Stock Status Summary – 2021

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

Assessment Authors and Year

Stewart, J. 2020. NSW Stock Status Summary 2018/19 – Sea Mullet (*Mugil cephalus*). NSW Department of Primary Industries. Fisheries. 10 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.

Stock Structure

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. 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. 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 tonnes in 1993/94 (Fig. 1). Since that time landings have fluctuated but have declined overall to a fairly stable average of approximately 2,800 t p.a. during the previous 5 years. During 2018/19 the total NSW commercial catch was reported to be 2,650 t. The commercial catch is divided approximately 50:50 between the Ocean Hauling and the Estuary General Fisheries (Fig. 2).

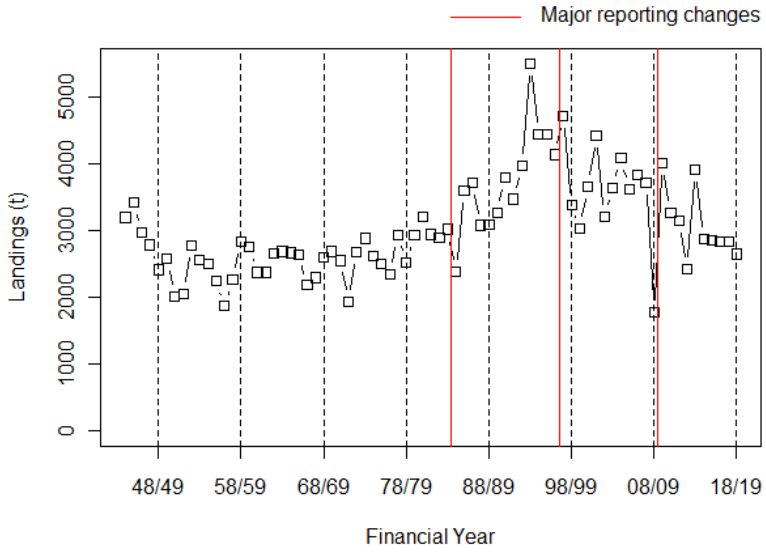

Figure 1. Commercial landings of Sea Mullet for NSW from 1944/45 to 2018/19 for all fishing methods.

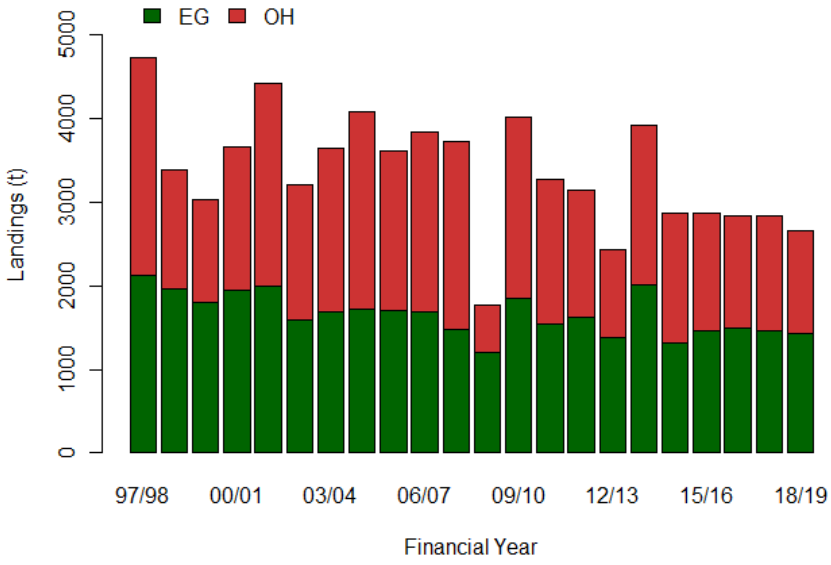

Figure 2. Landings by Fishery (including available historical records) of Sea Mullet in NSW for years 1997/98 to 2018/19. EG = Estuary General; OH = Ocean Hauling.

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 2018/19 were at historically low levels of approximately 490 and 11,500 respectively, down from around 1,000 and 15,000 days respectively in 2009/10 (Fig. 3).

