NSW Stock Status Summary – 2023/24

Blue Swimmer Crab (*Portunus armatus*)

Assessment Authors and Year

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Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Blue Swimmer Crab are currently assessed as **depleting**.

Stock structure & distribution

Blue Swimmer Crabs occur in coastal and estuarine waters along the length of the New South Wales (NSW) coastline. The stock structure on the east coast of Australia is uncertain, involving overlapping stocks or a semi-continuous stock (Chaplin *et al*., 2001). Using a high-resolution oceanographic model coupled with a Lagrangian particle tracking framework to simulate larval dispersal, Hewitt *et al*. (2022) suggest populations of Blue Swimmer Crab in NSW and Queensland (Qld) appear to constitute demographically separate stocks, supporting the current assessment and management at the state level.

Scope of this assessment

This stock assessment report provides a determination of stock status of the New South Wales (NSW) component of the East Coast Blue Swimmer Crab biological stock.

Biology

New South Wales Blue Swimmer Crab populations are at the southern end of the species distribution along the east coast and have a limited spawning period rather than the year-round spawning that occurs in more northern latitudes (Johnson *et al*., 2010). The duration of the spawning period (> 5% of mature females berried), proportion of mature crabs berried, and the size-structure of recorded catches of berried females from fishery-independent surveys varied between Wallis Lake, Port Stephens, and Lake Macquarie (Taylor *et al*., 2023).

Estimates of mean size sexual maturity (L_{50}) for Wallis Lake (50.9–52.5 mm) and Port Stephens (50.7-51.9 mm) from fishery-independent surveys (Taylor *et al*., 2023) exceed previous estimates for Wallis Lake (~46 mm Johnson *et al*., 2010). The size of the smallest functionally mature female (i.e., berried) recorded from fishery-independent survey trap catches (2018-2021) in Wallis Lake (47 mm) and Port Stephens (50 mm) was below the lower estimates of L_{50} from each estuary. Increasing the minimum legal length (MLL) for Blue Swimmer Crab in NSW from 60 to 65 mm (applied to commercial sector in 2017 and recreational in 2020) reduced fishing pressure on the spawning stock (Taylor *et al*., 2023).

Fishery statistics

Catch information

Commercial

Commercial estuarine catches of this species tended to fluctuate around a long-term average of about 132 t over the period 2000/01 to 2016/17 (Fig. 1). However, in 2020/21, 2021/22 and 2022/23 reported commercial landings declined to 83, 50, and 22 t, respectively. From 2012/13 to 2022/23 reported landings from the estuary general fishery (EGF) accounted for ~ 95% (range 91 – 98%) of total landings. Reported landings from Region-4 of the EGF account for approximately 75 per cent (range 61 - 83%) of commercial Blue Swimmer Crab landings in New South Wales (Fig. S1). Within Region 4, the most important estuary is Wallis Lake accounting for approximately 80 per cent of reported landings (Fig. S2). Most of the catch from the EGF is reported for the method of fish and crab trapping. From 2012/13 to 2022/23 reported landings from fish and crab trapping accounted for approximately 65 and 10% of estuary landings, respectively. The annual catch composition by sex is biased towards males with reported landings of females accounting for approximately 35% of total landings from 2009/10 to 2022/23 (Fig. S3).

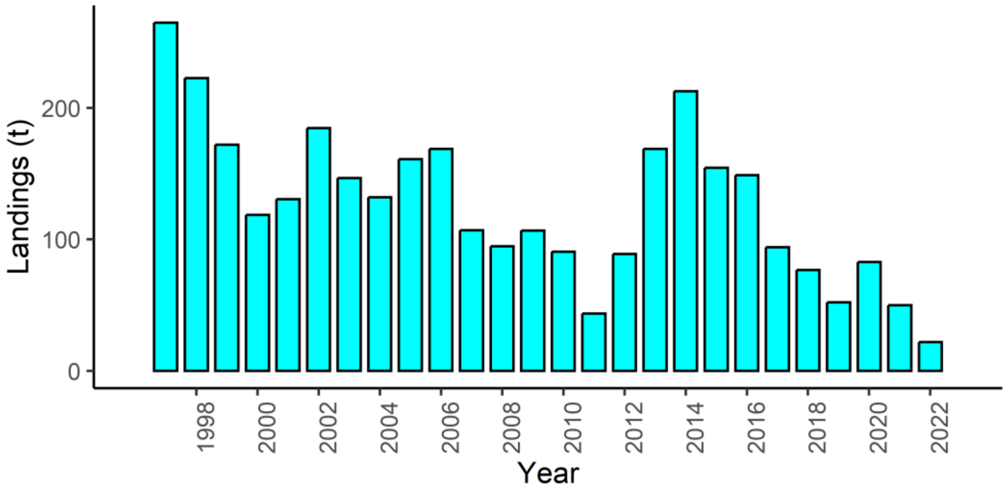

Figure 1. Annual reported commercial landings (t) from NSW estuaries for 1997/98 to 2022/23.

Recreational & Charter boat

From an estimated state-wide harvest of ~413, 000 individuals weighing ~155 t in 2000/01 (Henry & Lyle 2003), harvest declined by ~85% to 50, 637 (± 14, 220) individuals weighing ~27 t in 2013/14 (West *et al*., 2015). Annual estimates of recreational harvest for 2017/18 (63, 034 individuals, ~ 33 t), 2019/20 (42, 325 individuals, ~ 22 t) and 2021/22 (13, 124 individuals, ~ 6.9 t) applies only to 1-3 year recreational licence holders, and non-license holders residing in households selected within the sampling frame (Murphy *et al*., 2020, 2022, 2024).

Estimated harvest by recreational anglers in Lake Macquarie derived from boat ramp/ creel surveys in 2003/04 (61, 000 individuals, ~ 38 t), 18 months after it was designated as a recreational fishing haven were ~45% lower by number and 27% lower by weight than 1999/2000 (111, 000 individuals, ~ 51 t). Although estimated harvest of Blue Swimmer Crab had decreased from 1999/2000 to 2003/04, the difference was not statistically significant (Steffe *et al*., 2005). Like the 1999/2000 and 2003/04 surveys, Blue Swimmer Crabs were one of the most-harvested species by boat-based anglers in Lake Macquarie in 2011 (Ochwada-Doyle *et al*., 2014). From March to

May 2011 an estimated 24, 435 and 814 Blue Swimmer Crabs were harvested by boat-based and shore-based anglers, respectively.

Indigenous

Although Indigenous fishers harvest Blue Swimmer Crabs throughout New South Wales, there are no state-wide estimates of harvest. It is however, acknowledged and understood that fishing practices have been undertaken by Aboriginal people of many groups throughout NSW for many thousands of years and that fishing and related practices are valued by Aboriginal people for a wide range of reasons including subsistence (Smyth *et al*., 2018).

Illegal, Unregulated and Unreported

The level of Illegal, Unregulated and Unreported (IUU) fishing is unknown.

