Stock Status Summary – 2021/22

NSW Stock Status Summary – Australian Bonito
(*Sarda australis*)

Assessment Authors and Year

Stewart, J. 2023. NSW Stock Status Summary 2021/22 – Australian Bonito – (*Sarda australis*).

NSW Department of Primary Industries. Fisheries NSW. 15 pp.

Stock Status

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

Stock structure & distribution

Australian Bonito *Sarda australis* occurs in the western Pacific Ocean where it is restricted to waters around south-eastern Australia, Norfolk Island and northern New Zealand (Collette and Nauen 1983). South-east Queensland is the northern extent of the species range. Little is known about stock structure within this range; however Australian Bonito are highly mobile and commercial landings exhibit consistent seasonal patterns in availability in terms of both abundance and sizes (Stewart et al., 2013). Due to the latitudinal distribution along eastern-Australia, and influence of the prevailing southerly flowing Eastern Australian Current in this area Australian Bonito is considered to be a single biological stock in this region – the Eastern Australia biological stock.

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

Biology

Australian Bonito grow rapidly, potentially attaining 30 cm fork length (FL) in 3 to 4 months (Stewart et al., 2013). Growth varies seasonally being significantly faster during the summer months. Australian Bonito can reach 100 cm in length (Collette and Nauen, 1983); however the largest fish sampled in recent times was approximately 65 cm FL and in its 4th year of life (Stewart et al., 2013). The reproductive biology of Australian Bonito is not well understood; however, Stewart et al. (2013) reported a likely spring/summer spawning period, with maturity occurring at around 36 cm FL and 1 year of age. There are no differences in growth rates or size at maturity between males and females.

FISHERY STATISTICS

Catch information

Commercial

Line fishing in the Ocean Trap and Line Fishery accounts for almost all of the commercial catch, averaging more than 98% of total landings between 2009/10 and 2021/22. Annual commercial landings fluctuate considerably and tend to range between 150-350 t per year (Fig. 1). Australian Bonito are landed commercially throughout the year in NSW however landings tend to be lower during spring and early summer (Fig. 2).

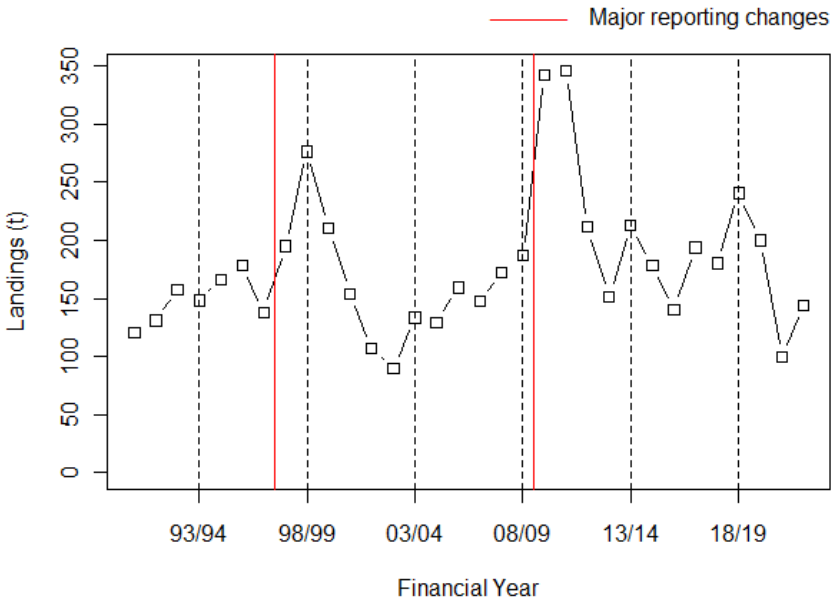

Figure 1 **Commercial landings (including available historical records) of Australian Bonito for NSW from 1990/91 to 2021/22.**

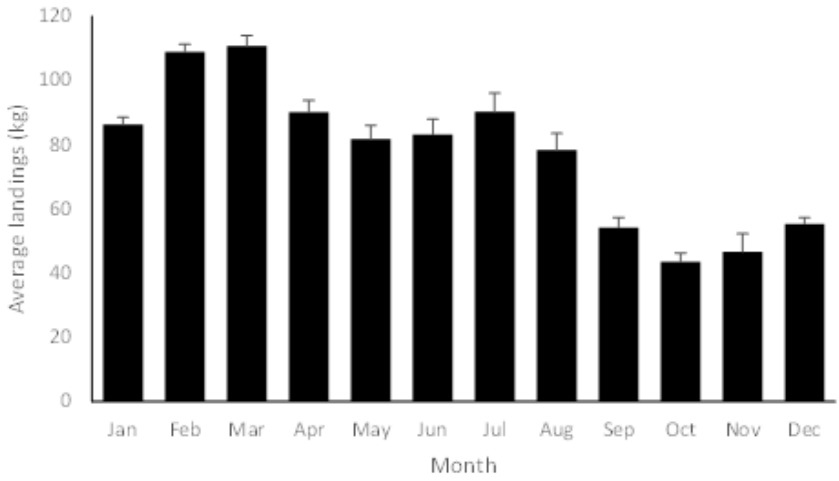

Figure 2 **Average (with SE) commercial landings by month of Australian Bonito between 2009/10 and 2021/22.**

