Department of Primary Industries
and Regional Development

NSW Stock Status Summary – 2024/25

Pipi (*Donax deltoides*)

Assessment Authors and Year

Johnson, D.D. 2025. NSW Stock Status Summary 2024/25 – Pipi (*Donax deltoides*). NSW Department of Primary Industries and Regional Development. 17 pp.

Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Pipi are currently assessed as sustainable.

Stock structure & distribution

Results of a collaborative study which used microsatellite and mitochondrial DNA marker techniques on samples collected from sites along the New South Wales (NSW), Victoria and South Australian coasts indicated that there were three reproductively isolated populations of Pipis (Miller *et al*., 2013). There is a high level of bidirectional gene flow along the east coast of Australia resulting in a single panmictic population stretching along the NSW coast and most likely extending as far north as Fraser Island, Queensland (Murray-Jones & Ayre, 1997).

Scope of this assessment

This stock status summary is an update to the full assessment completed in 2024 (Johnson 2024) and provides a determination of stock status of the NSW Pipi biological stock. The summary synthesises available fishery and biological information to inform setting of the Total Allowable Catch (TAC) for 2025/26. The report relies heavily on catch and effort data which were available from July 1984 to June 2024.

Biology

For the population of Pipi in NSW, the size at which 50% (SAM_{50}), and 95% (SAM_{95}) were sexually mature was 3.4, and 4.4 cm, respectively (Murray-Jones 1999). A minimum legal length (MLL) of 4.5 cm is in place in NSW to allow spawning to occur before recruitment to the fishery. Growth rates in Pipi are size dependent, maximum length (~8.0 cm) is reached after approximately 4 years (Murray-Jones 1999).

Fishery statistics

Catch information

Commercial

Total annual reported commercial catches of Pipi increased steadily from 15 tonnes (t) to 80 t from 1984/85 – 1988/89, and then increased rapidly to a peak of 670 t in 2000/01. Catches exceeded 250 t yr^{-1} from 1996/97 to 2005/06 then rapidly declined to 9 t in 2010/11 (Fig. 1). In response to the declines in landings a series of input controls including spatially explicit management strategies (i.e., conditional area closures), temporal closures of the commercial fishery (i.e., 6 months per-annum), MLL (i.e., 4.5 cm total length) and output controls limiting catch to 40 kg per fisher per day were implemented by NSW DPI in an attempt to stabilize the fishery. Catches then increased to ~180 t in 2016/17 before declining to 155 t in 2018/19 (1st June - 31st December). Total reported commercial landings managed by a Total Allowable Catch (TAC) of 147.4 t (2020/21) and 156 t (2021/22) were 128.3 t and 82.5 t, respectively. Total reported quota usage during 2021/22 was 92.7 t (~60% of TAC), declining from 138.2 t in 2020/21 (~94% of TAC). In 2022/23, of the 156 t TAC, fishers reported landings of 99.8 t (~64% of TAC) and quota usage of 108.5 tonnes (~70% of TAC). In 2023/24, reported landings increased to 134.1 t (quota usage 142.9 t, ~91.5% of TAC).

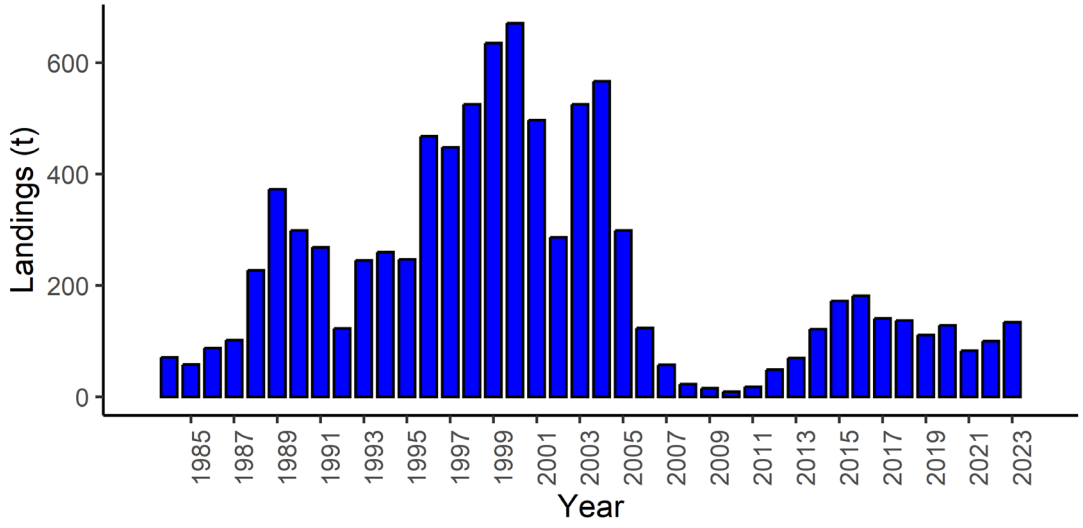

Figure 1. Annual reported commercial landings (t) for the fishery from 1984/85 to 2023/24. Years on x-axis refer to first year of fiscal year (i.e., 2023 = 2023/24).

Since 2009/10, reported catches of Pipis from Estuary General Handgathering (EGHG) Fishery Regions 1 to 4 have accounted for >95% of total fishery landings. From 2012/13, catches have been reported annually for each of the main regions (Fig. 2). Catch from Region 3 (EGHG3) has averaged 37% of total annual catches since 2012/13, with >52% of total state-wide catch reported in 2023/24 (Fig. 2). Catch from Region 4 (EGHG4) dominated total catches from 2016/17 to 2019/20 (~56% of total landings), but accounted for <6% of total state-wide catch from 2022/23 to 2023/24

(Fig. 2). Since 2012/13, catches from Region 1 (EGHG1) have averaged 17% of the total annual catch from the fishery, although in 2022/23 and 2023/24 catch in EGHG1 was 50% and 33% of total state-wide catches, respectively (Fig. 2). Catches from Region 2 (EGHG2) are not shown due to <5 fishing businesses reporting catches annually. Reported catches from main beaches fished are shown in Fig. S1 (EGHG3) and Fig. S2 (EGHG4).