Fishing effort information

Reported effort (days) crab trapping for Blue Swimmer Crab estimated from monthly catch and effort records slowly decreased from ~10, 900 days in 1997/98 to ~6, 900 days in 2003/04 then declined by ~50% in 2004/05 (3, 460 days). Following the introduction of daily catch and effort reporting in 2009/10, reported effort has remained below 3, 000 days per year (Fig. 2). In contrast reported effort fish trapping increased from 2004/05 and exceeded 2, 000 days per year from 2004/05 to 2008/09. After the initial decline in reported effort following the change from monthly to daily reporting (2009/10), effort increased and peaked at 4, 400 days in 2014/15. From 2015/16 reported effort fish trapping has continually declined with 2, 290 days reported in 2021/22 (~50% of 2014/15). The trends in reported effort suggest a large proportion of the catch of Blue Swimmer Crabs reported from crab trapping (pre 2004/05) was reported from the method of fish trapping from 2005/06 to 2018/19. However, reported days effort crab trapping has increased in recent years, with > 2, 000 days effort reported in 2018. In 2022/23, 1, 910 and 1, 355 days effort were reported from the method of fish trapping and crab trapping, respectively.

The annual total number of traps lifts reported for the method of fish trapping increased from a minimum of ~31, 400 in 2011/12 to ~92, 600 in 2018/19, before declining to ~62, 400 in 2021/22 (Fig. 3). In contrast, report effort (TrapLifts) crab trapping increased from ~13, 200 in 2017 to 24, 100 in 2018 and reached a historical peak of ~28, 200 trap lifts in 2021/22 (Fig. 3). In 2022/23, 38, 174 and 18, 950 trap lifts were reported from the method of fish trapping and crab trapping, respectively.

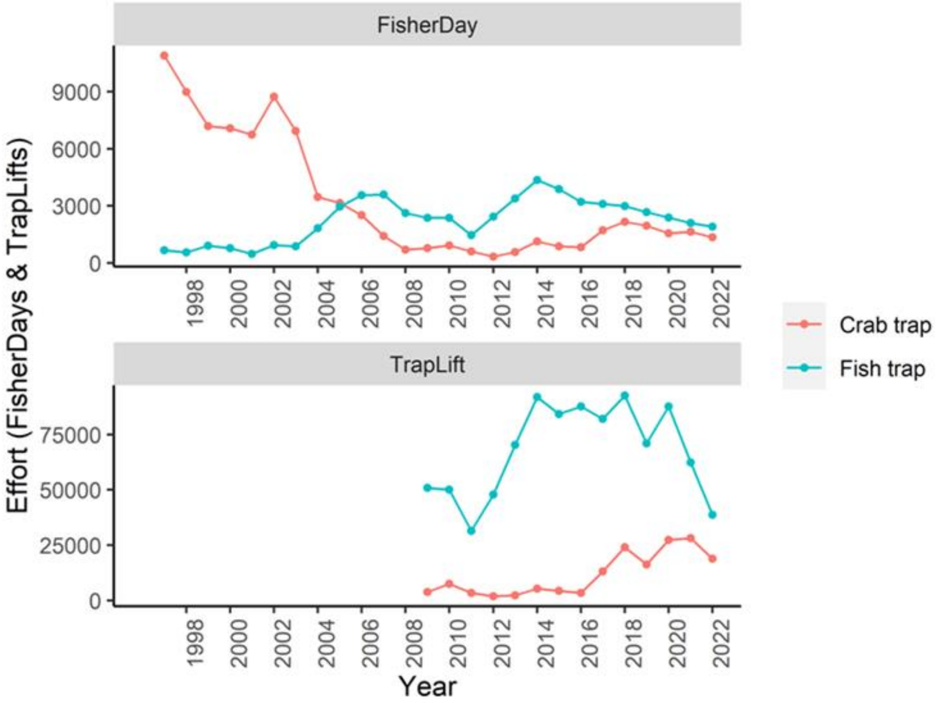

Figure 2 Reported days effort (top plot) and trap lifts (bottom plot) for the methods of fish and crab trapping from all NSW estuaries.

Catch rate information

Nominal catch rates (kg.FisherDay^{-1}) for fish trapping averaged ~20 kg.day^{-1} before increasing to > 30 kg per day^{-1} from 2013/14 to 2016/17 (Fig. 3). Under revised management arrangement (i.e., MLL increase and quota management) catch rates have declined from ~18 kg.FisherDay^{-1} (2017/18) to < 10 kg.FisherDay^{-1} (2022/23). Catch rates crab trapping steadily declined from 2002/03 to 2011/12 and remained low (< 9 kg.day^{-1}) until 2019/20 before increasing to ~13 kg.FisherDay^{-1} in 2020/21 (Fig. 3).

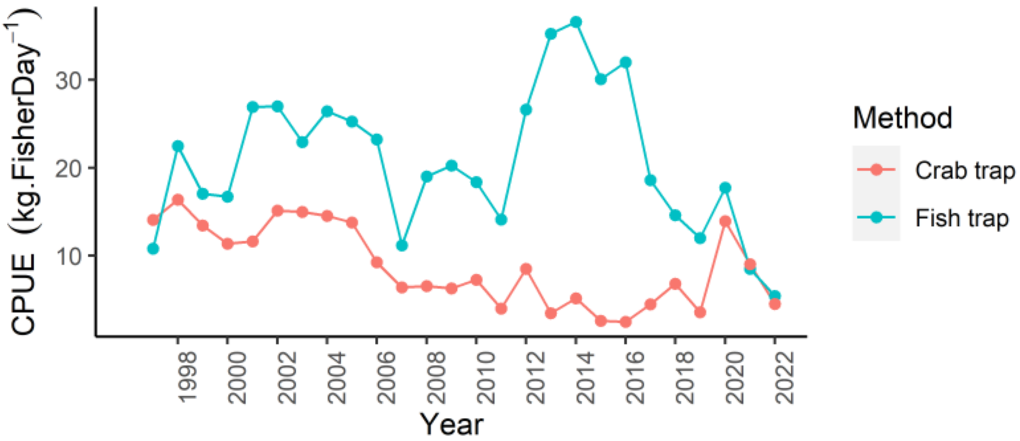

Figure 3. Nominal commercial catch rates from crab and fish trapping in the EGF.

Stock Assessment

Stock Assessment Methodology

Year of most recent assessment:

2024

Assessment method:

Weight of evidence approach, including standardised commercial catch rates, Fishery-independent survey catch rates of legal and undersize crabs in Wallis Lake, size-structure of observed catches and predictions of CPUE and harvest, and Bayesian state-space implementation of the Schaefer surplus production model (BSM).

Main data inputs:

1. Reported commercial landings from 1950/51 to 2022/23;
2. Commercial catch rates in $kg.day^{-1}$ for the methods of crab and fish trapping derived from fisher-reported monthly records by fiscal year (1997/98 -2008/09);
3. Commercial catch rates in $kg.day^{-1}$ for the methods of crab and fish trapping derived from fisher-reported daily records by fiscal year (2009/10 -2022/23);
4. Estimates of recreational harvest from state-wide surveys completed in 2000, 2012/13, 2017/18, 2019/20 and 2021/22;
5. Catch rates and size-structure of catches from fishery independent surveys (FIS) in Walls Lake from 2018/19 to 2022/23 (see Taylor *et al*., 2023 for a full description); and
6. Size-structure of observed catches from Wallis Lake from 2018/19 to 2019/20.

