Stock Status Summary – 2021/22

NSW Stock Status Summary – Spanner Crab *(Ranina ranina)*

Assessment Authors and Year

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Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Spanner Crab are currently assessed as **sustainable**

Stock structure & distribution

DNA analysis indicates that Spanner Crabs on the east coast of Australia comprise a single biological stock (Brown et al. 1999). The East Coast Spanner Crab stock is shared between Queensland and New South Wales; with Queensland accounting for the largest harvest (~85 per cent based on 2019 reported harvest).This stock assessment report provides a determination of stock status of the NSW component of the East Coast Spanner Crab biological stock.

Biology

The occurrence of ovigerous females in a large-scale, stratified, randomized survey of exploited populations of Spanner Crabs off the east coast of Australia identified their reproductive period to be around December each year (Kennelly 1992, Kennelly & Scandol 2002). Estimates of Spanner Crab growth parameters from previous studies are inconsistent, absolute age-length relationships and age at recruitment are still poorly understood (Brown et al. 2008).

FISHERY STATISTICS

Catch information

Commercial

Total annual reported commercial catches of Spanner Crabs rapidly increased from 150 t to 487 t between 1984/85 – 1987/88, and then fluctuated between 209 t (1989/90) and 444 t in 1997/98 (Fig. 1). Catches exceeded 100 t yr^{-1} from 1990/91 to 2007/08, and then declined to lowest annual reported landings of 79 t in 2014/15. Total reported commercial landings of Spanner Crab constrained by a Total Allowable Commercial (TAC) of 169 tonnes in 2018/19 and 2019/20 were 111.7 t and 87.9 t, respectively (Fig. 1). Reported landings for 2020/21 were 93.2 t (Quota usage 98.6 t).

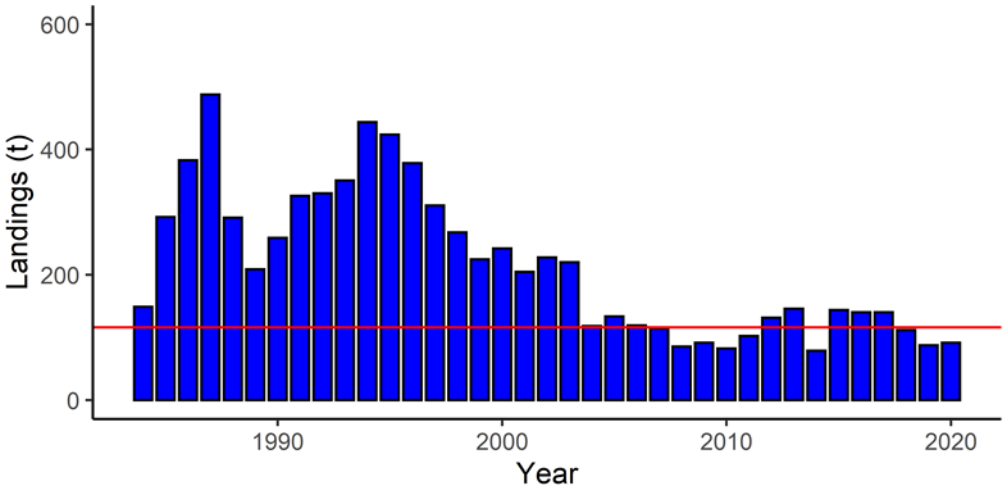

Figure 1. Annual reported commercial catch (t) from 1984/85 – 2019/20. Red line represents 10-year average catch (2011/12 – 2020/21).

Recreational & Charter boat

The most recent recreational survey completed in New South Wales did not report the capture of any Spanner Crabs (Murphy et al. 2020). However, the survey methodology is potentially too broad to pick up species, such as Spanner Crabs, which tend to be caught by 'niche' fisheries.

Indigenous

Aboriginal cultural catches are unknown.