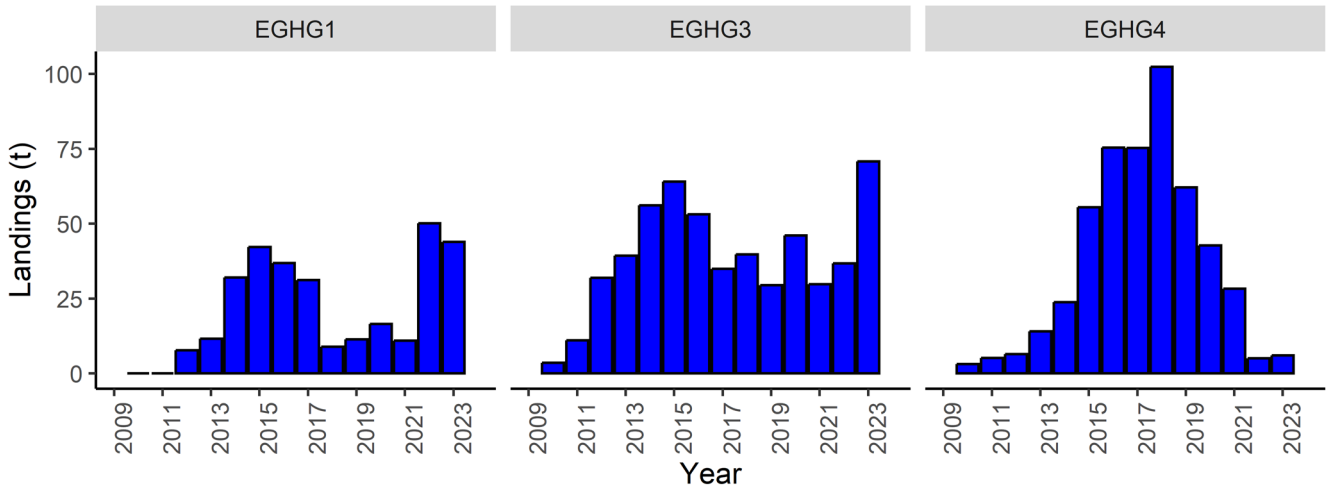

Figure 2. Annual reported commercial landings (t) for EGHG1, EGHG3 and EGHG4 from 2009/10 to 2023/24.

Recreational & Charter boat

Estimates of state-wide recreational harvest are available from the National Recreational and Indigenous Fishing Survey and NSW state-wide surveys completed in the 2000/01, 2013/14, 2017/18, 2019/20 and 2021/22 financial years, respectively (Henry & Lyle 2003, West *et al*. 2015, Murphy *et al*., 2020, 2022, 2024). In 2000/01, the catch from NSW was estimated to be 7 t (1, 076, 765 ± 169, 937 Pipis), representing one per cent of total harvest. In 2013/14 and 2017/18 the state-wide survey estimated the catch to be 1.3 t (87, 760 ± 31, 272 Pipis) and 1.1 t (75, 696 ± 42, 423 Pipis), respectively. In 2019/20 recreational anglers were estimated to retain 80, 604 (± 29, 362) Pipis weighing 1.2 t and in 2021/22, harvest declined to 45, 605 (± 23, 253) Pipis weighing 1.0 t (Murphy *et al*., 2024).

Indigenous

Although Indigenous fishers harvest Pipi throughout NSW, there are no state-wide estimates of Indigenous harvest. Onsite interviews of Indigenous fishers in the Tweed Heads region (Northern NSW) estimated an annual Pipi harvest in that region of 3, 056 – 7, 380 individuals (Schnierer 2011). Using a regional weight multiplier estimated at 14.81 g per Pipi (Murphy *et al*., 2020), indigenous harvest was estimated to be less than 0.12 t in the Tweed Heads region.

Illegal, Unregulated and Unreported

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

Fishing effort information

Reported days effort ($effort_{dy}$) in 2023/24 (1, 672) was ~15% lower than 2022/23 (1, 989 days) and was ~30% of the historical peak of 5, 610 days in 2001/02 (Fig. 3). From 2009/10, with the introduction of daily catch and effort reporting, fishers have reported hours spent hand-gathering per fishing day. From the recent minimum of 1, 802 hours in 2010/11, $effort_{hr}$ increased to 13, 688 hours in 2015/16 and was 6, 780 hours in 2019/20 (Fig. 3). Under revised management arrangements from 2019/20, $effort_{hr}$ declined to 7, 670 (2020/21), 5, 841 (2021/22), 5, 617 (2022/23) and 5, 344 hours in 2023/24 (Fig. 3).

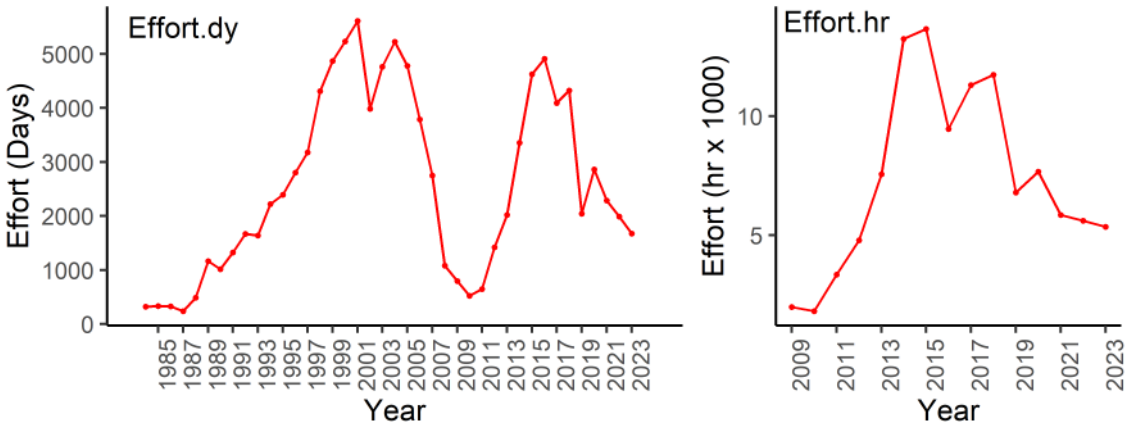

Figure 3. Reported days effort (left plot) and hours (right plot) spent handgathering.

Reported effort (hours handgathering - $effort_{hr}$) from EGHG3 has averaged 41% of total fishery effort since 2012/13, with >50% of fishery effort reported from EGHG3 in 2022/23. In 2018/19, ~60% of total effort was reported from EGHG4, however, <10% of total effort was reported in 2022/23 and 2023/24. Although reported effort from EGHG1 has averaged 20% of the total reported from the fishery from 2012/13 to 2023/24, effort in 2022/23 and 2023/24 accounted for ~52% and ~44% of total reported effort, respectively.

