

TASMANIAN LONGSPINED SEA URCHIN FISHERY ASSESSMENT 2019/20

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Executive Summary

STOCK STATUS	SUSTAINABLE
<ul style="list-style-type: none"> Fishing mortality in the <i>Centrostephanus rodgersii</i> fishery is represented by the use of catch (tonnes) as a proxy. In the most recent season 2019/20 annual catch has dropped to 376 tonnes compared to the previous season of 560 tonnes, due to changes in operations at the main processor and COVID-19. A reduced subsidy in the highest catch region has resulted in catch being more evenly distributed for each of the subsidy zones rather than concentrated in the North. However, the highest catch region is still the St Helens region. There is no evidence of biomass depletion through the observed catch rates. Biomass in the <i>Centrostephanus rodgersii</i> fishery is indicated by two methods: extrapolation from counts obtained from fishery-independent transect surveys; and trends in catch per unit effort (CPUE). Biomass assessed by fishery-independent transect data has increased over the last two decades. State-wide CPUE has not decreased over the span of the fishery from the first 2008/2009 season to the most recent 2019/2020 season even in the most heavily fished blocks. 	
STOCK	Tasmanian Longspined sea urchin fishery
INDICATORS	Catch, effort, CPUE trends and transects.

C. rodgersii has been harvested commercially in Tasmania since 2009. The annual catch remained below 100 tonnes until increasing to 185 tonnes in 2017/18, 560 tonnes in 2018/19 and 376 tonnes for the current season 2019/20. To date there is no evidence of widespread decrease in biomass when comparing catch rates over time, even in the most heavily blocks around St Helens in the north east of the state.

Catch rates would not necessarily decline as biomass falls because divers can shift to new areas. A recent survey of the commercial divers has suggested that in some areas divers have been forced into deeper waters by using Nitrox to sustain high catch rates (Cresswell et al. 2019). Fisheries-independent surveys indicate that biomass increased between 2001 and 2017 on the east coast of Tasmania, during which period only small fishing catches were taken. The survey showed a general trend of highest biomass/densities in the northeast to the lowest in the southeast (Johnson et al. 2005, Ling and Keane 2018). Given that this species is not endemic to Tasmania and has a negative impact on the ecosystem here, a depleting status for the fishery may be desired. This is supported by our observed regional trend in catch rates, which clearly decrease from north to south.

Biomass was estimated through a scientific survey in 2001/02 in the 6 to 24 m depth region (the depth of the dive fishery) to be 2523 tonnes (Table 1). This depth band covered 80% of the urchin biomass. A resurvey was conducted in 2016/17 and biomass was estimated at 4434 tonnes. Some small-scale removals from harvesting occurred through this period. Over the period between the two surveys, and accounting for removals from fishing, the average (linear) biomass increase was 153 tonnes/year. Catch in each of the three years since the last survey has exceeded this amount.

Table 1. Biomass estimated from scientific survey in 2001/02 and 2016/17 in bold and asterix, with average biomass increase (assuming a linear relationship) and removals from harvesting, culling and the complete harvest project (explained in text). Average linear biomass increase from the 2001/02 season to the 2016/17 season is 153 tonnes per year, accounting for the removals from harvesting.

Year	Estimated biomass 6 to 24m depth (tonnes)	Average linear biomass increase (tonnes)	Removals from harvesting (tonnes)	Removals from culling (tonnes)	Removals from "take-all" harvest (tonnes)
2001/02	2523	153			
2002/03		153			
2003/04		153			
2004/05		153			
2005/06		153			
2006/07		153			
2007/08		153			
2008/09		153	7		
2009/10		153	12		
2010/11		153	64		
2011/12		153	61		
2012/13		153	81		
2013/14		153	97		
2014/15		153	19		
2015/16		153	40		
2016/17	4434	153	41		
2017/18			185		
2018/19			560		
2019/20			327	14.8	34.9

Stock status definitions

We have adopted the most recent guidelines for national stock status categories, as specified by the Fisheries Research and Development Corporation.

	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.
	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.
	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.
	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.
	Negligible	Catches are so low as to be considered negligible and inadequate information exists to determine stock status.	Assessment will not be conducted unless catches and information increase.

Acknowledgements

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Introduction

Overview

Centrostephanus rodgersii (the Longspined sea urchin or Centro) is not native to Tasmania historically, nor is it considered an introduced marine pest. Rather, evidence suggests that this species has recently undergone a range extension to Tasmania from NSW due to extensions in the warm East Australia Current brought about by climate change (Johnson et al. 2005, Ridgway 2007, Ling 2008). Increased populations of Longspined sea urchins are of concern because they can damage kelp forests through overgrazing (Ling et al. 2009a, Johnson et al. 2011, Marzloff et al. 2016). Once established on a reef, increases in urchin density and subsequent grazing pressure of this species leads to discrete patches of bare rock termed 'incipient' barrens (Johnson et al. 2005). If urchin density continues to increase in incipient barrens, the grazed patches grow and join together into larger patches, leading to the formation of 'extensive' urchin barrens (Flukes et al. 2012), a habitat largely devoid of macroalgae (Lawrence 1975, Chapman 1981, Andrew and Underwood 1989). This fundamental change in the ecosystem has a substantial impact on a broad range of species and reduces the utility for human activities including diving, and recreational and commercial fishing of a number of species.

A commercial fishery for Longspined sea urchins began in 2009 in response to their increased biomass and densities in Tasmania. The total annual catch started and remained at 100 tonnes or less until the 2017/18 season, when the catch increased to 185 tonnes, then tripling in 2018/19 to 560 tonnes. The Tasmanian commercial fishery now exports nationally and internationally. Catch can only be taken by holders of a commercial dive license. There are no recreational regulations. In the 2019/20 season beginning September 1st 2019, there were 29 divers involved in the fishery. Most fishing effort occurs from December/January to June when roe quality is suitable for harvest.

Species biology

The Longspined sea urchin is a large, fast growing Diadematidae that inhabits temperate reefs at varying depths up to 60m around southeast Australia, Norfolk and Lord Howe Islands, the Kermadec Islands and northern New Zealand (Schiel et al. 1986, Andrew 1993, Andrew and Byrne 2007, Pecorino et al. 2012, Perkins et al. 2015). In Australia, evidence suggests that the species arrived to the east coast of Tasmania via larval transport from spawning communities in coastal NSW and Victoria; it was first recorded in the northeast coast of Tasmania in 1978 (Edgar and Barrett 1997, Johnson et al. 2005, Ling 2008). The species matures sexually at around 4 to 5 years old at a test diameter (TD) of 40-60mm (Table 2), approaching a maximum TD of ~120mm (Ebert 1982) at ~25 to 35 years of age, after which, growth slows considerably (Ling et al. 2009a). The skeleton of a sea urchin is known as the “test”. The diameter of the test is measured using callipers placed between the spines to measure the diameter of the skeleton without the spines.

