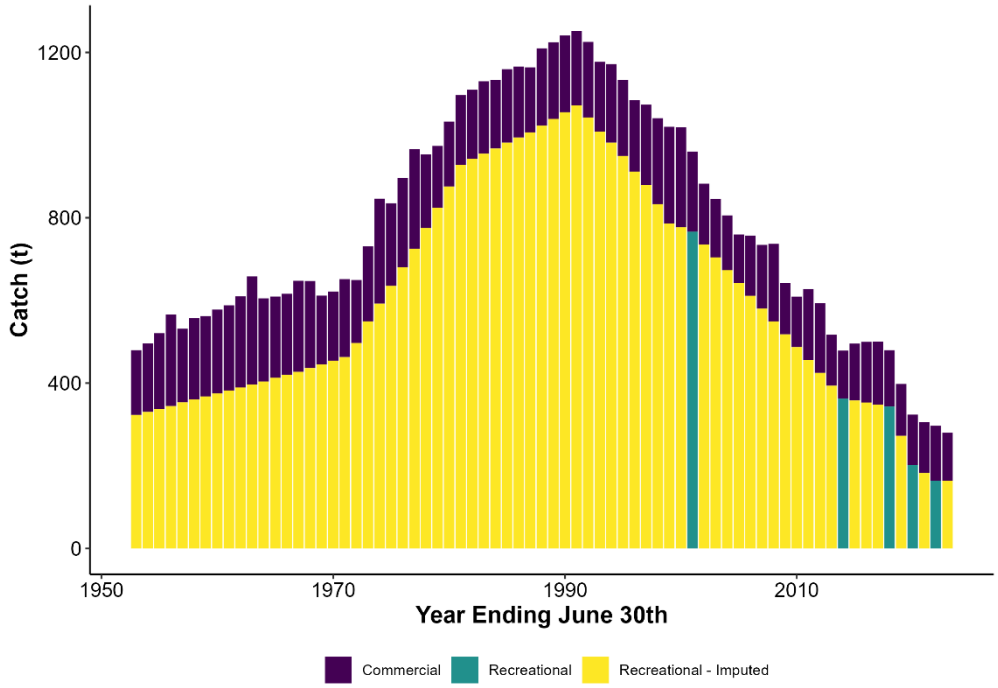

Figure 2 Historical catch series of Dusky flathead (from 1953 onward), including commercial and recreational landings from NSW. Years are financial years ending June 30th of the given year. Recreational catches have been imputed based on methods in the text to provide a more representative catch history.

Recreational & Charter boat

Surveys of recreational fishing have been conducted at the state-wide level in NSW. Catch and release of Dusky flathead is popular with approximately two thirds of captured fish released. Retained landings by recreational fishers resident in NSW have decreased since 2013/14 with landings estimated from off-site telephone/diary surveys (Recreational License Sampling Frame; RFF) declining from approximately 328,244 fish in 2013/14, to 310, 650 in 2017/18, 182,489 in 2019/20. The most recent estimate of retained catch is 2021/22 at 148,157 individuals (West *et al.*, 2015; Murphy *et al.*, 2020, 2022).

Retained catch weights by recreational fishing license holders estimated from the number of individual fish are 278 t during 2013/14, 189 t in 2017/18, 115 t in 2019/20, and 102 t in 2021/22, based on average body weights of individuals sampled from recreational catches in both estuarine and coastal locations (NSW DPI, unpublished).

The 2017/18 and 2019/20 NSW surveys sampled one- and three-year licence holders present in the NSW RFF Licence database, whereas the previous NSW survey in 2013/14 sampled households from the White Pages (including a subset of RFF households) (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 but it is clear that the RFF based surveys may not represent the whole NSW recreational catch. A previous survey was conducted in 2000/01 but it is not directly comparable due to a variety of reasons, most importantly a different sampling methodology (Henry & Lyle, 2003). As the 2000/01 survey reported all Flathead lumped together, we used the estuarine catch to represent “Dusky Flathead. In this assessment we have used all available estimates and attempted to standardise the sampling frame by multiplying the later (2013/14 onward) estimates up by 1.61x. This value was taken from a re-analysis of the 2013/14 survey comparing the proportion of respondents that in the white pages survey frame with those households holding a RFF (ratio of 1:0.62). The use of this scaling factor approximates total recreational catch across NSW after accounting for a number of demographics not required to hold a RFF, e.g. pensioners. Estimates for years between these estimates were interpolated using linear interpolation. Historical recreational catch prior to 2000/01 was hindcast using the method described in Kleisener et al. (2015)

back to 1953. After 2000/01, harvest was assumed to follow a linear path between each survey, with the estimate for 2022/23 being set as the same as in 2021/22.

For recreational fishers in NSW, the minimum legal size was raised from 33 to 36 cm TL in 2001, and a maximum size limit (i.e., a slot limit) of 70 cm was implemented for recreational fisheries in August 2022. The bag limit for Dusky Flathead was halved from 10 to 5 fish at the same time (with a possession limit of 10 fish).

