Department of Primary Industries
and Regional Development

NSW Stock Status Summary – 2025

Estuary Cockle (*Anadara trapezia*)

Assessment Authors and Year

Taylor, M.D. and Chick, R.C. 2025. Stock Status Summary 2023/24 – Estuary General Fishery (Hand Gathering) – Estuary Cockle. NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 16 pp.

This stock status summary report provides an update to the data series presented in the previous assessment (Chick, 2024), to inform a determination of stock status for the most recent fishing period.

Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Estuary Cockle are currently assessed as **undefined**.

Importantly, this classification is made on the basis that available data from commercial fishing logbook returns is limited and highly uncertain, and does not reflect reports made against usage of Estuary Cockle quota since FY2020, both at the statewide and estuary level, and with catch often unattributed to any specific area. In addition, patterns of catch in some key estuaries are consistent with uncontrolled serial depletion, and/or depleting or depleted components of the stock. These estuary-scale inferences generally contrast with patterns derived from aggregated data at the statewide level.

Stock structure & distribution

Knowledge of genetic population structure is essential for good fishery management that supports sustainable and productive harvests. Yardin (1997) studied genetic variation (using allozyme polymorphism) in the Estuary Cockle across NSW and Victoria — some differences in allele distribution were identified at both fine and broad scales, but no correlation between genetic distance and geographic distance along eastern Australia. Recent work by Taylor *et al.* (202X) applied much more powerful single nucleotide polymorphism (SNP) markers to evaluate genetic structure between Moreton Bay in Queensland and Merimbula Lake in southern NSW, and found no patterns of genetic differentiation among estuaries within this region, suggesting that Estuary Cockle is a genetically homogeneous stock across eastern-Australia. Importantly, the defined genetic homogeneity at these scales does not negate the need to maintain biologically functional stocks (based on variation in other ecological, demographic factors), which may operate at smaller spatial scales.

Scope of this assessment

This stock status summary presents an update of information and results presented in the most recent assessment of the NSW Estuary Cockle stock (Chick, 2024) that aimed to: 1) provide a summary of information regarding stock structure and biology of the Estuary Cockle; 2) summarise available fishery statistics and additional data sources to inform the assessment and aid in the determination of a Total Allowable Catch (TAC) for the 2024/25 fishing season; 3) assess and determine the biological status of the stock NSW; 4) outline information and data limitations and uncertainty in the assessment; and 5) provide comment on the strategic direction for future research and assessment. Assessment of NSW Estuary Cockle is based on a weight-of-evidence approach, as available data do not support the application of a reliable model-based stock assessment at an appropriate spatial scale.

Biology

Estuary Cockle are dioecious, broadcast spawning, bivalve molluscs that form a large component of the macroinvertebrate infauna assemblage in large parts of low-energy estuarine environments throughout the Australian east coast, from Cairns in northern Queensland to the south-eastern regions of Victoria (Dixon, 1975; Yardin, 1997), and also form a small population near Albany in Western Australia (Yardin and Richardson, 1996).

Estuary Cockle are sedentary as adults, typically spawning in late summer, coinciding with increases in water temperature and food availability (Hadfield and Anderson, 1988). Larvae develop in the plankton for up to six weeks, during which time they are likely to disperse from the location of spawning (Yardin, 1997). Larger cockles are more abundant in unvegetated sediments than in vegetated sediments (Wright et al. 2007), and adult cockles provide an important settlement habitat for new recruits. Survival of settled recruits is higher for cockles in vegetated habitats, likely because the vegetation provides a refuge from predation (Gribben and Wright, 2006; Gribben *et al.*, 2009).

Fishery statistics

Catch information

Commercial

Total annual reported commercial harvest of Cockles increased from <1 t to >80 t between FY1985 and FY1994, and peaked at 93.4 t in FY1992 before declining to 30–55 t y^{-1} between FY1995 and FY2002. From FY2003 to FY2009, annual harvest averaged 25 t yr^{-1}, with the lowest annual harvest of 16.3 t recorded in FY2009 (Figure 1). From FY2010 to FY2018, annual reported commercial harvest generally increased from about 30 t y^{-1} to levels among historical highs exceeding 70 t y^{-1}, taken by ~10 authorised fishers (but with harvest volume dominated by <5 fishers). In FY2019, the year immediately preceding the implementation of a TAC, total reported catch was 51.5 t, and from FY2014 to FY2019, the annual harvest increased substantially (Figure 1). Between FY2017 and FY2019, the percentage of reported harvest with no reported hourly effort ($effort_h$) was >50% for each year. In FY2020, this dropped to 9%, returned to 55% and 29% in FY2021 and FY2022,

respectively, and in FY2023 and FY2024 was <1%. Total harvest reported in FishOnline for FY2024 was 30 t, however quota usage reports indicate 34.6 t was taken against a TAC of 35 t (99% of TAC). This suggests continued underreporting of harvest through fisher logbook data, but the magnitude of underreporting appears to be declining (Figure 1). These reporting issues create substantial uncertainty and limit the suitability of data collected through fisher logbooks for assessment of fishery performance and stock status. It is also important to note that the pattern of change in levels of annual reported catch, effort and CPUE for the Statewide fishery are not consistent with patterns at finer (estuary) spatial scales (Chick, 2024). Total harvest reported through quota transactions shows that the TAC has been largely completely utilised during the past 3 fiscal years (Figure 1).

