Stock Status Summary 2021

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

Assessment Authors and Year

Stewart, J. 2020. NSW Stock Status Summary 2018/19 – 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

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 are 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.

Stock Status – New South Wales

Catch Trends

Commercial fisheries

Line fishing in the Ocean Trap and Line Fishery accounts for almost all of the commercial catch, averaging approximately 98% of total landings between 2009/10 and 2018/19. 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).

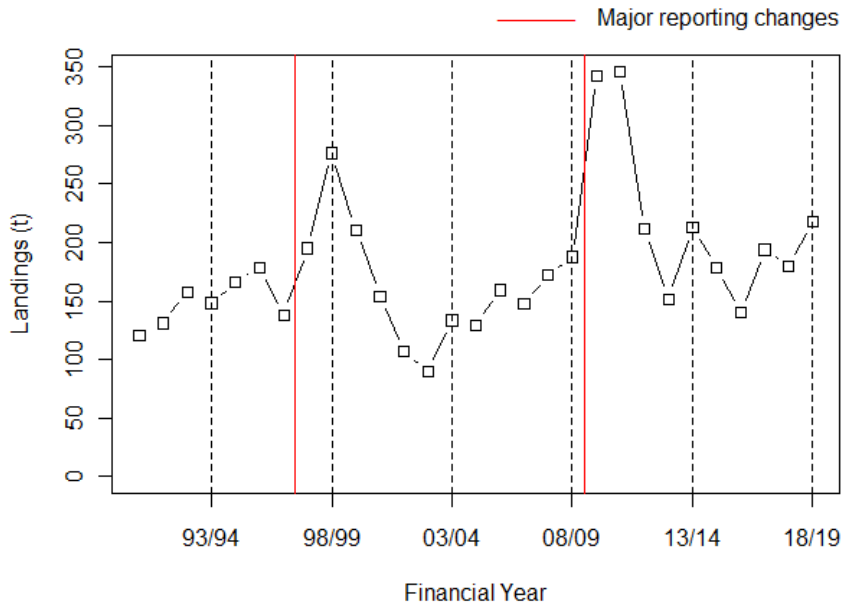


Figure 1. Commercial landings (including available historical records) of Australian Bonito for NSW from 1990/91 to 2018/19 for all fishing methods.

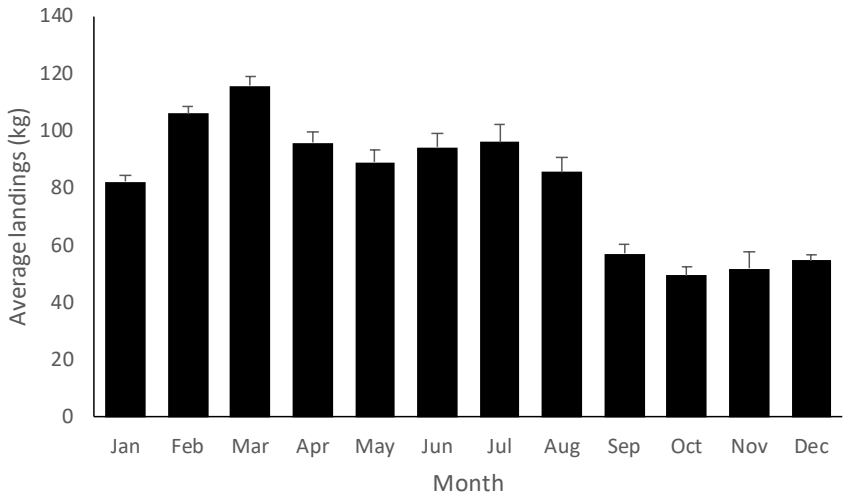


Figure 2. Average (with SE) commercial landings by month of Australian Bonito between 2009/10 and 2018/19.

Recreational

The most recent estimate of the recreational harvest of Australian Bonito in NSW was approximately 21,000 fish at around 32.4 t (Murphy et al., 2020). The previous estimate of approximately 40,000 Australian Bonito retained by recreational fishers during 2013/14 was around 65 t (West et al., 2015). In 2000/01 the Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) estimated a similar recreational harvest in NSW waters. While these survey results are not directly comparable due to differencing sampling frames, they likely represent a decline in recreational harvest since 2000/01.

There are no data on aboriginal harvest.

Fishing effort trends

Commercial fishing effort on 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 Bonito were also reported in a month have declined from more than 7,000 during 1990/00 to fewer 4,000 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 Bonito were landed have been relatively stable, averaging approximately 2,300 days p.a. since that time (Fig. 4).