Indigenous

Aboriginal cultural catch of Dusky flathead 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

As Dusky Flathead are caught in the multi-species Estuary General Fishery, effort is difficult to quantify due to changes in fisher behaviour as they target different species and this targeting behaviour is not recorded in log-books. The most reliable indicator of fishing effort is likely to be the number of days fishing conducted within a month by fisherman who recorded using a Flathead Net (as opposed to a general Mesh Net). Flathead nets are only permitted in a small number of estuaries so this may not fully represent the NSW population.

Fishing effort (days) in the Estuary General Fishery has declined 76.5% between 1998 and 2023 (Figure 3). This decline appears to be relatively uniform across all months (Figure 4). Effort has similarly declined 71.3% for the specific method of Flathead Net (Figure 3). Metres of net used is the nominal effort unit required on catch returns using mesh nets following reporting changes implemented in 2009, however this is not a useful metric for

quantifying fishing effort, so days of effort were back calculated from catch using the number of daily returns after 2009.

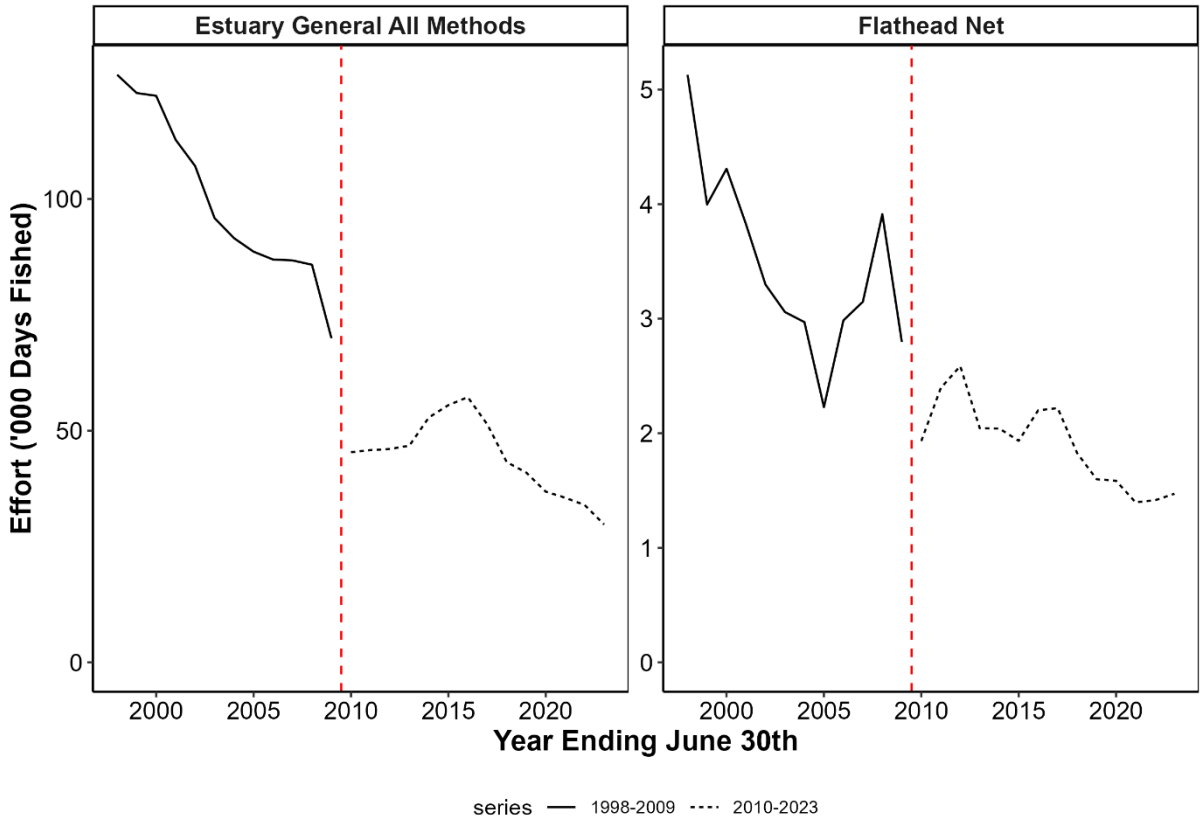

Figure 3 Fishing effort (Days Fished) over time for the Estuary Mesh Net (Estuary General Fishery) and Flathead Net (Estuary General Fishery). Dashed red line shows major reporting change.