Catch rate information

Standardised catch rates (Stock assessment section) are the most reliable index of relative abundance for Pipi. Nominal catch rates are presented to allow comparisons between the initial period of commercial exploitation in NSW and current catch rates. Catch per-fisher-day (CPUEdy, 80.1 kg^{-1}) and catch per-hour (CPUEhr, 24.7 kg^{-1}) in 2023/24 were greater than CPUEdy (49.3 kg^{-1}) and CPUEhr (16.4 kg^{-1}) in 2022/23 and 2021/22 (CPUEdy 37.2 kg^{-1}, CPUEhr 12.7 kg^{-1}, Fig. 4). In 2023/24, CPUEhr in EGHG1 (23.6 kg^{-1}) and EGHG4 (13.4 kg^{-1}) were ~30% greater than 2022/23, while in EGHG3, CPUEhr (26.0 kg^{-1}) and CPUEdy (133.9 kg^{-1}) were 47% and 220% greater than 2022/23, respectively.

Historically, $CPUE_{dy}$ increased from less than 100 $kg.day^{-1}$ (1984/85-1987/88) to a maximum of 218 $kg.day^{-1}$ in 1990/91 then declined to 58 $kg.day^{-1}$ in 1995/96 (Fig. 4). From 1996/97 to 2000/01 $CPUE_{dy}$ exceeded 100 $kg.day^{-1}$, then rapidly declined to 17 $kg.day^{-1}$ in 2010/11. The trend in $CPUE_{hr}$ is similar to that of $CPUE_{dy}$ from 2009/10 - 2019/20. From a minimum of 5.0 $kg.hr^{-1}$, $CPUE_{hr}$ increased to 18.6 $kg.hr^{-1}$ in 2016/17, but then declined again to 13.2 $kg.hr^{-1}$ in 2018/19 (Fig. 4). Following the removal

of the 40 kg daily possession limit in 2019/20, $CPUE_{dy}$ and $CPUE_{hr}$ increased to 55.1 kg and 16.0 $kg.hr^{-1}$, respectively (Fig. 4). However, in 2019/20 a total of 154 fishing events (~7.5% of total) reported a total catch of 8.58 t with nil effort (i.e. zero hours spent handgathering) which were omitted from analyses. The number of fishing events with nil effort declined to 51 in 2020/21 (1.55 t), 39 in 2021/22 (1.62 t), 14 in 2022/23 (0.49 t) and 18 in 2023/24 (0.45 t).

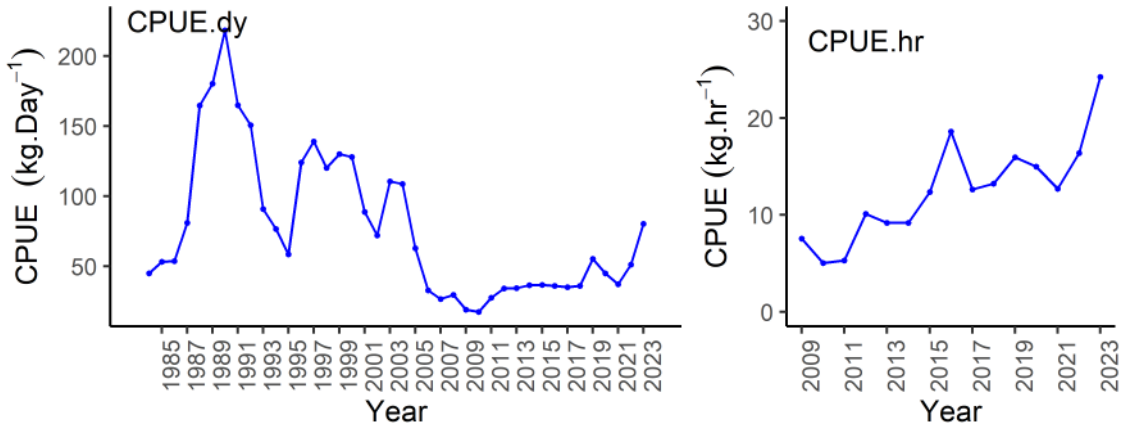

Figure 4. CPUE in $kg.day^{-1}$ (left plot) and $kg.hr^{-1}$ (right plot).

Stock Assessment

Stock Assessment Methodology

Year of most recent assessment:

2024 (using data up to June 2024)

Assessment method:

A weight-of-evidence approach has been used to assess the NSW Pipi stock. It incorporates the results from standardised commercial catch rates (2009/10 to 2023/24) for the main regions of the fishery, simple stock depletion models applied at the scale of regions and beaches, estimates of relative abundance from fishery-independent surveys (FIS), and analyses of commercial catch.

Main data inputs:

The following raw data inputs were used in analyses:

- Commercial catch rates in kg-per-hour ($kg.h^{-1}$) derived from fisher-reported daily records (2009/10 – 2023/24);
- Commercial catches by fiscal years (1984/85–2023/24);
- Estimates of relative abundance from FIS completed in 2023 (SP1) across the main commercial fishing areas on South Ballina (EGHG1), Killick (EGHG3), Yagon (EGHG4) and Stockton

(EGHG4) beaches to assess spatial variability in the distribution and relative abundance of Pipis; and

- Estimates of relative abundance from FIS completed on Stockton beach in October 2023 (SP1), February 2024 (SP2) and October 2024 (SP3).

Key model structure & assumptions:

Standardised catch rates

Annual catch rates were standardised using Generalised Additive Mixed Model (GAMM) using daily catch data and effort data ($kg.hr^{-1}$) from 2009/10 to 2017/18 and 2018/19 to 2022/23 to account for changes in reporting and management arrangements (described in full in Johnson 2024). For the GAMM, the variables considered as part of the standardisation process were, EGHG Region, Authorised Fisher ID (as a random effect), Month and Lunar Phase.

The Null model included a EGHG Region by fiscal year interaction, to allow the CPUE trends in each region to differ, and a random effect of Authorised Fisher to account for differences between fishers. To account for the moderate cyclic relationship between lunar phase and catch rates in NSW, and cyclical nature of Month, GAMMs included cyclical splines of Lunar Phase and Month. To ensure CPUE relationships identified were not driven by more records in individual regions or years, all data points were weighted to provide equal weighting between Year and Estuary combinations (Campbell 2015). All GAMMs were fit using the 'mgcv' R package (Wood, 2011).

Predicted CPUE indices for the main regions were aggregated to generate a single index of abundance by calculating the weighted average for the time series for each zone and weighting these by the area of beaches fished in each region. This assumes that larger beaches have larger Pipi populations and are therefore more representative of the whole NSW population (refer to Hoyle *et al*., 2024 for justification).

