NSW Total Allowable Fishing Committee

Report and Determinations for the 2020–21 Fishing Period

NSW Estuary General Fishery: Pipis, Cockles, Ghost Nippers, and Beachworms.

09 April 2020

EXECUTIVE SUMMARY

Preamble

The NSW Total Allowable Fishing Committee (the Committee) has responsibility under the NSW Fisheries Act (1994, No. 38, as amended) to determine the Total Allowable Commercial Catch (TACC) of four species taken in the NSW Estuary General Fishery (EGF): pipi (*Donax deltoides*), estuary cockle (*Anadara trapezia*, 'cockle'), beachworm (primarily *Australonuphis teres* but occasionally including *A. parateres* or *Hirsutonuphis mariahirsuta*), and ghost nipper (*Trypaea australiensis*). The TACCs in this Determination report are for the period 1 July 2020 to 30 June 2021, the 2020–21 Fishing Period. The TACCs are based on information available about the relevant stocks and their harvest in NSW over a long history, the most up-to-date assessments of stock status and likely future trends, reports from fishery managers, comments from fishers, and input at a public forum in Sydney on March 10th 2020.

The EGF is a multi-species, multi-method, share-managed fishery that includes multiple endorsement categories, including Handline, Meshing, Prawning, Fish Trapping, Eel Trapping, Mud-crab Trapping, Category 1 and 2 Hauling, and Hand Gathering (HG). Each endorsement specifies use of particular gears and rights to land particular species in one or more of seven regions of the NSW coast, with fishing restricted to the region(s) for which an endorsement is held. Approximately 76 estuaries and over 100 beaches are accessed across all regions. The TACCs set here apply only to the EGF Hand Gathering endorsements, under which the above species can be taken by specified hand-gathering methods.

Determination

The Committee has determined that:

1. The Total Allowable Commercial Catch of pipi by commercial fishers in the Estuary General Fishery during the 2020–21 Fishing Period should not exceed ***147.4 tonnes*** (t);
2. The Total Allowable Commercial Catch of estuary cockle by commercial fishers in the Estuary General Fishery during the 2020–21 Fishing Period should not exceed ***29.2 t***;
3. The Total Allowable Commercial Catch of beachworm by commercial fishers in the Estuary General Fishery during the 2020–21 Fishing Period should not exceed ***8.5 t***; and
4. The Total Allowable Commercial Catch of ghost nipper by commercial fishers in the Estuary General Fishery during the 2020–21 Fishing Period should not exceed ***5.6 t.***

Recommendations

The Committee provides the following recommendations to the Minister, the Department of Primary Industries (the Department), and the OTF industry (Industry), in addition to the above Determination components, towards improving performance of the fishery.

Recommendation 1: The Department take immediate action to rectify persistent non-reporting of effort in the cockle fishery.

Recommendation 2: The Department and Industry consider options for cost-effective fishery-independent monitoring of abundances of EGF-HG quota species in key estuaries and beaches.

Recommendation 3: The Department and Industry consider effective measures for spatial management of TACCs and regulate appropriately transfer of quota shares or lease of quota among Regions.

Recommendation 4: The Department and Industry jointly develop appropriate harvest strategies, including with specific objectives and reference points, for each of the EGF-HG quota species.

Recommendation 5: The Department and Industry work together to provide economic information about the EGF-HG fishery, initially focussing on reporting of quota transaction values but extending to information about multi-species marketing practices (if any) and costs of operation.

Recommendation 6: The Department and Industry support research into the biology and population dynamics of estuary cockle and investigate an appropriate minimum legal size for harvest.

Stock Status

The four species considered here are harvested from discrete populations that are unlikely to be connected other than by larval dispersal. Pipis and beachworms likely exist as meta-populations of moderately well-connected (by larval dispersal) sub-populations on ocean-facing beaches. Estuary

cockles and ghost nippers more likely have ittle mixing among estuary-specific populations. Each species aggregates to some extent within local habitats and are targeted in high-density patches. These features mean each species is vulnerable to serial depletion within and across beaches or estuaries and likely will exhibit hyper-stability of catch-rates as aggregations are harvested. Catch histories for pipis and cockles appear consistent with multiple instances of some localised and serial depletion.

The NSW pipi stock has a 'boom-bust' history but has been rebuilding over the last decade, probably in response to regulatory actions in response to the last stock crash. Recent commercial catches and catch-rates mostly increased to about 2015 and have been relatively stable since, though standardised CPUE has been declining recently in some regions. It seems likely that the pipi stock currently is about mid-way between what the Committee considers reasonable limit and target reference points of 20% and 40% of unfished biomass, respectively.

The current status of the NSW estuary cockle stock(s) is very uncertain, largely because of poor understanding of the species' biology, depauperate understanding of recreational harvest, and persistent non-reporting of effort in the commercial fishery. Continuation of these deficiencies will render untenable any informed adjustments of TACCs, including potential increases. The most rudimentary assessment of available fishery data suggests, with great uncertainty, that cockle stocks have been fairly stable recently.

Fishery and fishery-independent data suggest ghost nipper stocks are robust to recent harvests in estuaries favoured by commercial fishers, and probably in others frequented by recreational fishers. Spatial separation of commercial and recreational fisheries means that ghost nipper TACCs are likely to operate with greater integrity than if there was substantial overlap in harvests. Key risks for the effectiveness of nipper TACCs, therefore, are uncertainties in the amount and distribution of recreational catch and the prospect that distributions of commercial or recreational harvests might change materially.

The NSW beachworm stock appears to be reasonably robust and stable under current harvest rates. The biology of the organisms likely provides considerable buffering against persistence of localised depletions, notwithstanding the prospect that some beaches could be heavily fished under current management arrangements. There likely is additional robustness in beachworm populations provided by unfished 'refuge' sub-tidal populations along the coast.

No regular leading indicators of stock status (e.g., fishery-independent surveys, recruitment indicators) are available for any of the species considered here. That lack means TACC setting inherently is reactive, being limited to responding to changes in stock or fishery status only after such effects have become evident, rather than being able to anticipate future states and set TACCs proactively to optimise fishery performance. Fishers and Department officers at the recent public forum considered there were feasible and affordable options for annual fishery-independent surveys of selected beaches or estuaries to estimate the likely local population status of these species just prior to each fishing period. Such an approach has been used in pipi and cockle fisheries elsewhere and should be considered for stock monitoring in NSW to inform future TACC Determinations.

Economic Considerations

Pipis, cockles, ghost nippers, and beachworms are part of the catch of a diverse fishery involving many species and fishing methods. The four species are highly targetable individually, however, and the fishery generally is not constrained by harvest interactions that operate in many multi-species fisheries.

The fishery has seen a change in focus from beachworms a decade ago to pipis in more recent years, underpinned by a general increase in the real price of pipis of around 4.5% a year reflecting changes in the market for pipis for human consumption. The real price of beachworms, in contrast, has declined by around 3% a year. Preliminary modelling of effort supply response for pipis suggests that further price increases will drive increased effort applied to pipi over coming years, subject to quota constraints.

Information on the economic performance of the fishery is not available. The fishery is labour intensive, so costs other than labour are expected to be small. Changes in revenue, therefore, likely will be linked directly to changes in fisher income. The catch information provided indicates that current average fishing business revenue is less than the average Australian income, suggesting that fishers rely on other sources of income, such as catch of other species. Most fishers held endorsements for other fisheries.

There is some evidence of quota trading and autonomous adjustment in the fishery but this has not been substantial to date. The "newness" of the TACC-ITQ system for the fishery means the quota trading market has not yet developed and difficulties in accessing unused quota likely has limited internal adjustments in the fishery. This adjustment inertia likely will improve over time.

Management Considerations

The EG-HG fishery is a share fishery, managed via spatially explicit limited entry, TACCs, ITQs, gear controls, spatial closures and a size limit for pipis. Fishers tend to target and catch only a single species during each trip, using different fishing methods or gear for each species. The EG-HG fishery therefore functionally operates as four separate target fisheries, with a number of common operators, rather than as a multi-species fishery with mixed catches. The fishery is divided into seven Regions and many beaches and estuaries are unavailable to commercial fishers. All Regions have hand gathering access endorsements but most EG-HG catches are in Regions 3 and 4, in central NSW. TACCs and ITQs were introduced in this fishery in 2019–20, and businesses currently are still adjusting to managing quota.

Pipi has the highest catches and greatest contribution to fishery GVP. The pipi fishery is recovering from a significant depletion event between 2004–05 and 2010–11, with catches over the past 5 years stabilising at around 100–150 t. The TACC for pipi in 2019–20 was 147.4 t, reflecting recent (2013–17) average annual catches, and is projected to allow the population to continue to slowly rebuild.

Catches of estuary cockle have been between 50 and 80 t a year over the past 5 years. TACC-setting for cockle is hampered materially by significant and persistent underreporting of effort in the cockle fishery. The cockle TACC in 2019–20 was 29.2 t, the average annual catch during 2009–14.

Commercial catches of ghost nippers primarily come from one estuary and fishery dependent and independent data suggest that those catches are within sustainable harvest fractions. Healthy nipper populations also exist elsewhere which have the potential to support reasonable catches, though some of those probably experience significant recreational collecting. The TACC for nippers in 2019–20 was 5.1 t, being the maximum annual catch during 2009–17.

Catches and catch rates of beachworms in NSW have been relatively stable since 2009–10, and the stock is considered sustainable. The TACC for beachworm in 2019–20 was 7.7 t, the average annual catch during 2009–17.

A number of these species are vulnerable to localised depletions of populations, and there is concern among industry members that the recent change in management arrangements increases the risk of localised depletions by allowing trade of species quota across regions. The extent to which the recent management changes have triggered, or will trigger, changes in the distribution of effort and catch is not yet known, but the Committee encourages the Department to work with industry to consider practical and appropriate spatial management mechanisms for this fishery.

Conclusion

The EG-HG fishery is a relatively small fishery in its first year of TACC-ITQ management and clearly in a ‘settling-in’ period in which the internal adjustment processes expected of a TACC-ITQ system, such as permanent quota share sales and temporary, within year, quota leasing, are yet to be established.

The four stocks subject to EG-HG TACCs — pipi, estuary cockle, ghost nipper, and beachworm — all appear to be robust to recent levels of harvest and continued harvest up to the respective initial TACCs, notwithstanding some watch-points (recent localised declines in catch rates) for pipi and cockle. The biology of the quota species renders them particularly vulnerable to fishers sequentially targeting high-density aggregations, resulting in serial localised depletions that could undermine stock sustainability before signals of such decline were evident in any fishery-dependent metrics.

The Committee saw no evidence of extreme conditions that required material intervention in current TACCs for the quota managed species harvested by the EG-HG sector. Indeed, it appears that fisheries for ghost nipper and beachworm might be somewhat underdeveloped, at least from stock perspectives.

No leading indicators of likely future stock status exist for any of the species and TACC setting necessarily must be reactive and precautionary, because we will know the conditions to which TACCs must respond only with hindsight. The known distributions of the HG species, however, and the low-cost means of accessing them mean there is potential for low-cost, targeted, fishery-independent monitoring of stocks that could provide at least short-term leading indicators to inform future TACC setting.

The existence of Region-specific access shares for the fishery set regulatory conditions that could mitigate risks of serial depletion across the entire stocks, but the pan-regional allocation of species quota shares and free movement of quota among businesses with different Regional access undermines that potential mitigation. There is a strong case in this fishery to develop some mechanism(s) to moderate quota movement among Regions and build on the advantages of regionalised access shares.

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1. INTRODUCTION

The Total Allowable Fishing Committee (the Committee) is established under Part 2A S40 of the *Fisheries Management Act 1994* No 38. The committee in 2020 was:

- Dr Bruce Mapstone— Chair;
- Dr Rich Little — fisheries science;
- Ms Alice McDonald — fisheries management;
- Dr Sean Pascoe — natural resources economics; and
- Dr Keith Sainsbury[1] — fisheries science.

The Committee has been directed by the Minister to determine the Total Allowable Commercial Catch (TACC) of four fish species or species groups for the commercial Estuary General Fishery (EGF) in NSW during the 2020–21 Fishing Period, from July 1st 2020 to June 30th 2021. The species included in this direction are pipi (*Donax deltoides*), NSW estuary cockle (*Anadara trapezia*, hereafter 'cockle'), beachworms (primarily *Australonuphis teres* but also occasionally including *A. parateres* or *Hirsutonuphis mariahirsuta*), and ghost nipper (*Trypaea australiensis*).

TACCs for the above species were set first by administrative declaration for the 2019–20 Fishing Period at 147.4 t, 29.2 t, 7.7 t, and 5.1 t respectively. This Determination for the 2020–21 Fishing Period is the first by this Committee.

The Committee is to give effect to relevant objectives of the *Fisheries Management Act 1994,* and as since amended *(1997, 2004, 2006, 2010, 2015, 2018)*, and is not subject to control or direction from the Minister as to the outcomes of Committee considerations. The Act states (Section 40E):

(1) In making a fishing determination, the TAF Committee is to give effect to the objects of this Act and is to have regard to all relevant scientific, industry, community, social and economic factors.

(2) The TAF Committee is also to have regard to—

(a) the need to ensure that the exploitation of fisheries resources is conducted in a manner that will conserve fish stocks in the long term, and

(b) the impact of fishing activities on all species of fish and the aquatic environment, and

(c) the precautionary principle, namely, that if there are threats of serious or irreversible damage to fish stocks, lack of full scientific certainty should not be used as a reason for postponing measures to prevent that damage.