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

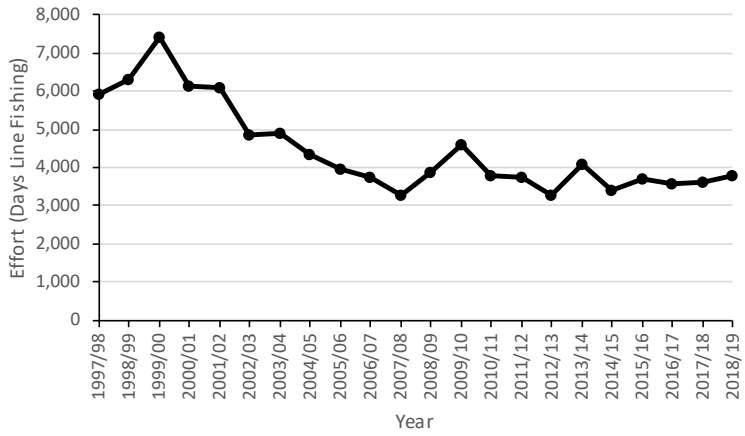


Figure 3 Annual reported days fished for months when Bonito were landed by line fishing methods 1997/98 to 2018/19.

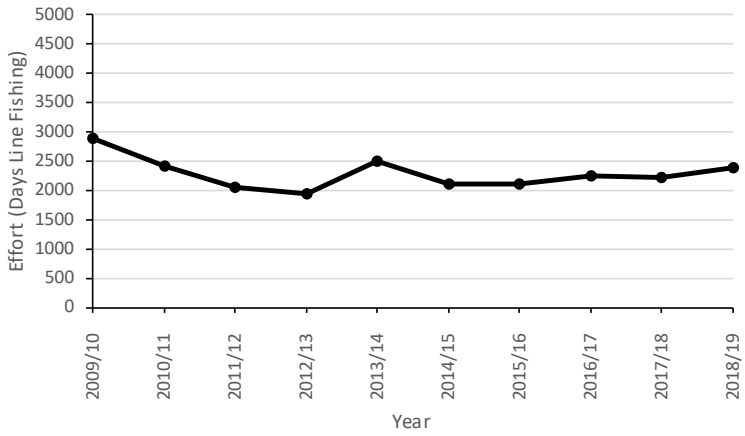


Figure 4. Annual reported days fished when Bonito were landed by line fishing methods 2009/10 to 2018/19.

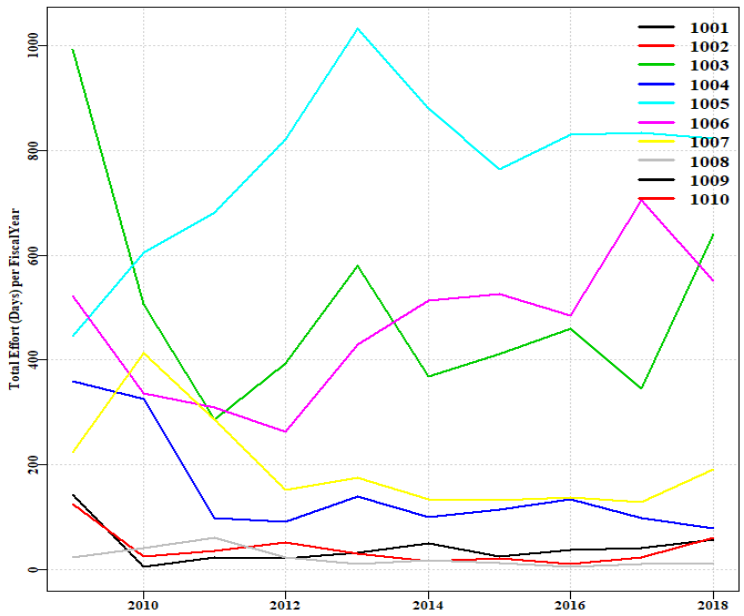


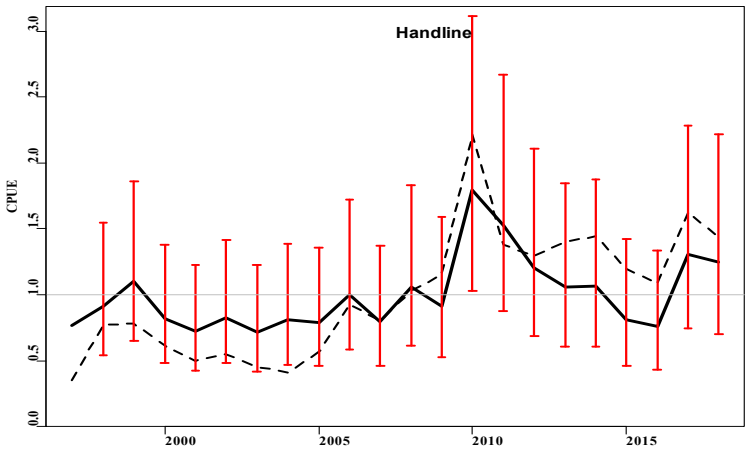
Figure 5. Annual reported days fished per year when Bonito were landed by line fishing methods 2009/10 to 2018/19 by Ocean Zone.

