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FISHERY ASSESSMENT REPORT

TASMANIAN ROCK LOBSTER FISHERY

2017/18

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Executive Summary

Current Stock Status

The southern rock lobster commercial TAC has been 1050.7t for the last four years preceded by three years at 1103.24t. For the last six years CPUE has risen steadily with a significant increase in the last two years. Standardised CPUE has risen from a low of 0.72 in 2010/11 to 1.27kg/potlift in 2017/18.

Improvement in CPUE has been distributed across all stock assessment areas. Areas in the East Coast Stock Rebuilding Zone (SRZ) had shown limited CPUE increase despite dramatic catch reductions. In the last two years these areas have finally experienced stock recovery and remain on track for reaching the 2023 rebuilding target of 20% virgin biomass.

Increasing CPUE has reduced the effort required to catch the TAC and hence the gap between lease price and beach price has narrowed. Consequently, competition for leased quota by fishers has become increasingly intense leading to a steady ongoing reduction in vessel numbers and consequently employment. A number of management strategies that would increase the price of lease quota and accelerate this process of reduction in the fleet and employment are currently under consideration.

Stock assessment modelling indicates that statewide egg production is well above the limit reference point. This reference point has been set at a level below which subsequent recruitment may be impacted, hence is a critical limit reference point for ensuring sustainability.

Due to the long pelagic larval period (up to two years), egg production in different areas of the fishery is not closely linked to future recruitment in that region. Recruitment is affected by patterns in larval dispersal and it's known that the most important regions for larval sources tend to vary from year to year. The appropriate management response to this is to ensure that healthy egg production of at least 20% of the unfished level is maintained in all areas. Area 5 is the only area falling below this level and a regional size limit change to address this is currently under consideration.

An interim biomass target reference point has been set at 25% of the unfished biomass. The target reference point is reflective of the stock state to which stakeholders aspire for maximising economic rent and recreational amenity. This TRP is an extremely low value for a target relative to those used in most fisheries so has been proposed as an interim target along a rebuild pathway. Once reached it is expected that a new and higher TRP that continues the rebuilding pathway will be established. Stock assessment modelling indicates that the TRP will be achieved with the current TACC.

There were no notable trends in by-catch or by-product data. A by-catch project to address this issue in a more robust manner across all SRL jurisdictions is currently underway and will contribute to the next stock assessment. There were no reported protected species interactions.

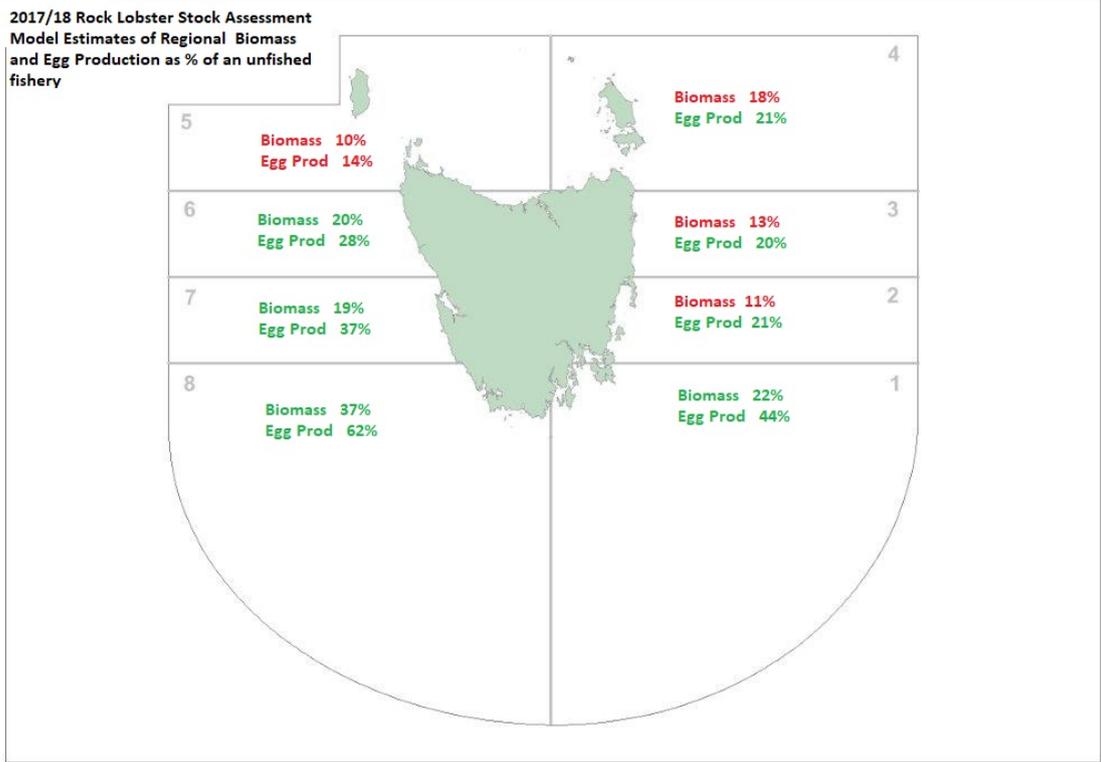


Figure 1: Regional biomass and egg production estimates from the 17/18 assessment model compared to the estimated level of the stock prior to the commencement of the fishery.

Table of Contents

1	Introduction	1
2	Commercial fishery assessment	3
2.1	Catch history	3
2.2	Catch per Unit Effort (CPUE).....	7
2.3	Fleet Characteristics.....	10
2.4	Recreational catch.....	12
3	Stock assessment model	13
3.1	Recruitment assumption	13
3.2	Assessment model results	14
3.2.1	Biomass	15
3.2.2	Egg production	17
3.3	East Coast Stock Rebuilding Strategy	20
4	Discussion.....	21
5	Ecosystem based management	22
5.1	Commercial logbook data	22
5.2	By-catch	22
5.3	By-product	24
5.4	Supply risk of bait.....	25
6	Bibliography	27
7	Appendix 1: Historical overview.....	28

1 Introduction

The present commercial catch is taken from areas all around the State and involves the annual harvest of around 1.1 million animals. In the 2017/18 season 194 licensed vessels reported catches of rock lobster, an ongoing decrease from almost 300 vessels that operated when the ITQ system was introduced for the 1998/99 season.

Commercial harvests were managed by input controls until March 1998 when a quota management system was introduced. Pre-quota effort increased from the mid-eighties with declining catches and catch rates (Figure 1). After the introduction of quota substantial stock rebuilding occurred in all assessment areas, effort was reduced and catch rates increased until 2005/06. A dramatic decline in recruitment from the early 2000s led to substantial decreases in catch rates from 2006 onwards and a reduction of the TACC from 1523 to 1050.7t. Since the TACC reduction catch rates have been steadily increasing.

In the last five years there has been an increasing focus on regional rock lobster management. This is appropriate for this fishery as adults do not move large distances, the habitat varies greatly in accessibility to both recreational and commercial fleets and biological characteristics such as growth vary substantially throughout the state. Consequently, regions such as the East Coast and North-West have seen far greater exploitation and require regional management to ensure sustainable populations. To this effect a catch cap for the combined catch from both sectors has been in place on the East Coast (stock assessment areas 1-3) since 2015, a commercial catch cap exists for the North East (area 4) and regional size limits are being discussed for the North West (area 5).

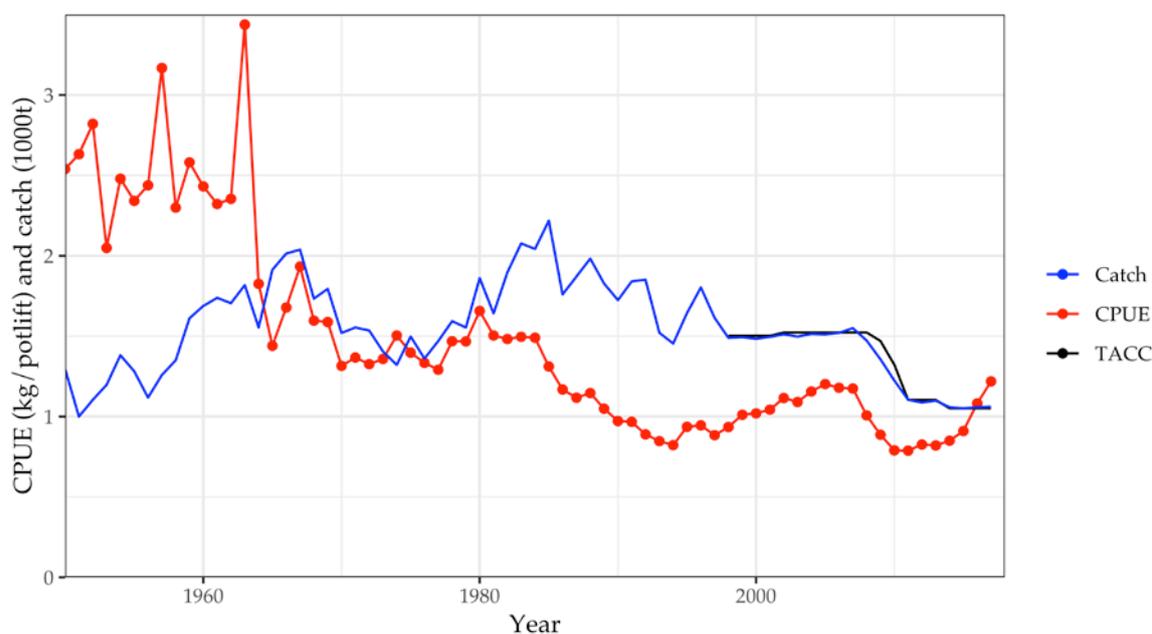


Figure 2. Commercial rock lobster catch (tonnes), CPUE (kg/potlift) and TACC (tonnes).

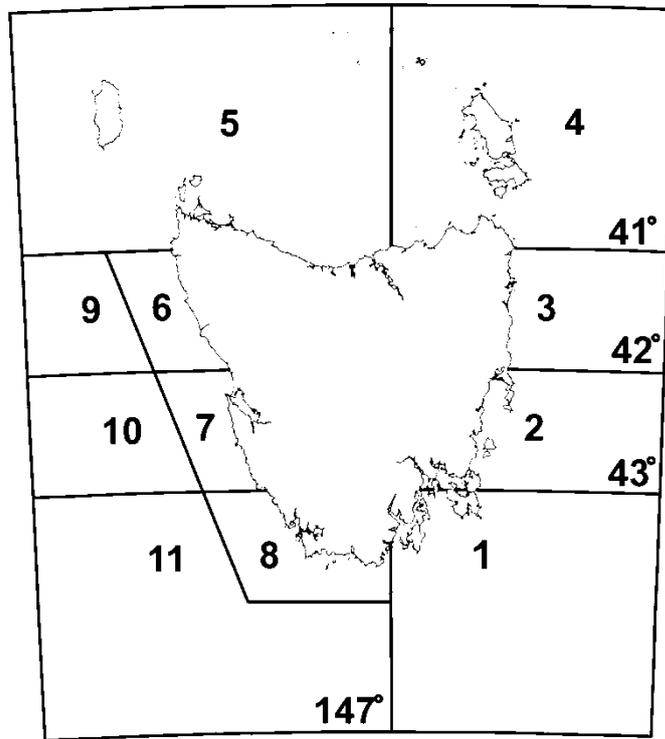


Figure 3. Schematic boundaries of the Stock Assessment areas and indicative area of State waters for the rock lobster fishery, provided by the offshore constitutional settlement (OCS).

