FISHERY ASSESSMENT REPORT

TASMANIAN ROCK LOBSTER FISHERY

2010/11

Klaas Hartmann, Caleb Gardner and David Hobday

February 2012

IMAS Taroona, Private Bag 49, Hobart, TAS 7001,
Australia. E-mail: Caleb.Gardner@utas.edu.au. Ph. (03) 6227 7277,
Fax (03) 6227 8035

Executive Summary

Current Stock Status

Biological Sustainability

- Biological sustainability is measured through egg production and recruitment. Egg production declined over the last year but is still at very high levels at an estimated 40% of virgin production and thus well above the limit reference point of 25%. The level of egg production may be unrelated to future stock stability because of the imprecise relationship between egg production and future recruitment and the likely reliance on egg production from other States.
- The average weight of lobsters in areas 3 and 4 (north east) continued to increase while catch rates fell, signalling a prolonged decline in recruitment. Average weight in the deep water areas 9-11 and in area 1 have shown some decline, which may indicate some recovery in recruitment.
- In most areas the number of new pre-recruits (sub legal lobsters larger than 60mm) has been below the decadal average for several years, indicating poor recruitment since 2007.
- Puerulus settlement off eastern Tasmania improved during 2010 with Bicheno and Flinders Island having above average settlement and Recherche Bay saw very high settlement peaks in January and March 2011.

Economic yield

- Economic yield is affected by changes in the legal sized portion of the stock only. The general trend over the last year was a reduction in economic yield due to decline in catch, catch rate, and an increase in effort.
- The 2010/11 commercial catch was 1,222 tonnes, which was the lowest since 1970 and 101 tonnes less than the TACC. This was the second season when the commercial catch was not constrained by the TACC (and carry over provisions). The TACC included an additional 37 tonnes carry over and was therefore under caught by 148 tonnes or 11% despite TACC reductions of 13% over the past two years.
- Effort during 2010/11 was 1.55 million potlifts, the highest since the introduction of quota. Subsequently, the Statewide catch rate (CPUE) fell to 0.79 kg/potlift, the lowest on record (since 1947). Catch rates in all stock assessment areas (except the deepwater SW Area 11) were close to, or approaching the limit reference point. Monthly catch rates for 2010/11 were below or equal to the lowest recorded over the last decade
- The only areas to increase catch over the past season were the south east (area 2) and north west (area 5). Both areas also saw a decline in catch rate.
- Legal size stock abundance (exploitable biomass) was close to or below an 11 year low point (1999-2010) in all areas except deepwater south west and decreased across all areas between 4 and 17%.

- The capacity for the Tasmanian southern rock lobster fishery to support the annual harvest is a function of both growth of the legal sized stock and also recruitment of new lobsters into the stock. Decline in productivity from both of these processes has resulted in a decline of the legal-sized stock, which in turn has led to a need for TACC reductions. The prolonged low recruitment to the fishery is exceptional and unlike any downturn seen previously over the period of four decades from 1970 to 2010. Low recruitment has led to erosion of the legal sized stock and thus reduced productivity through growth.

Ecosystem effects of fishing

- There were no notable trends in by-catch or by-product data.
- There were no reported protected species interactions.
- Biomass targets for rebuilding of large lobster stocks of eastern Tasmania are under development.

Evaluation of Future Harvest Strategies

The evaluation of changes in the TACC only indicated that TACCs of 100 kg / unit (1050.7 t) or less have acceptable probability of meeting most target and limit reference points (Table 1).

These analyses included some important assumptions which were:

(i) future recruitment will broadly reflect that observed from 1998-2007 (included periods of both high and low recruitment), actual recruitment over the last five years tended to be lower;
(ii) no expansion of catch beyond changes in the TACC (e.g. recreational and illegal catch was assumed to be 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 constant (in particular, they do not include gains in stock productivity from the commercial scale translocations operations that commenced in 2012).

Table 1. Evaluation against reference points

Performance measure	Reference point	Assessment
Biological Sustainability		
Egg production (assessment areas)	• Limit reference point: 90% probability of egg production above 25% unfished level (areas 1, 2, 3, 7-11) or above 20% (areas 4-6) after 5 years	Met for all areas with a TACC of 110 kg/ unit, except areas 3 and 5 (which were not met even with TACCs of 90 kg / unit)
Legal sized stock (economic benefit)		
Exploitable biomass (state)	• Limit reference point: 90% probability of remaining above 10 year low over next 5 years	94% probability with TACC = 100 kg / unit; 84% probability with TACC =105 kg / unit
	• Target reference point: 70% probability of rebuilding to 05/06 peak in 8-10 years	83% probability at TACC = 95 kg / unit
Exploitable biomass (assessment areas) *5 out of 8 areas to meet these reference points including key areas of 1, 5, 7 and 8*	• Limit reference point: 90% probability of remaining above 10 year low over next 5 years	6 of 8 areas >= 88% probability at TACC = 100 kg / unit
	• Target reference point: 70% probability of rebuilding to 05/06 peak in 8-10 years	Not met by any TACC scenario examined (TACC = 90 kg / unit fails on area 8)
CPUE (State-wide)	• Limit reference point: 90% probability of remaining above 1999 CPUE over next 5 year	94% probability at TACC = 100 kg / unit
	• Target reference point: 50% probability of 1.1 kg per pot lift by 2016	67% probability at TACC = 100 kg / unit
CPUE (Regional) *5 out of 8 areas to meet these reference points including key areas of 1, 5, 7 and 8*	• Limit reference point: 90% probability of remaining above 1999 CPUE over next 5 years	TACC = 100 kg / unit
	• Target reference point: 50% probability of returning to 2005/06 level by 2016	Target met for 7 of 8 areas at TACC = 90 kg / unit

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1 Introduction

1.1 The modern commercial fishery

The present commercial catch is taken from areas all around the State and involves the annual harvest of around 1.3 million animals. In the 2010/11 season 236 licensed vessels reported catches of rock lobster, down from 314 in 1994/95 but an increase of 6 from the previous year. In addition, there were approximately 11,000 licensed recreational fishers during 2010/11 which was down from around 19,500 the previous year. The latest recreational catch survey was taken in 2008/2009 when an estimated 107 tonnes was caught (Lyle, 2010).

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. For each of the past two seasons the TACC has not constrained the catch[1]. The total allowable commercial catch (TACC) has been reduced by 13% over the last two seasons but despite this reduction it was under-caught by 7.7% in 2009/10 and 7.5% in 2010/11 (**Error! Reference source not found.**). State-wide catch rates have continued to decline as the effort (cost) required to take the TACC has trended upward to pre-quota levels.