Catch rate trends

Catch rates of Bonito using the main line fishing methods of Handline, Trolling, Jigging, and Poling were standardized when all days within a month using these methods were included for 1997/98 to 2018/19. Catch rates were standardized for area, fisher and month using the r-package 'cede', with outputs standardized to 1.

Secondly, catch rates of Bonito were standardized in terms of kg/day using line fishing methods for the period 2009/10 to 2018/19 using the data as reported. Again, catch rates were standardized for area, fisher and month using the r-package 'cede'.

Standardized catch rates since 1997/98 have fluctuated with no overall trends for the major fishing methods (Fig. 6). High catch rates in 2009/10 and 2010/11 correspond to high landings in those years. Trends since 2009/10 reflect high catch rates in 2009/10 and 2010/11 followed by relative stability and slight increases each year since 2015/16 (Fig. 7).



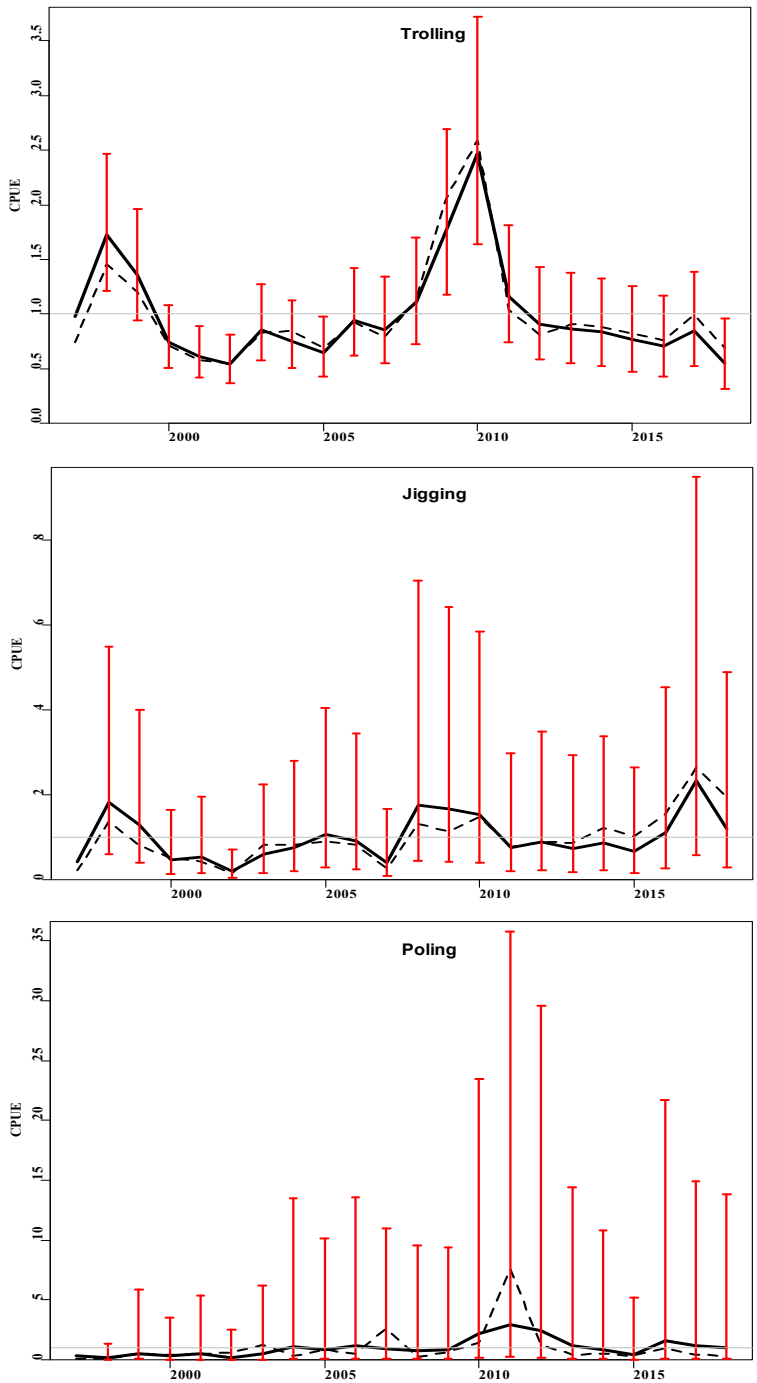


Figure 6. Standardized catch rates (kg/day) with standard errors for each major line fishing method for the period 1997/98 to 2018/19. Years represent the first year of the financial year.