Key model structure & assumptions:

1. Standardised catch rates. Annual catch rates were standardised using Generalised Linear Models (GLM) to account for the effects of month and fisher (i.e., authorised fisher ID). Models were fit using a lognormal distribution, with CPUE as the response variable, and year, month and fisher as explanatory terms (which were considered categorical variables). Estimated marginal mean values for each year and associated confidence limits were then calculated using the 'emmeans' package (Lenth, 2020) and rforCPUE (https://github.com/haddonm/rforcpue) in R (R Development Team, 2019). *Assumptions*: that annual catch rates are a relative index of abundance and not unduly influenced by other factors that are not accounted for through standardisation.
2. Bayesian state-space implementation of the Schaefer surplus production model (BSM) using CMSY+ and BSM (Froese *et al*., 2019). The main advantage of BSM compared to other implementations of surplus production models is the focus on informative priors and the acceptance of short and incomplete (= fragmented) catch-per-unit-of-effort (CPUE) data (See Froese *et al*., 2017 for full description). *Assumptions*: Productivity models such as used by CMSY 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 and CMSY will overestimate production of new biomass and will underestimate exploitation rates.
3. Predictions of summer (January – April) CPUE for Wallis Lake from a liner model fitted to the previous year's summer CPUE (kg scaled fisher day-1), the total catch taken the previous winter (June – November; kg), and the mean Pacific Decadal Oscillation (PDO) index from November – January leading into the fishing season (see Schilling *et al*., 2023 for a full description).

4. Quadratic discrimination analysis using the previous summer (January – April) CPUE and the winter (June – November) catch to classify years as above or below average (see Schilling *et al*., 2023 for a full description).

Sources of uncertainty evaluated:

The effect of data selection on standardisations of daily data (kg.Day^{-1}) from 2009/10 to 2016/17 and 2017/18 to 2022/23 was investigated using the following criteria:

1. Minimum number of years in the fishery (2, 4 & 6 or 8 (2009/10-2016/17 only));
2. Minimum average catch per fisher (1, 2 & 3 t);
3. Minimum catch per record (1, 2 & 5 kg);
4. Maximum catch per record (50, 100 & 150 kg); and
5. Maximum catch of other species per record (5, 10 & 20 kg).

The effect of three different catch scenarios imputed using the standard error of estimated recreational harvest in 2000/01 (Henry & Lyle 2003) on predicted B/B_{MSY} and F/F_{MSY} from BSM analysis.

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	None specified in a formal harvest strategy. This assessment used a weight-of-evidence approach, which included: standardised catch rates from Wallis Lake and other main estuaries (combined) for the methods of fish and crab trapping; catch rates from fishery-independent surveys in Wallis Lake (legal and undersize crabs); predictions of summer (January – April) CPUE and catches from Wallis Lake; and predicted biomass from BSM analyses.
Biomass Limit Reference Point	None specified in a formal harvest strategy. In the interim, the current catch rates were compared to the long-term averages of each time series. 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.
Fishing mortality indicator or proxy	None specified in a formal harvest strategy. In the interim, trends in the total fishing effort of the fish and crab trapping sector of the EGF was used as an indicator of relative fishing pressure.
Fishing mortality Limit Reference Point	None specified in a formal harvest strategy. In the interim, current effort levels were compared against historic levels.
Fishing Mortality Target Reference Point	None specified in a formal harvest strategy.

Stock Assessment Results

Standardised commercial catch rates

Catch rates (in mean CPUE kg-day^{-1}) for fish and crab trapping in Wallis Lake increased from 2011/12 and were ≥ mean catch rate from 2012/13 to 2016/17 (Fig. 4 – left panel). For other main estuaries, catch rates for fish trapping increased from 2011/12 and exceeded mean catch in 2013/14 before declining below average in 2015/16 and 2016/17 (Fig. 4 – left panel). In contrast, catch rates for crab trapping in other estuaries fluctuated around mean catch rate from 2013/14 to 2015/16 and exceeded mean catch rate in 2016/17. Under revised management arrangements from 2017/18, standardised catch rates for fishing trapping in Wallis Lake (~60% of average landings) and other main estuaries (15% of average landings) have declined (Fig. 4 – right panel). Fish trap catch rates in 2021/22 for Wallis Lake and other estuaries were 40% and 9% lower than 2020/21, respectively. In 2022/23, catch rates fish trapping in Wallis Lake continued to decline to the lowest levels in the available time series (Fig. 4 – right panel). When compared to 2017/18, catch rates fish trapping and crab trapping in Wallis Lake have declined by ~70% and ~80%, respectively. Similarly, in other estuaries catch rates fish and crab trapping in 2022/23 were 30-40% lower than 2017/18 (Fig. 4 – right panel).

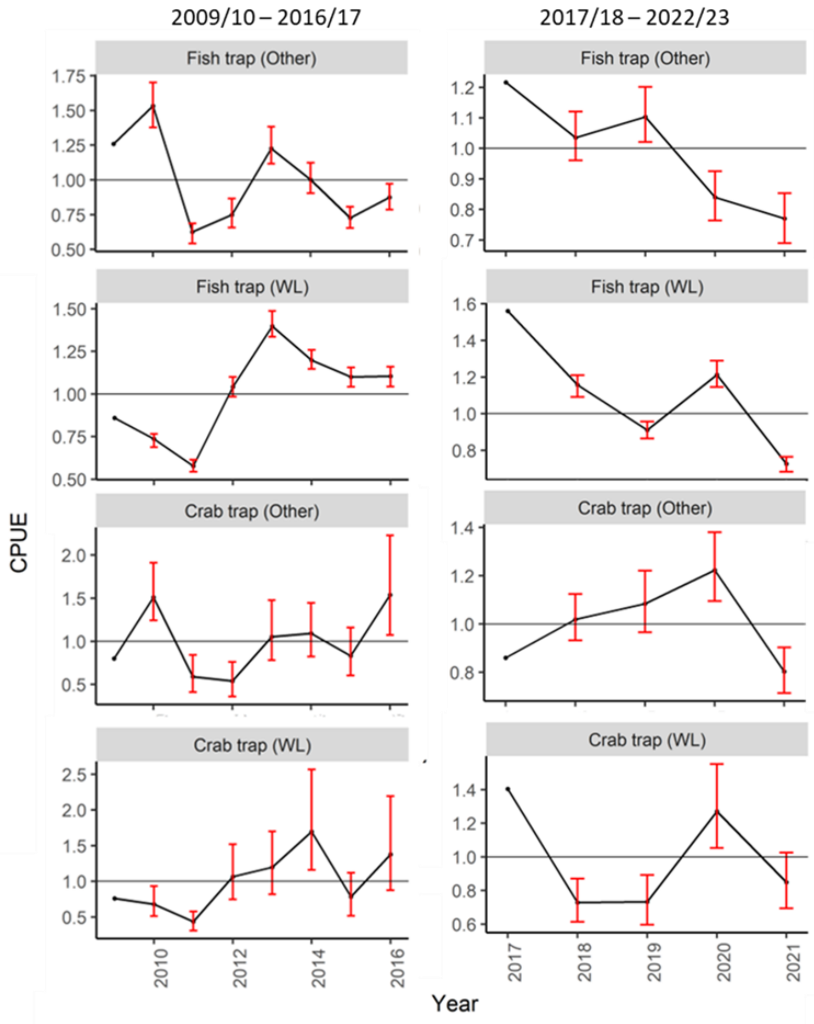

Figure 4. Standardised commercial catch rates (nominal scale) for fish trapping and crab trapping with 95% confidence intervals from main estuaries (Other - excluding Wallis Lake) and Wallis Lake (WL) in CPUE kg day^{-1} from daily records for 2009/10 to 2016/17 (left panel) and 2017/18 to 2022/23 (right panel).

