TASMANIAN OCTOPUS FISHERY ASSESSMENT 2017/18

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Executive Summary

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INDICATORS	Catch, effort and CPUE trends

The Tasmanian Octopus Fishery (TOF) operates off the north coast of Tasmania and in the Bass Strait, primarily targeting Pale Octopus *Octopus pallidus*, with Maori Octopus *Macroctopus maorum* and Gloomy Octopus *Octopus tetricus* landed as by-product. The Scalefish Fishery Management Plan (revised in 2015) provides the management framework for the fishery. The commercial fishery remains a sole operator fishery with the same operator since commencement in 1980.

In this assessment, the status of Pale Octopus in the TOF area is assessed with respect to patterns of catch, effort and catch per unit effort (CPUE). A more detailed analysis of catch, effort and CPUE at the fishing block level is also presented, with the commercial catch history for the period 2000/01 to 2017/18 being assessed.

Fishing mortality for Pale Octopus is represented by the use of catch as a proxy for absolute mortality and effort (potlifts) as a proxy for exploitation rate. In 2017/18, the total catch of Pale Octopus was 64.4 tonnes, representing the lowest level observed in six years. In contrast, catches of Gloomy Octopus were 18 times higher than those of the previous year, with a total of 16.9 tonnes recorded. Catches of Maori Octopus were 0.9 tonnes. For Pale Octopus, the 2017/18 catches were well below the long-term average for the fishery, with an annual average catch of 85.4 tonnes observed over the last decade. In contrast, effort was at the third highest level recorded since reporting began, with 366,500 potlifts in 2017/18, and slightly exceeded the proposed reference point of 350,000 potlifts, largely due to a large amount of exploratory fishing undertaken around the north-east of Flinders Island.

Biomass of Pale Octopus is indicated by trends in catch per unit effort (CPUE), which have decreased from 2005/06, albeit with annual fluctuations. Historically, CPUE declined after a peak in the mid-2000s and has been relatively stable since 2011/12, fluctuating at approx. 60% of the reference year (2004/05, corresponding to the start of the 50-pot sampling). In 2017/18 the 50-pot sample and logbook data-derived CPUE was 52% and 67% of that of the reference year, respectively.

While there are some indication of localised depletion, particularly around the fishing grounds centred off Stanley in the State's north-east and Bridport in the State's north-west, there are no indications that biomass of Pale Octopus stock as a whole is in a depleted state, or that current levels of fishing mortality are likely to drive the stock towards a depleted state. The proposed catch reference point was not breached indicating that ongoing catches at the 2017/18 level are not expected to result in the stock becoming recruitment impaired. On this basis, Pale Octopus in Tasmania is classified as a sustainable stock. However, the high level of effort as indicated by the breach of the proposed effort reference point suggests that the exploitation rate may be substantially higher than indicated by catch alone (due to a low abundance in 2017/18) and ongoing effort at this level may result in stock depletion.

Acknowledgements

We would like to thank Frances Seaborn and the Hardy family for their valuable contributions to this report. Caleb Gardner (IMAS) provided useful comments on an earlier draft of the report.

1. Introduction

The Tasmanian Octopus Fishery

The Tasmanian Octopus Fishery (TOF) has been operating since 1980. Until December 2009, access to the commercial fishery was provided to holders of a fishing licence (personal), a vessel licence and a scalefish or rock lobster licence with a trip limit of 100 kg. Since December 2009, a specific octopus licence was required to participate in the Bass Strait fishery. Two licences were issued, belonging to the same operator.

Since 1996, under the Offshore Constitutional Settlement (OCS) with the Commonwealth of Australia, Tasmania has assumed management control of the octopus fishery out to 200 nautical miles.

The TOF primarily targets the Pale Octopus (*Octopus pallidus*), with lesser targeted catches of the Gloomy Octopus (*Octopus tetricus*) and the Maori Octopus (*Macroctopus maorum*) also taken, primarily as by-product. The main fishing method is unbaited moulded plastic pots (volume 3,000 ml) with no doors, attached to a demersal longline 3–4 km long and set on the sea floor at variable depths of 15–85 m (Leporati *et al.*, 2009). Currently, a maximum of 1,000 pots per line is allowed (Table 1.1; Table 1.2). Octopus are attracted to these pots as a refuge. Pots are hauled after about 3–6 weeks in the water to achieve optimum catch rates. An abundant food supply may support a large population of octopus and when combined with a shortage of suitable shelters results in high catch rates. Commercial octopus fishing is presently restricted to the East Bass Strait and West Bass Strait fishing zones (Figure 1.1). While no further octopus licences can be issued for the Bass Strait area, the remaining State waters are classified as developmental and could be opened to fishing provided necessary research is undertaken. At the time of writing a single permit has been issued restricting the take of Octopus off the east and south coasts of Tasmania using 4,000 unbaited pots (from south of Eddystone Point and East of Whale Head).

From 2000/01 to 2005/06 catches of Pale Octopus in the TOF increased substantially and since then have remained around 80 tonnes, with some strong inter-annual variation. Gloomy Octopus has only been reported in the fishery since 2010/11, with catches concentrated predominantly around Flinders Island, with recent increasing catches indicative of range expansion outlined by Ramos *et al.* (2014, 2015). The catch of Maori Octopus in the fishery has continued to fluctuate since 2000/01 with a reduction in 2017/18.

Table 1.1 Summary the management and reporting changes for the Tasmanian Octopus Fishery.

Date	Management changes
Pre December 2009	Access provided to holders of personal fishing licence, a vessel licence and a scalefish (or rock lobster) licence. Trip limit of 100 kg if not the holder of a fishing licence (octopus) or permit.
December 2009	Two licences issued for the operation of two vessels. Sole Operator.
2004 / 2005	50-pot sampling program implemented
2016 / 2017	Two developmental permits issued (no reportable catches)
2017 / 2018	Single developmental permit issued (reportable catches)

Table 1.2 Summary the management systems for the Tasmanian Octopus Fishery.

Date	Management changes
Fishing methods	Access provided to holders of fishing licence (octopus), a vessel licence and a scalefish (or rock lobster) licence. Trip limit of 100 kg if not the holder of a fishing licence (octopus).
Primary landing port	Two licences issued for the operation of two vessels. Sole Operator.
Management methods	**Input control:** - Fishing licence (octopus) allows the use of 10,000 pots (maximum of 1,000 pots per line) to target *Octopus pallidus*, *O. tetricus* and *O. maorum.* - Fishing zone restriction (East and West Bass Strait Octopus zones only).
Main market	Tasmania and mainland Australia
Octopus licences	2
Active vessels	2

Recreational fishery

Small amounts of Octopus are also targeted by recreational fishing. As of 1 November 2015, recreational fishers have been subject to a bag limit of 5 octopus and a possession limit of 10 octopus (all species combined).

Data on the recreational catch of octopus in Tasmania is sparse. Surveys of the recreational fishery conducted in 2000/01, 2007/08 and 2012/13 provide the only comprehensive snapshots of the Tasmanian recreational fishery (Lyle, 2005; Lyle *et al.*, 2009; Lyle *et al.*, 2014). The recreational fishery surveys did not differentiate between cephalopod species with the exception of Southern Calamari and Gould's Squid. It is, however, understood that the majority of the catch reported as "cephalopods, other" are octopus, the remaining portion being cuttlefish. These surveys suggest that Octopus species are not a key target for the recreational fishery and appear as a bycatch caught predominantly by line fishing, gillnets and, to a lesser extent, rock lobster pots, with the majority being released (Table 1.3). A new survey for 2017/18 is currently being conducted and should be available for inclusion in the 2018/19 octopus assessment.