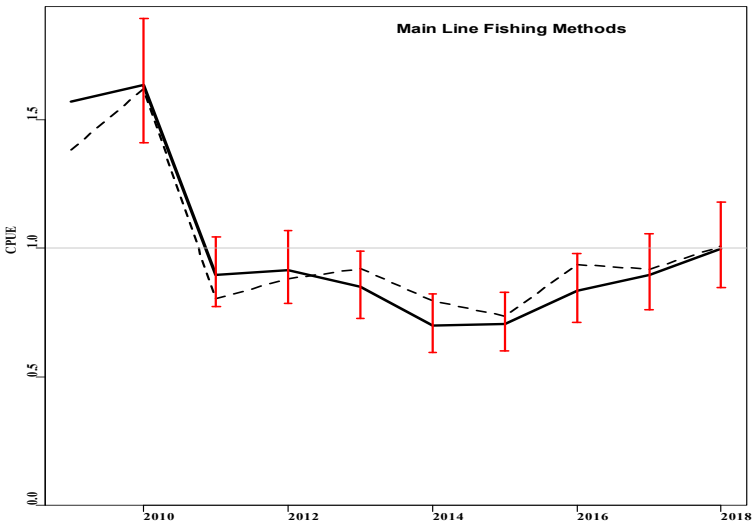


Figure 7. Standardized catch rates (kg/day) for line fishing for the period 2009/10 to 2018/19.

Stock Assessment Methodology

Year of most recent assessment	2020
Assessment method	Weight of Evidence 1. Catch-MSY model-assisted catch-only assessment (Martell and Froese, 2013) using the 'simpleSA' package in R (Haddon *et al*. 2018). This uses population productivity (*r*) and carrying capacity (*K*) parameters of an underlying Schaefer production model, applied to total annual catches, to estimate the ranges in biomass and harvest rate that could have resulted in the annual catches. 2. Standardized catch rates. 3. Trends in size composition in the landed commercial catch 2003/04 to 2014/15. 4. Mortality estimates derived from catch curves and empirical equations based on maximum age (Then et al., 2015).
Main data inputs	1. Annual total landed catch of Bonito by the NSW commercial fishery from 1990 – 2018. 2. Monthly total landed catch of Bonito and effort by the NSW commercial fishery from 1997/98 – 2018/19. Daily landed catch and effort data by the NSW commercial fishery by line fishing methods 2009/10 to 2018/19. 3. Size composition in landed commercial catch 2003/04 to 2014/15 derived from a Port Monitoring program.

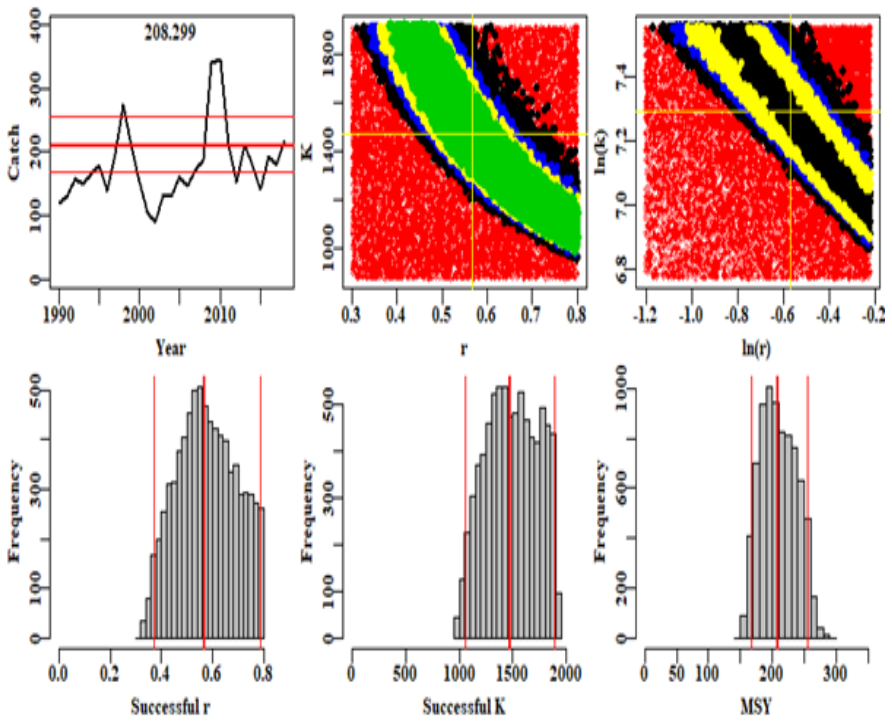
	4. Annual age compositions generated from a single age-length key compiled during 2004 to 2006 and applied to commercial length data derived from a stratified Port Monitoring program. Total mortality rates (Z) estimated using a catch curve analysis of the slope of the regression of the logged abundance of ages 0 to 3 each year. M estimated using an empirical equation based on maximum age of 4 years old (Then et al., 2015).
Key model structure and assumptions	1. 'Resilience' was set to 'Medium' in the Catch MSY model specification, which allows for a possible range in population growth rate (r) of 0.2 - 0.8. This is consistent with the life-history parameters of Bonito as described in Stewart et al., 2013. 2. Standardized catch rates - General Linear Models (which with log-normal errors give the same results as simple linear models). 3. The spatially and temporally stratified sampling program has resulted in size compositions that are presentative of commercial landings. 4. Age compositions are representative of not only the commercial landings but the exploitable population. The estimate of M is not biased.
Sources of uncertainty evaluated	1. The Catch-MSY analysis explored wide ranges of underlying Schaefer production model *r* and *K*, achieving successful biomass and harvest rate trajectories. The assessment successfully covered modes in the probability distributions of *r*, *K* and MSY. 2. Uncertainty around catch rates was assessed through standardization.