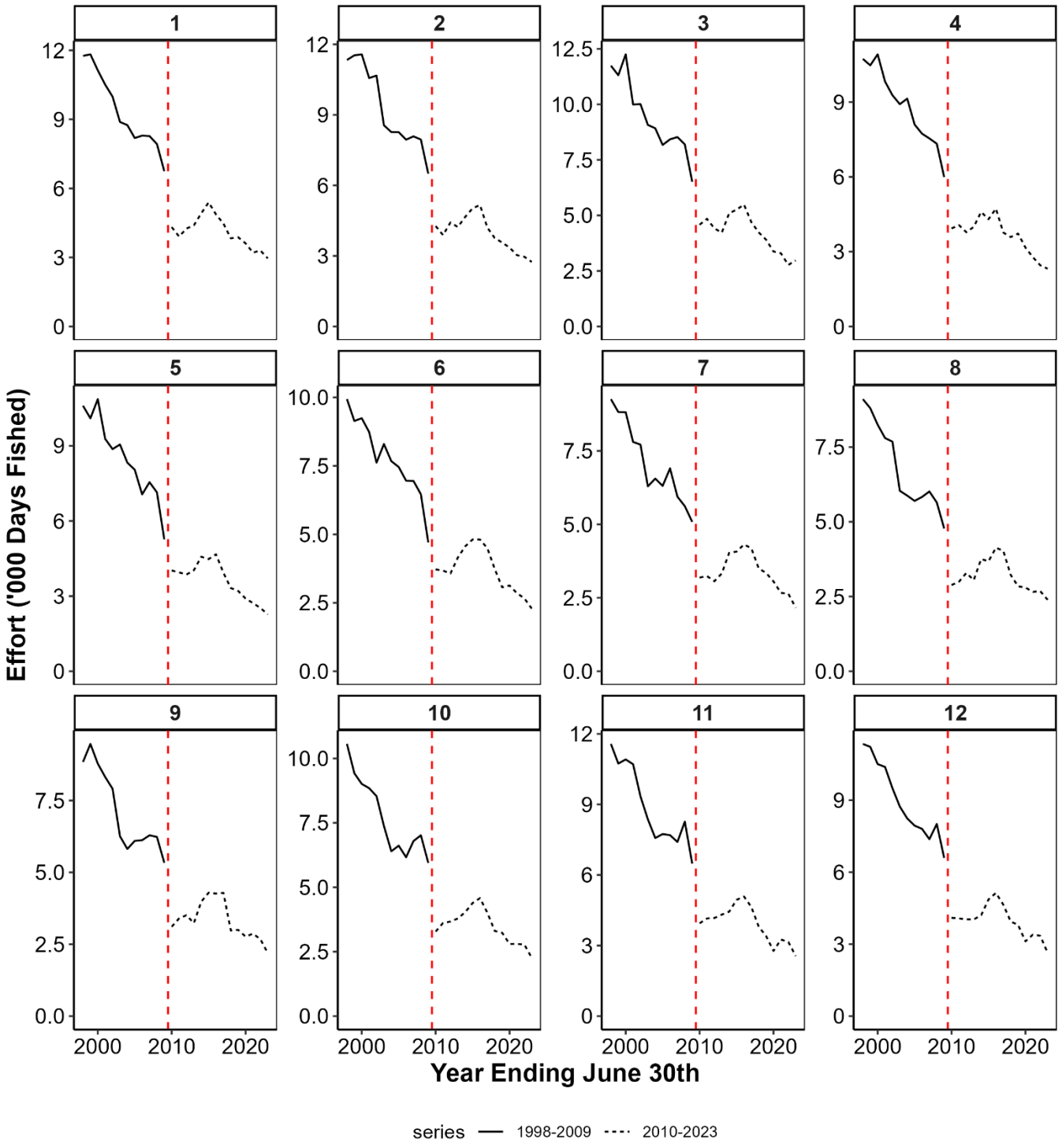

Figure 4 Fishing effort (Days Fished) over time in the NSW Estuary General Fishery by each month of the Year (1 = January, 12 = December). Note the y-axis varies between panels. The dashed vertical line represents a change in management/reporting.

Catch rate information

Due to the complexity of the multi-species estuary general fishery and targeting using Commercial Mesh Nets, we decided to focus on catch rates from Flathead Nets which are primarily used to target Dusky Flathead. This means the catch-rates are restricted to the three main estuaries in which Flathead Nets are used: Lake Illawarra, Wallis

Lake and Tuggerah Lake. Standardised Commercial Catch-Per-Unit-Effort rates were calculated for two time periods 1998 – 2009 and 2010 – 2023 using the logbook data for Commercial Estuary Mesh Nets. The final standardisations used generalised additive mixed models (GAMMs) and accounted for the following terms:

- Estuary;
- Authorised FisherID;
- Month;
- Fishing Effort (either days fished for monthly data or m of net used for daily data);
- Freshwater Flow in the previous month.

Standardisation of Flathead Net data from 1998 – 2009 showed no clear trends (Figure 5). Catch rates in Lake Illawarra were extremely variable and possibly show a declining trend. The standardisation of the catch rate for Lake Illawarra was also more influential compared to the other estuaries. Lake Illawarra underwent major physical changes in the early 2000s leading the creation of a larger permanently open entrance to the estuary opening in 2007. The change from an intermittently open estuary to permanently open may have contributed to this high variability.

