TASMANIAN OCTOPUS FISHERY ASSESSMENT - 2011/12

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TRANSLATINGNATUREINTOKNOWLEDGE

This assessment of the Tasmanian octopus fishery is produced by the Institute for Marine and Antarctic Studies (IMAS).

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Executive Summary

The Tasmanian Octopus Fishery is a multi-species fishery in the Bass Strait primarily targeting *Octopus pallidus* and the less abundant *Octopus tetricus* (Table 1). The Scalefish Fishery Management Plan (revised in 2009) provides the management framework for the fishery. This report represents the first assessment of Tasmanian Octopus Fishery.

In this assessment, the octopus fishery is described in terms of catch, effort and catch rates at the State level. A more detailed analysis of catch, effort and catch rates at the fishing block level is also presented. The commercial catch history for the period 2000/01 to 2011/12 is assessed.

Catches have increased over the last decade and stabilised at approximately 100 tonnes since 2005/06. Effort followed a similar pattern and has stabilised at around 300,000 pots since 2006/07. There is a strong seasonal pattern in CPUE, which is highest during the brooding peak for the species (autumn). CPUE has declined since the recent peak in the mid 2000s but remains at/above CPUE from the early 2000s which corresponds to a lower harvest. The decline of CPUE seemingly in response to an increase in catch suggests fishing mortality is reducing recruitment and should be closely monitored in future. While current changes are not of concern it is important to avoid a gradual ongoing decrease which would not be evident from considering catch data alone.

In 2011/12, catch and effort have focused on the fishing blocks out of Stanley (4E1 and 4E3) and around Flinders Island, specifically east Flinders. There has been a shift in the last five years from fishing the north-east coast of Tasmania to the west of Flinders Island.

Bycatch of octopus from other commercial fisheries (mainly *O. maorum* from the rock lobster fishery) has decreased over time and has been relatively low the last five years (around 11 tonnes on average). The recreational catch of octopus appears minimal at less than a tonne retained per annum.

Formal indicators are still to be developed to define stock status, impact on bycatch and impact on protected species for the octopus fishery. However, the decrease in catch rate over the last seven years, possibly in response to an increase in catch implies the need for ongoing assessments. The impact of the fishery on bycatch and protected species is low due to the nature of the gear used.

The (commercial) fishery is effectively a sole operator fishery with the same operator since its commencement in 1980. This is one of the most effective arrangements for ensuring profitability in the fishery and stewardship of the resource.

Table1 Main features and statistics for the Tasmanian Octopus Fishery.

Fishing methods	Unbaited octopus pots.
Primary landing port	Stanley.
Management methods	**Input control**: • Fishing licence (octopus) allows the use of 10,000 pots (and a maximum of 1,000 pots per line) to target *Octopus pallidus*, *O. tetricus* and *O. maorum*. • Fishing zone restriction (East Bass Strait and West Bass Strait octopus zones only) **Output control*:*** • Possession limit of 100 kg of octopus per day (all species con-founded) for other commercial fisheries and recreational fishery.
Main market	Tasmania and mainland Australia
Fishing permits	**2**
Active vessels	**2**

Future assessments will work towards setting reference points for this fishery. Data from the 50-pot samples should be used to this effect as they are more representative of the stock status. It is therefore important that the 50-pot sampling continues at a consistent and high level so that a sufficient time series is available to set appropriate reference points.

1 Introduction

1.1 The fishery

The Tasmanian Octopus Fishery has been operating since 1980. Prior to December 2011 the fishery operated under permit. Historically, access to the commercial fishery was provided to holders of a personal fishing licence, a vessel licence and a scalefish or rock lobster licence via a trip limit of 100 kg. This limit also applies to recreational fishers.
Since December 2011, a specific octopus licence was required to participate in the fishery. Two licenses were issued, belonging to the same operator. No further licenses are likely to be issued at this stage for the undeveloped area.

Since 1996, under the Offshore Constitutional Settlement (OCS) with the Commonwealth of Australia, Tasmania has management control of the octopus fishery out to 200 nautical miles. However, when signing the OCS it was agreed that fishers will not be able to extend their access into areas that they did not have access to prior to the changes in jurisdiction, without consultation with and agreement by both the Commonwealth and the State. Therefore only fishers who held a Commonwealth permit for octopus have access outside 3 nautical miles. To date, only one operator has been successful in establishing a commercial industry.

The Tasmanian Octopus Fishery primarily targets the pale octopus (*Octopus pallidus*), with lesser targeted catches of the Gloomy octopus (*Octopus tetricus*) and the Maori octopus (*Octopus maorum*) also taken, primarily as byproduct. The main fishing method is unbaited moulded plastic pots (volume 3000 ml) 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. Octopuses 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 a shortage of suitable shelters may account for high catch rates in some areas. Commercial octopus fishing is presently restricted to the East Bass Strait and West Bass Strait fishing zones (Figure 1.1). While no further octopus licenses can be issued for the Bass Strait area, the remaining State waters are classified as developmental and could be open to fishing providing necessary research is undertaken (at the cost of the applicant). There are however no plans to open further areas to commercial octopus fishing at this stage.