Since at least FY2011, the spatial distribution of commercial harvest has been dominated by five estuaries located within reporting EGF Regions 4, 6 and 7 (Chick, 2024), however reporting of spatial data and the estuary of harvest has been inconsistent through this period. Reporting of spatial data improved in FY2024, but there were still some inaccuracies in spatial reporting (i.e., catch from ocean areas etc). Spatial distribution of catch among estuaries through time has not been consistent (Chick, 2024). In fact, patterns of catch distribution through time continue to support the hypothesis of serial decline among estuaries. Peaks in annual catch, that are between 3.5 and 2.5 times average annual catch levels since FY2010 have occurred sequentially in Pambula Lake (FY2011), Merimbula Lake (FY2015) and Wallis Lake (FY2018). In the Shoalhaven/ Crookhaven River peak catch (17.8 t in FY2019) was ~2 times the average annual catch from FY2010 – FY2024. Further, within 3-5 years of these historical peaks, annual catch in each estuary had declined to historically low levels. In Merimbula Lake and Wallis Lake these declines in catch have occurred whilst measures of catch rate (from data contributed to by >1 fisher) have either been maintained at or fallen below long-term average levels.

Recreational and charter boat

Recreational fishers harvest Estuary Cockle either for personal consumption or for use as bait. Estimates of recreational catch are largely unknown. Information from the National Recreational and Aboriginal fishing Survey completed in 2000/01 (Henry and Lyle, 2003) describes recreational and Aboriginal cultural catches of cockles restricted to the category of 'Bivalves (other)' - consisting of clams (unspecified), Cockles (*Anadara* and *Katelysia* spp.), Cockles – mud and Cockles – unspecified). Since 2013/14, recreational fishing in NSW has been monitored through ongoing surveys of NSW long-term Recreational Fishing Licence (ltRFL) holders and their household members by the Recreational Fisheries Monitoring Program (RFMP). The offsite statewide RFMP survey completed in 2013/14 (West *et al.*, 2015) aggregated any reported harvest of Estuary Cockle into a non-specific 'Other' category. The 2017/18, 2019/20, and 2021/22 surveys included 'Cockles' as a reported "species" (Murphy *et al.*, 2020; Murphy *et al.*, 2022, 2024). The 2017/18 survey generated an estimate suggesting minor recreational harvest of cockles, however the estimate was generated from only a limited number of households and was highly uncertain. Households surveyed in 2019/20 and 2021/22 did not record any recreational catch of cockles. Recent on-site survey data confirmed pulses of recreational harvest of cockles occurring in specific NSW estuaries (Asquith, 2024). Lake Macquarie and Lake Illawarra were surveyed for three months (mostly autumn) in 2024, and while there was negligible harvest in Lake Macquarie, 12,046 individual cockles (equating to ~0.5 tonne) were estimated to have been harvested from Lake Illawarra. Catch estimates were highly variable, with a relative standard error of ~70%). Due to the recreational harvesting of Estuary

Cockle being a comparatively 'niche' and sporadic activity, there are significant challenges associated with estimating recreational harvest using both onsite and offsite survey designs.

Social media postings, of relatively high and increasing levels of recreational catch at various NSW estuaries. The magnitude and/or variation in these levels of harvest have not been quantified. New South Wales Fisheries Compliance information suggests considerable seizure of cockles from fishers exceeding bag limits (see Illegal, Unregulated and Unreported fishing).