Recreational & Charter boat

Australian Bonito is important to recreational fishers and the charter industry in NSW. The most recent estimate of the recreational harvest was approximately 7,000 fish during 2019/20 (Murphy et al., 2022), equivalent to roughly 4 t (NSWDPI unpublished). Previous estimates of the recreational harvest in NSW were approximately 21,000 fish during 2017/18 (Murphy et al., 2020), 40,000 fish during 2013/14 (West et al., 2015) and 50,000 fish during 2000/01 (Henry and Lyle,

2003; NSWDPI unpublished data). While these survey results are not directly comparable due to differencing sampling frames, they likely represent a decline in recreational harvest since 2000/01. Charter catch is estimated as a component of the recreational harvest in recreational fishing surveys; however reported catch of Australian Bonito in charter logbooks has been relatively low, averaging around 1,200 fish per year 2017/8 to 2021/22 (NSWDPI unpublished).

Aboriginal cultural fishery

There are no data on Aboriginal harvest of Australian Bonito or the importance to Aboriginal communities. As an inshore species it has likely been harvested at some level by Aboriginal people.

Illegal, Unregulated and Unreported

The level of Illegal Unregulated and Unreported (IUU) catch of Australian Bonito is unknown, but considered to be minimal.

Fishing effort information

Commercial fishing effort on Australian Bonito is difficult to estimate prior to 2009/10 as the monthly catch returns listed days fished per month by method and had no direct link to the number of days within a month that a particular species was landed. The number of days handlining reported for when Australian Bonito were also reported in a month have declined from more than 7,000 during 1990/00 to fewer 3,000 in recent years (Fig. 3). More accurate estimates of fishing effort are available after 2009/10 and show that the number of days using line fishing methods on which Australian Bonito were landed have been relatively stable, averaging approximately 2,200 days p.a. since that time but with a decline in the most recent two years (Fig. 4).

The majority of fishing effort on Australian Bonito during the last decade has been from ocean zones 3, 5 and 6 since 2009/10 (Fig. 5).

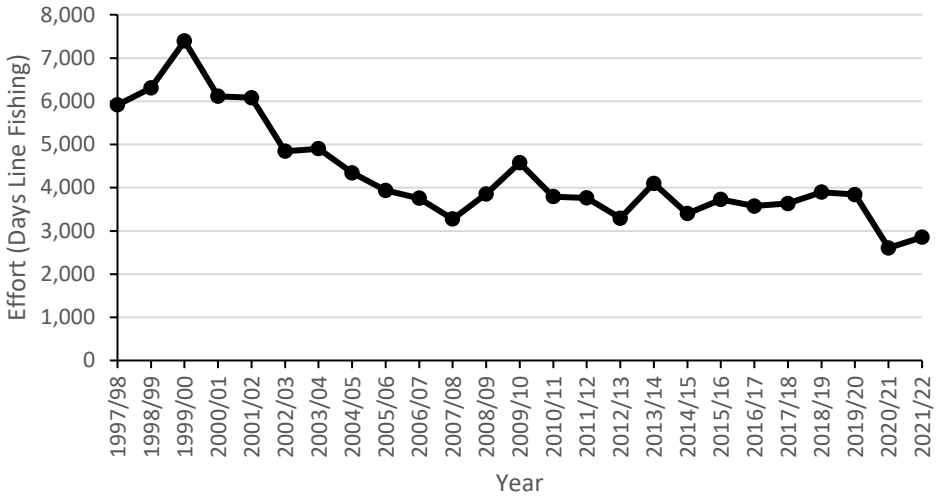

Figure 3 **Annual reported days fished for months when Australian Bonito were landed by major line fishing methods 1997/98 to 2021/22.**

