

Assessment Authors and Year

Stewart, J. 2023. NSW Stock Status Summary 2021/22 – Sea Mullet (*Mugil cephalus*). NSW Department of Primary Industries. Fisheries. 12 pp

Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Sea Mullet are currently assessed as Sustainable for the NSW component of the stock.
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Stock Structure and Distribution

Sea Mullet (*Mugil cephalus*) was formerly regarded as a single species with a global distribution; however recent genetic evidence indicates that they are in fact a complex of many cryptic species worldwide (Whitfield and Durand, 2023). The Sea Mullet occurs around much of the Australian coastline and those along the west and east coasts of Australia are regarded as distinct species (Durand et al., 2012; Krück et al., 2013). Along eastern Australia adult Sea Mullet aggregate into large schools between late summer and early winter that then travel northward along the open coastline on their way to spawn. Spawning occurs at sea, from autumn to early winter. The larvae enter estuaries and the small juveniles subsequently live in sheltered shallow water habitats (Harding et al., 2019). Extensive tagging studies (Kesteven, 1953; Virgona et al., 1998) indicate a single east coast biological stock of Sea Mullet, extending from central Queensland to eastern Victoria.

In SAFS stock status is presented at the biological stock level—Eastern Australia; and the jurisdictional stock level—Western Australia.

The data presented in this summary relate only to the NSW part of the Eastern Australia stock.

Stock Status – New South Wales

Catch Trends

Commercial

NSW commercial landings peaked at approximately 5,508 t in 1993/94 (Fig. 1). Since that time landings fluctuated but declined overall to be fairly stable at close to 3,000 t p.a. for roughly 10 years, noting declines during the previous two years to be only 1,800 t during 2021/22.

The commercial catch is divided approximately evenly between the Ocean Hauling and the Estuary General Fisheries (Fig. 2).

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NSW Stock Status Summary - Sea Mullet (*Mugil cephalus*)

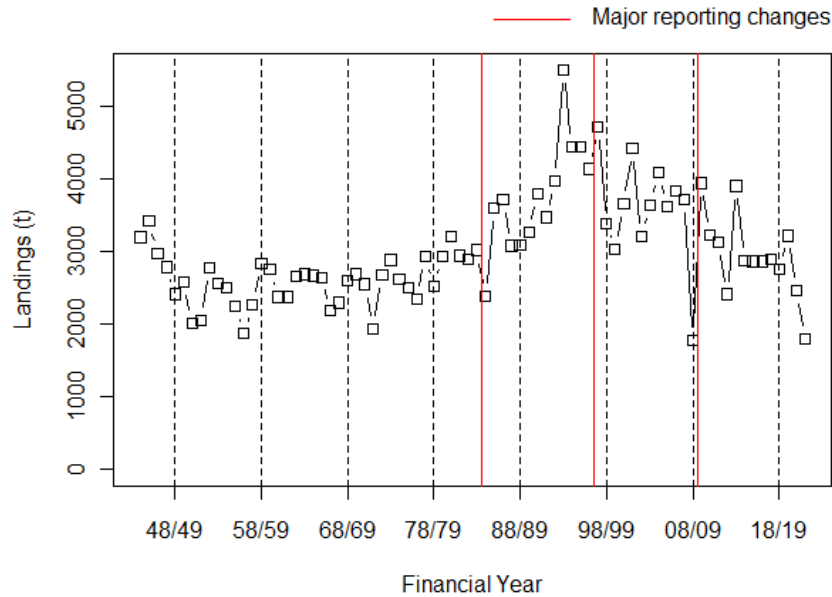


Figure 1. Commercial landings of Sea Mullet for NSW from 1944/45 to 2021/22 for all fishing methods. Red lines indicate logbook reporting changes.