The Committee interprets 'threat' in this context to mean an 'indication of probable harm to come'. The Committee therefore must respond to evidence before it proves future harm to the fishery or the stocks and not postpone action to prevent that harm occurring even if there is uncertainty surrounding such evidence. Similarly, the Committee should not take pre-emptive decisions on issues such as increasing the TACC when there is insufficient verifiable information on which to base such decisions. The Committee may be consulted out of session on a range of management issues.

The Committee must consider, as far as possible, the full extent of exploitation that might affect resource sustainability to meet its statutory obligations. Total removals from the stocks considered here are made up of, to varying degrees:

- Quotas allocated to commercial fishers in the EGF;
- Total legal catch by recreational and Aboriginal fishers, including those from charter fishing;
- Catches by commercial, recreational, or Aboriginal fishers not sanctioned by the Regulations controlling the fishery and not recorded in catch statistics (illegal catches).

The Committee makes determinations on the TACCs and matters it is required to regard that affect directly those TACCs. This stand-alone report has been prepared in support of TACC Determinations for 2020–21. The report also includes recommendations for management of the fishery related to setting TACCs, based on the experience and background of the Committee members, reports received by the Committee, and submissions or comments from stakeholders. The degree to which the Committee's other suggestions or recommendations are accepted is a matter entirely for the Minister and the Department. Constructive dialogue between the Committee, the Department, and Industry on fishery-related issues is an important and valuable part of the Committee's deliberations.

The NSW EGF is a multi-species, multi-method, share-managed fishery that includes multiple endorsement categories, including Handline, Meshing, Prawning, Fish Trapping, Eel Trapping, Mud-crab Trapping, Category 1 and 2 Hauling, and Hand Gathering. Each endorsement specifies use of particular gears and rights to land particular species in one or more of seven regions of the NSW coast (Appendix 2, Figure A1), with fishing restricted to the region(s) for which an endorsement is held. Approximately 76

[1] Dr Sainsbury did not participate in these Determinations. Dr Little was his appointed alternate.

estuaries and over 100 beaches are accessed across all regions. The TACCs set here apply only to the EGF Hand Gathering endorsements, under which the above species can be taken by specified hand-gathering methods.

The four species taken under Hand Gathered (HG) endorsements are targeted separately and taken specifically, rather than as mixed catches. The largely separate fishing methods used mean that the EG-HG fishery essentially operates as a series of single-species fishing activities with little or no technical or species interactions. These characteristics mean that the species-specific TACCs are effected mostly independently, notwithstanding any economic relationships among sale of catches where individual fishers harvest more than one of the quota species.

The Committee notes concerns from industry that the TACCs and Individual Transferable Quotas (ITQs) have been in place for the EGF for less than a year and many operators are unfamiliar with the operation of a TACC-ITQ management system. The Committee also was advised that some appeals against share allocations during the NSW fisheries structural reform process remain unresolved and concern was expressed that the resolution of those appeals might influence the effect of TACC settings for fishers, though it was acknowledged that the appeals were unrelated to the TACCs *per se*. Concerns also have been raised that the TAFC's TACC settings might be influenced inappropriately by issues arising in this first year 'settling-in' period for the EGF.

The Committee therefore has taken great care to weight lightly the 'behaviours' of the quota management system in this first year. The Committee typically approaches TACC setting informed by a range of information reflecting the medium-long term dynamics of the harvested stocks and somewhat more recent trends in fishery metrics, and is unlikely to base TACC changes predominantly on just single-year events unless something exceptional and extreme has occurred. The TACCs reported here have been set after considering the long-term information available about stock status and harvest, the most up-to-date formal assessments of current and projected stock status, management arrangements and fishery dynamics during and since the reference period of July 1 2009–June 30 2017, or subsets of it, used by the Independent Allocations Panel (IAP) for allocating species quota shares, and, especially for economic considerations, data from the last three years up to 2019.

2. PROCEDURES

2.1 Public Consultation by the Committee

The Committee, through the Department, called for public submission on the appropriate total allowable commercial catches under the requirements of Sections 40F and 284 of the *Fisheries Management Act* 1994. EGF fishers, relevant industry and stakeholder bodies, and the community were invited to make submissions on the Total Allowable Commercial Catches from NSW of pipis, cockles, beachworms, and ghost nippers. The consultative process is set out in Appendix 1. Twelve written non-government submissions were received during this process.

The Committee obtained input from participants in the Total Allowable Fishing Committee Open Forum in Sydney on March 10th 2020 and received written reports from:

- NSW Department Primary Industries (DPI) Fisheries Research; and
- NSW Department Primary Industries Commercial Fisheries Management.

Public verbal submissions and presentations to the Committee were invited during the Open Forum. The Committee also was able to call for *in-camera* discussions, where appropriate. In-camera discussions with Department officials were requested following the 2020 forum to clarify legislative and regulatory matters and request additional economic and fishery information for consideration by the Committee.

2.2 Matters considered

The Committee considered the following matters before reaching its Determinations:

- The original administrative TACC Determinations for 2019–20;
- The data and assessment reports for each species' stocks provided by the Department;
- Advice on the status of management of the fishery provided by the Department;
- Advice on the economic status of the fishery by the Department and Industry representatives;
- Advice on compliance with regulations from the Department and Industry representatives;
- The current state of the fishery;
- The spatial nature of the fishery; and
- Submissions, commentary, and presentations provided in writing and at the Open Forum.

2.3 Format of the Report

This report covers the three key areas affecting management of the fishery and setting the allowable commercial catch:

- Status of the stocks;
- Economic considerations; and
- Management considerations.

The key considerations for each of these areas are presented as relevant for each species or collectively in the following sections 3, 4, and 5, respectively. The Committee's conclusions in view of these considerations are presented in section 6, together with the details of this year's Determinations.

The Committee has made several recommendations with the Determinations to clarify the position of the Committee on a number of issues related to the TACCs. The primary recommendations are included in the Executive Summary.

The Determinations of the Committee are to be published by the Minister. The Minister is required to review the regulations and any other instruments under the Act In the light of the Determinations. The Determinations are to be implemented in accordance with the Act.

3. STATE OF THE STOCKS

3.1 Introduction

Determinations of four Total Allowable Commercial Catches (TACCs) in this report are based, in part, on Department assessments of stock status for pipi (*Donax deltoides*), NSW estuary cockle (*Anadara trapezia*, hereafter 'cockle'), beachworms (primarily *Australonuphis teres* but also occasionally including *A. parateres* or *Hirsutonuphis mariahirsuta*), and ghost nipper (*Trypaea australiensis*). The pipi, cockle, and ghost nipper TACCs are for single species whilst the beachworm TACC is for all harvested beachworms (as a basket), though it is believed that *A. teres* (stumpy or king worm) constitutes the majority of the commercial catch. The species are not taken commercially in any fishery other than the Estuary General Fishery (EGF) but all are taken to some degree by recreational fishers, mostly for bait. The TACCs discussed here apply only to catches from the EGF. The initial (2019–20) NSW TACCs, set administratively for these species, and the basis on which they were determined, are given in Table 3.1.

Table 3.1. Administratively determined initial Total Allowable Commercial Catches for selected species taken in the NSW Estuary General Fishery between July 1 2019 and June 30 2020.

Species or Group	2019–20 TACC	Basis of Administrative TACC
Pipi	147.4	Average Catch July 2013–June 2017
Estuary cockle	29.2	Average Catch July 2009–June 2014
Beachworms	7.7	Average Catch July 2009–June 2017
Ghost nipper	5.1	Maximum Catch July 2009–June 2017

3.2 Stock Status and Trends

3.2.1 Pipis

The Committee relied heavily on an assessment report[2] for pipis provided by the Department for insights to stock status, supplemented by discussion with fishers at the public forum in Sydney on March 10 2020.

The pipi (*Donax deltoides*) is a burrowing bivalve found on relatively high-energy sandy beaches around the south-eastern coast of Australia, from central Queensland to central South Australia and including northern and eastern Tasmania. Pipis are dioecious, short-lived (4–5 years), grow to a maximum size of about 80 mm shell length at about 3.5 years of age, and reach sexual maturity at around 34–44 mm. Pipis are highly fecund and spawn over most of the year, though with peak spawning in late summer along much of the NSW coast. Eggs and larvae are planktonic for some weeks[3] and expected to be well dispersed by ocean currents. Recent genetic research indicated three fairly distinct populations, one along the east coast (Queensland, NSW), one in Victoria, and one along the South Australian coast. It has been inferred, therefore, that the NSW pipi is a single stock comprised of a metapopulation of beach-specific sub-populations with likely, but uncertain, larval exchange among neighbouring beaches. Pipis notably have been vulnerable to nematode infections that cause sterility and, sometimes, mass-mortality.

Pipis are harvested by recreational, indigenous, and commercial fisheries. Pipis are used for bait in the recreational sector, including via sale of commercial catches, and historically were taken for food by all sectors, though recreational harvest for food has been banned since 2000. Pipis are susceptible to infection with biotoxins and commercial harvest for human consumption now is regulated by biotoxin management plans and monitoring at individual beach scale.

Evidence exists of a very long (1,000s years) history of aboriginal harvest of pipis for food along the NSW coast. There are no state-wide estimates of aboriginal harvest, but annual harvest in the far north of the state has been estimated at around 3,000–7,400 individuals, or roughly 20–50 kg. Estimates of recreational annual catches estimated from surveys in 2000–01 and 2013–14 were ~7 t (± 1.1 t) and 1.3 t (± 0.5 t) respectively, equating to 1.04% and 1.8% of contemporary commercial catches. An earlier study of recreational and commercial catch at Stockton Beach in 1996–97 estimated that the recreational catch (46.5 t) was about 24% of the commercial catch at the same time. The more recent state-wide estimates of recreational catch likely are significant under-estimates, by an unknown amount, because of the sampling frames used for the surveys. Comparisons among recreational surveys also are uninformative because of different sampling frames and methods used in different surveys. It seems reasonable to

[2] Johnson, D.D. 2020. Stock assessment report 2020 — Estuary General Hand Gathering Fishery — Pipi (*Donax deltoides*). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 71 pp.

[3] Early estimates put larval duration at 6-8 weeks but more recent work indicated larvae could settle from the plankton after 2–3 weeks.

infer, however, that recreational harvest is relatively low overall compared to commercial catch and aboriginal harvest likely is an even smaller component of total pipi catches.

Commercial catches of pipi in NSW (all Regions) have fluctuated greatly during the last 4 decades, suggesting the fishery is vulnerable to boom-bust dynamics driven by environmental or fishing effects or both. Catches built from 14 t to 80 t during 1984–88, jumped to 210–250 t during 1989–92, were less than 200 t until 1995-96 and then fluctuated between 300 t and 670 t during 1996–2005 before plummeting to less than 10 t in 2010–11. Catches since 2011–12 have built steadily to be 140–176 t during 2015–19.

Most (>95% in most years) of the commercial catches of pipi have been taken from Regions 1, 3, and 4 (Appendix 2, Figure A1) since the 1980s, with peak regional catches of over 100 t in various years. Material catches of up to about 50 t also were taken from Region 2 during 1988–92 and 1996–98 but Region 2 has delivered very low commercial catches since (< 5 t, mostly < 1 t annually). Catches from Regions 5–7, though small, collectively have exceeded those from Region 2 in many years.

Regions 1, 3, and 4 have similar catch-history patterns to the state-wide pattern, though Region-specific patterns were more exaggerated. Region 1, for example, had near-zero catches during low-catch periods (1993–95, 2005–12). Comparing catch histories across Regions 1, 3, and 4 indicates a north-south lag in peaks and troughs in annual catches with earlier (1998–92, 1996–2005) peak catches in Regions 3 and 4 often being about 2-5 years behind those in Region 1. The most recent peak (2015–16) had similar shape in Regions 1 and 3 but again lagged (to 2018–19) in Region 4. It is not clear from the information provided whether effort was similarly lagged, though relatively strong relationships between effort and catch in different reporting periods suggests that was likely. These patterns might indicate serial depletion at Regional scales, and that overall catch rates have been hyper-stable during peak periods, creating a misleading impression of prolonged high catches at state-wide level during 1989–92, 1996–2005, and since 2014–15. Some degree of hyper-stability of catches, and in particular catch-rates[4], is likely for pipis because (a) fishing tends to be targeted at high-abundance aggregations of pipis within beaches, and (b) multiple beaches can be targeted sequentially as each in-turn is heavily harvested[5].

State-wide average catch rates (Catch per Unit of Effort, CPUE[6]) have fluctuated widely, especially during 1984–2007, but overall have trended down from peaks of 165–220 kg/fisher-day in 1988–92 to less than 20 kg/fisher-day during 2007–11[7]. CPUE has increased slightly since 2009–11 to be fairly stable at about 34–36 kg/fishery-day since 2012–13, equating to standardised[8] CPUE of around 1.1–1.3 kg/hour. Standardised catch rates since 2009 have varied slightly among Regions 1[9], 3, and 4. Region 1 CPUE reached a peak of about 1.1 kg/hour n 2015–16 and then consistently declined to around 0.9 kg/hour in 2018–19. CPUE in Region 3 had a similar pattern, but with a slightly higher peak and much greater variation within years. These patterns suggest relatively stable stocks over recent years, though the decreases in standardised CPUE in Regions 1 and 3 since 2015–16, and steep decline in catch from Region 1 in 2018–19, warrant careful review in light of future data.

