# Stock Status Summary – 2021/22

NSW Stock Status Summary – Estuary Cockle (*Anadara trapezia*)

## Assessment Authors and Year

Chick, R.C. 2022. NSW Stock Status Summary 2021/22 – Estuary Cockle (*Anadara trapezia*). NSW Department of Primary Industries, Fisheries. 10 pp.

## Stock Status

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

Importantly, this classification is made primarily due to a lack of reported commercial fishery data in recent years and whilst understanding that available but limited data from an increasing number of estuaries indicate possible serial depletion and likely depleting or depleted local stocks, with this understanding generally in contrast with state-wide measures that compose the aggregate of available finer scale data.

This stock status summary outlines the more detailed information available in the NSW stock assessment report for Estuary Cockles (Chick 2022).

## Stock structure & distribution

The stock structure of Estuary Cockles is likely a complex of populations, functioning at a local (estuary) scale. This understanding is largely based on known biology and the reported genetic structure reported by Yardin (1997). Yardin (1997) studied genetic variation in the Estuary Cockle (*A. trapezia*) and sampled from populations across macro (1000 km), intermediate (within estuaries) and micro (within patches - 50 m to 6 km – within estuaries) scales within NSW and Victoria, from Tweed River estuary, Wallis Lake, Hawksbury River, Burrill Lake and Corinella (Western Port Bay, Victoria). That study identified significant differences in the genetic structure of populations among the six sites sampled. Further, finer spatial scale sampling at sites within the Hawkesbury River showed complex patterns of genetic variation within the 6 km area sampled (including at scales <100s m). Yardin (1997) concluded that, despite the high potential for gene flow through larval dispersal and panmixis at small and large scales, there is a high degree of heterogeneity among populations, even at a local scale, and the complex population structure is likely supported by discrete ecological processes and the ability of larvae to remain together through to settlement. Given this understanding of population structure, Yardin (1997) commented that management strategies that assume broad-scale biologically functional populations may lead to the depletion of local populations.

## Biology

Cockles 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, cited in Yardin 1997), and form a small population near Albany in Western Australia (Kendrick and Wilson 1959, cited in Yardin 1997; Yardin and Richardson 1996).

Cockles 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, with likely active dispersal (larval behaviour affecting dispersal; Yardin 1997). Cockles are more abundant in unvegetated (bare) habitat than in sediment inhabited by seagrass (Wright et al. 2007). Recruitment of Cockles is positively influenced by the presence of conspecific adults, with recruits showing a preference to settle on adult conspecifics than on alternate substrates provided by locally occurring vegetation (seagrass). However, recruit survival in vegetated habitat is greater than on adults in bare habitat, 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 catches of Cockles increased from <1 t to >80 t between 1984/85 and 1993/94, peaked at 93.4 t in 1991/92 and declined to 30–55 t.yr$^{-1}$ between 1994/95 and 2001/02. From 2002/03 to 2008/09, annual catches averaged 25 t.yr$^{-1}$, with the lowest annual catch of 16.3 t recorded in 2008/09. From 2009/10 to 2017/18, annual reported commercial catches generally increased from about 30 t.yr$^{-1}$ to levels among historical highs and ≥70 t.yr$^{-1}$, harvested by ~10 fishers (Figure 1). In 2018/19, the year immediately preceding the implementation of a TAC, total reported catch was 51.5 t, harvested by 10 authorised fishers. Importantly, for assessment purposes, from 2013/14 to 2018/19, the annual catch and percent of total catch with no reported hourly effort (effort$_{hr}$) increased substantially (Figur1 1). Between 2016/17 and 2018/19, the percentage of reported catch with no effort$_{hr}$ was >50% for each year. In 2019/20, this dropped to 9%, but returned to 55% in 2020/21. Importantly, total reported catch in 2020/21 was 16.8 t. This is in contrast with the 2020/21 TAC of 29.2 t and public reporting (as of 28 June 2021) of 94.7% of the quota having been reportedly used (i.e. 27.7 t; NSW DPI Fisheries 2021). Together the reported catch data (16.8 t) and quota usage data (27.7 t) indicate it is highly unlikely that fisher monthly logbook returns of daily fishing activity (i.e. reported data including catch and effort) presented in this report, accurately represent the total levels of catch and effort and there is high uncertainty if derived fishery-dependent measures are representative of the broader fishery used to assess fishery performance and stock status for the 2020/21 fishing period. It is also notable that the pattern of change in the levels of annual catch for the state-wide fishery are not consistent with patterns of catch at finer spatial scales (estuaries).