Illegal, Unregulated and Unreported

Comparisons between quota reconciliations and reported catch and effort log-sheets illustrate that catch and effort was under-reported by 12.6 % and 7.8 % in the 2016/17 and 2017/18 fishing seasons, respectively.

Fishing effort information

Reported effort (days) increased from less than 300 days in 1984/85 to a historical peak of 2, 462 days in 1997/98 then declined to less than 700 days in 2014/15 (Fig. 2). In response to revised management arrangements in the fishery, effort decreased from 892 days in 2015/16 to 673 and 654 days in 2018/19 and 2019/20, respectively. Following the introduction of daily reporting (2009/10) fishers have been required to report number of net-lifts per fishing day. From a minimum of 46, 400 net-lifts in 2010/11, effort increased to 70, 900 net-lifts in 2013/14 and was 49, 900 net-lifts in 2019/20 (Fig. 3). In 2020/21, reported days effort (787) and net-lifts (66,120) were approximately 17% and 33% greater than 2019/20.

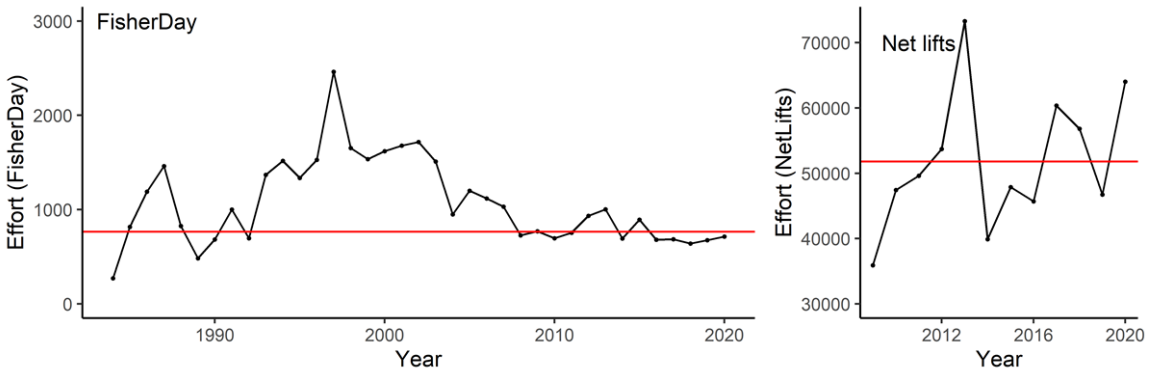

Figure 2. Annual reported commercial effort in units of FisherDays (1984/85 – 2020/21) and net lifts (2009/10 – 2020/21). Red line represents 10-year average (2011/12 – 2020/21).

Catch Rate information

Nominal catch rates (CPUE; catch/ effort) of Spanner Crabs were greater than long-term averages from 2016/17 to 2018/19 (Fig. 3). CPUE increased from less than 100 kg.FisherDay^{-1} (1984/85 - 1986/87) to a maximum of 205 kg.FisherDay^{-1} in 2016/17 (Fig. 3). From a minimum of 1.7 kg.net-lift (kg.NL^{-1}), CPUE increased to 2.7 kg.NL^{-1} in 2015/16 and was at a historical peak of 3.3 kg.NL^{-1} in 2016/17 (Fig. 3). In 2020/21, CPUE per-day (118.3 kg.FisherDay^{-1}) and net-lift (1.41 kgNL^{-1}) were approximately 10% and 20% lower than CPUE per-day (123.6 kg.FisherDay^{-1}) and net-lift (1.81 kg.NL^{-1}) in 2019/20.