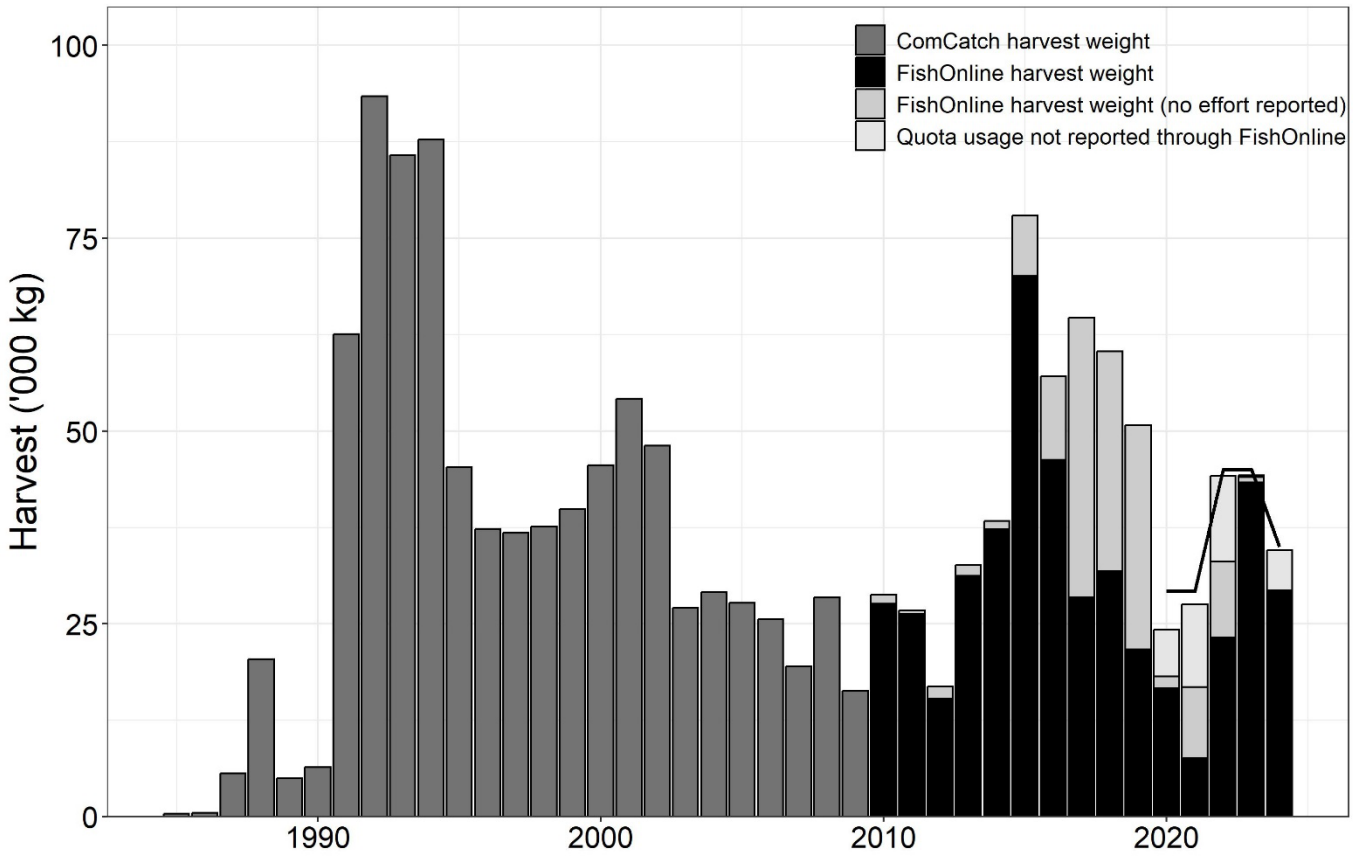

Figure 1 Total annual Estuary Cockle harvest reported for the Estuary General Fishery within NSW from FY1985 – FY2024. Data derived from different catch reporting systems (ComCatch and FishOnline) are indicated in the figure legend, as are harvest volumes which had no effort reported, or were only evident in quota usage reports (and not fisher logbook data). Annual TAC is shown as a solid black line (since FY2020)

Indigenous

Estuary Cockle are a notable species identified in Aboriginal middens in NSW (4.5% of species in middens at 13 locations in NSW), suggesting that they contributed an important food source for Indigenous people in south-east Australia, at least within the last 3,000 years (Schnierer and Egan, 2016). Further, descriptions of the use of cockles as a preferred burly/bait by Aboriginal people fishing in Port Jackson, NSW are provided by Attenbrow (2010), citing records published in the late 1700's.

The benefits (and costs) of fishing to the cultural, broader social, health, wellbeing and prosperity of Indigenous people and communities are substantial (Voyer *et al.*, 2016). Schnierer and Egan (2012) described a case study in NSW of the impact of management changes on the viability of Indigenous

commercial fishers and the contribution commercial fishing and aquaculture makes to Indigenous communities. Included in this case study were estimates of the contribution Indigenous commercial fishers make to Indigenous communities, including the contribution of between 5% - 20% of their annual commercial catch. The contribution made to Indigenous communities by commercial fishers was, on average, 9.8% of annual catch and the contribution from broader Indigenous commercial fishers was greater than that made by fishers in the EGF, with this being a consequence of hand gathering being a "…traditional skill that is widely practiced by coastal families so they can fulfil their own needs." (Schnierer and Egan, 2012). Moreover, Schnierer and Egan (2012) report substantial harvests of hand gathered species (principally Pipi) by Indigenous fishers that were either not reported in commercial catch records nor reported as 'other' species and went unrecorded as species-specific catches and were utilised for personal and community use.

Cockles have been harvested by Indigenous people in the Tweed region for many generations. In a survey based in the Tweed region (Schnierer, 2011; Schnierer and Egan, 2016), annual catch by Indigenous fishers was estimated to be between 731 and 1,810 Cockles. Based on logbook data from 2010 in the Tweed region, cockles were listed as an important species but were not among the top-10 culturally most important species. Schnierer (2011) reports that the total effort of the Indigenous fishery in the Tweed region was 542 hours or 92 days. Cultural catch of cockles was seen to be important in delivering benefits to the community. The most recent survey of cultural fishing in NSW evaluated Aboriginal fishing in the Birpai Barray (Hastings River) region, but no cockles were reported to be harvested over the 12 month survey period (Ochwada-Doyle *et al.*, 2025).

Illegal, Unregulated and Unreported

The level of total Illegal, Unregulated and Unreported (IUU) fishing has not been quantified.

There are anecdotal reports of IUU fishing occurring in several estuaries, related to commercial fishers misreporting and recreational fishers exceeding bag limits or fishing without a licence. NSW Fisheries Compliance provide annual summaries of seizures of fish and invertebrates due to non-compliance (https://www.dpi.nsw.gov.au/fishing/compliance/fisheries-compliance-enforcement). These reports indicate that cockles have had the greatest numbers of animals seized annually from FY2012 to FY2023 (no public report is available for FY2024). Annual seizures have ranged between 8,897 and 25,110 individual cockles (the equivalent to ~371 kg – 814 kg in any year). Notably, during FY2022, NSW Fisheries Compliance conducted operation 'DPI Zulu 21' between September 2021 and April 2022, targeting illegal take of cockles and whelks from Lake Illawarra.

Fishing effort information

During the period FY1985-FY1997 fishers were required to report their catch monthly and effort (in days fished) by gear type, not linked to catch unless only a single gear type was used (and then not even linked to species catch within a gear type). Therefore, prior to FY1998, reported fisher-days attributed to hand gathering within the EGF cannot be specifically allocated to harvest of a particular species, and reflects the total fisher-days reported for hand gathering by the fisher for each month where one method was reported and the species of interest was also reported in that month. Effort in fisher-days ($effort_d$) increased from <50 days (FY1985–FY1991) to 205 days in FY1994, before declining to <50 days again in FY1997 (Figure 2). In FY1998, 292 days were fished. $Effort_d$ increased to 452 days by FY2001, and decreased to 304 days over the following two years

before increasing again to the maximum recorded level of 850 days in FY2006, and subsequently declining each year to 302 days in FY2009. The substantial changes in days fished from pre-FY1998 and later periods were concurrent with changes to commercial fishery reporting requirements described above. As such, substantial changes in $effort_d$ are not solely indicative of changes in effort targeted at Estuary Cockle. Rather, the peaks in effort likely reflect changes in effort to catch other species (likely Pipis) by the same fishing method, while also harvesting cockles in the same month. Therefore, $effort_d$ reported each month by hand gathering has been attributed to each species reportedly harvested that month (including Estuary Cockle). In FY2010, $effort_d$ was 264 days, and the number of days fished generally increased to a recent peak of 514 days in FY2015, coinciding with a similar peak in catch. Over the last 10 years $effort_d$ had oscillated, including a 20-year low of 89 days in FY2021 (which coincided with >70% of catch being reported with no effort, or with no logbook records submitted, Figure 1). In FY2022, $effort_d$ more than doubled from FY2021 to 215 days and in FY2024 was 231 days (Figure 2). The sustained increase in effort coincided with the quota increase from 29.2 t to 45 t, for FY2022 and FY2023 (Figure 1). These figures belie the fact that much of the reportedly used quota (and its associated effort) has not been reported in fisher logbooks (Figure 1).

