Stock Status Summary – 2021

NSW Stock Status Summary Australian Sardine
(*Sardinops sagax)*

Assessment Authors and Year

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Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Australian Sardine is currently assessed as **Sustainable** for the NSW component of the stock.

Stock Structure

Australian Sardine (*Sardinops sagax*) is distributed around the entire southern half of the continent where they inhabit continental shelf waters and the lower reaches of estuaries. The population structure in Australian waters is complex, with evidence of broad separation between sardines in Western Australia, South Australia and eastern Australia. These areas comprise smaller size dependent shoals that effectively create a single semi-continuous Australian meta-population. Australian Sardine off southern Australia is a meta-population (Whittington et al. 2008), with effective isolation of four separate biological stocks: the South-western (off Western Australia); Southern (off South Australia); South-Eastern (off Victoria, Tasmania and southern NSW) and Eastern (off northern New South Wales and southern Queensland) Australian stocks (Izzo et al. 2017, Sexton et al. 2019).
While east coast Australian Sardine are currently assessed through the Status of Australian Fish Stocks (SAFS) framework at the biological stock level— Eastern Australia and South Eastern Australia, the Commonwealth assesses and manages Australian Sardine as a single east coast stock. The NSW Ocean Hauling (Purse Seine) quota fishery for Australian Sardine is similarly managed as a single stock.

Stock Status - Catch Trends

The sardine subarea off eastern Australia is the only area of the SPF that is fished, Australian sardine in the SPF is therefore assessed and managed as a single east coast stock. As such the data presented do not separate the newly identified Eastern and South Eastern Australia stocks.

State catches of Australian Sardine comprise most of the total catch. State catches increased substantially from 2001/02 to 2009/10, contributing to reductions to the Commonwealth TAC. Total sardine catches from Commonwealth and state fisheries (other than those taken in South Australia) peaked in 2008/09 at 4,787 t and decreased to 893 t in 2014/15. The total combined catch (state and Commonwealth, excluding Victorian catches because they were confidential) for 2018/19 was 596 t, comprising 132 t of Commonwealth catch and 464 t of state catch. Commonwealth catch for 2019/20 was 226 t (Figure 1); noting that state catches were not available when the report was compiled. The NSW Ocean Hauling Purse Seine catch has averaged around 522 t p.a. since 2009, substantially less than the TAC (Fig. 2).

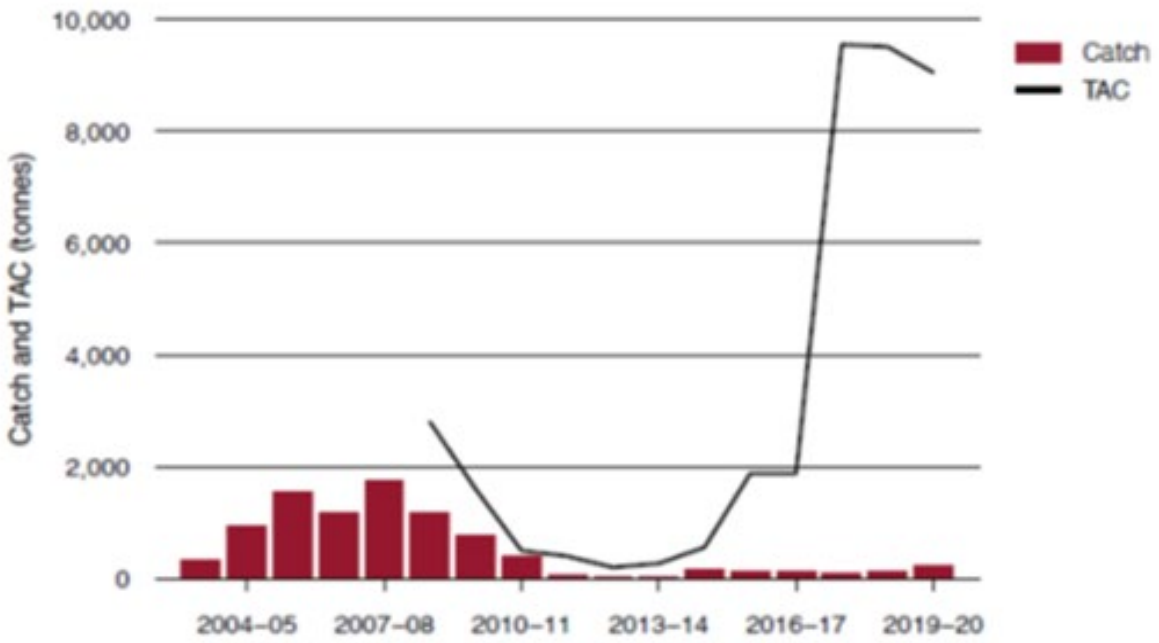

Figure 1. Commonwealth Australian Sardine catch and TAC in the SPF, 2003/04 to 2019/20 (from Patterson et al. 2020).