Table 2. Biological parameters for Longspined sea urchins.

Parameter	Meaning	Value
Test diameter at maturity	Size at which 50% of population becomes mature	40 to 60 mm (King et al. 1994) (NSW) 60 to 70 mm (Andrew and Byrne 2007) (NSW)
Maximum test diameter	The asymptotic length at which growth in zero	>110 mm (Andrew and Byrne 2007) (NSW) 120 mm (Ebert 1982) (NSW) 126 mm (Pecorino et al. 2012) (New Zealand) 133 mm (Ling et al. 2009b) (TAS)
Lifespan	Time to reach 95% maximum test diameter	20 years (Andrew and Byrne 2007) (NSW) 15 to 20 years (Pecorino et al. 2012) (New Zealand) 25 to 30 years (Ling et al. 2009b) (TAS)
Weight	Weight calculated from test diameter (TD)	Weight (g) = $0.0032 \cdot TD^{2.566}$ (live weight) Weight (g) = $0.0035 \cdot TD^{2.5257}$ (factory weight) *data collected in May 2020 from Complete Harvest project, John Keane unpublished data)

Sea urchin gonads or “roe” have been consumed by some cultures for millennia and are now highly appreciated worldwide as a gourmet product comparable to caviar (Andrew et al. 2002, Sun and Chiang 2015, Lourenco et al. 2019). The profitability of a sea urchin fishery relies heavily on the marketable condition of the sea urchins’ roe, which can vary greatly between individuals depending on many factors (Blount and Worthington 2002, Blount et al. 2017). Gonad yield (as a percentage of body weight) and quality (judged by texture, colour, granularity and many other factors) are both affected by food availability, diet, season and individual movement, not just size and age (Lawrence et al. 1997, Lawrence et al. 2001, Andrew and Byrne 2007, Phillips et al. 2009, Phillips et al. 2010). Roe quality varies seasonally, with energy intake increasingly proportioned towards gonad development resulting in higher roe quality in the lead up to spawning, which for this species occurs around August (Ling et al. 2008). During and immediately following spawning, the roe/gonads are at low quality for the fishery, so the bulk of harvesting in Tasmania occurs between December and June (see below). The native Tasmanian short-spined sea urchin *Heliocidaris erythrogramma* has a complementary spawning season to the Longspined, meaning factories can continue processing sea urchins in Tasmania all year around.

Sea urchin populations, like other low-mobility resources, are spatially structured with aggregations occurring primarily because of habitat structure and food availability, making them highly patchy as a resource (Ouréns et al. 2015, Gutierrez et al. 2017). Longspined sea urchins have low mobility, homing strongly to available crevices, but do not show directional movement towards food sources (Flukes et al. 2012) unlike other sea urchins, where directional movement towards available food results in mobile grazing fronts (Lauzon-Guay et al. 2006). Tracey et al. (2015) demonstrated this lack of directional movement in a culling experiment conducted in 2012 in Wineglass Bay Tasmania, showing that when plots were surveyed a year after targeted culling efforts, *C. rodgersii* densities had not increased. Because of this patchiness in stock, assessment methods should avoid the assumption of uniform distribution, and keep in mind that fishers will be concentrating their efforts in the higher density patches (Hernández-Flores et al. 2018, Casal et al. 2020).

Species ecological role

Longspined sea urchins have a pelagic larval stage of ~100 days (Huggett et al. 2005) meaning this species can travel long distances in ocean currents under the right conditions for their temperature limits (Ling et al. 2009b). Larvae have likely travelled to Tasmania through the poleward advance of the warm East Australia Current, which has extended further south with greater frequency over the past 60 years due to climate change (Ridgway 2007, Banks et al. 2010). Longspined sea urchins were first reported on the east coast of Tasmania in 1978 (Edgar and Barrett 1997) but now extend down most of the east coast (Johnson et al. 2005, Ling and Keane 2018). The first major fisheries-independent survey conducted in 2001/02 established a baseline estimate of the biomass of this species in Tasmania at 6.7 million individuals (Johnson et al. 2005). A repeat survey conducted 15 years later estimated the population to have grown to almost 20 million individuals (Ling and Keane 2018).

IMAS have been researching Longspined sea urchins and their associated barrens for more than 18 years. Above threshold densities of ~700g/m² the species can have devastating impacts on reefs due to overgrazing which can lead to the formation of extensive urchin barrens (Ling et al. 2015). The barren state is problematic because urchins can exist in a starvation state on an extensive barren for decades (Filbee-Dexter and Scheibling 2014). To convert extensive barren back to forest nearly all Longspined urchins need to be removed (to an urchin density of <70g/m²) (Ling et al. 2009a, Filbee-Dexter and Scheibling 2017). Removal experiments, such as those conducted by Tracey et al. (2015) in Wineglass Bay, Tasmania, show that after targeted and systematic removals, kelp forest regrows. The regrowth of kelp after a reduction in urchin density below a given threshold is a pattern that has been demonstrated repeatedly elsewhere in Australia and around the world (Keats et al. 1990, Leinaas and Christie 1996, Ling et al. 2015, Tracey et al. 2015, Kriegisch et al. 2016, Sanderson et al. 2016).

Urchin density control

In Tasmania, there has been research into various strategies for reducing urchin densities to prevent or reverse barren formation, one of which is to increase numbers of their predators. Worldwide, there are numerous examples of where overfishing the apex predator has led to a loss of kelp forests through the creation of urchin barrens (Steneck et al. 2002) and also the reverse effect where reduced harvest rates on urchin predators have resulted in the reestablishment of kelp forests, such as rebuilding sea otter populations in Alaska (Estes and Palmisano 1974) and rock lobster populations in South Africa (Mayfield and Branch 2000).

Southern Rock Lobster *Jasus edwardsii* is the key predator for the native sea urchin *Heliocidaris erythrogramma* in Tasmania (Pederson and Johnson 2006). Southern Rock Lobster has also been shown to predate the Longspined sea urchin and is the only known predator of large emergent urchins in Tasmania (Ling et al. 2009a). As a result of prolonged intense fishing pressure, the Southern Rock Lobster biomass off eastern Tasmanian had dropped to extremely low levels prompting the development of the East Coast Rock Lobster Stock Rebuilding Strategy in 2013. This has maintained catches at below half the recent peak in the mid 2000s and has led to stock rebuilding that will continue into the future. The interactions between seaweed, Longspined sea urchins and Southern rock lobster in Tasmania have been examined in detail by a simulation model of Tasmania reef communities, called TRITON (Marzloff et al. 2013, Johnson et al. 2014). One of the main findings of the model was that the initial prevention of urchin barren formation through increased predator numbers would be more effective than reversal through the same strategy, and that reduced catch of lobster on incipient barrens could mitigate the formation of extensive barrens in these areas within a 20 year time frame (Johnson et al. 2014). That modelling was conducted at a time when the current high catches taken by the urchin fishery were not anticipated.