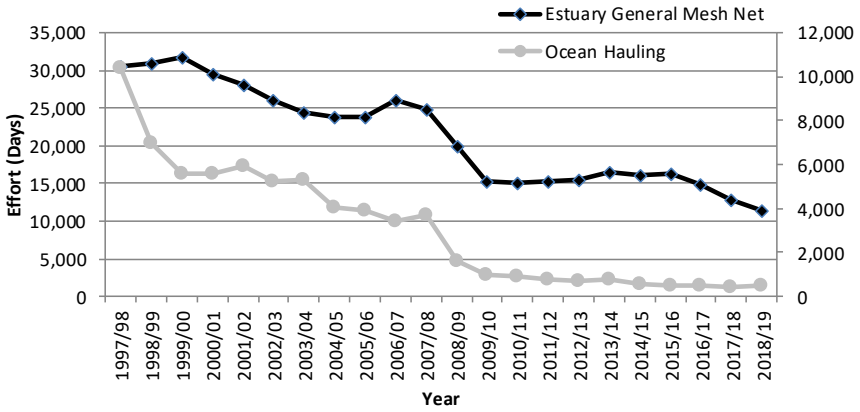

Figure 3. Annual reported days fished in the Ocean Hauling and Estuary General mesh net fisheries when Sea Mullet were reported 1997/98 to 2018/19.

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 (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 (Fig.5). Catch rates in 2018/19 were down by 40% from 2017/18 levels.

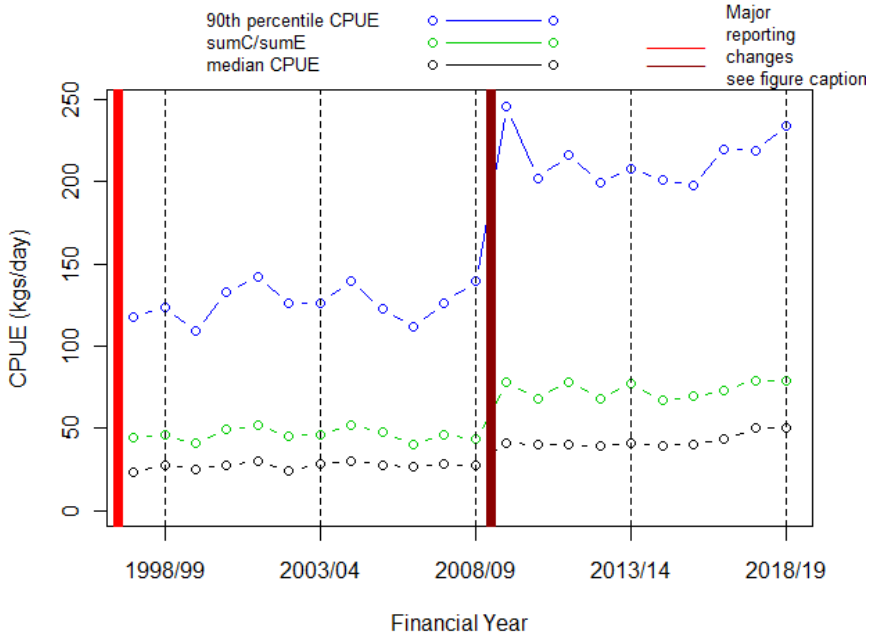

Figure 4. Commercial catch rates of Sea Mullet using Mesh-Netting for years 1997/98 to 2018/19 in NSW. Three indicators are provided: (1) median catch rate from available monthly records (solid line); (2) sum of

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.