Fishery-independent surveys (FIS)

Totals of 18, 181 undersize and 4, 964 legal Blue Swimmer Crabs have been caught from ~4, 630 trap lifts from November 2018 to February 2024. There was substantial temporal variability in catch rates (number.crabs.trap^{-1}) of undersize and legal sized crabs throughout the survey period (Fig. 5). Catches of undersize crabs in 2018/19, 2019/20 and 2020/21 peaked in mid-late summer (January or February). Catch rates of undersized crabs in January 2024 (9.61 ± 0.71crabs.trap^{-1}), 2023 (0.76 ± 0.11 crabs.trap^{-1}) and 2022 (5.00 ± 0.46 crabs.trap^{-1}),) were lower than 2019 (17.18 ± 1.44 crabs.trap^{-1}) and 2021 (13.6 ± crabs.trap^{-1}). Catches of legal sized crabs were less variable but generally declined throughout the fishing season reaching a minimum from July to September. Monthly catch rates of legal sized crabs for 2022 (July to June) and 2023 (July to January) were below mean long-term average (1.11 crabs.trap^{-1}) and mean catch rate calculated for the first three years (November 2018/19 to June 2021/22) surveyed (1.27 crabs.trap^{-1}). Nominal catch rates of legal crabs calculated annually (ALL) and for the main fishing period (legal crabs; November to June, MAIN) were similar in most years. Catch rates declined from 1.73 (± 0.08) crabs.Trap.lift^{-1} in 2018/19 to 0.85 (± 0.04) and 0.69 (± 0.03) crabs per trap lift for the main fishing period and all months in 2022/23 (Fig. 6). Similarly, annual catch rates of undersize crabs from November to March (Main) have declined from 9.50 (± 0.49) crabs.Trap.Lift^{-1} in 2018 to 3.37 (± 0.16) and 1.10 (± 0.06) crabs.Trap.Lift^{-1} in 2021/22 and 2022/23, respectively (Fig. 6). Catch rates of undersize crabs in 2023/24 (Main; 5.37 ± 0.33) were ~6x higher than 2022/23, but were 60%, 76% and 57% below catch rates in 2020/21, 2019/20 and 2018/19, respectively (Fig. 6). Similarly, catch rates of legal crabs in 2023/24 (Main; 1.58 ± 0.33) were 86% above 2022/23, and were 91% of peak catch rates recorded in 2018/19 (Fig. 6).

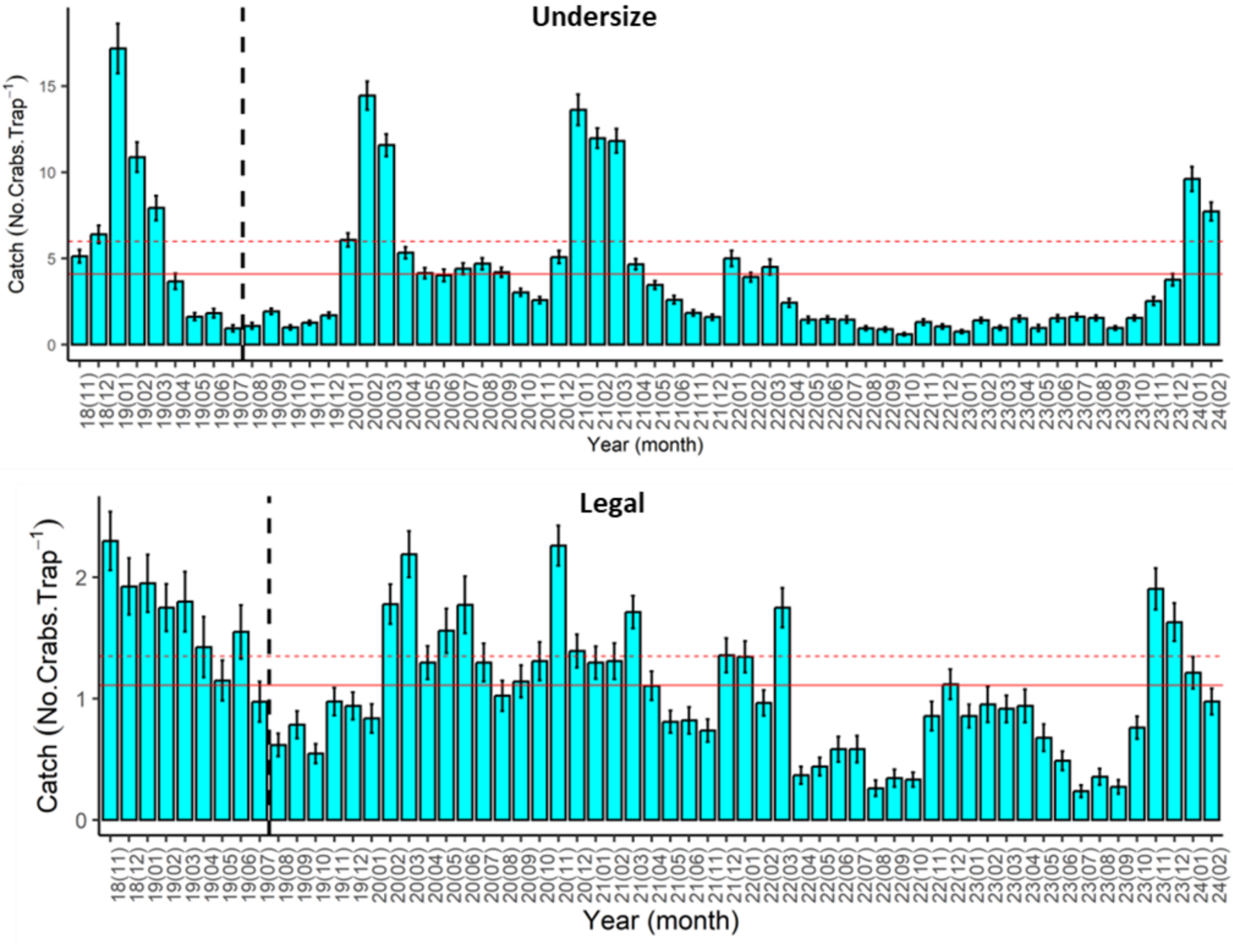

Figure 5. Mean (± SE) monthly catch rate (number.crabs.trap^{-1}) of undersize (top plot) and legal crabs (bottom plot). Dashed vertical line indicates change in sampling design (See Taylor *et al*., 2023).