Other strategies have been explored in Tasmania to reduce urchin densities in an effort to prevent or reverse urchin barren formation. Culling is an alternative removal method to

harvesting in diveable depths. When harvesting, divers remove urchins generally in the mid-large size range of >85mm test diameter leaving smaller urchins, and are limited to finding urchins with roe quality that is acceptable to the processor. This means urchin harvesting takes place outside of spawning season, with most harvesting taking place between approximately December and June. In comparison, divers that are culling can kill urchins of most size ranges (that are visible) at any time of year by smashing them with a spike or similar instrument. When culling, divers are not limited to choosing urchins of high roe quality or transporting urchins to the boat and truck. On extensive barrens in Victoria, the rate of culling is reported to be close to 3x faster than harvesting (John Minehan, *pers. comm.*). However, culling is labour-intensive and can be costly compared to subsidised harvesting depending on subsidy rate, whether divers are paid for culling, and the density of urchins (Tracey et al. 2015, Cresswell et al. 2019). Culling by commercial divers has been funded in small areas on the Tasman Peninsula and there is also volunteer culling by abalone and recreational divers.

In other parts of the world, problems of high urchin densities and associated extensive urchin barrens have been dealt with by use of quicklime (Leighton et al. 1966). Quicklime, which is made by heating limestone and is used in cement, has been used to control starfish in oyster bed and sea urchins in commercially harvested kelp beds (Bernstein and Welsford 1982). It releases heat when combined with water and kills echinoderms by causing epidermal lesions that permit bacteria to enter (Bernstein and Welsford 1982). Kill rates in excess of 96% can be achieved with an apparatus that mixes quicklime with sea water at the surface and then pumps the slurry through a hose to the bottom. In some cases, greater precision is achieved by a diver who directs the flow onto sea urchins (Bernstein and Welsford 1982). In Tasmania, with other methods available for removing sea urchins with diving depths, quicklime offers potential for removing urchins from depths deeper than 25m.

The Commercial Fishery

Catch and effort

In Tasmania, *C. Rodgersii* are harvested by commercial divers, about half of whom also dive commercially for abalone. Commercial urchin divers in Tasmania tend to target individual *C. rogersii* of a size between the range of 85 to 125mm test diameter (Johnson 2016). Catch weight is confirmed by a log recording from the processor who receives the catch. The location of the catch is recorded using the blocks of the commercial fishery (shown in Figure 3). Depth is not recorded. A finer-scale approximate location, such as name of the point or bay, is recorded in the log by the diver, along with diver ID, date, and total time of dive/s (effort in hours). For the 2019/20 season GPS and depth logger units have been used by most divers, which will provide more accurate data both spatially and temporally. Divers are paid either by total wet weight of catch (\$/kg) or by weight and quality of roe from the processor.

Commercial harvesting began in March 2009. The total annual harvest began at less than 10 tonnes a year and gradually increased to 100 tonnes in 2013/14, followed by a decline in 2015 following the closure of the main processor (Figure 1). A subsidy was introduced from the 2016/17 season (in Figure 2) to encourage harvesting of urchins as a way to prevent extensive barrens forming. The catch in the most recent 2019/20 season dropped to 376 tonnes (including 15 tonnes culled) from the previous year's catch of 560 tonnes. In total the commercial harvest has removed more than 1500 tonnes of Longspined urchins over the last 12 years.

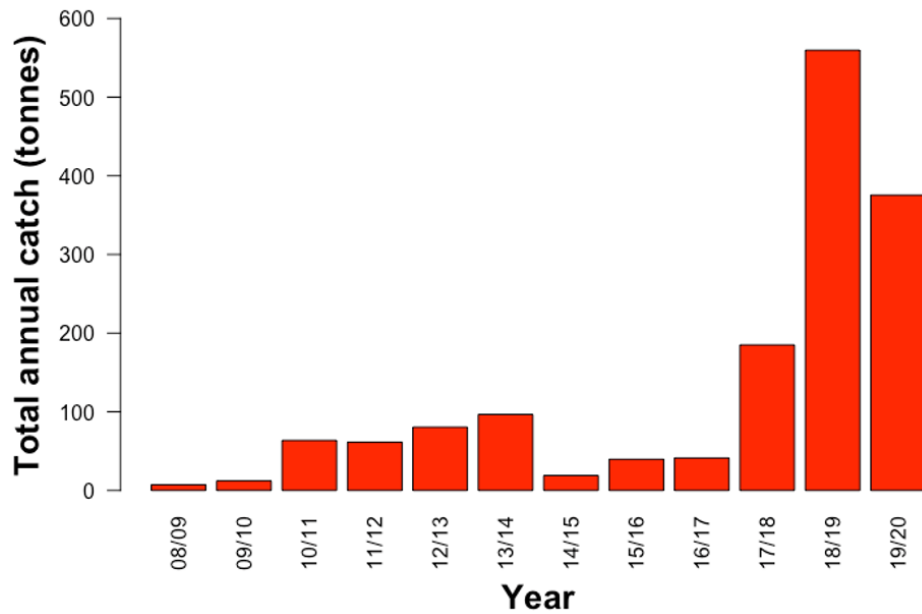


Figure 1. Annual catch of Longspined sea urchins.

Monthly effort for the fishery is focussed between January and June (Figure 2), which is complementary to the spawning season which occurs around August (Ling et al. 2008).

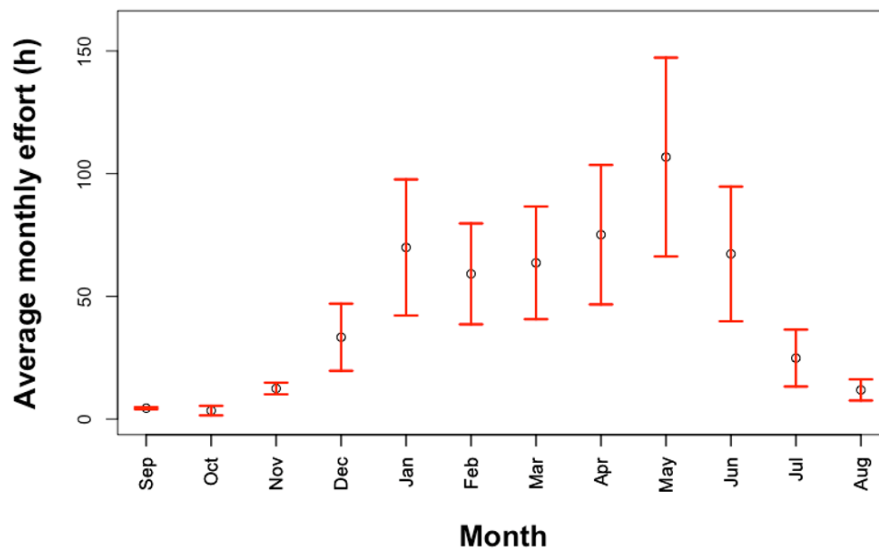


Figure 2. Monthly effort (hr) averaged by year since the beginning of the fishery 2009 to the current season 2019/20, error bars represent standard error.