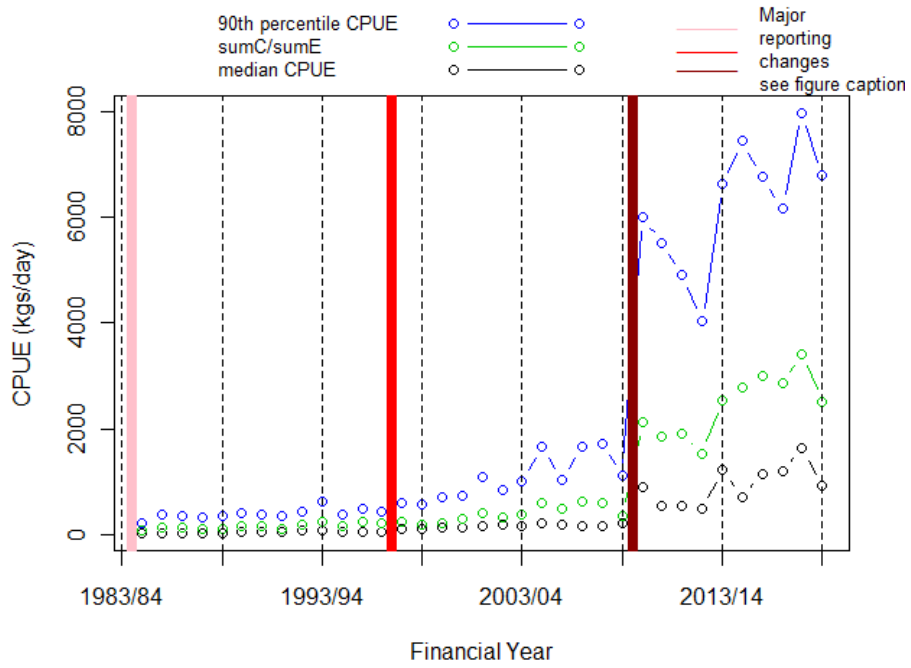

Figure 5. Commercial catch rates of Sea Mullet using Beach Hauling for years 1984/85 to 2018/19 in NSW. Three indicators are provided: (1) median catch rate from available monthly records (solid line); (2) sum of the catch divided by the sum of the effort (dotted line); and (3) 90th percentile of the 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	2020 on data up to and including 2018/19.
Assessment method	Age and sex structured population model with an annual time step using data up to 2016 (Lovett et al., 2018). Weight of evidence post 2016.
Main data inputs	NSW and QLD fishery and biological data including catch, catch rates, size and age compositions, growth, mortality and selectivity. NSW Landed catch 1944/45 to 2018/19. NSW Catch rates 1997/98 to 2018/19. NSW Fishing effort 1997/98 to 2018/19. NSW Size and age structure in landed catch 2004/05 to 2018/19.

Key model structure and assumptions	Age-structured population model (See Lovett et al., 2018). 1. Instantaneous natural mortality rate (M) was different for each sex and fixed throughout time. 2. The weight and fecundity of a fish were parametric functions of size. 3. The proportion of mature fish depends on age but not size. 4. The proportion of fish vulnerable to fishing depends on age, sex and fishing method. 5. Fishing takes place in a pulse in the middle of each year, over a short enough period that natural mortality, although it happens all year round, can be neglected over the duration of the fishing season; i.e., the fishery is a type I fishery in the terminology of Ricker (1975).
Sources of uncertainty evaluated	The Beverton-Holt steepness parameter h was unable to be estimated in the model. Hence, low, middle and high values for h were chosen creating three separate analyses.

Status Indicators and Limits Reference Levels

Biomass indicator or proxy	Biomass and recruitment estimates from population model. Nominal catch rates.
Biomass Limit Reference Level	1. 0.2 of B0. 2. No formal reference levels for length and age compositions; however, trends are assessed.
Fishing mortality indicator or proxy	1. Total NSW and QLD catch in relation to MSY. 2. NSW Landed catch. 3. NSW Fishing effort. 4. Size and age composition in landed NSW catch.
Fishing mortality Limit Reference Level	1. Catch below MSY. 2., 3., 4. No formal levels, rather trends through time in particular post 2016 being the last year in the stock assessment.

Stock Assessment Results

Model results indicate that biomass levels were around 60% of virgin exploitable biomass prior to the late 1980s, assuming	

deterministic recruitment. After the late 1980s, annual recruitment variation was estimated from the fish age-length data. Resulting biomass proportions experienced a cyclic fluctuation influenced by the addition of recruitment information to the model (Fig. 6). A trend line through the midpoint of these cyclic fluctuations indicates a downward trend in biomass to around 50% of virgin levels in 2016. The final year of the model occurs during a biomass downcycle.

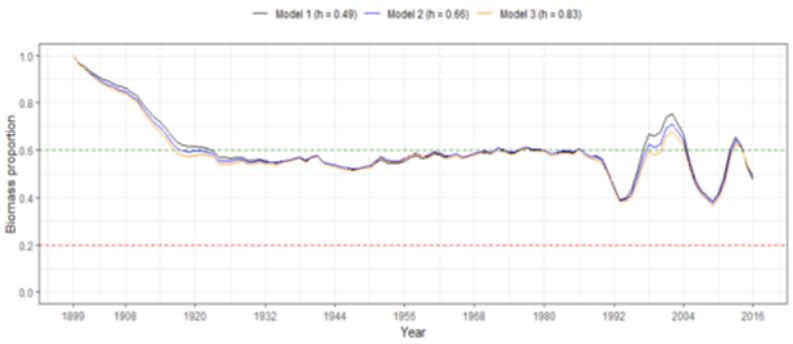

Figure 6. Plot of exploitable biomass proportion relative to virgin exploitable biomass for each model.