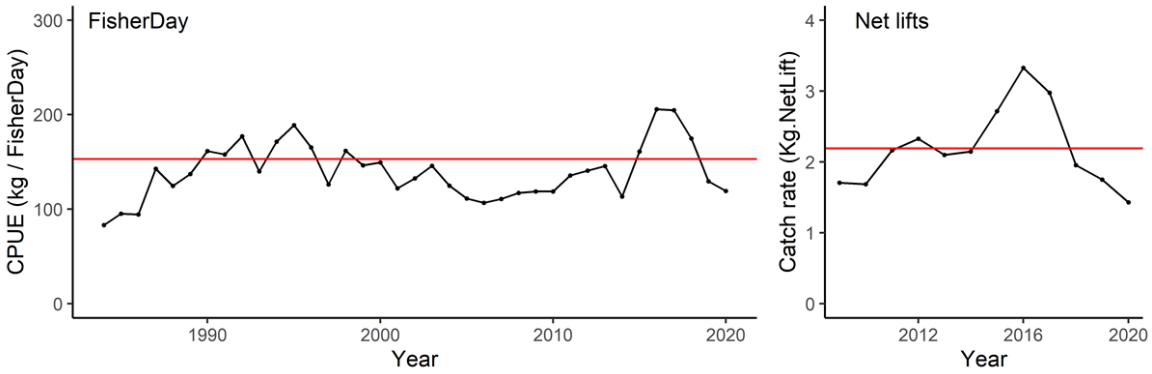

Figure 3. Annual reported catch rate in units of FisherDay (1984/85 – 2020/21) and net-lift (2009/10 – 2020/21). Red line represents 10-year average (2011/12 – 2020/21).

STOCK ASSESSMENT

Stock Assessment Methodology

Year of most recent assessment:

2021

Assessment method:

A weight-of-evidence approach was used for the most recent stock assessment of Spanner Crab in NSW waters. It incorporated the results from three different analyses; i) standardised catch rates from the commercial fishery; ii) Bayesian state-space production model (BSM) analyses of historical catch and CPUE time series (1984/85 – 2020/21); and iii) standardised catch rates of

legal, undersize and total Spanner Crabs from annual NSW fishery-independent surveys (2005-2021).

Main data inputs:

The following raw data inputs were used in analyses:

- Reported commercial catch (kg) and effort (days) derived from fisher-reported monthly records (1984/85 – 2020/21);
- Commercial catch (kg) and effort (Net lifts) derived from fisher-reported daily records (2009/10 – 2020/21);
- Catch-rate (Number of crabs per groundline) from fishery-independent surveys (2005 – 2021).

Key model structure & assumptions:

Standardised catch rates from the commercial fishery;

Spanner Crab standardised catch rates were predicted from generalised linear models (GLM). The GLM statistical modelling provided an estimate of mean catch rates that were corrected for a variety of variables that bias raw data. The importance of individual model terms was assessed formally using F statistics by dropping individual terms from the full model. Explanatory model terms considered different catch rates between fishing years, seasons, individual fisher operations, their transformed fishing effort (the number of net-lifts, which was a function of the number of ground-lines used, nets per ground-line and ground-line lifts per day; log or cube root scale), the spatial locations of catches based on 6 x 6 min latitude and longitude grids (O'Neill 2018).

Commercial catch rates were predicted from the model 'year' term using R procedures for prediction (R Development Core Team 2017), which provided the annual abundance estimates standardised to the mean number of net-lifts per fisher-day.

Bayesian state-space production model (BSM)

CMSY+ is a Monte-Carlo method that estimates fisheries reference points (MSY, F_{msy}, B_{msy}) as well as relative stock size (B/B_{msy}) and exploitation (F/F_{msy}) from catch data, a prior for resilience or productivity (r), and broad priors for the ratio of biomass to unfished biomass (B/k) at the beginning, an intermediate year and the end of the time series (See Froese et al. 2017 for full description). The package also includes an advanced Bayesian state-space implementation of the Schaefer surplus production model (BSM).

Productivity models assume average recruitment across all stock sizes, including stock sizes below half of B_{msy}. However, if recruitment is indeed reduced at lower stock sizes, then production models will overestimate production of new biomass and will underestimate exploitation rates.