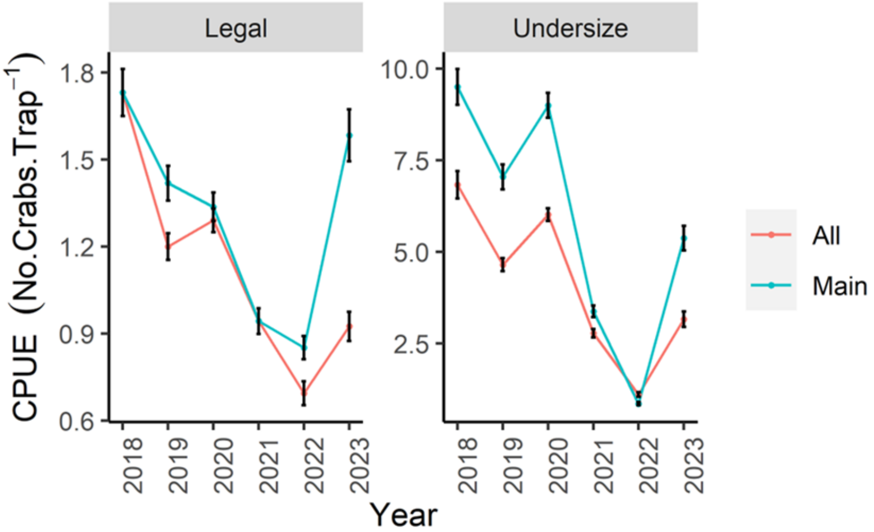

Figure 6. Mean catch rate (± SE) of legal crabs and undersize crabs for all months and November to June for legal crabs and November to March for undersize (Main).

Size-structure of observed catches

Increasing the minimum legal length (MLL) from 60 to 65 mm in 2017 increased protection of the spawning stock. The size-structure of observed catches from Wallis Lake trap fishery indicate that ~60% of the total catch of both berried and female Blue Swimmer Crabs were below the current MLL (Fig. 7). Approximately 55 and 64% of the total observed catch of male Blue Swimmer Crabs from 2018/19 and 2019/20 were undersized, respectively (Fig. 8). The proportion of the observed annual catch of undersized Blue Swimmer Crabs ≥ 60 < 65 mm ranged from 59.6% for males to 65.9% for females (Fig. 7, Fig. 8). Within individual months, the proportion of female and male crabs ≥ 60 < 65 mm ranged from 17.3 to 49.3% and 12.2 to 46.6%, respectively (Fig. S4).

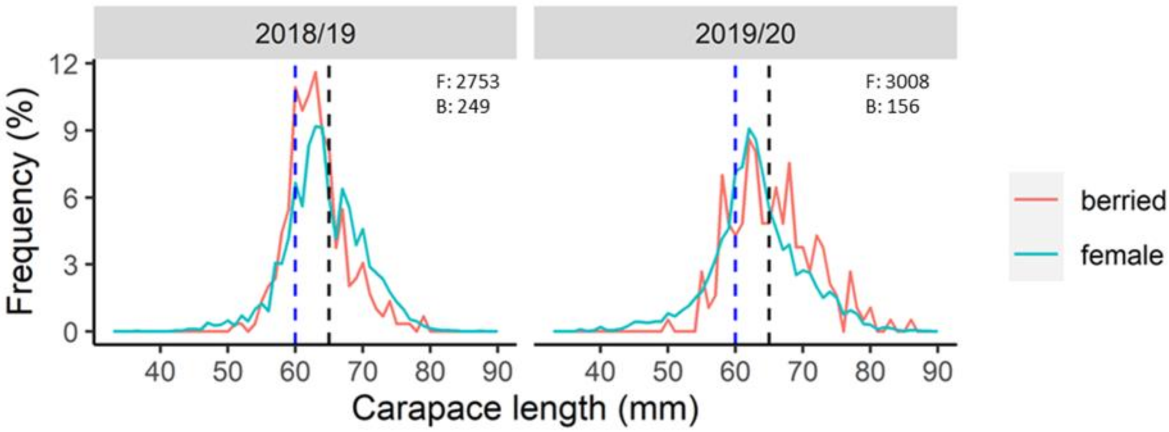

Figure 7. Size-frequency distribution of berried female and female Blue Swimmer Crabs recorded from observer-based survey of Wallis Lake from 2018/19 to 2019/20. The number of female (F) and berried female (B) crabs measured is shown. Dashed line represents historic (blue - pre December 2017) and current (black) MLL.

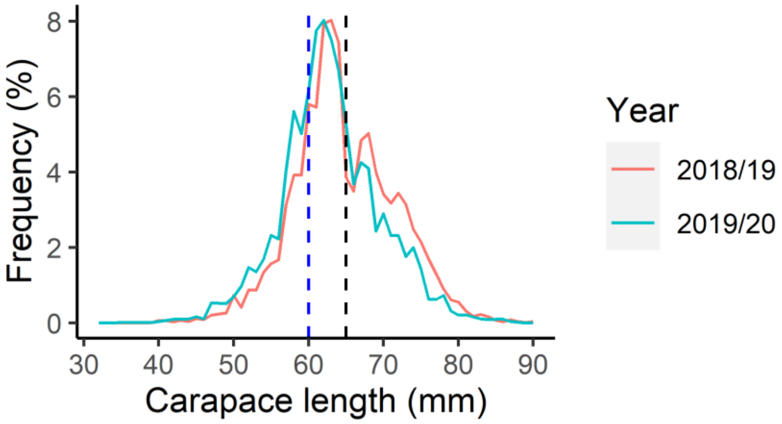

Figure 8. Size-frequency distribution of male Blue Swimmer Crabs recorded from observer-based survey of Wallis Lake for 2018/19 (n = 6, 673) and 2019/20 (n = 8, 153). Dashed line represents historic (blue - pre December 2017) and current (black) MLL.

CPUE and catch prediction for Wallis Lake (Schilling *et al.*, 2023)

Following integrative analysis drawing together information to test specific hypotheses of a variety of factors that could influence Blue Swimmer Crab commercial fisheries harvest in Wallis Lake, Schilling *et al.*, 2023 used a single ecologically relevant regression model to predict the summer (January – April) CPUE (the period when most of the blue swimmer crabs are harvested). The model predicted CPUE (January in April) in 2022/23 (18.7 kg day^{-1}) to be greater than 2021/22 (10. 6 kg day^{-1}), but below long-term average (Fig. 9, 24.7± 2.0 kg day^{-1}). However, predicted CPUE in 2021/22 was lower than observed (18.9 kg day^{-1}).

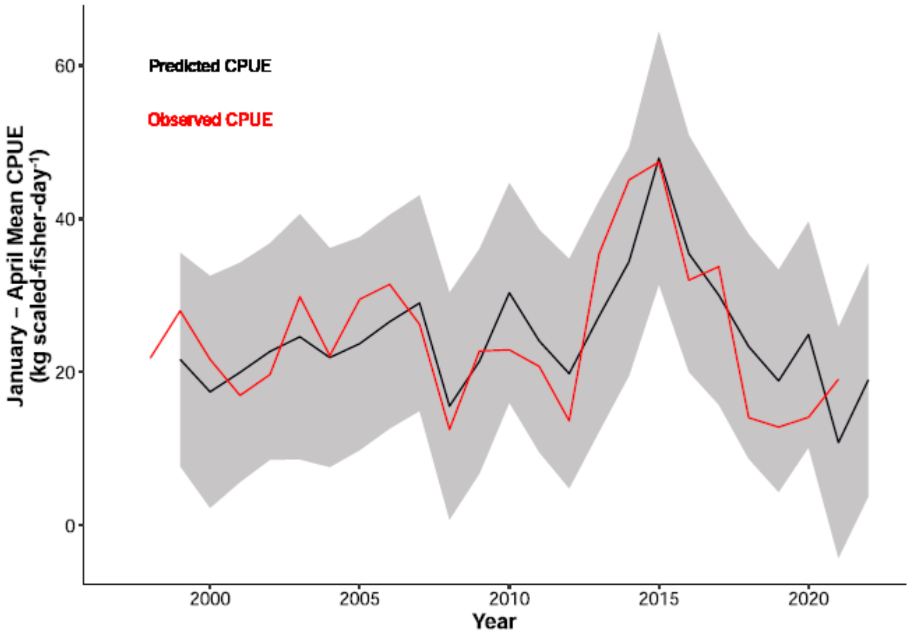

Figure 9. Hindcast predictions of summer (January – April) CPUE (kg scaled Fisher Day^{-1}) for Blue Swimmer Crab in Wallis Lake. The red line shows observed CPUE while the black line shows the predicted CPUE. The grey ribbon shows the 95% prediction interval using the linear model (Source Schilling *et al.*, 2023).