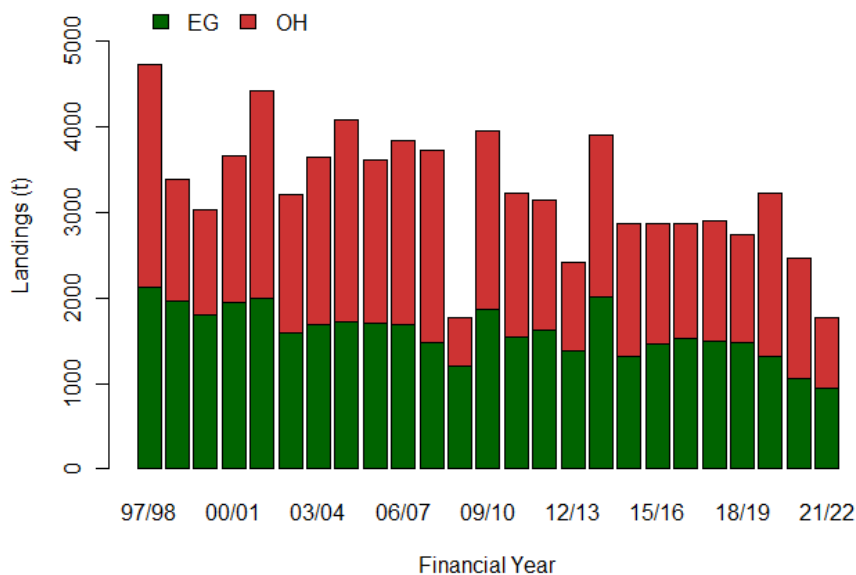


Figure 2. Landings by Fishery (including available historical records) of Sea Mullet in NSW for years 1997/98 to 2021/22. EG = Estuary General; OH = Ocean Hauling.

Recreational and Indigenous

The annual recreational harvest of Sea Mullet in NSW is considered to be minor. There are no data on Aboriginal harvest.

Fishing effort trends

The reported number of fisher days in the ocean hauling and estuarine mesh net fisheries in 2021/22 were at historically low levels of approximately 430 and 9,293 respectively, down from around 1,000 and 15,000 days respectively in 2009/10 (Fig. 3).

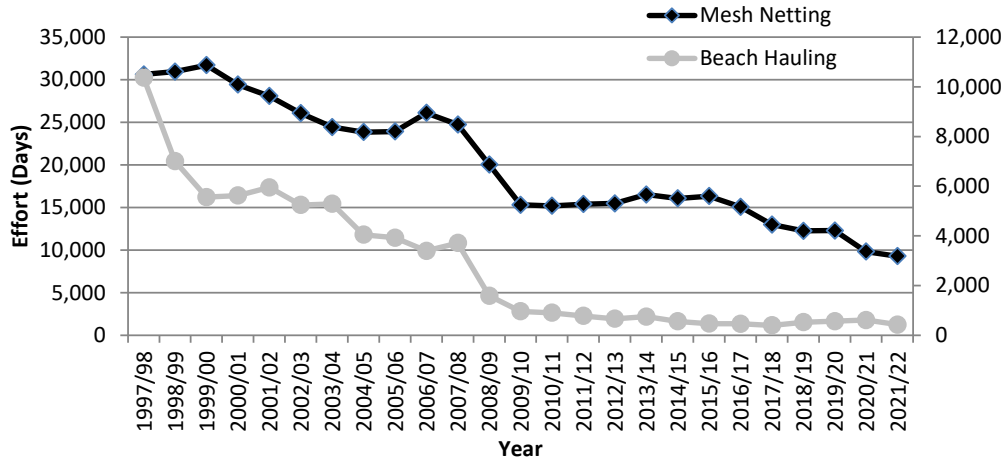


Figure 3. Annual reported days fished in the Ocean Hauling and Estuary General mesh net fisheries when Sea Mullet were reported 1997/98 to 2021/22.

Catch rate trends

Commercial median catch rates in the New South Wales component of the fishery have remained remarkably stable in the estuary fishery (kg per day of mesh netting) since 2009/10 as well as prior to the logbook change in 2009, noting increases during the previous two years (Fig.4). Catch rates in the ocean fishery were not very informative prior to 2009/10, but have fluctuated with an overall increase since that time to 2017/18 followed by declines during recent years (Fig.5). Catch rates in 2021/22 were down by 90% from 2017/18 levels; however the 2021/22 ocean beach fishery was severely impacted by flood events along the east-coast and as such this decline in catch rates is not a great concern.