Standardised catch rates from fishery-independent surveys;

NSW only standardised catch rates were predicted from generalised linear models. The GLM statistical modelling provided an estimate of mean catch rates that were corrected for a variety of variables that bias raw data. To ensure that the catch rate from the FIS is comparable to the commercial CPUE, FIS catch rates were standardised for the number of total, legal and undersize crabs.

Sources of uncertainty evaluated:

Known or likely uncertainties in the key indicators were taken into consideration in ranking of the quality of key indicators, and in reaching a conclusion regarding stock status.

The sensitivity of BSM model to various data series was tested.

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	None specified in a formal harvest strategy. In the interim, for the purposes of this stock assessment a weight-of-evidence approach was used, which included: annual standardised catch rates and estimated biomass from BSM analyses.
Biomass Limit Reference Point	None specified in a formal harvest strategy. For the purpose of this stock assessment, 20% of the estimated unfished biomass was selected for the limit reference point (B_{lim}).
Biomass Target Reference Point	None specified in a formal harvest strategy. For the purpose of this stock assessment, 48% of the estimated unfished biomass was selected as the target reference point (B_{targ}).
Fishing mortality indicator or proxy	None specified in a formal harvest strategy. For the purposes of this stock assessment estimates of fishing mortality (F) and exploitation rate (F/F_{msy}) were estimated from BSM analyses.
Fishing mortality Limit Reference Point	None specified in a formal harvest strategy.
Fishing Mortality Target Reference Point	None specified in a formal harvest strategy.

Stock Assessment Results

Standardised commercial catch rates (sCPUE)

When compared to the historical peak of sCPUE in 2016 (205.8 kg.FisherDay^{-1}), sCPUE in 2018/19 (159.8 kg.FisherDay^{-1}) and 2019/20 (120.2 kg.FisherDay^{-1}) declined by ~30 and 40%, respectively. In 2020/21, sCPUE declined to 103.0 kg.FisherDay^{-1} (~50% of 2016) and was below the long-term average (137.4 kg.FisherDay^{-1}).The observed decline in standardised catch rates is a direct result of an increase in the mean number of net-lifts reported per fisher-day. From the historical peak of sCPUE (2016), the mean number of net-lifts reported per fisher-day has increased from ~ 60 to > 80 in 2020/21.

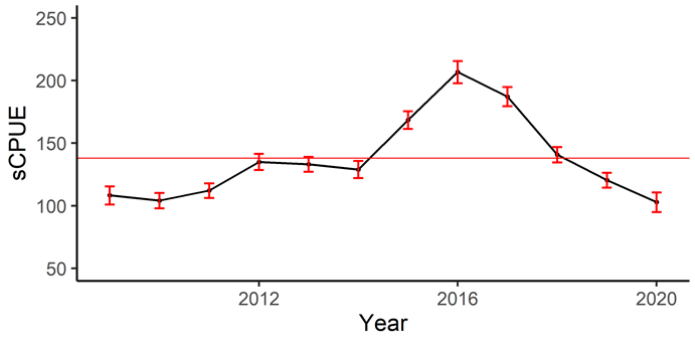

Figure 4. Standardised commercial catch rate (kg.FisherDay^{-1} + net lifts). Red line is mean average catch rate (2009/10 - 2020/21).

Bayesian state-space implementation of the Schaefer surplus production model (BSM)

Results of BSM modelling suggest that the biomass of Spanner Crab in NSW waters was depleted to ~36.2% (CI; 30.4 – 43.1%) of the estimated unfished biomass (Fig. 5). Based on BSM analysis, Biomass in the last year (~2, 090 t, CI; 1,760 -2,490 t) was estimated to be lower than B_{msy} (~2,900 t, CI; 1,950 – 4,290). Estimates of fishing mortality (F) and exploitation rate (F/F_{msy}) in 2020/21 were 0.0464 (CI: 0.039 - 0.0553) and 0.625 (CI: 0.405 – 1.12), respectively. The lower bound (~ 133 t) of estimated MSY (~211 t) is approximately equal to the TAC applied to the 2020/21 fishing season (135.5 t).