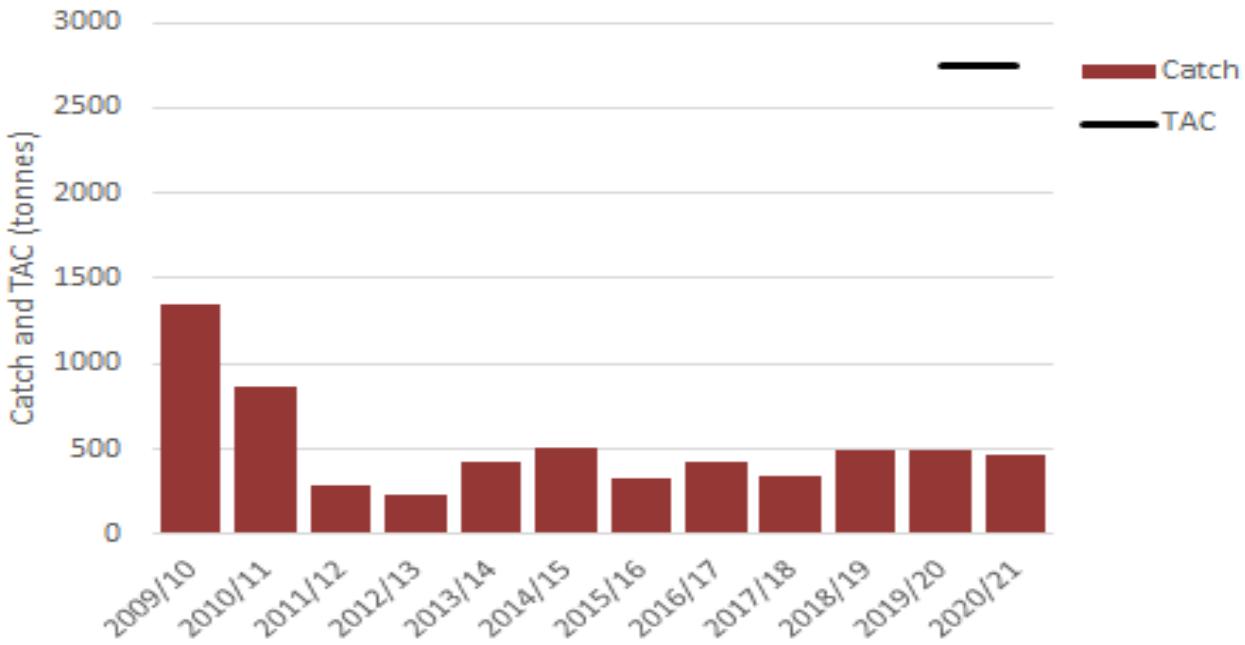

Figure 2. New South Wales Ocean Hauling Purse Seine landings of Australian Sardine and TAC 2009/10 to 2020/21. Note that the 2020/21 fishing season was only 6 months completed when these data were collated.

Recreational and Indigenous

The recreational harvest of Australian Sardine is thought to be minor and there are no data available on aboriginal harvest (West et al., 2015).

Fishing effort trends

Fishing effort is not a consideration for the Commonwealth assessment.

Catch rate trends

Catch rate trends are not a consideration for the Commonwealth assessment

Stock Assessment Methodology

Year of most recent assessment	2014 – Daily Egg Production Method (DEPM) biomass estimate. 2015 – Population model and MSE testing.
Assessment method	Daily Egg Production Method (DEPM) biomass estimates (Ward et al., 2015a, b). Management Strategy Evaluation (MSE) of the Commonwealth SPF Harvest Strategy (Smith et al., 2015).
Main data inputs	Egg survey August/September 2014 between Sandy Cape, Queensland and Batemans Bay, New South Wales. Egg survey January 2014 around northern Tasmania and southern Victoria. The surveys produced estimates of Australian Sardine egg abundance, egg age and spawning area. Other inputs included adult reproductive parameters: average weight, sex ratio, batch fecundity, spawning fraction. MSE: Growth, maturity, weight and selectivity by age. Natural mortality and stock-recruitment relationship.
Key model structure and assumptions	NA for DEPM MSE operating model is age-structured, and recruitment is driven by spawning stock biomass and uses values for biological parameters (natural mortality, growth, maturity, stock-recruitment and selectivity).
Sources of uncertainty evaluated	Considerable uncertainty exists around key input data for the Australian Sardine 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 various potential SPF harvest strategy control 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.