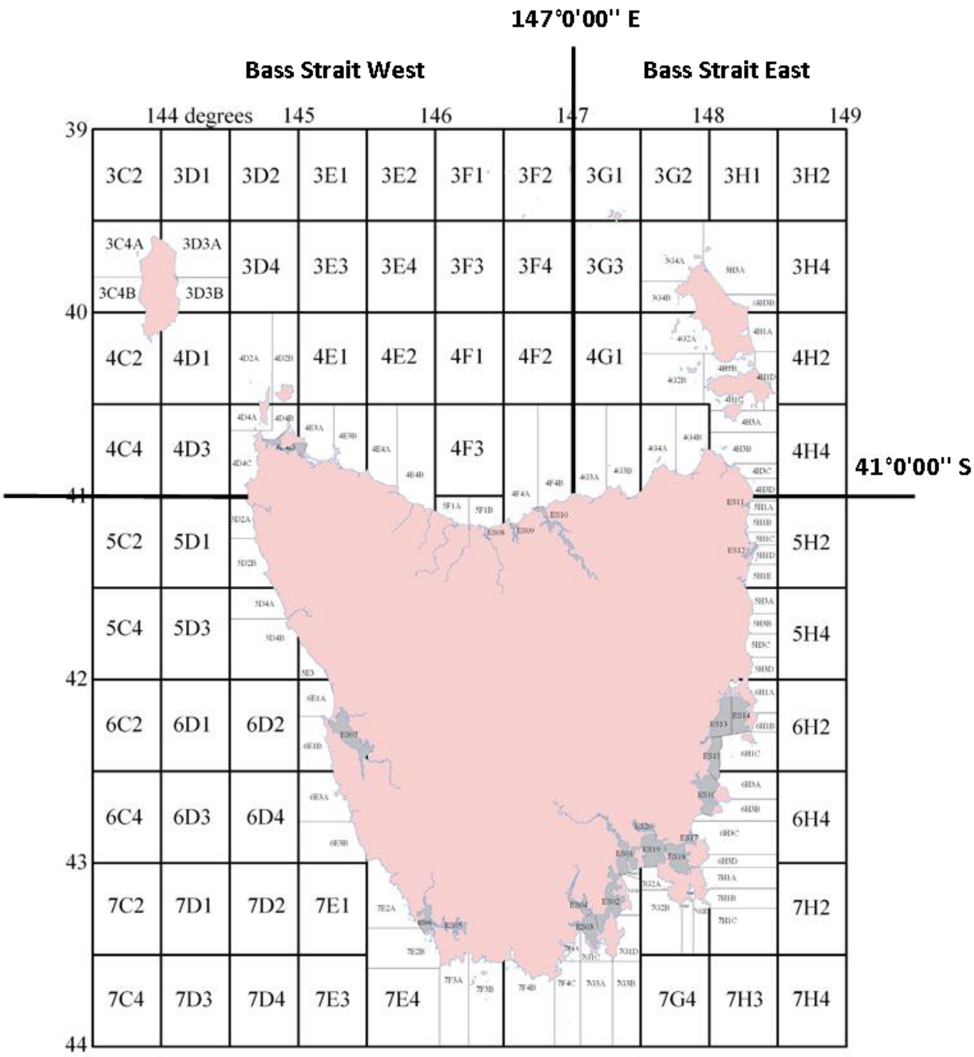


Figure 1.1 East and West Bass Strait octopus fishing zones and reporting blocks.

Octopus are also targeted by recreational fishing, although catch sizes are small. A total of 100kg of octopus in any one day and at any one time is allowed under Tasmanian legislations.

From 2000 to 2005 octopus catches increased substantially, and since then have been around 100 tonnes with some strong inter-annual variation (Figure 1.2). The majority of the catch originates from the Octopus Fishery. *O. tetricus* has only been reported in the commercial fishery since 2010, mostly from around Flinders Island and reached around 2 tonnes in 2011. This increase in catch is likely due a combination of a southern expansion of the species' range (REDMAP, 2013) and an increase in targeted effort for *O. tetricus*. The catch of *O. maorum* has been stable at around 1.5 tonnes since 2008 although catches are possibly underestimated in the current dataset due to potential unaccounted catch from Commonwealth trawlers.

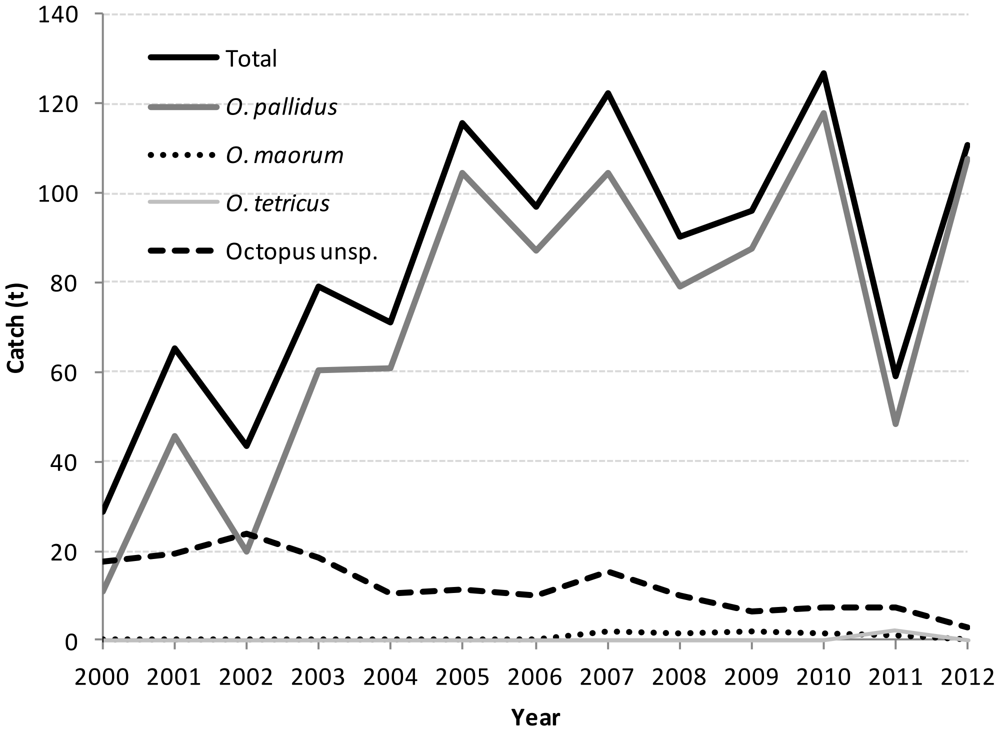


Figure 1.2 State-wide octopus catches since 2000 from all commercial sources (see section 1.2.1).