Quadratic discrimination analysis was successful (83.3% accuracy) at using the previous summer (January – April) CPUE and the winter (June – November) catch to classify most years as above or below mean total harvest (78.7 t) calculated from reported landings for Wallis Lake from 1998 – 2021 (Fig. 10, Schilling *et al.*, 2023). The classification analysis showed that when the previous summer harvest was high, the forecast season was likely to be above average but if the winter harvest was too large then there was a risk of a below average harvest (Schilling *et al*., 2023). The magnitude of winter harvest has declined in recent years (2017/18-2022/23).

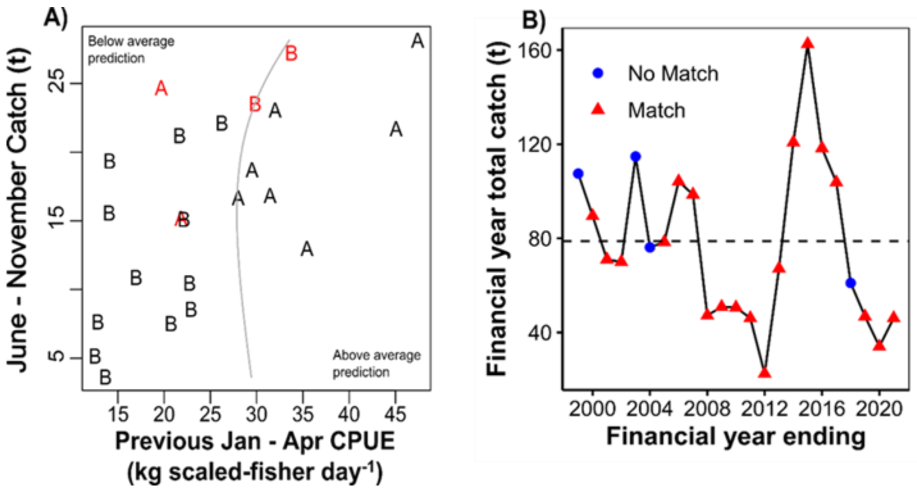

Figure 10. Visual representation of classification of above- and below-average seasons based upon the quadratic discrimination analysis using winter (June – November) catch and the previous summer (January – April) CPUE (kg scaled fisher day^{-1}). Panel A shows the outcomes of the discrimination analysis. Letters represent the predicted outcome for the season (A = above average, B = below average) and colour represents whether the prediction was correct (black = correct, red = incorrect). The grey line shows the prediction boundary based upon the two variables. Panel B shows the performance of the predictions over time relative to the observed financial year catch (year ending June 30th). The dashed line represents the mean total catch (source Schilling *et al*., 2023).

BSM analysis

For BSM analyses, all catch series produce similar trends in long-term trajectories of biomass (B) B/B_{msy} (maximum sustainable yield), albeit with minor differences in estimates of B/B_{msy} for 2022/23. Estimates of MSY for the base-case (± SE) fitted to daily and monthly CPUE were similar, ranging from 164 t (± 107 - 251 t) to 217 t (± 142 – 331 t). Mean estimates of B_{2022}/B_{MSY} for the base-case (± SE), fitted to daily and monthly CPUE, were all < 0.5, and 95% confidence interval of estimates were < 1.0.

Stock Assessment Result Summary

Biomass status in relation to Limit	NA – no biomass limits has been set. Weight-of-evidence is sufficient to support an understanding that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. However, for the period 2017-18 to 2021-22 the biomass declined, but the stock is not yet considered to be recruitment impaired. The status is based on: For recent data analysed as mean catch rates (kg.day^{-1}), standardised catch rates for fish trapping in Wallis Lake have declined by more than 50% in the five most recent years. Similarly, for other estuaries standardised catch rates for fish trapping declined from 2017/18 to 2022/23.

	Catch rates for crab trapping in Wallis Lake and other estuaries fluctuated around the mean from 2012/13 to 2020/21, but sharply declined in 2022/23; Catch rates of undersize crabs from FIS for November to March in 2022/23 were 25% lower than 2021/22, and were ~90% lower than 2020/21, 2019/20 and 2018/19; Catch rates of legal crabs from the FIS for November to March in 2022/23 were 10% lower than 2021/22, and were 10%, 37% and 40% below catch rates in 2020/21, 2019/20 and 2018/19, respectively; The model predicted CPUE (January in April) in 2022/23 (18.7 $kg.day^{-1}$) to be greater than 2021/22 (10.6 $kg.day^{-1}$), but below long-term average (24.7 $kg.day^{-1}$); and Mean estimates of B_{2022}/B_{msy} for the base-case catch series fitted to monthly and daily CPUE data were < 0.5. If the assumption of the Schaefer production function that MSY occurs at 50% of B_0 is correct, then this implies B_{2022}/B_{msy} < 0.25.
Biomass status in relation to Target	NA – no biomass target has been set.
Fishing mortality in relation to Limit	NA – no fishing mortality limit has been set. Weight-of-evidence provided is sufficient to support an understanding that fishing mortality is at a level to avoid the stock being recruitment impaired. The trend of decreasing catch rates from the fishery and main regions coincides with a reduction in total commercial landings and effort following the transition to quota management in 2017/18.
Fishing mortality in relation to Target	NA – no fishing mortality target has been set.
Current SAFS stock status	Sustainable (Johnston *et al*., 2021)

Fishery interactions

Of the ~51 incidental species recorded from a fishery-wide observer-based assessment of the Blue Swimmer Crab trap fishery in Wallis Lake completed over two fishing season, only one individual of two protected species: a green turtle (*Chelonia mydas*) and a pied cormorant (*Phalacrocorax varius*) (both deceased), and two alien species, including 11 *Carcinus maenas*, and one *Charybdis japonica* were caught (Barnes *et al*., 2022).

Stakeholder engagement

NSW DPI Fisheries presented the current stock assessment to stakeholders in the Estuary General Fishery on the 5th March 2024, to outline the assessment process and provide an opportunity for feedback.

Qualifying Comments

On the basis of the evidence contained within this assessment, Blue Swimmer Crabs are currently assessed as **depleting.** The weight of evidence provided supports an understanding that the biomass of Blue Swimmer Crabs has decreased, but recruitment is not yet impaired. Declining biomass is a result of fishing mortality and substantial environmental changes in recent years.

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 impact of recent management changes (i.e. quota management) on catch rates has not been fully quantified. However, the results of the observer-based survey of the Wallis Lake trap fishery indicate the increased MLL has likely resulted in increased levels of discarding reducing retained catches (*Barnes et al*., 2022). NSW estuaries are subject to periodic flooding events which have the potential to limit catches during large-scale floods, the most recent occurring in 2018, 2021 and 2022. The impact of factors other than changed population dynamics, including changed fishing practices, locations, catch reporting and catchability need to be investigated further.