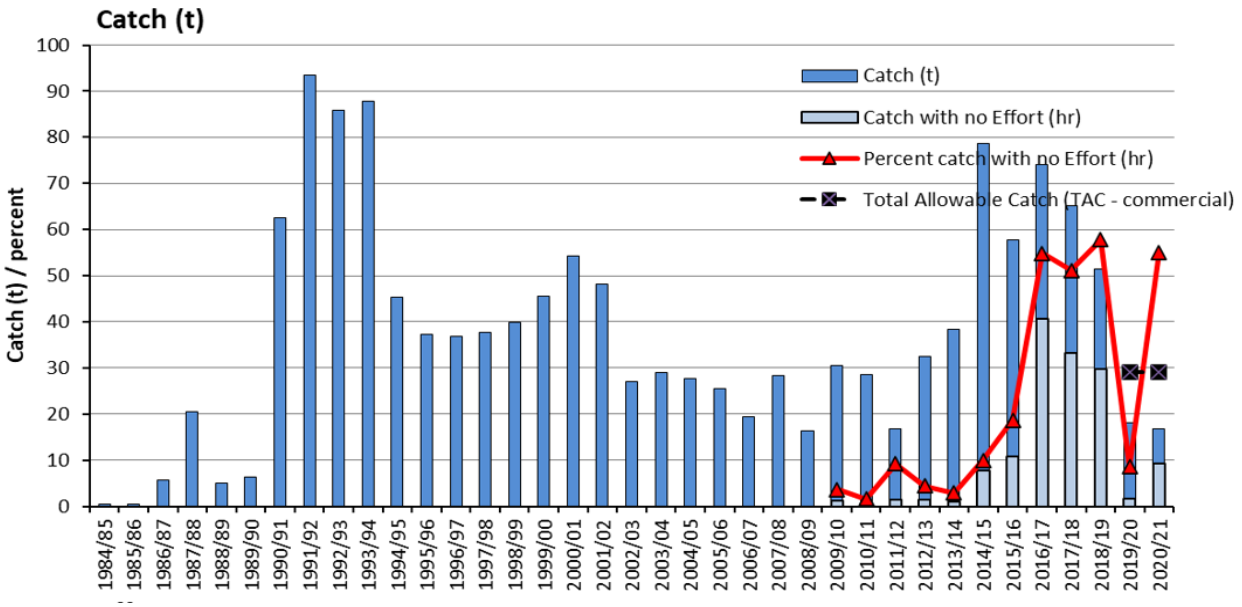


Figure 1. Total annual commercial catch (t) and catch with no reported effort of Estuary Cockles from 1984/85 to 2020/21.

Since at least 2009/10, the spatial distribution of annual commercial catches has been dominated by catches from five estuaries located within Regions 4, 6 and 7. Peaks in annual catch, that are three times average annual catch levels since 2009/10 in each estuary have sequentially occurred in Pambula Lake (2010/11), Merimbula Lake (2014/15) and Wallis Lake (2017/18). Further, within 3-5 years of these historical peaks, annual catch in each Estuary has declined to at or among 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 & Charter boat

Recreational fishers harvest Cockles either for personal consumption or for use as bait. Estimates of recreational catch are unknown. Information from The National Recreational and Indigenous Fishing Survey completed in 2000/01 (Henry and Lyle 2003) describes recreational and Indigenous catches of Cockles restricted to the category of 'Bivalves (other)' - consisting of clams (unspecified), Cockles (*Anadara* and *Katelysia* spp.), Cockles – mud and Cockles – unspecified). The NSW state-wide recreational fishing survey completed in 2013/14 (West et al. 2015) further limited the categorisation of recreational catch of Cockles into a more diverse category i.e. 'Other taxa'. The most recent NSW state-wide recreational fishing survey (2017/18; Murphy et al. 2020) did identify Cockles as an optional self-reported species. Further, the 2017/18 sampling frame resulted in an estimate for the state-wide recreational harvest of Cockles of ~10 kg. There is anecdotal evidence of relatively high levels of recreational harvests of Cockles from specific NSW estuaries. As such, this state-wide estimate underrepresents the actual recreational harvest and is likely a function of this species being a relatively niche species for recreational fishers and highlights some of the challenges these types of species pose for such large-scale surveys.