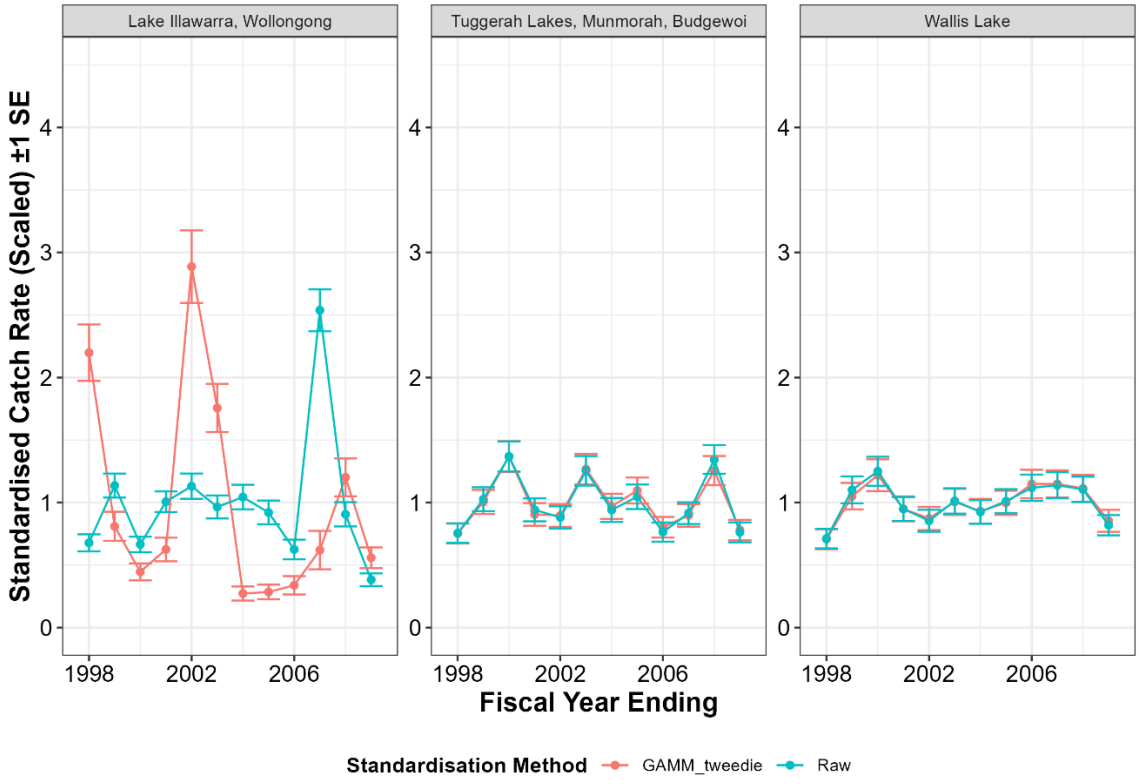

Figure 5 Standardised CPUE time series for pre-2009/10 time period. The blue lines represent unstandardised catch rates while red represents the standardised catch rates. All lines are scaled to have a mean of 1.

Standardisation of Flathead Net catch data from 2010 – 2023 showed divergent trends in the three estuaries (Figure 6). While the variability was more consistent across estuaries, Tuggerah Lakes showed a clear increase in catch rate while Wallis Lake showed an increasing trend. Lake Illawarra on the other hand was variable but showed no clear trend. When both the 1999-2009 and 2010-2023 time series of standardised catch rates are considered, it seems likely that catch rates in all three estuaries have been stable or increased since 1998.