Table 1.3 Estimated total recreational harvest numbers, number kept and % released for cephalopod taken by Tasmanian residents (Lyle *et al.*, 2009, 2014). Note: the survey periods do not correspond with fishing years; 2000/01 represented the period May 2000 to Apr 2001, and 2007/08 represented the period Dec 2007 to Nov 2008.

Cephalopod, other	Number fished	Number kept	% released
2000/01	6,264	<1,000	85.3
2007/08	5,605	1,149	79.5
2012/13	3,773	1,443	61.8

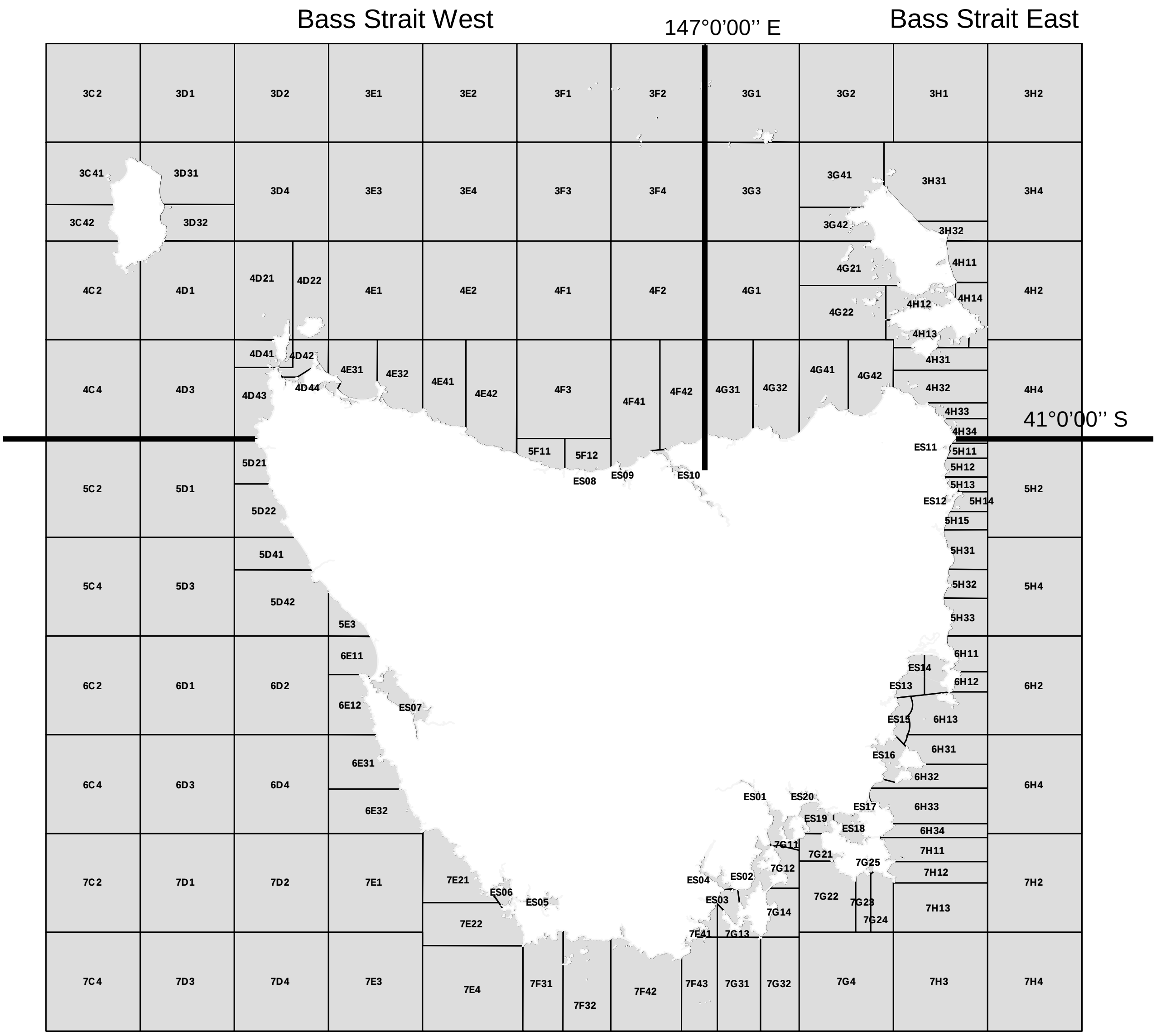
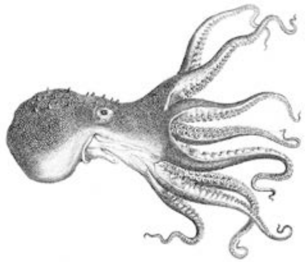


Figure 1.1 East and West Bass Strait octopus fishing zones and blocks. The octopus fishery reports in latitude and longitude but for the purpose of this report, fishing areas will be reported in fishing blocks.

Species Biology

All three octopus species harvested in Tasmania are short lived and fast growing. Table 1.4 summarises the biology of each species.

Table 1.4 Life history and biology of Pale Octopus (*Octopus pallidus*), Gloomy Octopus (*Octopus tetricus*) and Maori Octopus (*Macroctopus maorum*). In the 'Source' column, [1] refers to *O. pallidus,* [2] to *O. tetricus and* [3] to *M. maorum.*

Species	**Pale Octopus** *Octopus pallidus*	**Gloomy Octopus** *Octopus tetricus*	**Maori Octopus** *Macroctopus maorum*	**Source**
Illustration	 (William Hoyle)	 (Angustus Gould)	 (Peter Gouldthorpe)	
Habitat	Sand and mud habitats to depth of 600m.	Rocky reefs and sand habitats in shallow waters, up to 30 m depth.	Rocky reefs, beds of seagrass or seaweeds, sand down to 549 m.	Norman (2000)[1,2,3] Edgar (2008)[1,2,3]
Distribution	South-east Australia, including Tasmania.	Subtropical eastern Australia and northern New Zealand, increasingly found in Tasmania.	Temperate and sub-Antarctic waters of New Zealand and southern Australia.	Norman (2000)[1,2] Stranks (1996)[3]
Diet	Crustaceans and shellfish (bivalves).	Crustaceans (crabs, lobster) and shellfish (gastropods, bivalves).	Crustaceans (crabs, lobsters), fish, shellfish (abalone, mussels) and other octopuses.	Norman and Reid (2000)[1,2] Norman (2000)[1,2,3]
Movement and stock structure	Limited movement and dispersal from natal habitat. Eastern and western Bass Strait populations likely to be two discrete sub-populations.	Undefined.	• Several genetically distinct populations. • At least 2 populations in Tasmania: North-east Tasmanian population and South-west Tasmanian populations (which extends to South Australia). • Adults of the species aggregate all year-round in Eaglehawk Bay in the Tasman Peninsula).	Doubleday *et al*. (2008)[1] Doubleday *et al*. (2009)[3]
Natural mortality	Undefined but potentially high	Undefined.	Undefined.	
Maximum age	Up to 18 months.	Maximum of 11 months	Maximum of 7.3 months from ageing study but lifespan potentially up to 3 years.	Leporati *et al*. (2008b)[1] Doubleday *et al*. (2011)[3] Grubert and Wadley (2000)[3] Ramos *et al.* (2014)[2]