Status Indicators and Limits Reference Levels

Biomass indicator or proxy	Depletion estimates (Smith et al., 2015).
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 20% 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. Note that Smith et al. (2015) recommended an exploitation rate of 33% was acceptable for Eastern Australian Sardine. Five years after a Tier 1 assessment, the RBC is set at the Tier 2 level that is 10% 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 5% of the DEPM derived estimate of spawning biomass.

Stock Assessment Results

Biomass status in relation to limit	Smith et al. (2015) reported an exploitation rate of up to 33% may be suitable for Eastern Australian Sardine under the Commonwealth SPF harvest strategy. The current harvest strategy exploitation rate following a Tier 1 assessment is only 20%, ensuring a very low probability of the stock falling below 20% of unfished levels. Catches have always been low relative to the estimated spawning biomass and as a result, fishing is not believed to have substantially reduced spawning biomass.
Fishing mortality in relation to Limit	The most recent estimates of Australian Sardine biomass off eastern Australia were done via DEPM surveys in 2014. The first survey done during August/September 2014 between Sandy Cape, Queensland and Batemans Bay, NSW estimated the spawning biomass in that area to be approximately 49,575 t (95% confidence intervals 24,200 to 213,300 t) (Ward et al, 2015a). A second survey done during January 2014 around northern Tasmania and southern Victoria estimated the spawning biomass in that area to be approximately 10,962 t (95% confidence intervals 8,000 to 15,000 t) (Ward et al, 2015b), noting that the entire southern spawning area was not believed to have been surveyed. Recent harvests of Australian Sardine have been well below the reference level of 20% of the 2014 derived DEPM estimate of spawning biomass (estimated to be around 49,575 t) (Ward et al., 2015a) with the RBC calculated as 20% x 49,575 ~9,915 t. The

	2016/17 catch from all jurisdictions was 2,887 t, representing < 6% of the spawning biomass in 2014. The total 2018/19 catch was 596 t (noting that Victorian catches were not available) and the Commonwealth catch for 2019/20 was 226 t, noting that state catches were not available when the report was compiled. Total harvest from all sectors peaked during 2009 at approximately 5,000 t representing ~ 10% of the spawning biomass in 2014.
Previous SAFS stock status	SAFS 2012 **Sustainable**. SAFS 2014 **Sustainable.** SAFS 2016 **Sustainable.**
Current SAFS stock status 2018	<u>Eastern Australia stock</u> 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 Australia biological stock is classified as a **Sustainable** stock. <u>South Eastern Australia stock</u> 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 South Eastern Australia biological stock is classified as a **Sustainable** stock.

Qualifying Comments

Whilst the MSE testing suggests that fishing has never been large enough to substantially reduce the spawning biomass of Eastern Australian Sardine, and that the SPF harvest strategy is precautionary and appropriate for maintaining stocks, on average, within the defined reference levels, that there exists huge uncertainty around the risks of harvesting Australian Sardines. Firstly, many exploitation scenarios examined during MSE testing suggested quite high depletion levels, well below the target level of 50%. Secondly, small pelagic species are characterized globally by huge fluctuations in abundance as a result of environmental factors beyond the control of fishery managers. As an example, Australian Sardines suffered two mass mortality events during 1995 and 1998, during which time the biomass was substantially reduced. The MSE model results may, therefore, under-estimate the risks associated with low stock sizes.

The DEPM-based estimates of Eastern Australian Sardine spawning biomass are highly likely to be under-estimates, due to any potential biases in terms of key parameters (such as spawning area and the assumption that surveys are done at the peak spawning time) always leading to under-estimating spawning biomass.

The very wide confidence intervals of DEPM-derived spawning biomass need to be acknowledged; in 2014 it was estimated at 49,575 t with 95% confidence intervals 24,200 to 213,300 t (Ward et al, 2015a).