2 Commercial fishery assessment

2.1 Catch history

Following the introduction of the ITQ system in 1998/99, the TACC was held stable for the first decade but was lowered by 13% over the two seasons 2009/10 and 2010/11 and a further 17% reduction for the 2011/12 quota season in response to decline in the exploitable biomass (Table 2, Figure 4). A further 4.8% reduction was made in 2014/15 to ensure the fishery remained on track to meet a rebuilding target reference point (which has now been achieved).

Over the last four years there has been a consistent increase in the proportion of the catch taken during early in the season and during the male only winter period (Figure 5). This has been driven by operators seeking to maximise their profit in the context of seasonal beach price patterns and increasing CPUE.

Regionally much of the reduction following the TACC decrease took place in the Eastern half of the state (Figure 6), following the decrease this has been intentionally maintained at the lower level through the “East Coast Rock Lobster Stock Rebuilding Strategy” and the catch cap in Area 4. In the Western Zone over the last few years Areas 5 and 6 have been decreasing in catch whilst Areas 7 and 8 have been increasing.

Table 1 Total allowable commercial catch, kilos per unit, percentage change in TACC and percent of the TACC uncaught for each quota year.

Quota year	TACC	kilos per unit	% change in TACC	% TACC uncaught
1998/99	1502.5	143	0	0.8%
1999/00	1502.5	143	0	0.6%
2000/01	1502.5	143	0	1.1%
2001/02	1502.5	143	0	0.5%
2002/03	1523.5	145	+1.4%	0.7%
2003/04	1523.5	145	0	1.7%
2004/05	1523.5	145	0	0.6%
2005/06	1523.5	145	0	0.8%
2006/07	1523.5	145	0	0.2%
2007/08	1523.5	145	0	0%
2008/09	1523.5	145	0	3.3%
2009/10	1470.98	140	-3.4%	7.7%
2010/11	1323.9	126	-10.0%	7.6%*
2011/12	1103.24	105	-16.7%	0%
2012/13	1103.24	105	0	0.14%
2013/14	1103.24	105	0	0.35%
2014/15	1050.7	100	-4.8%	Over 0.62%
2015/16	1050.7	100	0	0.35%
2016/17	1050.7	100	0	1.82%
2017/18	1050.7	100	0	1.27%

* 11% if the carry over TACC of 37 tonnes is included.

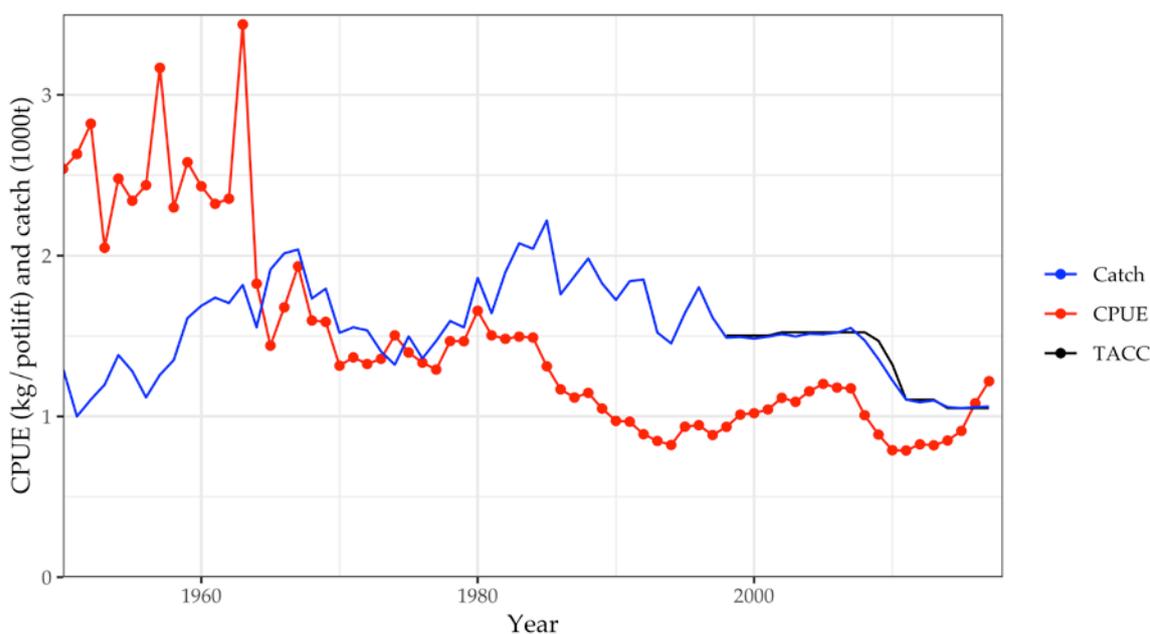


Figure 4: Statewide commercial catch, CPUE (kg/potlift) and the TACC since the inception of the ITQ system.

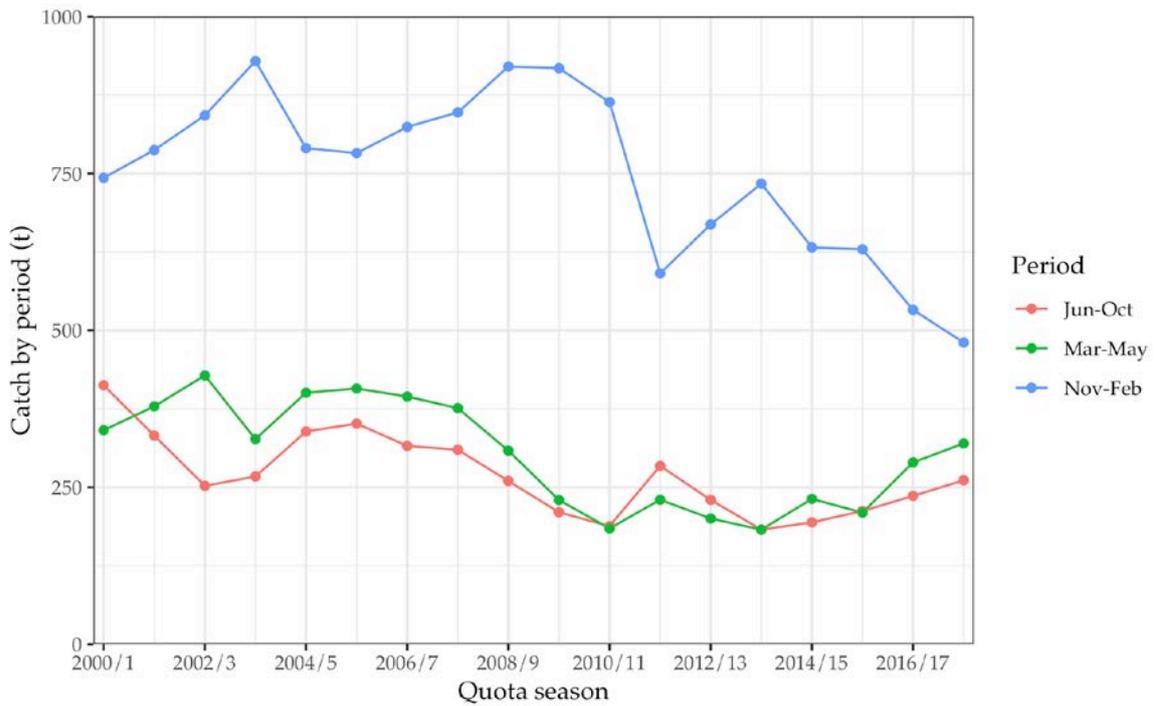


Figure 5. Annual catches divide by three key fishing periods. The first period is March to May, which corresponds to the initial period of the fishing season during which both males and females can be retained. The second period runs from June until the closure during which only males can be retained. The third period runs from the re-opening of the fishery until the end of the season in February.

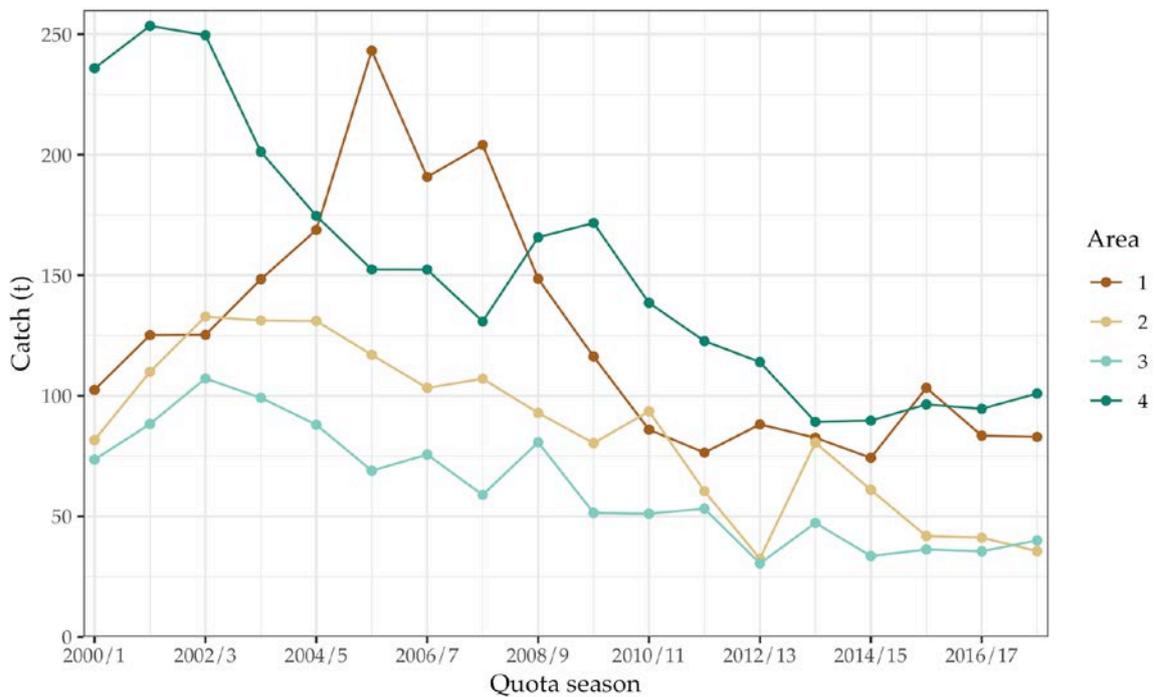


Figure 6: Commercial catch in the four Eastern stock assessment areas.