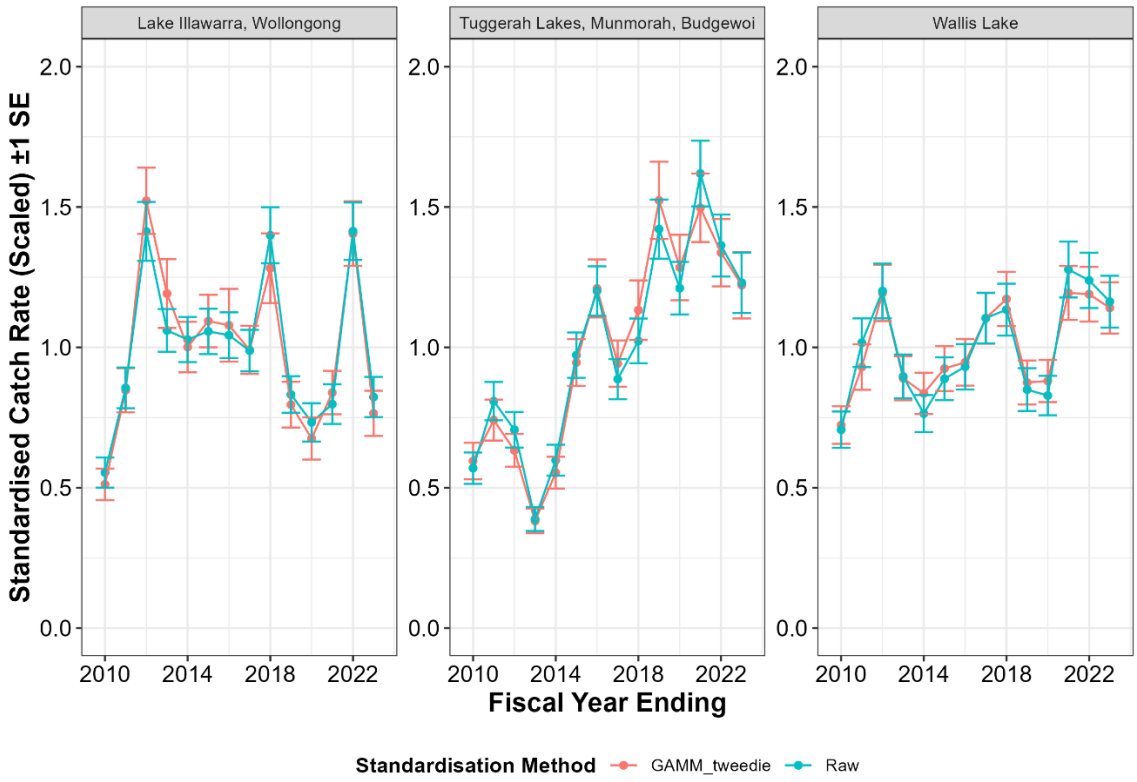

Figure 6 Standardised CPUE time series for the 2010-2023 time period. The blue lines represent unstandardised catch rates while red represents the standardised catch rates. All lines are scaled to have a mean of 1.

Stock Assessment

Stock Assessment Methodology

Year of most recent assessment:

2024 – Using data up to July 2023

Assessment method:

A weight of evidence approach was taken in this assessment including the following lines of evidence:

1. Inspection of commercial length frequency data;
2. Standardised catch-rate analyses using both commercial fisheries using the Flathead Net method;
3. Inspection of commercial fisheries age frequencies.

Main data inputs:

The following raw data inputs were used in analyses:

- Reported commercial catch (kg) and effort (days) derived from fisher-reported monthly records (1998/99 – 2008/09);
- Reported commercial catch (kg) and effort (days) derived from fisher-reported daily records which were accumulated to monthly (2009/10 – 2022/23);
- Representative length compositions of NSW commercial catch sampled in some years;
- Age at length data derived from otolith analyses taken as a subsample of the length composition monitoring (2007/08 onwards).

Key model structure & assumptions:

- Standardised catch rates

Key model structure: The standardisation process for the flathead net data used Generalised Additive Mixed Models accounting for Estuary, Authorised FisherID (random effect), Month (cyclical smoother), Fishing Effort (days fished in a month), and Freshwater flow in the previous month (non-linear smoother for each estuary).

Assumptions: Annual catch rates are a relative index of abundance and not unduly influenced by other factors that are not accounted for through standardisation. The three estuaries with catch rate data are representative of the wider NSW Dusky flathead population.

- Length compositions

Assumptions: Lengths sampled from the commercial fisheries are representative of the wider Dusky flathead population (above a minimum size).

- Catch curve analysis

Assumptions: Recruitment and mortality is constant over time. Catchability is constant for all ages above age of recruitment to the fishery. Length sampling is both representative of the population and the age at length relationships are constant across estuaries.

Sources of uncertainty evaluated:

No model-based assessments were conducted so there was no additional quantitative analysis of uncertainty.

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	None specified in a formal harvest strategy. In the interim, for the purposes of this stock assessment a weight-of-evidence approach was used, which included: annual standardised catch rates from three main estuaries in the fishery as an index of relative abundance.
Biomass Limit Reference Point	None specified in a formal harvest strategy. In the interim, for the purposes of this stock assessment current catch rates were assessed relative to long-term averages of each time series.
Biomass Target Reference Point	NA
Fishing mortality indicator or proxy	None specified in a formal harvest strategy. In the interim, for the purposes of this stock assessment, estimates of fishing mortality (F) relative to natural mortality (M) were made from catch curve analyses.
Fishing mortality Limit Reference Point	None specified in a formal harvest strategy.
Fishing mortality Target Reference Point	None specified in a formal harvest strategy. For the purposes of this stock assessment, F ≈ M was assumed to represent an acceptable level of F.

Stock Assessment Results

The NSW Dusky flathead stock is classified as **sustainable**. The status is based on:

1) Visual inspection of length composition data from both Flathead Net and General Mesh Net catches across NSW showing no evidence of detrimental changes to the size structure with possible improvements in the size structure particularly since 2017 as observed by increasing proportions of large fish;

2) Inspection of age frequencies in the commercial harvest suggest that total mortality (*Z*) declined since 2017 and that fishing mortality is likely to be at a sustainable level ($Z = 1.218$, $F = 0.668$); and

3) Inspection of fishery dependent catch rates suggesting increasing or stable biomass.