Growth	• Highly variable, partly dependant on water temperature and hatching season. • Max weight: 1.2 kg • Growth is initially rapid in the post-hatching phase, before slowing down. Growth has been represented by a 2-phase growth model with an initial exponential growth phase followed by a slower growth phase. Average growth in the first 114 days was estimated at $W = 0.246e^{0.014t}$ in spring/summer and $W = 0.276e^{0.018t}$ in summer/autumn, where *W* is the weight in g and *t* is the age in days.	• Max weight: up to 2.6 kg • Growth between 49 g to 2.64 kg described by the growth equation: $W = 3.385(1 - e^{-0.07642t})^3$ where *W* is the weight in kg and *t* is the age in days. Growth in the field might however only be about 40% of growth in aquarium.	• Max weight: 15 kg • Growth equation undefined	Leporati *et al*. (2008a)[1] André *et al*. (2008)[1] Joll (1977, 1983)[2] Stranks (1996)[3]
Maturity	Size at 50% maturity for females reached at 473g. Males appear to mature earlier (<250 g).	• Size-at-50% maturity was 132g for females and 92g for males • Age at 50% maturity 224 days for females and 188 days for males	• Size-at-50% maturity undefined. • Female mature between 0.6 to 1 kg. • Weight-specific fecundity range from 6.82 to 27.70 eggs/gram body. • Mating activity is independent of female maturity.	Leporati *et al*. (2008a)[1] Grubert and Wadley (2000)[3] Ramos *et al.* (2015)[2]
Spawning	• Semelparous (i.e. reproduces only once before dying). • Spawns all year round with peaks in late summer/early autumn • Around 450-800 eggs per spawning event. • Egg length: 11-13 mm.	• Semelparous (i.e. reproduces only once before dying). • Spawning season undefined but likely all year round. • Average fecundity is 278,448 eggs ± 29,365 se • Average size (maximum length) of ripe eggs is 2.2 mm ± 0.1 se	• Semelparous (i.e. reproduces only once before dying). • Spawning season: spring-summer in New Zealand but appear to mate and lay all year round in Tasmania. • Lay around 7,000 eggs in captivity but up to 196 000 eggs in ovaries of wild caught animals. Egg length: 6.5-7.5 mm.	Leporati *et al*. (2008a)[1] Joll (1983)[2] Anderson (1999)[3] Grubert and Wadley (2000)[3] Ramos *et al* (2015)[2]
Early life history	Large benthic hatchlings (0.25g) settling directly in the benthos.	Planktonic hatchlings (2-5mm length) settling at 0.3g (8 mm).	Planktonic hatchlings (5 mm length).	Leporati *et al*. (2007)[1] Joll (1983)[2] Anderson (1999)[3]
Recruitment	Variable.	Variable. No stock-recruitment relationship defined.	Variable. No stock-recruitment relationship defined.	

2. Methods

Data sources

Commercial data

Commercial catch and effort data used in this assessment are based on that entered into TOF Commercial Catch, Effort & Disposal Record logbook returns. This information facilitates the determination of catch per unit effort (CPUE). In these cases octopus catches are reported as a weight. Since November 2004, a 50-pot sampling program has been conducted, where fishers are required to collect all octopus caught in 50 randomly selected pots from a single line, representing 10% of a standard commercial line. From these 50-pot samples, the numbers of males and females of each species and the percentage of pots with eggs are recorded. The total and gutted weight of the catch was also recorded from 2004 to 2010. Fishers are only required to sample a single line where multiple lines were located within a 15 km radius. Additional data of catch from the Rock Lobster and Scalefish fisheries is reported as by-catch tonnage and is not included in the CPUE calculations. At the time of publication this information was not available for the 2017/18 season.

Weight-at-age is highly variable in octopus species due to a high individual variability and a rapid response to environmental factors (Leporati *et al.*, 2008b; André *et al.*, 2009). This introduces stochasticity in catch weight so that it becomes difficult to use when interpreting trends in population size. The 50-pot samples provide numbers of octopus, which is more representative of the state of the stock. A continuation of this practice aims to enhance the understanding of the stock status – particularly at a smaller spatial scale (e.g. block level).

In the 2017/18 season commercial data also exists for the developmental permit for the east coast of Tasmania. This data has not been included in the above analysis and has been summarised separately.

Data analysis

Catch, Effort and CPUE

For the purpose of this assessment, catch, effort and CPUE analyses were restricted to commercial catches of Pale Octopus for the period March 2000 to February 2018.

A fishing year from 1st March to the last day of February has been adopted for annual reporting, which reflects the licensing year. Catches have been analysed fishery-wide and by fishing blocks (Figure 1.1).

Data on logbook returns includes gutted and non-gutted (i.e. whole) weights. All gutted weights were converted to whole weight as follows:

$$\textit{Whole weight} = 1.233472 * \textit{Gutted weight}$$

where *Whole weight* and *Gutted weight* are in kilograms. The relationship was estimated from 8,510 individuals recorded in the 50-pot sampling dataset between December 2004 and April 2010.

The number of pots pulled in a given month was used as a measure of effort in this assessment. Catch returns for which effort information was incomplete were flagged and excluded when calculating effort or catch rates, however in recent years this has been negligible to nil. All records were included for reporting catches.

The impact of soak time (the time during which the fishing gear is actively in the water) was determined by analysing CPUE trends (in catch number per pot) through time for the 50-pot sampling data.

Catch per unit effort of Pale Octopus have been standardised using a generalised linear model (GLM) to reduce the impact of obscuring effects such as fishing year or season on the underlying trends (Kimura, 1981, 1988). However, while standardised catch rates are preferred over the simple geometric mean, other factors may remain unaccounted for that obscure the relationship between standardised catch rates and stock size, such as increasing fisher efficiency or spatial shifts in fishing effort from areas of low to higher catch rates.

There is currently only one operator in the Tasmanian Octopus Fishery. The depth fished is relatively constant and the two vessels cooperate, with the vessel pulling the gear not necessarily being the same vessel that set it. Consequently, depth, vessel and skipper were not included in the GLM. Factors considered in the GLM were year, month and block. The GLM was applied to weight per pot for the whole commercial dataset and number per pot for the 50-pot sampling dataset. This process removes the effect of season and location so that trends in CPUE are more accurately reflective of change in octopus density.

Assessment of stock status

Stock status definitions

To assess the status of Pale Octopus in the TOF in a manner consistent with the national approach (and other jurisdictions), we have adopted the national stock status categories used in the 2018 Status of Australian Fish Stock (SAFS) reporting (Table 2.1). These categories define the assessed state of the stock in terms of recruitment overfishing, which is often treated as a limit reference point. Recruitment overfished stocks are not collapsed but they do have reduced productivity. Fisheries are ideally also managed towards targets that maximise benefits from the harvesting, such as economic yield or provision of food. The scheme used here does not attempt to assess the fishery against any target outcomes. Determination of stock status into the below categories was based on temporal and spatial trends in commercial catch, effort and standardised CPUE data from the TOF area.

Proposed performance indicators and reference points

The determination of stock status is based on the consideration of the commercial catch and effort data, which are assessed by calculating fishery performance indicators and comparing them with reference points (Table 2.2).

Fishing mortality and biomass are typical performance indicators used to assess stock status in fisheries. Here, total commercial catch and effort, and CPUE (numbers per pots from the 50-pot samples), are used as proxies for fishing mortality and biomass, respectively, as there are insufficient data to calculate these parameters directly. These are compared to a reference period: 2000/01 to 2009/10 for catch and 2004/05 for CPUE (corresponding to the start of the 50-pot sampling program).

Table 2.1 The stock status classifications that were adopted for this assessment.