The size-structure of catches from the fishery and fishery-independent surveys suggests that either crabs are rapidly removed by fishers as soon as they enter the fishery, or crabs are emigrating from the estuary with Taylor *et al*., (2023) reporting catches of large crabs (70-80 mm CL) from inshore waters adjacent to Wallis Lake from May to August. Due to reduced fishing pressure on mature female crabs following the MLL increase, and declining winter harvest the stock is unlikely to be recruitment impaired.

The increased minimum legal length and, the implementation of daily possession limit for all ocean fisheries (25 kg) has reduced fishing pressure on the spawning stock, resulting in a decline in harvest rate over the last two years. However, Schilling *et al*., (2023) found that winter harvesting in Wallis Lake disproportionally impacts large females which negatively impacts the following January to April harvest. The negative relationship between increased fishing mortality on mated pre-spawning females during winter and, a declining summer harvest aligns with previous research on Blue Swimmer Crabs in Western Australia (Johnston *et al*., 2011).

The BSM production model is based on an underlying Schaefer production function. These simple modelling approaches (i) assume that MSY occurs at 50% of B_0, (ii) do not explicitly model recruitment, (iii) are sensitive to the accuracy of historical catches, and (iv) BSM is sensitive to the accuracy of indices of abundance used for calibration. Consequently, model outputs need to be interpreted with caution.

References

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Appendices

Supplementary figures

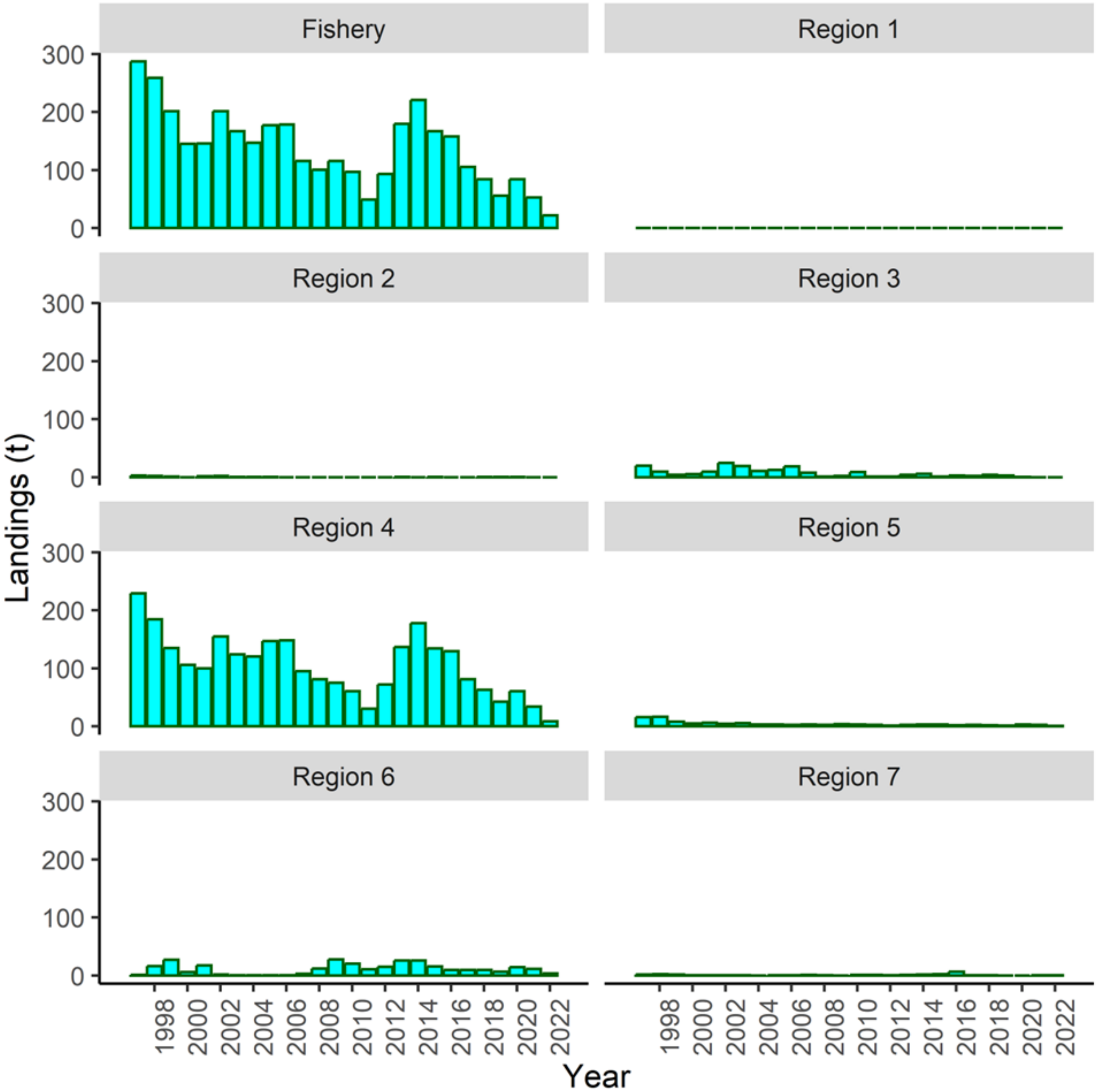

Figure S1. Reported landings (t) from NSW estuaries and estuary general management regions from 1997/98 to 2022/23.