Spatial distribution of the catch

The fishery-independent transect survey of the east coast involved segmenting the coast into thirteen regions, numbering 1 to 13 from north to south (Johnson et al. 2005, Ling and Keane 2018). For this assessment we used regions 1 to 9 (Figure 3), because surveyed abundance of Longspined sea urchins in regions 10 to 13 was negligible for both transect surveys. A subsidy began in late 2016 at \$0.75/kg in all subsidy zones. The structure changed on March 11th 2019 to be \$0.50/kg in the northern zones, \$0.75/kg in the central zone and \$1/kg in the southern zone. A new subsidy structure was implemented from March 1st 2020 (the start of the licensing year) with \$0 subsidy in the northern zone, \$0.75 in the central zone and \$1.50 in the southern zone, and 2 extra zones for the subsidy were added north of the east coast of Tasmania (Figure 3).

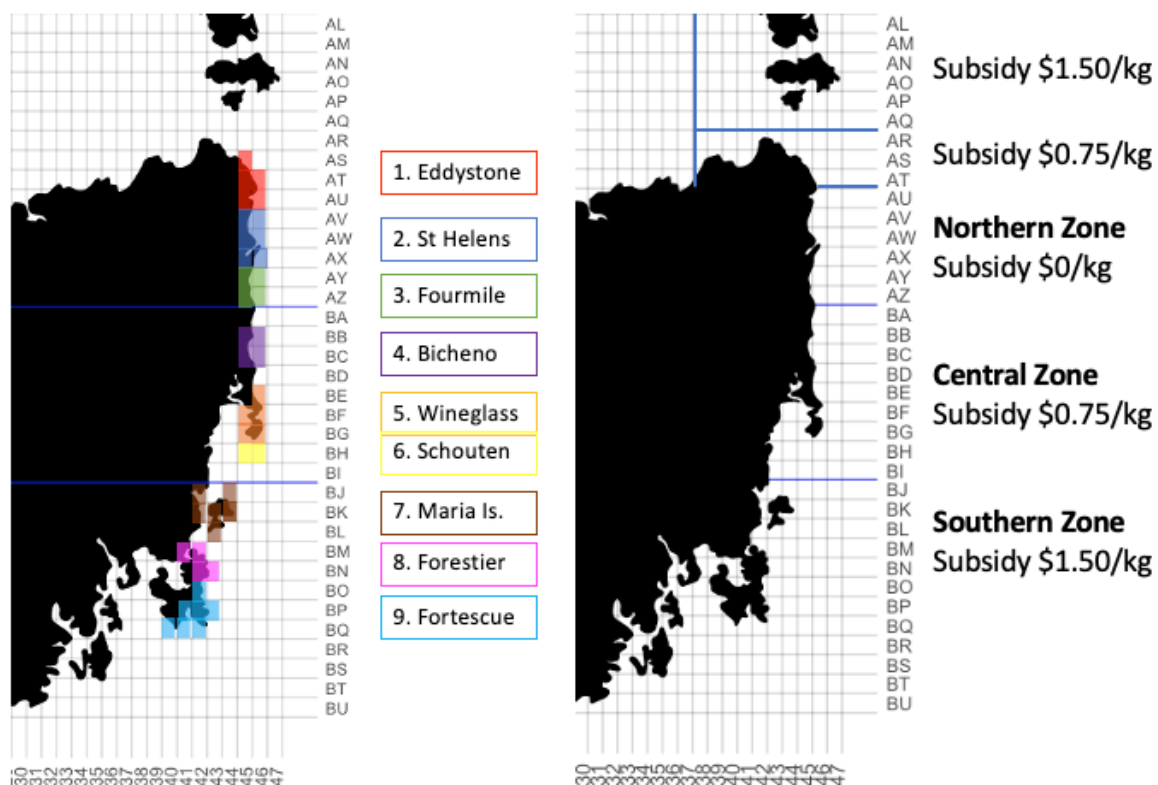


Figure 3. Map of regions referred to in this report (left), coloured labelled areas show which blocks have contributed catch to each of the regions. Subsidy zone boundaries for the subsidy in effect from March 1st 2020 (right), labelled with the commercial fishing blocks used in the fishery.

The total catch in each commercial fishing block for the most recent season 2019/20 shows a similar spatial distribution to the summed preceding 11 years of the fishery (2008/09 to 2018/19) (Figure 4). The majority of the catch was concentrated in commercial fishing blocks AW45 and AW46, which are in the St Helens region (region 2) on the northeast coast of Tasmania. However, in the most recent season (2019/20) there was a higher catch around Maria Island, particularly block BK44.