Table 1. Maximum Sustainable Yield estimates for each model scenario.

	Model 1 (h=0.49)	**Model 2 (h=0.66)**	**Model 3 (h=0.83)**
MSY (t)	5,969	6,526	6,709

Standardized catch rates for NSW ocean hauling estimated during the stock assessment to 2016 (Lovett et al., 2018) (Fig. 7) showed similar trends to the median catch rates (Fig. 5). Median catch rates in NSW post 2016 increased for the estuary fishery (Fig. 4) and increased then declined to around 2016 levels for the ocean hauling fishery (Fig. 5).

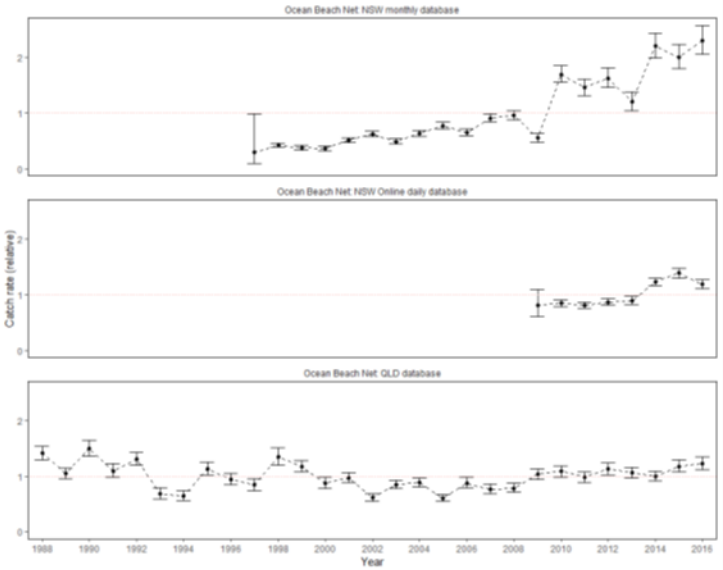

Figure 7. Standardized catch rates to 2016 for ocean hauling from Lovett et al., 2018.

Fairly typical length and age frequency compositions were found in landings in 2017/18 and 2018/19, with most fish being between three and six years of age

(Figs. 8 and 9). Landings were dominated by slightly younger fish than usual with a relative lack of fish aged five and greater. A stronger age class is apparent as two year old males in 2017/18 and then as three year males and females in 2018/19.