1.2 Data sources and analysis

1.2.1 Commercial data

Commercial catch and effort data are based on the Octopus Fishery and the Scalefish Fishing Record logbook returns. In both cases octopus catches are reported in weight. Since November 2004, a 50-pot sampling program has been introduced, 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 total and gutted weight of the catch, numbers of males and females, and the percentage of pots with eggs are recorded. Fishers are only required to sample a single line where multiple lines were located within a 15 km radius.

Weight-at-age is highly variable in octopus due to a high individual variability and a rapid response to environmental factors (André et al., 2009; Leporati et al., 2008b). This introduces stochasticity in catch weight so that it becomes difficult to use in interpreting trends in population size. The 50-pot samples provide numbers of octopus, which is more representative of the state of the stock. Consistent, high level sampling has only been in place since 2011 and a longer time-series will be required to obtain a more accurate understanding of the stock status – particularly at a smaller spatial scale (e.g. block level).

1.2.2 Recreational fishery

Recreational fisheries data in Tasmania is relatively sparse. Detailed analyses of the Tasmanian recreational fishery available are based on the 2000/01 National Survey (Lyle 2005) and the 2007/08 state-wide fishing survey (Lyle et al 2009).

1.2.3 Data analysis

For the purpose of this assessment, catch, effort and catch rate analyses are restricted to commercial catches of *Octopus pallidus* for the period March 2000 to February 2011.
A fishing year from 1st March to 28th 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).

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. All records were however 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 both catch weight per pot and catch number per pot) through time for the 50-pot sampling data.

Catch rates of pale octopus have been standardised using a generalised linear model (GLM) to reduce the impact of obscuring effects such as season on the underlying trends (Kimura, 1981; Kimura, 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.

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 the same vessel that set it. Consequently depth, vessel and skipper were not included in the generalised linear model, the factors considered were month and block. The generalised linear model was applied to weight per pot in the whole commercial dataset and both weight per pot and number per pot for the 50-pot sampling dataset (Table 1.1).

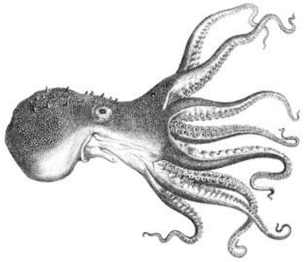
Table 1.1 Generalised linear model (GLM) for the catch rates of pale octopus across the whole of Tasmania. For the 50-pot sampling, CPUE was expressed in weight/pot and number/pot. The adjusted R^2 has been used for the Variation described.

Data	**Model**	**Variation described**
Whole dataset	Ln cpue = Constant + year + month + block	33.04%
50-pot sampling (weight)	Ln cpue = Constant + year + month + block	35.87%
50-pot sampling (number)	Ln cpue = Constant + year + month + block	22.18%

1.3 Species biological summaries

All three octopus species are short lived and fast growing. Table 1.1 summarises the biology of each species.

Table 1.2 Life history and biology of *O. pallidus*, *O. tetricus* and *O. maorum*. In the Source column, [1] refers to *Octopus pallidus*, [2] to *Octopus tetricus and* [3] to *Octopus maorum.*

Species	**Pale octopus** *Octopus pallidus*	**Gloomy octopus** *Octopus tetricus*	**Maori octopus** *Octopus 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 sea-weeds, sand down to 549 m.	Norman (2000)[1,2,3] Edgar (2008)[1,2,3]
Distribution	South-east Australia, including Tas-mania.	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 dis-crete sub-populations.	Undefined.	• Several genetically distinct popula-tions. • 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	High. Undefined.	Undefined.	Undefined.	
Maximum age	Up to 18 months.	Undefined.	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]
Growth	• Highly variable, partly dependant	• Max weight: up to 2.6 kg	• Max weight: 15 kg	Leporati et al. (2008a)[1]

	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 (generally power) 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.	• 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.	• Growth equation undefined	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 undefined. • Males are mature between 100-150g. Females commence sexual activity at about 500 g and generally spawn between 1-2 kg.	• 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] Joll (1983)[2] Grubert and Wadley (2000)[3]
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. • Between 125 000 and 700 000 eggs depending on size • Egg length: 2.4 mm.	• 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]
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. No stock-recruitment relationship defined. reined.	Variable. No stock-recruitment relationship defined.	Variable. No stock-recruitment relationship defined.	

2 State catch, effort and catch rates

2.1 Commercial catch from octopus pots

2.1.1 Influence of soak time

The 50-pot samples were used to examine whether catch rates are influenced by soak time. Results indicated that soak time did not appear to affect CPUE by number or weight (*Catch weight per unit effort*= -0.001**Soak time* + 2.89, *p*>1) (Figure 2.1). This indicates that fishers are choosing a soak time sufficient to obtain maximum catch rates and that the soak time can be disregarded when calculating catch rates. Consequently the number of shots was used as the measure of effort when calculating catch rates.

