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

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).

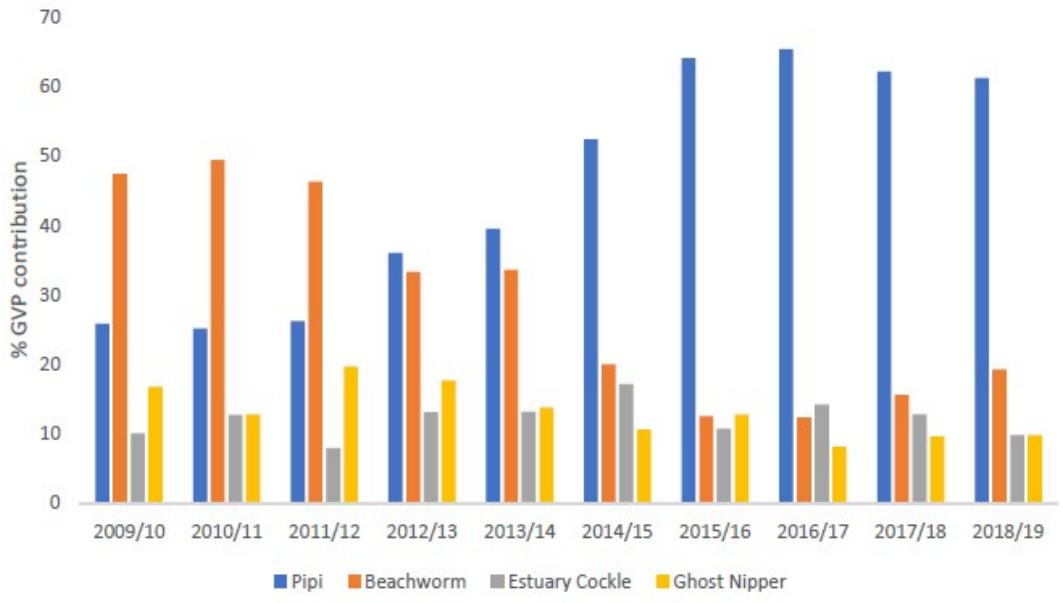

Figure 4.1: Percent contribution of estimated nominal GVP by EG-HG quota species (2009–19)[19]

[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.

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)

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). :

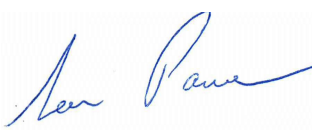
Table 6.1: Total Allowable Commercial Catches for four species taken in the NSW Estuary General (Hand Gathering) Fishery during the 2020–21 fishing period.

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.

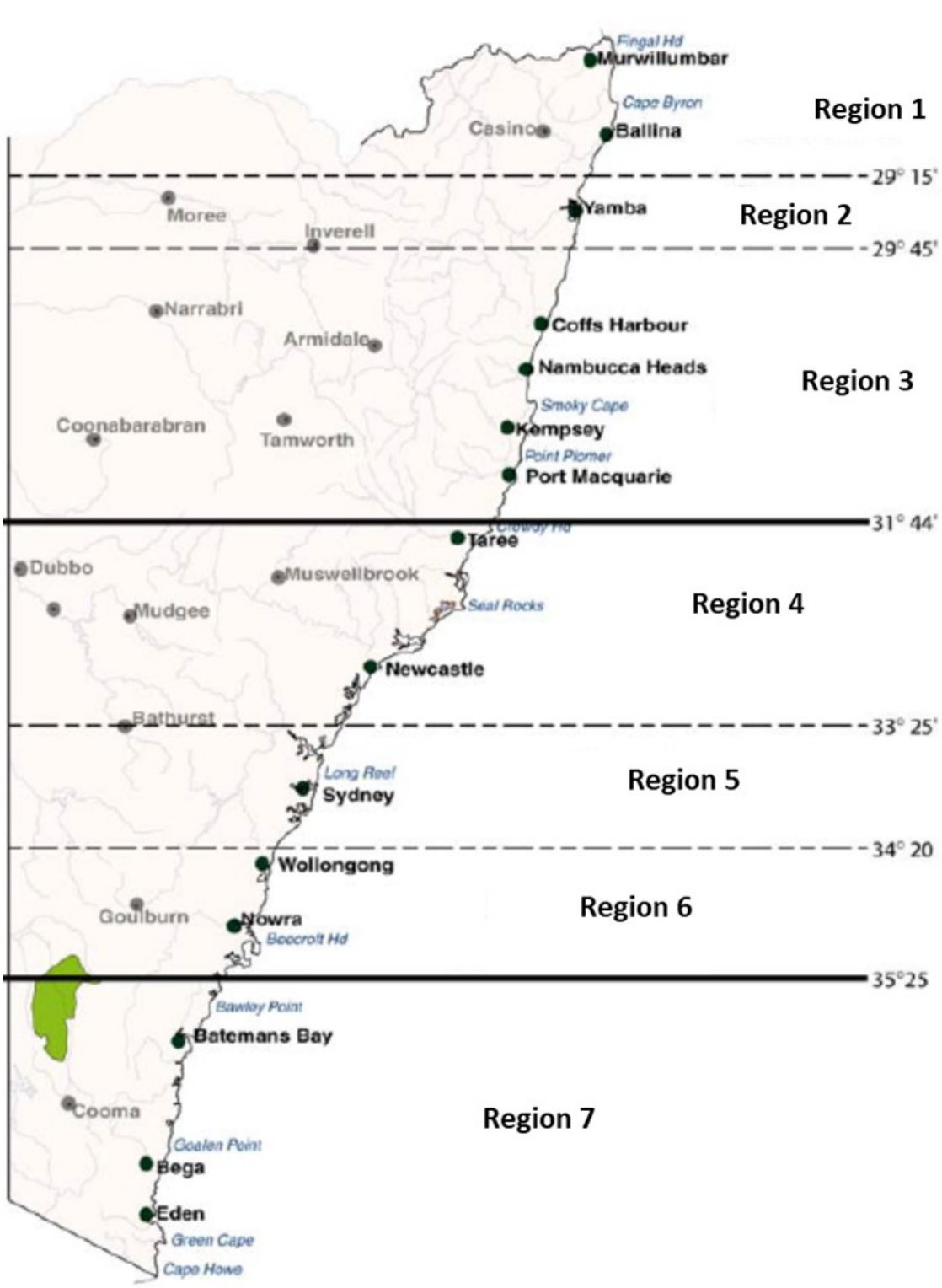


Figure A1: Map of NSW coast showing regions by which access to the commercial Estuary General Fishery is allocated by share allocations (from Johnson, 2020, Pipi assessment report).