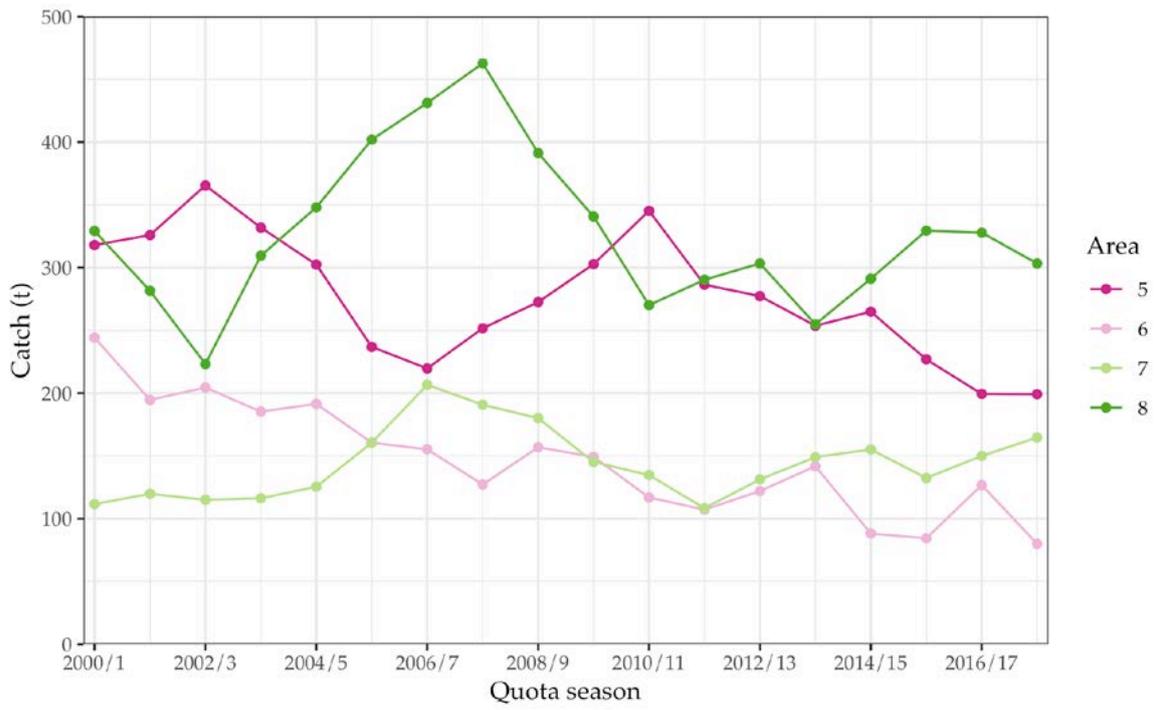


Figure 7: Commercial catch in the four Western stock assessment areas.

2.2 Catch per Unit Effort (CPUE)

Consideration of long term CPUE data (Figure 4) reveals that the stock has decreased substantially through time, particularly given that early CPUE values were obtained by vessels fishing with substantially lower technology and hence lower efficiency. Important technology improvements include GPS, weather forecasting and sophisticated sonar / 3D mapping technology used on some modern vessels, this effect is often referred to as technological creep.

The CPUE analysis presented here focusses on the period following the introduction of the ITQ system. A critical component of the analysis of this data, involves a process referred to as CPUE standardisation. This process removes the effect that changes in fisher behaviour have on CPUE index that are unrelated to biomass.

The state-wide nominal and standardised CPUE are shown in Figure 8. At around the time of the 2004/05 season, fishers utilised high stock abundance to fish more during Winter (which has lower CPUE) in order to increase profits. This biased the nominal CPUE to lower levels that did not reflect the true biomass increase. There have been other changes in fishing practices over the last few decades that have led to changes in catch rate unrelated to stock abundance. The fact that CPUE is affected by processes other than simply biomass is well understood and is addressed through a process termed standardisation.

Standardisation removes the effect of processes unrelated to abundance on CPUE. It is used to produce an index that is more indicative of stock abundance and less influenced by changing fisher behaviour / fishing patterns.

The CPUE standardisation conducted for this assessment addresses effects of:

- Month (and therefore season)
- Assessment area
- Vessel
- Moon Phase
- Depth

Factors that are difficult to account for and most concerning are changes to the fishing behaviour of a large proportion of the fleet that cannot be detected from logbooks. The classic example of this is technological creep, this has been less pronounced since the introduction of ITQ (which was near coincidental with the removal of selective availability for GPS), however consideration of the impact of 3D mapping tools would be worthwhile. Another factor of concern is if the combination of high CPUE and market forces combine to promote large-scale high-grading of catch. That is, the situation of fishers reporting a smaller retained catch than the actual number of legal size lobsters captured in pots. Fishers report that the incidence of high grading is currently small enough to not affect this assessment, however, this is likely to become increasingly common as stocks recover.

The standardised catch rate (Figure 8) shows that following the introduction of ITQs there was a steady increase in lobster abundance through a combination of several good recruitment events and constrain in catch through the TAC. These recruitment events were followed by record low recruitment leading to dramatic CPUE declines from the 2006/07

season. In response the TACC was progressively and dramatically reduced from 1523.5t in 2008/09 to the current value of 1050.7t in 2014/15. Since that time CPUE has increased steadily with especially large increases in 2016/17 and again in 2017/18. Whilst these are positive signs it should be noted that the last two years of increases have exceeded expectations and are the result of above average recruitment – they are not an indicator of the likely magnitude of future CPUE increases.

Regional standardised CPUE (Figure 9 and Figure 10) shows that catch rates have continued to increase in all areas. In areas 4-8, CPUE has been increasing since 2013/14, whilst in the East coast areas 1-3 the increase has taken place over the last 1-2 years.