Stock status	Description	Potential implications for management of the stock
SUSTAINABLE	Biomass (or proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (recruitment is not impaired) and for which fishing mortality (or proxy) is adequately controlled to avoid the stock becoming recruitment impaired (overfishing is not occurring)	Appropriate management is in place.
RECOVERING ↑	Biomass (or proxy) is depleted and recruitment is impaired, but management measures are in place to promote stock recovery, and recovery is occurring.	Appropriate management is in place, and there is evidence that the biomass is recovering.
DEPLETING ↓	Biomass (or proxy) is not yet depleted and recruitment is not yet impaired, but fishing mortality (or proxy) is too high (overfishing is occurring) and moving the stock in the direction of becoming recruitment impaired.	Management is needed to reduce fishing mortality and ensure that the biomass does not become depleted.
DEPLETED	Biomass (or proxy) has been reduced through catch and/or non-fishing effects, such that recruitment is impaired. Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements.	Management is needed to recover this stock; if adequate management measures are already in place, more time may be required for them to take effect
UNDEFINED	Not enough information exists to determine stock status.	Data required to assess stock status are needed.

Table 2.2 Summary of the proposed performance indicators and reference point.

Performance indicators	Reference points
Fishing mortality	• Catch > highest catch value from the reference period (106.3 t) • Effort > Approximate effort required to achieve highest catch value from the reference period (106.3 t) assuming average (unstandardised) catch rates across the period 2004/05 to 2009/10 (0.306 kg per pot) (=350,000 pot lifts)
Biomass	• Numbers per pot < lowest value from the reference period (0.40 octopus/pot)

3. Results

Broad scale patterns in catch, effort and catch per unit effort

Catch and effort within the Tasmanian Octopus Fishery

Influence of soak time

The number of pots continues to be used as a measure of effort when calculating catch rates. As per the 2017/18 report, an analysis of the 50 pot samples indicated that soak time did not appear to affect CPUE by number or weight. Hence, soak time could be disregarded when calculating catch rates. The number of pots remains the used measure of effort when calculating catch rates.

Sex ratio

No difference in the ratio of male to female Pale Octopus was observed on a licencing year basis since the start of the 50-pot sampling program (Figure 3.1).

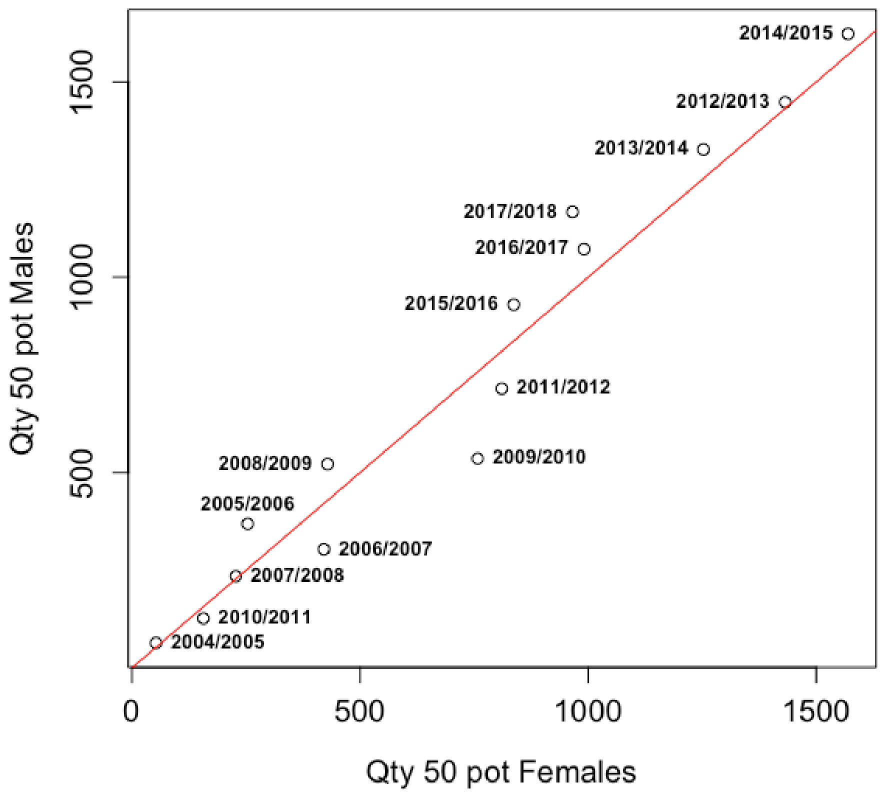


Figure 3.1 Ratio of Male to Female Octopi for 50-pot samples

Catch and effort

The total catch of Pale Octopus in the TOF in 2017/18 was 64.4 t, a decrease of 19.6 t from the previous year. Whilst showing a degree of inter-annual oscillation, catch has generally decreased since the record catch in 2012/13 (Figure 3.2). The 2017/18 catches were well below the long-term average for the fishery, with an annual average catch of 85.4 t observed over the last decade.

Catches vary temporally on an intra-annual basis within the fishery (Figure 3.3). In 2017/18, spring and summer landings constituted 25.6% and 33.9% of the total annual catch, respectively. Catches were lower in autumn and winter, when only 18.6% and 21.9% of the total landings for 2017/18 were recorded, respectively.

Fishing effort in 2017/18 increased to 366,500 potlifts, the third highest value observed in the history of the fishery (Figure 3.4). Effort was largely consistent throughout the year.

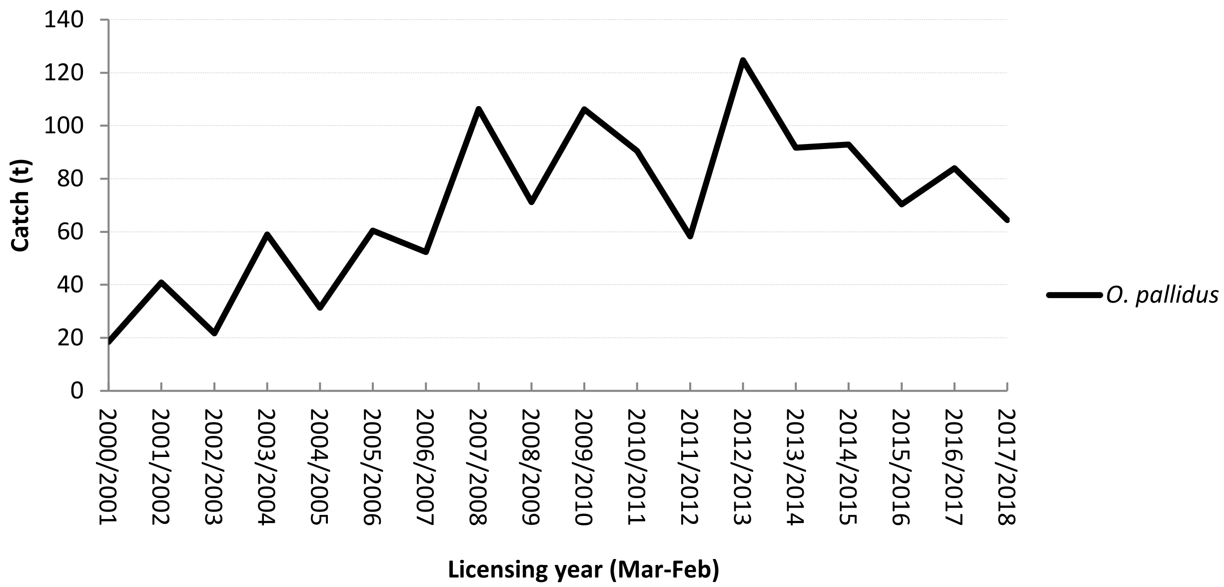


Figure 3.2 Total catches of Pale Octopus in the Tasmanian Octopus Fishery since 2000/01.