A model selection process using a manual backwards selection process, whereby each variable was removed one at a time and the Akaike information criterion values (AIC) compared between competing models was completed to determine the optimum model. Model fits were assessed visually with residual and partial effects plots generated by the 'appraise' and 'draw' functions of the 'gratia' package in r (Simpson, 2023).

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.

Stock depletion models

Leslie and DeLury models (each including the Ricker modification) were applied to seasonal Pipi catch and effort data and involve regression fits of linear models (Hilborn & Walters 2001). Stock depletions were completed using the 'FSA` R package (Ogle *et al*., 2025). *Assumptions*: i) a closed population (no recruitment, natural mortality, immigration or emigration); (ii) constant catchability; (iii) sufficient removals such that CPUE is substantially reduced; (iv) equal vulnerability of individuals to capture; (v) independence of units of effort and (vi) the assumptions associated with linear regression (Liggins 2017). Depletion analyses estimate depletion of the component of the stock above the selectivity point, not depletion of the spawning stock.

Sources of uncertainty evaluated:

Two different model scenarios were tested:

- Daily data GAMM with lognormal distribution: and
- Daily data GAMM with Tweedie distribution.

The effect of data selection on standardisations of daily data ($kg.hr^{-1}$) from 2018/19 to 2023/24 was investigated using the following criteria:

- Minimum number of years in the fishery (2 & 4);
- Minimum average catch per fisher (1, 2 & 3 t);
- Minimum catch per record (2, 5 & 10 kg); and
- Maximum catch per record (100, 150 & 200 kg).

The variables considered as part of the initial CPUE standardisations were expanded to include swell height for South Ballina, Ten Mile, Killick and Stockton Beaches. Swell height was extracted from the NSW Nearshore Wave Tool (https://nearshore.waves.nsw.gov.au/home/forecast) for the following points (South Ballina: 100408, Ten Mile: 10056, Killick: 101516, Stockton: 102580). All wave data available using the Nearshore Points pages are generated using the parametric nearshore transformation (Kinsela *et al.*, 2024).

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 from the fishery and three main regions; estimated biomass and the depletion of this biomass over the season from stock depletion models; and estimates of relative abundance from FIS.
Biomass Limit Reference Point	None specified in a formal harvest strategy.
Biomass Target Reference Point	None specified in a formal harvest strategy.
Fishing mortality indicator or proxy	None specified in a formal harvest strategy. For the purposes of this stock assessment a weight-of-evidence approach was used, which included: estimates of exploitation rate (calculated as catch/initial biomass) from stock depletion models.
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

Standardised commercial catch rates (in mean CPUE kg h^{-1}) is likely to be the most reliable index of relative abundance for Pipi. For data analysed as mean daily catch rate from 2009/10 to 2018/19, catch rates within the four main regions of the fishery were variable (Fig. S3). For example, catch rates in EGHG3 increased from 2009/10 to 2015/16 then declined consistently each year. In contrast, despite an increase in total catches and the proportion of the state-wide harvest taken in EGHG4 catch rates continually increased reaching a maximum in 2018/19. There is no clear trend in catch rates from EGHG1, however, catch rates in 2017/18 and 2018/19 were below average. The aggregated standardised CPUE (i.e., fishery level) index continually increased from 2010/11 and remained above average from 2014/15 to 2018/19 (Fig. 5).

Post the transition to quota management and removal of the daily trip limit (2018/19), standardised catch rates from EGHG1, EGHG2 and EGHG3 have fluctuated around the mean (Fig. S4). Standardised catch rates from EGHG4 continually declined from 2018/19 to 2022/23, but increased in 2023/24 (Fig. S4). The aggregated standardised CPUE index showed minimal deviation from the mean over the time-series (Fig. 5).

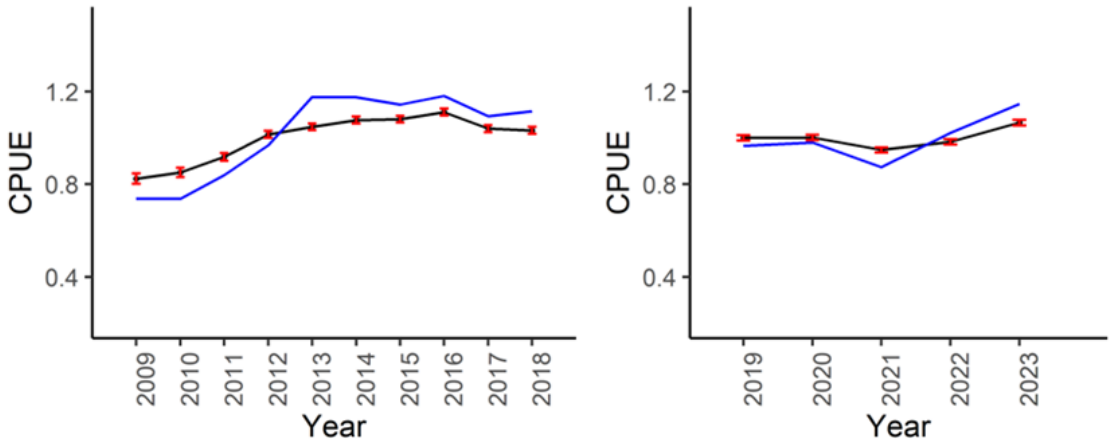

Figure 5. Standardised CPUE (± SE) and nominal catch rates (blue line) in kg.hr^{-1} for daily data from 2009/10 to 2017/18 (left) and 2018/19 to 2023/24 (right) predicted from the Tweedie GAMM.

Stock depletion models

Based on available trends in nominal CPUE kg.hr^{-1}, reported harvest of 68 t from Killick beach (Fig. 6) and 45 t from South Ballina beach in 2023/24 did not result in declining CPUE across the fishing season, suggesting that the fishing mortality was not significantly impacting abundance/ biomass of Pipis (≥4.5 cm).

Prior to 2023/24 fishing season, simple stock depletion models were applied to 23 beach/ season combinations from 2009/10 to 2022/23. For 2022/23, estimates of exploitation rate (calculated as

catch/initial biomass) on individual beaches ranged from 48 - 55% (South Ballina), 19 – 32% (Crowdy) and 21 - 22% (Yagon). For 2021/22, estimates of exploitation rate on individual beaches ranged from 20 - 23% (South Ballina), 23 - 26% (Gooloowah), 51 – 52% (Killick) in EGHG3, and 49 - 55% (Yagon) and 51 - 53% (Stockton) in EGHG4. Prior to the transition to quota management and removal of season closure (2019/20), estimates of exploitation rate for individual beaches ranged between 0.20 and 0.83 from 2009/10 to 2018/19. In 2018, reported landings of 73.2 t from Stockton Beach were estimated to remove 40 – 46% of the biomass of Pipis (≥4.5 cm) during the fishing season (June - December).