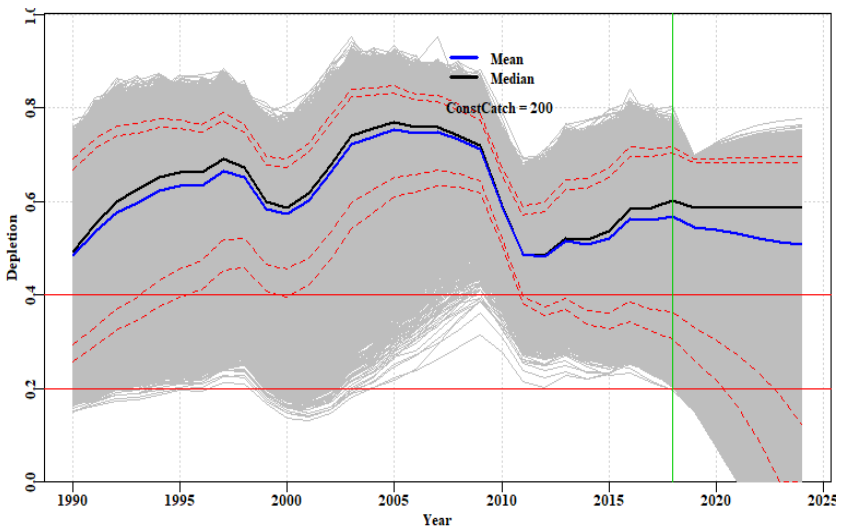
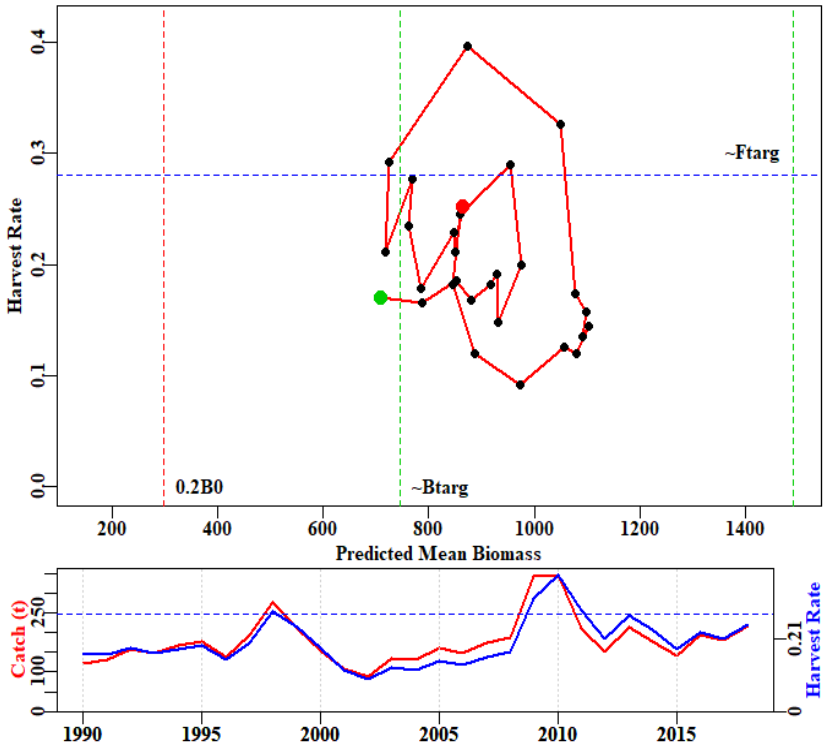
Status Indicators and Limits Reference Levels

Biomass indicator or proxy	1. Mean annual biomass and depletion level, as estimated in these assessments. 2. Standardized catch rates.
Biomass Limit Reference Level	1. 0.2 of B_0. 2. No formal reference level for catch rates; however, trends are assessed.
Fishing mortality indicator or proxy	1. Mean annual harvest rate, as estimated in these assessments. 2. Landed catch. 3. Fishing effort. 4. Size composition in landed catch. 5. Mortality rates.