Monthly catches of pipi in the first half of the 2019–20 fishing period, under quota management, have been less than those in corresponding months from recent years in Regions 1, 3 and 4, though monthly catch rates have been fairly consistent with those in previous years.

The Committee was provided with results from some simple stock-depletion modelling of harvest over the open-fishing seasons (June–November) in selected years since 2011 in each of regions 1 (2 years) , 3 (4 year), and 4 (2 years) — 8 cases in total. Depletion models are subject to an array of model assumptions about population dynamics during the periods of stock depletion, which it was argued were satisfied moderately well for these 10 cases. The results indicated that around 25–30% of the pipi stocks targeted in a given year and region were harvested in 5 of the 8 cases, whilst harvest rates were estimated to be

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[4] Hyper-stability occurs when a fishery's catch rate (CPUE) stays stable while the actual fish population declines.

[5] The strict requirement for beach-specific biotoxin management plans is likely to reduce the number of beaches available for serial targeting but might exacerbate serial depletion of fishable populations as fishing effectively is restricted to fewer (available) beaches.

[6] Catch-per-unit effort (CPUE) is used as an indirect measure of stock abundance, especially when fishery-independent measures of abundance are not available. Many fishery-related processes can subvert the relationship between CPUE and actual abundance, however, and the measure therefore is regarded with caution.

[7] CPUE data prior to 2009 are less certain or consistent than those since because of uncertainties associated with effort reporting during earlier decades.

[8] CPUE is often ‘standardised’ to remove some biasing effects of different fishers, seasons, locations, gears, etc. that distort the relationship between CPUE and true abundance of targeted species. Standardised CPUE generally is considered a more reliable indicator of stock abundance than is raw CPUE.

[9] No catch was reported from Regions 1 or 2 during 2009–12 and catches in Region 2 since have been very low.

about 50–70% in the other 3 cases (all in Region 3). The latter would be considered higher than desirable, whilst the former seem reasonable for a high-fecundity, short-lived species such as pipi.

State-wide and Region-specific catch-only MSY assisted modelling of pipi stocks also was reported to the Committee. Those models do not produce robust estimates of unfished or current biomass but do result in a range of trajectories of past and future biomass considered credible given known catches and (somewhat arbitrary) specified stock-dynamic characteristics. The models for NSW pipi resulted in mean and median values for biomass in 2018 overall and in Regions 3 and 4 of 33% of unfished biomass, each with 5th–95th percentiles of about 9–49% of unfished biomass, whilst those for Region 1 put biomass in 2018 at about 42% of unfished biomass. Projections of plausible biomass responses to various constant harvests were provided, including one scenario close to the initial TACC and including an allowance for about 1.75% of that as recreational catch. Constant harvest close to or below the TACC resulted in mean and median projections slowly increasing over 5 years, whilst constant catches about one-third or more above the TACC resulting in flat or declining biomass projections. All future catch scenarios, however, included some projections of biomass declining to zero within the 5-year projection period. The NSW pipi stock was considered 'sustainable'[10] by the Department in its report to the Committee.

3.2.2 Cockles

The Committee relied heavily on an assessment of cockles provided by the Department[11] for insights into stock status, supplemented by discussion with fishers at the public forum in Sydney on March 10, 2020.

Cockles are dioecious, broadcast spawning, bivalve molluscs living in low-energy estuarine environments throughout the Australian east coast, and in Western Australia. Cockles are sedentary as adults and spawn in late summer along the NSW coast, producing eggs and larvae that are planktonic for up to six weeks. Cockles are more abundant in unvegetated habitat than in seagrass habitats. Larvae settle preferentially onto conspecific adults, though survival of juveniles is greater in vegetated habitat than on adults in open habitat, perhaps because the vegetation provides some protection against predation.

Genetic variation in estuary cockle populations is evident at a range of scales from 100 m–1,000 km, indicating a high degree of local-scale population dynamics despite the potential for considerable genetic exchange suggested by a relatively long planktonic larval life. It has been suggested that larvae may respond to local (within-estuary) ecological processes and so have more local recruitment than widespread dispersal among estuaries. These characteristics mean that cockles are likely to be vulnerable to local, estuary-specific depletion from which it might take considerable time to recover.

Recreational harvests of cockles cannot be estimated from available data. Cockles were recorded with 'other bivalves' or 'other taxa' in recreational fishing surveys in 2000–01 and 2013–14 respectively and so catches of cockles cannot be estimated separately. A specific estimate of cockle harvest by recreational fishers was derived from recreational fishing surveys in 2017–18 but the restricted sampling frame and quantum of that estimate (10 kg total catch) render the estimate non-credible. There are anecdotal reports of large catches of cockles by recreational fishers in several estuaries, including recent media articles alleging catches in excess of bag limits. Regular compliance seizures of large numbers of illegally taken cockles from recreational fishers (6,300–25,110 cockles per year during 2013–19) also indicates an active recreational fishery in at least some estuaries, especially in the southern half of the NSW coast.

Schnierer and Egan (2016[12]) have reported cockles from aboriginal middens along the NSW coast, indicating a long history of some cockle harvesting by indigenous people. They also estimated an aboriginal annual harvest of 731–1,810 cockles from the Tweed estuary, but there are no state-wide estimates of aboriginal harvests. It seems likely from the available research that current aboriginal harvests of cockles are very minor compared to likely recreational and recorded commercial catches.

Cockles are taken commercially each year by a relatively small number of endorsed fishers or nominated fishers, typically less than a third of all cockle quota shareholders, with most cockle fishers also reporting catches of one or more other EG-HG quota species. Annual commercial catches have varied considerably since 1984–85 between less than 1 t (in the 1980s) and peaks of over 85 t during 1991–94 and over 70 t in 2014–15 and 2017–18. Annual catches generally declined after 1993–4 to less than 30 t annually during 2002–2012 but have increased since to be around 50 t or more annually since 2014–15. Effort is poorly documented prior to 2009–10 but appears to have varied inversely with catch. Estimated

[10] Consistent with the Status of Australian Fish Stocks classification regime (www.fish.gov.au)

[11] Chick, R.C. 2020. Stock assessment report 2019 — Estuary General Fishery (Hand Gathering) — Estuary Cockle (*Anadara trapezia*). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 53 pp.

[12] Schnierer, S. and 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.

CPUE prior to 2009–10 accordingly declined from highs above 100 kg/fisher-day in the early 1990s to lows of less than 50 kg/fisher-day during 2004–08. Patterns in CPUE during this period should be interpreted with caution, however, because of the underlying problems with allocating effort reliably to the cockle fishery. CPUE since 2009–10 again has been over 100 kg/fisher-day (range 107–148 kg/fisher-day, generally > 40 kg/fisher-hour) but these estimates are plagued by increasing failures to report effort since 2013–14, with 60% of catch records in 2018–19 having no accompanying effort data, likely rendering CPUE estimates even less reliable indicators of stock abundance than usual. Monthly catches since the introduction of quota management in July 2019 have been below 2 t per month, materially less than in corresponding months in most years since 2009–10. Reasons for this depression cannot be inferred from available data, especially given the recent history of poor reporting by major cockle fishers.

Over 95% of annual catches of cockles since 2010–11 have come from just 5 estuaries in Regions 4 (Wallis Lake), 6 (Shoalhaven/Crookhaven and Lake Illawara), and 7 (Merimbula Lake and Pambula Lake). Around one third of total catch in 2009–10 came from two other estuaries, but catches from them since have been zero or around just 1 t per year (in 2016–18). The contributions from each of the dominant five estuaries have changed considerably since 2010–11, with catches from Wallis Lake accounting for over 40% of total catches during 2011–12 (8 t) and 2017–19 (20–28 t), Shoalhaven/Crookhaven catches accounting for over 40% of total catches during 2012–14 (15–17 t) and around 36% (17.6 t) of catches in 2018–19, and Merimbula Lake delivering around 40% or more of catches during 2014–17 (23–42 t). Catch rates that could be calculated since 2009–10, given poor effort reporting, have been relatively stable at about the long-term averages in Wallis Lake, Lake Illawarra (calculable only to 2015–16), Shoalhaven/Crookhaven (also calculable only to 2014–15), and Merimbula Lake. CPUE at Pambula Lake increased steeply from 2011–12 to 2014–15 whilst catches fell sharply but both catches and catch rates have been zero there since 2014–15.

The status of the estuary cockle stock(s) in NSW has been classified as 'undefined'[13]. The uncertain, but likely complex, nature of the stock, uncertain recreational and indigenous removals, likely susceptibility to localised depletion, and increasing lack of fine scale estuary effort data represent the key uncertainties associated with the stock, and prevent the Committee from gaining a clear understanding of the status across the main estuaries or reaching definitive conclusions about recent stock dynamics.

3.2.3 Ghost nippers

The Committee relied heavily on an assessment of ghost nippers provided by the Department[14] for insights to stock status, aided by discussion with fishers at the public forum in Sydney on March 10, 2020.

Ghost nipper (*Trypaea australiensis*) is a small callianassid decapod crustacean that inhabits muddy and sandy shorelines in low-energy estuarine environments between north Queensland and central southern Victoria[15]. Individuals can reach 3–4 years of age and 15–20 mm carapace length (approximately 60 mm total length) and reach maturity at about 5–8 mm carapace length, at unknown age. There appears to be a north-south gradient in both size at maturity and timing of reproduction, with more southern individuals maturing at smaller sizes and commencing breeding earlier in spring-summer than those further north. Females brood 2,00–4,000 eggs until hatching, releasing pelagic larvae with unknown larval duration. The low-energy estuarine environments in which ghost nippers are found suggest dispersal might be small and it is hypothesised that there likely is little exchange among estuaries. Natural mortality (M) of 1.2–1.8 and fishing mortality (F) of 0.23–0.94, have been reported, which are very uncertain but broadly consistent with other similar species.

Ghost nippers are harvested both commercially and recreationally. Ghost nippers are used only as bait, almost exclusively by recreational fishers, with commercial fishers supplying retailers selling bait to recreational fishers. Aboriginal harvest of ghost nippers has been documented in far northern NSW, where annual catch was estimated to be less than 15 kg (about 2,000–4,000 individuals) but state-wide catch is not known. Recreational annual harvests were estimated in 2000–01, 2013–14, and 2017–18 at 2.5, 1.3, and 0.5, million (m) individuals, estimated to weigh 7.5 t (± 1.5 t), 3.9 t (± 1.2 t), and 1.4 t (± 0.4 t) respectively. Those catches would have equated to 242%, 108%, and 30% of the commercial harvests in the corresponding years but comparisons among the years is not sensible because different sampling frames and survey methods were used in the three surveys. The survey methods, particularly in 2013–14 and 2017–18, however, mean those recreational catches likely were significant underestimates. Small

[13] Status of Australian Fish Stocks (www.fish.gov.au/).

[14] Chick, R.C. 2020. Stock assessment report 2019 — Estuary General Fishery (Hand Gathering) — Ghost Nipper (*Trypaea australiensis*). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 59 pp.

[15] Several records of *Trypaea australiensis* also were recorded from relatively deep shelf waters around Rowley Shoals on the North-West Shelf by the CSIRO during benthic surveys in the 1980s and early 1990s.

catches (2.4–42 kg per year) have been reported from charter fishing operations in far-northern NSW but no other catches are reported from charter fishing elsewhere in NSW.

Commercial harvest of ghost nippers is by few authorised fishers (6–13 since 2009–10) operating for 4–9 fishing business, with just a couple of businesses taking most of the total catch. Total catches generally have been increasing since the early 1990s, with near-zero catches prior to 1991–92. Total catches were less than 2.5 t during 1991–96, 1998–2000, 2001–02, and 2006–2009 and mostly 3–4 t in intervening years. Total annual catches since 2009–10 have been 3.6–5.1 t, with the single exception of 2010–11 (2.6 t). Commercial catches of ghost nippers tend to peak in summer (particularly December–January), probably reflecting increased recreational fishing during summer holidays, but relatively high catches often continue to mid-Autumn. Catches during July–November of 2019–20 appear roughly consistent with those in corresponding months of previous years but summer peak catches appeared very low. It cannot be inferred whether that apparent depression is real or reflects lagged-reporting, nor whether recent bushfire-related suppression of tourism in NSW has resulted in reduced markets for ghost nippers.

Effort data prior to 2009–10 are particularly subject to variations and uncertainty in reporting requirements but appear to have varied substantially between highs of around 350–500 fisher-days per year during 1991–99 and lows of around 100–200 fisher days per year during 2001–2009. Catch rates also are uncertain prior to 2009 but appeared to increase sharply from below 15 kg/fisher-day prior to 2001–02 to peaks of over 36 kg/fisher-day in 2002–03 and 2004–06 and above 18 kg/fisher-day in other years during 2002–2008. CPUE since 2009–10, when effort reporting has been more robust and reliable, has been variable within approximately 7–10 kg/fisher-day or about 1.5–3.0 kg/fisher-hour and has showed no consistent trend over the last decade.

Commercial effort for and catches of ghost nippers are extremely uneven spatially, with 80–99% (average 92%) of total annual catches since 2009–10 being taken from the Port Hacking estuary (Region 4). Relatively consistent catches have been taken from only one other estuary (Shoalhaven/Crookhaven, Region 6), and there only since 2013–14, coincident with commencement of fishing by a new entrant to the fishery. This distribution of catch most likely results from the fishing habits of the very few commercial fishers who focus on ghost nippers and take the majority of catches. Periodic dips in catches, for example, correspond well with periods of inactivity by just a single regular fisher. CPUE from the Shoalhaven/Crookhaven estuary was relatively consistent during 2013–17 and has increased since. CPUE from Port Hacking, however, increased during 2013–16 and has been steadily decreasing since, though remained above the long-term average in 2018–19.