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NSW Stock Status Summary - Sea Mullet (*Mugil cephalus*)

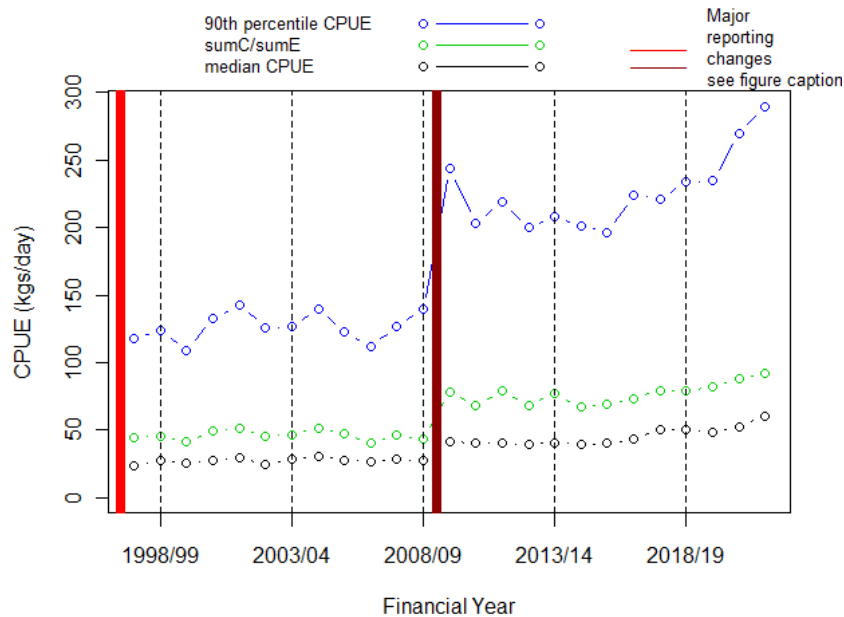


Figure 4. Commercial catch rates of Sea Mullet using Mesh-Netting for years 1997/98 to 2021/22 in NSW. Three indicators are provided: (1) median catch rate from available monthly records (solid line); (2) sum of the catch divided by the sum of the effort (dotted line); and (3) 90th percentile of the catch rate from available monthly records (dashed line). Records with a zero catch rate (i.e. no catch recorded) are not included in these analyses.

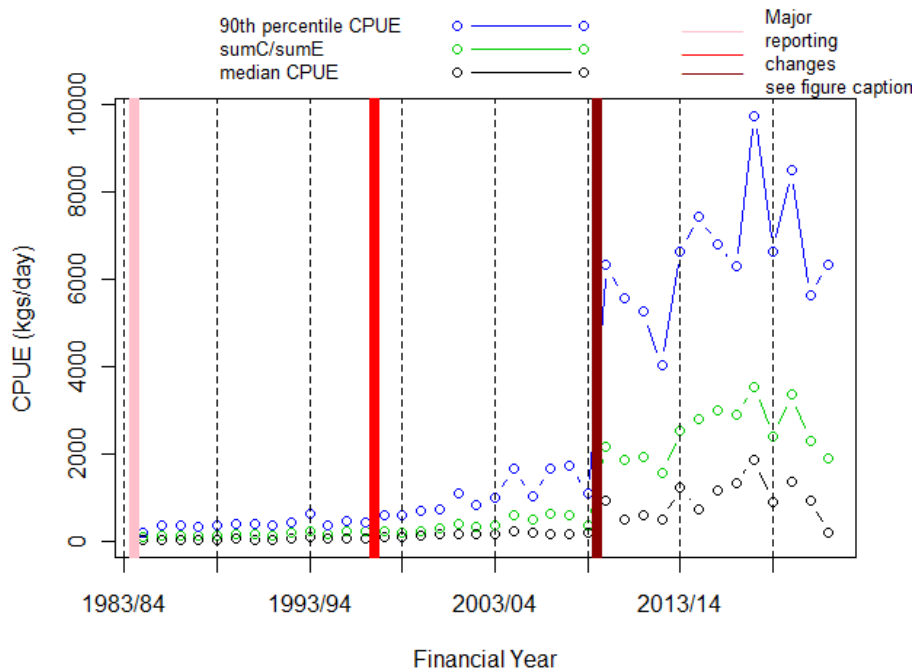


Figure 5. Commercial catch rates of Sea Mullet using Beach Hauling for years 1984/85 to 2021/22 in NSW. Three indicators are provided: (1) median catch rate from available monthly records (solid line); (2) sum of the catch divided by the sum of the effort (dotted line); and (3) 90th percentile of the catch rate from available monthly records (dashed line). Records with a zero catch rate (i.e. no catch recorded) are not included in these analyses.