Fishing mortality Limit Reference Level	1. F_{targ}, being the estimated harvest rate that should prevent the stock from declining below the biomass target B_{targ} (B_{MSY}). 2. Landed catch: No formal reference levels determined. Trends in indicator through time are used to estimate trends in fishing mortality. 3. Fishing effort: No formal reference levels determined. Trends in indicator through time are used to estimate trends in fishing mortality. 4. Size composition in landed catch: No formal reference levels determined. Trends in indicator through time are used to estimate trends in fishing mortality. 5. Mortality: Ratio of F:M. F not to exceed M.

Stock Assessment Results

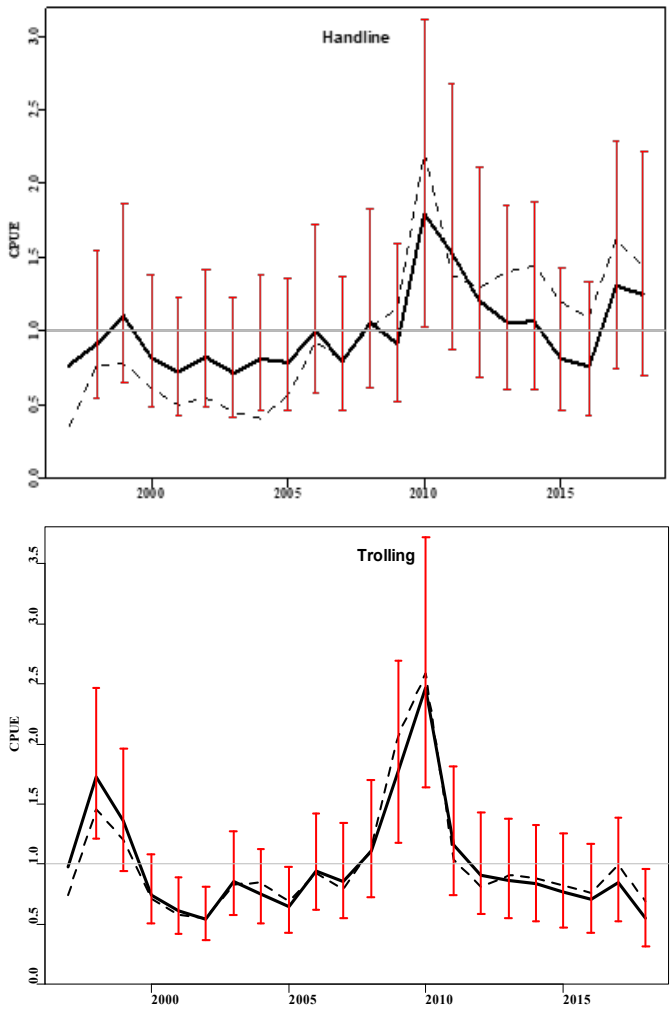
1. Bonito C_{MSY} assessment results showing: annual catch trajectory (t) with estimated MSY and 90th percentile; scatter plots of *K* vs *r* combinations explored with red dots depicting failure and other colours depicting combinations of initial depletion that succeeded for each *r-K* pair (right-hand plot is the log-transformed version of the left-hand plot); and histograms of the probability distributions of successful *r-K* pairs and the resulting MSY estimates, with red lines showing the median and 90th percentile confidence intervals.	