Very small catches (<0.3 t) have been taken irregularly from 12 other estuaries but none of those places has been fished consistently for ghost nippers. Peaks of catches and catch rates in estuaries other than Port Hacking or Shoalhaven/Crookhaven generally have been followed by rapid declines or cessation of fishing activity by one or few individuals and it is not known whether those changes have reflected localised depletions of nipper populations or redirection of effort to other species or fisheries.

The distribution of recreational catches was estimated in 2017–18, when catches were approximately equally distributed among recreational survey areas 1, 2, 5, and 6 (18–27% of catch in each), effectively mapping to commercial regions 1–3 and 6–7. These data indicate relatively little spatial overlap between areas of peak recreational or commercial catches except perhaps in the Shoalhaven/Crookhaven estuary.

The Committee was provided with preliminary results from fishery independent surveys of ghost nipper populations in four estuaries in 2015–16 and 2016–17, including the two main commercially harvested estuaries (Port Hacking and the Shoalhaven river). Those surveys were used to provide probabilistic estimates of population sizes and total harvests at a range of harvest fractions in each estuary. Population estimates varied considerably between years in each estuary, as might be expected of a relatively short-lived, highly fecund species, probably vulnerable to large inter-annual variations in recruitment. In the two commercially harvested estuaries in both years, however, commercial harvests in 2015–16 and 2016–17 years would have translated to relatively low harvest rates at even the lowest (and most likely) biomass estimates (~3–13% Port Hacking, <2% Shoalhaven/Crookhaven). Harvest rates would have remained low (~2–6%) in 3 out of the 4 cases even allowing for recreational harvest equivalent to the commercial catches. Recreational or commercial harvest from the other two estuaries seem likely but no estimates were available so the standing of postulated harvest rates with respect to actual catches cannot be inferred. It also was noted in the assessment report that all the fishery-independent estimates of biomass likely were under-estimates because sub-tidal ghost nipper habitat was not sampled and it was assumed that samples collected 100% of nippers in the sample sites. These results together suggest a relatively under-developed fishery potential, at least in the sampled estuaries, notwithstanding the short-term of the surveys and uncertainties about recreational harvests.

The ghost nipper stock was considered 'sustainable' by Chick (2020), based on the weight of evidence from recent fishery performance, improved commercial reporting, ghost nipper biology and likely population dynamics, and the results of recent fishery-independent surveys of some estuaries.

3.2.4 Beachworms

The Committee relied heavily on an assessment of beachworms provided by the Department[16] for insights to stock status, supplemented by discussion with fishers at the public forum in Sydney on March 10.

Beachworms are marine polychaetes found predominantly in the intertidal areas of exposed-coast sandy beaches, though there also are reports of significant sub-tidal populations to substantial depths and distances off-shore. The main species harvested in NSW is the stumpy or king worm (*Australonuphis teres*) but two other species (*A. Parateres*, *Hirsutonuphis mariahirsuta*) also are taken occasionally by recreational and commercial fishers. Most available life-history information is for *A. terres* and it is not known how life-history or population dynamics differ among the three species.

A. terres occurs from Queensland to South Australian waters but is most abundant on beaches from southern Queensland to eastern Victoria. Individuals can reach up to 1 m long, weigh over 36 g, and live for up to 9 years. Individuals in the north of NSW tend to reach larger sizes than in the south. Females mature at about 42 cm long and carry over 100,000 eggs more or less continuously, with broadcast spawning and external fertilisation occurring throughout the year. Larvae are believed to be dispersed widely by ocean currents and there is considered to be a single harvested stock along the NSW coast, notwithstanding the presence of up to six intermixed, widely distributed genetic groups.

Beachworms are taken only for bait, by both commercial and recreational fishers. Commercial catches generally are sold through retail outlets to recreational fishers, for bait. Recreational annual harvests were estimated in 2000–01, 2013–14, and 2017–18 at 2.9 t (± 0.7 t), 2.4 t (± 0.9 t), and 0.6 t (± 0.3 t) respectively, equating to 13%, 30%, and 9% of the commercial harvests in the corresponding years. Different sampling frames and survey methods used in the three years, however, mean that these estimates are not comparable directly and the latter two in particular likely underestimate the total NSW recreational catch. Beachworms also are taken by indigenous fishers and it has been estimated that up to 0.5 t might be taken annually in far northern NSW, but state-wide catch has not been estimated.

Commercial fishers tend to select larger *A. terres*, with catch sampling indicating on average that more than 40% of catches are worms > 10 g and 80% of catches are of worms > 7 g. Commercial catch records were provided from 1984–85 to 2020 and indicated peak harvests in 1994–97 of a 31.2–37.7 t, relatively high annual catches (17–23 t) in 1989–90 and 1997–2005, and subsequently declining catches to a low of 5.5 t in 2015–16 followed by slight increases (to 7.7 t) since. Fishing effort generally has varied roughly in parallel with catch since the early 1990s and catch rate has been relatively consistent over most of that period, though with a conspicuous dip during 2005–09[17]. Catch rates to date in 2019–20 have dropped in the most fished regions, but it cannot be inferred whether those changes reflect incomplete reporting, response to the introduction of quota management, or effects of recent seasonal events, most notably bush fires, on markets (for example, via effects on tourism to NSW regions). Overall catch between July 2019 and January 2020 showed a monthly pattern very similar to that in previous years, though with a lower peak in December-January. Monthly catch rates overall have been relatively constant since the beginning of quota management, though generally below those from corresponding months in most years since 2009–10.

The bulk of commercial catch since 2009 has been taken from Regions 3 (36–72% annually) and 4 (15–46%) followed by Region 1 (7–18%), with little catch taken annually from Regions 2 (<1%) or 5–7 (generally <5%, though 8–9% of annual catch was taken from Region 6 in 2013–15). The single estimate of distribution of recreational catch (in 2017–18) indicated that over 50% of that catch was taken from Region 6. There is significant regional variation in patterns of annual commercial catches, though the main harvest regions have returned sustained catches with relatively stable catch rates since 2014–15 or before. It is notable, however, that CPUE in Regions 1, 4, and 6 declined during 2009–14. Beachworms are taken commercially in all months in most regions and years, though fishing effort and catches tend to peak in summer months, likely related to summer holidays and associated recreational demand for bait.

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[16] Chick, R.C. and Barnes, T.C. 2020. Stock assessment report 2019 — Estuary General Fishery (Hand Gathering) — Beachworms (Onuphidae). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 70 pp.

[17] It should be noted that multiple changes in reporting requirements up to and including 2009 mean that comparisons of CPUE over the full history of available data should be regarded with some caution. CPUE data since mid-2009 generally will be most reliable.

Beachworm harvest varies spatially within Regions, with 56 beaches being fished commercially since 2009–10 but just 12 beaches fished in all years, 7 of which were in Region 3. Beachworm distribution within beaches has been attributed to beach morphology and wave energy and so is likely to change frequently, as well as in response to harvest. Catch histories of individual beaches suggests that beachworms might be vulnerable to periodic localised depletion but that such effects are unlikely to be long-lived, perhaps reflecting the continuous reproduction and larval dispersal dynamics of the animals.

Results were provided from a rudimentary catch-only based assessment model of the NSW beachworm stock, with projected stock scenarios under alternative constant total (recreational and commercial) harvest rates of 10 t and 15 t per annum. Such models rest on several assumed (somewhat arbitrary) conditions and their results should be considered with caution, and certainly not as robust predictions of stock behaviour under harvest. There currently is no harvest strategy or specific objectives for this fishery or for the beachworm stock but notional target and limit reference points of 40% and 20% of potential unfished biomass were used to assess model results. Model outputs of feasible historical stock status, given estimated catches, and (very wide) ranges of feasible projections of future biomass were provided. Trajectories of stock status to the present mostly were consistent with the stock currently being above the limit reference point and perhaps closer to the target. Projected total harvest at 10 t per year (7 t commercial, 3 t recreational) resulted in mean and median biomass projections that were increasing slightly toward the target reference value, though with 80th percentile boundaries that included stock collapse to zero biomass. Most projections of biomass under 15 t annual harvest declined over 10 years, with mean and median projections falling below the limit reference point after approximately 5 years. No projections were done with current TACC settings, but the results presented to the Committee suggest that substantially increased harvests likely would come with considerable risk to the beachworm stock.

The NSW beachworm stock status was assessed as ‘undefined’ until recently, when it has been considered ‘sustainable’, based on ‘weight of evidence’ from improved biological information, some recent fishery-independent survey data, and recent analyses of catch and effort data. Poor estimates of recreational harvest, some suggestion of localised depletion within some Regions, reporting inconsistencies, and poor understanding of fishery-independent drivers of abundance remain key uncertainties in the assessment.

3.3 Conclusions

The four species considered here are all harvested from discrete habitats separated spatially and with little likelihood of connection among local populations other than by larval dispersal. It seems likely that pipis and beachworms exist as meta-populations of moderately well-connected (by larval dispersal) sub-populations on ocean-facing beaches. Estuary cockles and ghost nippers, on the other hand, appear likely to have relatively little mixing among populations local to specific estuaries. Each of the species exhibits some degree of aggregating behaviour within local habitat patches and often are targeted in high-density patches. These characteristics suggest that each of the species is vulnerable to serial depletion within and across habitat patches (beaches or estuaries) and likely to manifest hyper-stability of catches and catch-rates as aggregations are serially harvested. Catch histories for pipis and cockles appear consistent with multiple instances of such localised serial depletion and will require careful management of TACC amount and its distribution among regions, and perhaps even among estuaries or beaches within regions, to avoid future localised stock shocks.

The NSW pipi stock and fishery has a demonstrated ‘boom-bust’ history but appears to have been rebuilding over the last decade, probably as a result of management actions taken in response to the last stock crash. Recent commercial catches and catch-rates mostly increased to about 2015 and have been relatively stable since, though there is some evidence of recently declining standardised CPUE in some regions. The pipi stock has several features that make it susceptible to serial depletion at local (beach) and Regional scales and there is some evidence in historical patterns of catches that Region-scale serial targeting and depletion has occurred. No specific objectives or harvest strategy exists for harvest of pipis in NSW but it seems likely that the stock currently is about mid-way between what the Committee considers reasonable limit and target reference points of 20% and 40% of unfished biomass respectively. The available assessment suggests that the initial TACC set for pipis is unlikely to result in stock decline and might allow for stock rebuilding, though prospects of serial depletion require careful monitoring.

It is difficult to assess the current status of the NSW estuary cockle stock(s) given the absence of any formal stock assessment analysis, uncertainties about stock structure and estuary-specific or overall population dynamics, and recent significant increases in non-reporting of fishing effort in two key estuaries. It is notable that reporting failures have been increasing over the last 4 years apparently without compliance action, despite the non-reporting consistently having been by a small number of the same known fishers. Continued reporting violations of this magnitude will render untenable any informed

adjustments of TACCs, including potential increases. The Committee understands that a proposal for research funding to investigate the population dynamics and stock structure of NSW estuary cockles is under consideration and endorses such an approach to resolving some of the key uncertainties for management of cockle harvest.

The NSW ghost nipper stock likely is a highly fragmented meta-population with many estuary-specific sub-populations of varying size and unknown, but probably low, connectivity. The available data, however, suggests stocks are reasonably robust to recent harvests in those estuaries favoured by commercial fishers. It seems likely that recreational fishers might harvest as many ghost nippers as commercial fishers but it also is likely that commercial and recreational harvests are well-separated spatially. Fishery independent data from the two main commercially targeted estuaries indicate robust ghost nipper populations there and that those estuary-specific fisheries probably are under-developed. Spatial separation of commercial and recreational fisheries means that TACCs set for ghost nippers are likely to operate with greater integrity locally than if there was substantial overlap in harvests, especially given the very uncertain estimates of recreational harvest. Key risks for the effectiveness of ghost nipper TACCs, therefore, are uncertainties in the amount and distribution of recreational catch and the prospect that distributions of commercial or recreational harvests might change materially. Poor quality and frequency of estimates of recreational harvests also is a key uncertainty in assessment of the state-wide status of the ghost nipper stock, given that most harvest in estuaries in the north and south one-thirds of NSW is likely by recreational fishers.

The NSW beachworm stock appears to be reasonably robust and stable under current harvest rates. The biology of the organisms likely provides considerable buffering against persistence of localised depletions, notwithstanding the prospect that some beaches could be heavily fished under current management arrangements. There is some evidence from catch history prior to 2019–20 that the beachworm stock could withstand continued harvest at the current, or slightly increased, rates but poor understanding of recreational harvest is a key uncertainty, and risk, in TACC setting.

A key issue raised at the public forum was the movement of quota among endorsement Regions in NSW, despite the regionalisation of fishing endorsements. Quota shares are not spatially restricted and so either leases of quota within fishing periods or permanent transfers of quota shares can result in movement of quota use among regions. That means that harvests of each species within any region largely are uncapped and large amounts of quota could be landed from any region where a leasing or purchasing fisher has an endorsement to operate. Region-specific allocation of quota might help reduce the risk of serial depletion of stocks across regions but also would entail material restrictions on fishers' opportunities to realise non-fishing benefits from quota, either through leasing or transfer of shares.