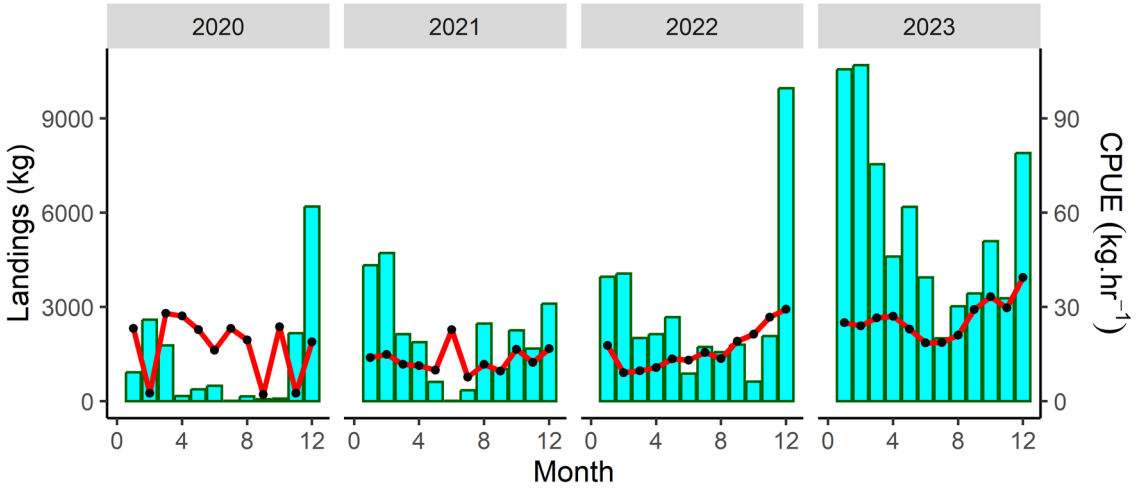

Figure 6. Monthly landings (kg - bars) and CPUE (kg.hr^{-1} -red line) between 202020/21 and 2023/24 on Killick beach. Month number refers to order of months (1 – 12) within fishing period (June (1) – July (12)).

Fishery-independent surveys (FIS) completed in October 2023 (SP1), February 2024 (SP2) and October 2024 (SP3)

For data pooled across zones on Stockton beach, the abundance of legal sized Pipis in the dry area increased from 0.9 ± 0.2 individual per m^2 (ind.m^2) in SP1 to 7.1 ± 0.8 ind.m^2 in SP3 (Fig. 7). However, abundance of legal Pipis in the wet area remained low across surveys (<1.2 ind.m^2). In SP3, the abundance of undersize sized Pipis in the wet area (49.3 ± 8.0 ind.m^2) was greater than SP2 (5.6 ± 0.5 ind.m^2) and SP1 (11.3 ± 1.0 ind.m^2). Although the abundance of undersize Pipis in the dry area was lower than the wet, patterns were similar between areas with the highest abundance observed in SP3 (18.8 ± 3.0 ind.m^2). Pre-recruits (<4.5 cm) comprised 95.7% (SP1), 79.0% (SP2), and 94.2% (SP3) of the size frequency distributions pooled across areas (Fig. S5).

For data pooled across zones in SP1 when four beaches were sampled, the abundance of legal sized Pipis in the dry area on killick (3.6 ± 0.7 ind.m^2) was greater than South Ballina (1.2 ± 0.3 ind.m^2), Yagon (0.8 ± 0.3 ind.m^2) and Stockton (0.9 ± 0.2 ind.m^2) beaches (Fig. 8). The abundance of undersized Pipis in the swash area on Stockton (11.3 ± 1.0 ind.m^2) was greater than Yagon (6.1 ± 0.9 ind.m^2), South Ballina (4.0 ± 0.4 ind.m^2) and Killick (1.3 ± 0.2 ind.m^2) beaches (Fig. 8). In contrast, the abundance of undersize Pipis in the dry area on South Ballina (12.0 ± 2.2 ind.m^2) and Killick (11.7 ± 1.6 ind.m^2) beaches was greater than Stockton (6.8 ± 1.0 ind.m^2) and Yagon (1.2 ± 0.3 ind.m^2) beaches (Fig. 8). Pre-recruits comprised 87% (South Ballina), 70% (Killick), 90% (Yagon) and 96% (Stockton) of the size frequency distribution in October-November 2023, indicating low abundance of legal sized Pipis (Fig. S6).

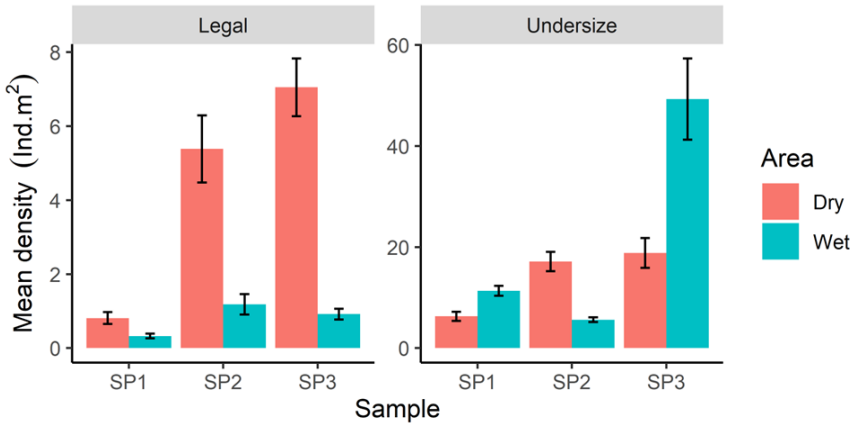

Figure 7. Mean density (individuals.m^2) of legal (left plot) and undersize (right plot) in the dry and swash areas (pooled across zones) sampled on Stockton beach in SP1, SP2 and SP3.