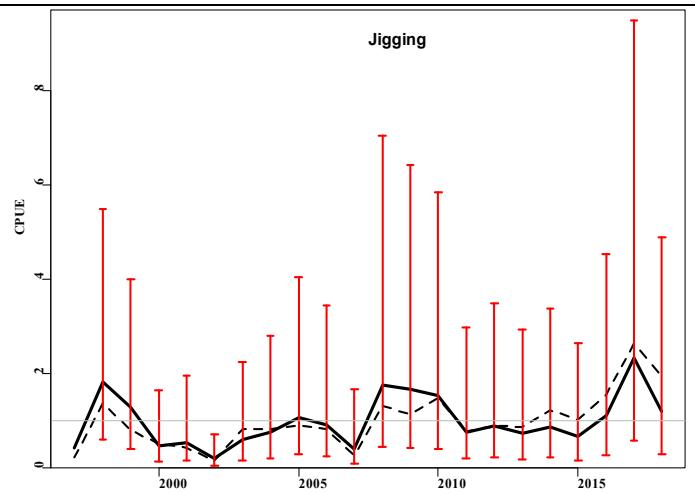
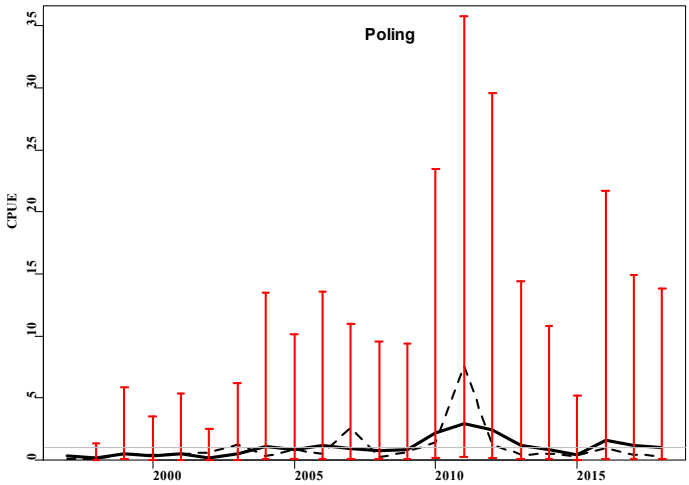
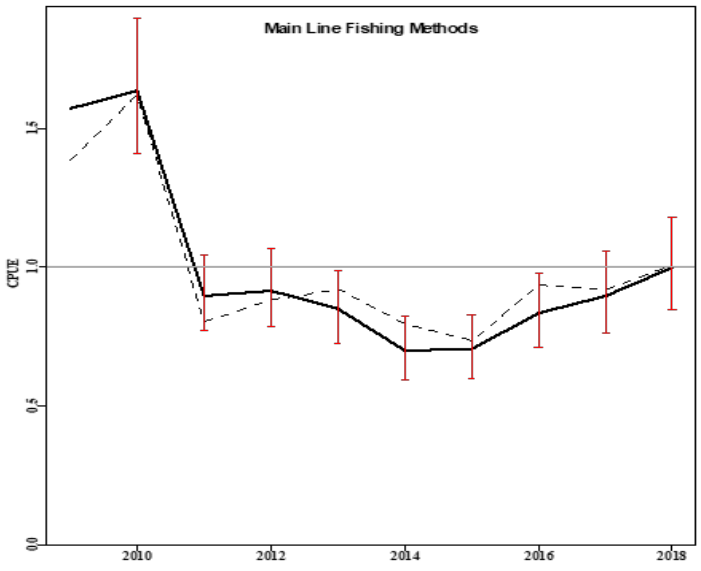
1. Range of depletion trajectories for successful *r-K* pairs, showing mean and median annual depletion and 80th and 90th percentiles (dashed lines). The lower red line is the $0.2B_0$ limit reference point, while the upper is the Schaefer B_{MSY} ($0.5B_0$) target reference point. The vertical green line indicates 2018/19, the final year for which data are available. Projected depletion levels are shown for 5 years thereafter at constant catch at 200 t.	
1 Bonito stock status trajectory from 1990 - 2018, showing annual stock status in estimated biomass (t) and harvest rate. Reference levels are shown for biomass target (B_{MSY}) and limit ($0.2B_0$) reference levels, and for the corresponding harvest rates that should keep biomass at or above the target F_{targ} (F_{MSY}) and above the limit F_{lim} (F_{B20}) The start of the trajectory in 1990 is indicated by a green point and final year 2018/19 by a red point. The red line on the bottom plot is catch and the blue line is harvest rate.	

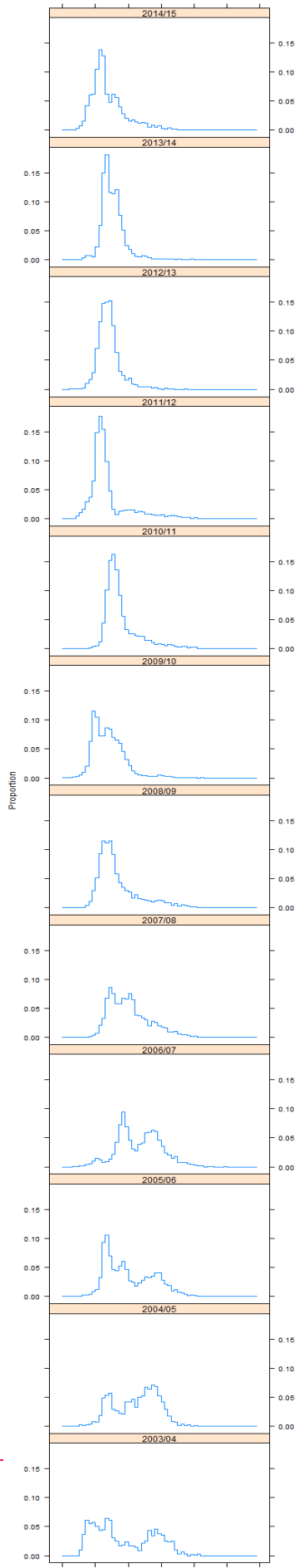
1. Summary output of key parameters from the Bonito Catch-MSY stock assessment, showing mean (50%) estimates for r, K, MSY and Current Depletion, with 95% intervals