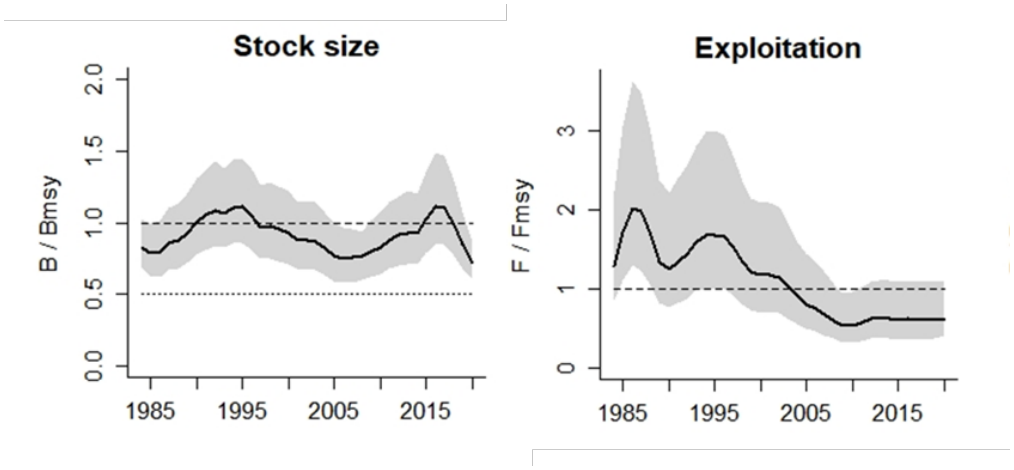

Figure 5. BSM results for the historical catch series of Spanner Crabs. Grey shading indicates the uncertainty (95% confidence intervals) in parameter estimates.

Fishery-independent survey

Catch rates of legal-sized crabs reached a peak in 2016 (22.2 crabs.Groundline) after which they declined and fluctuated around the mean from 2017 to 2021 (Fig. 6). The historical peak in catches rates of legal-sized crabs (2016) occurred one year after the historical peak of catch rates in undersized crabs (2015; 18.8 crabs.Groundline). Catch rates of both legal (12.1 crabs.Groundline) and undersize (10.0 crabs.Groundline) crabs during the most recent survey (2021) were ≥ long-term averages. Fishery-independent survey results in both NSW and QLD indicate there is marked

sexual dimorphism in Spanner Crabs, with males being generally larger than females (Fig. 6). The proportion of female crabs protected by the legal-size limit (93 mm orbital carapace length = 100 mm rostral carapace length) in NSW ranged between 70 and 85% in 2016 and 2019, respectively. The NSW FIS shows peaks in the numbers of small male crabs (below the minimum legal size) in 2015, 2019 and 2020.