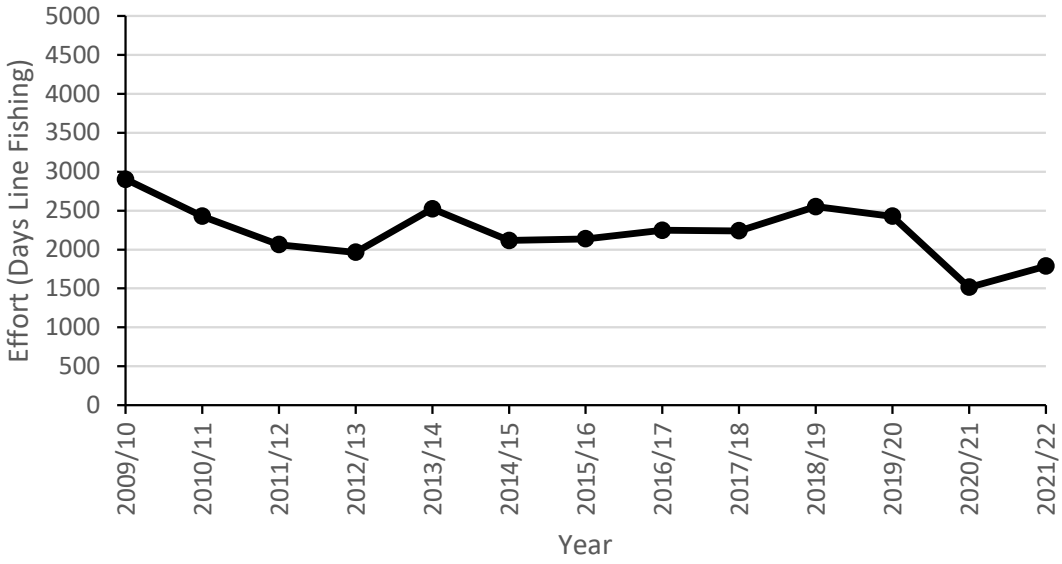

Figure 4 **Annual reported days fished when Australian Bonito were landed by line fishing methods 2009/10 to 2021/22.**

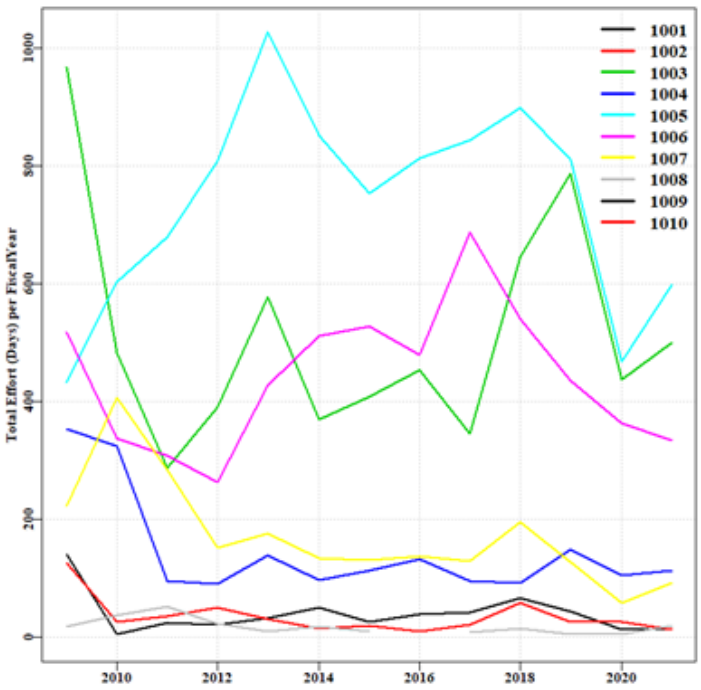

Figure 5 **Annual reported days fished per year when Australian Bonito were landed by major line fishing methods 2009/10 to 2021/22 by Ocean Zone.**

Catch Rate information

Catch rates of Australian Bonito using the main line fishing methods of Handline, Trolling, Jigging, and Poling were standardised using two data sources. Catch rates for 1997/98 to 2021/22 were derived from monthly logbook data when all days within a month using these methods were included. Secondly, catch rates from daily logbook data were derived for 2009/10 to 2021/22. Catch rates were standardised for year, area, fisher and month using the r-package 'cede', with outputs standardised to 1.

Standardised catch rates using the monthly aggregated data and daily data were extremely similar (Fig. 6), providing confidence that the longer time-series of catch rate from 1997/98 is indicative of catch rates in the fishery when targeting Australian Bonito. Standardised catch rates since 1997/98 have fluctuated but with no overall trend (Fig. 7). Years of higher landings generally corresponded to high catch rate years.

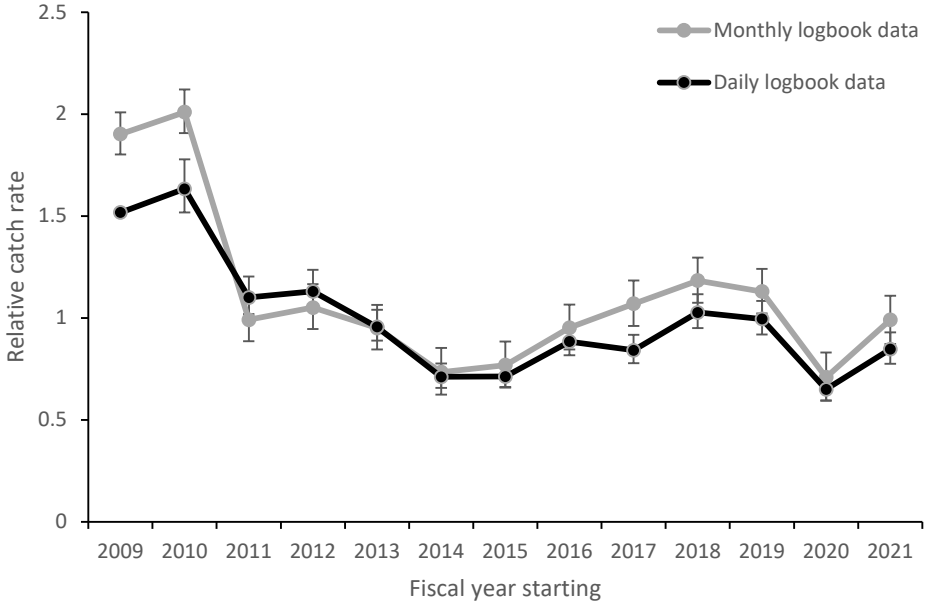

Figure 6 **Standardised catch rates with standard errors for Australian Bonito 2009/10 to 2021/22 derived from daily logbook data and aggregated monthly logbook data. Years represent the first year of the financial year.**