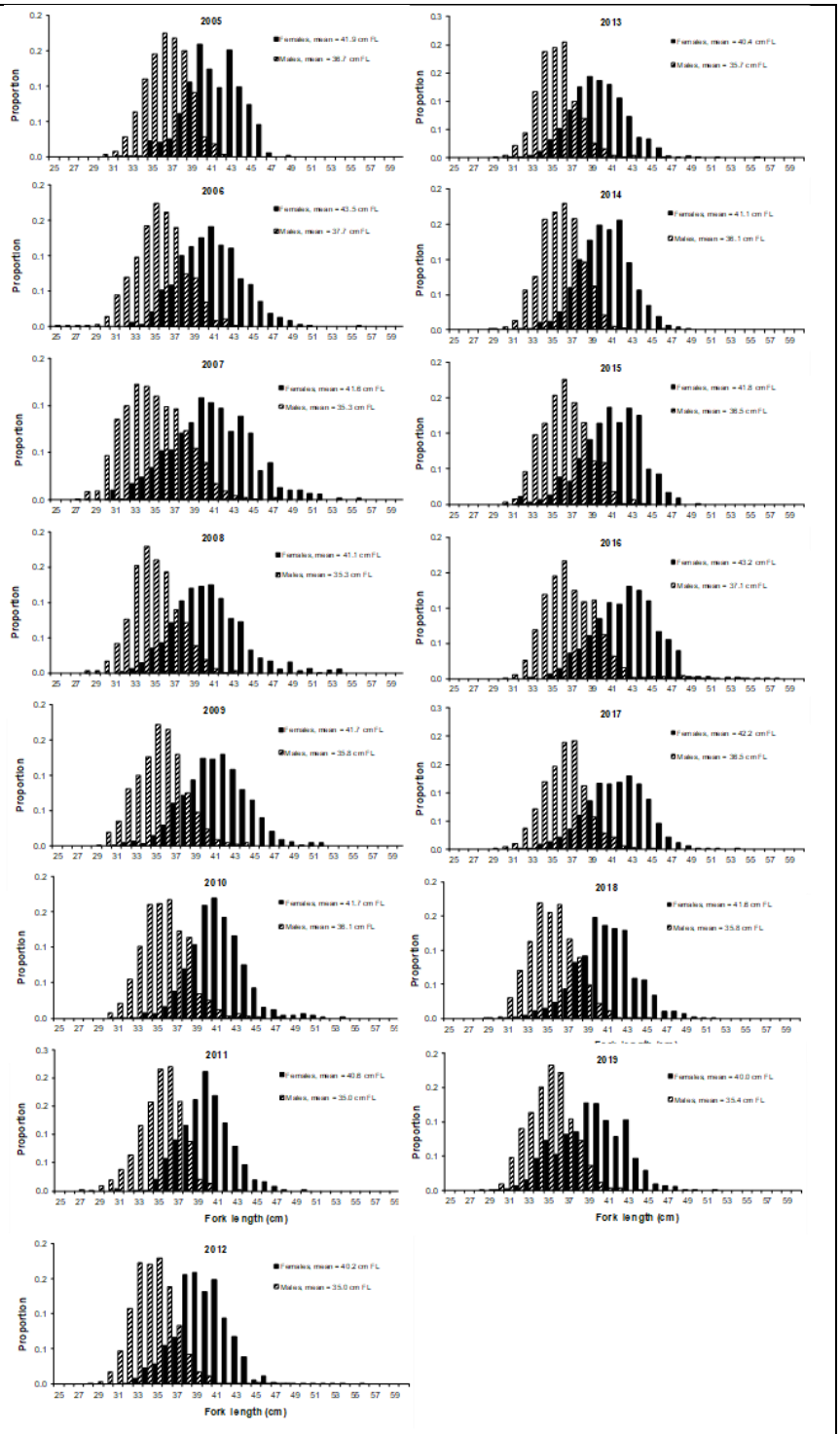

Figure 8. Length–frequency compositions of male and female *Mugil cephalus* in the spawn run fishery between 2004/05 and 2018/19. FL, fork length. Year denotes calendar year sampled, so 2004/05 = 2005.