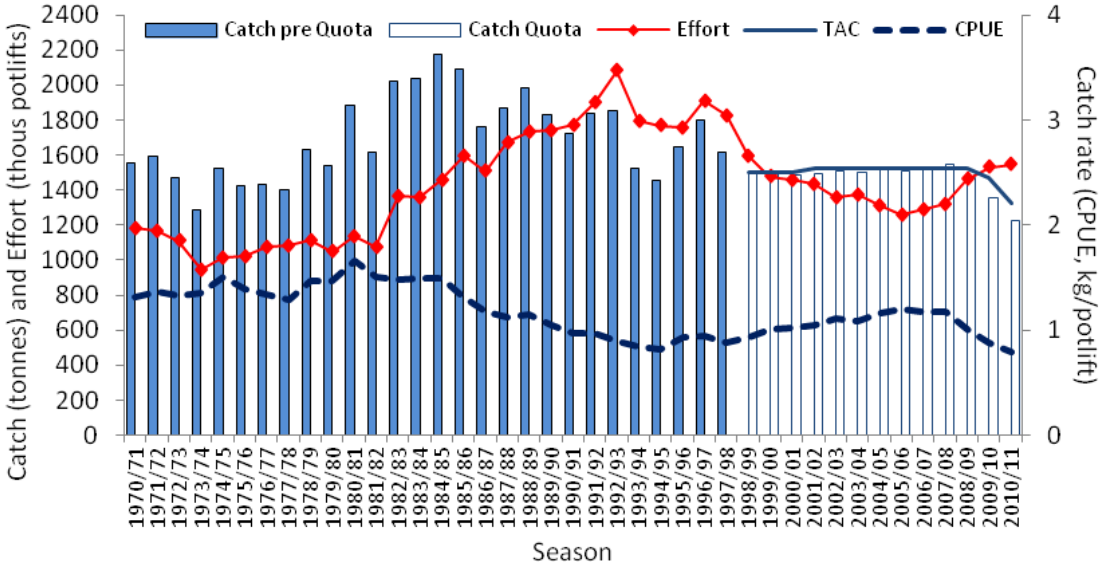


Figure 1. Historical commercial fishing effort (pot-lifts), catch (pre and post quota, tonnes), CPUE (kg/potlift) and TACC (tonnes). From 1998 to 2005 the amount of effort required to take the catch diminished. This trend has reversed in recent years so that effort and catch in the most recent year approximate that in 1998 when quota was introduced.

[1] The commercial catch was less than the TACC in 2008/09 also but this gap was equal to the carry over provision available to the fishery at that time. Thus the catch did not fall below the TACC, rather it was deferred.

The post quota recovery can be seen in the historical trends in the fishery (Figure 1 and Figure 2), however, the estimated total legal biomass has now shown a decline for the last four years. Trends in legal biomass and catch rates are roughly similar although with some important differences. In the period of stock rebuilding from 1995 to 2005, catch-rates recovered slower than biomass due to a changing fishery dynamics. For example, fishers increased their effort in locations and months when catch rates are lower but price is higher. In recent years, catch rates have declined faster than estimated biomass, possibly again due to fleet effects. Prior to the 2008/09 quota period, the TACC was confining the catch with only 1-2% uncaught. During the 2009/10 and 2010/11 quota periods the percentage of the TACC caught declined to 92% (Figure 3).

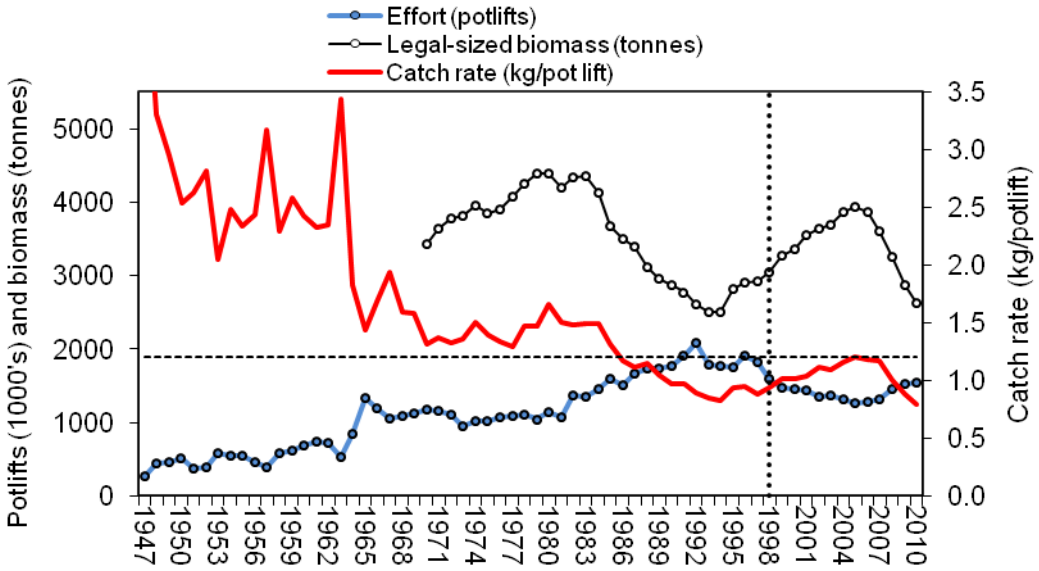


Figure 2. Historical trends in estimated fishing effort (pot-lifts), estimated catch-rate (kg/pot-lift) and estimated legal-sized biomass (tonnes). Data is in quota years (Mar to Feb) from 1970 onwards. Catch rate and effort are inversely correlated through the series. Dashed lines indicate the introduction of ITQ management and the current commercial industry catch rate target of 1.2 kg/pot lift.

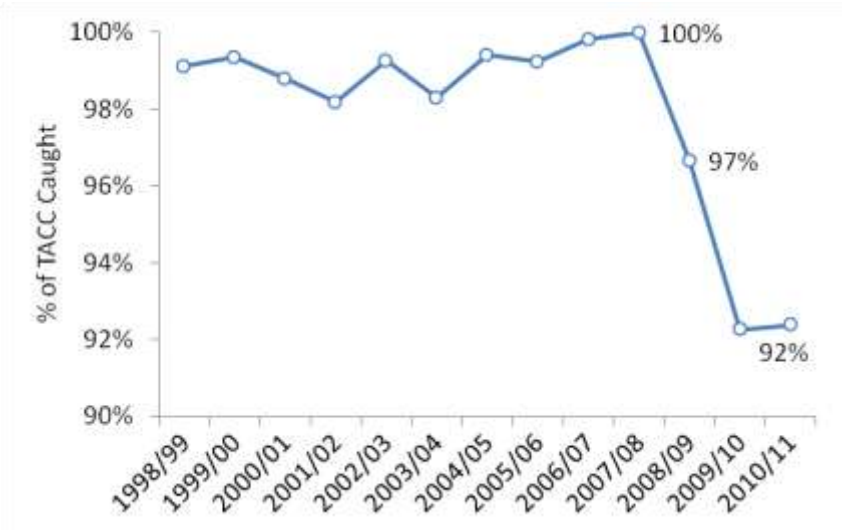


Figure 3. Percentage of the TACC caught during each quota period. In 2009/10 and 2010/11 the TACC did not constrain the catch.