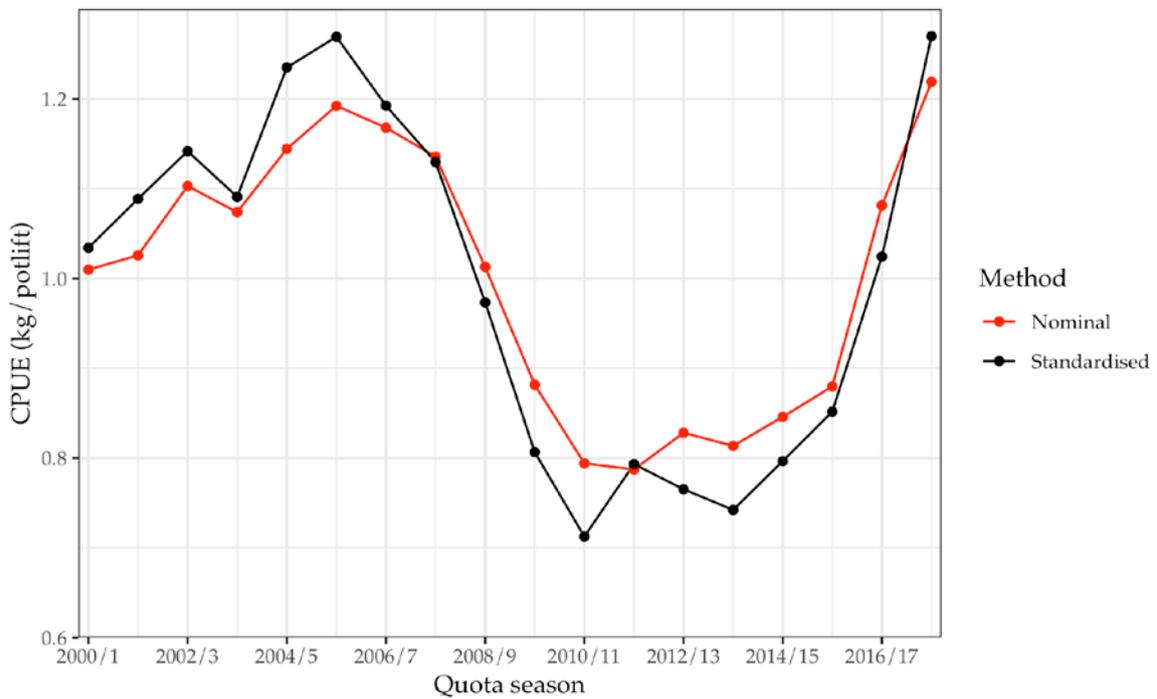


Figure 8: Nominal and standardised annual CPUE

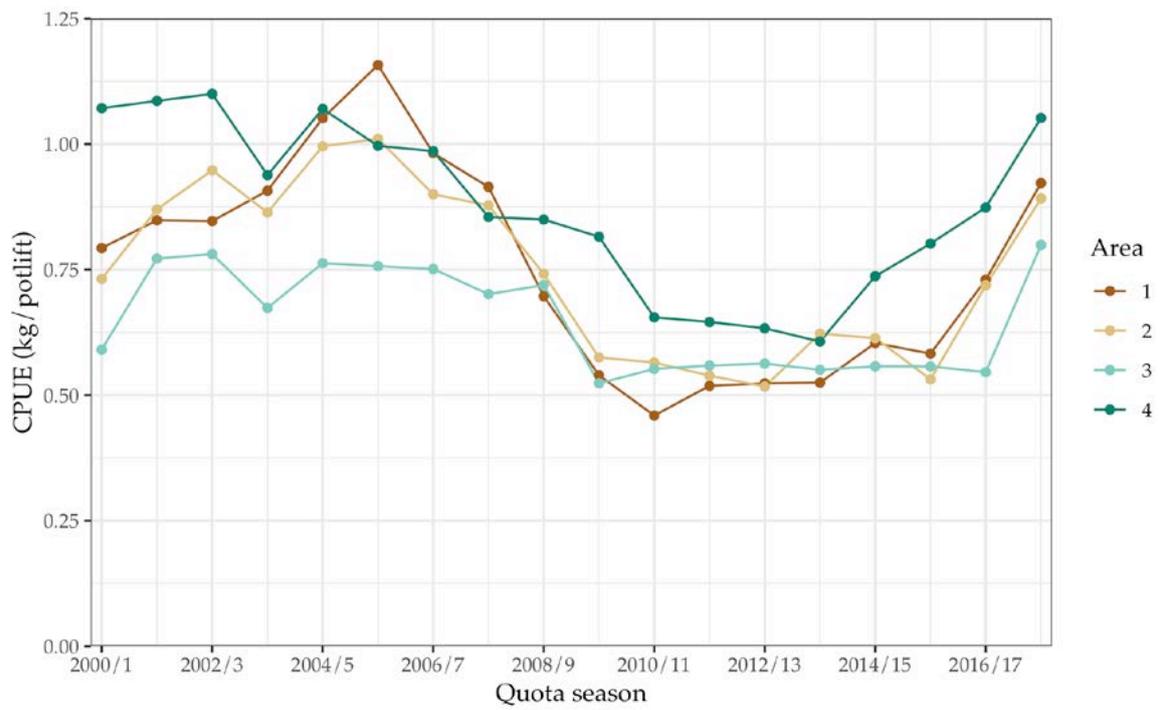


Figure 9: Standardised CPUE in the Eastern stock assessment areas

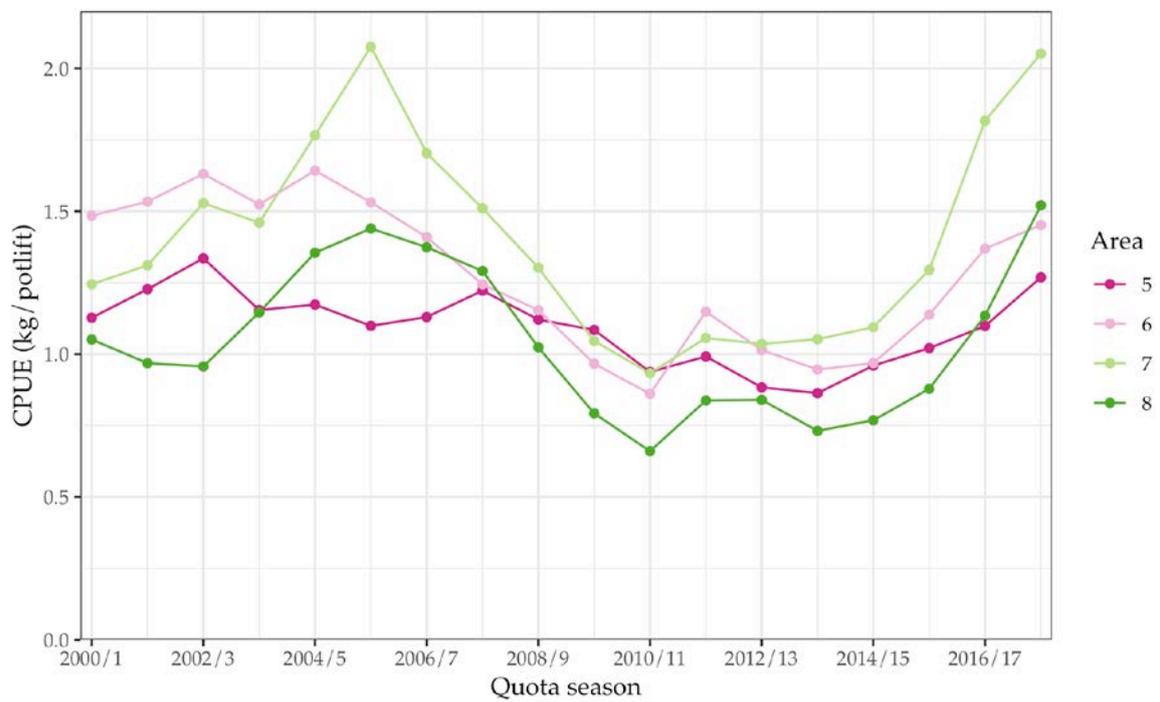


Figure 10: Standardised CPUE in the Western stock assessment areas

2.3 Fleet Characteristics

Prior to the introduction of the ITQ system the Tasmanian rock lobster fishery had nearly 300 active vessels. The combined effects of the introduction of the ITQ system, stock rebuilding and changes to vessel pot limits led a sharp decline in the number of active vessels and employment. This cut in employment was an expected outcome of the ITQ system and a limit reference point of 220 vessels was in place reflecting initial concerns about fleet size. The limit reference point was breached in the 2006/7 season at which point the industry and management was faced with the choice of allowing the fleet to shrink further so that lease prices could grow, or introducing input control to maintain the fleet above the 220 vessel threshold. Ultimately the decision was made to prioritise economic rent (seen as lease payments) so the use of an indicator for employment/vessel numbers was discontinued.

The previously discussed low recruitment and falling CPUE in 2009 and 2010 resulted in low quota lease prices as more vessel days were required to take the TACC, so that costs rose. Vessels opportunistically and rapidly re-joined the commercial rock lobster fleet leading to a short spike in employment in the fishery. This period in the history of the fishery demonstrated that new entrants exist and will readily join the industry when opportunities emerge. The long term decline in the number of commercial operators over the last 20 years is not for lack of willing and able new entrants, rather, this trend is an outcome of the policies designed to reduce the fleet size.

From 2011/12 onwards, the fleet has declined to 194 vessels in 2017/18 due the combined effects of stock rebuilding (higher CPUE), a lower TACC, and greater effort per vessel (Figure 11). The average effort of the remaining vessels has increased with mean pot usage at 47 pots / shot in 2017/18 (Figure 12).

The current stock rebuilding trajectory and target reference points are expected to drive an ongoing decline in vessel number and employment. A mechanism slowing this decline is a limitation that prevents any operator catching more than 200 units of quota (20t in 2017/18) although there are no limits on leasing. Other measures to accelerate the contraction of the such as relaxing input controls have been considered or trialled (for example a trial allowing operators to use 60 pots instead of the usual 50 pots).

Ogier et al. (2018) examined changes in ownership and flow of benefit in the fishery. Economic rent from the fishery has been created through policies effective at reducing employment and the fleet as described above. This led to flow of rent to the holders of the commercial quota through either catching and selling the lobsters (if they are fishers) or leasing the quota (if they are investors). There has been a trend of greater ownership of quota units by firms who lease out the quota rather than catching it directly. There has also been a trend of greater flow of economic rent from the fishery towards quota owners who are based outside Tasmania, estimated at over 25% of rent in 2016/17.

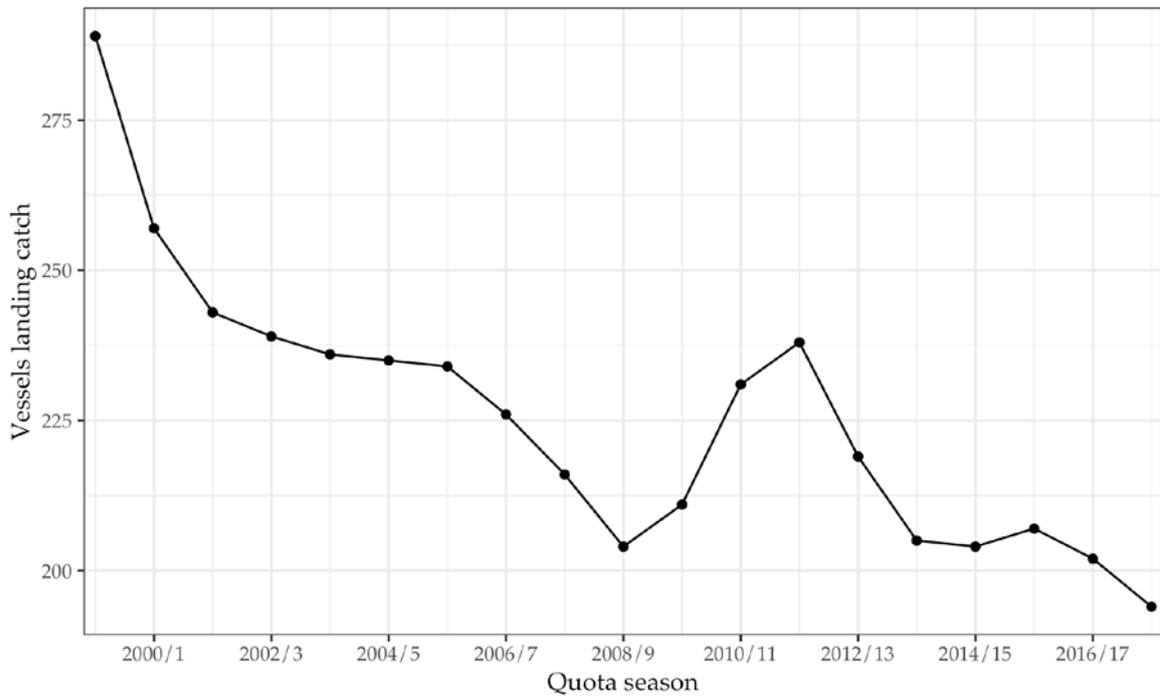


Figure 11: Number of vessels landing catch in each quota season.

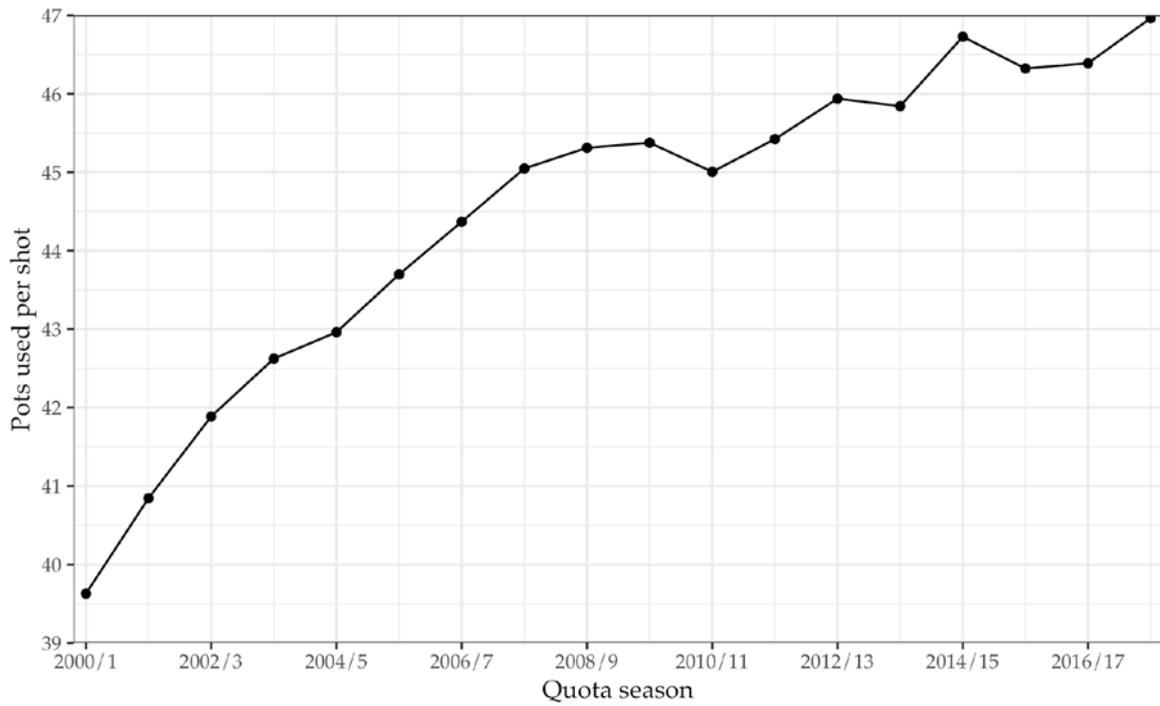


Figure 12: The mean number of pots used per shot during each quota season.