An alternative approach to regulating local harvest also was discussed. Both fishers and Department officers considered it might be feasible and affordable to implement annual fishery-independent surveys of selected beaches or estuaries to estimate the likely local population status just prior to each fishing period and use that information to set agreed caps to harvest during the coming fishing period. Such an approach has been used in pipi and cockle fisheries elsewhere nationally and internationally and warrants consideration as a cost-effective approach to stock monitoring and management to mitigate risks of localised population depletion or serial depletion of whole stocks.

No regular leading indicators of stock status (e.g., fishery-independent surveys, recruitment indicators) are available for any of the species considered here and so TACC setting necessarily is reactive, based on assessing stock response to previous settings. An appropriate, and probably only available, TACC-setting strategy, therefore, is to set TACCs for at least 2-3 years before revision, so that stock responses can be assessed, unless there is immediate evidence of stock decline that would require intervention to prevent further decline. Such a strategy, however, is inherently encumbered with the risk that stock declines or improvements are seen only after they have occurred, potentially precipitating more severe corrections or missed opportunities, respectively, than if they had been anticipated. Implementation of a cost-effective, regular pre-season fishery-independent survey regime such as that discussed above would be of great help for making better-informed TACC Determinations and reducing dependence on reactive adjustments to TACCs.

4. ECONOMIC CONSIDERATIONS

4.1 Introduction

The Estuary General (EG) Fishery is a diverse fishery involving several species and fishing methods, including handlines, traps, prawn nets, fish haul netting, and hand gathering (HG). The latter is the subject of this report, with four species having individual transferable quotas (ITQs): pipis, estuary cockles, ghost nippers, and beachworms.

Beachworms and ghost nippers are caught exclusively for recreational bait. Pipis and Cockles are marketed primarily for human consumption, but may also be sold for bait. The fishery is multi-species but each of these four hand gathered quota species is separately targetable, and hence their TACCs can be assessed at individual species level without need to consider technical interactions in their harvest.

The fishery has a range of input controls as well as output controls, including the need to hold region-specific 'access' shares in one or more of seven Regional access share classes and have a minimum holding of such shares to receive an endorsement to fish in the associated Region(s). Each fishing business therefore is restricted to operate only in the Region(s) for which it holds an endorsement. Quota shares and allocations, however, are transferable among fishers without regard to the Regions in which they will be used. There were 73 fishing businesses owned by 64 shareholders with EG-Hand gathering access shares as of March 2020. Seven fishing businesses held access shares but no endorsement because they did not meet minimum shareholding requirements (100-125 shares depending on the Region). About one third (22) of the 73 EG-HG fishing businesses are exclusively EG-HG, with the remainder having one or more other EG Fishery endorsement types or endorsements in other fisheries.

4.2 Volume and Value of Production

4.2.1 Gross value of production and contribution of TACC species

The gross value of production (GVP) of EG-HG quota species in 2018–19 was about $2.8 m, increasing from $2.4 m in 2009–10.[18] The increase mostly was due to increased catch of pipis, with increased value from $0.8m in 2009–10 to $1.7m in 2018–19. The value of landings of beachworms, in contrast, declined from $1.2m in 2009–10 to $0.5m in 2018–19. The value of landings of other species has remained relatively constant, resulting in a shift in the relative contribution of each species to total GVP (Figure 4.1).

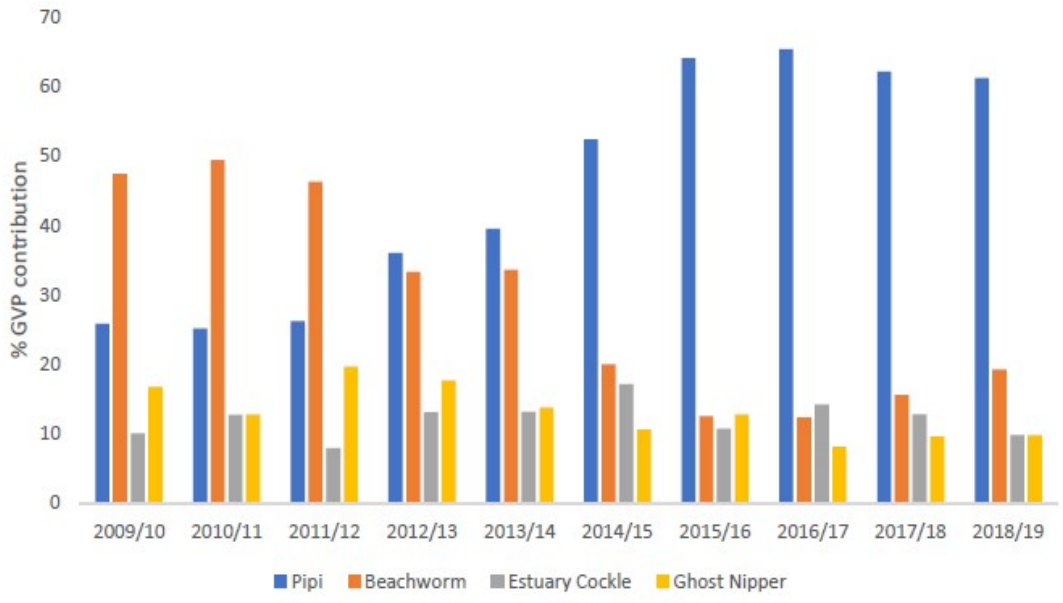

Figure 4.1: Percent contribution of estimated nominal GVP by EG-HG quota species (2009–19)[19]

[18] Real values are transaction values at each time adjusted for inflation between that time and a standard reference period (here 2018–19). Nominal values are actual or 'raw' transaction values at each time, without adjustment for inflation from previous or later times. Comparison of real values over time are more sensible because effects of inflation have been removed. The Consumer Price Index (CPI) relating to Sydney was applied for this adjustment.

[19] Source: Mckinnon, Fiona (2020) Estuary General Fishery - Hand Gathering Management Report February 2020, OUT20/, NSW Department of Primary Industries, Fisheries.

4.2.2 Market prices

The fishery supplies markets for both bait and human consumption. Beachworms and ghost nippers are supplied exclusively to the bait market. Cockles and pipis are mostly supplied to the human consumption market, but can be supplied only to the bait market from beaches where biotoxin levels are elevated.

Anecdotal comments suggest prices for beachworms and nippers remained fairly constant during 2009–10 in nominal terms, decreasing in real terms by up to 35% over the 10 years. Prices for both pipis and cockles appear to be increasing, and there is an apparent asymmetry between the prices in recent years.

Preliminary demand modelling[20] suggests that price of pipis is influenced by the quantity landed of both pipis and cockles, but price of cockles is influenced only by landings of cockles (Table 4.1). The demand models in Table 4.1 estimate how the price of each species is affected by changes in the quantity landed. All variables are expressed as natural logs, where $\ln(P_{pipi})$ and $\ln(P_{cockles})$ are the logs of the price of pipis and cockles respectively, and $\ln(Q_{pipi})$ and $\ln(Q_{cockles})$ are the logs of the quantity landed of pipis and cockles respectively. The coefficients of the log-linear model represent the price flexibilities, that measure the percentage change in price due to a one percent change in quantity landed. The Adjusted R^2 measure represents the proportion of variation in price that is captured by the model, in this case about 84% for both species.

Table 4.1. Preliminary demand model results for pipis and cockles.

	$Ln(P)_{Pipsi}$			$Ln(P)_{Cockles}$		
Parameter	**Coefficients**	**Standard Error**	**t-Statistic**	**Coefficients**	**Standard Error**	**t-Statistic**
Intercept	3.636	0.440	8.265	1.411	0.179	7.893
$Ln(Q)_{Pipi}$	-0.276	0.048	-5.701			
$Ln(Q)_{Cockle}$	-0.289	0.101	-2.870	-0.088	0.045	-1.951
Time	0.045	0.006	6.934	0.030	0.003	11.009
Adjusted R^2	0.836			0.835		

Preliminary estimates of price flexibilities suggest a 10% increase in pipi catch would decrease pipi price by 2.7%, meaning total revenue still would increase but by less proportionally than increase in pipi catch. A 10% increase in cockle catch would decrease cockle price by 0.9% and decrease pipi price by 2.9%, suggesting that cockles are the preferred product and consumers would switch from pipis to cockles if more cockles were available. Changes in the cockle quota, therefore, might affect pipi producers but not vice versa. Increasing both pipi and cockle quota (and catch) by 10% thus would result in almost a 6% decline in pipi price but only (roughly) a 1% decline in cockle prices. Both species exhibited exogenous increasing price trends (4.5% a year for pipis, 3% for cockles – indicated by the coefficients relating to the time variable) that represent shifts in market demand for these species.

The above analysis is preliminary only, but if these results are correct then increasing cockle quota without increasing pipi quota may result in a net loss for the fishery given the differences in their relative values, as the reduction in pipi revenue may be greater than the increase in revenue from cockles. It is recommended that further analysis be undertaken to improve and validate these demand models, as the market interactions may have implications for future quota setting.

4.2.3 Economic drivers of production

A significant relationship between the level of fishing effort for pipis and the price and catch rate for pipis was observed from the data (Table 4.2), although this relationship was relatively weak, explaining only 28% of the variation in the level of pipi fishing effort. 'Effort' in the analysis was not standardised, and also does not take into account changes in spatial distribution of effort, so the results are preliminary only. They suggest, however, that the level of fishing effort for pipis is highly responsive to both price and catch rate, with a 10% change in either resulting in a 13% change in the number of days fished.

[20] These results are based on simple models only. Tests for market co-integration have not been undertaken, nor has a dynamic systems approach been applied, which may be more appropriate if the two species are related through the market. The results assume also that quantity landed is exogenous (i.e. is not determined by factors internal to the fishery), but as seen in the next section, fishing effort (and hence landings) is likely to be endogenous (i.e. a function of influences within the fishery). This disparity arises from the preliminary nature of the analyses and, as a consequence, the results are indicative only and hint at what could be done with better data and deeper analysis.

A similar analysis was run for cockles but no significant relationship was observed. It was noted, however, that there was substantial substitution between hours fished per day and the number of days fished in the more recent years when hours fished information was available, which would have distorted the model based on days fished. Earlier estimates of days fished also were uncertain as they were not specifically recorded as fishing for cockles.[21]

Table 4.2. Preliminary (log) effort supply (days fished) model for pipis (1984–19). The log of pipi fishing effort in days is regressed against the log of the price of pipis and the log of catch per unit of effort (CPUE, catch per day) as a proxy indicator of stock abundance. The coefficients in the table represent supply elasticities — the percentage change in the supply of fishing effort due to a one percent change in price or CPUE.

Parameter	Coefficients	Standard Error	t-Statistic
Intercept	-0.247	2.016	-0.123
Ln(P)	1.260	0.327	3.851
Ln(CPUE) (kg/day)	1.279	0.350	3.659
Adjusted R^2	0.285		

There were insufficient data to examine these relationships for other species, but, anecdotally, fishing effort for beachworms declined by roughly 30% over 2009–10 to 2018–19[22] while real prices declined by around 35%. Catch rates over this period were fairly constant, suggesting a significant response of effort to changes in price. In contrast, fishing effort (in days fished) and catch per unit effort for ghost nippers was relatively constant over this period, despite the apparent 35% reduction in real prices.

4.3 Quota Markets Functioning

4.3.1 Quota allocations

Initial quota allocations were skewed, with a small proportions of fishing businesses allocated large proportions of quota shares. The emphasis on catch history for quota allocation (95% weight for cockles, nippers, and beachworms, 80% for pipis) meant the skew largely reflects the varying history of dependence of fishers on each species. The (minor) use of prior endorsements (20% weighting for pipi, 5% otherwise), however, meant that all fishers got some quota, even if only very small amounts and even in the absence of any history or taking a species. Over half of the beachworm quota shares, for example, were allocated to five fishing businesses and over 80% was allocated to 11 businesses, whilst the remaining 20% was shared amongst 46 businesses. Similarly, pipi quota shares were allocated to 58 fishing businesses, with over half allocated to 10 fishing businesses and about 80% allocated to 23 businesses. Around 95% of ghost nipper quota shares were allocated to just three fishing businesses. The “need” for active fishers to buy quota from fishers who had been allocated quota but had not previously been involved in the fishery for one or more species was seen as inequitable by some fishers.

4.3.2 Quota trading

The EG-HG quota market has had little opportunity to develop yet given that quota was allocated only at the end of 2018–19, with 2019–20 (July 1 2019–June 30 2020) being the first full year of operation. Industry, through their submissions to the TAF, noted difficulties in identifying sources for additional quota, including uncertainty as to how much quota was unused at a given time and who held that quota.

There nevertheless is evidence that quota trading has occurred. For example, 11 beachworm quota share transfers took place in the first seven months of the 2019–20 Fishing Period, representing 2.2% of the TACC, with four businesses transferring their full allocation. Similarly, 36 fishing businesses transferred pipi quota shares in the first seven months of the 2019–20 Fishing Period.

4.4 Economic Performance Indicators

Information on economic performance is limited, and information on quota trading and leasing prices is not yet available. Industry members provided anecdotal information that lease prices for pipis were roughly 30% of the market value of product, although given the limited development of the quota market

[21] Chick, R.C. 2020. Stock assessment report 2019 – Estuary General Fishery (Hand Gathering) – Estuary Cockle (*Anadara trapezia*). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 53 pp.

