Stock status summary

Relevant fisheries statistics and stock assessment results are summarized to inform the setting of a Total Allowable Catch (TAC) for the NSW purse seine blue mackerel quota fishery. Where data are unavailable or insufficient to reliably inform a particular criterion the heading has been retained and the lack of information or alternative proxy indicated in the summary. This format has been maintained to transparently represent the data available and highlight areas where alternate data sources or analyses may be required to improve status determination in the future.

Biology and stock structure

Blue Mackerel (*Scomber australasicus*) occur in sub-tropical and temperate waters of the Pacific and Indian Oceans. Blue Mackerel inhabit inshore and continental shelf waters off all states of Australia except the Northern Territory.

Blue Mackerel mature at about 24-28 cm fork length (FL) and spawning takes place during late winter and spring in outer continental shelf waters off northern NSW and southern QLD. Blue Mackerel grow relatively quickly, reaching approximately 17-22 cm FL after one year. They reach a maximum age of about 8 years and length of 44 cm FL in Australian waters. Blue Mackerel have been aged to be more than 20 years old in New Zealand.

The stock structure of Blue Mackerel is uncertain (Patterson et al., 2017). Genetic analysis of samples from southern Queensland, Western Australia and New Zealand indicates population subdivision with differences detected between Western Australia and Queensland, and between Western Australia and New Zealand, but not between Queensland and New Zealand (Ward et al., 2007; Whittington et al., 2012). No finer-scale analyses of Blue Mackerel have been undertaken to further define stock structure.

Blue Mackerel off southern Australia is currently considered to be comprised of two biological stocks: the Western stock that extends from western Tasmania to southern Western Australia and the Eastern stock, which occurs to the east of Bass Strait. Following a data synthesis undertaken to establish management zones in the Small Pelagic Fishery (Commonwealth), Blue Mackerel and other target species are managed in western and eastern sub-areas, which reflect this stock structure.

Stock status and assessment method

The 2016 Status of Australian Fish Stocks (SAFS) assessment for the Eastern Australian stock of Blue Mackerel was a sustainable stock (Ward et al., 2016). The rationale being that catches until that time were less than one per cent of the estimated spawning biomass during 2014 of approximately 83, 300 t and well below what was considered the sustainable exploitation rate at that time of 23%. Spawning biomass is estimated through the Daily Egg Production Method (DEPM). The evidence indicated that the stock was unlikely to be recruitment overfished and that the current level of fishing pressure unlikely to cause the stock to become recruitment overfished.

The Commonwealth currently assess Blue Mackerel as not overfished and not subject to overfishing (Patterson et al., 2017).

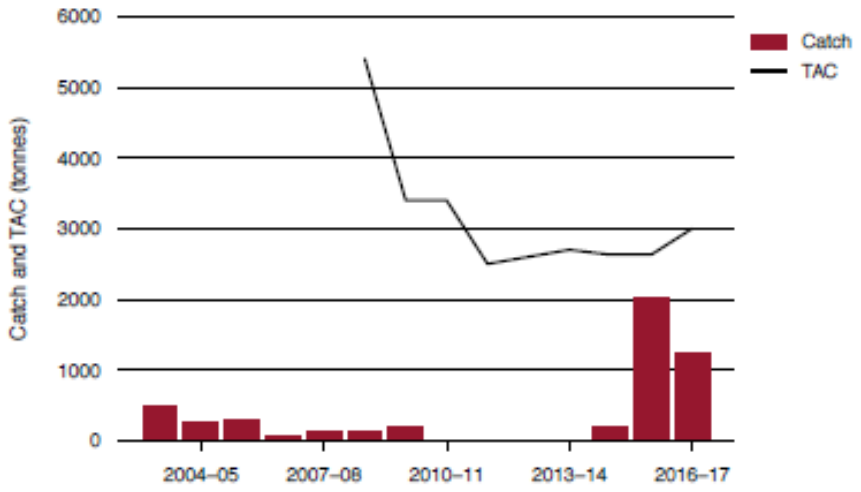
Fishery statistics - summary underpinning assessment

The Commonwealth stock assessment for Blue Mackerel does not rely on fishery statistics, other than reference to the total harvest from the stock in relation to the recommended biological catch (RBC). Therefore only data on total catch as reported by the Commonwealth is presented here.

Reference to 'Year' in the tables and figures presented in this summary refers to the first year of the financial year. For example, 2010 refers to the financial year 2010/11, unless otherwise stated.

Catch information

The majority of the eastern Blue Mackerel catch has historically been taken in state fisheries. However, with the introduction of a freezer vessel, the Commonwealth catch has recently exceeded state catch. Commonwealth catch increased in 2015–16 to 2,022 t (up from 203 t in 2014–15) and decreased to 1,248 t in 2016–17 (Fig. 1) (Patterson et al., 2017).