2.4 Recreational catch

The most recent published recreational survey of rock lobster catches was for the 2017/18 fishing year (Lyle, 2018). Estimated recreational catches increased in each survey from 1996 until 2002/2003 and have since decreased steadily to the lowest value in 2015/16 (58.14 t, Figure 13). The recreational catch comes mainly from the East coast, especially from area 1, which on average accounts for 36% of the catch with areas 2 and 3 respectively contributing 16% and 11%.

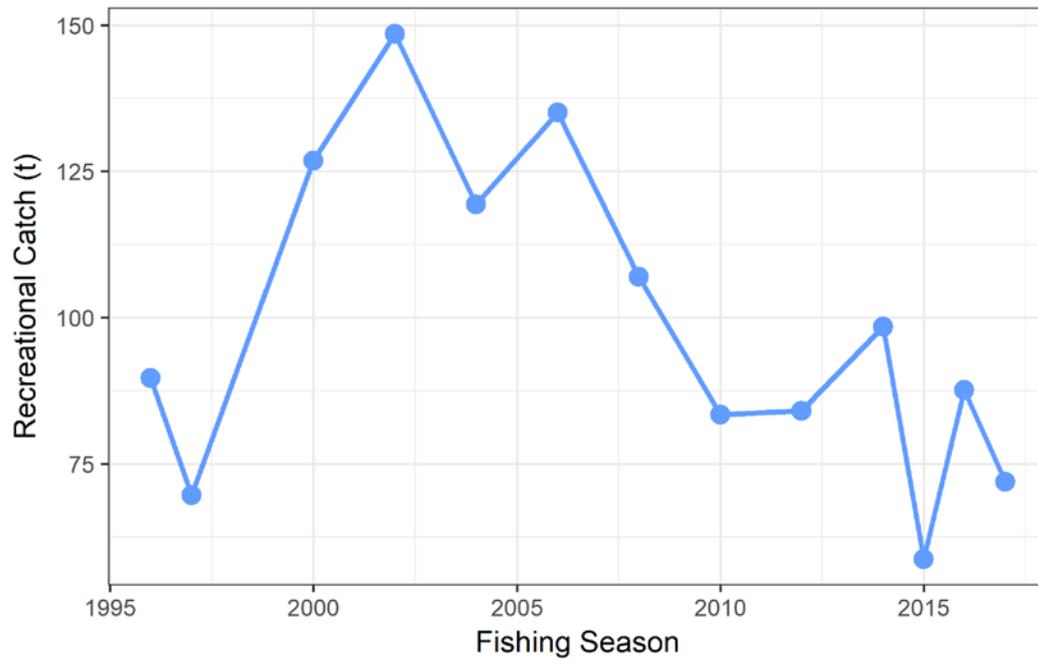


Figure 13. Estimated state-wide weight (tonnes) of recreational catches by season.

3 Stock assessment model

A stock assessment model was used to determine the current status of the stock and formally evaluate different TACCs against the developed limit and target reference points. Projections of the stock made for the purposes of this report had a series of settings with the most important being:

- (i) future recruitment assumed to be broadly reflect that observed from 2000-2014 noting that undersize length frequency data also contributes information on future recruitment in projections;
- (ii) no change in catch was modelled except through changes in the TACC (i.e. recreational and illegal catch was held constant);
- (iii) no loss of productivity through expansion of no-take MPAs;
- (iv) no loss of productivity through expansion of urchin barrens;
- (v) no loss of productivity through increase in natural mortality (e.g. through increase in octopus mortalities); and
- (vi) all other management rules were held constant (including commercial scale translocations operations that commenced in 2012)
- (vii) the proposed minimum legal-size change in area 5 will be implemented for the 2020/21 season.

These assumptions and settings were made as they were considered to represent the best and most likely settings for examining future trends. Uncertainty around these settings is acknowledged and included in the decision-making process through the design of reference points. The probability of meeting reference points in the future is required to be 70% for a target reference point and 90% for a limit reference point. This conservative approach provides protection against declines in productivity that could occur through processes such as expansion of urchin barrens, increase in natural mortality or decline in recruitment.

The rock lobster stock assessment model used in previous years was updated with the new catch and effort data from fishers' logbooks and the size/sex composition obtained from the observer-based sampling program and the research pot program. Other model parameters (such as lobster growth) which are periodically reviewed were not updated in this assessment.

3.1 Recruitment assumption

The model projects forward in time to determine the effect of proposed management strategies on the fishery, which requires inclusion of values of possible future recruitment. The relationship between egg production and recruitment is highly dependent on environmental variables and poorly understood. Hence, the best indication of future recruitment is given by historic recruitment estimates. The model also uses information from undersize sampling, which gives some guidance on probable future recruitment.

The model estimates historic recruitment data using commercial catch data and length-frequency data collected by observers, scientific sampling and the research pot program. An important consideration when projecting forwards is the range of years selected to

represent historic recruitment. Characteristically, recruitment to this fishery occurs in infrequent large pulses with low levels of recruitment between these pulses.

If the recruitment process is not undergoing a fundamental change, using all years for which reliable recruitment data is available is the preferred option as this will provide the best estimate. Alternatively, if the recruitment process has fundamentally changed (for example due to changing oceanic currents) it will be preferable to estimate recruitment from more recent data. The potential pitfall with selecting only a short period of recent years is that a series of years with poor recruitment may be interpreted as a change in the recruitment process when it may simply be a ‘run of bad luck’. In this case using more recent low recruitment estimates may result in inappropriate management changes.

Very similar reductions in recruitment have taken place across all SRL jurisdictions. Consequently, the Victorian, South Australian and Tasmanian model all use recruitment estimates from 2000 onwards to the most recent reliable recruitment estimate for that jurisdiction. In this stock assessment 2014 recruitment was the last year that was included. In addition to these recruitment estimates the model uses undersize size structure data to inform likely recruitment in the short term.

3.2 Assessment model results

A summary of outcomes against formal performance measures is presented in Table 1. These measures were developed in consultation with stakeholders including the CFAC and RecFAC and are subject to ongoing refinement. Limit Reference Points (LRPs) define undesirable states for the fishery. Target reference points (TRPs) generally define ideal desirable performance states for the fishery, however in this fishery which is rebuilding from a very low state, the TRPs are intermediate targets on a rebuilding trajectory.

LRPs tend to be associated with management objectives related to biological sustainability. The use of LRPs to prevent recruitment overfishing is consistent with the National Status of Australian Fish Stocks report which uses LRPs to separate the status of “recruitment overfished” from “sustainable”:

“the spawning stock biomass has been reduced through catch, so that average recruitment levels are reduced” (SAFS 2016).

The use of LRPs to avoid recruitment overfishing is a very conservative measure. It means that the average levels of juveniles recruiting to the fishery should be equivalent to that which occurs in the unfished stock. This is possible with well-controlled fishery harvesting because of surplus production of recruits.

This LRPs is biologically conservative but doesn’t necessarily deliver good economic and social outcomes. Put simply, the job of government goes beyond merely managing fisheries to be sustainable. Sustainable fisheries are easier to achieve than fisheries that maximise benefits to the community.

The economic benefit from both recreational and commercial fisheries is related to the abundance and catch of the legal sized stock. In this case LRPs are paired with Target

Reference Points (TRPs). Target reference points are logical for managing benefit from fisheries because there is a trade-off between catch and stock abundance. This is true for recreational fisheries where benefit is the success or enjoyment of fishing and also for commercial fisheries the benefit is the financial earnings (technically, both these benefits are forms of economic yield). High levels of catch provide high revenue but reduce the legal sized biomass. Low catch rates are undesirable for both sectors because they imply high cost of fishing in the commercial sector and a greater number of unsuccessful fishing trips in the recreational sector. Hence there is a trade-off between catch rates and catch, and the TRP attempts to optimise this balance.

Management action is intended to be more forceful in achieving LRPs than TRPs because it's more serious to have a fishery that is unsustainable than a fishery that is not maximising economic yield. This different weighting is achieved through probabilities –most LRPs are assigned a high probability of 90% and TRPs a 70% probability.

Aside from biomass indicators, data is collected and reported for protected species interactions, by-catch and by-product.

Table 2. Evaluation of biological reference points. The required levels are relative to the estimated unfished stock. For example, the egg production limit requires egg production to remain above 30% of the level estimated to have been produced prior to the commencement of fishing.

State-wide Reference Point	Level	Year	Probability	
			Required	Achieved
Egg Production Limit	30%	2021	90	100
Virgin Biomass Limit	20%	2021	90	99
Virgin Biomass Target	25%	2023	70	93

3.2.1 Biomass

State-wide biomass projections against the limit reference point at the required 90% probability show that at a TACC tested (95, 100 and 105 kg/pot), the biomass is currently over the limit, following a rebuilding pattern since 2015 when this hit a minimum (top, Figure 14). Projections for the target reference point at the required 70% probability shows that the TACC at the three levels will exceed the target reference point by 2023 (bottom, Figure 14).

Regional biomass varies, and areas respond differently to the current level of TACC (100 kg/pot) with some rebuilding more rapidly (Figure 15). Areas 8 to 11 remain well above the limit reference point, and the biomass in areas 4, 6 and 7 is just on the limit point. The remaining areas are responding to the regional management measures that have been / will be put in place and will meet the limit reference point by 2023.

LRP: 20% Virgin Biomass 2021

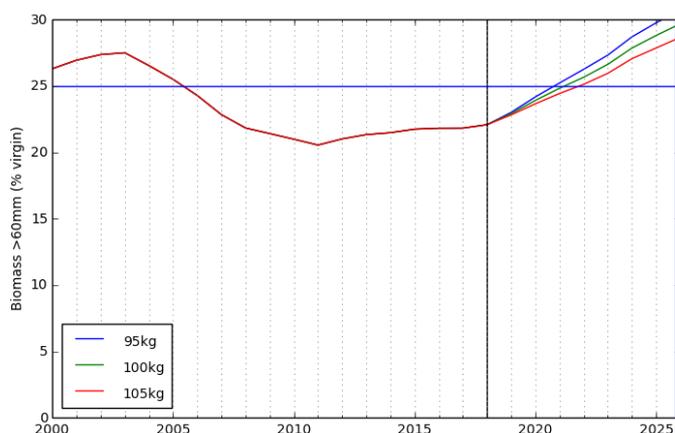
Total Biomass (% Virgin)



Generated on 02/11/2018

TRP: 25% Virgin Biomass by 2023

Total Biomass (% Virgin)



Generated on 01/11/2018

Figure 14. State-wide biomass projections showing the limit and target reference points (LRP and TRP respectively) with limit reference points with 90% probability (bottom); 70% probability projections (top). Horizontal lines – target (blue) and limit (red) reference points. Vertical black line – current year; vertical red and blue lines – timeline for limit and target (2021 and 2026 respectively).