Of note is that the NSW state-based catch has always been far larger than the Commonwealth catch. Previous assessments have been largely supported by NSW data on the quantities, sizes and ages of Australian Sardines being harvested in NSW waters. More recent DEPM-based assessments have been funded by the FRDC, with substantial co-investigation from NSW in those assessments.

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 RBCs are set at extremely precautionary levels. Several NSW endorsed fishers also hold Commonwealth SPF endorsements.
NSW Estuary General Fishery – only minor landings of Australian Sardines.
Recreational fishers - only minor landings of Australian Sardines; however a very large user of sardines as bait.

NSW Fishery

The stock status summary for Australian Sardine summarizes information from the Commonwealth assessment only. Here, additional information is presented that may assist in understanding the dynamics of the NSW fishery for Australian Sardine.

Commercial

Australian Sardine in NSW is mainly caught by the Ocean Hauling Fishery in purse seine nets. Smaller quantities are also taken using general purpose hauling nets and bait nets (which are modified hauling nets). The largest landings occur during winter/spring in northern NSW and autumn/winter in southern NSW.

Commercial landings of Australian Sardines in NSW were historically below 500 t p.a. until the early 2000s, when industry investment in processing and marketing, coupled with a considerably larger purse-seine vessel being introduced to the fishery, resulted in landings increasing rapidly to more than 2,000 t (Fig. 3). Landings declined considerably following the destruction of the main processing factory in late 2010 and the subsequent departure of the main catching vessel from the fishery, averaging around 450 t p.a. since 2009/10.

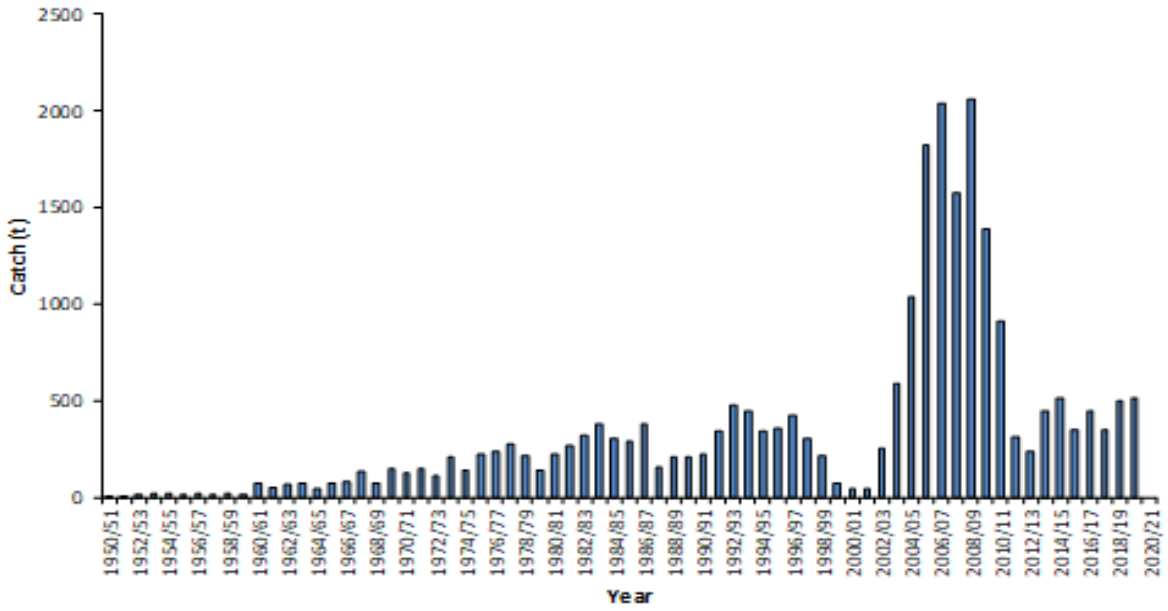

Figure 3. Commercial landings in NSW (including available historical records) of Australian Sardine for NSW from 1950/51 to 2018/19 for all fishing methods.

Total NSW landings by biological stock show that following the destruction of the processing factory in Eden in 2010, that the majority of landings have come from the more northern Eastern Australia biological stock (Fig. 4).

Figure 4. Commercial landings of east coast Australian Sardines by biological stock from NSW fisheries.

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