Both fishing effort and biological parameters vary dramatically from region to region, which presents major challenges for fishery assessment and management. An important step towards meeting these challenges is the use of a spatially-explicit stock assessment model that considers different assessment areas separately and informs harvest strategies which incorporate regional differences. Recent changes to the assessment model have enabled information to be presented separately for water shallower or deeper than 35 fathoms off the west coast. These areas have been assigned numbers of 9, 10 and 11 (Figure 4).

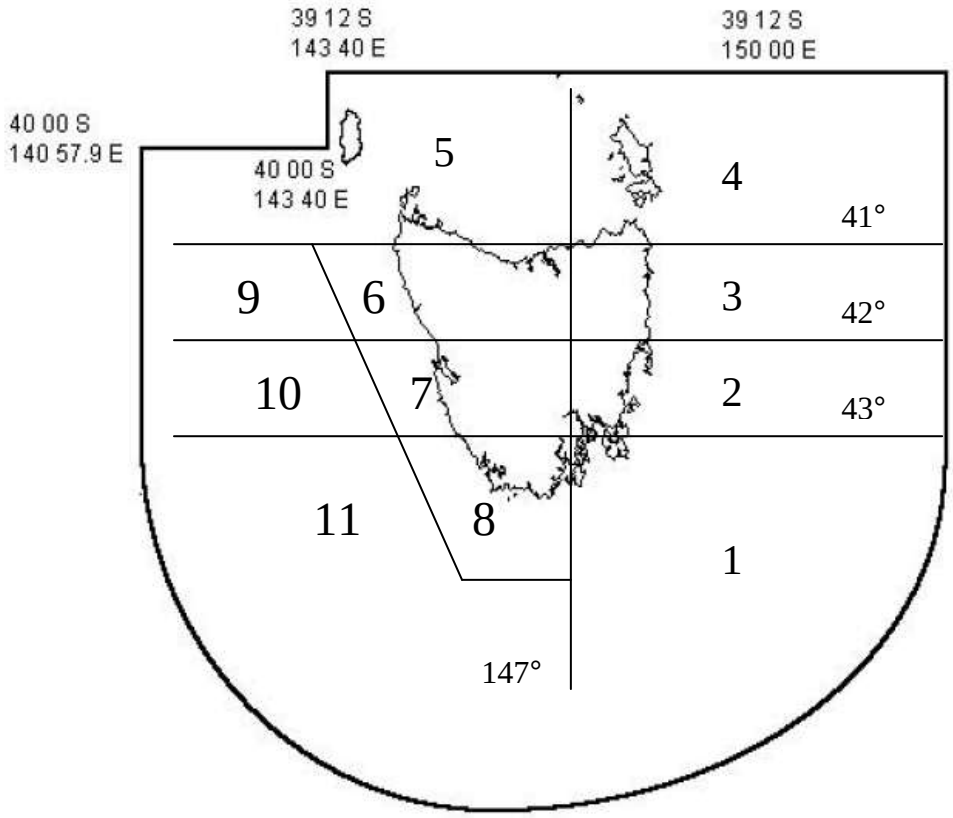


Figure 4. Schematic boundaries of the Stock Assessment areas and indicative area of State waters for the rock lobster fishery, provided by the offshore constitutional settlement (OCS).

1.1 Performance measures

A summary of outcomes against formal performance measures is presented at the front of this report in Table 1. These measures were developed through the CFAC and RecFAC process in 2009 and 2010. The values for each of these performance measures are compared to standards, termed Reference Points. Limit Reference Points (LRPs) define undesirable states for the fishery. Target reference points (TRPs) define ideal desirable performance states for the fishery.

A LRP only is defined for management of biological sustainability. This is because the optimal level of security to ensure biological sustainability is to have an unfished population. For example, would be illogical to have a target for egg production that involve depleting the stock through fishing. In contrast, LRPs are important for biological sustainability because they prevent stock depletion that could lead to decline in recruitment.

LRPs for stock sustainability in this fishery are set to prevent recruitment overfishing, which is defined for Australian fisheries by ABARES as:

"*Recruitment overfished: the spawning stock biomass has been reduced through catch, so that average recruitment levels are reduced."*

The use of LRPs to avoid recruitment overfishing is a very conservative measure. It means that the levels of juveniles recruiting to the fishery should be equivalent to the unfished stock.

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 economic benefit from fisheries because there is a trade-off between catch and stock abundance. High levels of catch provide high revenue but reduce the legal sized biomass. This means costs of commercial fishing increases and a greater proportion of recreational fishing effort results in no catch. 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 and this intent is achieved through probabilities – that is, most LRPs are assigned a high probability of 90% and TRPs a 70% probability.

There are no performance measures developed for ecosystem interactions in the Tasmaniam lobster fishery at present although data is collected and reported for protected species interactions, bycatch and byproduct.

Ecosystem data from unfished sites is available and the development of performance measures was pursued in 2010 however none could be developed. This was because (i) changes in non-fished sites are mainly of target species rather than ecosystem changes; (ii) the effect is confounded by closure to all fishing types, not just lobster fishing; and (iii) no meaningful thresholds could be developed (for example, the purple sea urchin *Heliocidaris erythrogramma* was more abundant outside reserves, presumably through release from lobster predation, but what level is of concern and can be used a LRP?).

2 Recent developments

2.1 Management history of the fishery

The implementation of the quota system in the commercial fishery in March 1998 resulted in an increased focus on economic yield rather than simply trying to maximize catch and thus revenue. Previous assessments have discussed the change in the dynamics of the fishing fleet since quota was introduced and noted that there was some shift in effort towards winter fishing and shallow water to maximise value (Frusher *et al*, 2003). This has the potential to bias the stock assessment as it could lead to localized depletion in inshore waters while harvest rates in offshore stocks remain low due to the lower price of deep water, pale lobsters. This issue has been addressed in recent assessments by dividing west coast assessment areas into shallow (less than 35 fathoms) and deep components.

The TACC was stable for the first decade but has been lowered by 13% over the past two seasons in response to decline in the exploitable biomass (Table 2).

Management of the recreational fishery has remained stable with a daily legal catch limit of five lobsters. Licensing has been now been introduced for all methods of recreational lobster fishing and this provides information about levels of participation.