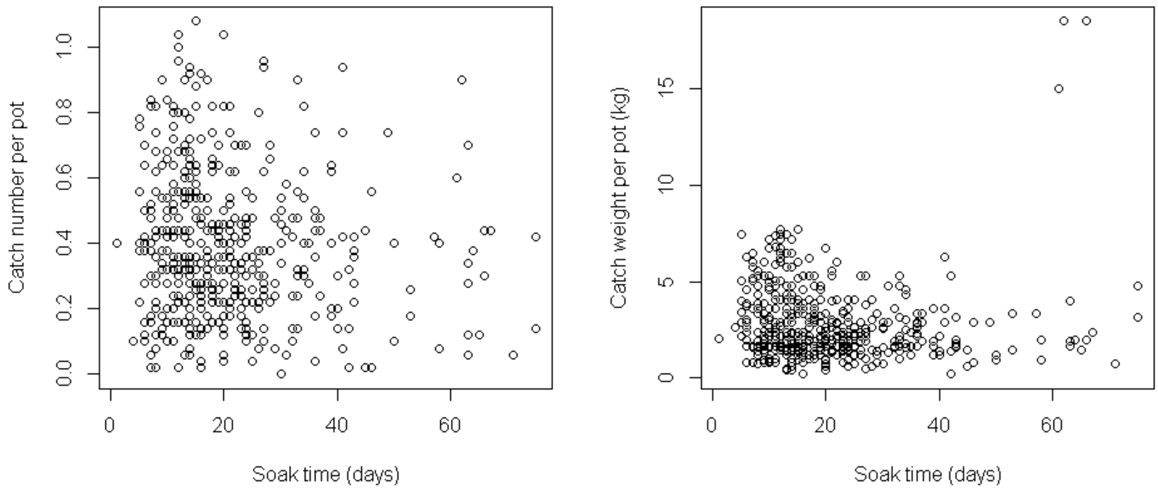


Figure 2.1 CPUE (in catch number per pot and catch weight per pot) relative to soak time of octopus pots.

2.1.2 Catch and effort

Catch of *O. pallidus* has increased since 2000/01 but has remained consistent over the last seven years at around 100 tonnes (Figure 2.2). Current catch levels are about double of what they were prior to 2000 (Leporati et al., 2009). Effort has also increased from 2002/03 and stabilised in the last six years at around 300,000 pots (Figure 2.3), which is on average the same level as pre-2000 (Leporati et al., 2009).

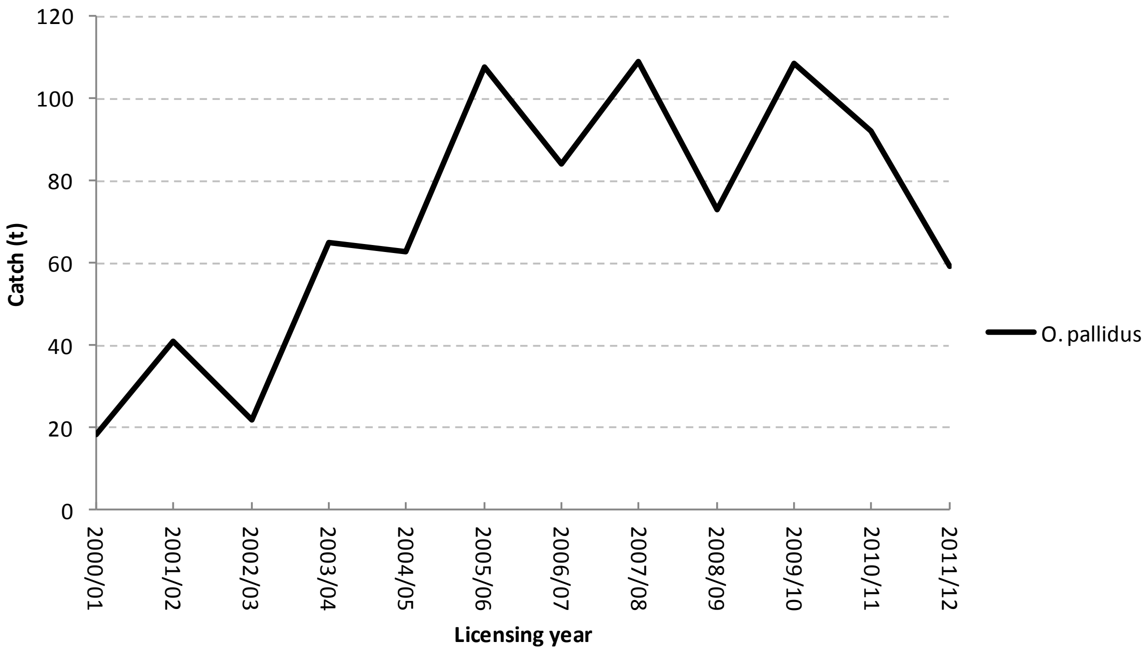


Figure 2.2 Total catches State-wide (tonnes) for *Octopus pallidus* since 2000/01.