## Indigenous

Estuary Cockles are a notable species identified in Aboriginal middens in NSW (4.5% of species in middens at 13 locations in NSW), supporting the understanding that they contributed an important food source for Indigenous people in south-east Australia, at least within the last 3000 years (Schnierer and Egan, 2016).

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 1810 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.

### Illegal, Unregulated and Unreported

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

There are anecdotal reports of IUU fishing occurring at the scale of estuaries, related to commercial fishers misreporting and recreational fishers exceeding bag limits or fishing without a licence. Further, NSW Fisheries Compliance provide annual summaries of seizures of fish and invertebrates due to non-compliance. These reports indicate regular seizures of Cockles each year from 2010/11 to 2019/20 (most recent report), ranging between 8 897 and 25 110 individual Cockles. In 2019/20, 24,543 Cockles were seized due to non-compliance (https://www.dpi.nsw.gov.au/fishing/compliance/fisheries-compliance-enforcement).

## Fishing effort information

### Commercial

Effort in days fished ($Effort_{dy}$) increased from <50 days (1984/85–1990/91) to 205 days in 1993/94, before declining to <50 days again in 1996/97. During this period fishers were required to report their catch monthly and effort (days) by gear type, not linked to catch unless only a single gear type was used and then not linked to species catch. Therefore, prior to 1997/98 total $effort_{dy}$ reported within the EGHGF cannot be allocated to a species catch and is the total $effort_{dy}$ reported by the EGHG fisher for each month where one method was reported, and the species of interest was also reported in that month (Appendix 1). In 1997/98, 292 days were fished. $Effort_{dy}$ increased 55% to 452 days in 2000/01, decreased to 304 days over the following two years before increasing each year to the maximum recorded level of 850 days in 2005/06, and subsequently declining each year to 302 days in 2008/09. The substantial changes in days fished between 1996/97 and 2008/09 was concurrent with changes to commercial fishery reporting requirements. As such, substantial changes in $effort_{dy}$ are likely not a function of effort to catch Cockles. Rather, the peak in effort reflects changes in effort to catch other species by the same fishing methods (likely Pipis), while also harvesting Cockles in the same month. Therefore, $effort_{dy}$ reported each month by hand gathering has been attributed to each species reportedly harvested that month, including Cockles. In 2009/10, $effort_{dy}$ was 265 days. Since 2009/10, the number of days fished increased to a peak, in 2014/15, of 515 days, reflecting a similar peak in catch. In the last 4-5 years $effort_{dy}$ has decreased substantially. In 2019/20 and 2020/21, $effort_{dy}$ was 118 89 days, respectively, which belies the fact that about 40% of the reportedly used 29.2 t quota in each year, and the associate effort, has not been reported in logbooks (Figure 2).

Effort (hr; $effort_{hr}$) has changed substantially since 2009/10 (Figure 2). Importantly, between 2016/17 and 2018/19, and in 2020/21, the percent of catch records with no $effort_{hr}$ reported was >50% for each year (Figure 1). To provide a more probable estimate of recent $effort_{hr}$ per year, average annual $hours.day^{-1}$, from records with hours reported, was multiplied by reported days fished (Figure 2). These data suggest fished hours increased substantially from 2013/14 and was in excess of 1200 $hr.yr^{-1}$ in each year from 2014/15 to 2017/18, peaking at ~1700 hr in 2014/15. In 2018/19, estimated $effort_{hr}$ was about 900 hr (i.e. about double the reported $effort_{hr}$) and in 2020/21

estimated effort$_{hr}$ was 165 hr, and whilst still about double that reported (Figure 2), suffers from likely being inaccurate given the discrepancy between reported catch and used quota.