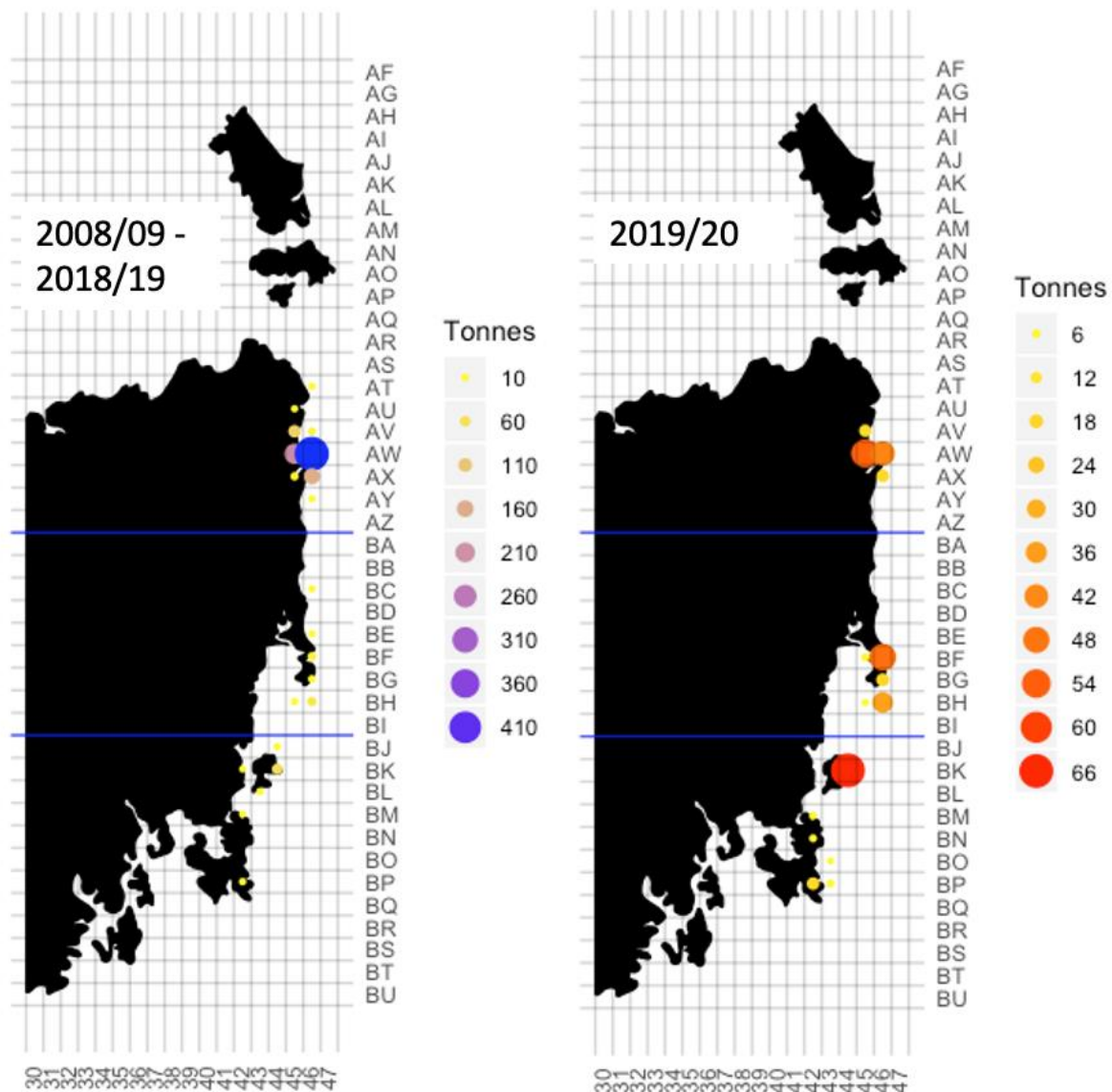


Figure 4. Total catch summed over each commercial fishery block for the 2019/20 season (right) and summed over the previous 11 years of the fishery (left). Tick labels show the commercial fishing block names. Blue lines show the divisions between the northern, central and southern subsidy zones.

Catch has historically been concentrated in the northern subsidy zone, making up almost 100% of the relative catch between the zones until the 2016/17 season (Figure 5). With the introduction of the first subsidy (\$0.75/kg across the board) catch began to spread to the central and southern zones by the 2017/18 season. A further shift in catch southward occurred in the 2018/19 season in response to the spatial structuring of the subsidy (N \$0.5/kg, C \$0.75/kg, S \$1/kg. With \$0 subsidy in the northern zone for 2020, we have seen a further shift in catch away from the north, so that catch between zones now is almost equal.

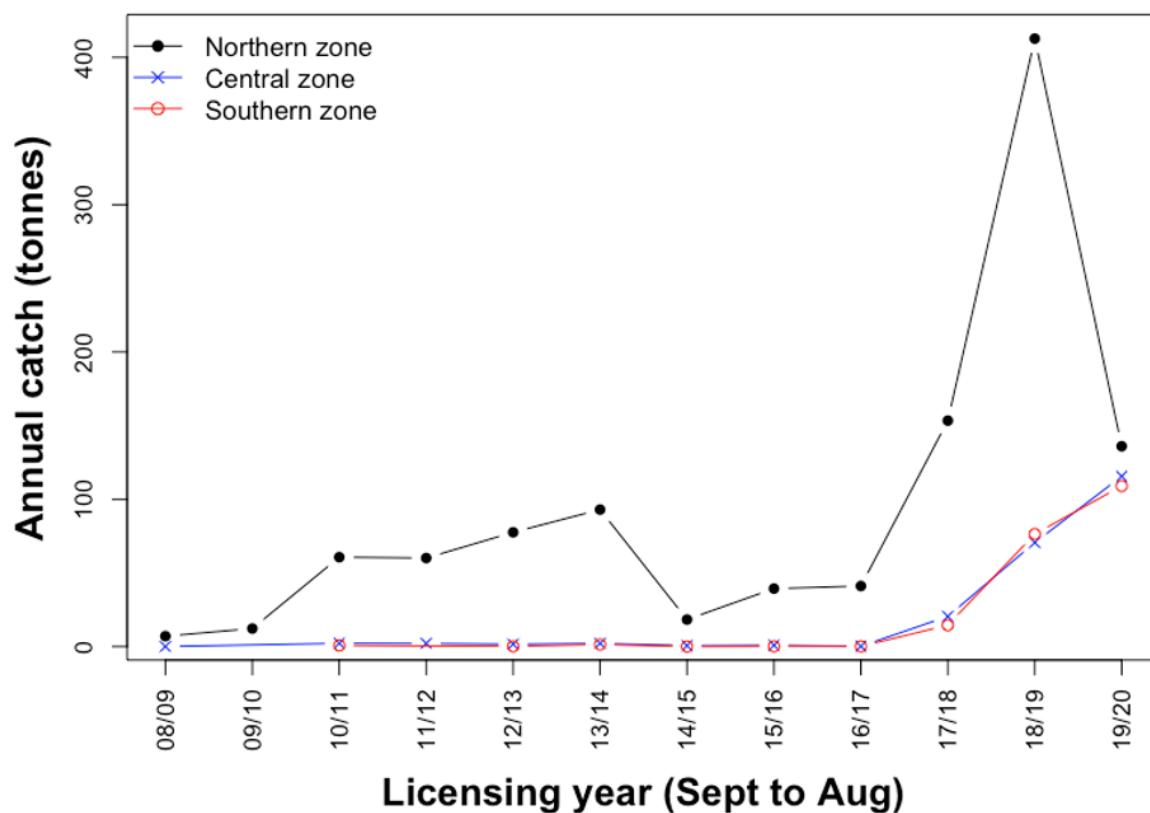


Figure 5. Total annual catch (left) and relative annual catch (right) for each of the subsidy zones over time.

Catch rate

Catch rate or catch-per-unit-effort (CPUE) is calculated per dive day by the total wet weight of harvest (in kg, measured at the boat ramp) divided by the dive time (hr). CPUE can give an indication of relative biomass over time. However, with a highly spatially-aggregated

species such as sea urchins, CPUE throughout the range of the fishery may remain stable as the stock is being depleted. This is especially the case for developing fisheries that target spatially structured stocks, because fishers may continue to move to new areas and/or depths while maintaining a high CPUE but sequentially depleting reefs over time and space. Longspined sea urchins are patchy because of low movement rates and homing to crevices (Flukes et al. 2012), so density is highly dependent on substrate. In addition, the fishery data is currently recorded at a very coarse spatial scale, with commercial fishing blocks at the scale of 11.1 km by 11.1 km. An area of this size may contain many different reefs. Due to the coarse spatial scale, divers may be undertaking a rotational or sequential harvest of different reefs within the one block without affecting CPUE data. The results here should be considered in the context of these limitations.