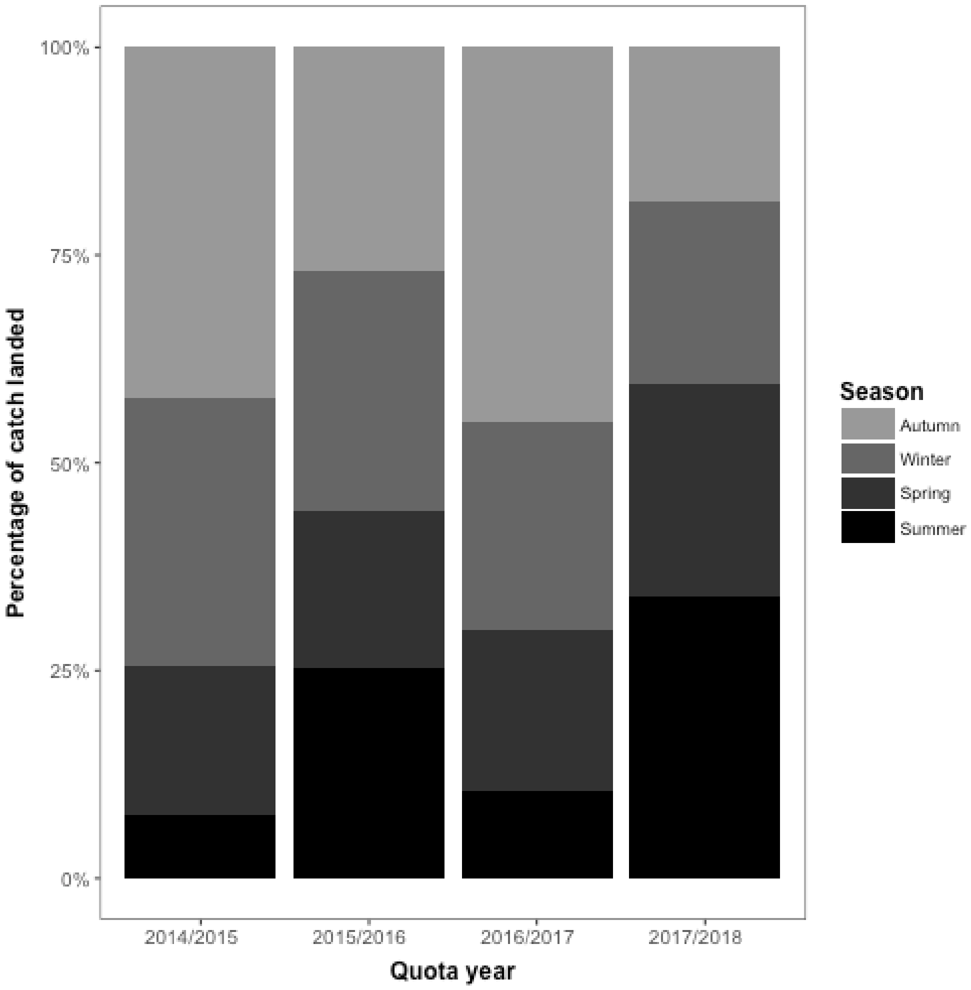


Figure 3.3 Percentage catches of Pale Octopus landed by season for the last four licensing years.

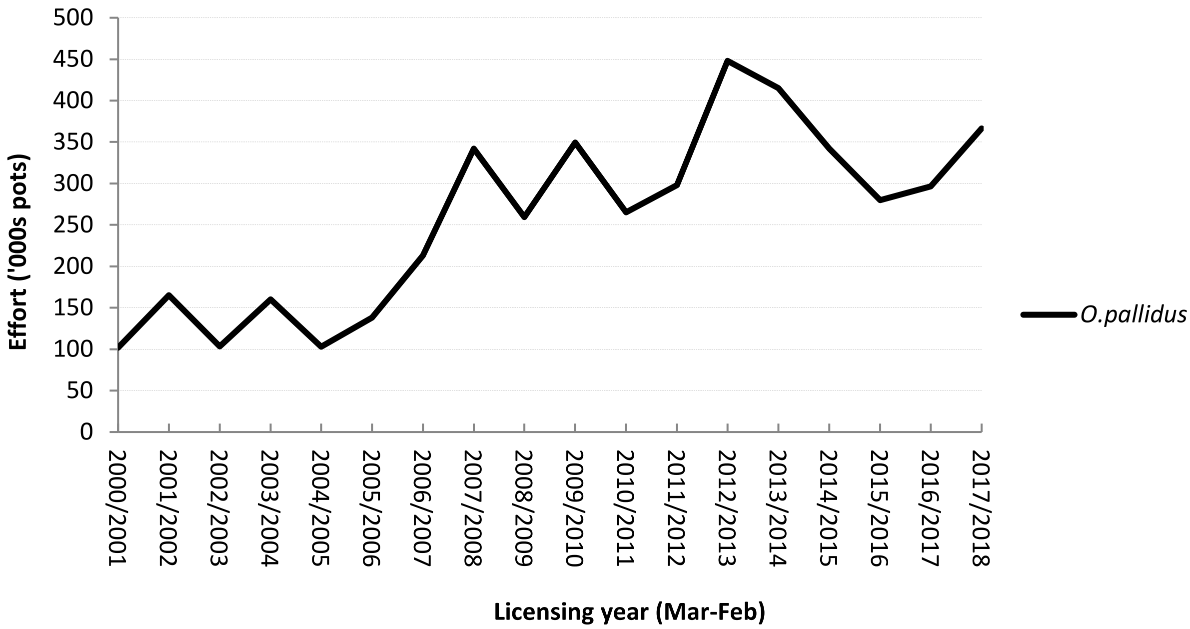


Figure 3.4 Effort (thousands pots) for Pale Octopus in the Tasmanian Octopus Fishery since 2000/01.

Catch per unit effort

In 2017/18, as with previous assessments, CPUE was highest from autumn to mid-winter (March-July, Figure 3.5), coinciding with the brooding peak for the species (Leporati *et al.*, 2009).

The licensing year 2004/05 was chosen as a reference year for CPUE as the 50-pot sampling commenced in that year (Figure 3.6). The CPUE standardisation, with removed seasonality (evident in Figure 3.5), shows inter-annual stochasticity in CPUE and a steady decline in CPUE from both the total commercial catch data and 50-pot sampling since 2004/05 to 2010/11. The inter-annual variation to some extent is likely due to the biological characteristics of Pale Octopus, which are inherently linked to environmental conditions, influencing hatching success and timing, larval mortality, recruitment, growth and spawning success. Stocks may be relatively abundant in one year but decline in the succeeding year due to less favourable environmental conditions and/or fishing pressure (Boyle, 1996; Rodhouse *et al.*, 2014). The fishery is also removing brooding females, which use fishing pots as shelters to deposit their eggs. As Pale Octopus is a holobenthic species (i.e. produce egg batches in the hundreds with benthic hatchlings) there is limited dispersal and the stock is highly structured (Doubleday *et al.*, 2008), increasing the potential for localised recruitment failure if fishing effort becomes concentrated. The ability of CPUE based on the total commercial catch data to detect declines in localised production may be somewhat limited by spatial shifts in fishing effort from areas of low to high productivity. There is also the potential that the increased range expansion of Gloomy Octopus may further increase pressure on Pale Octopus, through inter-specific competition for resources.

Since 2011/12 the standardised catch rate for the total commercial catch from logbooks has fluctuated at around 60% of the reference year, with large variations in annual fishing effort. In 2017/18, CPUE from the total commercial catch decreased to 52% of the reference year. Estimates of CPUE from the 50-pot sampling program have largely remained stable since 2011/12, although in 2017/18 it marginally decreased relative to the previous year, falling to 67% of that of the reference year (Figure 3.6).