Stock Assessment Methodology

Year of most recent assessment	2022 on data up to and including December 2020.
Assessment method	<p>Age and sex structured population model with an annual time step using data up to 2020 (Lovett et al., 2022). The model was done in Stock Synthesis and used four fleets: QLD Estuarine; QLD Ocean Beach; NSW Estuarine; NSW Ocean Beach.</p> <p>Weight of evidence using reported catch and effort, nominal catch rates, size and age composition in landed NSW catch post 2020.</p>
Main data inputs	<p>NSW and QLD fishery and biological data including catch, catch rates, size and age compositions, growth, mortality and selectivity.</p> <p>NSW catch 1899 to 2020.</p> <p>QLD catch 1925 to 2020</p> <p>NSW Catch rates 2009 to 2020.</p> <p>QLD Catch rates 1988 to 2020</p> <p>NSW Size and age structure in landed catch 1994 to 2021.</p> <p>QLD Size and age structure in landed catch 1999 to 2020.</p>

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<p>Key model structure and assumptions</p>	<p>Annual sex and age-structured population model (See Lovett et al., 2020).</p> <ul style="list-style-type: none"> • The fishery began from an unfished state in 1899. • The fraction of fish that are female at birth is 50%. • Growth occurs according to the von Bertalanffy growth curve. • The weight and fecundity of sea mullet are parametric functions of their size. • The instantaneous natural mortality rate is constant for each sex and does not depend on age. • Annual recruitment is a Beverton-Holt function of stock size. It was assumed deterministic before 1982 (for the base case) and stochastic between 1982 and 2021.
<p>Sources of uncertainty evaluated</p>	<p>Seven additional model runs were undertaken to determine sensitivity to fixed parameters, assumptions and model inputs. Sensitivities were tested in four categories: steepness, one or two-sex natural mortality, start of recruitment deviations and von Bertalanffy parameters used. Each component was varied from the base case to test the difference such a change would make.</p>

Status Indicators and Limits Reference Levels

<p>Biomass indicator or proxy</p>	<p>Biomass and recruitment estimates from population model. Nominal catch rates.</p>
<p>Biomass Limit Reference Level</p>	<p>0.2 of B₀. No formal reference levels for length and age compositions; however, trends are assessed.</p>
<p>Fishing mortality indicator or proxy</p>	<p>Total NSW and QLD catch in relation to MSY. NSW Landed catch. NSW Fishing effort. Size and age composition in landed NSW catch.</p>
<p>Fishing mortality Limit Reference Level</p>	<p>Catch below MSY. Weight of evidence - no formal levels, rather trends through time in particular post 2020 being the last year in the stock assessment.</p>

Stock Assessment Results Summary

Model results indicate that biomass levels were around 60% of virgin exploitable biomass prior to the late 1980s, followed by a general decline through cyclic fluctuations to around 37% of virgin levels in 2020 (Fig. 6).

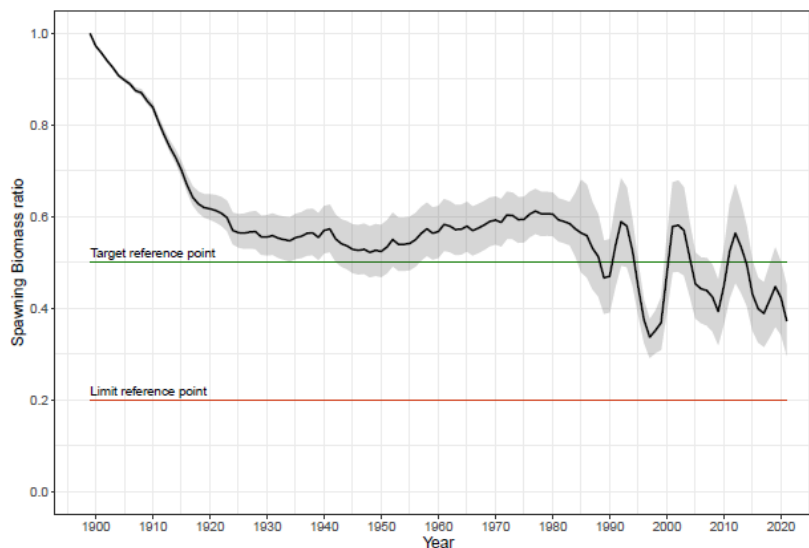


Figure 6. Plot of exploitable biomass proportion relative to virgin exploitable biomass for the base case model.