Effort in fisher-hours ($effort_h$) has similarly oscillated since FY2010, peaking in FY2015. The percent of reported catch with no reported $effort_h$ was >50% in FY2017, FY2019, and FY2021, but this has decreased in recent years. To provide an estimate of recent $effort_h$ per year for reported catch, average annual hours of daily effort across the fishery were assigned to records with no effort reported in that year. These data follow a roughly similar pattern, with a peak in FY2015 exceeding 1,500 fisher-hours, which was largely maintained through to FY2018. Despite a reduction in records with no reported effort in recent years (and the convergence of the two series, Figure 2), discrepancies between quota transactions and fisher logbook reports (Figure 1) highlight that there is still likely to be substantial effort that is unaccounted in the records available.

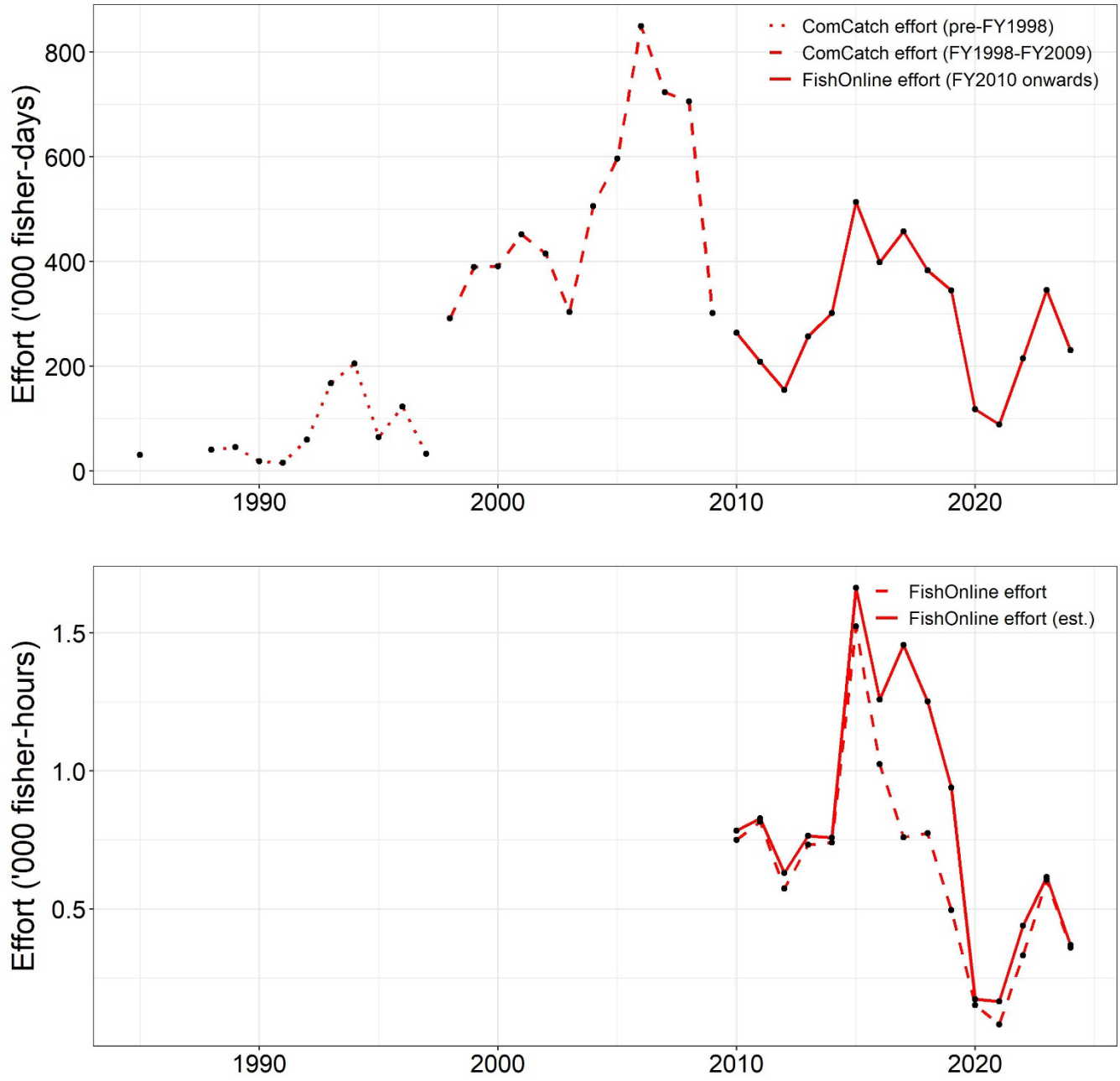

Figure 2 Total annual hand-gathering effort reported against Estuary Cockle harvest in the Estuary General Fishery within NSW from FY1985 – FY2024, reported as fisher-days (upper panel) and fisher-hours (lower panel). Fisher-hours is only available for the FishOnline series (post-FY2010), and is presented as two series calculated using: (1) only records where hourly effort data was reported, and (2) all records, with missing hourly effort records estimated (as described in the text).