Table 2. Total allowable commercial catch, kilos per unit, percentage change in TACC and percent of the TACC uncaught for each quota year. Proposed TACC for 2012/13 is indicated in italics.

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%	7.7%
2010/11	1323.9	126	-10%	7.6%*
2011/012	1103.24	105	-17%	
2012/013	*1103.24*	*105*	*0*	

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

3 Fishery assessment

3.1 Commercial catch and effort analysis

3.1.1 State-wide commercial catch and effort

Total commercial catch for 2010/11 taken through the quota management system was 1222 t (Figure 5) of the TACC of 1323 t (a deficit of 101 t). This catch included carry-over of 37 tonnes from the previous year. This was the second consecutive year that the TACC was substantially undercaught with the uncaught proportion around 7.6% despite a reduction of 13% in the TACC over the past two years (Table 2).

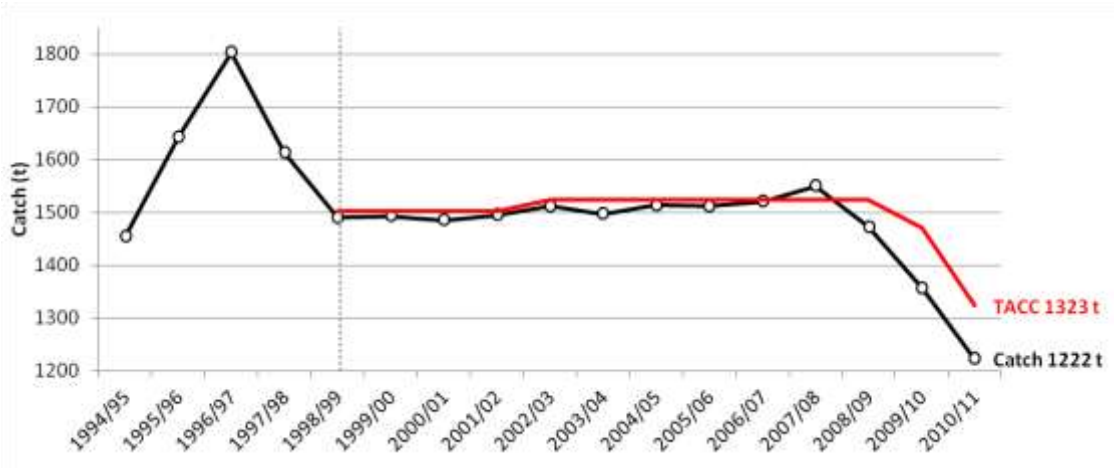


Figure 5. Commercial catch reported through catch and effort logbooks. These differ slightly from the TACC because of carry-over provisions and under-catch. Red line shows TACC

Catch rate or catch per unit of effort (CPUE) data from the commercial sector serves as a proxy for two factors of interest for fisheries management: the variable cost of fishing and the abundance of lobsters. State-wide commercial catch rate for the 2010/11 quota year was 0.79 kg/potlift, which is the lowest in the recorded history of the fishery with the previous lowest CPUE of 0.82 kg/potlift recorded in 1994 (Table 3). Monthly catch rate for 2010/11 was below or equal to the lowest recorded over the last decade (Figure 6). Apparent declines in mean catch rates can be caused by factors unrelated to abundance and for this reason trends in biomass derived from the assessment model shown later in the report provides a more reliable guide to stock changes.

When the catch is controlled by quota, changes in catch rate translate into changes in effort (potlifts) required to take the catch. In 2010/11 the level of effort was 81% of the effort expended in 1996/97, a slight increase on the previous year (Table 3). This indicates that there is further capacity to expand effort as the catch rate falls.

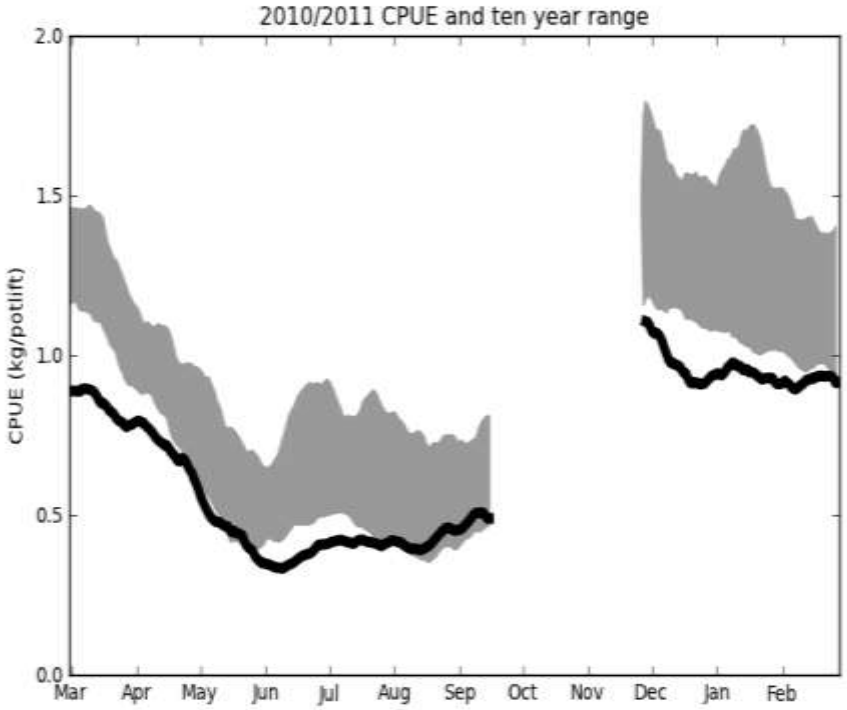


Figure 6. Monthly catch rate for 2010/11 (black line) compared with range from the previous decade.

Table 3. Summary of state-wide commercial catch and effort statistics. 1996/97 had the maximum level of effort since 1994/95 and other years are scaled to this peak. QYear is quota year (Mar 1st – Feb 28/29th). State CPUE is the total catch divided by the total pot lifts.

Q Year	Catch (t)	Pot Lifts ('1000)	% of 96/97 effort	State CPUE (kg/potlift)
1994/1995	1454	1768	92.6	0.82
1995/1996	1643	1755	91.9	0.94
1996/1997	1803	1909	100.0	0.94
1997/1998	1614	1826	95.6	0.88
1998/1999	1490	1594	83.5	0.93
1999/2000	1493	1477	77.4	1.01
2000/2001	1485	1456	76.3	1.02
2001/2002	1495	1433	75.1	1.04
2002/2003	1512	1356	71.1	1.11
2003/2004	1497	1374	72.0	1.09
2004/2005	1514	1309	68.6	1.16
2005/2006	1511	1257	65.9	1.20
2006/2007	1520	1289	67.6	1.18
2007/2008	1550	1320	69.2	1.17
2008/2009	1472	1462	76.6	1.01
2009/2010	1356	1529	80.1	0.89
2010/2011	1222	1545	81.0	0.79

3.1.2 Active vessels

When QMS was established, a reference point of 220 active licences was established to track participation in the fishery (Figure 7). As stocks and catch rates improved from 1994 to 2005, the number of vessels required to take the catch declined (Figure 8). In addition, an increase in the maximum number of pots per vessel from 40 to 50 in 1998, intended to increase efficiency, reduced the number of active vessels.