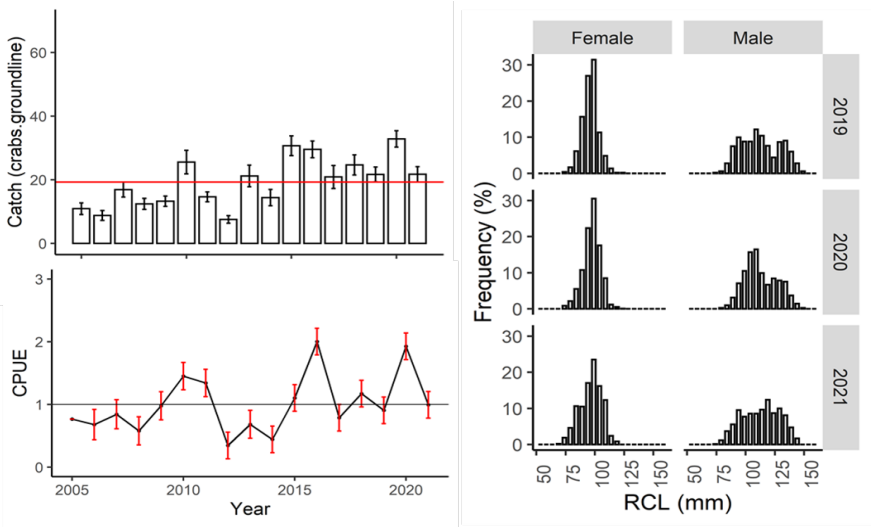

Figure 6. Mean FIS catch rates (number.Groundline ± SE) of total crabs (Top left), red line is the average mean of catch rate (2005 – 2021), Standardised catch rate of legal crabs (bottom left, nominal scale); and length-frequency distribution of female and male Spanner Crabs (2019 - 2021). Carapace-length refers to distance between centre spine and mid carapace base (Rostral carapace length – RCL, applied in QLD).

Stock Assessment Result Summary

Biomass status in relation to Limit	Results of BSM modelling suggest that the biomass of Spanner Crab in NSW waters was depleted to ~36.2% (CI; 30.4 – 43.1%) of the estimated unfished biomass. This is above the B_{lim} reference point of 20%. When compared to the historical peak of sCPUE in 2016 (205.8 kg.FisherDay^{-1}), sCPUE in 2019/20 (120.5 kg.FisherDay^{-1}) and 2020/21 (103. kg.FisherDay^{-1}) has declined by ~40 and ~50%, respectively. Catch rates of both legal (12.1 crabs.Groundline^{-1}) and undersize (10.0 crabs.Groundline^{-1}) crabs during the most recent FIS (2021) were ≥ long-term averages.
Biomass status in relation to Target	Current estimated biomass is below the proxy B_{targ} reference point of 48% of estimated maximum biomass.
Fishing mortality in relation to Limit	Results of BSM modelling estimated an exploitation rate (F/F_{msy}) of 0.625 (CI: 0.405 – 1.12) in 2020/21.

Fishing mortality in relation to Target	NA
Current SAFS stock status	Sustainable (Roelofs et al. 2021)
Current Queensland stock status	Sustainable

Fishery interactions

Injury and fatality to vertebrate marine life caused by entanglement is listed nationally as a Key Threatening Process (KTP) under the Environment Protection and Biodiversity Conservation *Act 1999*. There has been a small number of reported interactions between Spanner Crab fishing gear and Humpback Whales (*Megaptera novaeangliae*). Due to the selective nature of fishing gear used in the fishery, bycatch and discarding of non-target species is minimal.

Qualifying Comments

Status of the QLD Spanner Crab stock is assessed relative to limit and target reference points prescribed in the harvest strategy/ management procedure (Campbell et al. 2016, QDAF 2020). The management procedure followed a process of a baseline quota and performance targets for standardised catch rates with range intervals. The stock performance indicators are the average fishery and survey standardised catch rates in the most recent two completed calendar years. In 2017, it was identified that the base quota of 1, 631 tonnes was not effectively constraining harvest and decisions rules were not adjusting the TAC in response to declining indicators. In response, Queensland Department of Agriculture and Fisheries (QDAF) declared a TAC of 847 tonnes for the 2018/19 fishing season (90% of the reported 2017 harvest of 941 tonnes). The purpose of the reduced TAC was to restrict total fishing mortality and increase protection on the spawning stock. In 2020, the QLD fishery was assessed against a revised harvest strategy (QDAF 2020) relative to target reference points of 1.33 $kg.NL^{-1}$ ($CPUE_{targ}$ 95% of the 2006 - 2010 average) and 10.49 legal-sized crabs per groundline (FIS_{targ} 95% of the 2006 - 2010 average). The average of the commercial (0.54) and survey index (0.58) in 2019 (0.56) and 2020 (0.56) was less than 1, which resulted in no change in the TAC using the revised harvest strategy rules.

Given the small proportion of total landings taken in New South Wales (<15% with revised QLD TAC of 847 t), it is unlikely that fishing of this part of the stock is having a detrimental effect on the entire East Coast stock. However, the degree to which the exploitable NSW stock is dependent on recruitment from QLD is unknown.