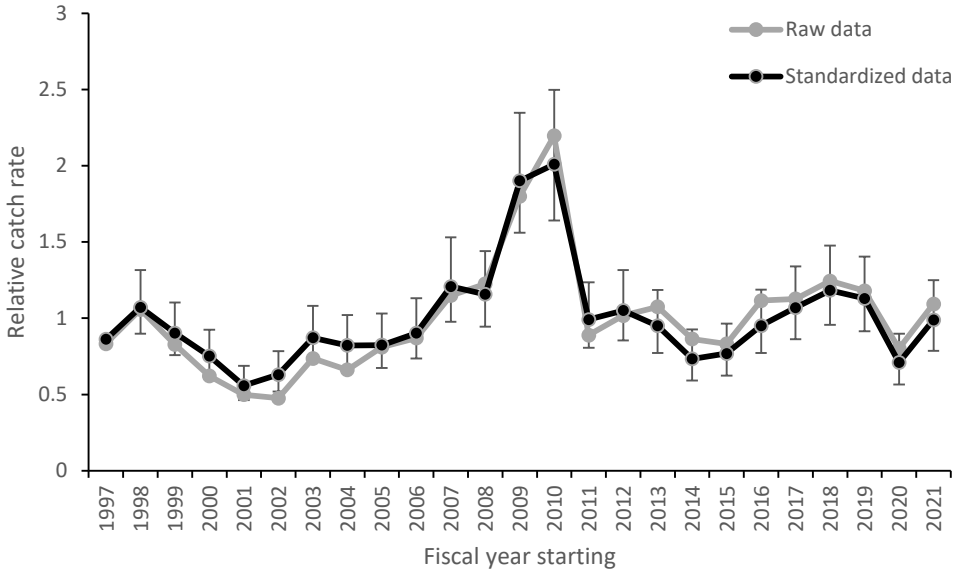

Figure 7 **Standardised catch rates with standard errors for Australian Bonito for the major line fishing methods for the period 1997/98 to 2021/22. Years represent the first year of the financial year.**

STOCK ASSESSMENT

Stock Assessment Methodology

Year of most recent assessment:

2023 on data up to and including 2021/22.

Assessment method:

Weight of Evidence incorporating:

- Surplus production modelling done using the open-source modelling software JABBA (Just Another Bayesian Biomass Assessment) by Winker et al. (2018).
- Standardized catch rates 1997/98 to 2021/22 (Fig. 7).
- Trends in size composition in the landed commercial catch 2003/04 to 2021/22.
- Mortality estimates derived from catch curves and empirical equations based on maximum age (Then et al., 2015).

Main data inputs:

- Commercial landings data 1990/91 to 2021/22.
- Standardized catch rates 1997/98 to 2021/22.
- Estimates of r (the intrinsic rate of population increase), K (carrying capacity) and initial depletion.

Key model structure & assumptions:

- Surplus production model used the Pella-Tomlinson production function. Prior estimates of r were based on a medium classification from FishBase (Froese and Pauly, 2000), which

represents a possible range of 0.2 - 0.8. This is consistent with the life-history parameters of Australian Bonito as described in Stewart et al. (2013). The depletion at 1990/91 was estimated at 0.5 with a CV of 0.25.

- Standardized catch rates represent trends in relative abundance.
- Size compositions are representative of not only the commercial landings but the exploitable population.
- The estimate of M is not biased.

Sources of uncertainty evaluated:

- Various starting parameters (r and initial depletion) for the model were trialled to examine the effects on outputs and the diagnostic plots from JABBA.
- One scenario whereby commercial landings were increased by 1.5 to approximate the addition of recreational harvest was run to evaluate the impact on the model outputs.

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	Mean annual biomass and depletion level, as estimated in the surplus production model. Standardized catch rates.
Biomass Limit Reference Point	0.2 of unfished biomass (B_0). No formal reference level for catch rates; however, trends are assessed.
Biomass Target Reference Point	There are no Target Reference Points for Australian Bonito.
Fishing mortality indicator or proxy	Fishing mortality (F) derived in the surplus production model. Landed catch. Fishing effort. Size composition in landed catch. Mortality rates.
Fishing mortality Limit Reference Point	F relative to F_{MSY} Landed catch relative to the estimate of MSY. No formal reference levels determined for fishing effort or the size composition in the landed catch; however trends through time are used to infer trends in fishing mortality. F not to exceed M.
Fishing Mortality Target Reference Point	There are no Target Reference Points for Australian Bonito.