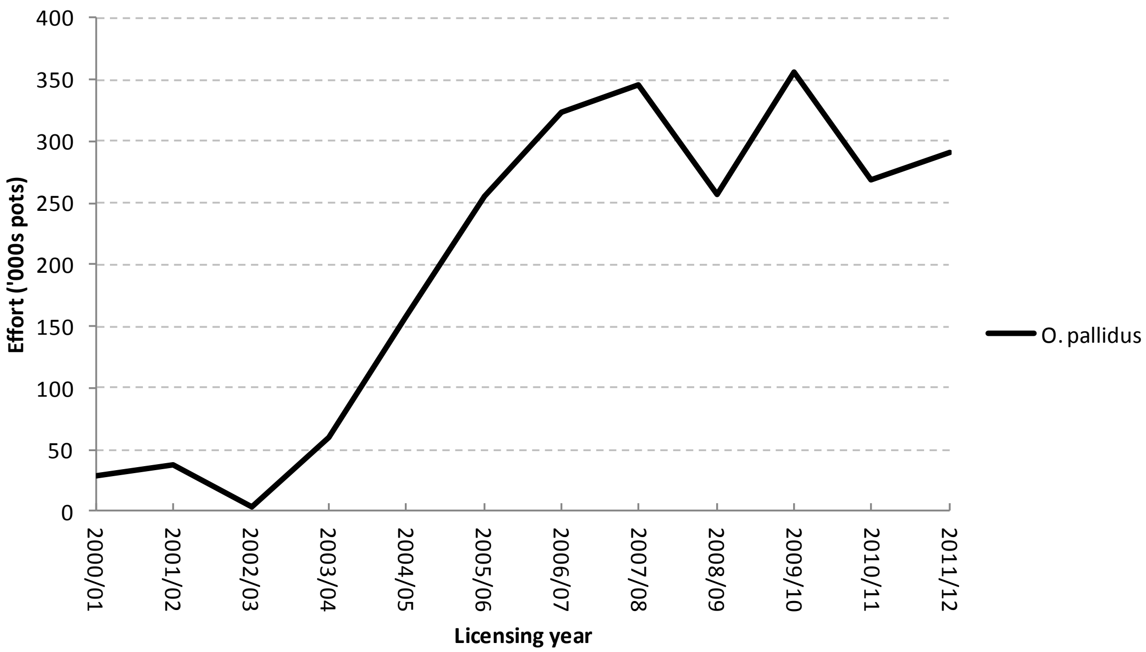


Figure 2.3 State-wide effort (thousands pots) for *Octopus pallidus* since 2000/01.

2.1.3 CPUE

CPUE based on the 50-pot sampling followed a similar pattern to the CPUE for the total commercial catch (Figures 2.4 and 2.5). CPUE appears to be seasonal with higher catch rates in autumn/early winter (March to July, Figure 2.4), which is in accordance with previous CPUE analyses (Leporati et al., 2009). This peak in CPUE corresponds to the brooding peak for the species, which occurs in autumn (Leporati et al., 2008a). Female octopus use the pots as shelters to deposit their eggs and the impact on recruitment of removing brooding females has been questioned previously, especially since *O. pallidus* is an holobenthic species with limited juvenile dispersal.

The licensing year 2004/05 was chosen as a reference year for CPUE as the 50-pot sampling started in that year (Figure 2.5). The catch rate standardisation removes the seasonal effect (which was evident in Figure 2.4). CPUE has declined since the recent peak in the mid 2000s but remains at/above CPUE from the early 2000s, which corresponds to a lower harvest. Thus the decline may be due to natural variability in the stock, however 50-pot sampling was not conducted at this time and this earlier CPUE may be misleading. It is however worth noting that CPUE information alone is an unreliable indicator of the stock status for holobenthic species of octopus (Leporati et al., 2009). The underlying composition and recruitment potential of the population may be substantially impacted by fishing without the CPUE being affected (Leporati et al., 2009).

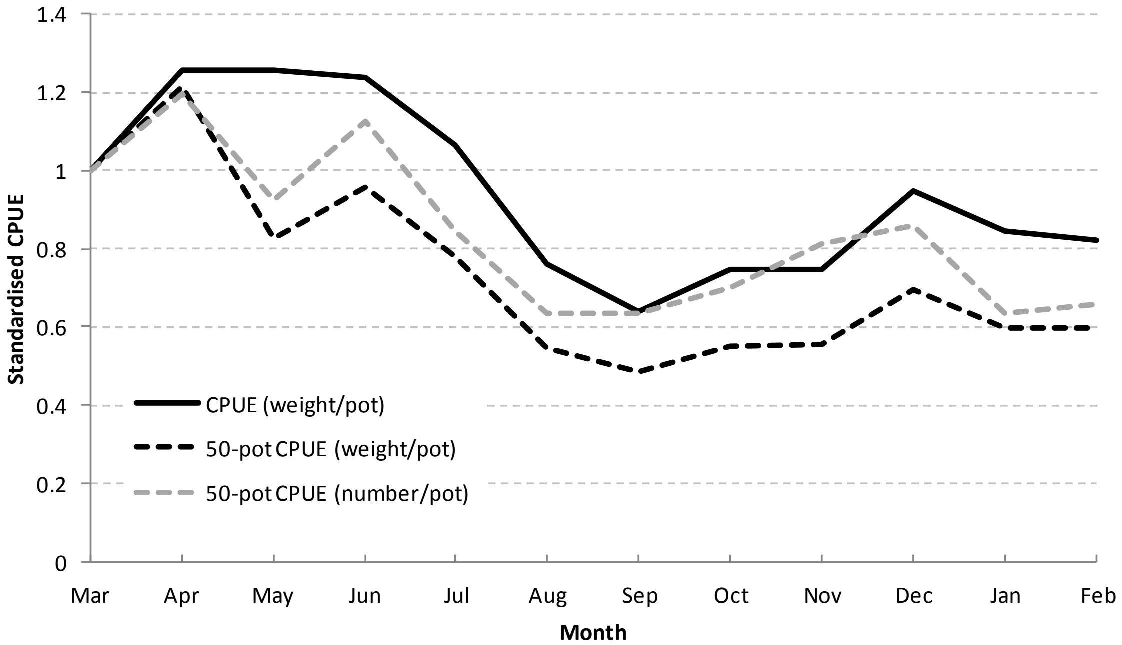


Figure 2.4 *Octopus pallidus* standardised catch per unit effort (CPUE) relative to March levels in weight per pot (total commercial and 50-pot sampling) and in number per pot (50-pot sampling).