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Standardised catch rates for QLD and NSW sectors estimated during the stock assessment to 2020 (Lovett et al., 2022) showed either stable or increasing trends (Fig. 7).

Median catch rates in NSW post 2020 increased for the estuary fishery (Fig. 4) but declined substantially for the ocean hauling fishery (Fig. 5).

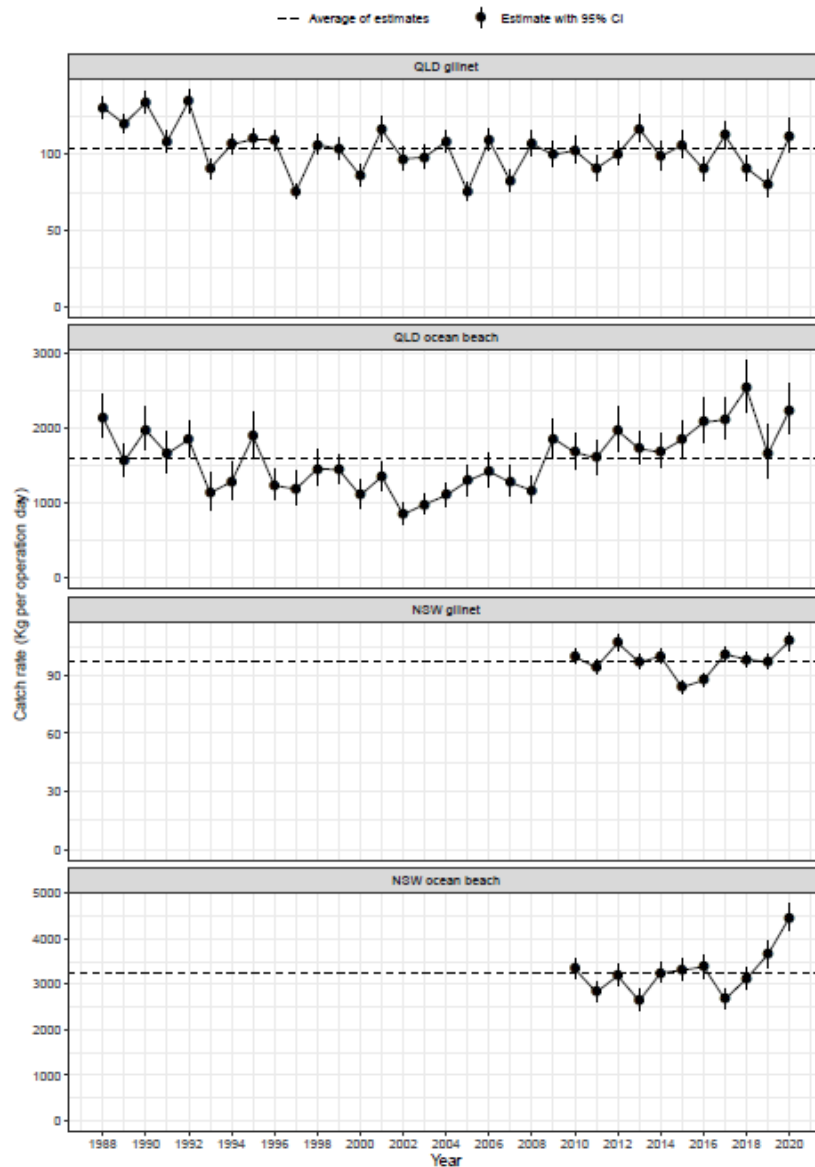


Figure 7. Standardized catch rates to 2020 for each sector from Lovett et al., 2022.

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Fairly typical length frequency compositions were found in landings in 2021 and 2022 (Fig 8).

Age compositions typically range between 2 and 7 years of age (Fig. 9). There is a strong year class moving through the fishery, first identified as 2 year old fish in 2018 and 6 year old fish in 2022. The age compositions in the most recent years (2021 and 2022) show a good spread of ages in the fishery.