Stock Assessment Results

The surplus production model estimated the Australian Bonito stock at the end of 2021/22 to be 0.53 (CIs 0.28 to 0.88) of unfished levels (Table 1 and Fig. 8). Fishing mortality (F) was estimated to be 0.3 of F at MSY and the landed catch of 145 t in 2021/22 less than the estimated MSY of approximately 200 t p.a. (Table 1, Fig. 8). The model produced estimates of depletion, biomass and fishing mortality with reasonably high levels of uncertainty; however the kobe plot indicates that both B and F have not breached the limit reference points with a very high degree of certainty (Fig. 9).

The diagnostic plots indicated reasonable fits to the input data (Appendix. 1).

Table 1 Summary of posterior estimates (medians) and 95% Bayesian Credibility Intervals (C.I.s) of parameters for Australian Bonito.

	Median	2.5%	97.5%
K (t)	1730.2	1050.7	5126.7
r	0.356	0.206	0.552
$\Phi = B1990/K$	0.485	0.302	0.785
$\sigma\eta$	0.17	0.10	0.21
FMSY	0.30	0.17	0.47
BMSY (t)	692.1	420.3	2,050.6
MSY (t)	199.8	150.8	581.2
B2021/BMSY	1.32	0.71	2.19
F2021/FMSY	0.55	0.12	1.15

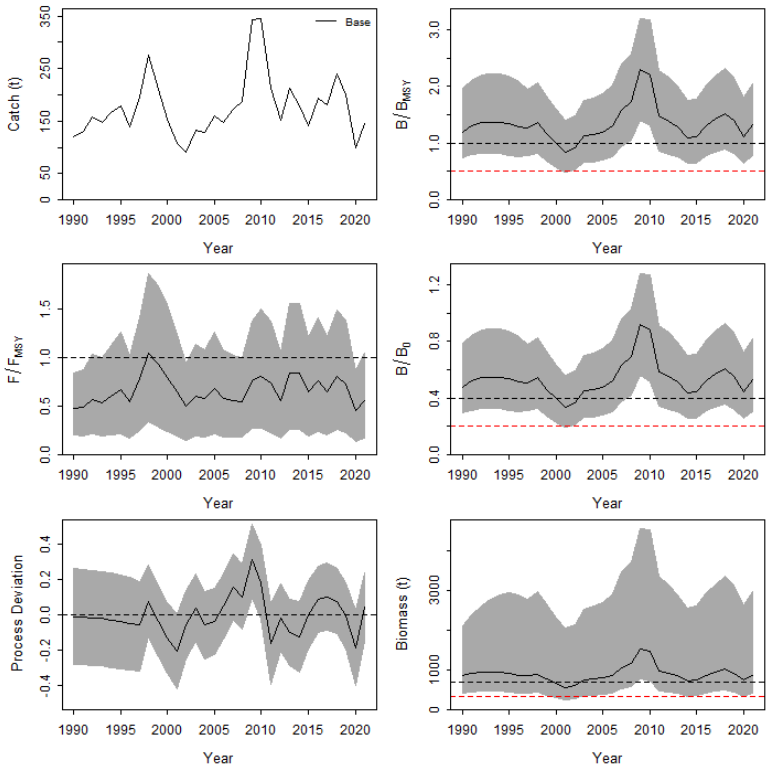

Figure 8 **Surplus production model outputs from JABBA showing estimated trajectories relating to biomass and fishing mortality. Grey-shaded areas denote 95% confidence intervals.**

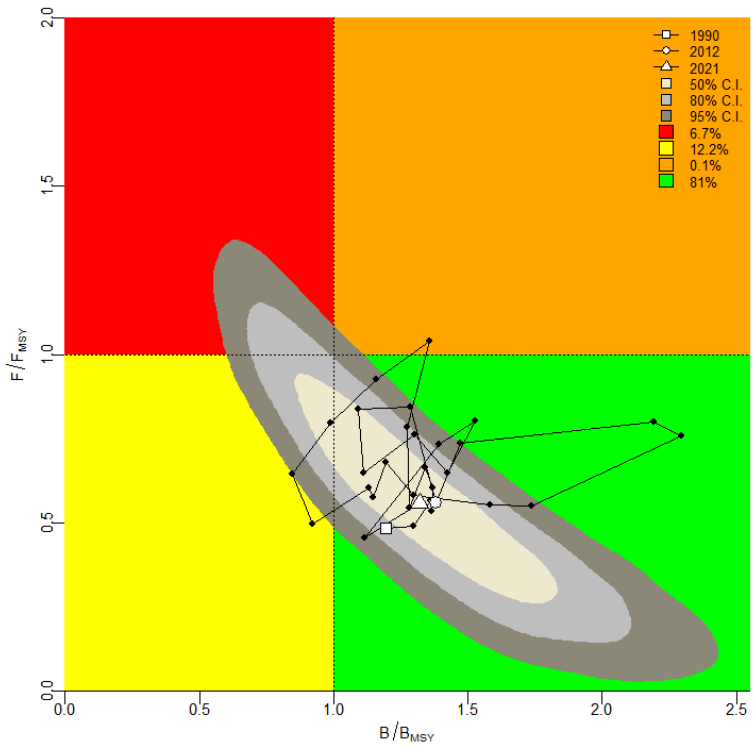

Figure 9 **Kobe phase plot for the JABBA base case scenario showing the estimated trajectories (1990/91–2021/22) of B/B_{MSY} and F/F_{MSY}. Different grey shaded areas denote the 50%, 80%, and 95% credibility interval for the terminal assessment year. The probability of terminal year points falling within each quadrant is indicated in the figure legend.**

The scenario run using an estimated recreational harvest equivalent to 1.5 of the commercial harvest produced extremely similar values of r and depletion levels to the commercial only analysis, with expected higher values of K and MSY.