Being able to estimate the total fishing mortality is fundamental to understanding the dynamics of the Spanner Crab population, estimating and setting appropriate annual catch limits and managing the fishery sustainably. Previous studies investigating mortality of undersize, discarded Spanner Crabs reported significant rates of mortality due to disentanglement: 60 - 70% of crabs with one or more dactyli removed died within 50 days, whilst 100% of crabs which lost whole limbs (after being pulled off nets) died after eight days (Kennelly et al. 1990). To evaluate the effects that morality due to disentanglement may have on the Spanner Crab population, it may be necessary to quantify rates of discarding and estimate annual fishery-wide discard rates. Management actions to remove or reduce mortalities may provide the opportunity to increase fishery production.

References

Brown, I. W., Kirkwood, J., Gaddes, G., Dichmont, C. & Ovenden, J. 1999. Population dynamics and management of spanner crabs (*Ranina ranina*) in southern Queensland. Department of Primary Industries, Queensland. Final report on Project 95/022 to the Fisheries Research and Development Corporation, Canberra. 145 p. + append.

Brown, I. W., Scandol, J., Mayer, D., Campbell, M., Kondylas, S., McLennan, M., Williams, A., Krusic-Golub, K. & Treloar, T. 2008. Reducing uncertainty in the assessment of the Australian Spanner Crab Fishery, Final report on Project 2003/046 to the Fisheries Research and Development Corporation, Canberra. 96 p. + append.

Campbell, M. J., O'Neill, M. F. & McGilvray, J. G. 2016. Queensland Spanner Crab Fishery: commercial quota setting for June 2016–May 2018 Department of Agriculture and Fisheries, Queensland.

Froese, R., Demirel, N., Coro, G., Kleisner, K. M. & Winker, H. 2017. Estimating fisheries reference points from catch and resilience. Fish and Fisheries, 18, 506-526.

Kennelly, S. J. 1992. Distributions, abundances and current status of exploited populations of spanner crabs *Ranina ranina* off the East-coast of Australia. Marine Ecology Progress Series, 85, 227-235.

Kennelly, S. J. & Scandol, J. P. 2002. Using a fishery-independent survey to assess the status of a spanner crab *Ranina ranina* fishery: Univariate analyses and biomass modelling. Crustaceana, 75, 13-39.

Kennelly, S. J., Watkins, D. & Craig, J.R. 1990. Mortality of discarded spanner crabs *Ranina ranina* (Linnaeus) in a tangle-net fishery – laboratory and field experiments, Journal of Experimental Marine Biology and Ecology, 140, 39-48.

Murphy, J.J., Ochwada-Doyle, F.A., Hughes, J.M., West, L.D., Stark, K.E. 2020. The NSW Recreational Fisheries Monitoring Program - Survey of recreational fishing, 2017/18. NSW DPI - Fisheries Final Report Series No. 158.

O'Neill, M, F. 2018, New South Wales Spanner Crab, Development of analysis code for standardised catch. Department of Agriculture and Fisheries, Queensland.

Queensland Department of Agriculture and Fisheries (QDAF). 2020. Spanner Crab working group https://www.daf.qld.gov.au/business-priorities/fisheries/sustainable/fishery-working-groups/spanner-crab-working-group/communiques/communique-24-february-2020.

Roelofs, A, Johnson, D. & McGilvray, J. 2021. Spanner Crab *Ranina ranina*, in Toby Piddocke, Crispian Ashby, Klaas Hartmann, Alex Hesp, Patrick Hone, Joanne Klemke, Stephen Mayfield, Anthony Roelofs, Thor Saunders, John Stewart, Brent Wise and James Woodhams (eds) 2021, Status of Australian fish stocks reports 2020, Fisheries Research and Development Corporation, Canberra.

R Development Core Team. 2017. R: A Language and Environment for Statistical Computing. Vienna: Foundation for Statistical Computing. http://www.R-project.org.