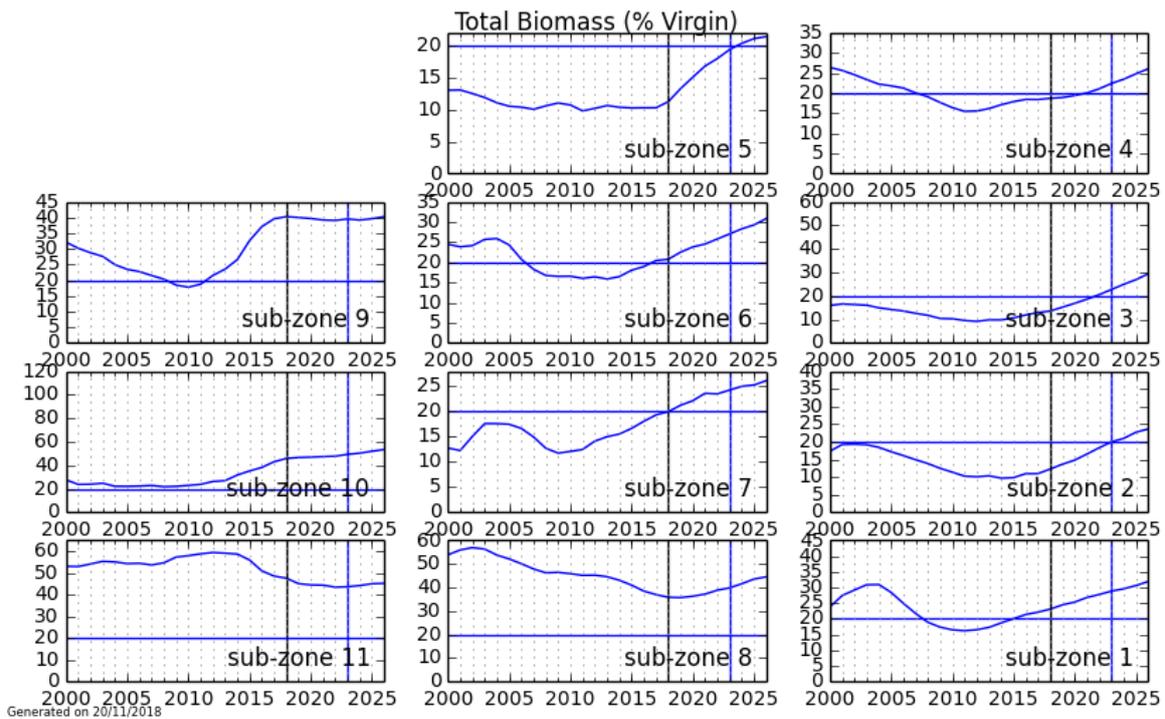


Figure 15. Biomass projections for each area with a TACC of 100 kg/pot. Vertical black line is the current year (2018); vertical and horizontal blue lines show regional limit reference points with 70% probability its timeline (2023).

3.2.2 Egg production

At current levels there is no clear link between egg production and subsequent recruitment to the fishery. This is due to the high variability inherent in the long larval duration phase (larvae spend up to two years drifting on the open ocean), plus high variability in survival between settlement and recruitment to the fishery. Nevertheless, there is inevitably some lower limit of egg production below which subsequent recruitment is likely to be significantly impacted (ie clearly at some level of depletion few adults leads to few juveniles). Responding to information on egg production requires an understanding of the following points:

- The planktonic larval stage is very protracted (1.5 – 2 years)
- Plankton sampling has demonstrated that larvae are not retained inshore on the continental shelf. Rather they live beyond the shelf in oceanic waters and are thus transported over large distances.
- There is no pattern in historical stock data between levels of egg production and future recruitment
- Modelling of larval dispersal suggest many Tasmanian recruits originate from elsewhere (SA and Vic.)
- Variation in current movement between years suggests that no one region is consistently important for larval supply and thus the source of larvae seems to vary between years.

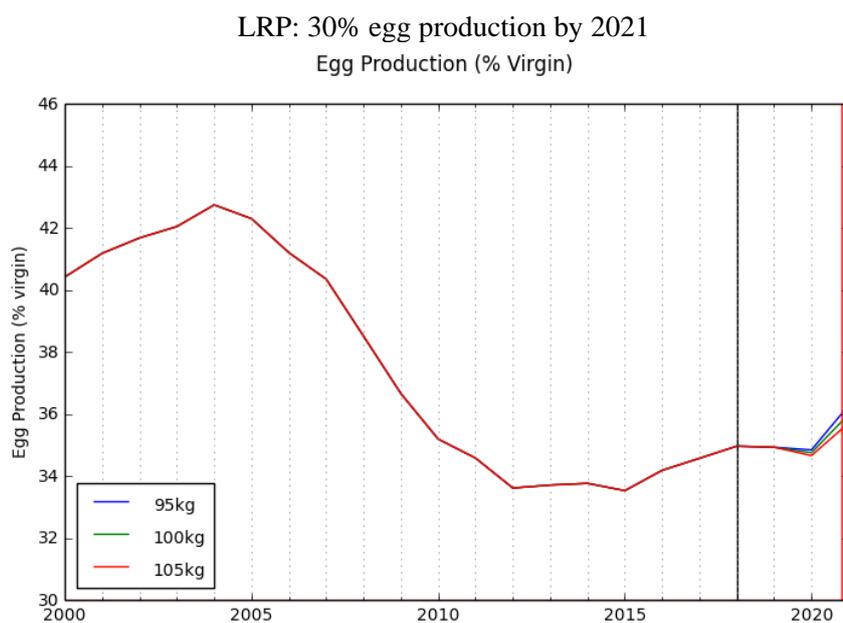
Modelling of dispersal of lobster larvae has indicated that Tasmania benefits from larvae produced elsewhere, especially to the west, but there is also some degree of recruitment

back to the state. It is also known from genetic studies that areas that are important as larval sources varies from year to year – a process termed “chaotic patchiness”.

The accepted management response to this is to maintain egg production at reasonable levels in all regions of the State - the “eggs in many baskets” approach.

State-wide spawning biomass or egg production has increased over the last few years and is well over the 30% reference point (Figure 17). The south west areas 8 and 11 are near virgin spawning biomass due to a large number of mature females in that area which are below the legal minimum length. Spawning biomass in the areas 2-3 is currently below the limit reference; however, they show an increasing trend of egg production.

Note that targets for spawning stock biomass differ between northern areas. The ultimate goal is for all areas to have production above 30% of the unfished state, but this is unattainable with current size limits in areas 4, 5 and 6 so a target of 20% is used instead. This means that only area 6 is over the reference point but the other two will exceed or reach this limit within 5 years. This is worth noting that any target is arbitrary as the level of spawning biomass required to maintain the fishery is unknown without dropping to the level that crashes the fishery. Thus, the state-wide 30% target used in Tasmania is different and more conservative to that used in Victoria (20%) and South Australia (no formal limit).



Generated on 01/11/2018
Figure 16. State-wide egg production projection with a TACC from 95 to 105 kg/pot. Vertical black line – current year (2018); vertical red– timeline for limit reference point with 90% probability by 2021.

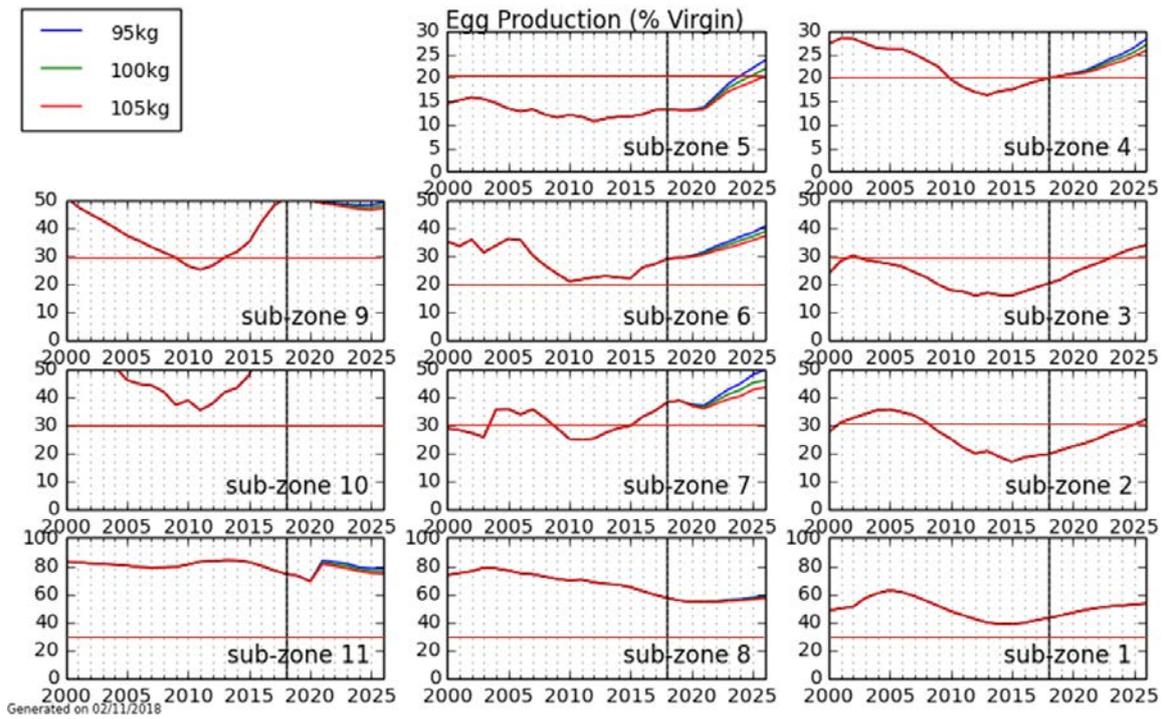


Figure 17. Egg production projections for each area with a TACC 95-105 kg/pot. Vertical black line is the current year (2018).

3.3 East Coast Stock Rebuilding Strategy

In 2011/12 east coast stocks were assessed to have hit historically low levels, attributed to a combination of years of below average recruitment and heavy fishing pressure (Hartmann et al. 2013). In response, a formal stock rebuilding strategy was implemented in 2013 with a goal to rebuild east coast stocks to greater than 20% of unfished stock level by 2023 (DPIPWE 2013, 2018). A key element of this strategy, the East Coast Stock Rebuilding Strategy (ECSRS), is to limit the average annual total catch (recreational and commercial) off the east coast of Tasmania to 200 tonnes. Under the strategy the commercial Rock Lobster fishery is subjected to a catch cap which is monitored within the quota management system. In addition, several measures have been implemented to constrain non-commercial catches, including a progressive reduction in the daily bag limit (from 5 to 2 lobster) and reductions in the length of the recreational fishing season.