Note: **TAC** Total allowable catch.

Figure 1 Commonwealth eastern Blue Mackerel catch and TAC 2003/04 to 2016/17 (from Patterson et al. 2017).

Stock assessment methodology (Risk Assessment Methodology) (List of Indicators)	
Year of most recent assessment	2014 - Daily Egg Production Method (DEPM) biomass estimate. 2015 - Stochastic Stock Reduction Analysis.
Assessment method	Daily Egg Production Method (DEPM) biomass estimate (Ward et al., 2015). Stochastic Stock Reduction Analysis (SSRA) and Management Strategy Evaluation (MSE) of the Commonwealth SPF Harvest Strategy (Smith et al., 2016; Punt et al., 2016a; Punt et al., 2016b).
Main data inputs	Egg survey August/September 2014 between Sandy Cape, Queensland and Batemans Bay, New South Wales. The survey produced estimates of Blue Mackerel egg abundance, egg age and spawning area. Adult reproductive parameters: average weight, sex ratio, batch fecundity, spawning fraction. Catch and effort data. SSRA: Catch, 2014 spawning biomass estimate, growth, maturity, selectivity, stock-recruitment relationship. MSE: Weight, maturity and selectivity by age.
Main data inputs (rank)[1]	Egg survey - 1 – High Quality. Adult reproductive parameters - 2 – Medium Quality as adult

[1] 1 – High Quality: data have been subjected to documented quality assurance and peer review processes, are considered representative and robust and provide a high level of confidence to support fisheries management decisions.

2 – Medium Quality: data have been subjected to some internal quality assurance processes, have some documented limitations, but are still considered sufficiently accurate and informative to be useful to inform management decisions with some caveats.

3 – Low Quality: data have been subjected to limited or no quality assurance processes, may be compromised by unknown or documented limitations that have not been fully explored, but are considered the best available information and require a high level of precaution to be exercised when interpreted to inform management decisions.

Stock assessment methodology (Risk Assessment Methodology) (List of Indicators)	
	parameters for Blue Mackerel were adopted from surveys done in South Australia between 2001 and 2006. Catch and effort - 2 – Medium Quality. SSRA: Catch, 2014 spawning biomass estimate, growth, maturity, selectivity, stock-recruitment relationship. – 2 – Medium Quality as parameters not from the eastern stock. MSE: Weight, maturity and selectivity by age - 2 – Medium Quality.
Key model structure and assumptions	NA for DEPM. SSRA: age-structured model, fixed parameters for weight-at-age, natural mortality, selectivity at age and stock-recruitment steepness. Free parameters unfished recruitment, fishing mortality on fully-selected age classes, deviations around the stock-recruitment relationship. 2014 spawning biomass estimate based on the DEPM derived 83,300 t with a CV of 0.5. Assumptions include negligible catch prior to 1997/98, and that assumed parameters are correct. MSE operating model is age-structured, and recruitment is driven by spawning stock biomass and uses pre-specified values for biological parameters (natural mortality, growth, maturity, and stock-recruit steepness.
Sources of uncertainty evaluated	Considerable uncertainty exists around all of the key input data for the Blue Mackerel DEPM assessment. Sensitivity analyses were done for all parameters to determine which had the largest influence on estimated spawning biomass. These were done by varying each individual parameter whilst keeping the others constant at the value used to calculate spawning biomass. Conclusions were drawn based on the most precautionary parameter estimates, resulting in the spawning biomass likely to be under-estimated. MSE testing of the SPF harvest strategy rules to examine the probability of the biomass falling below the limit reference point of 20%of unfished levels with a less than 10% chance over 50 years.

Status Indicators and Limits Reference Levels	
Biomass indicator or proxy	Stochastic Stock Reduction Analysis (SSRA) derived depletion level (Punt et al., 2016a; Punt et al., 2016b).
Biomass limit reference level	Biomass falling below the limit reference point of 20% of unfished levels with a less than 10% chance.
Fishing mortality indicator or proxy	Catch as a proportion of spawning biomass.
Fishing mortality limit reference level	Annual catch is less than 15% of the DEPM derived estimate of spawning biomass. This is the Tier 1 exploitation rate in the Commonwealth SPF Harvest Strategy for setting a Recommended Biological Catch (RBC) for each of five fishing seasons following a DEPM assessment. Five years after a Tier 1 assessment, the RBC is set at the Tier 2 level that is 7.5% of the DEPM derived estimate of spawning biomass. Five years after a Tier 2 assessment, if no updated DEPM is done, the RBC is set at the Tier 3 level that is 3.75% of the DEPM derived estimate of spawning biomass.
Target reference level	NSW does not have target reference levels for Blue Mackerel, however, the Commonwealth has a target reference point of 50% of unfished levels.