First, we filtered the data to exclude dives with the top and bottom 5% of effort recorded (hr). Annual catch rate was calculated by averaging all individual dive catch rates for the year. We then standardised the catch rate by the effects of individual diver ID, latitudinal region and time of year (month) (

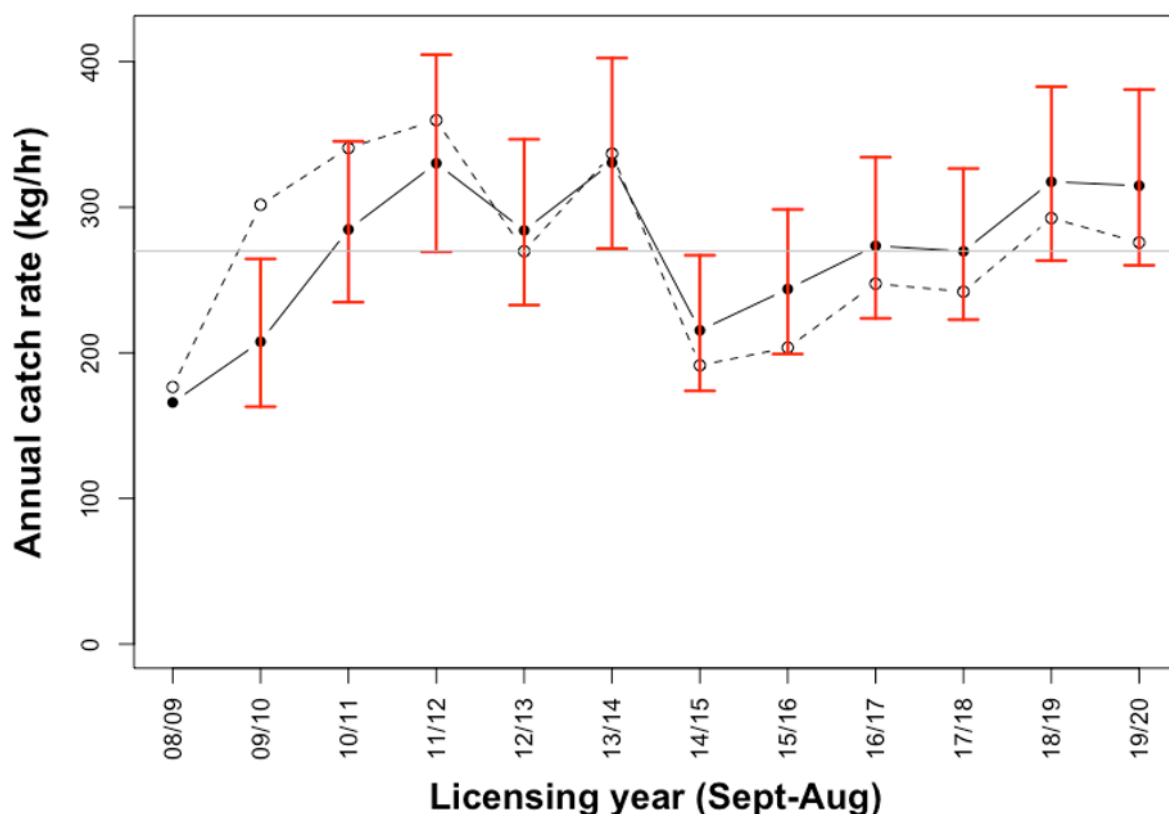


Figure 6). The regions are identified above (Figure 3). There is no discernible trend in CPUE for the entire east coast of Tasmania over the course of the fishery.

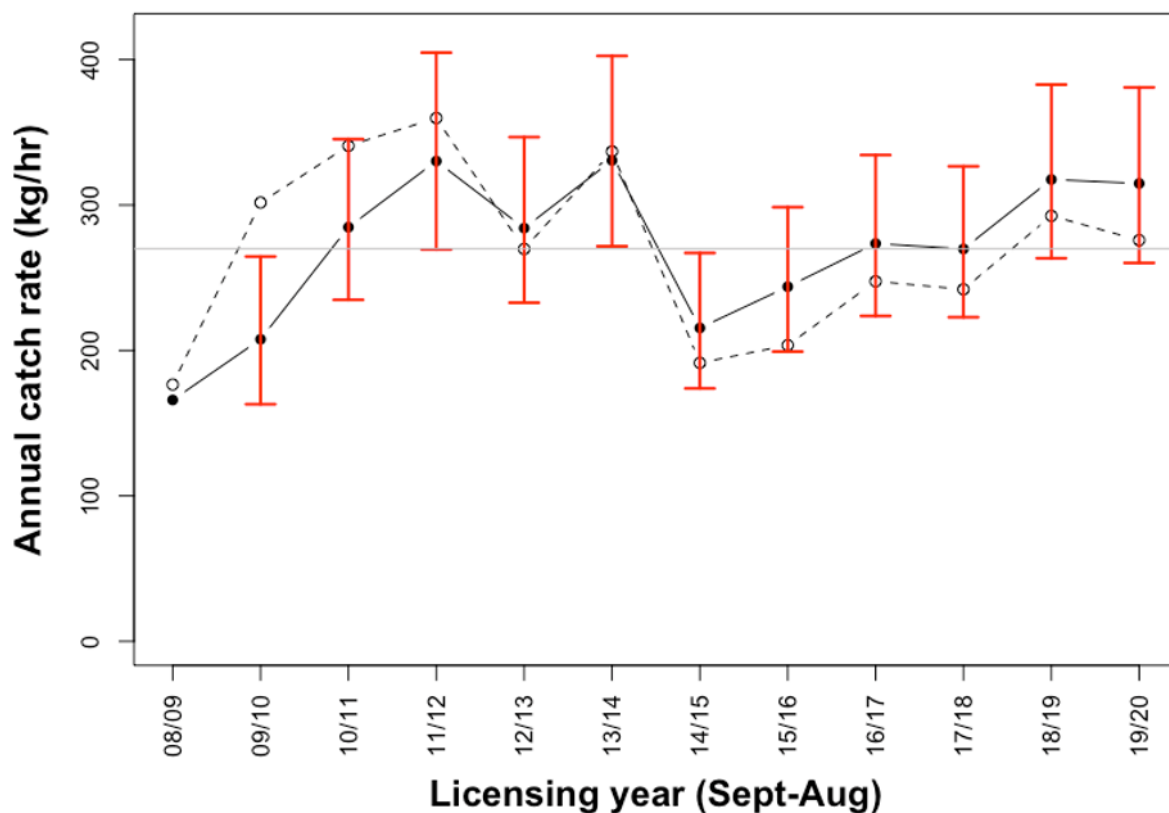


Figure 6. Standardised annual catch per unit effort (CPUE) (solid black line and points) relative to the annual geometric mean (dashed line). Error bars show the log normally distributed 95% confidence intervals for the standardised model. Horizontal grey line is the geometric mean of all the catch rate data.