Catch rate information

Catch per fisher-day ($CPUE_d$) is a problematic metric to define and interpret prior to FY2010, for reasons outlined for the $effort_d$ time series. Nonetheless, $CPUE_d$ fluctuated substantially between FY1985 and FY1995, ranging between 9 and 151 kg d^{-1}, with low rates possibly reflecting drivers of catch and effort other than abundance (as described for $effort_d$; Figure 3). $CPUE_d$ increased from 77 kg d^{-1} in FY1998, to 116 kg d^{-1} in FY2002, then decreased each year until FY2007, reaching 24 kg d^{-1}. Relatively low $CPUE_d$ throughout the mid-2000s is likely a function of EGF days fished being

allocated to relatively low catches of Estuary Cockle per month, where Cockles and other species (likely Pipis) were potentially caught by the same method in the same month, in addition to likely reductions in Estuary Cockle abundance from periods of high harvest in the 1990s and early 2000s (Figure 3). Thus, interpretation of changes in catch rate are complicated by challenges in defining targeted fishing effort and any changes in abundance during this time. $CPUE_d$ has remained comparatively stable from FY2015 to FY2024, oscillating around a geometric mean of ~150 kg d^{-1}. These oscillations have increased in magnitude since FY2020, possibly due to comparatively tumultuous environmental conditions over this period (Ochwada-Doyle *et al.*, 2024), and have remained slightly lower than the 10-year average for the last two years. Statewide patterns in $CPUE_d$ do not consistently represent patterns at finer spatial scales (i.e., estuaries) which may be due to serial depletion among estuaries, as discussed elsewhere (Chick, 2024).

Trends in catch per fisher-hour ($CPUE_h$) largely mirrored each other for the two series calculated (reported data only, and with missing hourly effort records estimated, Figure 3). $CPUE_h$ increased considerably in FY2020 to ~125 kg h^{-1}, but this coincided with the introduction of the TAC and the commencement of effort reporting for some fishers who had irregularly reported effort within the previous 3-4 years (prior to FY2020, $CPUE_h$ had been ~50 kg h^{-1} or less. Notably, uncertainty surrounding estimated mean $CPUE_h$ has increased in recent years (Figure 3), coinciding with fewer active fishers reporting catch (likely due to changes in fishery operations and/or implementation of the TAC). Nonetheless, $CPUE_h$ has remained above the 10-year average for the past 5-years, for both series.

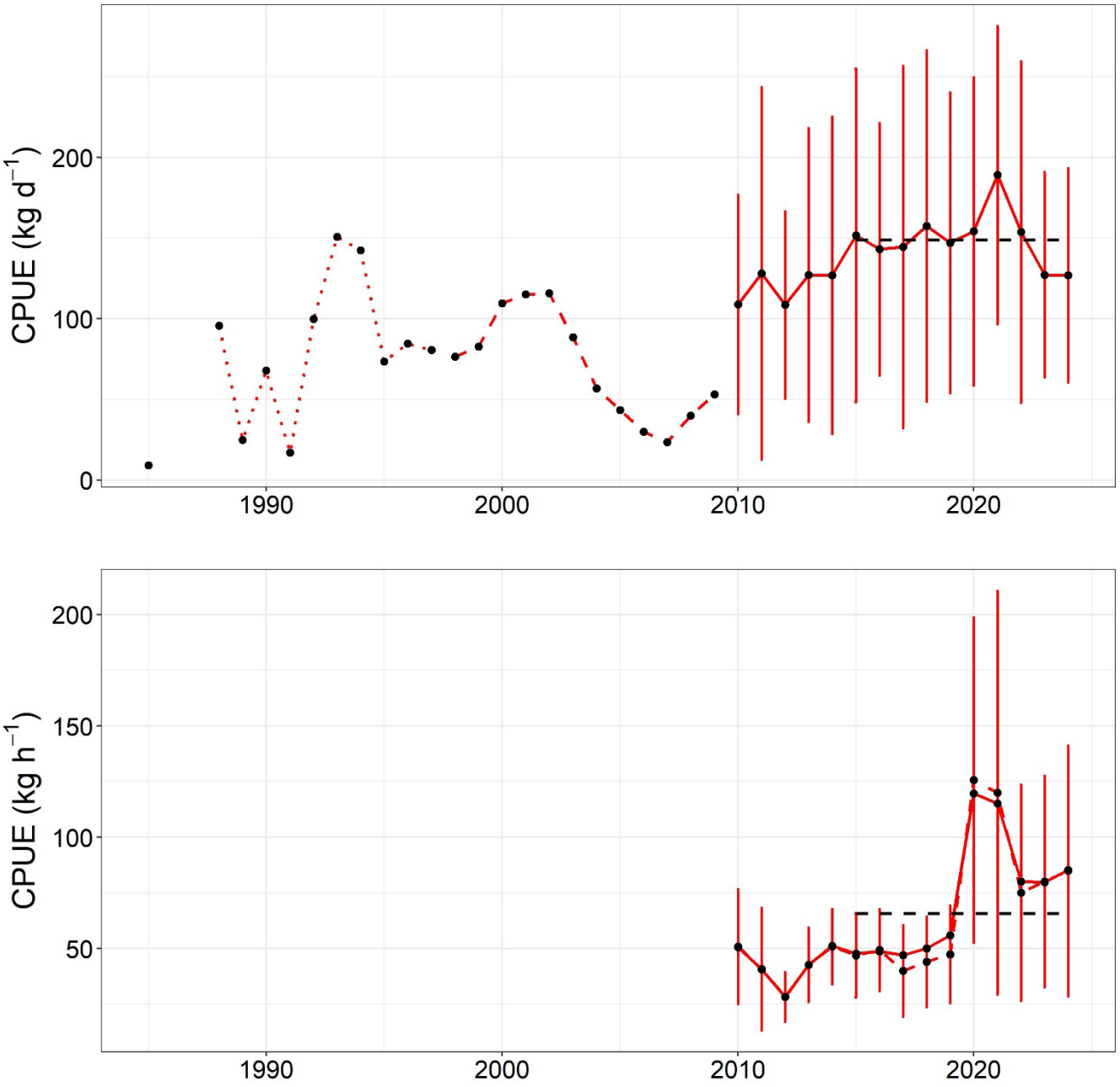

Figure 1. Average annual Estuary Cockle catch-per-fisher-day ($CPUE_d$, upper panel) from FY1985 – FY2024, and catch-per-fisher-hour ($CPUE_h$, lower panel) from FY2010 – FY2024, aggregated and calculated at the statewide (NSW) level. Error bars reflecting 1 standard deviation of the mean are included for the latter FishOnline series (FY2010 – FY2024). Legends for both panels are as for Figure 2. The horizontal black dashed line indicates the most recent 10-year geometric mean.