Catch Rates

Standardisation of Flathead Net data from 1998 – 2009 showed no clear trends (Figure 5). Catch rates in Lake Illawarra were extremely variable and possibly show a declining trend. Standardisation of Flathead Net catch data from 2010 – 2023 showed divergent trends in the three estuaries (Figure 6). While the variability was more consistent across estuaries, Tuggerah Lakes showed a clear increase in catch rate while Wallis Lake showed an increasing trend. Lake Illawarra on the other hand was variable but showed no clear trend. When both the 1999-2009 and 2010-2023 time series of standardised catch rates are considered, it seems likely that catch rates in all three estuaries have been stable or increased since 1998.

Length Compositions

Dusky Flathead retained in Flathead Nets were slightly smaller than those retained in General Mesh Nets (Figure 7). Despite this, for both methods the right-hand side of the distribution appears to be relatively stable since 2007/08 (Figure 7). The most recent two years of length data (2020/21 and 2021/22) appears to show a larger mean size and potentially a larger cohort progressing through the population with a healthy proportion of larger fish (Figure 7).

Age Compositions

The commercial harvest of Dusky Flathead in both net types was dominated by fish aged between 2 and 4 for most years for which age and length data were available (Figure 8). 2010/11 showed a relatively higher proportion of fish aged 7. Most years showed older fish up to 6 or 6 years with the most recent year showing fish up to age 10. The modal age does vary between years suggesting possible variations in recruitment success.

Total mortality (*Z*) as calculated from a catch curve analysis based on the General Mesh Net age distributions appears to have decreased between 2007/08 and 2021/22 although there is high variability between years. The most recent estimate of *Z* (2021/22) is 1.218 (0.131 SE). Assuming the natural mortality (*M*) estimate of 0.54, estimated fishing mortality (*F*) is 0.668.

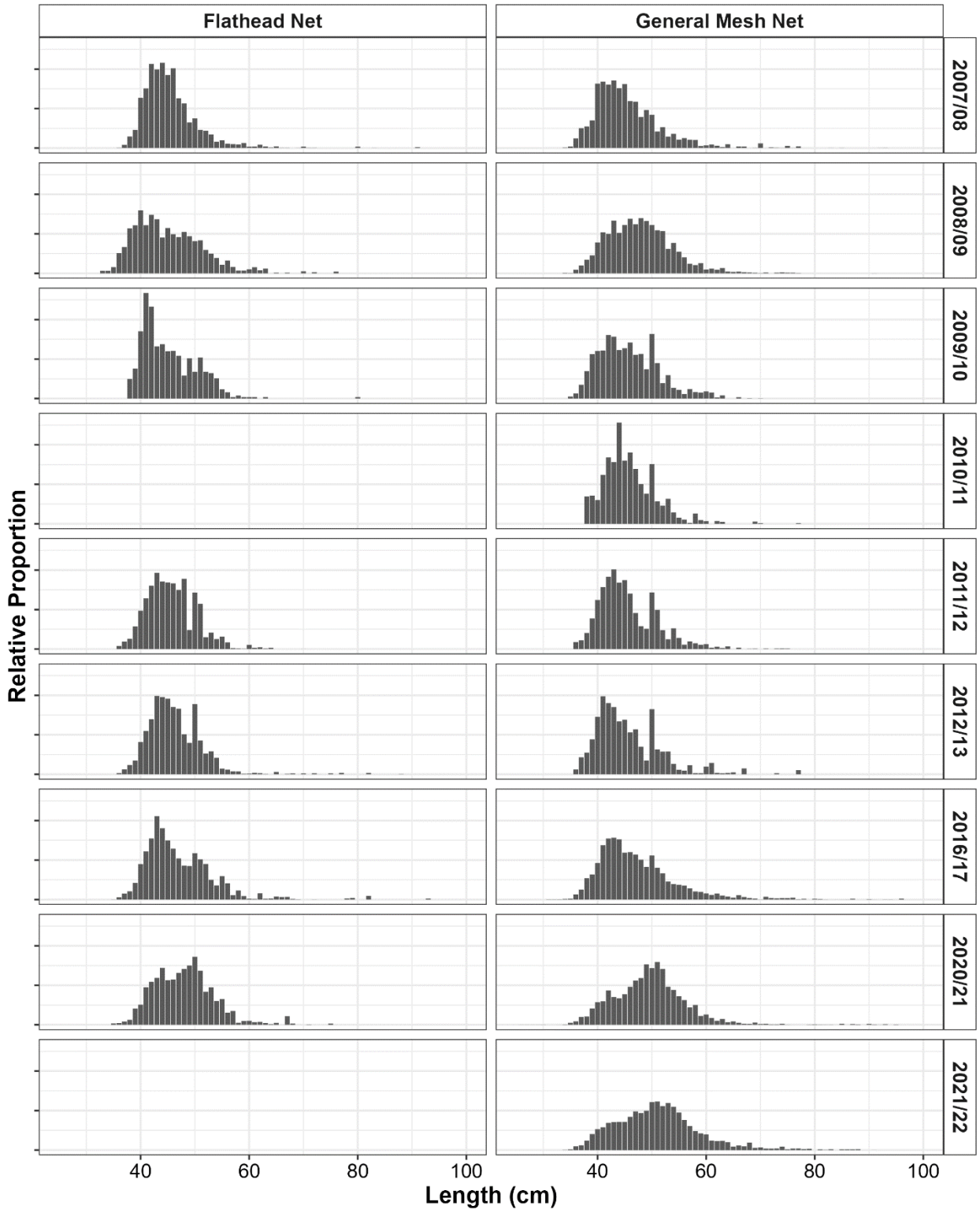

Figure 7 Length distributions of Dusky Flathead from the commercial fishery by Flathead Nets and General Mesh Nets. Flathead Net data from 2010/11 and 2021/22 is not shown as the sample sizes were too small to be representative (n = 0, n =2 respectively).