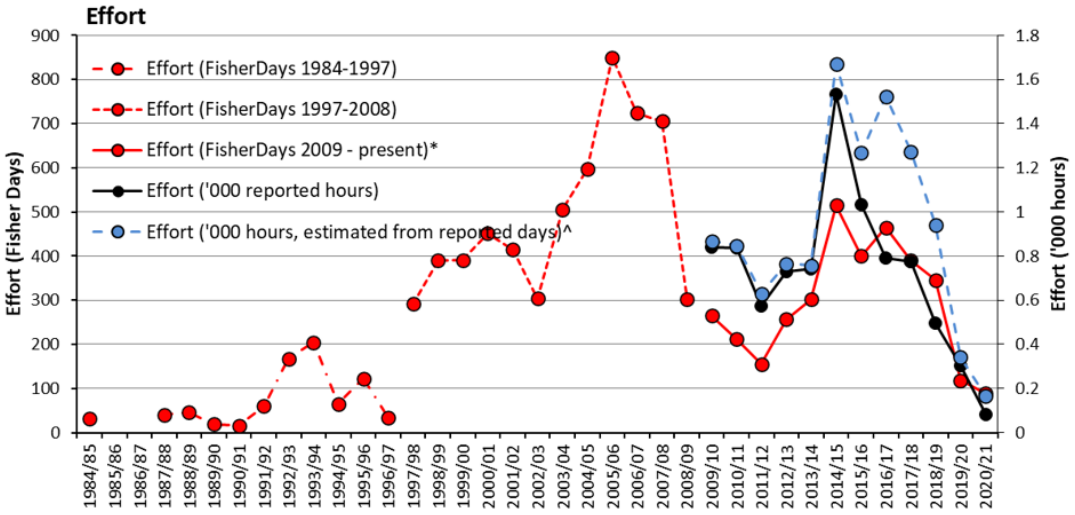


Figure 2. Total annual commercial effort (days and hours) fishing for Estuary Cockles from 1984/85 to 2020/21.

## Catch Rate information

Catch per FisherDay ($CPUE_{dy}$) is a problematic metric to define and interpret prior to 2009/10, for reasons outlined for the effort$_{dy}$ time series. Nonetheless, $CPUE_{dy}$ fluctuated substantially between 1984/85 and 1994/95, ranging between 9 and 150 kg.day$^{-1}$, with low rates possibly reflecting drivers of catch and effort other than abundance (as described for effort$_{dy}$; Figure 3). $CPUE_{dy}$ increased from 77 kg.day$^{-1}$ in 1997/98, to 116 kg.day$^{-1}$ in 2001/02, then decreased each year until 2006/07, reaching 24 kg.day$^{-1}$. Relatively low $CPUE_{dy}$ throughout the early to mid-2000s is likely a function of EGHG days fished being allocated to relatively low catches of Estuary Cockle per month, where Cockles and other species (likely Pipis) were caught by the same method in the same month, in addition to likely reductions in Estuary Cockle abundance preceding years of historically high periods of harvest. So, changes in catch rate are complicated by challenges in defining targeted fishing effort and any changes in abundance during this time. From 2009/10 to 2020/21 $CPUE_{dy}$ has tended to increase from an average of 115 kg.day$^{-1}$ (2009/10) to 189 kg.day$^{-1}$ in 2020/21, although these measures of average annual $CPUE_{dy}$ are associated with substantial variation and do not consistently represent patterns at finer spatial scales.

Similarly, since 2009/10 $CPUE_{hr}$ at the whole fishery scale has been relatively stable, averaging ~46 kg.hr$^{-1}$, with the exception of an anomalous peak of ~100 kg.hr$^{-1}$ reported in 2019/20 (associated with a large proportion of completed logbook records, including those from long-term active fishers with incomplete records from previous and subsequent years), Notably, measures of $CPUE_{hr}$ are associated with substantial variation that has increased in recent years with fewer fishers and fewer complete reports (Figure 3). Notably, the decline in number of active fishers in recent years, as fishery operations have changed either coincident with or in response to share management and a TAC, and the retention of some fishers regularly reporting consistently small quantities of effort irrespective of the level of catch may further limit the reliability of $CPUE_{hr}$ as a measure of relative abundance/biomass.