Stock Assessment

Stock Assessment Methodology

Year of most recent assessment:

2024 (using data to the end June 2024)

Assessment method:

Assessment of the NSW Estuary Cockle stock is based on a weight-of-evidence approach. This is done as the available data do not support a model-based stock assessment.

Main data inputs:

- Commercial harvest by NSW EGF for the period FY2010 to FY2024
- Nominal Estuary Cockle statewide commercial catch rate ($CPUE_d$) in the NSW EGF for the period FY1985 to FY2024
- Nominal Estuary Cockle commercial catch rate ($CPUE_h$) in the NSW EGF for the period FY2010 to FY2024
- Harvest by the NSW Recreational Fishery in the periods 2000/01, 2013/14, 2017/18, 2019/20, and 2021/22

Data interpreted at statewide and estuary scales.

Key model structure & assumptions:

No model-based quantitative assessment was undertaken.

Sources of uncertainty:

General data limitations and uncertainty was considered in the weight-of-evidence approach.

Defining the status of the Estuary Cockle resource with any level of reasonable certainty is not possible due to various issues primarily relating to the unavailability and/or inaccuracy of available data, from all fishing sectors.

Since FY2010, commercial fishery statistics from mandatory logbook reporting in the NSW EGF are incomplete and reported data have high levels of uncertainty including discrepancies between quota usage and catch from logbooks, logbook catch with no complementary effort data and inaccurate spatial reporting. The scale of these problems is substantially larger than for other hand gathered species within the NSW EGF. Uncertainty in these data is further exacerbated by fewer active commercial fishers contributing to fishery-dependent data since FY2018. Of these fishers, some (active since at least FY2010) have either inconsistently or not reported effort for a number of years or have, in recent years, regularly reported relatively very low (seemingly erroneous) levels of effort (≤1 h) for levels of catch that previously had reported substantially greater effort. These data are not excluded from the limited data available, yet they substantially influence measures of catch

rate, and result in more recent measures substantially greater than those previously reported. Similarly, these inconsistencies and associated uncertainties are continued, and often magnified at the estuary scale. Since at least FY2010 the majority (>90%) of annual harvest has been from five NSW estuaries (Chick, 2024), with the exception of reporting since FY2022 where estuary data has not been reported for a substantial proportion of the harvest. However, patterns of catch and effort within the five estuaries that most often support harvest do not reflect patterns at the whole fishery scale. It is unlikely that logbook returns of daily fishing activity accurately represent total levels and there is high uncertainty surrounding the representativity of derived fishery-dependent measures (e.g., catch rate) to assess fishery and stock performance.

There are no recreational or cultural fishing data available to quantify the levels of harvest from these fishing sectors. However, anecdotal evidence and limited studies describing small-scale spatial and temporal patterns of fishing by some sectors of the fishery indicate that fishing activities, other than commercial fishing, do contribute to fishing mortality for Estuary Cockle, particularly at a local scale.

Similarly, it is not possible to quantify the level of IUU catch. The level of IUU fishing, or its detection varies throughout the spatial distribution of the stock, with evidence of high and increasing IUU catch at local scales over relatively short periods of time (DPI unpublished data).

Factors other than fishing, including environmental factors, likely affect changes in the abundance and biological functioning of Estuary Cockle through time, and at spatial scales that likely vary through time. There are a variety of studies that have investigated the effects of environmental changes on Estuary Cockle, including heavy metal contamination and freshwater influx. Further, it is likely that environmental factors would affect the productivity of these populations through time. Understanding the interaction of these factors with the effects of fishing will be important in informing the role of fishing in influencing the abundance of Estuary Cockle. Further, market disruptions (e.g., as a consequence of the COVID-19 pandemic) and other associated social impacts (Ogier *et al.*, 2023) are not well known and the impact of these extraneous factors on this assessment has not been assessed.

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	None specified This assessment used a weight-of-evidence approach, with data including: • Nominal $CPUE_d$ (statewide) • Nominal $CPUE_h$ (statewide)
Biomass Limit Reference Point	None specified
Biomass Target Reference Point	None specified
Fishing mortality indicator or proxy	None specified This assessment used a weight-of-evidence approach, with data including:

	• Harvest (commercial only; statewide, and estuary, where available)
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

The status of the NSW Estuary Cockle stock remains classified as **undefined**, both in terms of the levels of biomass depletion and fishing mortality.

This classification is made because available but limited data from commercial fishing logbook returns does not reflect the harvest volume identified through quota transactions (~34.56 t) for FY2024. The available data shows patterns of catch in some key estuaries are consistent with serial depletion and likely depleting or depleted local stocks. Estuary scale inferences derived from available data generally contrast with indices calculated from statewide aggregates.

The classification is consistent with the Status of Australian Fish Stocks (SAFS) framework, adopted to inform NSW stock status determinations from 2018, and that of previous assessments (Chick, 2018, 2020, 2021, 2022, 2024). The assessment has been, and remains reliant on fishery-dependent data (i.e., logbook reported fishing activity) including daily catch and effort and derived measures, and spatial reporting to areas defined in the logbook or accurate and precise latitude and longitude). There are no quantitative, relative or absolute measures of recreational fishery activity for NSW Estuary Cockle or trends in IUU fishing. Similarly, despite Estuary Cockle being an important species for cultural fisheries and contributing an important food source for 1000's of years, there is little quantitative information to describe recent spatial and temporal trends in harvest.