The deterioration of the stocks over the last few years has reversed the decline in number of active vessels. Thus there were 236 vessels reporting catch in 2010/11, up by 6 vessels from the previous year. These changes emphasise that vessel numbers respond in the opposite direction to rock lobster abundance. Under higher levels of stock, catch rates increased and the number of days a boat needed to fish decreased. This created an economic pressure on the fishing fleet to rationalise. Since the stock has declined over the last few years, vessels and fishers have needed to work more days to take the same catch. This created an undersupply of vessels, improves business conditions for new entrants, and the number of active vessels increases (Table 4).

The decline in catch rate has led to lower daily catches, and more working days per active vessel. The average vessel is now working an extra 21 days per year (+17%) to take a reduced TACC compared to 2004/05 (Table 4). Fishers report that this increases the risk of accidents at sea as they are less willing to avoid bad weather. The number of active days per vessel remained the same as last year and therefore the extra effort going into the fishery over the last year is through more vessels operating, rather than the existing vessels fishing harder.

Up until 2008 there was much concern amongst industry about succession and the barrier effect of high quota unit prices on new entrants. The responsiveness of vessel numbers to catch rate seen over the last few years indicates that there is no cause for concern – there are many willing new entrants who emerge when business opportunities arise.

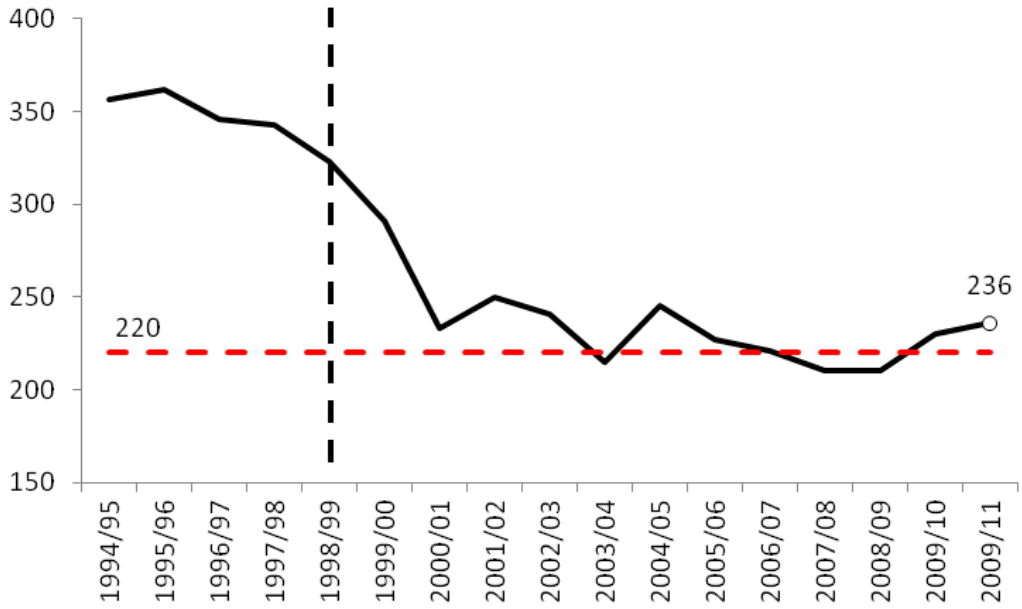


Figure 7. Number of vessels around the State reporting rock lobster catch. The dashed red line is the reference point (220) introduced in 1998, while the dashed black line marks the start of the QMS.

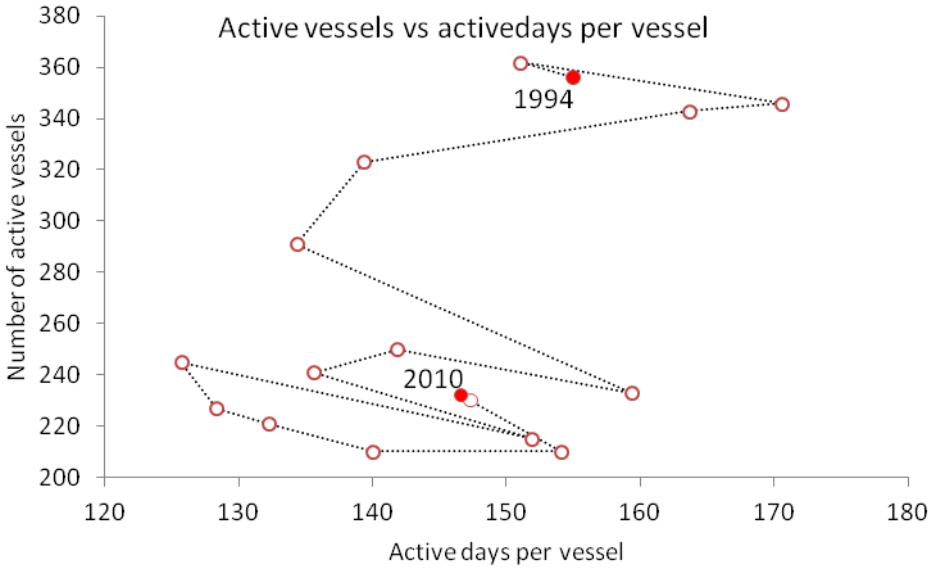


Figure 8. Number of vessels around the State reporting rock lobster catch in relation to the days fished per vessel. Upper and lower constraints on vessel activity affect the overall fleet size.

Table 4. Number of active vessels reporting catch of rock lobsters throughout the State and the average number of days fished by vessels.

Quota Year	Number of active vessels	Active days per vessel
1994/95	344	155
1995/96	340	151
1996/97	328	171
1997/98	325	164
1998/99	286	139
1999/00	255	134
2000/01	233	159
2001/02	250	142
2002/03	241	136
2003/04	215	152
2004/05	245	126
2005/06	227	128
2006/07	221	132
2007/08	210	140
2008/09	210	154
2009/10	230	147
2010/11	236	147

3.1.3 Regional commercial catch and effort

During the 2010/11 quota year, statewide catch decreased by 10%, an equivalent amount to the TACC reduction while effort increased by 1% (Table 5). Catch from areas 1, 8 and 9 was much reduced (26-29%). Area 2 increased catch by 15% and Area 5 by 13% as a result of increases in effort of 19 and 26% respectively (Table 5). Area 9 catch was down by 49% but there was a 31% drop in effort.