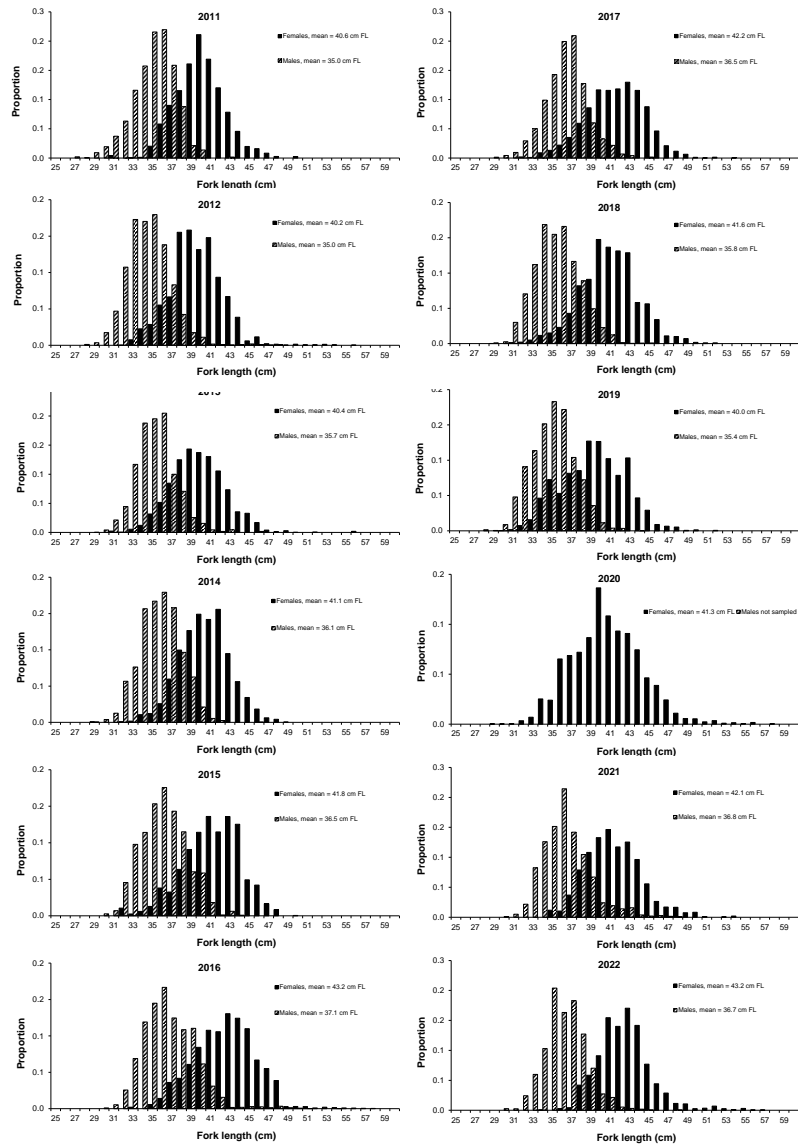


Figure 8. Lengths of male and female *Mugil cephalus* landed in the NSW spawn run fishery between 2010/11 and 2021/22. Year denotes calendar year sampled, so 2010/11 = 2011.