Stock Assessment Results (Risk Assessment Results) (Results of Review of Indicators)	
Biomass status in relation to limit	Stochastic Stock Reduction Analysis (Punt et al., 2016a; Punt et al., 2016b) estimated that the current (2015) depletion of Blue Mackerel was likely to be fairly close to the average unfished level. The estimate of 2015 depletion based on the parameter values on which the MSE conducted by Smith et al. (2015) was based is 0.93, but the uncertainty about that

Stock Assessment Results (Risk Assessment Results) (Results of Review of Indicators)	
	estimate is high, particularly when account is taken of autocorrelation in recruitment.
Fishing mortality in relation to limit	Recent harvests of Blue Mackerel have been well below the reference level of 15% of the 2014 derived DEPM estimate of spawning biomass (estimated to be around 83 300 t with 95% confidence intervals of 35,100 to 165,000 t) (Ward et al., 2015) with the RBC calculated as 15% x 83,300t ~12,500 t. Total harvest from all sectors peaked during 2016 at roughly 4,500 t representing < 6% of the estimated spawning biomass in 2014.
Previous SAFS stock status	Moderately Fished in NSW assessments 2004/05 to 2014/15. SAFS 2016 Sustainable.
Current SAFS stock status	The above evidence indicates that the stock is unlikely to be recruitment overfished, and that the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished. On the basis of the evidence provided above, the Eastern biological stock is classified as a sustainable stock.

Fishery Interactions

Commonwealth Small Pelagic Fishery – purse seine and midwater trawl, interacts with the NSW commercial fishery. The SPF has TACs based on RBCs derived from the SPF harvest strategy rules and then subtracting state catches. The TACs are very large, an order of magnitude greater than the NSW state catches, that until recently have been the largest, and have never been attained.

Commonwealth Tuna boats accessing Blue Mackerel for bait under permit.

Recreational fishers who harvest Blue Mackerel for food and bait. An historically contentious fishery interaction with concerns about the impact of commercial operations on the availability of bait for recreational fishers and on the distribution and therefore availability of gamefish.

References

Patterson, H., Noriega R., Georgeson, L., Larcombe, J. and Curtotti, R. 2017. Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Punt, A.E., Little, R. and Hillary, R. 2016a. Updated management strategy evaluation for Eastern Jack and Blue Mackerel, report for AFMA, CSIRO Oceans and Atmosphere Flagship, Hobart.

Punt, A.E., Little, L.R. and R. Hillary. 2016b. Assessment for Eastern Blue Mackerel. Document submitted to AFMA. 6pp.

Smith, A., Ward, T., Hurtado, F., Klaer, N., Fulton, E. and Punt, A. 2015. Review and update of harvest strategy settings for the Commonwealth Small Pelagic Fishery: single species and ecosystem considerations, report for FRDC project 2013/028, CSIRO Oceans and Atmosphere Flagship, Hobart.

Ward, T.M., Schmarr, D.W., McLeay, D.W., Rogers, L. and Ivey, A. 2007. A preliminary investigation of the spawning biomass of sardine (pilchard, *Sardinops sagax*) off eastern Australia, Final report for New South Wales Department of Primary Industry, SARDI Aquatic Sciences, Adelaide.

Ward, T.M., Grammer, G., Ivey, A., Carroll, J., Keane, J., Stewart, J. and Litherland, L. 2015b. Egg distribution, reproductive parameters and spawning biomass of blue mackerel, Australian sardine and tailor off the east coast during late winter and early spring, FRDC project 2014/033, FRDC & SARDI, West Beach.

Ward, T., Moore, A., Norriss, J., Lyle, J. and Stewart, J. 2016. Blue Mackerel *Scomber australasicus*, in Carolyn Stewardson, James Andrews, Crispian Ashby, Malcolm Haddon, Klaas Hartmann, Patrick Hone, Peter Horvat, Stephen Mayfield, Anthony Roelofs, Keith Sainsbury, Thor Saunders, John Stewart, Ilona Stobutzki and Brent Wise (eds) 2016, Status of Australian fish stocks reports 2016, Fisheries Research and Development Corporation, Canberra.

Ward, T.M. and Rogers, P.J. 2007. Evaluating the application of egg-based stock assessment methods for blue mackerel, *Scomber australasicus*, in southern Australia, Final report to FRDC, Canberra.

Whittington, I.D., Ovenden, J.R. and Ward, T.M. 2012. Discriminating stocks of blue mackerel using a holistic approach: a pilot study, in JR McKenzie, B Parsons, AC Seitz, R Keller Kopf, M Mesa & Q Phelps (eds), Advances in fish tagging and marking technology, American Fisheries Society Symposium 76, pp. 397–417.