[22] Chick, R.C, Barnes, T.C. 2020. Stock assessment report 2019 – Estuary General Fishery (Hand Gathering) –beachworms (Onuphidae). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 70 pp.

these estimates may be unreliable. Lease and transfer prices will provide better information about changes in the economic performance of the fishery as the market develops, but at this stage provide unreliable indications of economic performance.

Fishing for these species is labour intensive, with most non-cash costs representing returns to labour. Information in the pipi assessment report[23] suggests the average catch per day in 2018–19 was valued at $562/day. The total number of days fished and number of businesses reporting catch together indicate that the average number of days fished was 120. This represents an average fishing business revenue of around $67,500. The average income in Australia in 2019, for comparison, was $86,300.[24] Most fishers were involved in more than one fishery, however, and those few who were fully dependent on the pipi fishery may have fished for more days than the average, meaning that extrapolations of overall economic performance of the industry from the limited information available should be considered with caution.

South Australia has developed a simple gross margin model for assessing quota changes in their pipi fishery[25] that factors in price changes due to quota changes as well as cost changes in the fishery. The report includes a survey template to collect data necessary to apply the model. Development of a gross margin model for the NSW pipi fishery would aid future TACC-setting processes. The model would need to include the cockle fishery given likely market interactions.

The stock assessment for ghost nippers suggests potential to increase catch within limits of stock sustainability and there are some indications that the resource is underused. The fact that harvest of nippers is concentrated with just two fishing businesses in primarily one region suggests that there may be other constraints to expansion of nipper harvesting. The species also is harvested by recreational fishers for use as bait. The relative ease of harvest by recreational fishers and the declining real price may suggest that the market is the main limiting factor in expansion of the commercial harvest of nippers.

4.5 Economic Targets for the Fishery

The fishery is yet to have developed a harvest strategy and no formal economic targets have been identified. The stock assessments estimated stock status relative to estimated maximum sustainable yield. Most stocks appear likely to be on positive trajectories under current TACCs.

4.6 Management Cost Recovery and Community Contribution

Annual management charges are payable by fishing business owners, as for managed fisheries. Management charges contribute to the cost of managing NSW commercial fisheries. Management charges for a fishing business are based on the number of share classes held within that fishing business and charged in 2019–20 at $1,184 each for the first two share classes held with a cumulative discount of 40% applying to each additional share class held.

The distribution of business by share class was not available at the time of writing, although many hold other EG Fishery endorsements as well as shares in other fisheries. The total management fees, including community contributions, from EG-HG shareholdings alone are estimated to be $93,032, based on 59 businesses holding EG-HG access shares for only one Region, 7 holding access shares for two Regions, and two business holding EG-HG species quota but no Regional access shares. This estimate does not include fees paid by any of these businesses that also hold access shares for other (i.e., non-HG) EG share classes and represents 3.3% of the EG-HG GVP in 2018–19.

Such a cost structure results in a disproportional burden on fishers with small quota holdings, as they pay the same management charge as fishers with high quota holdings but similar share class holdings. Some fishers were allocated quota without having any previous track record in the fishery, and would be subject to these charges without a commensurate revenue. Linking cost recovery to quota holdings would result in a more equitable distribution of the burden of management cost recovery.

The fishery also is subject to a community contribution, as are all NSW fisheries. This is based at the fishing business level, with the annual community contribution of $100 per fishing business. The community contribution represents only 0.3% of the whole-of-fishery GVP of the four quota species in 2019–20.

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[23] Johnson, D.D. 2020. Stock assessment report 2020 – Estuary General Hand Gathering Fishery – Pipi (*Donax deltoides*). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute: 71 pp.

[24] ABS 2020. 6302.0 - Average Weekly Earnings, Australia, Nov 2019. ABS, Canberra.

[25] Lisa Rippin and Julian Morison 2012. Lakes and Coorong Pipi Fishery Gross Margin Model Development. A report prepared for Primary Industries and Regions South Australia, EconSearch, Adelaide.

4.7 Conclusion

The EG-HG fishery is a relatively small fishery in terms of GVP but is important to the livelihoods of a small number of NSW fishers. The fishery is labour intensive, with the GVP also largely reflecting the level of income generated by the fishery.

The four quota species considered in this report are highly targetable, so each can be considered separately to a large extent as there are no technical interactions at the point of capture. There is some evidence that pipis and cockles are linked through market interactions, and if this is true then changes in the quota for cockles will also have implications for the revenue of the pipi component of the fishery. Increasing the cockles quota could – potentially – result in an overall reduction in fishery revenue unless the pipi quota also was increased. The prices of both pipis and cockles appear to be increasing due to shifts in demand. Issues such as quota market efficiency therefore are likely to become increasingly important. There is some anecdotal evidence that the quota trading market is not working efficiently, but it is expected that this will improve over time. There is evidence that quota trading has taken place, and that some autonomous adjustment (through fishers transferring their full allocation) also has taken place.

The available information on the prices of beachworms and ghost nippers suggests that prices are decreasing. These species are aimed at the bait market, which has many competitors such as prawns and artificial baits such as soft plastics and lures, which are increasing in popularity with recreational fishers. It appears from a biological sustainability perspective that ghost nippers are underused and there is scope for expansion but it is likely that economics of the fishery is a major constraint to such expansion.

5. MANAGEMENT CONSIDERATIONS

5.1 The Estuary General Fishery — Hand Gathering

The Estuary General Fishery (EGF) is a share managed, multi-species fishery for estuarine and coastal species that uses 9 endorsement types, to regulate harvest using 17 different fishing gears. There are two types of shares in the fishery, the first is access shares which determine the Region(s) where a fisher can operate and the type of gear they can use. The second is species quota shares that determine the amount of quota for a certain species that a shareholder is allocated in each fishing period.

The EGF is divided into seven geographical regions, with access to each Region controlled through allocation of access shares. A fishing business, or its nominated fisher, needs to hold a minimum number of access shares with specific gear-type endorsements (e.g., Hand Gathering) to fish in a given Region using those gears. Fishing businesses can hold access shares for one or more Regions, with one or more gear-type endorsements for each Region.

Species quota shares are not spatially constrained, so the use of species quota shares can be undertaken in any area for which an operator has access shares. The trade of any species quota (either by within-season leasing of quota or permanent sale of quota shares) is not spatially constrained, meaning that species quota could be traded from an operator in one region to operators in either the same or any other region.

Hand Gathering endorsements exist and are active in all Regions, with the highest numbers of HG access shares being for Regions 3 and 4 in central NSW (Figure A1, Appendix 2). Commercial Hand Gathering is permitted in 76 estuaries and on more than 100 beaches across NSW. Many other estuaries and beaches along the NSW coast are not open to EG-HG fishing as part of the network of marine protected areas, local council sustainable development plans, or restrictions on harvest under Marine Biotoxin Management Plans.

The EG-HG sector harvests pipi, estuary cockle, ghost nipper, beachworm, cuttlefish, and mussel, four of which (pipi, cockle, nipper, beachworm) are subject to quota management. Harvest of the four quota-managed species requires a business to hold a HG endorsement with a minimum number of the relevant species quota shares. Region 4 was the region in which the highest number of species quota shares could be used at allocation in 2018–19, given businesses holding both species quota and access shares for that Region at that time.

The GVP of the EG-HG sector has been around $2.5–$3 million over the last 5 years. Pipis currently make the greatest contribution to the HG GVP, contributing approximately 4 times more than any other species since 2014–15. Some EG-HG operators target a range of different species over a fishing season, whilst others exclusively target only one species. Nine businesses rely solely on beachworms, 3 on cockles, 2 on nippers, and 3 businesses with HG endorsements exclusively catch pipis, whilst another 28 businesses get over 50% of their incomes from pipis.

Fishers typically target a single species during fishing trips as switching between species requires changing gears or location or both. The EG-HG therefore functionally operates as four separate target fisheries, with some common operators, rather than a single multi-species fishery with mixed catches. The stocks of some of these species extend both north and south of NSW waters but harvest in other jurisdictions is not thought to have a significant impact on the abundance of these species in NSW, due to either the small levels of harvest in other jurisdictions or the population biology of the species.

5.2 Catch History Since 2009–10

5.2.1 Pipis

The NSW pipi fishery is currently recovering from a significant depletion event which saw catches fall from over 568 t in 2004–05 to 9 t in 2010–11. The cause of this depletion likely was a combination of exploitation, variable recruitment, and environmental reasons, such as toxins or viral diseases resulting from algal blooms. Catches and catch rates generally have increased since the dramatic drops through to 2010–11, stabilising in the past 5 years at an annual catch of around 100-150 t. Pipis are primarily harvested for human consumption, with only 5% of catches estimated to go to the bait market.

Regions 1-4 account for 98% of the total pipi catch. Contributions of various Regions to total catch have shifted over time but Regions 3 and 4 have been the highest contributors to the total since 2009. Region 3 had the highest exploitation levels historically, likely through having the most accessible beaches and the highest number of endorsed fishers, but Region 4 has had the highest total catches since 2016–17.

Region-specific catch rates of pipi generally have increased since 2009–10, although some slight decreasing trends are evident in Regions 1 and 3 over the last 5 years. Pipi catch rates must be interpreted with caution given the potential for hyper-stability in Regional catch rates as fishers move from one beach-specific population to another within Regions.

The TACC for pipi in 2019–20 was 147.4 t, which was the average annual catch of pipis over the 4 year period 2013–17. The reference period for TACCs set by the Department in 2019 typically has been the 8-year IAP reference period of 2009–17, but the reference period used to set the pipi TACC excluded the low catch years following severe depletion of the stock, reflecting a more stable period for the stock.

Assessment against the SAFS[26] criteria indicates the stock is now sustainable. Modelling and projections undertaken by the Department suggest that pipi abundance is stable or increasing and a constant catch of 150 t (including recreational harvest) likely will allow the biomass to continue to increase slowly. There is uncertainty with regards to these results, however, given the many underlying model assumptions, and some projections at a total catch of 150 t include trajectories that result in zero biomass. The relatively few beaches along the NSW coast that are commercially fished for pipis also provide some insurance against this uncertainty by ensuring that a proportion of the stock is protected from harvest.

5.2.2 Estuary Cockles

The estuary cockle stock is currently classified as undefined due to limited understanding of the biology and population dynamics of estuary cockles, uncertainty about recreational catches, and poor reporting by commercial fishers creating uncertainty about recent fishery indicators of the cockle stocks.

Catches of cockles in NSW have increased since 2009–10 from around 30 t to between 50 and 80 t in the last 5 years. It is likely that effort has increased similarly but effort data for the fishery is incomplete as greater than 50% of reported catch in the last 3 years had no attributed effort. The under-reporting of effort has seriously compromised the effort and catch rate data in the cockle fishery, and the estuary level effort data that is available is very noisy with contrasting catch rate trends in different estuaries. Catch rate estimates therefore cannot be used as indicators of abundance or biomass trends in the fishery.

Over 90% of the catch of cockles comes from 5 estuaries, with the single estuary contributing the greatest catches changing sequentially over time. Three of the 5 estuaries (Wallis Lake, Shoalhaven/Crookhaven River, and Lake Illawara) have had relatively stable catches but Pambula Lake and Merimbula Lake have both experienced significant declines in recent years after earlier spikes in catches. The sequential movement through estuaries and estuary level depletions after high catch periods indicate that cockles are vulnerable to localised depletion.

The TACC for cockles in 2019–20 was 29.2 t, which was the average annual catch of cockles in the EG-HG fishery over the 5 year period 2009–14. The Department's rationale for using that reference period has not been provided to the Committee. Cockles are primarily harvested for human consumption, including by recreational fishers, though recreational harvests cannot be estimated from current data.

5.2.3 Ghost nippers

Ghost nippers are harvested to supply the recreational bait market. The nipper fishery is considered sustainable, with all available indicators suggesting healthy stocks in a number of estuaries. State-wide catches since 2009–10 have fluctuated between 2.5 and 5.1 t, with a general increasing trend since 2009–10 accompanied by relatively stable catch rates. Monthly catches indicate highest catches in summer months (December and January) which likely reflects increased demand from the live bait market during the long summer school holidays.

One estuary, Port Hacking, contributes over 90% of the state catch. Catch rates for that location generally have been increasing and currently are above the long term average. More catches are taken by recreational fishers than the commercial sector outside of Port Hacking. Commercial fishing for nippers in the Shoalhaven/Crookhaven River commenced in 2013–14 and has sustained relatively consistent levels of catch since this time. Independent surveys undertaken in 2015–16 and 2016–17 indicate that current catches in Port Hacking and Shoalhaven are within reasonable harvest fractions and higher catches potentially could be sustained. The surveys also found that significant populations also exist within Port Stephens and Terranora Inlet that have the potential to support commercial harvests, though those estuaries also may have significant recreational harvests of ghost nippers.

The TACC for nippers in 2019–20 was 5.1 t, which was the maximum annual catch of nippers over the 8 year period 2009–17. The maximum catch during the reference period likely was used in recognition of the underdeveloped nature of the nipper fishery.

[26] Status of Australian Fish Stocks classification regime (www.fish.gov.au)

5.2.4 Beachworms

The NSW beachworm stock is classified as sustainable. Annual catches of beachworms since 2009–10 have been relatively stable between 6 and 11 t, which is well below historical highs of over 20 t between 1994–95 and 2001–02. Catches however have largely mirrored effort, while catch rates have been relatively stable, suggesting that the lower catches seen over the past 20 years might have been driven by changes in effort, perhaps linked to changes in demand or removal of available ground by declaration of marine parks, rather than stock status. Over 80% of catches come out of Regions 3 and 4 in central NSW, where catch rates generally have been either stable or increasing since 2009–10.