Following the implementation of the ECSRS, biomass and CPUE initially increased more slowly in the Stock Rebuilding Zone (SRZ) than anticipated from model simulations. Consequently in 2017/18 the total catch allowed from the stock rebuilding zone was reduced to 195t to ensure that the strategy remained on target. The last two years have shown substantial increases in CPUE bringing the rebuild back in alignment with stock assessment modelling (Figure 18). This indicates that the strategy remains on target to achieving 20% virgin biomass in all three areas. Area 2 is the area where this is most difficult to achieve, because of being more accessible than area 3 in combination with faster growth than in area 1 – consequently the lobster population in area 2 receives less protection from the size limit.

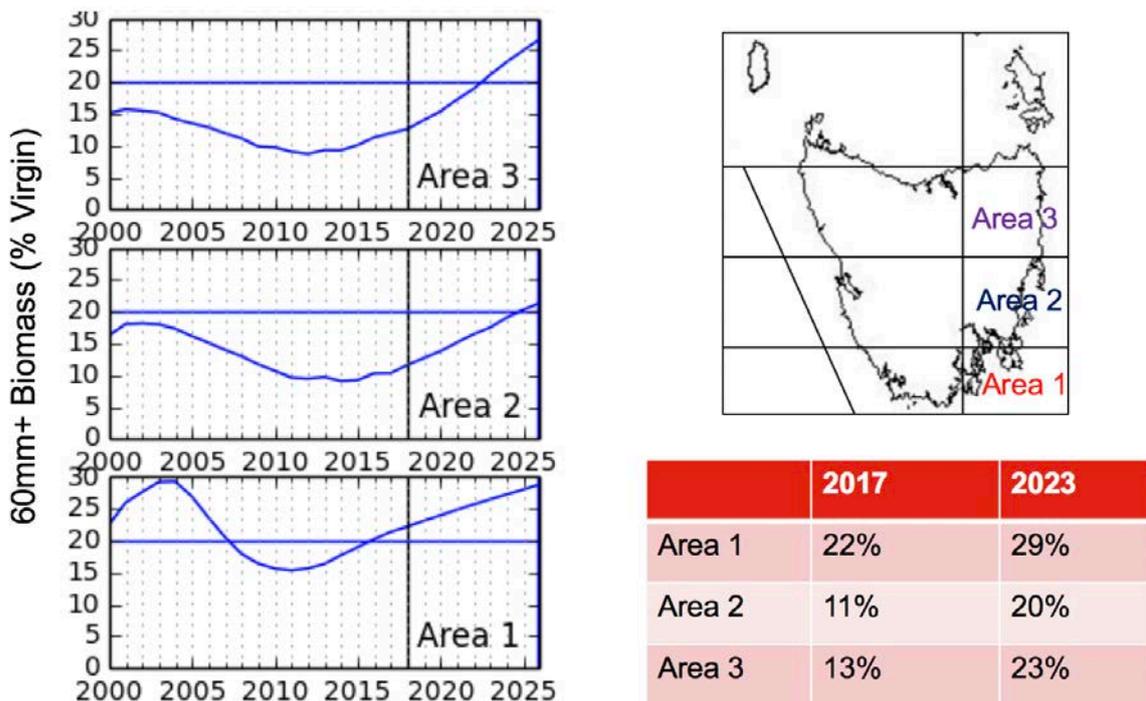


Figure 18: Virgin biomass projections in the three east coast stock assessment areas. The estimated 2017 level and projected 2023 level are shown in the table.

4 Discussion

The fishery has seen strong increases in CPUE in all assessment areas as a result of the reduced TACC in conjunction with high recruitment. The stock assessment model indicates that at the current TACC the fishery meets both limit reference points and the target reference point.

Significant management challenges are now being created as a result of the stock rebuild. Notably this includes whether to continue with further cuts to the fleet / employment, decreasing season length in the ECSRZ and increasing recreational catches that have the potential to undermine stock rebuilding if they remain unaddressed. A key limiting factor in addressing these challenges is the lack of clear management objectives to guide these decisions concerning the allocation of access between and within sectors. This challenge will continue to increase as CPUE increases and lobsters become easier to catch.

Model projections make a broad range of assumptions about ongoing management of the fishery. If these assumptions are not met then the targets may not be achieved or other corrective management actions may be required. For example, if translocation ceases or recreational catches increase it may be necessary to lower the TACC.

Numerous changes to management are possible that would increase economic and biological yield per recruit while also addressing the problem of low egg production in some regions. The most significant opportunity is the lowering of the minimum legal size in the south west. This would increase the long-term productivity of the stock and lead to stock rebuilding when combined with a constraining TACC.

5 Ecosystem based management

5.1 Commercial logbook data

DPIPWE records protected species interactions through the catch and effort database. Fishers are now required to record species and the nature of interaction in their logbooks to provide greater detail than was available in previous years. However, there is still confusion amongst fishers about what needs to be reported. The current data is unsuitable for analysis to provide guidance on the extent of any interactions.

5.2 By-catch

By-catch information is collected through research trips and also with observers aboard commercial vessels. These fishing trips are identical except that commercial fishers use pots with open escape gaps whereas research close these gaps to increase the number of undersize lobsters in catches. Catches of the main bycatch species are shown in Figure 20, with the major species being hermit crabs. Discard mortality of individuals captured varies between species with very low or no mortality of crabs, draughtboard sharks, conger eels and leatherjackets. Consequently, the species of most impact for by-catch monitoring are wrasse, perch, cod, octopus and leatherjackets, which are also reported under by-product.

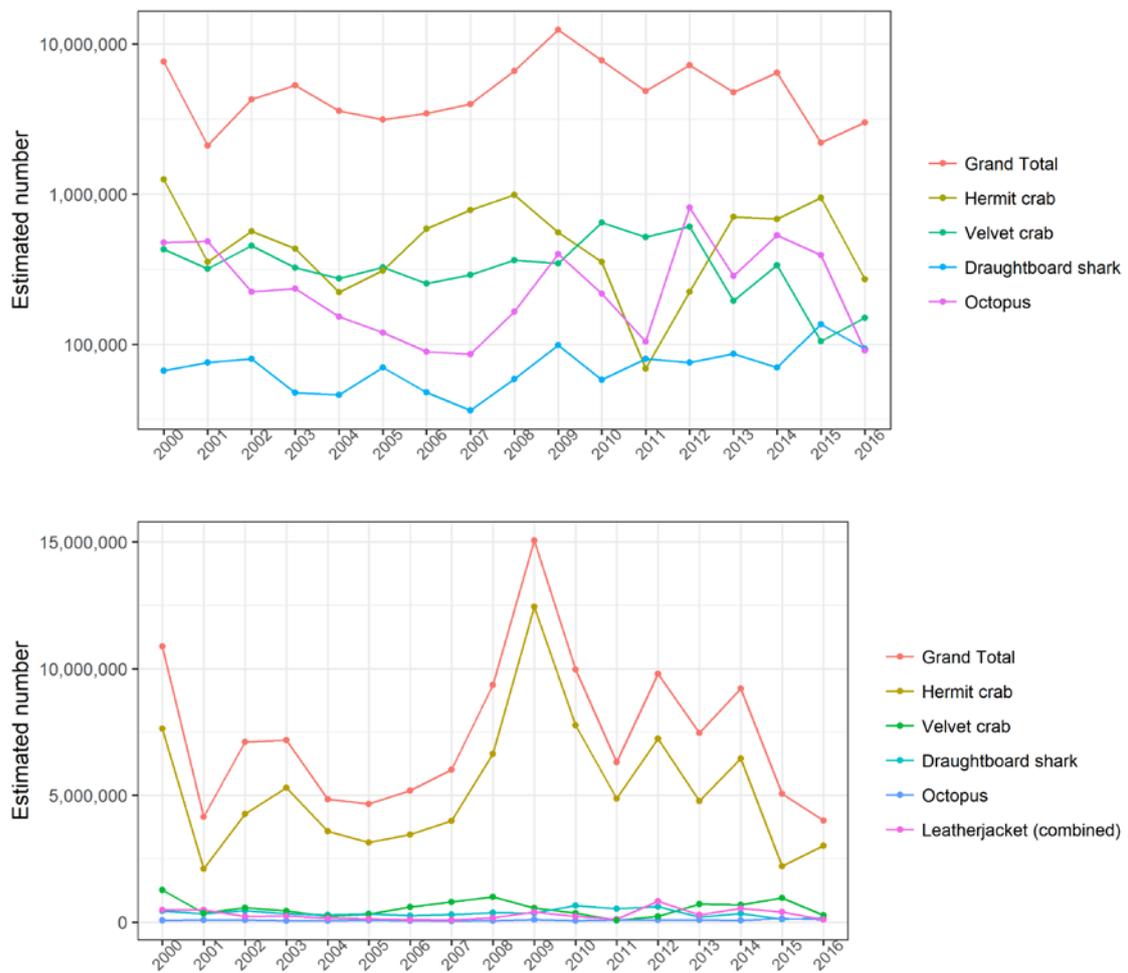


Figure 19 Total by-catch of top five species estimated by multiplying research sampling effort and catches up to the equivalent of the annual commercial effort. Both plots show the same data however, the top has number plotted on a log scale to highlight catches of the less abundant species in the catches.

5.3 By-product

By-product reported is differentiated into bait and product for sale (consumption). All reported by-product from lobster pots was of a small volume, the largest being octopus with 32 t and striped trumpeter with four tonnes, for bait between seasons 2012/13 and 2016/17. (Figure 20). Octopus and leatherjackets are the most important species for bait with 3.5 tonnes each. The rest of species used as bait were reported with a volume lower than 3 tonnes (Figure 20).

By-product is clearly under-reported by the fishery, especially for animals used as bait. For example, research sampling indicates that around 10 t of wrasse are likely to be captured by fishers, yet less than one tonne is reported on average each year as by-product (Table 3). There is no apparent improvement in rate of reporting between years.