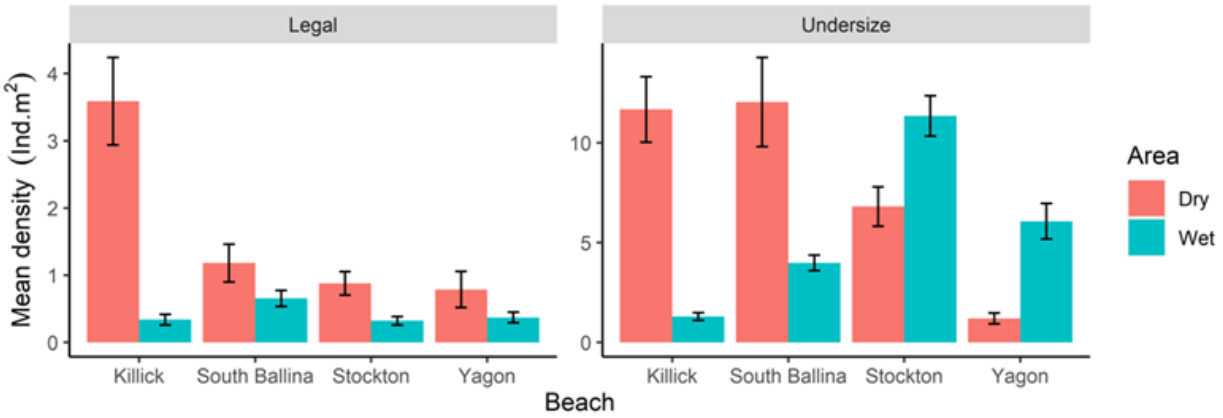

Figure 8. Mean catch rate (individuals.m^2) of legal (left plot) and undersize (right plot) in the dry and swash areas (pooled across zones) on beaches surveyed in SP1.

Stock Assessment Result Summary

Biomass status in relation to Limit	For recent data analysed as mean catch rates (kg.hr^{-1}), standardised catch rates (regions combined) remained stable and above the average from 2012/13 – 2018/19, and fluctuated around the mean from 2019/20 to 2023/24. However, catch rates within the three main regions of the fishery are variable with large declines in catch rates in EGHG4 from 2019/20 to 2022/23. In 2023/24 reported harvest of 68 t from Killick beach and 45 t from South Ballina beach did not result in declining CPUE across the fishing season.

	In 2022/23, estimates of exploitation rate on individual beaches ranged from 48 - 55% (South Ballina), 19 – 32% (Crowdy) and 21 - 22% (Yagon). In 2021/22 , estimates of exploitation rate on individual beaches ranged from 23 - 26% (Gooloowah) to 51 – 52% (Killick) in EGHG3, and 49 –55% (Yagon) and 51 – 53% (Stockton) on EGHG4 beaches. Estimates of exploitation rate for individual beaches from 2009/10 to 2018/19 ranged between 34 and 63% for beaches examined in EGHG3 and between 20 and 84% for the beaches examined in EGHG4. The relative abundance of legal sized Pipis in FIS on Stockton beach increased from 0.9 ± 0.2 ind.m^2 in SP1 to 7.1 ± 0.8 ind.m^2 in SP3. Similarly, abundance of undersize Pipis in the wet area in SP3 (49.3 ± 8.0 ind.m^2) was greater than SP1 (6.28 ± 0.9 ind.m^2) and SP2 (5.6 ± 0.5 ind.m^2). The FIS in 2023 recorded low abundance of legal-sized Pipis on South Ballina, Stockton and Yagon beaches (<1.5 ind.m^2). However, pre-recruits were recorded at all sampling locations on South Ballina, Killick, Yagon and Stockton beaches at densities up to 40.8 ± 9.7 ind.m^2.
Biomass status in relation to Target	Not assessed.
Fishing mortality in relation to Limit	Estimates of exploitation rate of Pipis ≥4.5 cm on individual beaches ranged from 23 - 55% in 2021/22 and 22-55% in 2022/23. No within season declines in CPUE were observed on main beaches fished in 2023/24.
Fishing mortality in relation to Target	Not assessed
Current SAFS stock status	Sustainable (Ferguson *et al*., 2023)

Fishery interactions

Nil interactions have been reported between Estuary General Handgathering fishers and species protected under the Environment Protection and Biodiversity Conservation *Act 1999*.

Stakeholder engagement

NSW Department of Primary Industry and Regional Development (DPIRD) presented the current stock assessment summary to stakeholders in the Estuary General Fishery on the 6th March 2025 to outline the assessment process and provide an opportunity for feedback.

Qualifying Comments

A weight-of-evidence approach has been taken for this assessment. The weight of evidence supports and understanding that the biomass of Pipi is currently unlikely to be depleted and the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.

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.

In 2023, through the NSW Fisheries Business Efficiency Program (NSW DPIRD) passed regulations to allow one unlicensed (unendorsed) person to harvest EGHG Fishery species with an endorsement holder (Authorised Fisher). Currently it in unclear how changes in operational characteristics have affected measures of effort and subsequently measures of catch rate used to assess the Pipi stock. The accuracy of reported effort where an unlicensed fisher contributed to the catch is unknown. Additionally, the impact of unlicenced crew on catch rate standardisations that use authorised fisher as a variable have not been quantified.

The depletion analyses presented estimate depletions of the component of stock above the selectivity point (SL_{50}). As the size of maturity (~3.4 cm) for Pipi is below the MLL (4.5 cm) and the size of selectivity (SL_{95}, ~5.1 cm), depletion analyses do not estimate depletion of the spawning stock (Johnson, 2024).

The relationship between CPUE and abundance is often disproportional and nonlinear (Harley *et al*., 2001). Aggregations of fish and fishing effort have been shown to produce hyperstability in the CPUE- abundance relationship, in which CPUE remains stable while actual abundance declines (Harley *et al*., 2001, Ferguson *et al*., 2015). Management regulations that restrict harvest to 40 kg of Pipi per fisher day (2011/12 – 2018/19) may have produced hyperstable catch rates. The potential for re-aggregation of Pipi following fishing suggests that the abundance of Pipi may decline faster than CPUE as the stock is depleted (Defeo, 2003). If fishers succeed in finding aggregations of Pipi, large declines in CPUE will only be observed when the number of aggregations is greatly reduced and catching operations become more random. Simple estimates of commercial CPUE remain a poor predictor of Pipi relative biomass compared to those obtained from fishery-independent surveys in South Australia (Ferguson *et al*., 2015).