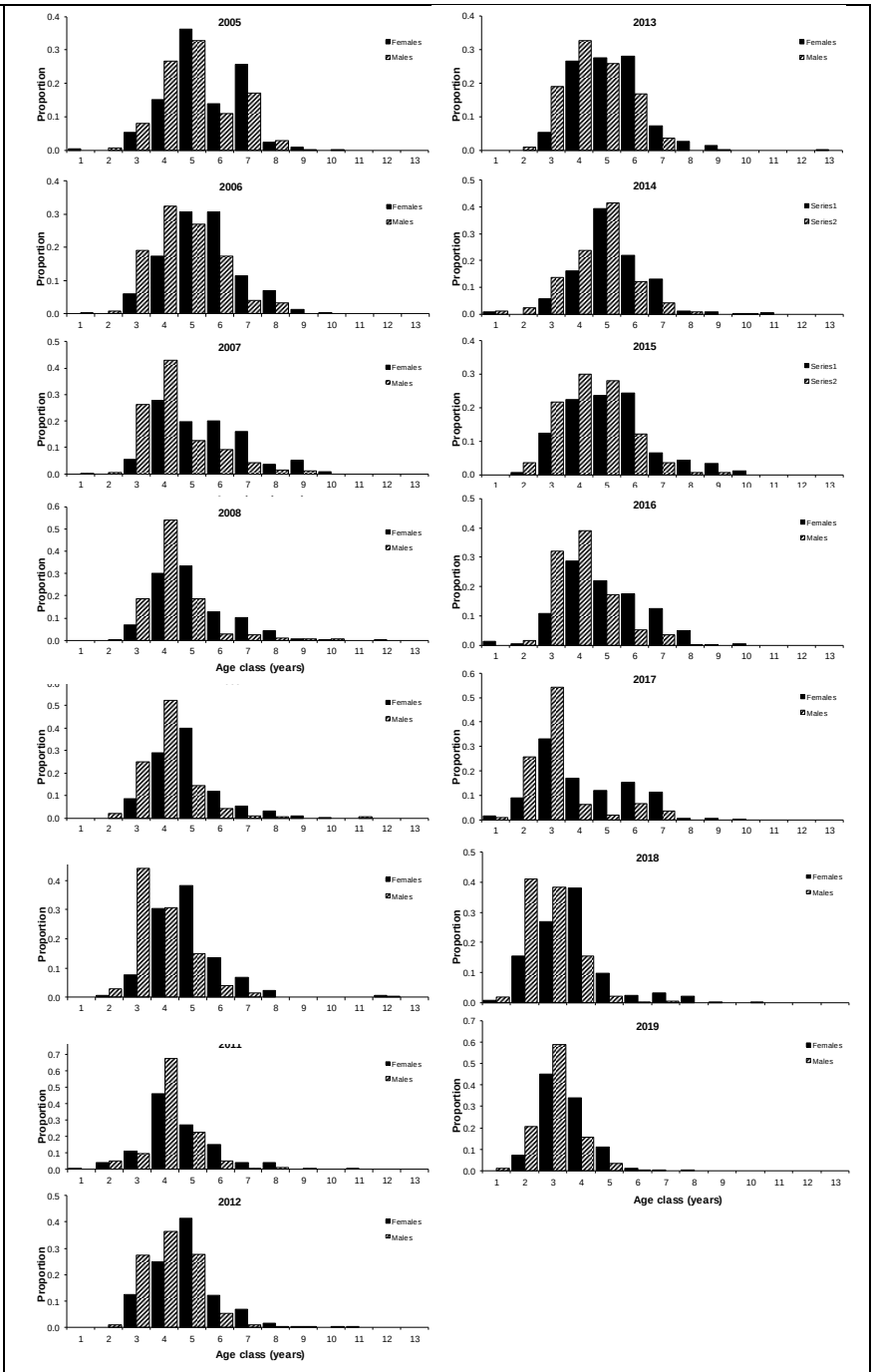

Figure 9. Age compositions of male and female Mugil cephalus in the spawn run fishery between 2004/05 and 2018/19. FL, fork length. Year denotes calendar year sampled, so 2004/05 = 2005.

Biomass status in relation to Limit	The biomass during the final year of the model (2016) was estimated to be approximately 0.5 of B0 – well above the limit reference level of 0.2. Since 2016 catch rates have not declined in either the estuary or ocean fisheries indicating that the biomass has not declined.

Fishing mortality in relation to Limit	The total landed catch (NSW and QLD combined) in 2016 was approximately 4,260 t and in 2017 was approximately 3,930 t (Stewart et al., 2018), and well below the estimates of MSY (range 6,000 to 6,700 t). The NSW landed catch and days of effort are at historically low levels (Figs 1,2 and 3) suggesting that fishing mortality is constrained. 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. Recent domination of younger age classes is noted.
Previous SAFS stock status	Fully Fished in NSW assessments 2001/02 to 2014/15. Sustainable (2012) Sustainable (2014) Sustainable (2016) Sustainable (2018)
Current SAFS stock status	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. On the basis of the evidence provided above, Sea Mullet is classified as a sustainable stock

References

Durand, J. D., Chen, W J., Shen, K. N., Jamandre, B. W., Blel, H., Diop K., et al. 2012. Systematics of the grey mullets (Teleostei: Mugiliformes: Mugilidae): molecular phylogenetic evidence challenges two centuries of morphology-based taxonomy. Molecular Phylogenetics and Evolution, 64 73–92.

Kesteven, G. L. 1953. Further results of tagging sea mullet Mugil cephalus Linnaeus. On the eastern Australian coast. Australian Journal of Marine and Freshwater Research 47:251-306.

Krück, N. C., Innes, D. I. and Ovenden, J. R. 2013. New SNPs for population genetic analysis reveal possible cryptic speciation of eastern Australian sea mullet (Mugil cephalus). Molecular Ecology Resources, 13: 715–725. doi:10.1111/1755-0998.12112.

Lovett, R. A., Prosser, A. J., Leigh, G. M., O'Neill, M. F. and Stewart, J. 2018 Stock assessment of the Australian east coast sea mullet (Mugil cephalus) fishery 2018. Technical Report. State of Queensland.

Stewart, J., Prosser, A. and Smith, K. 2018. Sea Mullet (Mugil cephalus), in Stewardson, C., Andrews, J., Ashby, C., Haddon, M., Hartmann, K., Hone, P., Horvat, P., Mayfield, S., Roelofs, A., Sainsbury, K., Saunders, T., Stewart, J., Nicol, S and Wise, B. (eds) 2018, Status of Australian fish stocks reports 2018, Fisheries Research and Development Corporation, Canberra.

Virgona, J., Deguara, K., Sullings, D., Halliday, I., and Kelly, K. 1998. Assessment of the stocks of sea mullet in New South Wales and Queensland waters. Final Report to Fisheries Research and Development Corporation. Project no 94/024.