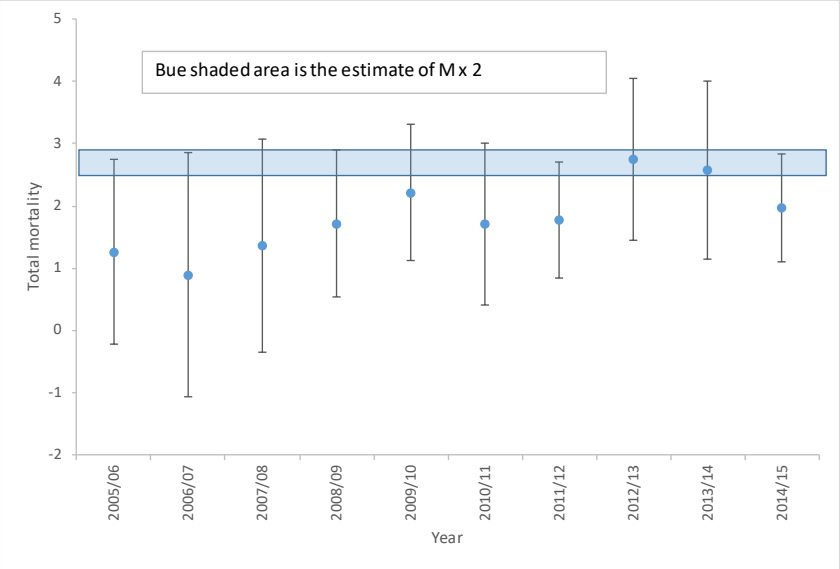
Parameter	2.50%	50.00%	97.50%
r	0.376	0.578	0.785
K	1050.618	1483.573	1860.435
MSY	163.999	207.837	259.709
CurrDepl	0.218	0.587	0.696

2. Catch rates by main methods 1997/98 to 2018/19.



	 
2. Catch rates by line fishing methods 2009/10 to 2018/19.	

3. Size composition in landed commercial catch 2003/04 to 2014/15.	

4. Mortality estimates derived from length-based catch curve analysis 2005/06 to 2014/15 and the empirical equation of Then et al. 2015, using a maximum age of 4 years (M=1.38).	
Biomass status in relation to Limit	The Catch-MSY model using data since 1990 produced imprecise estimates of depletion; however even the lowest trajectories during 2018/19 were above the limit reference limit of 0.2. The median depletion level in 2018/19 was 0.59 which is well above the limit reference level. Standardized 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 and recent slight increases suggest that the biomass is not declining.
Fishing mortality in relation to Limit	Estimated mean harvest rate is below that estimated to cause the stock to decline. Harvest rate may have been excessive during the late 2000s and early 2010s when large landings occurred but has since declined. The landed commercial catch of Bonito fluctuates annually but in recent (the last 5) years has averaged approximately 180 t which is below the mean estimate of MSY of 207t. The landed commercial catch exceeded this level in 2018/19. Fishing effort on Bonito has been relatively stable during the previous decade. The size composition in the landed catch indicates a change from generally being bi-modal 2003/04 to 2006/07 to mainly the smaller mode being present between 2008/09 and 2014/15 with an associated decline in average size. This may reflect high abundance of younger cohorts in more recent years, or alternatively the fishing out of the majority of larger fish. Given that these 'bi-modal' years were generally lower catch years and that the years of

<table>
<tr><td></td><td>very high landings were mainly the smaller mode the former hypothesis is most likely.
Estimates of Mortality indicate that Z is unlikely to exceed 2 x M, noting the broad Standard Errors around the Z estimates.</td></tr>
<tr><td>Previous SAFS stock status</td><td>Stock status for Bonito has not previously been reported in SAFS.
Within the NSW assessment framework, Bonito were previously assessed as:
<table>
<tr><th>Year</th><th>Exploitation Status</th></tr>
<tr><td>2002/03</td><td>Undefined</td></tr>
<tr><td>2003/04</td><td>Undefined</td></tr>
<tr><td>2004/05</td><td>Undefined</td></tr>
<tr><td>2005/06</td><td>Undefined</td></tr>
<tr><td>2006/07</td><td>Undefined</td></tr>
<tr><td>2007/08</td><td>Fully Fished</td></tr>
<tr><td>2008/09</td><td>Fully Fished</td></tr>
<tr><td>2009/10</td><td>Fully Fished</td></tr>
<tr><td>2010/11</td><td>Fully Fished</td></tr>
<tr><td>2011/12</td><td>Fully Fished</td></tr>
<tr><td>2012/13</td><td>Fully Fished</td></tr>
<tr><td>2013/14</td><td>Fully Fished</td></tr>
<tr><td>2014/15</td><td>Fully Fished</td></tr>
</table></td></tr>
<tr><td>Current SAFS stock status</td><td>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, Bonito in New South Wales is classified as a sustainable stock</td></tr>
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Qualifying Comments

Australian Bonito are extremely fast growing and mature 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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