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Appendices

Supplementary figures

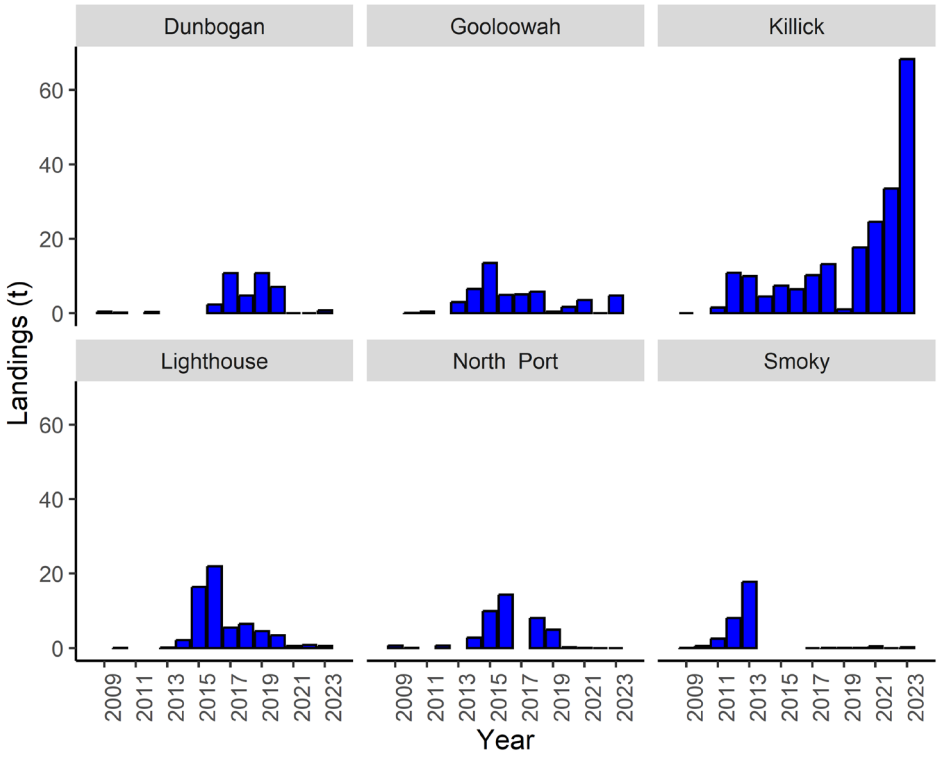

Figure S1. Reported catches from main beaches fished in EGHG3 from 2009/10 to 2023/24.

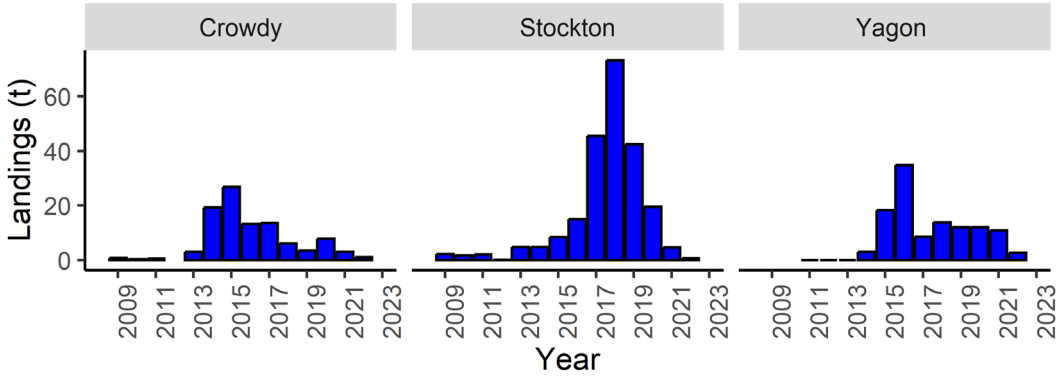

Figure S2. Reported catches from main beaches fished in EGHG4 from 2009/10 to 2023/24.

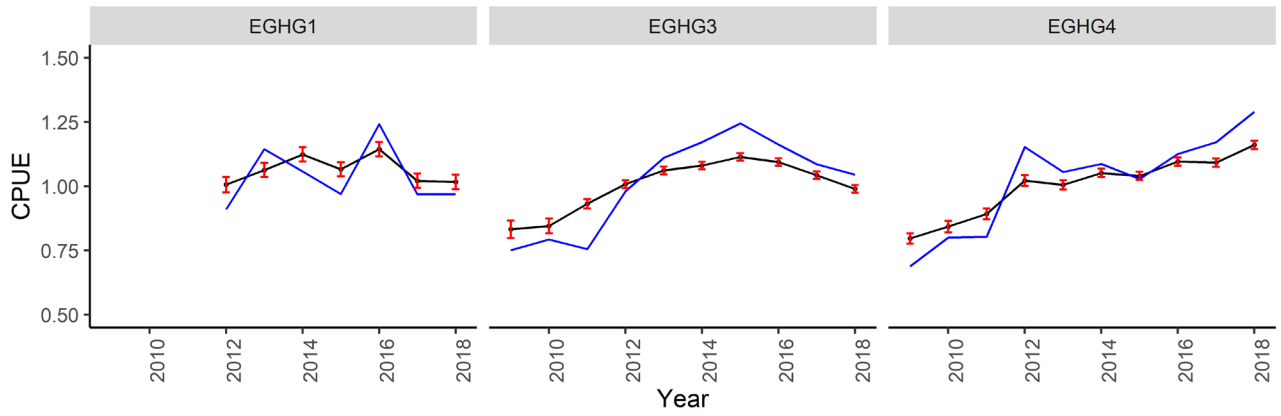

Figure S3. Standardised CPUE (± SE) and nominal catch rates (blue line) in kg.hr^{-1} for EGHG regions from the Tweedie GAMM for the 2009/10 to 2017/18 time series. Nil catch reported from EGHG1 from 2009/10 to 2011/12.

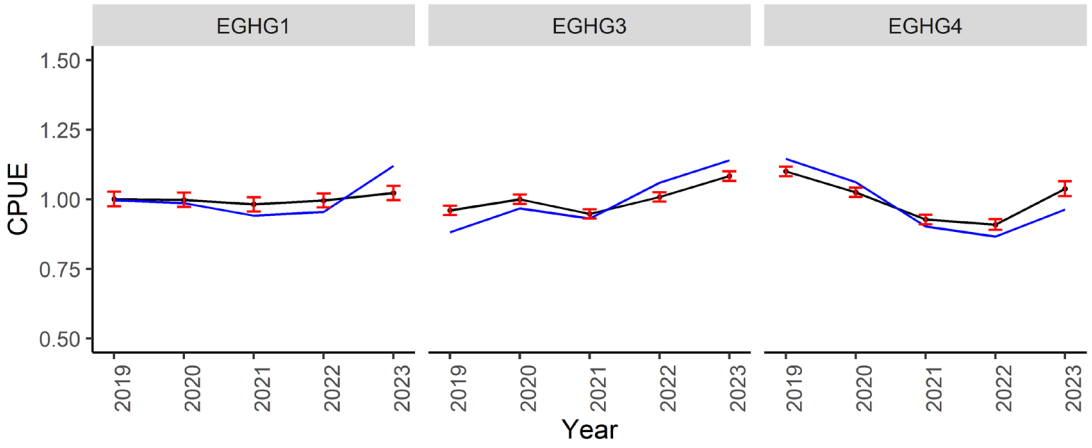

Figure S4. Standardised CPUE (± SE) and nominal catch rates (blue line) in kg.hr^{-1} for EGHG regions from the Tweedie GAMM for the 2018/19 to 2023/24 time series.