The dominant trend in regional catch rate was a decline, however areas 3 and 10 increased by 8-9% and Area 11 by 1% (Table 6). The Statewide catch rate for 2010/11 of 0.79 kg/potlift was the lowest recorded as was the catch rates from areas 1, 6, 7, 8 and 9. The increases in effort and catch from areas 2 and 5 saw a catch rate reduction of 2 and 10% respectively.

Analysis of monthly trends showed increasing effort during January and December compared with the previous year and Autumn effort reduced in areas 5,7 and 2 compared with the longer term average (2003-08, **Error! Reference source not found.**). November catches were more than the previous year in areas 2, 10 and 11 with January catch higher in areas 5 and 7. Winter catches during 2010/11 were generally lower than the previous year and the longer term average. In all areas monthly catch rates were lower than the long term average and generally lower than the previous year.

Table 5. Annual catch and effort for the whole State and each area for the past two quota years and percentage change during that time.

	Catch (tonnes)			Effort(potlifts x1000)		
AREA	2010/11	2009/10	% change	2010/11	2009/10	% change
Statewide	1222	1337	-10%	1525	1505	1%
1	84	114	-26%	179	202	-11%
2	90	78	15%	147	124	19%
3	51	49	4%	90	94	-4%
4	144	176	-18%	185	179	3%
5	338	298	13%	326	258	26%
6	83	89	-7%	93	90	3%
7	118	129	-9%	108	108	0%
8	206	284	-27%	309	349	-11%
9	30	59	-49%	27	39	-31%
10	13	14	-7%	12	13	-8%
11	47	47	0%	49	49	0%

Table 6. Annual commercial catch-rates for the whole State and each area for the 2010/11 quota year compared with the year with the lowest catch rate. Percentage change in catch rates are compared with the lowest year and the previous year (2009/10). * 2010/11 is the lowest year.

	Commercial catch rate (kg/potlift)				% change	
	Lowest	Lowest	CPUE	CPUE	vs lowest	vs
AREA	Year	CPUE	2009/10	2010/11	year	2009/10
Statewide	2010	0.79	0.89	0.79	*	-11%
1	2010	0.47	0.56	0.47	*	-16%
2	1994	0.54	0.63	0.62	15%	-2%
3	1994	0.43	0.52	0.56	30%	8%
4	1994	0.61	0.99	0.78	28%	-21%
5	1995	0.89	1.15	1.04	17%	-10%
6	2010	0.89	0.99	0.89	*	-10%
7	2010	1.1	1.19	1.1	*	-8%
8	2010	0.67	0.81	0.67	*	-17%
9	2010	1.1	1.53	1.1	*	-28%
10	2002	0.94	1.04	1.13	20%	9%
11	1993	0.83	0.95	0.96	16%	1%

The following assessment overviews (Figure 9-21) provide a snapshot of the key performance indicators for the whole State and for each of the eleven assessment areas. Graphs of commercial catch, potlifts, catch per unit effort (CPUE) and stock abundance (legal size) are shown. The numbers at the top of each figure give the current value for catch, potlifts, CPUE and legal size stock abundance, as well as the % change from the previous year. The dotted lines on the CPUE and stock abundance graphs are the area reference points. The lower red dotted line is the limit reference point and is the lowest year since Quota (1998/99 – 2010/11). The upper dotted blue line is the target reference point and is the most recent peak period of the fishery, for most areas this occurred around 2005/6.

The most consistent trends in these overviews are:-

1. The catch declined Statewide and in seven of the eleven areas,
2. Both the catch rate and abundance for the 2010/11 quota year were at the limit reference Statewide and in six of the areas.
3. Abundance decreased in all areas between 4 and 17%
4. The only areas to increase catch (2 and 5) also experienced a decline in catch rate.

The maps in Figure 21 show how catch has shifted during the last year. The lower quota reduced catch in the south and North West and these areas generally had decreased catch rates. The far north-western mainland and northern King Island saw catch increases and falling catch rates while east coast catches increased along with catch rates (Figure 22).