Catch rate was further examined for the most heavily fished region (region 2) St Helens, which is the region with the greatest abundance of urchins and the longest history of fishing on the east coast. As per the data for the whole fishery, catch rate from the St Helens region was standardised for the effects of diver ID and month (Figure 7). Again, there is no discernible trend in catch rate for region 2, the St Helens region, over the course of the fishery. **Error! Reference source not found.**

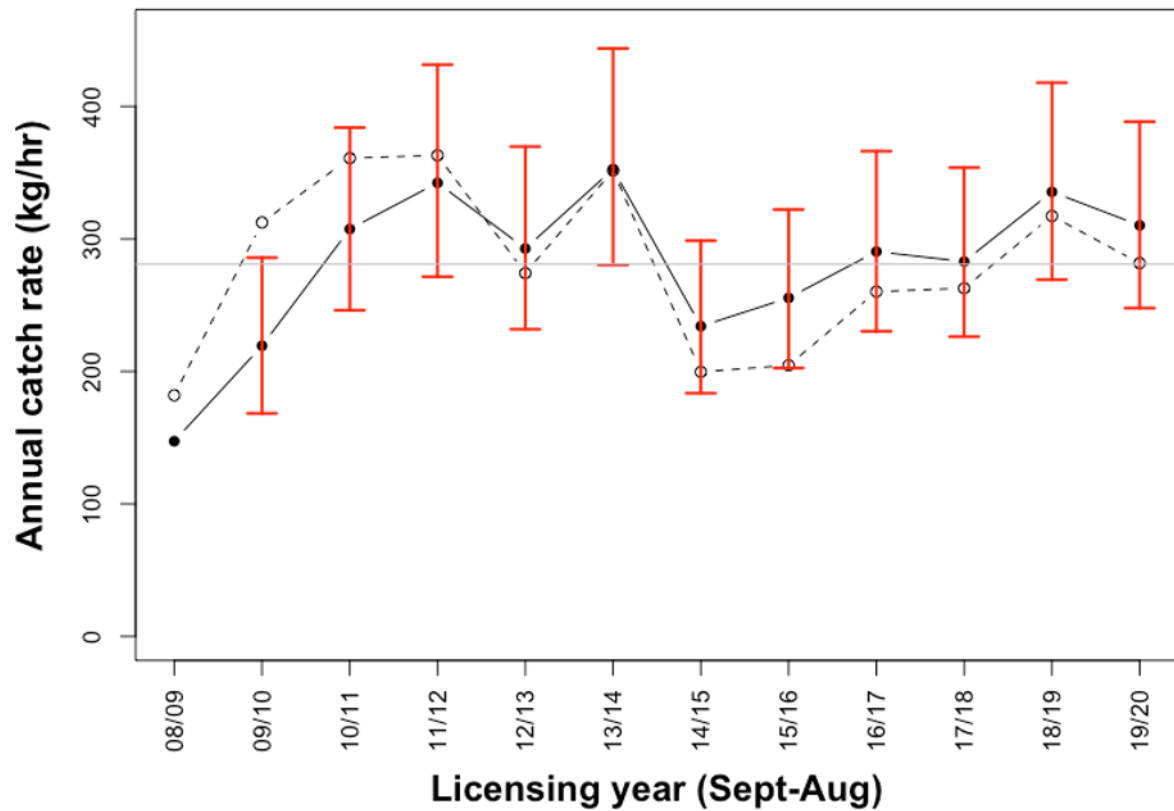


Figure 7. Standardised catch per unit effort (CPUE) (solid line) for the St Helens region relative to the geometric mean (dashed line). Error bars show the 95% confidence intervals for the standardised model. The horizontal grey line is the geometric mean of all the catch rate data.

Finally, we examined the catch rate in the most heavily fished blocks of the highest fished region, blocks AW45 & AW46 in region 2, St Helens regions (Figure 8). There is no noticeable

trend for the average annual CPUE recorded in these blocks over time.

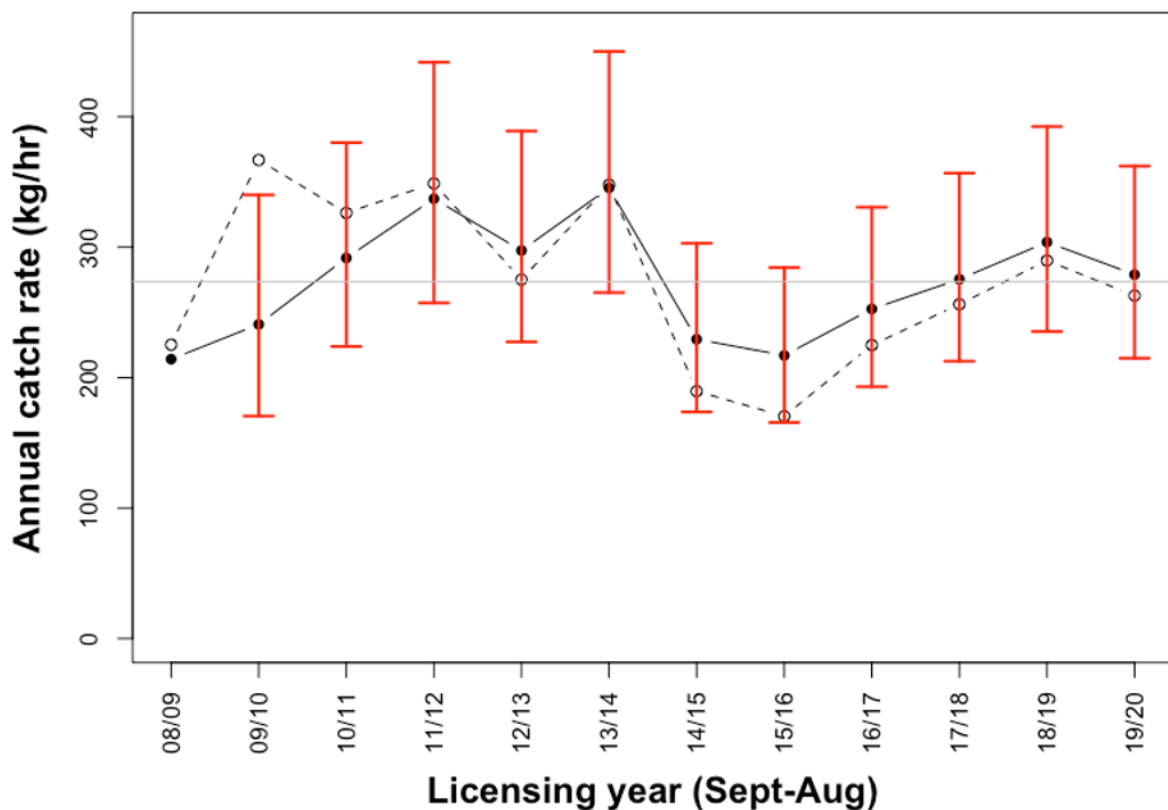


Figure 8. Standardised catch per unit effort (CPUE) (solid line) for blocks AW45 and AW46 in the St Helens region relative to the geometric mean (dashed line). Error bars show the 95% confidence intervals for the standardised model. The horizontal grey line is the geometric mean of all the catch rate data.