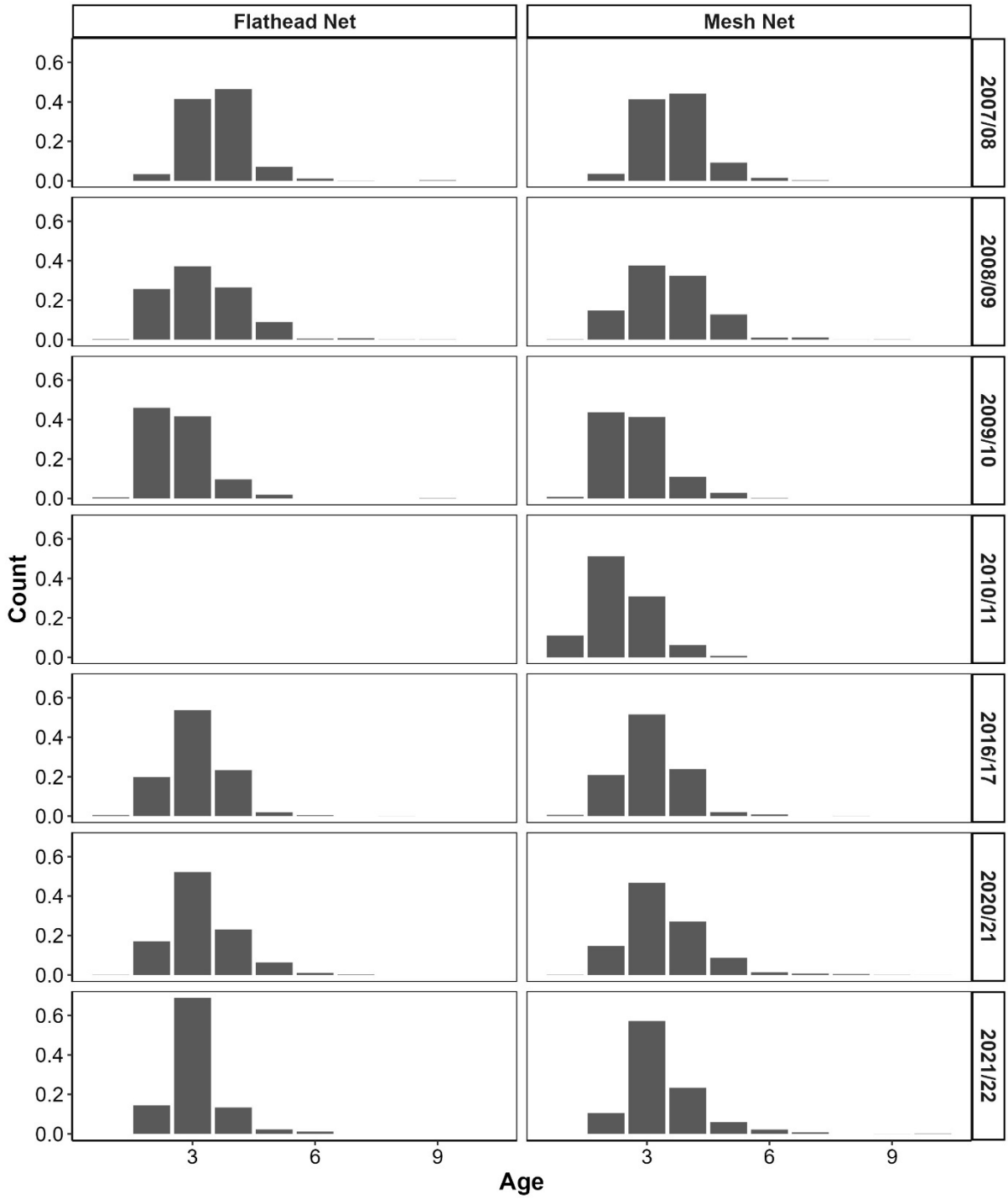

Figure 8 Age distributions of Dusky Flathead from Flathead Nets and Mesh Nets.