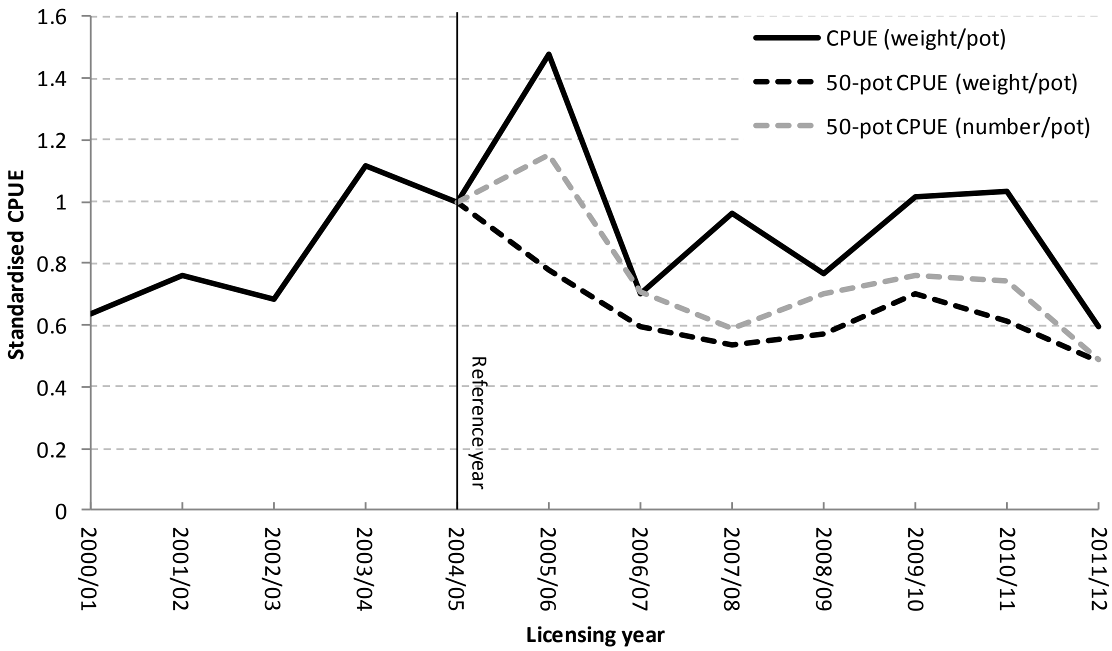


Figure 2.5 *Octopus pallidus* standardised catch per unit effort (CPUE) relative to 2004/05 levels in weight per pot (total commercial and 50-pot sampling) and in number per pot (50-pot sampling).

2.2 Commercial catch from other fishing methods

Although historical total octopus bycatch has reached up to 30 t in the early 2000's, recent records of octopus bycatch has dropped, reaching around 8 t in 2010/11 and 7 t in 2011/12 (Fig. 2.6). Species are seldomly recorded and 96.4% of the bycatch is qualified as unspecified octopus species. It is however generally accepted that the rocklobster fishery octopus bycatch is predominantly *O. maorum*.

Most of the octopus bycatch in recent years originated from the rock lobster commercial fishery, with an average bycatch of 6.4 t per annum in the last 5 licensing years (Fig. 2.6). The commercial scalefish fishery provides the other source of octopus bycatch, although its contribution has dropped since 2007/08 (Fig. 2.6). Gears that produce the most catch are hand collection, graball nets, and crab pots. The current pressure from other commercial fisheries does not appear excessive and does not show any upwards trends. The impact of octopus bycatch on the octopus stocks is therefore considered low at present.

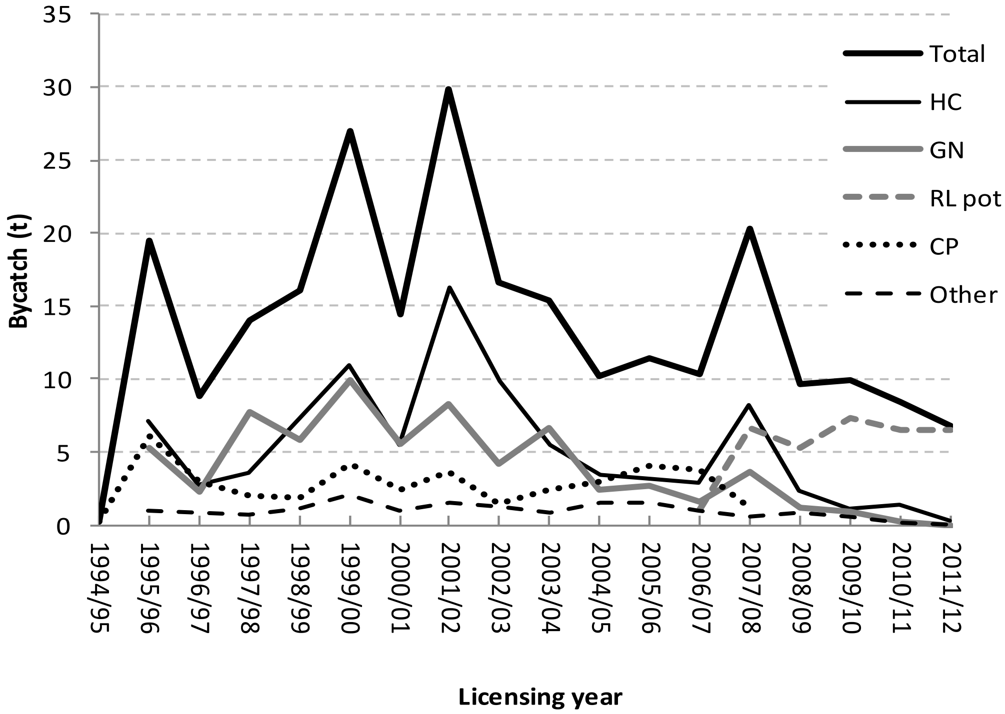


Figure 2.6 Octopus bycatch (tonnes) in other commercial fisheries.