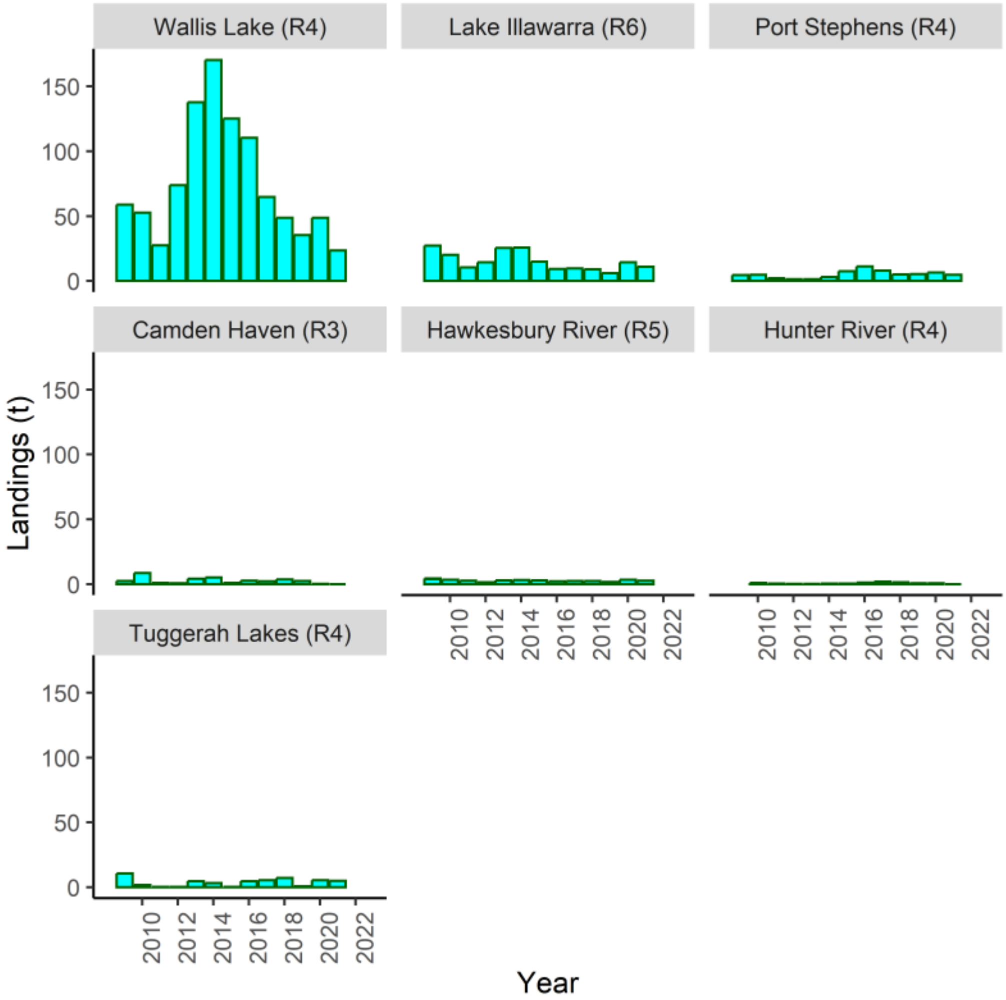

Figure S2. Reported landings (t) from main estuaries from 2009/10 to 2022/23. Estuary general regions shown in parentheses.

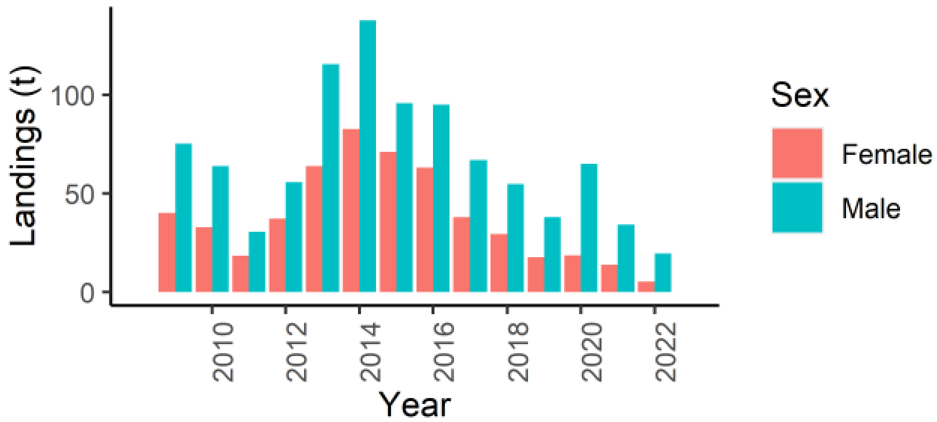

Figure S3. Reported landings of female and male Blue Swimmer Crabs from 2009/10 to 2022/23.

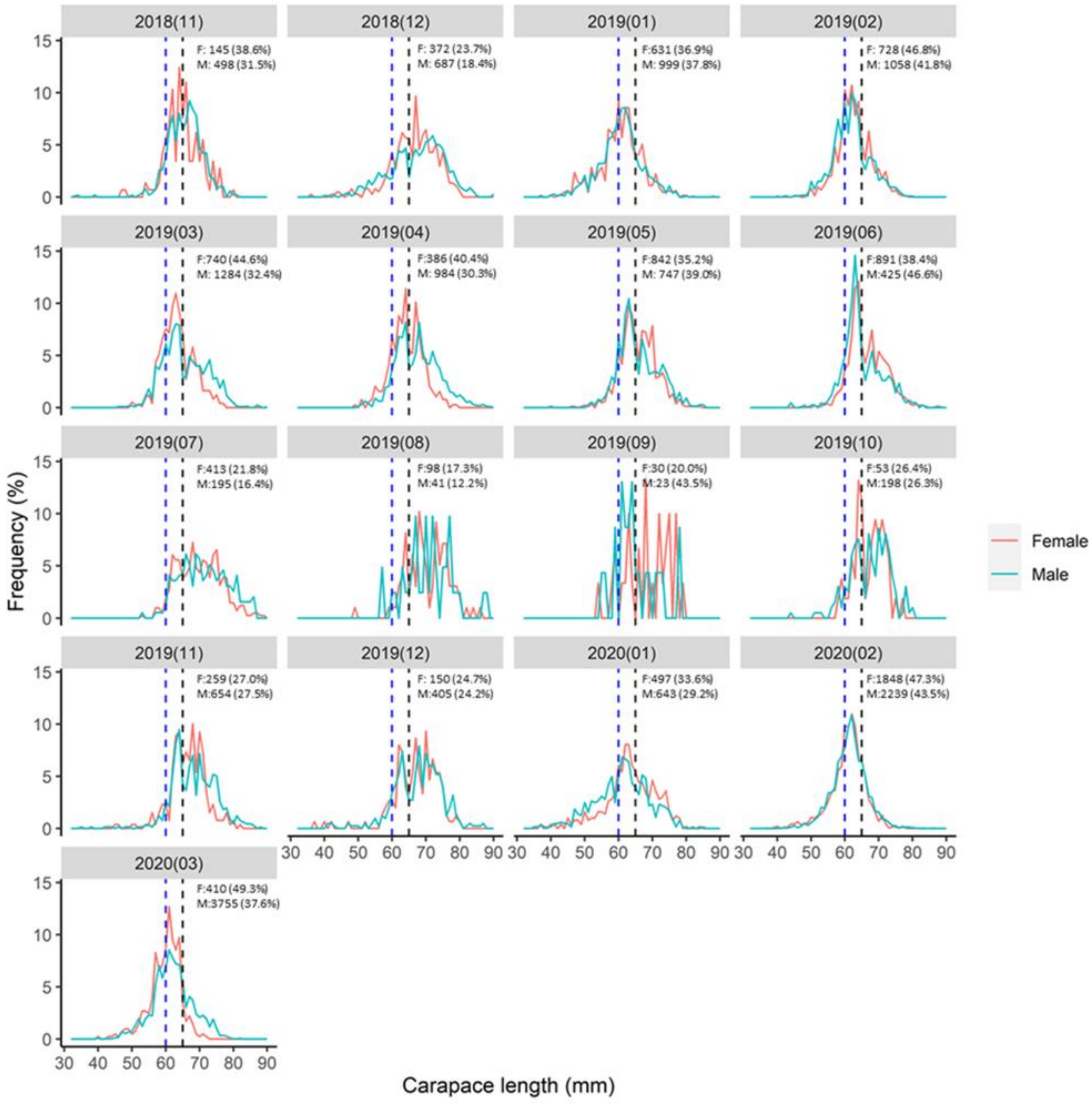

Figure S4. Monthly size-frequency distribution of female and male Blue Swimmer Crabs for observed catches from November 2018 to March 2020. The number of female (F) and Male (M) crabs measured and proportion of catch ≥ 60 < 65 mm is shown in parenthesis (%). Dashed lines indicate historic (blue 60 mm) and current (black 65 mm) MLL.