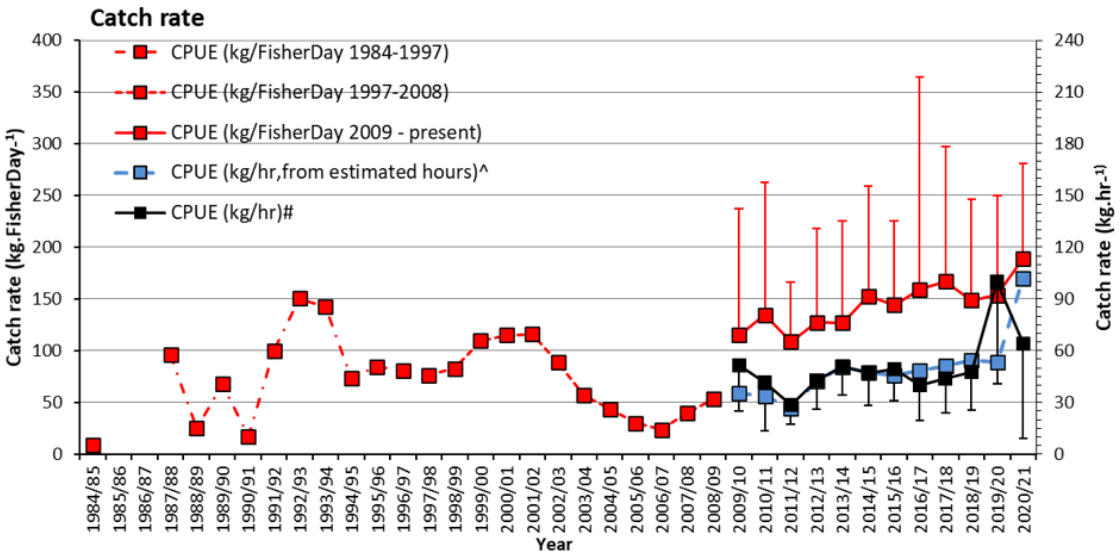


Figure 3. Average annual catch rate (kg.hr$^{-1}$ and kg.FisherDay$^{-1}$, plus or minus one standard deviation) from 1984/85 to 2020/21.

# STOCK ASSESSMENT

## Stock Assessment Methodology

### Year of most recent assessment:

2021/22 (using data to end of June 2021)

### Assessment method:

A review of indicators (weight-of-evidence approach) was used to assess the status of the NSW Estuary Cockle stocks. There are insufficient data available to support more quantitative stock assessment methods.

### Main data inputs:

- Catch (commercial) (t) – 1984/85 to 2020/21
- Catch (recreational) (t) 2000/01, 2013/14, 2017/18
- CPUE (kg.day$^{-1}$) – 2009/10 to 2020/21
- CPUE (kg.hr$^{-1}$) – 2009/10 to 2020/21

Data interpreted at state-wide and estuary scales.

### Key model structure & assumptions:

NA – no model-based quantitative assessment approach was used.

### Sources of uncertainty evaluated:

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 2009/10, commercial fishery statistics have become increasingly uncertain. For example, ~95% of the 2019/20 and 2020/21 individually transferable quota (TAC - 29.2 t.yr$^{-1}$) was reportedly used within each fishing season. However, reported catch from logbooks for these years are 18.2 and 16.8 t, respectively i.e. ~60% of the TAC. As such, ~40% of each year's TAC has not been reported through fishery logbooks. Further, since 2016/17, commonly ~50% of reported catch data has not had complementary effort data reported. Uncertainty in these data is further exacerbated by fewer active commercial fishers contributing to fishery-dependent data since 2017/18. Of these fishers, some (active since at least 2009/10) inconsistently report effort for the first time in 2019/20 since 2015/16, with those levels of effort seeming erroneously low compared to previously reported levels for similar or greater levels of daily catch. 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 2009/10 the majority (>90%) of annual catch has been from five NSW estuaries. However, patterns of catch and effort within these estuaries do not reflect patterns at the whole fishery scale. It is unlikely that logbook returns of daily fishing activity i.e. catch and effort, presented in this report, 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 Indigenous cultural fishing data available to quantify the levels of harvest from these fishing sectors. 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 may make a substantial contribution to the levels of fishing mortality on Estuary Cockles, 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 stocks, 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, may affect changes in the abundance and biological functioning of Estuary Cockles through time, likely with inconsistent differences among estuaries. There are a variety of studies that have investigated the effects of environmental changes on Estuary Cockles, 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 Cockles. Further, market disruption as a consequence of the COVID-19 pandemic and other associated social impacts (FAO 2021) are not well known and the impact of these extraneous factors on this assessment has not been quantified.