Stock Assessment Result Summary

Biomass status in relation to Limit	Catch rate in three key estuaries show stable or increasing trends compared to long-term (1998 – 2023) averages.
Biomass status in relation to Target	NA
Fishing mortality in relation to Limit	NA
Fishing mortality in relation to Target	The most recent estimate of *Z* (2021/22) is 1.218 (±0.131 SE). Fishing mortality (F) was estimated as 0.668. This was based a catch-curve analysis and an assumed natural M of 0.54 (Hamel & Cope, 2022). F (0.668) is therefore slightly higher than M (0.54) but within the estimated SE from the catch curve so F and M can be judged approximately equal.
Current stock status	Sustainable (New South Wales)
SAFS stock status	SAFS (2020): Sustainable

Fishery interactions

As a commercial species, Dusky flathead are primarily caught in the Estuary General fishery but the species is also taken in much larger significant quantities by the recreational sector. There are currently no formal resource sharing agreements for Dusky flathead.

Stakeholder engagement

Preliminary results from this assessment were presented at an online presentation to members of the Estuary General Fishery to gain feedback (6th March 2024). No major concerns were raised at these meetings.

Qualifying Comments

The current assessment represents a starting point for the assessment of NSW Dusky flathead and is the first step of an evolving process of assessment and continual improvement of both data and models. A major assumption of this assessment is the reliance on CPUE trends. Our assessment assumes these reflect real changes in biomass but these are potentially biased by operational, economic and social factors. Such biases may result in data and trends that do not reflect the biology of the stock. Using the length and age data as an alternative line of evidence reduces the impact of these biases in the overall analyses but integrating these lines of evidence in an integrated model with additional fisheries independent data could improve future assessments.

The current (post-2009) reporting requirements for effort in the use of Mesh Nets and Flathead Nets is the length of the net used which does not provide any information regarding the actual amount of effort or mesh size used. This increases uncertainty in the CPUE analyses of mesh net data. The change in reporting in 2009 also limits the conclusions that can be made around that time.

There is uncertainty around the catch time-series, particularly the recreational catch. Factors other than fishing, including environmental factors, may affect abundance and biological functioning of fish stocks through time.

Temporal and spatial variations in estuarine and nearshore oceanic conditions may influence available trophic resources, growth, population connectivity and ultimately recruitment. Knowledge of the interaction of these factors with fishing activity will be important for isolating the role of fishing on changes in the biomass of Dusky flathead.

Fishing operations over the past four years are likely to have been affected to some extent by the COVID-19 pandemic, the severe bushfires during 2019/20, subsequent high rainfall and resulting flooding. These events showed clear impacts on estuaries and while they may have reduced fishing effort and catch in the most recent years they also potentially impacted fish population health.

References

Broadhurst M., Gray C., Young D. & Johnson D. (2003). Relative efficiency and size selectivity of bottom-set gillnets for dusky flathead, *Platycephalus fuscus* and other species in New South Wales, Australia. *Archive of Fishery and Marine Research* **50**, 287–300

Gray C., Jones M., Rotherham D., Broadhurst M., Johnson D. & Barnes L. (2005). Utility and efficiency of multi-mesh gill nets and trammel nets for sampling assemblages and populations of estuarine fish. *Marine and Freshwater Research* **56**, 1077–1088. https://doi.org/10.1071/MF05056

Gray C.A. & Barnes L.M. (2015). Spawning, maturity, growth and movement of *Platycephalus fuscus* (Cuvier, 1829) (Platycephalidae): fishery management considerations. *Journal of Applied Ichthyology* **31**, 442–450. https://doi.org/10.1111/jai.12703

Hamel O.S. & Cope J.M. (2022). Development and considerations for application of a longevity-based prior for the natural mortality rate. *Fisheries Research* **256**, 106477. https://doi.org/10.1016/j.fishres.2022.106477

Henry G.W. & Lyle J. (2003). *The national recreational and Indigenous fishing survey*. Fisheries Research and Development Corporation, Canberra.

Kleisner K., Brennan C., Garland A., Lingard S., Tracey S., Sahlqvist P., *et al.* (2015). Australia: Reconstructing estimates of total fisheries removals 1950-2010. *Fisheries Centre, University of British Columbia - Working Paper Series*

Murphy J., Ochwada-Doyle F., West L., Stark K. & Hughes J.M. (2020). *The NSW Recreational Fisheries Monitoring Program - survey of recreational fishing, 2017/18*.

Murphy J., Ochwada-Doyle F., West L., Stark K., Hughes J.M. & Taylor M.D. (2022). *Survey of recreational fishing in NSW, 2019/20 – Key Results.*

Schilling H.T., Hinchliffe C., Gillson J.P., Miskiewicz A.G. & Suthers I.M. (2022). Coastal winds and larval fish abundance indicate a recruitment mechanism for southeast Australian estuarine fisheries. *Fisheries Oceanography* **31**, 40–55. https://doi.org/10.1111/fog.12561

Taylor M., Becker A., Quinn J., Lowry M., Fielder S. & Knibb W. (2020). Stock structure of dusky flathead (*Platycephalus fuscus*) to inform stocking management. *Marine and Freshwater Research* **71**, 1378–1383. https://doi.org/10.1071/MF19364

West L., Stark K., Murphy J., Lyle J. & Ochwada-Doyle F. (2015). *Survey of recreational fishing in New South Wales and the ACT, 2013/14*. NSW Department of Primary Industries, Wollongong.