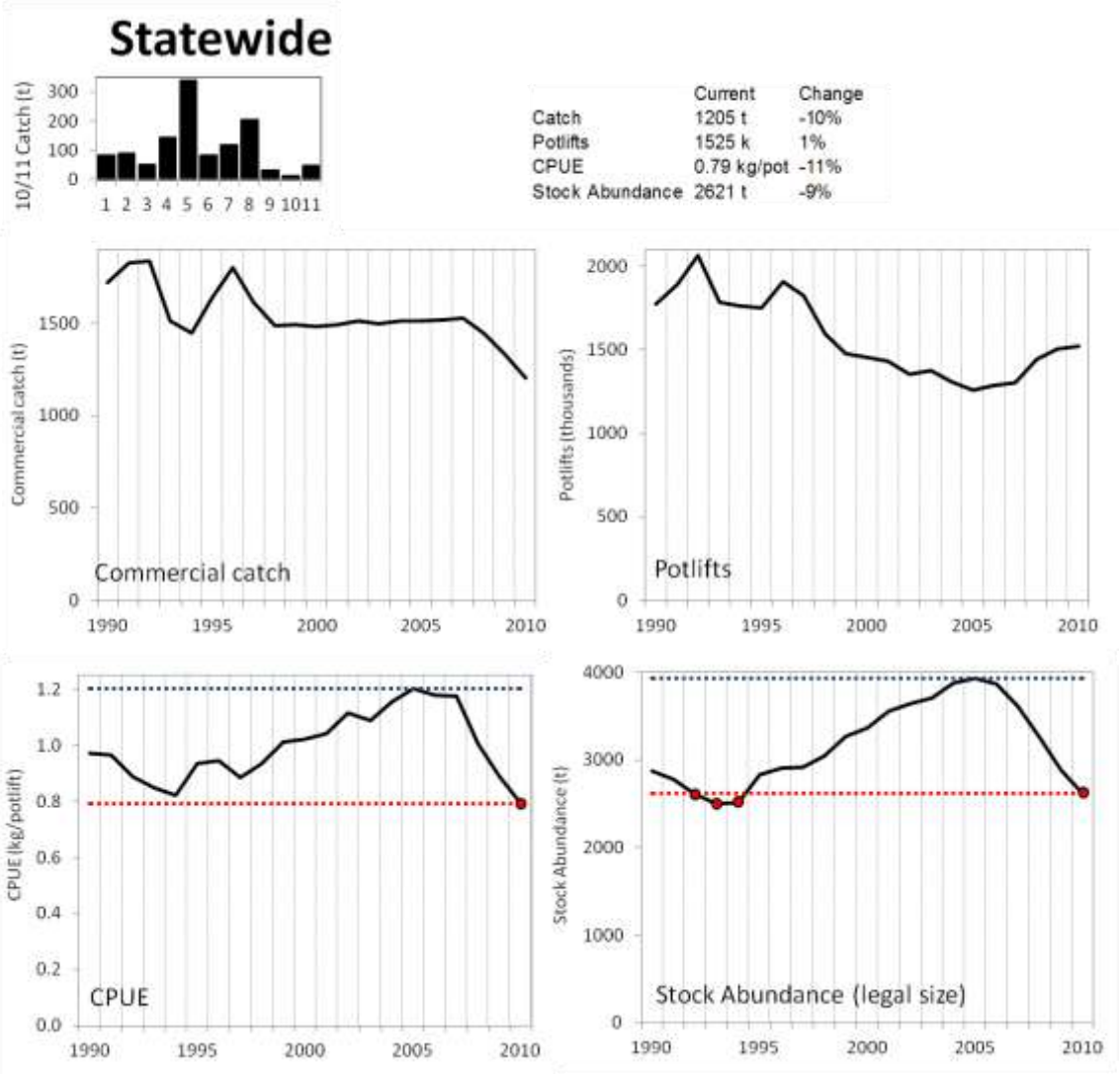


Figure 9. Whole State summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively. Note that the total catch (1205t) differs from the previously reported catch of 1222t as the two quantities are derived from different data sources (the quota monitoring system versus the catch and effort logbooks) which have some discrepancy due to the weights estimated from logbooks