The length composition of Australian Bonito in the landed commercial catch shows a change from generally being bi-modal 2003/04 to 2006/07 to mainly the smaller mode being present between 2010/11 and 2021/22 with an associated decline in average size (Fig. 10).

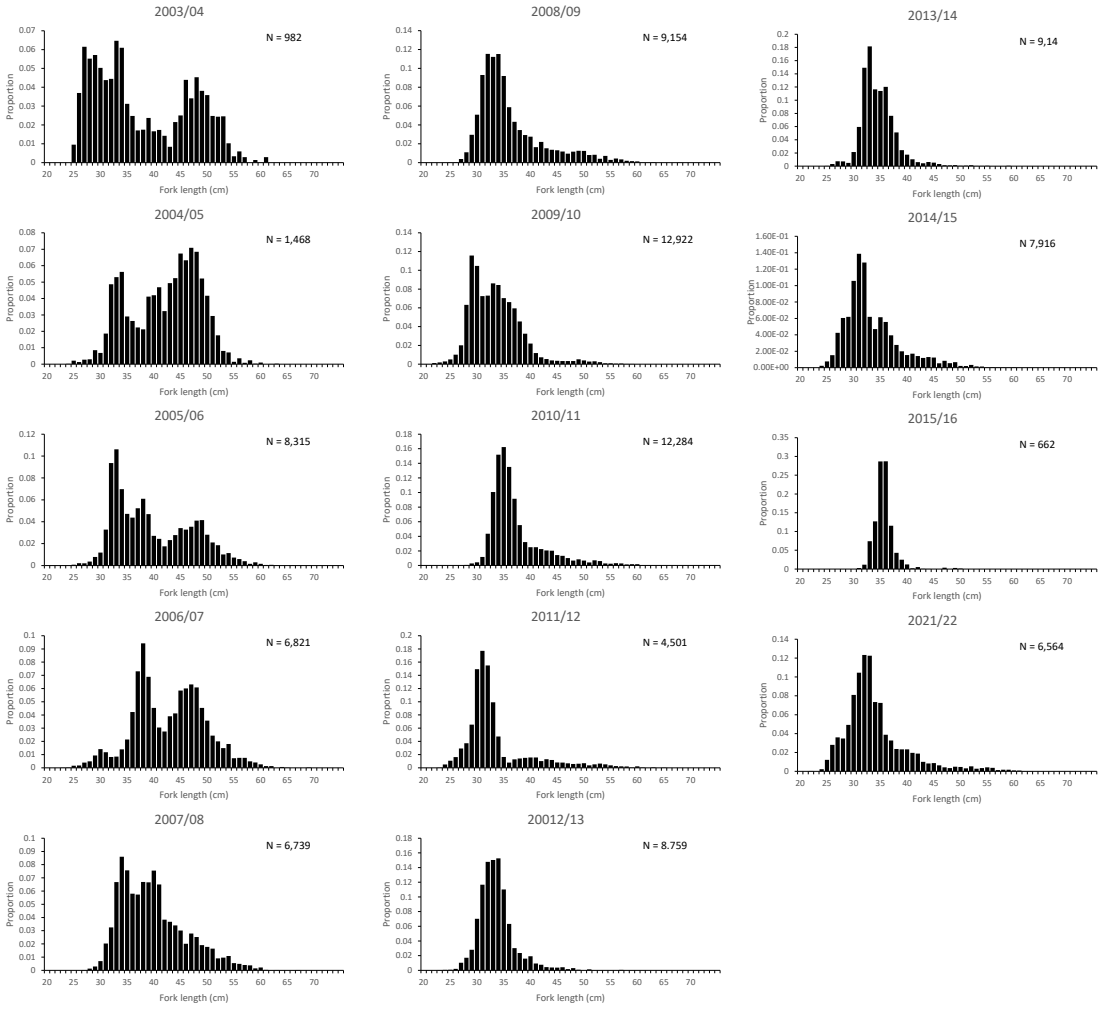

Figure 10 **Length composition of Australian Bonito in the landed commercial catch 2003/04 to 2021/22.**

Mortality estimates derived from length-based catch curve analysis 2005/06 to 2021/22 and the empirical equation of Then et al. (2015), using a maximum age of 4 years (M=1.38) indicate that total mortality is unlikely to have exceeded 2 x M, and so F has been less than M (Fig. 11).