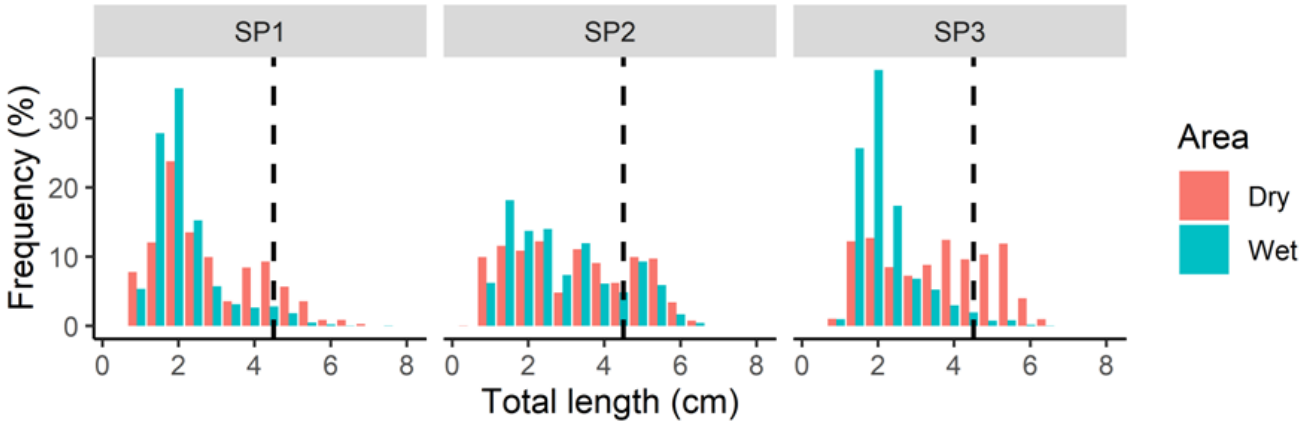

Figure S5. Size-structure of fishery independent surveys catches on Stockton beach in the dry and wet areas in SP1, SP2 and SP3. The dashed vertical line indicates the MLL (i.e., 4.5 cm).

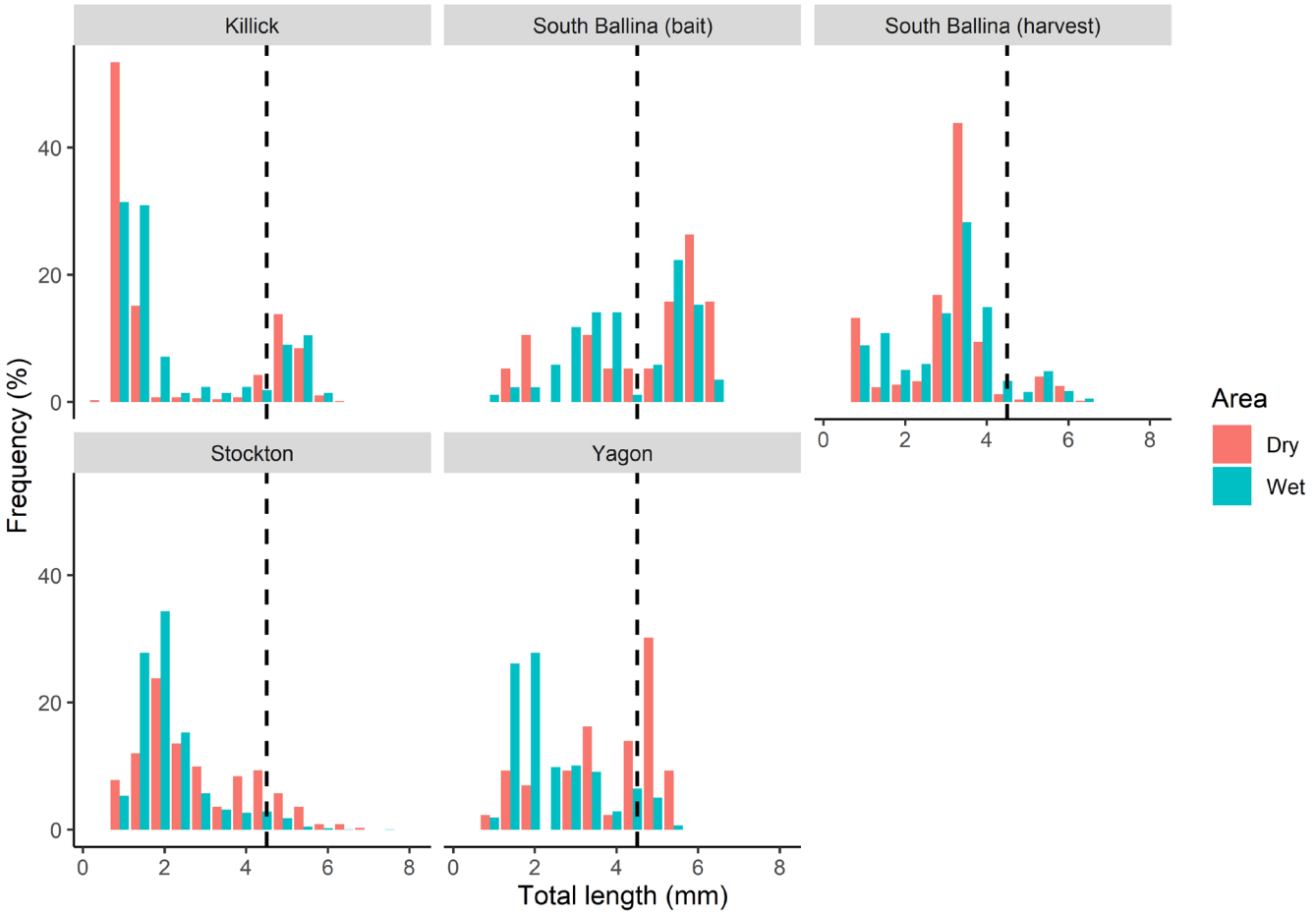

Figure S6. Size-structure of fishery independent survey catches by beach in the dry and swash areas. For south Ballina, catches from the bait only and harvest zones are shown separately. The dashed vertical line indicates the MLL (i.e., 4.5 cm).