Unstandardised annual catch rate from the different regions decreases from north to south along the coast, where region 1 is further north and 9 is furthest south (Figure 9). This is consistent with observations from fishery independent surveys and is important as it demonstrates a link between CPUE and density. This is evidence that CPUE provides value as an indicator for assessing this fishery despite issues around hyper-stability as noted earlier.

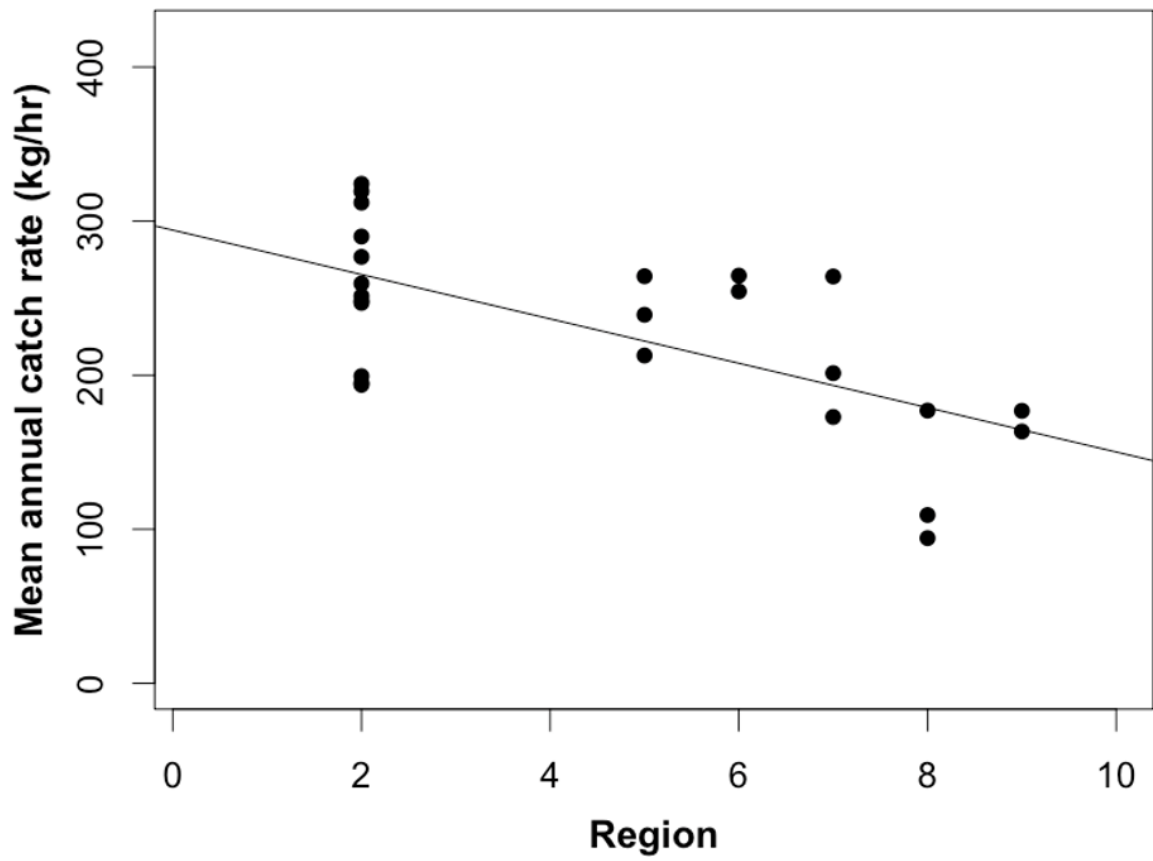


Figure 9. Regional annual trend in CPUE from north (region 1) to south (region 9), unstandardised. Solid line is linear regression trend in data for annual regional catch rate.

Bycatch, habitat and other sources of mortality

Bycatch

There is no bycatch in this fishery as urchins are harvested by hand.

Protected species interaction

Interactions with protected species and the vessel or dive gear are possible although unlikely. The same gear has been assessed as negligible risk in abalone fishing

Habitat interaction

Interaction between the habitat and fishery is limited to catch bags and considered negligible risk. The fishery (removal of urchins) will promote habitat recovery.

Indigenous fishing

The species has only been present in Tasmanian waters since 1978 thus there was no historic Indigenous harvesting. There is no regulation of current Indigenous harvesting. No information has been collected but the volume of catch is considered negligible relative to commercial harvesting.

Recreational fishing

There is no regulation of recreational harvesting. No information has been collected but the volume of catch is considered negligible relative to commercial harvesting.

Culling

Two culling events, sponsored by the Abalone Industry Reinvestment Fund, undertaken by professional abalone divers have taken place during the 2019/20 fishery season. The first was in Munroes Bight, abalone fishing block 22A (in the most southerly urchin fishery region Fortescue) in October 25th 2019, with 64 dive hours of culling completed over 4 days to a depth of 21m, and a total of 33,400 *C. rodgersii* urchins culled. An estimate of 10.188 tonnes were culled. This area has historically been a productive area for the abalone fishery. The second cull took place in the same location with a total of 15100 urchins culled over 48 dive hours. An estimate of 4.6 tonnes of urchins were culled. The total estimate of culled urchins between these 2 culls was 14.793 tonnes.

“Take-all” harvest project

A recent ‘take-all’ harvest was conducted over April and May 2020 between Marion and Fortescue Bays, in the Fortescue Bay region of Tasmania’s east coast. This was a joint project between commercial urchin divers (Tasmanian Commercial Dive Association) and IMAS researchers were involved, sponsored by the Abalone Industry Reinvestment Fund. The ‘take-all’ harvest removed all (detectable) size classes of *C. rodgersii* from target sites and transported the urchins to the RTS PauaCo factory for processing, and was trialled as an alternative method to culling to reduce urchin densities in productive abalone and rock lobster habitat. Measurements of urchin size and weight were taken, and those urchins large enough (>85mm) were processed for sale. Divers were paid at a rate of \$2.90/kg wet weight. A total of 114,471 urchins were harvested, with the total tonnage calculated to 34.916 tonnes.

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