A weight-of-evidence approach has been taken to assess NSW Estuary Cockle. This evidence includes:

i) a limited understanding of the species biology and impacts of environmental variability;

ii) high uncertainty in the commercial fishery data, particularly over the last 6-7 years (including no reported harvest for an average of 30% of the reportedly used quota since FY2020; logbook returns of reported fishing activity with no $effort_h$ reported for an average of 28% of the reported harvest over the last 10 years, and inadequate spatial reporting);

iii) discontinuity in the time series of commercial effort data over the history of the fishery;

iv) fishery-dependent, estuary-scale data, available from FY2010, are noisy (low number of fishers) and incomplete. Despite this, patterns of reported data in some of the top estuaries (by catch) support an inference of serial depletion and depleting or depleted local stocks. Together with generally low levels, or no catch from key estuaries (despite most recent levels of $CPUE_h$ at or above long-term averages), these changes in the distribution of catch and the vast records with inadequate spatial reporting contribute increasing uncertainty to the distribution of commercial catches and status of the stock;

v) limited information on the volume and distribution of recreational harvest;

vi) unknown levels of cultural harvest; and

vii) unquantified levels of illegal, unregulated and unreported fishing.

These lines of evidence identify substantial uncertainty in interpreting possible change in fishery and stock performance indicators, and limited confidence in inferring change in biomass and fishing mortality using available data. This prevents determination of any stock status other than undefined.

Stock Assessment Result Summary

Biomass status in relation to Limit	Weight-of-evidence provided is insufficient to inform the level or trend in biomass.
Biomass status in relation to Target	Not assessed.
Fishing mortality in relation to Limit	No fishing mortality limit has been set. Weight-of-evidence provided is insufficient to inform the level or trend in fishing mortality.
Fishing mortality in relation to Target	Not assessed
Current stock status	**Undefined**

Fishery interactions

Fishing for Estuary Cockle in the EGF is done with hand collection of individuals. There are limited, if any, interactions with other fisheries. Estuary Cockle inhabit seagrass habitat in addition to sandy/muddy habitats and there is anecdotal evidence of fishers (from all sectors) interacting with seagrass habitat. There are no recorded interactions with TEPS or other protected habitats.

Stakeholder engagement

EGF stakeholders with hand gathering endorsements were invited to participate in online presentations of fishery assessments for Pipi, Estuary Cockles, Beachworms and Nippers on 6 March 2025. Unfortunately, no stakeholders directly involved in the harvest of Cockles attended. Commentary from other EGF stakeholders surrounding Estuary Cockle suggested: 1) the current allocation of quota among quota holders limits the ability of some holders to target the species, and leasing quota was difficult; and 2) that some industry members had significant concerns about IUU catch, and were also concerned about the volume of biomass that could be taken by cultural and recreational fishers.

Qualifying Comments

Since the regular production of stock assessment reports (Chick, 2018), uncertainties and limitations in the reported commercial fishery data have been highlighted and these remain the primary source of uncertainty in the assessment and for the determination of an undefined stock status. That substantial uncertainties and limitations continue in the reporting of commercial fishery data in FY2024, it is unlikely that stock status will change within the next 3-5 years, if the assessment relies solely only on commercial fishery data. It is only through continued and more reliable, thorough, and timely reporting of commercial fishery data, and/or the development of alternate data sources that regularly and reliably inform the assessment (e.g. fishery independent data) that a stock status determination will change, and only after a sufficient time-series of such data has built. Given statements from the NSW Total Allowable Fishing Committee (TAFC 2023) including "Any increase in the TACC cannot be contemplated given the highly uncertain stock assessment", the onus is on fishing business owners to ensure complete and accurate logbook data are recorded and reported, to reduce uncertainty in the assessment, and support a stock status determination other than undefined.

A precautionary interpretation of the available data - including, persisting low catches in historically important estuaries and data in FY2022 and FY2024 demonstrating a high and increasing proportion of commercial catch from 'Other' estuaries, or from 'unknown' (not reported) areas, compounded by likely high levels of recreational harvest at local scales, and reported IUU harvest - supports the inference that stocks in key estuaries remain unable to support the catch contribution they previously made to historical catch levels. Continued uncertainty, and particularly increased levels of uncertainty may support further precautionary approaches to the management of Estuary Cockle. Precautionary harvest levels are below those demonstrably capable of being sustained whilst supporting an ongoing stock status of 'sustainable', informed by reliable indicators and reference levels of biomass and fishing mortality. Quota usage reports since FY2020 indicate most of the TAC is being harvested each year. However, the time series of uncertain and unreported data that continues and necessitates the stock status of 'undefined' (both in terms of the level of biomass and fishing mortality), by definition, indicates there is insufficient information to reliably inform a status of sustainable.

DPIRD Fisheries is leading the research project *Maintaining productivity and access to Estuary Cockle across sectors through improved science-based decision making* (FRDC 2021-003). The project includes objectives to define stock structure, characterise basal population parameters (size structure, age, growth mortality, reproduction) and characterise spatial and temporal patterns in biomass and recruitment and undertake a pilot study to assess recreational fishing in Lake Illawarra and Lake Macquarie. Outputs from this project will reduce some important knowledge gaps to inform an assessment. Further, these outputs will inform investment opportunities for fishery stakeholders to secure an ongoing data monitoring and assessment strategy that could support an assessment to determine a stock status, other than undefined, and inform a harvest strategy. Such a strategy would describe objectives and define levels of stock and fishery performance and provide transparency and greater certainty in management decisions to meet the objectives of the strategy, including data requirements, TAC determination and recreational harvest controls (e.g., bag limits), and likely increase the value and productivity of the resource (and associated shares in the commercial fishery).