The TACC for beachworms in 2019–20 was 7.7 t, which was the average annual catch over the 8 year period 2009–17. Beachworm is harvested to supply the recreational bait market. Projections undertaken by the department suggest that a constant total catch of 10 t (including recreational catches) would allow the stock to remain stable, while increased catches above this level have a higher likelihood of depleting the stock and compromising sustainability.

5.3 Current Management Arrangements

5.3.1 Commercial fishing

Management of the EGF is governed by the *Fisheries Management Act 1994* and the arrangements are set out in the *Fisheries Management (Estuary General Share Management Plan) Regulation 2006*, *Fisheries Management (Supporting Plan) Regulation 2006,* and *Fisheries Management (General) Regulation 2019*.

The catch of pipi, beachworm, cockle and nipper is primarily controlled through spatially-explicit limited entry, Total Allowable Commercial Catches and Individual Transferable Quotas. These mechanisms are supported by a range of other management tools, including gear limits, spatial closures, and a size limit for pipis. Hand Gathering is restricted to methods of taking fish by hand, including using a single blade knife while diving, pump (or similar), tube or cylinder, spade or fork, or pliers. Fishers also may use a handheld cockle rake and a fork, chisel, or trowel for the harvest of pipis.

A suite of special controls were implemented after 2012 to stabilise pipi catches and allow the pipi population to recover from severe depletion of pipi stocks between 2004–05 and 2010–11. These included beach closures, a 6 month temporal closure, a minimum legal length (45mm total length or 32mm radial length), and a 40kg catch limit per fisher per day. The MLL was set at 45mm total length to protect pipis beyond the point at which 95% of the population is estimated to achieve maturity (44mm). Catches have since increased, likely as a result of these controls. The 6 month closure and daily catch limit have been removed since introduction of a pipi TACC and quota management in 2019–20 but the MLL has been retained.

There are currently 73 businesses owned by 64 shareholders with EG-HG shares, 22 of which are exclusively hand gathering businesses. The other 51 businesses own endorsements in other EGF share classes or other NSW commercial fisheries, or both.

Shareholders in the EG-HG fishery were allocated quota shares for species on the basis of the number of shares they held (20% for pipi, 5% for beachworm, cockles and nippers) and their catch history (80% for pipi, 95% for beachworm, cockle and nippers). The quota shares thus were allocated primarily on the basis of the catch history of each shareholder over the period 2009–17. Some shareholders will have received a small number of quota shares for species that they have never caught, however, because of the small fraction of species quota shares allocated simply on the basis of possession of EG-HG shares.

The Committee acknowledges that there are concerns among some businesses with how the species quota shares were allocated in the IAP process. It also is understood that some appeals to the IAP process remain open, and the outcome of those appeals might change the distribution of species quota shares among businesses. The IAP process outcomes are outside the remit of the Committee, however, and do not have a direct effect on the determination of the TACC for each of these species. It would be inappropriate, therefore, for the Committee to comment on either the IAP process or any appeals of it.

The catch amount represented by each species quota share in a fishing year is dictated by the Total Allowable Commercial Catch (TACC) for each of the species. TACCs relevant to the EGF are set for pipi, beachworm, cockle and nippers for each Fishing Period, from 1 July to 30 June the following year. The first TACC determinations were set administratively by the Department for the 2019–20 Fishing Period. The TAFC has been asked to determine the TACCs for these four species for the fishing period 1 July 2020 to 20 June 2021.

There is no harvest strategy for this fishery and the management arrangements in place do not contain performance indicators or reference points to guide management decision making or TACC Determinations. The Department has used proxy limit and target reference points of 20% and 40% of unfished biomass, respectively, in assessment reports for pipi and beachworm, but referred to neither in assessment reports for ghost nipper or cockle. The Department is currently developing a harvest strategy policy and intends to prepare draft harvest strategies for a number of trial fisheries over the next year, which will specify limit and target reference points.

5.3.2 Recreational fishing

The recreational catch of these species is primarily managed through bag limits of 20 beachworms, 100 nippers, and 50 in total for cockles, mussels, and pipis.

Recreational fishers can only harvest pipis for bait, not for consumption, and must not take pipis more than 50 m from the high-water mark on a beach. Surveys undertaken in 2000–01 and 2013–14 estimated a recreational pipi harvest of 7 t and 1.3 t respectively. These estimates equate to approximately 1% of the commercial harvest of pipi in those years.

Recreational fishers can take cockles for either personal consumption or for use as bait. The 2017–18 survey estimated a state-wide harvest of cockles of 10 kg. There is numerous anecdotal and compliance evidence of substantial recreational harvests of cockles in some estuaries, however, and it is acknowledged that the survey estimate is likely a non-credible underestimate.

The charter boat fishery harvests nippers with average annual catches estimated 14 kg/year. Greater than 90% of those catches are reported from the Tweed River. Recreational fishing surveys in 2000–01, 2013–14, and 2017–18 estimated annual nipper catches from the sector of 7.5 t (± 1.5 t), 3.9 t (± 1.2 t) and 1.4 t (± 0.4 t) respectively, though these figures cannot be used to infer a decline in recreational catches of nippers because the sampling frames and methods changed among surveys. Just over half of recreational catches are estimated to be taken in northern NSW while the remainder is taken in recreational areas 5 and 6 in southern NSW, outside of the core commercial fishery in central NSW.

Various state-wide surveys have estimated that the recreational harvest of beachworms represents between 9% and 30% of the commercial catch for those years. The recreational catch of beachworms, like that of ghost nippers, predominantly is taken in the northern and southern regions of the state, away from the core of the commercial fishery in central regions of NSW.

5.3.3 Aboriginal

Pipis and cockles are important species to the Aboriginal community in NSW and have been prominent in the diet of coastal Aboriginal communities for more than 10,000 years. Hand gathering of pipis and cockles is considered a traditional skill that continues to be widely practiced by coastal communities. There are few data on the harvest of these species by Aboriginal fishers, though interviews and surveys of Aboriginal fishers in northern NSW have estimated an annual pipi harvest of 3,056–6,380 individuals and an annual catch of 731–1,810 cockles. A small amount of beachworms and nippers also are estimated to be taken by Aboriginal fishers in northern NSW.

The Aboriginal Cultural Fishing Interim Access policy allows an Aboriginal person to take double the prescribed recreational bag or possession limit, or up to specified limits for certain species to provide for cultural needs where elders, incapacitated, or other community members are unable to fish for themselves. The Committee encourages the Department to increase their understanding of the contribution of Aboriginal people and communities to the landings of these and other species.

5.4 Spatial Considerations

The EG-HG fishery is divided in to seven geographical regions for the purposes of access shares and reporting but species quota is not spatially constrained and can be leased or traded across regions. Catches prior to the introduction of ITQs effectively were spatially constrained to the Regions to which operators had endorsed access. The introduction of quota share management, however, means catches (within quota limits) are not spatially constrained because quota or quota shares can be leased or traded, respectively, across regions.

Only 7 of the 68 currently endorsed EG-HG fishing businesses fishing businesses have access shares for two Regions and can use their species shares in either of those Regions. All other businesses have access to only one region but all businesses can lease quota or transfer quota shares to or from businesses in any region, effectively disrupting any link between quota allocation and Regional access. The quota market is in its infancy at the moment and most species quota held by the 61 businesses with

access shares for only one Region is likely to be used in the single Region where a business has operated traditionally. More movement of species quota among operators and regions is likely, however, as the quota market matures.

The ability to move species quota among regions is a useful mechanism to respond to fluctuations in populations and should benefit the price of quota and the amount of quota in the market, as well as aiding internal market adjustment of quota holdings among fishers. Industry has raised concerns with this opportunity to shift quota among Regions, however, given that catches were more spatially constrained prior to the introduction of ITQs. Some industry reported that since the introduction of species quota there have been "influxes" of new fishers into areas where they had previously not fished, increasing pressure on some key fishing locations.

A number of the species under consideration are vulnerable to localised and serial depletions, and would be appropriate candidates for finer scale spatial management. Some regions and locations are showing signs of localised depletion of pipi populations, for example, including Stockton beach which has seen a significant increase in effort. Mechanisms for finer-scale spatial management of the pipi fishery thus would be beneficial to prevent overfishing of key locations such as Stockton beach. Spatially-explicit regulation of catch, if introduced by some agreed mechanism(s), could be supported by pre-season surveys of abundance at key locations, which both industry and the Department suggested could be feasible, efficient, and affordable.

Spatial management also would be appropriate for the cockle fishery which likely also is vulnerable to localised depletion of estuary level populations. Industry has advocated for spatially constrained species quota for cockles, noting concerns that movement of quota across regions could lead to overfishing of key cockle populations.

The lack of spatial management mechanisms available in this fishery means that TACCs have to be more precautionary, given the risk that the entire TACC could, in theory, be harvested in just one or two Regions or even concentrated in more localised areas. There always will be some spread in effort in practice, to maintain catch rates, but improved management of the spatial distribution of catch has the potential to enable higher TACCs and more optimal biological and economic outcomes for this fishery.

The Committee has recommended the Department investigate mechanisms to improve spatial management for a number of different quota species in other fisheries. Mechanisms being considered for those fisheries also might be applicable for the quota managed species in the EG-HG fishery. The Committee therefore encourages the Department to consider appropriate extension of any mechanisms available to reduce the risks of localised and serial depletions of populations of these species.

The Committee recognises that 2019–20 is the first year of the TACC and ITQ systems being implemented and will look with interest at any changes in the spatial distribution of catches when these species are considered in future.

5.5 Compliance

The Department uses a risk-based approach to fisheries enforcement activities that uses State wide and fishery specific risk analysis. Compliance strategies employed include intelligence gathering and analysis, education, targeted patrols, and covert and overt operations.

The Department's compliance analysis of the EGF indicates increased numbers of offences detected over the past 5 years, and an average compliance rate of around 80%. The number of commercial offences related to Hand Gathered species, however, has decreased over the past 4 years. Compliance data must be interpreted with caution as many factors can influence compliance rate reporting, including improvements in targeting offenders, the use of intelligence led and risk-based approaches, and changes to regulation and rules. For example, the introduction of species quotas in the EG-HG fishery in 2019, and associated quota reporting requirements, might have affected compliance rates in the 2019–20 fishing season simply related to fishers becoming familiar with new quota reporting requirements.

The level of illegal, unreported, and unregulated (IUU) harvest of EG-HG species has not been quantified. The highest number of compliance issues associated with these species occur in the recreational sector, particularly in association with cockles, with large numbers of cockles seized over the past 5 years. The Department has undertaken operations to target the illegal harvest and sale of cockles in both the Sydney and Illawara regions, resulting in a number of apprehensions and significant penalties. There is anecdotal evidence of substantive IUU catches of cockles in some estuaries and there have been high numbers of cockles seized since 2010. Mortality from illegal catches may be high enough to affect cockle biomass in some estuaries, but insufficient information exists to quantify such an effect. A smaller number of non-commercial offences and seizures have been reported for the other three species.

Fishers are required to report their catch and effort through two different mechanisms. Those harvesting quota managed species must report real time quota use through the FisherMobile Application, either in total weight for pipis and cockles or number of animals for beachworms and ghost nippers. Business owners or their nominees also are required to submit more detailed fishing data (including catch, effort, location, method) in monthly log sheets using either paper logbooks or FisherDirect online reporting.

There is a significant issue with reporting of effort in the cockle fishery with cockle catches in two estuaries (Lake Illawara and Shoalhaven/Crookhaven River) having no reported effort for the past three years, and limited effort reported in Merimbula Lake. This effort reporting issue arises from a small number of fishers and has been evident since at least 2015–16. The lack of compliance action against these fishers by the Department is a concern and should be rectified immediately. Underreporting effort suggests illegal activity, compromises all cockle data, and undermines understanding of stock status. The TACC must take into account these uncertainties and will be more precautionary as a result. The Committee therefore recommends that compliance action immediately be taken to address this serious breach of reporting requirements in the cockle fishery.

5.7 Recommendations for Review of Management Arrangements

5.7.1 Cockle size limits

Some industry representatives were of the view that a MLL would benefit the sustainability of cockle stocks and assist with protecting populations from the risk of localised depletions. Little information is available currently to determine whether a MLL is an appropriate management mechanism for the cockle fishery or what an appropriate MLL might be. A joint submission for FRDC funding has been made by industry and the Department to support research to improve understanding of cockles, which would support consideration of an appropriate size limit. The Committee recommends that the Department and industry work together to consider whether a MLL for cockles would benefit the cockle fishery and, if so, what an appropriate MLL might be.

5.7.2 Spatial management

Pipis, cockles, and nippers are at risk of localised depletion of key populations. The lack of spatial management mechanisms to mitigate such risk, however, means that TACCs have to be more precautionary than they might be if appropriate spatially-explicit management arrangements were in place. The Committee encourages the Department to continue to investigate what spatial management mechanisms might be available to reduce the risk of localised depletions, and to work with industry to explore their feasibility for application in this fishery.

5.7.3 Effort reporting by cockle fishers

A small number of operators in the cockle fishery are not reporting the amount of effort they have expended while harvesting. This is seriously compromising the understanding of the cockle fishery activity and stock abundance. The cockle TACC as a result must be set with sufficient precaution to account for the uncertainty caused by such significant gaps in the data. The Committee recommends that compliance action immediately be taken to address this serious breach of reporting requirements in the cockle fishery.