2.3 Recreational catch

Catch and effort information are not routinely available for the recreational fishery. Surveys of the recreational fishery conducted in 200/01 and 2007/08 provide the only comprehensive snapshots of the Tasmanian recreational fishery (Lyle et al., 2009; Lyle, 2005). The recreational fishery surveys did not differentiate between cephalopod species to the exception of southern calamari and Gould's squid. It is however understood that the majority of the catch reported as "cephalopods, other" are actually octopuses, the remaining portion being cuttlefish.

Octopus species are not the focus of the recreational fishery and appear as bycatch caught predominantly by lines, and by gillnets and, to a lesser degree, pots. The impact of the recreational fishery on the octopus stocks is considered minimal.

Table 2.1 Estimated total recreational harvest numbers, number kept and % released for cephalopod taken by Tasmanian residents (refer to Lyle et al., 2009).
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

3 Fine-scale catch, effort and catch rates

Catch and catch rates have been analysed at the scale of the fishing block to examine the potential issue of localised depletion. Trends for each block have been calculated as the difference in catch and (unstandardised) CPUE between the current licensing year and the previous licensing year (Figure 3.2).

Areas of high catches are off Stanley (4E1 and 4E3) and east of Flinders Island (3H3) (Figure 3.1A). While the effort around Stanley and east of Flinders Island has remained similar over the years, effort has shifted from the north-east coast of Tasmania towards west Flinders in the year 2011/12 (Figure 3.1B). Catches in these areas have concomitantly increased although east Flinders has seen a reduction in catch in 2011/12 compared to the previous five years. CPUE has remained high in the north west of the State and east Flinders over the years (Figure 3.1C).

The analyses of trend in catch and CPUE between the current (2011/12) and the previous year (2010/11) reveals a decrease in catch and CPUE for the blocks off Stanley and the north-east coast of Tasmania and an increase in catch and CPUE around Flinders, particularly east Flinders. Some offshore blocks in the north west of the State have also recorded an increase in CPUE from the previous year.

Significantly the trends in catch and catch-rate (Figure 3.2) are closely aligned, likely indicating that fishers are responding to changes in CPUE by shifting effort (and therefore catch) from areas with decreasing CPUE to areas with increasing CPUE. This is a positive factor in that the fleet is shifting its catch to those areas with highest abundance. However, care needs to be taken when assessing the fishery that this does not mask CPUE trends (a common problem with serial depletion).

As a precautionary approach, a previous study from Leporati et al. (2009) recommended to set the actual catch limit per fishing block to less than the 2005 single block maximum (33.4 t) in order to avoid overexploitation. It is worth noting that the block with the highest exploitation rate (4E1) is currently under that value, with an annual catch of 29.4 t.