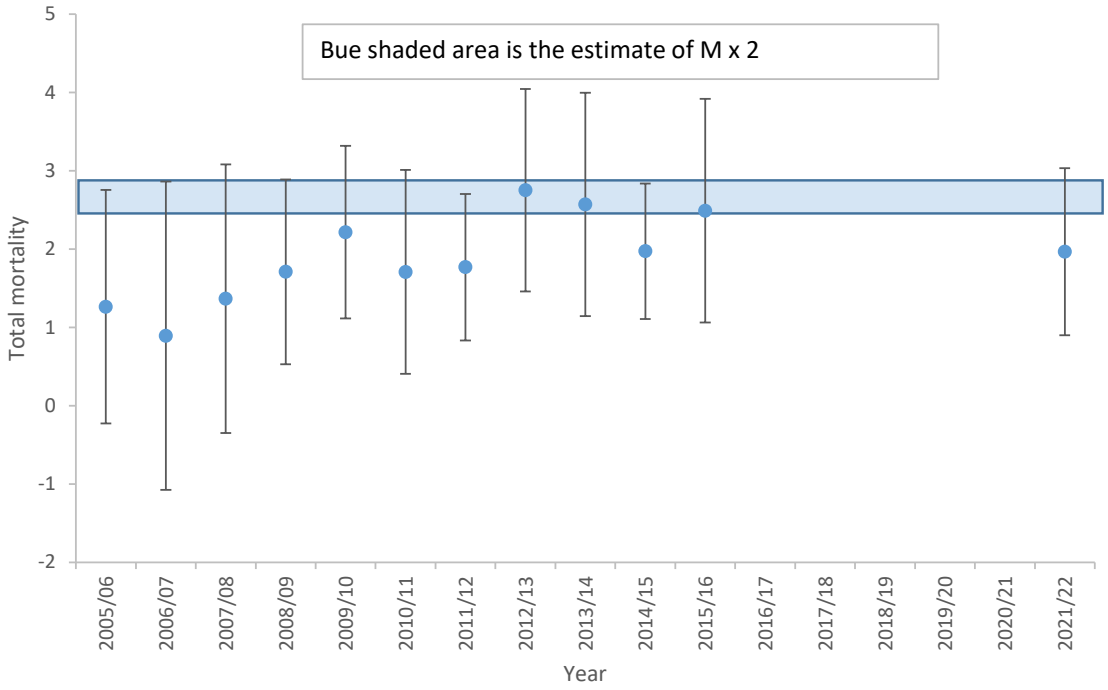

Figure 11 **Mortality estimates derived from length-based catch curve analysis 2005/06 to 2021/22 and the empirical equation of Then et al. 2015, using a maximum age of 4 years (M=1.38)**

Stock Assessment Result Summary

Biomass status in relation to Limit	The surplus production model estimated the Australian Bonito stock at the end of 2021/22 to be 0.53 (CIs 0.28 to 0.88) of unfished levels and well above the limit reference level. Standardised catch rates fluctuated substantially, likely a reflection of highly variable abundance of Australian Bonito as a result of their life history. No obvious overall trends in catch rates suggest that the biomass is not declining.
Biomass status in relation to Target	There are no Target Reference Points for Australian Bonito.
Fishing mortality in relation to Limit	F is below F_{MSY} with a high degree of certainty (Figs. 8 and 9). Landed catch is beneath the estimated MSY of ~ 200 t p.a. (Fig. 8.).

	Fishing effort on Australian Bonito has been relatively stable with slight recent declines during the previous decade (Fig. 4). The change in length compositions from generally being bimodal to mainly the smaller mode from around 2010/11 onwards is potentially concerning (Fig. 10). This may reflect higher abundance of younger cohorts in these more recent years, or alternatively excessive fishing of larger fish. Given that these 'bi-modal' years were generally lower catch years and that the years of very high landings were associated with mainly the smaller mode years, the former hypothesis is most likely. F is estimated to be below M with a reasonably high degree of certainty (Fig. 11).
Fishing mortality in relation to Target	There are no Target Reference Points for Australian Bonito.
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, Australian Bonito in New South Wales is classified as a sustainable stock.

Fishery interactions

There are few fishery interactions for Australian Bonito in NSW, with relatively small landings reported from Commonwealth waters and anecdotal reports of Australian Bonito occasionally occurring in south-eastern Queensland and north-eastern Victorian waters.

Qualifying Comments

Australian Bonito is an important target of recreational fishers along eastern Australia; however their harvest is estimated with substantial bias (downwards) and low precision. Nevertheless, the sensitivity scenario whereby the commercial harvest was multiplied by 1.5 to examine the effect of a larger recreational harvest than reported produced almost identical model outputs, with higher estimates of MSY and K. It is therefore concluded that the lack of quality data on the recreational fishery has not biased the stock status assessment for Australian Bonito.

Australian Bonito is extremely fast growing and matures at only 1 year of age, making them a highly productive species.

Landings of Australian Bonito from other jurisdictions are very small relative to those from NSW. As such it is likely that this SAFS status of Sustainable could be applied to the entire biological stock.

References

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Appendix 1. Diagnostic plots from the JABBA surplus production model.