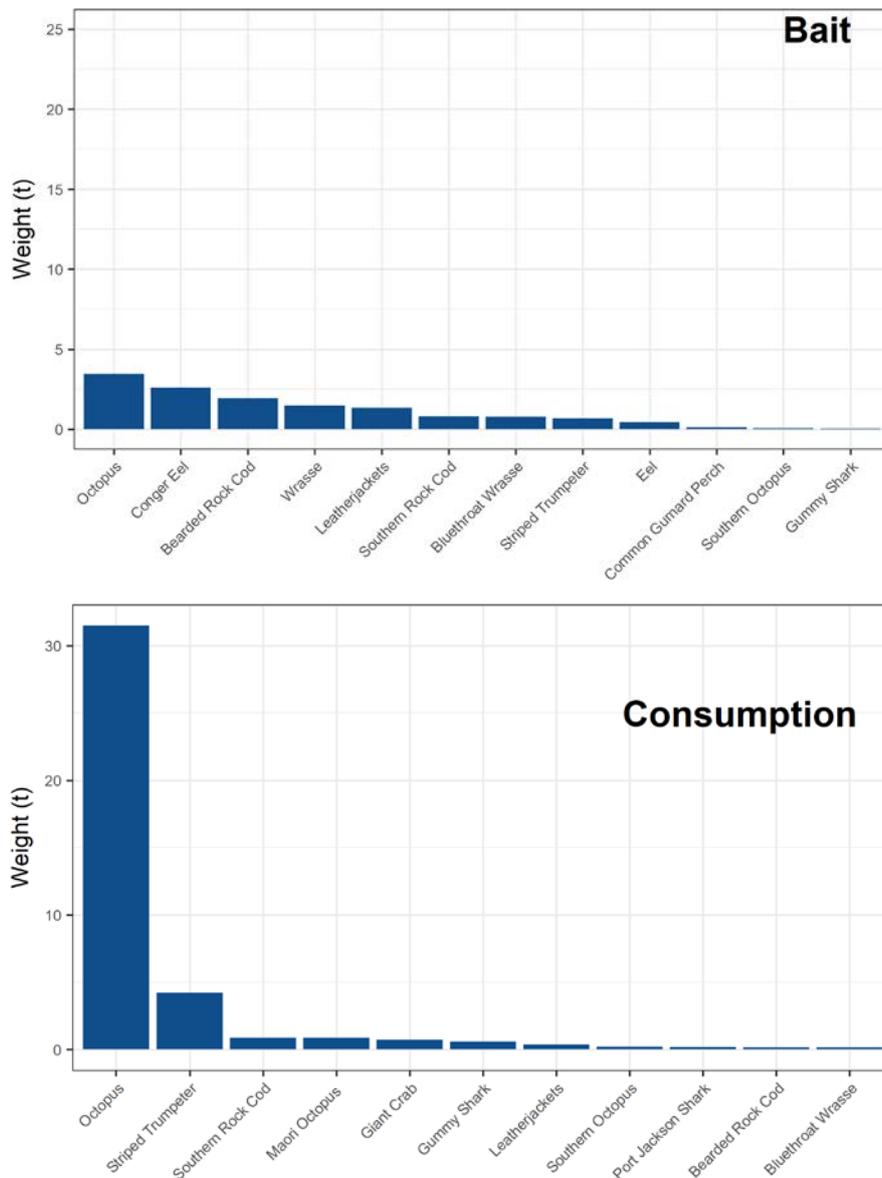


Figure 20. Relative importance of by-product species, based on weight, reported by commercial fishery (pooled data 2012/13-2016/17). Species included that account 95% of the total by-product catch.

Table 3. By-product reported by the commercial fishery (tonnes). All species with catch less than 100 kg in any one year have been excluded.

Species	Bait					Consumption				
	12/13	13/14	14/15	15/16	16/17	12/13	13/14	14/15	15/16	16/17
Octopus	0.46	0.73	0.87	1.02	0.40	5.56	6.91	4.53	5.70	5.17
Wrasse	0.45	0.23	0.30	0.25	0.11	0.11	0	0	0	0
Bluethroat Wrasse	0.36	0.26	0	0.38	0	0	0	0	0	0
Eel	0.16	0	0	0	0	0	0	0	0	0
Conger Eel	1.03	0.69	0.61	0.90	0.35	0	0.10	0	0	0
Leatherjackets	1.31	0.42	0	0.22	0.12	0	0	0	0	0
Striped Trumpeter	0	0.33	0.31	0	0	0.35	0.98	1.05	0.34	0.69
Bearded Rock Cod	0.48	0.31	0.18	0.33	0.18	0	0	0	0	0
Southern Rock Cod	0.55	0.31	0.00	0.12	0.25	0.14	0	0.11	0	0.53
Giant Crab	0	0	0	0	0	0.19	0.16	0.11	0	0.13
Maori Octopus	0	0	0	0	0	0	0	0	0	0.11
Gummy Shark	0.46	0.73	0.87	1.02	0.40	5.56	6.91	4.53	5.70	5.17

5.4 Supply risk of bait

A survey was conducted to determine what species are being used for this purpose and explore any risks around future supply. A total of 29 individual fishers were surveyed in TAS who declared using 8 different species of fish as a bait; however, they declared preference for Blue Mackerel and Jack Mackerel (*Scomber australasicus* and *Trachurus* spp.), Australian Salmon (*Arripis* spp.), and Barracouta (*Thyrsites atun*). Most of this bait is sourced from New Zealand.

The stock status of many of the preferred bait species used in the Southern Rock Lobster Fishery is not available through formal reporting so was classified as unknown, particularly those from NZ (Table 4). Australian Salmon and some stock assessment areas for Blue Mackerel, Jack Mackerel and Barracouta from NZ are classified as sustainable.

We found that fishers preferred a limited number of bait species and that some were being sourced from fisheries with an ‘unknown’ sustainability status and many fishers were concerned about future supply. Insecurity of existing supply means that other bait options need to be explored. Ongoing monitoring of species being used for bait would assist any future third party sustainability accreditation.

Most fishers in TAS felt that the quality of bait has remained stable. This is, when asked to rate their level of concern regarding the risk of bait supply, 62.1% of the respondent declared that they were ‘*somewhat concerned*’ about the future risk of bait supply. They also declared (52.2%) that they have not considered using alternative baits to this point.

Lobster buyers / processors also tend to be suppliers of bait and interviews confirmed that Blue Mackerel, Jack Mackerel, Australian Salmon, and Barracouta are the preferred bait types in the Southern Rock Lobster Fishery contributing roughly 90% of bait used (M.

Blake, South Australian Lobster Company, *pers. comm.*). A major supplier of Australian Salmon indicated that they had high demand from the Australian bait market (C. Pappageorge, Account Manager of United Fisheries LTD in NZ, *pers. comm.*), and MD Pty Ltd, a major seafood processor and bait supplier on King Island, TAS indicated that they are very concerned about the future supply of bait. A common theme of discussions with bait suppliers was the increasing prevalence of competition from other markets, namely the human consumption market, for fish species that have been traditionally used as bait.

The apparent shortage in bait is a market issue as Australian salmon is abundant in southern Australia but at historically low levels of catch, while Australia's small pelagic fishery has 10,000s tonnes of uncaught quota allocated each year.

Table 4. Reported bait taxa used in the Southern Rock Lobster Fishery from each state by origin, type, stock status.

Species	Origin	Type	Stock status	Source
Blue mackerel (<i>Scomber australasicus</i>)	New Zealand	Whole	Unknown	(MPI, 2017)
Australian Salmon (<i>Arripis spp.</i>)	Australia	Cut-lets/Heads	Sustainable	(Stewart et al., 2015)
Jack Mackerel (<i>Trachurus spp.</i>)	New Zealand	Whole	Unknown	(MPI, 2017)
Kahawai (<i>Arripis spp.</i>)	New Zealand	Heads	Sustainable/unknown	(MPI, 2017)
Tiger Flathead (<i>Platycephalus richardsoni</i>)	Australia	Frames	Sustainable	(Maloney et al., 2015)
Atlantic salmon heads (<i>Salmo salar</i>)	Australia	Heads	Farmed	
Shark heads (unspecified species)	Australia	Heads	Unspecified species	

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7 Appendix 1: Historical overview

The following section is based largely on a synopsis of the history of the fishery compiled by Tony Harrison (<http://www.users.on.net/~ahvem/Fisheries/Tasmania/Tasmania.html>).

Tasmania's rock lobster resource is distributed around the coast although fewer animals are found along the central north coast bordering Bass Strait due to limited opportunity for recruitment.

Aborigines fished lobsters around the State and a small indigenous harvest continues, mainly in the northeast. The resource has been harvested commercially since European settlement with fishing effort initially focused on the East Coast.

The commercial and recreational fisheries initially proceeded without records but the need for management of the fishery was recognised nonetheless. The first Act for the protection of Rock Lobster was passed by Parliament in 1885. This Act prohibited the possession of soft-shelled "crayfish" and egg-carrying females and introduced a minimum legal-size of 10 inches. This size limit is essentially equivalent to that used today and remains one of the main management constraints.

Some commercial catch information was collected in the late 1880's with around 60,000 lobsters a year landed into Hobart. This remains around the average annual commercial harvest from shallow waters in the SE of the State today (average of 39 tonnes in <10 fathoms for the period 2000-2003, Area 1; although it should be noted that now the recreational catch could match the commercial harvest).

In 1888 fisheries matters were placed under the control and management of a single Fisheries Board comprising 23 commissioners. Much of their time was spent debating the merits of different gear types.

Hemispherical cane pots (based on pots used for taking clawed lobsters in Cornwall, England) were used in Victoria while in Tasmania a baited hoop ("cray" ring) was the traditional (and preferred) method of catching rock lobsters. The two methods led to two quite different commercial fishing industries; one using larger, more robust boats that could operate pots and the other using smaller boats sufficient for operation of "cray" rings. These two fleets came into contact and conflict during periods around the moult when lobsters were too soft for freight to Victoria. Pots were subsequently banned in Tasmania in November 1902, later amended to latitudes south of 39° 31' S in February 1904 and subsequently south of 40° 38' S (*i.e.* north of St Marys) in July 1904. The Fishing Board ratified this ban in November 1905.

In response to further pressure from northern commercial fishers, a Parliamentary enquiry conducted by Joseph Lyons considered that pots were not destructive and recommended that pots be legalised. However, it wasn't until 1925 that pots were finally legalised as part of a new fisheries bill that placed responsibility for the management of sea fisheries with a newly appointed Sea Fisheries Board. The centrepiece of this new bill was the allocation of varying numbers of pots to commercial vessels depending on their size. For example, a limit of 30 pots was adopted for larger vessels with proportionately fewer pots

allowed for smaller vessels. Inevitably, the use of pots led to dramatic increases in commercial catch due to greater efficiency, halted fleetingly by reduced market demand during the depression years (1930s) and the Second World War.

Markets have adapted to change in technology throughout the development of the fishery.

The adoption of diesel engines during the Second World War meant that more product could be shipped to mainland Australia, which led to expanded markets. Soon after this, the development of refrigeration enabled a rapid expansion into the American frozen tail market. Most of the commercial catch is now transported live into Asia, the world's premium market for lobsters. The increased value of lobsters that has resulted from the development of these markets along with growing recognition of rock lobster as preferred seafood is considered to be a motivating factor for the steadily increasing recreational effort.

The annual commercial catch reached its historical maximum in 1984 at 2250 tonnes, prior to falling to 1440 tonnes in 1994. Concerns about declining future catches led to a shift away from a commercial fishery managed by input controls (*i.e.* number of pots and licences etc.) to one managed through control of fishery outputs (or total catch limits). This resulted in the adoption of an individual quota system in March 1998 for the commercial fishery.



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