References

Asquith R.A. (2024) *Quantifying the recreational harvest of Sydney Cockle (Anadara trapezia) in NSW estuaries*. University of Wollongong, Wollongong, 74 pp.

Attenbrow V. (2010) Aboriginal fishing on Port Jackson, and the introduction of shell fish-hooks to coastal New South Wales, Australia. In: D. Lunney, P.A. Hutchings & D. Houchuli (eds.) *The Natural History of Sydney*. Royal Zoological Society of NSW, Mosman, NSW, Australia, 16-34.

Chick R.C. (2018) Stock status summary and stock assessment report - Estuary General Fishery (Hand Gathering) – Estuary Cockle (*Anadara trapezia*). 47 pp.

Chick R.C. (2020) Stock assessment report 2019 – Estuary General Fishery (Hand Gathering) – Estuary Cockle (*Anadara trapezia*). 53 pp.

Chick R.C. (2021) Stock assessment report 2020/21 – Estuary General Fishery (Hand Gathering) – Estuary Cockle (*Anadara trapezia*). 47 pp.

Chick R.C. (2022) Stock assessment report 2021/22 – Estuary General Fishery (Hand Gathering) – Estuary Cockle (*Anadara trapezia*). 49 pp.

Chick R.C. (2024) Stock assessment report 2022/23 Estuary General Fishery (Hand Gathering) - Estuary Cockle (*Anadara trapezia*). 40 pp.

Dixon P.I. (1975) *The ecological genetics of Anadara trapezia with particular reference to its haemoglobin*. 364 pp.

Gribben P.E. & Wright J.T. (2006) Invasive seaweed enhances recruitment of a native bivalve: roles of refuge from predation and the habitat choice of recruits. *Marine Ecology Progress Series* **318,** 177-185.

Gribben P.E., Wright J.T., O'Connor W.A., Doblin M.A., Eyre B. & Steinberg P.D. (2009) Reduced performance of native infauna following recruitment to a habitat-forming invasive marine alga. *Oecologia* **158,** 733-745.

Hadfield A. & Anderson D. (1988) Reproductive cycles of the bivalve molluscs *Anadara trapezia* (Deshayes), *Venerupis crenata* Lamarck and *Anomia descripta* Iredale in the Sydney region. *Marine and Freshwater Research* **39,** 649-660.

Henry G.W. & Lyle J.M. (2003) The national recreational and indigenous fishing survey. 188 pp.

Murphy J.J., Ochwada-Doyle F.A., West L.D., Stark K.E. & Hughes J.M. (2020) Survey of recreational fishing in NSW, 2017/18. 208 pp.

Murphy J.J., Ochwada-Doyle F.A., West L.D., Stark K.E., Hughes J.M. & Taylor M.D. (2022) Survey of recreational fishing in NSW, 2019/20. 80 pp.

Murphy J.J., Ochwada-Doyle F.A., West L.D., Stark K.E., Hughes J.M. & Taylor M.D. (2024) Survey of recreational fishing in NSW, 2021/22. 66 pp.

Ochwada-Doyle F.A., Lowry M.B., Murphy J.J., Taylor M.D., Fairfull S., Bevalaqcua C., Barnes S., Barnes M., Hindman S., Campbell A.B., Slater K., Obrien K., Donovan A. & O.'Brien W. (2025) Pilot Assessment of Cultural Fishing in Birpai Barray (Hastings) Local Management Plan. 33 pp.

Ochwada-Doyle F.A., Miles N.G., Hughes J.M., Murphy J., Fowler A., Lowry M.B. & Taylor M.D. (2024) Exploring spatio-temporal changes in coastal recreational fisheries and potential links to extreme weather events. *PLoS ONE*, accepted 25 May 2024.

Ogier E.M., Smith D.C., Breen S., Gardner C., Gaughan D.J., Gorfine H.K., Hobday A.J., Moltschaniwskyj N., Murphy R., Saunders T., Steer M. & Woodhams J. (2023) Initial impacts of the COVID-19 pandemic on Australian fisheries production, research organisations and assessment: shocks, responses and implications for decision support and resilience. *Reviews in Fish Biology and Fisheries* **33,** 513-534.

Schnierer S. (2011) Aboriginal fisheries in New South Wales: determining catch, cultural significance of species and traditional fishing knowledge needs 89 pp.

Schnierer S. & Egan H. (2012) Impact of management changes on the viability of Indigenous commercial fishers and the flow on effects to their communities: Case study in New South Wales. 104 pp.

Schnierer S. & Egan H. (2016) Composition of the Aboriginal harvest of fisheries resources in coastal New South Wales, Australia. *Reviews in Fish Biology and Fisheries* **26,** 693-709.

Taylor M.D., Chick R.C. & Subramanian S. (202X) Basal stock structure of *Anadara trapezia* along eastern Australia. *In preparation for submission to Marine and Freshwater Research*.

Voyer M., Barclay K., McIlgorm A. & Mazur N. (2016) Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries: Valuing Coastal Fisheries. 208 pp.

West L.D., Stark K.E., Murphy J.J., Lyle J.M. & Ochwada-Doyle F.A. (2015) Survey of Recreational Fishing in New South Wales and the ACT, 2013/14. 150 pp.

Yardin M.R. (1997) *Genetic variation in Anadara trapezia (Sydney cockle): implications for the recruitment of marine organisms*. Doctor of Philosophy, University of Western Sydney, 374 pp.

Yardin R.M. & Richardson J. (1996) Status of *Anadara trapezia* (Deshayes)(Bivalvia: Arcoida) from Oyster Harbour, Albany (Western Australia) as compared with east Australian populations. *Records of the Western Australian Museum* **18,** 121-127.