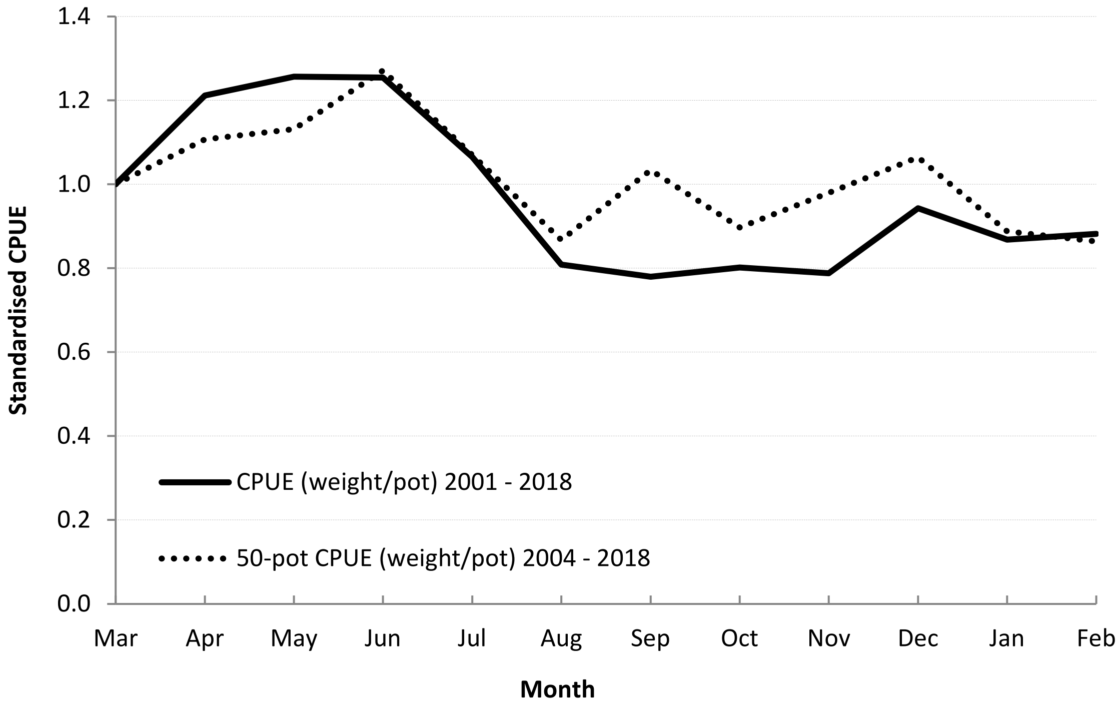


Figure 3.5 Pale Octopus standardised catch per unit effort (CPUE) relative to March levels in weight per pot (total commercial) and in number per pot (50-pot sampling).

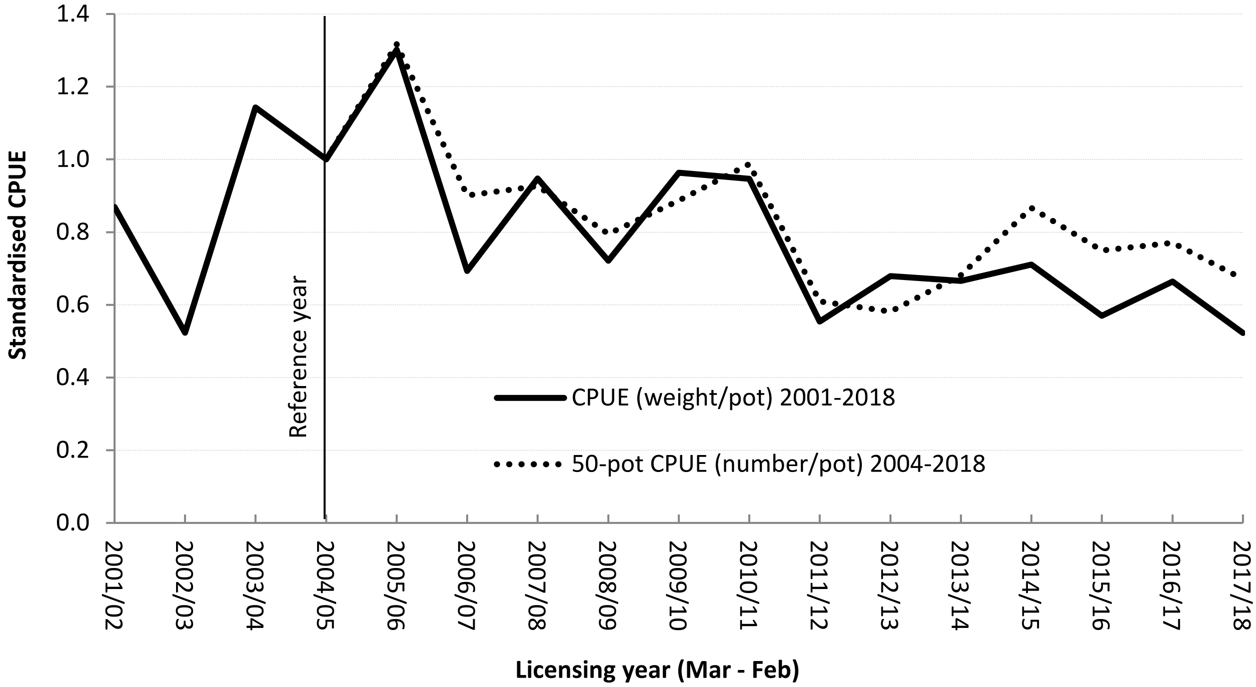


Figure 3.6 Pale Octopus standardised catch per unit effort (CPUE) relative to 2004/05 levels in weight per pot (total commercial) and in number per pot (50-pot sampling).

Commercial catch from developmental fishing permits

The single fishing permit, permitting access along the east coast below latitude 41° 0' 00'' South resulted in a total catch of 1,708 kg of Pale Octopus from a total of 17,500 potlifts. The catch of non-targeted species totalled 78 kg for Gloomy Octopus and 60 kg of Maori Octopus, respectively.

Commercial catch from other fishing methods

At the time of writing this report information regarding by-catch for octopus species from other commercial fisheries was not available. The following text is from the 2016/17 report:

Although historical total octopus bycatch has reached up to 30 tonnes in the early 2000's, recent records are indicating a stable, albeit lower value, with a total of 8.9 tonnes recorded in 2016/17 (Figure 3.8). Species are seldom identified with 65% of the bycatch from the rock lobster and scalefish fisheries detailed as "unspecified octopus" species. It is generally accepted that the rock lobster fishery octopus bycatch is predominantly Maori Octopus.

Most of the octopus bycatch in recent years originated from the rock lobster commercial fishery, with an average bycatch of 6.5 tonnes per annum over the last six licensing years, which is probably an underestimate (Figure 3.8). In 2016/17 the reported catch was 4.7 tonnes, which remains the lowest recorded catch in recent history. The commercial scalefish fishery provided the other source of octopus bycatch with an average of 4.1 tonnes per annum over the last six licensing years (Figure 3.8), with the 2016/17 catch totalling 4.2 tonnes. Gears that produce most of the octopus catch are hand collection and gillnets. Hand collected octopus was once a targeted fishery in Eaglehawk Neck but declined after DPIPWE stopped the use of gillnets as a barrier in late 2009. The current pressure on the Octopus Fishery from other commercial fisheries does not appear excessive and indicates stability. The impact of bycatch from these fisheries on octopus stocks is therefore considered low.