5.7.4 Development of harvest strategies

This fishery currently does not have a harvest strategy that specifies the biological and economic objectives for the fishery or any of the quota managed species. The Committee recommends that the Department work with industry to develop harvest strategies for these species with specific performance indicators and reference points to support management decision-making. Harvest strategies for these species should be context appropriate in that they should have specific regard to the scales of the EG-HG fishery and the information available to support management.

6. CONCLUSION

6.1 Summary

The Estuary General Hand Gathering (EG-HG) fishery is a relatively small fishery discretely targeting 6 species or species groups, four of which are regulated by annually determined, species- or group-specific Total Allowable Commercial Catches (TACCs) distributed among quota share holders as Individual Transferable Quotas (ITQs). The EG-HG fishery is in its first year of TACC-ITQ management and clearly in a 'settling-in' period in which the internal adjustment processes expected of a TACC-ITQ system, such as permanent quota share sales and temporary, within year, quota leasing, are yet to be established.

The four stocks subject to EG-HG TACCs — pipi, estuary cockle, ghost nipper, and beachworm — all appear to be robust to recent levels of harvest and continued harvest up to the respective initial TACCs, notwithstanding some watch-points (recent localised declines in catch rates) for pipi and cockle. No leading indicators of likely future stock status exist for any of the species and so TACC setting necessarily must be reactive and precautionary, because we will know the effects of TACCs on stocks and the fishery only with hindsight. The known distributions of the HG species, however, and the low-cost means of accessing them mean that there is considerable potential to establish low-cost, targeted, fishery-independent monitoring of stocks that could provide at least short-term leading indicators to inform future TACC setting. Such an approach has been demonstrated for ghost nipper in NSW and is in place for pipi and cockle fisheries in other jurisdictions. We encourage the Department and industry to investigate the feasibility of such methods for this fishery.

The biology and ecology of each of the quota species renders them particularly vulnerable to fishers sequentially targeting high-density aggregations, resulting in serial localised depletions that could undermine stock sustainability before signals of such decline were evident in any fishery-dependent metrics. Effects of severe local or general population crashes are likely to be more persistent for cockle and ghost nipper than for pipi or beachworm, but the risk exists for all species and is evident especially for pipi in historical fishery statistics. The existence of Region-specific access shares for the fishery set regulatory conditions that could mitigate such risks of serial depletion across the entire stocks, but the pan-regional allocation of species quota shares and free movement of quota among businesses with different Regional access undermines that potential mitigation. The option to sell quota shares or lease quota without constraint to particular Regions, however, provides significant benefit to quota holders because they can more easily obtain a non-fishing return on investment than likely would be possible if quota transfers were allowed only within Regions. There nevertheless is a case in this fishery for development of some mechanism(s) to moderate the movement of quota among Regions and build on the regionalised use of access shares to mitigate risks of serial depletion of these vulnerable stocks.

6.2 Total Allowable Commercial Catches for 2020–21

The Committee saw no evidence of extreme conditions that required material intervention in current TACCs for the quota managed species harvested by the EG-HG sector. Indeed, it appears that fisheries for ghost nipper and beachworm might be somewhat underdeveloped, at least from stock perspectives.

6.2.1 Pipis

There is evidence of recent rebuilding of pipi stocks from dire condition a decade ago but there also is some evidence in recent catch rates that that rebuilding might have peaked in at least some important Regions, perhaps as long ago as 2014–15. The Committee considers it prudent, therefore, to proceed cautiously with any TACC increases to avoid undermining that rebuilding. The absence of any regular monitoring of abundance or stock condition and of any leading indicators that would allow us to infer future conditions also mean that we will see any effects of the current TACC only in coming years. The rudimentary modelling with which the Committee was provided suggested that recent harvests in some Regions and years was likely at a sustainable level whilst in other Regions or years harvest rates likely were too high to be sustainable. Basic projections of pipi stocks under different harvest scenarios also suggested increasing the pipi TACC should be approached cautiously and gradually. The Committee accordingly has decided to retain the initial TACC for pipi for the 2020–21 Fishing Period.

6.2.2 Cockles

The cockle fishery might have some room for expansion but persistent reporting failures from the commercial sector, extremely poor understanding of recreational harvest, despite a weight of evidence that recreational catches might be substantial, and poor understanding of the species' biology undermine confidence in exploring that potential, such as by small increase in the TACC. There is some evidence in

the fishery history of sequential targeting of different estuaries, though it is unclear whether movement from one estuary to another was motivated by stock declines (and so serial depletion), business decisions, or changes in fishery participation. There is no obvious reason at this stage to constrain the commercial cockle fishery with a lower TACC but there also is no basis on which to justify an expansion, for the above reasons. The Committee accordingly has decided to retain the initial TACC for cockle harvest by the EG-HG fishery.

6.2.3 Ghost nippers

The commercial fishery for ghost nipper is very localised and exercised by few commercial fishers. Ghost nipper is targeted by recreational fishers in some estuaries, likely with total catches as large as commercial harvest, but with little overlap spatially with commercial fishing. Fishery metrics and recent fishery-independent research indicate that ghost nipper populations likely are large relative to existing total catches from estuaries targeted by commercial or recreational fishers, but also likely to be very variable year-to-year. The initial TACC for nipper was set at a (recent) historical maximum catch but there appears considerable evidence that the nipper stock(s) could sustain even greater catches, assuming market conditions will support an expanded fishery. The Committee according has decided to increase the ghost nipper TACC slightly for the 2020–21 Fishing Period.

6.2.3 Beachworms

The beachworm stock also appears robust and potentially somewhat underdeveloped. Expansion of the beachworm fishery, however, might be limited more by markets than stock status. Beachworm, like the other HG quota species, also has potential for serial depletion but there is little evidence of that having occurred to date and it seems likely that localised depletions would have a high prospect of replenishment from neighbouring beaches or unexploited subtidal populations. The Committee accordingly has resolved to increase the beachworm TACC slightly for the coming Fishing Period.

6.3 The Determinations

The Total Allowable Fishing Committee, pursuant to Division 2 of Part 2A of the Fisheries Management Act 1994 (as amended), determines that the commercial catches of pipi, cockle, ghost nipper, and beachworm by the NSW Estuary General (Hand Gathering) Fishery should not exceed 147.4, 29.2, 5.6, and 8.5 tonnes respectively during the 2020–21 Fishing Period (Table 6.1). :

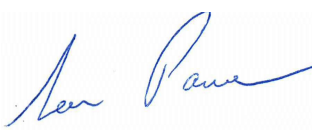
Table 6.1: Total Allowable Commercial Catches for four species taken in the NSW Estuary General (Hand Gathering) Fishery during the 2020–21 fishing period.

Species	2020–21 TACC (t)
Pipi	147.4
Cockle	29.2
Ghost nipper	5.6
Beachworm	8.5

Bruce Mapstone, Chair

Alice McDonald, Fisheries Management

Rich Little, Fishery Scientist



Sean Pascoe, Natural Resource Economist

APPENDIX 1. DETAILS OF PUBLIC CONSULTATION

Public consultation steps taken by the Committee, with support from the Department, are summarised in the table below. These steps effected the consultation requirements stipulated, *inter alia*, in the *Fisheries Management Act 1994, Part 2a, Division 2, S40.*

Date	Fisheries Management Act Reference	Consultation Stages
10.02.2020	Section 40F(1)	The Department called for public submissions on the appropriate level of the annual TACC for pipi, estuary cockle, ghost nipper, and beachworm for the 2020–21 fishing period.
10.02.2020	Section 284 (2)(c)	Individual calls for submissions sent to particular interest groups who the Committee considered might wish to provide collective submissions either due to their direct involvement in the Estuary General (Hand Gathering) Fishery or their interest in related issues. These groups included: ■ Estuary General Fishery (Hand gathering) shareholders; ■ NSW Professional Fishermen's Association.
10.02.2020	Section 284 (2)(c)	Advertisement inviting public submissions placed in the "Open for Comment" section of the Department of Primary Industries web-site.
10.03.2020	Section 284 (2)(b)	Public consultation closing date, after at least 30 days.
11.03.2020	Section 40F (2)	The Committee received the following collated submissions: ■ NSW DPI — Commercial Fisheries Management Report; ■ NSW DPI — Species Assessment Reports; ■ NSW DPI — Fishery compliance report; 12 submissions were received from stakeholders.
10.03.2020	Section 40F (2)	The Committee considered submissions and heard formal presentations and opinions at the Total Allowable Fishing Committee Open Forum in Sydney on 10th March 2020. The following made presentations or provided information to the Committee: ■ Ms Fiona McKinnon, NSW DPI — Management & compliance ■ Dr. Rowan Chick, NSW DPI Stock Status Reports (cockles, ghost nipper, beachworms); ■ Daniel Johnson, NSW DPI Stock Status Report (pipis); The following also attended the public forum: ■ Tricia Beatty, NSW Professional Fishermen's Association ■ Bob Kearney, University of Canberra ■ Mary Howard, Wild Caught Fishing Coalition ■ Robert and Heather Elliott, Shareholder - Estuary General Fishery ■ Mark Phelps, Shareholder - Estuary General Fishery ■ James Strutt, Shareholder - Estuary General Fishery ■ Geoffrey Liggins (NSW DPI) ■ James McLeod (NSW DPI) *Apologies:* Dr Keith Sainsbury.

APPENDIX 2. Management Regions for the NSW Estuary General Fishery.

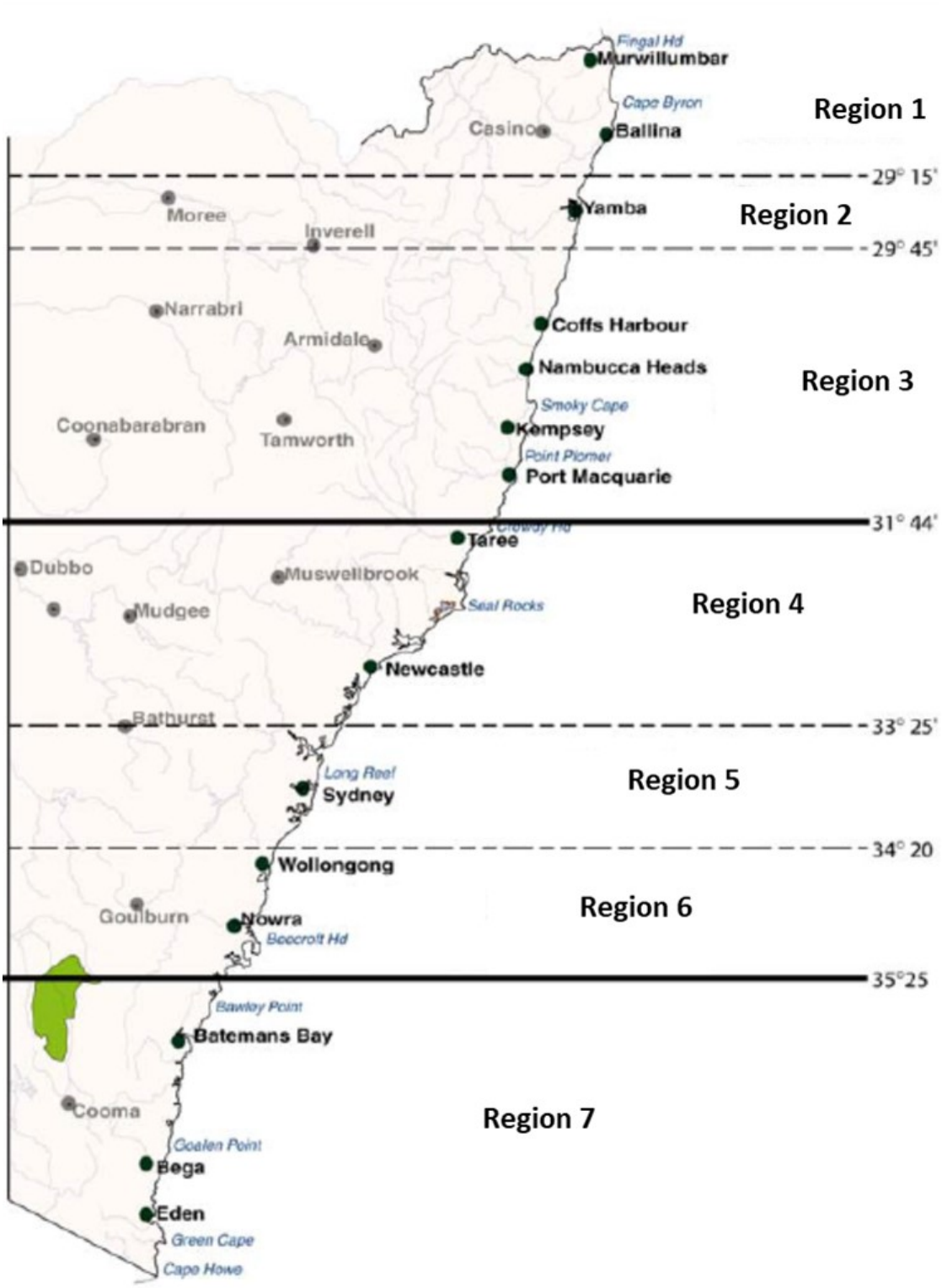


Figure A1: Map of NSW coast showing regions by which access to the commercial Estuary General Fishery is allocated by share allocations (from Johnson, 2020, Pipi assessment report).