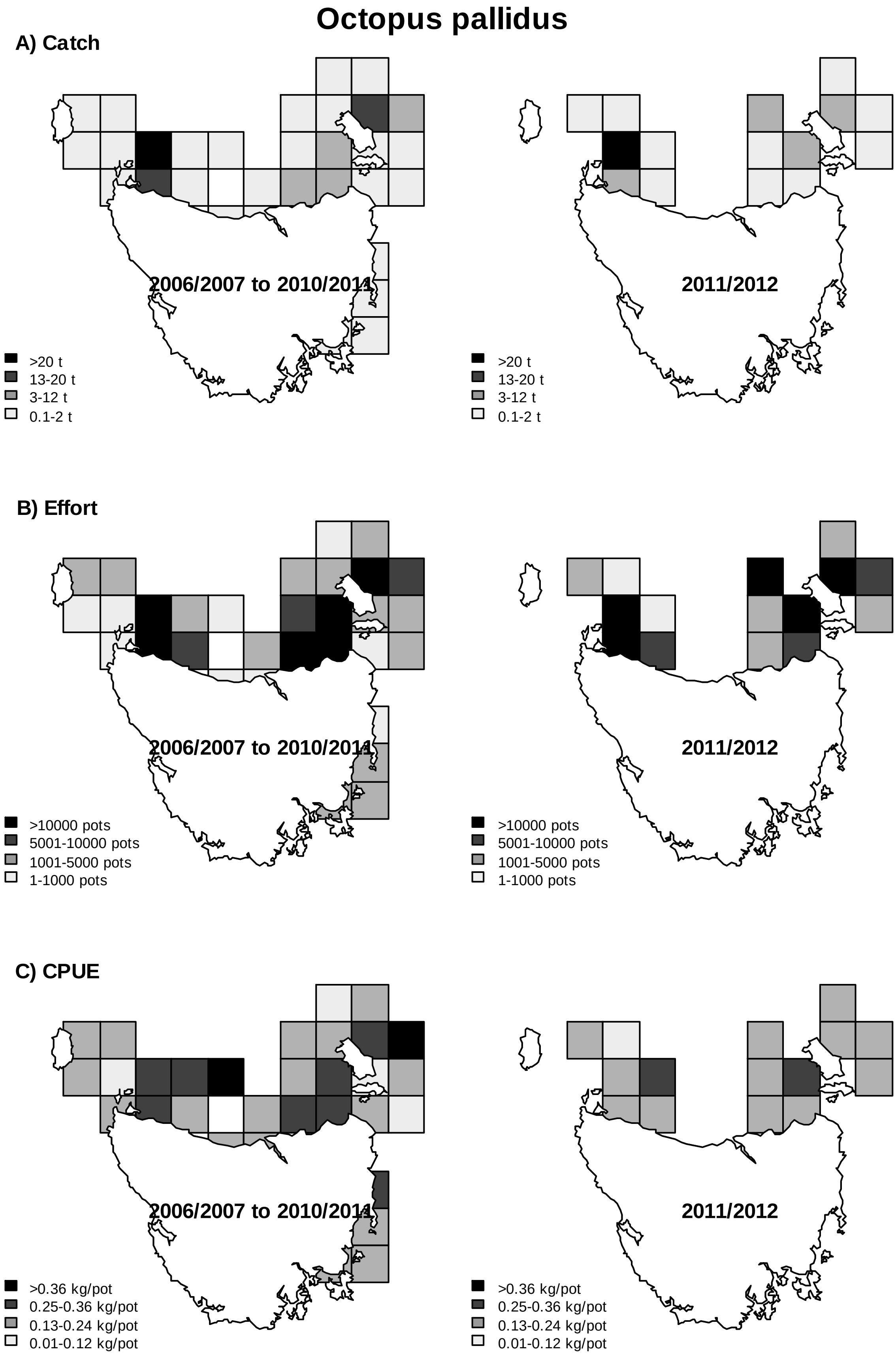


Figure 3.1 (A) Catch, (B) effort and (C) CPUE averaged over the last 5 years and for the licensing year 2011/12.

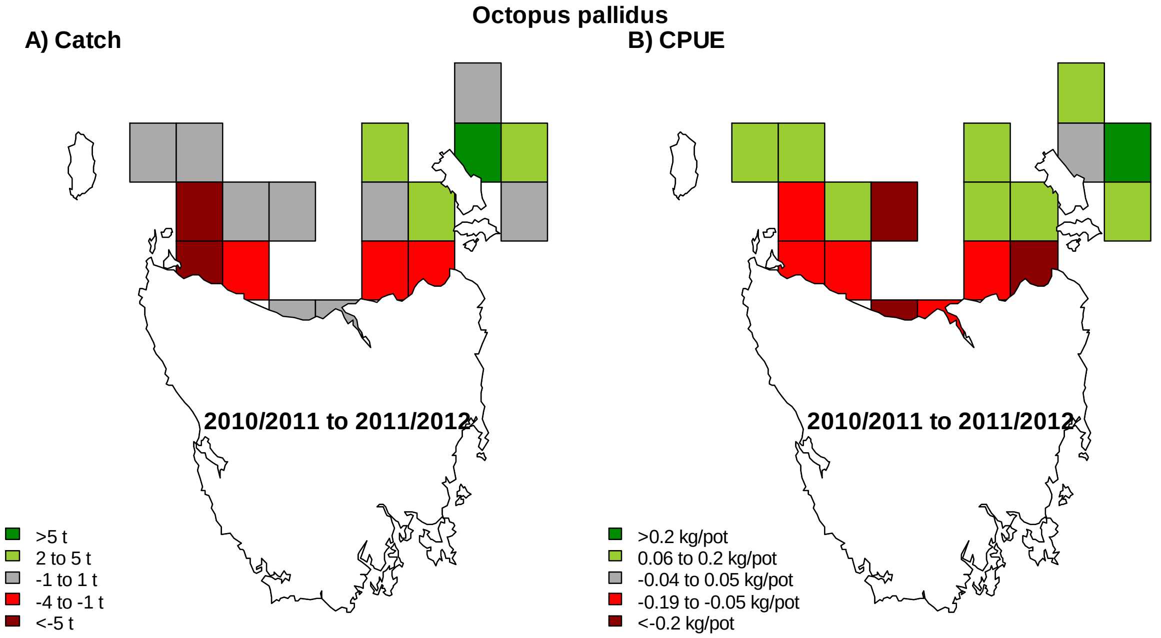


Figure 3.2 Trends in (A) catch and (B) CPUE by blocks between 2010/11 and 2011/12.

4 Bycatch and protected species interaction

Bycatch in the octopus pot fishery is low. While *O. pallidus* is the main target, pots also attract other octopus species such as *O. tetricus* (around 2 tonnes caught in 2011/12) and to a lesser extend *O. maorum* (less than 0.5 tonnes caught for that same licensing year).

Protected species interactions are also minimal, seals being the only species for which interactions have been recorded. These occurrences are relatively rare (28 interaction records since 2000/01) and result in losses in catch and gear damage. Most interactions appear to occur in blocks 4E1, 4E2 and 4E3.

The nature of the fishery and the specific gear used make interactions unlikely. Boats do not operate at night; hence birds are not attracted to working lights. There are no bait discarding issues since the pots are unbaited. Surface gear is minimal (two buoys and two ropes for each demersal line).

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, such as the Tasmanian Rock Lobster fish where a *single operator* may have up to 50 sets of pots and ropes.

The octopus pots currently used in the fishery are lightweight and set in a sandy bottom environment, which is the preferred substrate for *O. pallidus*. Moreover, the impact of commercial potting has been found to have little impact on benthic assemblages (Coleman et al., 2013). The impact of the Tasmanian Octopus fishery on the benthic biota is therefore considered minor.

The overall impact of the fishery on bycatch and protected species appears to be negligible.

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