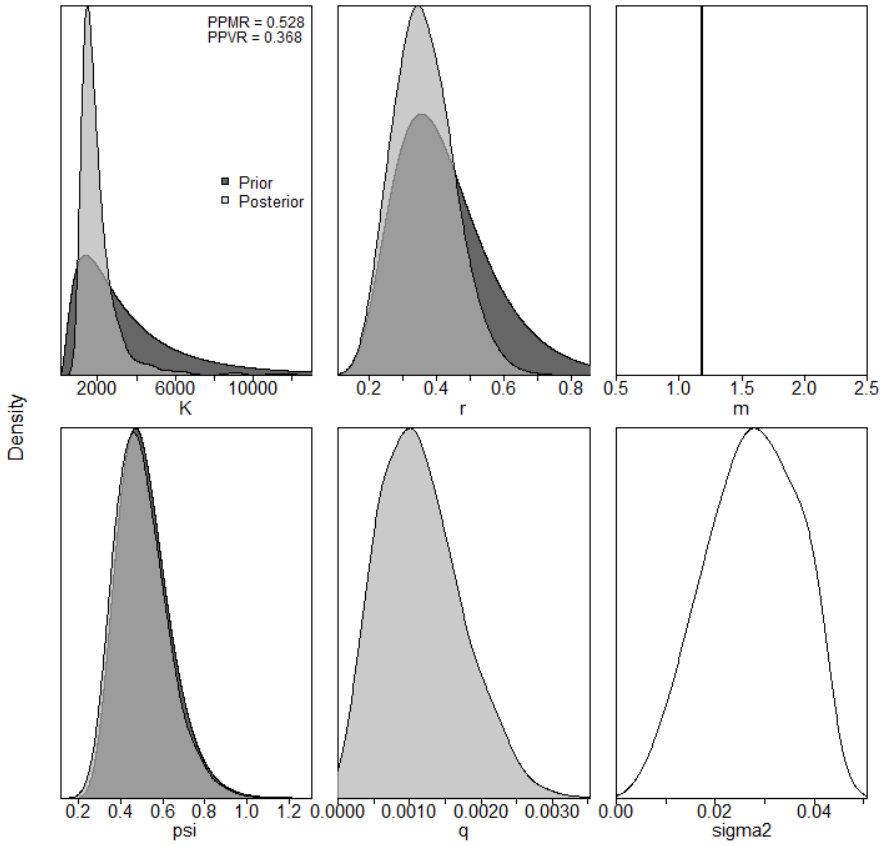

Fig. A1. Prior and posterior distributions of key model parameters for the base case scenario. Posteriors distributions are plotted using generic kernel densities.

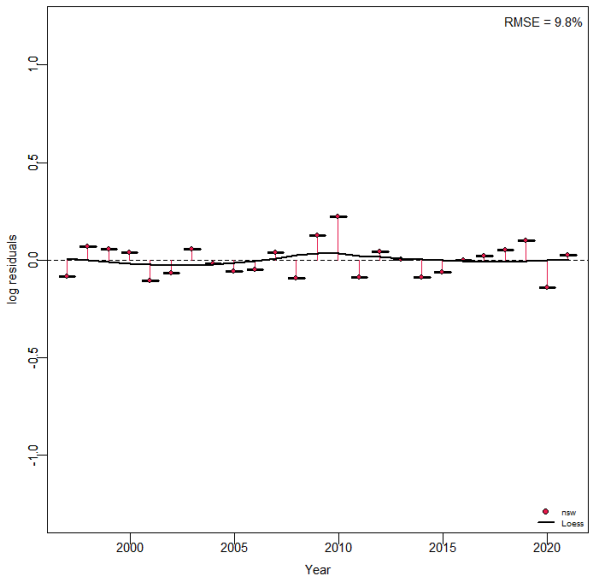

Fig. A2. JABBA residual diagnostic plots for Australian Bonito CPUE series.

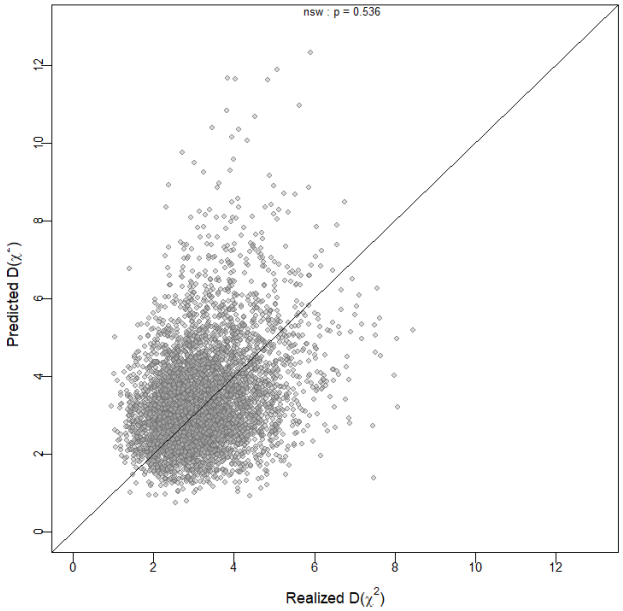

Fig. A3. Posterior Predictive Checks with Bayesian p values