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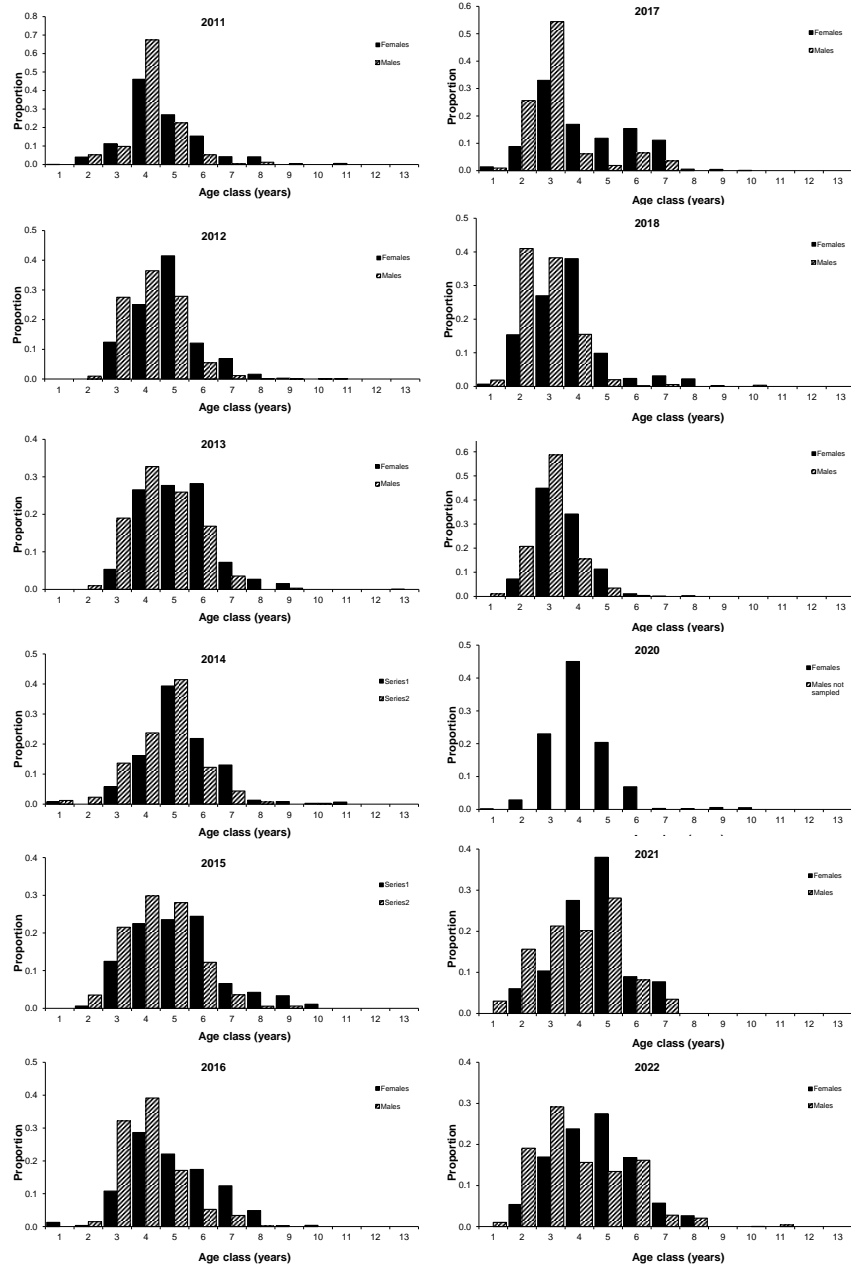


Figure 9. Age compositions of male and female *Mugil cephalus* in the spawn run fishery between 2010/11 and 2021/22. Year denotes calendar year sampled, so 2010/11 = 2011.

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Biomass status in relation to Limit	The biomass during the final year of the model (2020) was estimated to be approximately 0.37 of B0 – above the limit reference level of 0.2. Since 2020 nominal catch rates declined in the ocean beach sector (likely due to weather events) but increased in the estuary sector.
Fishing mortality in relation to Limit	<p>The total landed catch (NSW and QLD combined) in 2020 was approximately 4,102 t and below the estimated MSY of 5,353 t. The relative biomass at 0.37 of B0 was just above the estimated biomass at MSY, being 0.33 of B0.</p> <p>The NSW landed catch and days of effort are at historically low levels (Figs. 1, 2 and 3) suggesting that fishing mortality is constrained.</p> <p>Long-term stability in length and age compositions showing variable recruitment strengths (Figs. 8 and 9), suggest that levels of fishing mortality have not resulted in large changes to the population.</p>
Previous SAFS stock status	<p>Fully Fished in NSW assessments 2001/02 to 2014/15.</p> <p>Sustainable (2012)</p> <p>Sustainable (2014)</p> <p>Sustainable (2016)</p> <p>Sustainable (2018)</p> <p>Sustainable (2020)</p>
Current SAFS stock status	<p>The stock in NSW is not considered to be recruitment impaired. The current level of fishing mortality is unlikely to cause the biological stock to become recruitment impaired.</p> <p>On the basis of the evidence provided above, Sea Mullet is classified as a sustainable stock.</p>

Qualifying Comments

The modelled cyclic variations and steady declines in biomass since the 1980s need further investigation. The assessment team acknowledged the potential for the biomass cycles to be spurious; however, decided to consider them as real for the assessment. As a result, the catch rate data was down-weighted in the model. The catch rate data do not indicate the long-term declines during the past 30 years, nor the cyclical patterns in biomass, indicated in the model outputs. Recent age composition data indicate stronger year classes in the fishery at present and harvest across a wide range of ages. Therefore, it is concluded that the most recent stock assessment for sea mullet is likely to be overly pessimistic in terms of both current relative biomass and long-term decline.

References

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