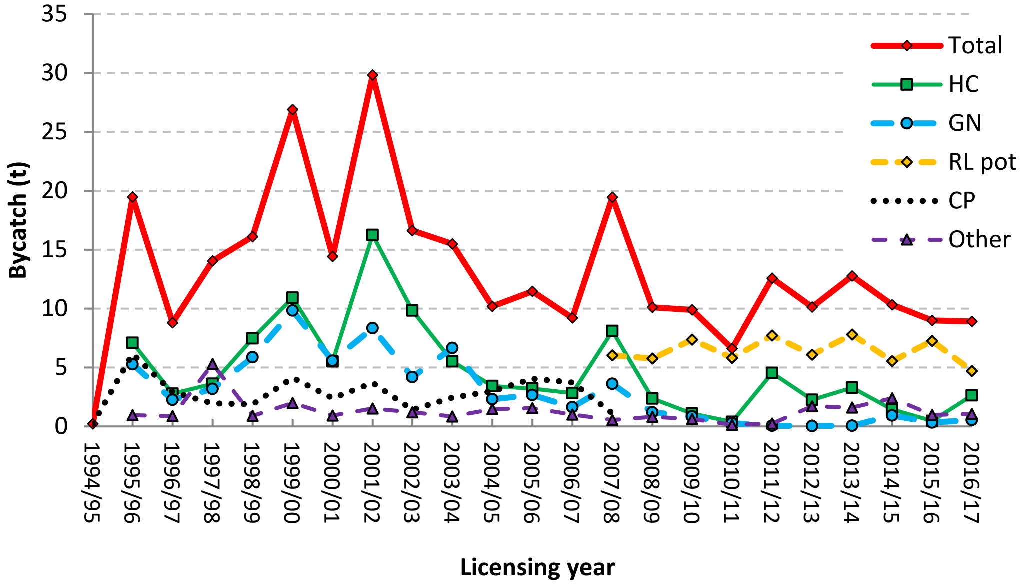


Figure 3.8 Octopus bycatch (tonnes) in other commercial fisheries. HC= hand collection, GN= gillnet, RL pot= Rock lobster pots, CP= crab pot.

Fine-scale patterns in catch, effort and catch per unit effort within the Tasmanian Octopus Fishery

Catch and CPUE from the Tasmanian Octopus Fishery area have been analysed at the scale of the fishing block to examine the potential issue of localised recruitment overfishing. Trends for each block have been calculated as the difference in catch and un-standardised CPUE between the current licensing year and the previous licensing year, as well as between the current licensing year and the average of the five previous licensing years (Figures 3.9 and 3.10).

Catch and effort values (Figures 3.9 and 3.10, A and B) indicate a shift in spatial distribution for recent years relative to historical fishing. Most notable is a shift in effort, and subsequently catch, from the north-east coast off Bridport, to central, coastal areas of the state, as well as areas north-east of Flinders Island and east of King Island (Figure 3.9; Figure 3.10). Reductions in CPUE have been observed in the inshore waters off Bridport (Figure 3.10 C), suggesting biomass may be locally depleted in this area.

Areas of high catch and effort have historically been concentrated in inshore waters off Stanley (Blocks 4E1, 4E3 and 4E4, Figure 1.1). In recent years, catch and effort in this region had declined significantly. For Block 4E3 at least, this may be in part due to fishers choosing to avoid interactions with the Tasmanian Scallop Fishery operating in the area (Semmens *et al*. 2018). Increased effort was directed to this region in the 2017/18 season, although CPUE was largely consistent with previous years (Figure 3.10 C).

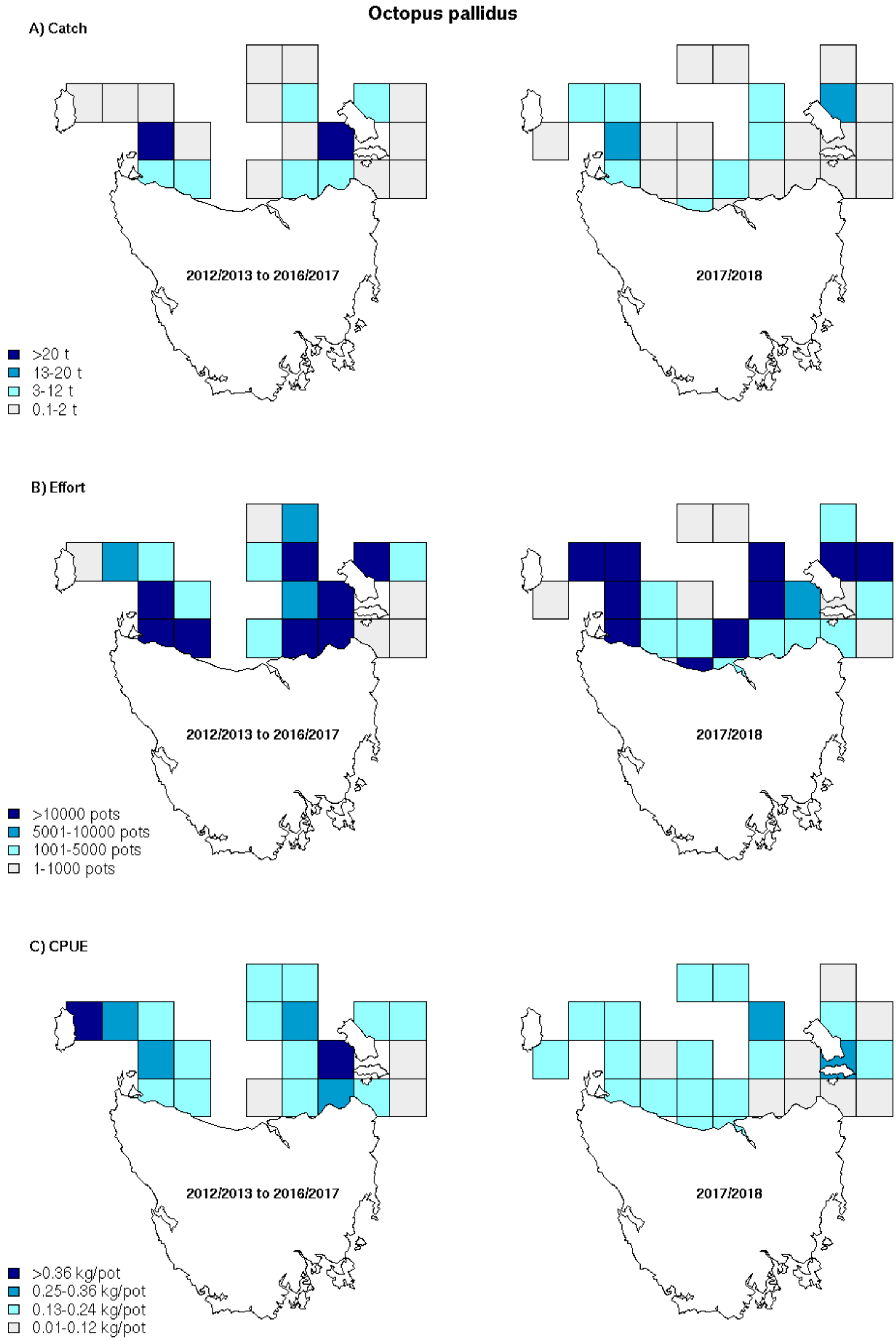


Figure 3.9 (A) Catch, (B) effort and (C) CPUE averaged over the last 5 years and for the licensing year 2017/18.