## Status Indicators - Limit & Target Reference Levels

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| Biomass indicator or proxy | None specified in a formal harvest strategy.<br>This assessment used a weight-of-evidence approach, with data including:<br>• Nominal $CPUE_{hr}$ (state-wide and estuary)<br>• Nominal $CPUE_{dy}$ (state-wide) |
| Biomass Limit Reference Point | None specified in a formal harvest strategy. |

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|---|---|
| Biomass Target Reference Point | None specified in a formal harvest strategy. |
| Fishing mortality indicator or proxy | None specified in a formal harvest strategy.<br>This assessment used a weight-of-evidence approach, with data including:<br>• Catch (state-wide and estuary scale) |
| 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 is classified as **undefined.** This classification is made both in terms of the level of biomass and fishing mortality.

Importantly, this classification is made primarily due to a lack of reported commercial fishery data in recent years and whilst understanding that available but limited data from an increasing number of estuaries indicate possible serial depletion and likely depleting or depleted local stocks, with this understanding generally in contrast with state-wide measures that compose the aggregate of available finer scale data.

A weight-of-evidence approach has been taken to assess the EGHG Fishery – Estuary Cockle. This includes: i) the current understanding of stock structure indicating there are a complex of populations, likely functioning at a local (estuary) scale and a paucity of information on biology and population dynamics; ii) high uncertainty in the commercial fishery data over the last 4-5 years (i.e. no reported catch for ~40% of the allocated and reportedly used, 29.2 t TAC in 2019/20 and 2020/21 and logbook returns of fishing activity with no $effort_{hr}$ reported for >50% of the reported catch); iii) the discontinuous time series of commercial effort data over the history of the fishery; iv) fishery-dependent estuary-scale data, available from 2009/10, 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 local stocks; v) anecdotally substantial, yet unquantified levels and distribution of recreational catch; vi) unknown levels of Aboriginal cultural fishing; and vii) unquantified levels of regular illegal, unregulated and unreported fishing. These lines of evidence identify substantial uncertainty in interpreting change in possible fishery and stock performance indicators, and limited confidence in inferring change in biomass and fishing mortality, and hence determination of a stock status other than undefined (Chick 2022).

## Stock Assessment Result Summary

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| Biomass status in relation to Limit | NA – no biomass limits has been set.<br>Weight-of-evidence provided is insufficient to support an understanding of the level or trend in biomass. |
| 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 insufficient to support an understanding of the level or trend in fishing mortality. |
| Fishing mortality in relation to Target | NA – no fishing mortality target has been set. |
| Current stock status | **Undefined** |

## Fishery interactions

Fishing for Estuary Cockles in the EGHG Fishery is done by hand with hand collection of individuals. There are limited, if any interactions with other fisheries.

Estuary Cockles inhabit seagrass habitat in addition to sandy/muddy substratum 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.

## Qualifying Comments

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 2009/10, commercial fishery statistics have become increasingly uncertain. For example, ~95% of the 2019/20 and 2020/21 individually transferable quota (TAC - 29.2 $t.yr^{-1}$) was reportedly used within each fishing season. However, reported catch from logbooks for these years are 18.2 and 16.8 t, respectively i.e. ~60% of the TAC. As such, ~40% of each year's TAC has not been reported through fishery logbooks. Further, since 2016/17, commonly ~50% of reported catch data has not had complementary effort data reported. Uncertainty in these data is further exacerbated by fewer active commercial fishers contributing to fishery-dependent data since 2017/18. These inconsistencies and associated uncertainties are continued, and often magnified at the estuary scale. Since at least 2009/10 the majority (>90%) of annual catch has been from five NSW estuaries. However, patterns of catch and effort within these estuaries do not reflect patterns at the whole fishery scale. It is unlikely that logbook returns of daily fishing activity i.e. catch and effort, presented in this report, 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 Indigenous cultural fishing data available to quantify the levels of harvest from these fishing sectors. 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 may make a substantial contribution to the levels of fishing mortality on Estuary Cockles, 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 stocks, 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, may affect changes in the abundance and biological functioning of Estuary Cockles through time, likely with inconsistent differences among estuaries. There are a variety of studies that have investigated the effects of environmental changes on Estuary Cockles, 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 Cockles. Further, market disruption as a consequence of the COVID-19 pandemic and other associated social impacts (FAO 2021) are not well known and the impact of these extraneous factors on this assessment has not been quantified.

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