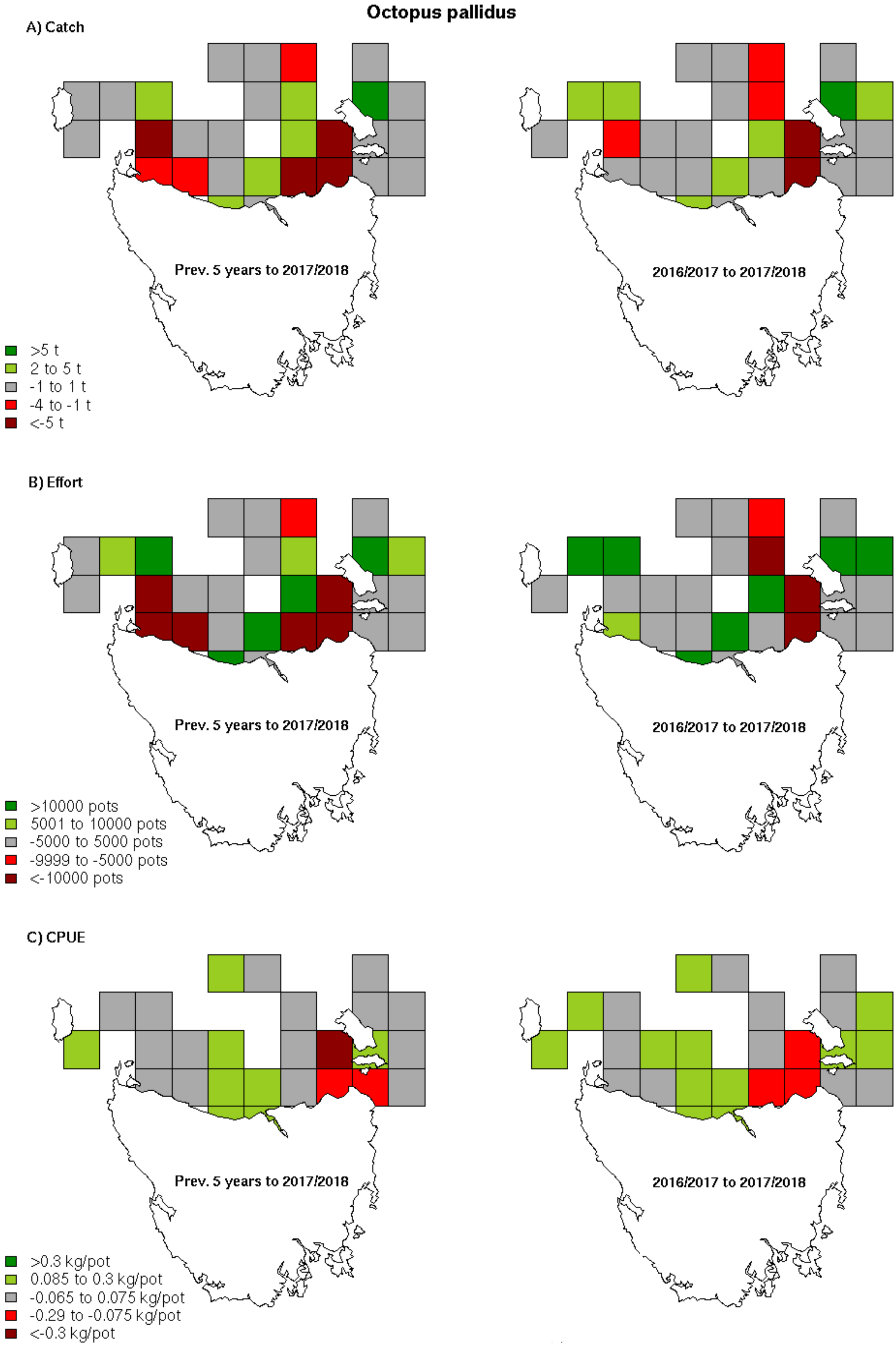


Figure 3.10 Change in (A) catch, (B) effort and (C) CPUE by blocks between the 2017/18 and the previous year (right), and between the 2017/18 and the previous 5 years (2012/13 to 2016/17) (left).

4. Stock status

STOCK STATUS	SUSTAINABLE

Fishing mortality for Pale Octopus is represented by the use of proxies - catch (tonnes) for absolute mortality and effort (potlifts) for exploitation rate. In 2017/18 catches of Pale Octopus in the Tasmanian Octopus Fishery fell by approximately 19.6 t from 2016/17 to approximately 64.4 t representing the lowest level observed since 2011/12. The 2017/18 catches of Pale Octopus were well below the long-term average for the fishery, with an annual average catch of 85.4 t observed over the last decade. In contrast, catches of Gloomy Octopus were 18 times higher than those of the previous year, with a total of 16.9 tonnes recorded. Effort was at the third highest level recorded since reporting began, with 366,500 potlifts in 2017/18.

Biomass of Pale Octopus is indicated by trends in catch per unit effort (CPUE), which have decreased from 2005/06, albeit with annual fluctuations. Historically, CPUE declined after a peak in the mid-2000s but has been relatively stable since 2011/12, fluctuating at around 60% of the reference year (2004/05, corresponding to the start of the 50-pot sampling). In 2017/18 the 50-pot sample and logbook data-derived CPUE estimates were 52% and 66% of those of the reference year, respectively. Historically, high levels of fishing effort have been proceeding declines in fishery-wide CPUE, yet the magnitude of this effect is masked by shifts in spatial fishing effort and the biology of the species.

Based on the evidence provided above, there are no clear indications that the biomass of Pale Octopus in the Tasmanian Octopus Fishery is in a depleted state, and although the proposed effort trigger reference point was slightly exceeded, catch was at the lowest level observed in 6 years. As such, levels of fishing mortality experienced in the 2017/18 fishing season are not expected to result in the stock becoming recruitment impaired. On the basis of the evidence provided above, Pale Octopus in Tasmania is classified as a sustainable stock. However, in several previous years fishing mortality was likely too high and would drive the stock in the direction of becoming depleted. Formalising limit or target parameters may serve to reduce fishing pressure and prevent future depletion of the biomass.

5. Bycatch and protected species interactions

Bycatch in the octopus pot fishery is historically low. While Pale Octopus is the main target, pots also attract other octopus species such as Gloomy Octopus and Maori Octopus as by-product. Catches of Gloomy Octopus increased considerably relative to 2016/17, with 16.9 tonnes landed in 2017/18. Alternatively, Maori Octopus catch values halved to 0.9 tonnes in 2017/18. These by-product species were considered to be at negligible risk from octopus potting in the 2012/13 Ecological risk assessment (ERA) of the Tasmanian Scalefish Fishery due to their low historical catches (Bell *et al.*, 2016). The trends associated with *O. tetricus* should be reinvestigated in the 2018/19 season.

Protected species interactions in the fishery are minimal, with seals being the only species group for which interactions have been recorded. These occurrences are relatively rare (28 interaction records since 2000/01, with no records since 2010/11).

The nature of the fishery and the gear used make interactions with bycatch or protected species unlikely. Boats do not operate at night hence seabirds are not attracted to working lights. There is no bait discarding issues since the pots are unbaited. Surface gear is minimal (two buoys and two ropes for each demersal line). The 2012/13 ERA considered that risks from octopus potting to protected species were negligible (Bell *et al.*, 2016).

Entanglement of migrating whales in ropes of pot fisheries have been reported in Western Australia (WA Department of Fisheries, 2010). While the Tasmanian Octopus Fishery operates in Bass Strait, part of which is in the migratory route of southern right whales (TAS Parks and Wildlife Service), no such interactions have been reported in Tasmania. Furthermore, the limited amount of surface gear, typically 40 buoys in the entire fishery at any one time is negligible in contrast to other pot fisheries. For example in the Tasmanian Rock Lobster Fishery a single operator may set up to 50 sets of pots and ropes and there are approximately 1.3 million potlifts set annually, or in the Western Australia Rock Lobster Fishery where there are approximately 2 million potlifts set annually (De Lestang *et al.*, 2012; Hartmann *et al.*, 2013).

The octopus pots currently used in the fishery are lightweight and set in a sandy bottom environment, which is the preferred substrate for Pale Octopus. The impact of commercial potting has been found to have little impact on benthic assemblages (Coleman *et al.*, 2013) and the 2012/13 ERA considered that octopus potting was of low risk to both the ecosystem and habitat (Bell *et al.*, 2016).

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