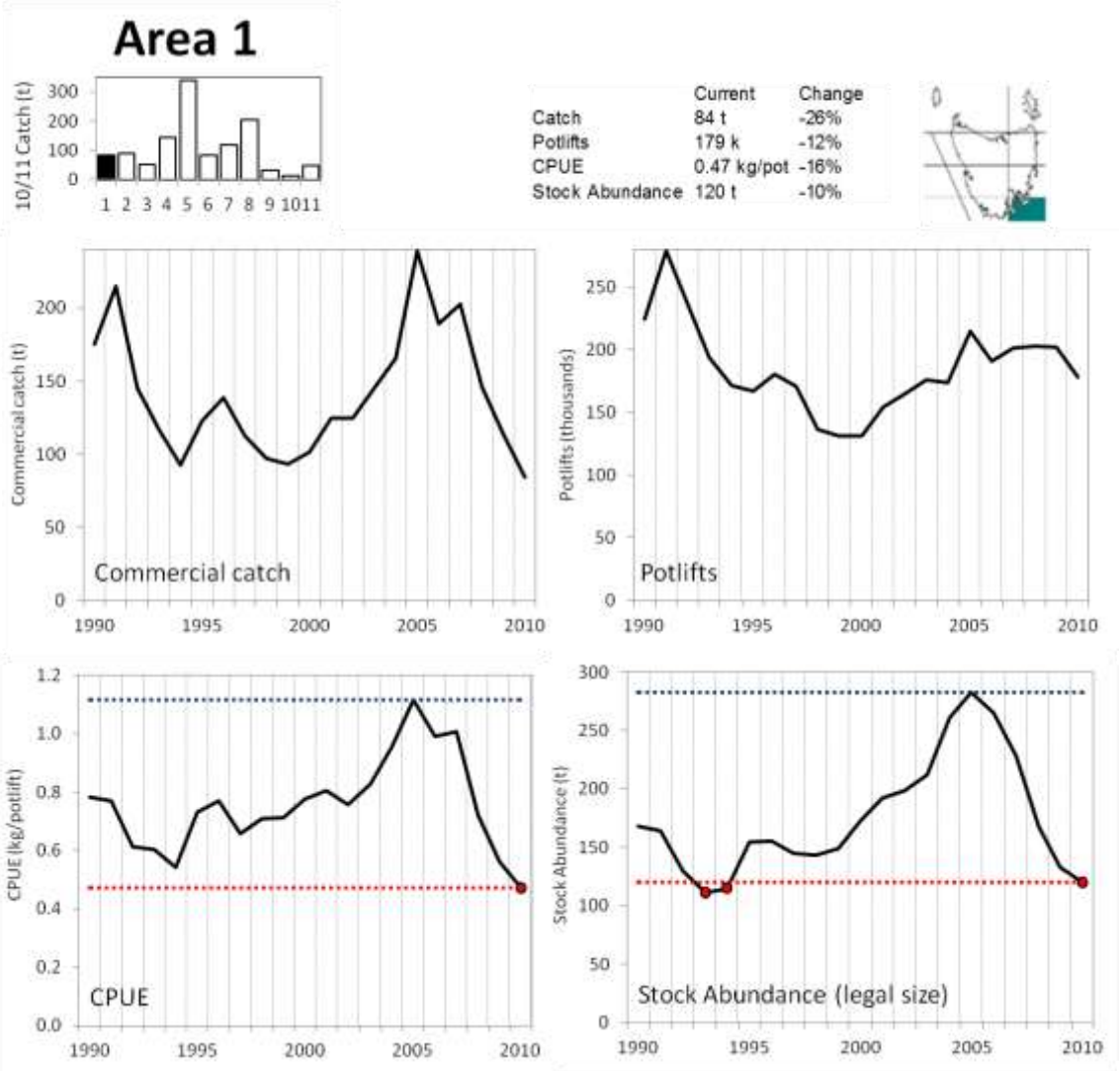


Figure 10. Area 1 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

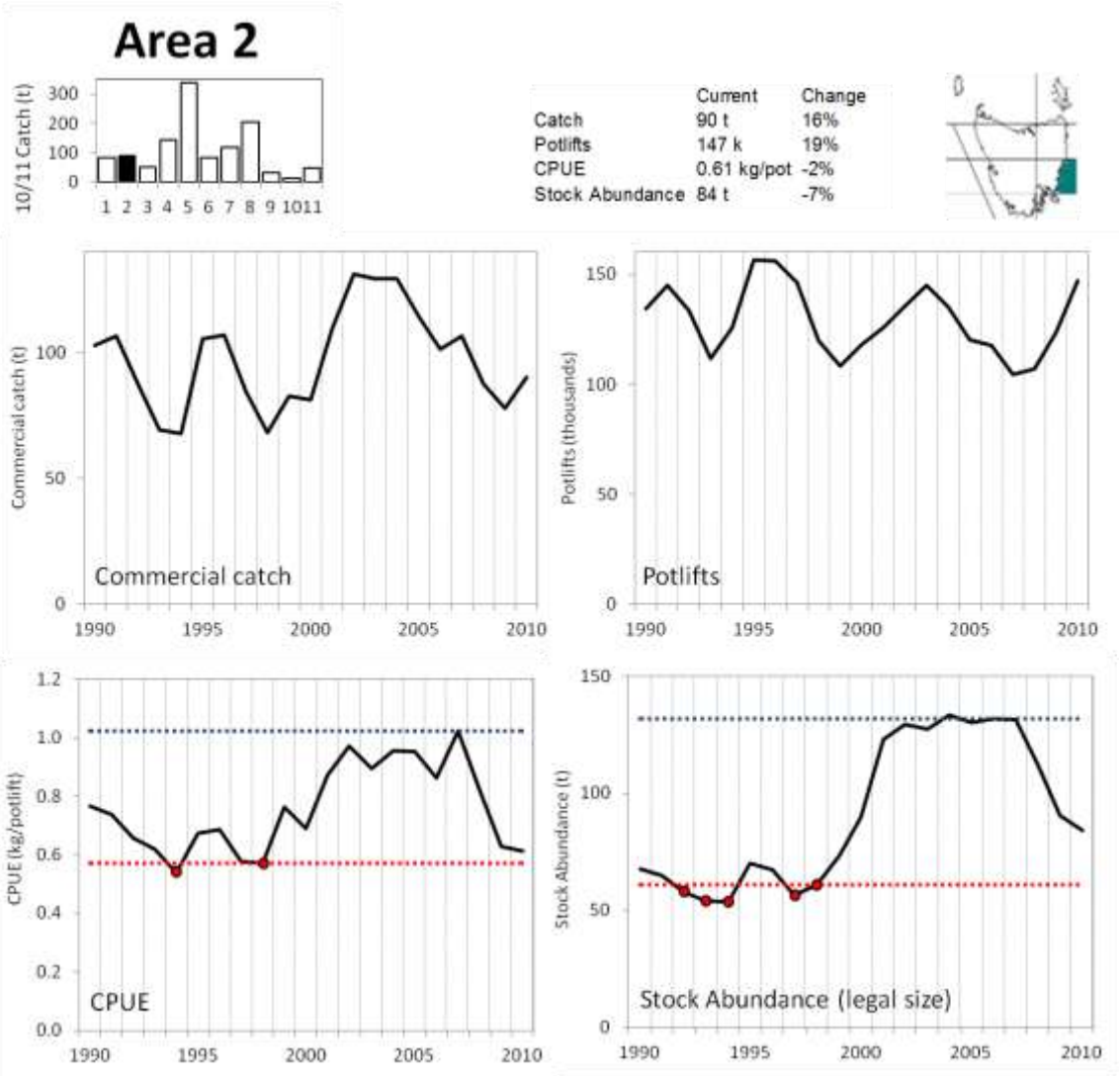


Figure 11. Area 2 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

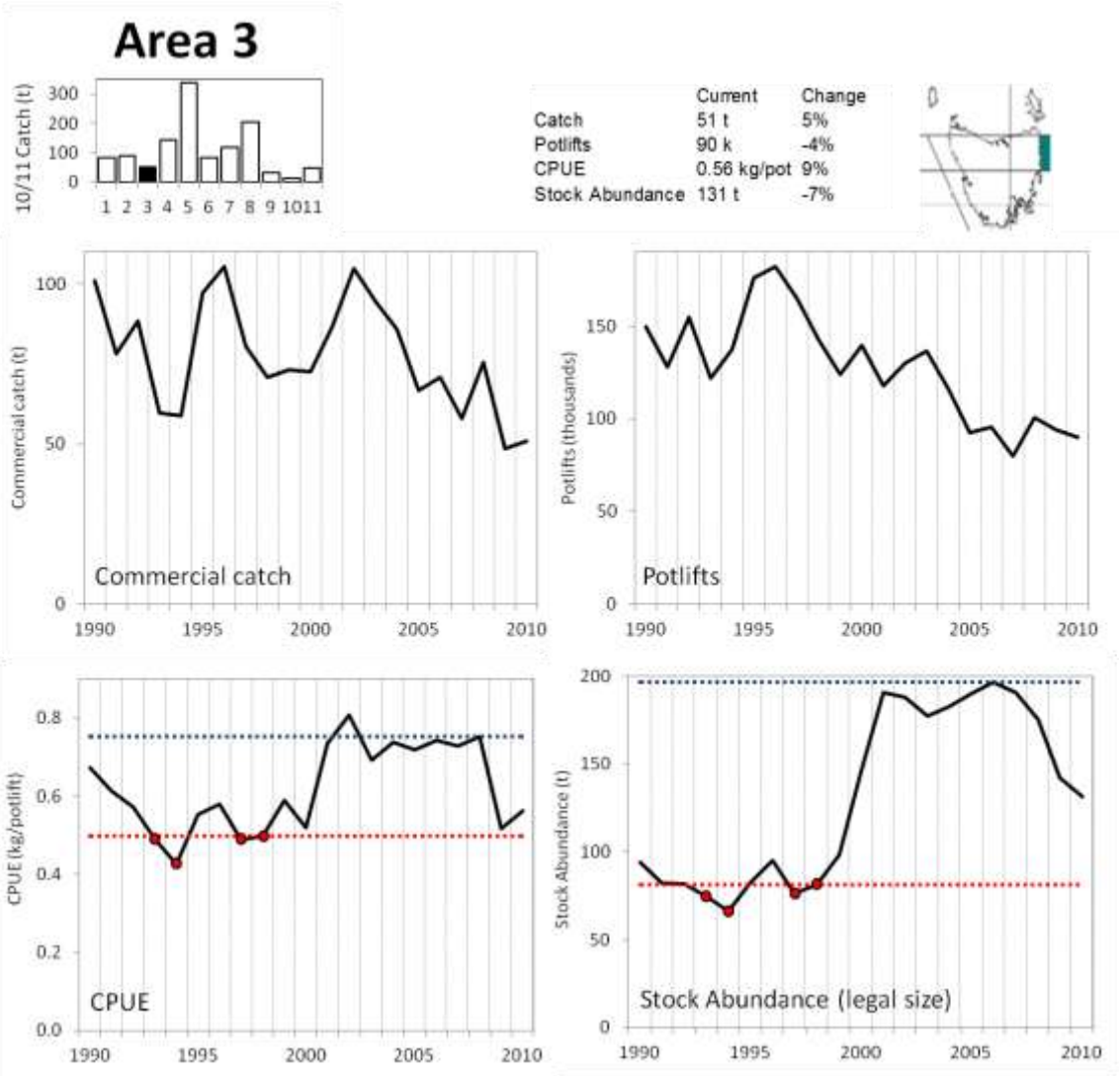


Figure 12. Area 3 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

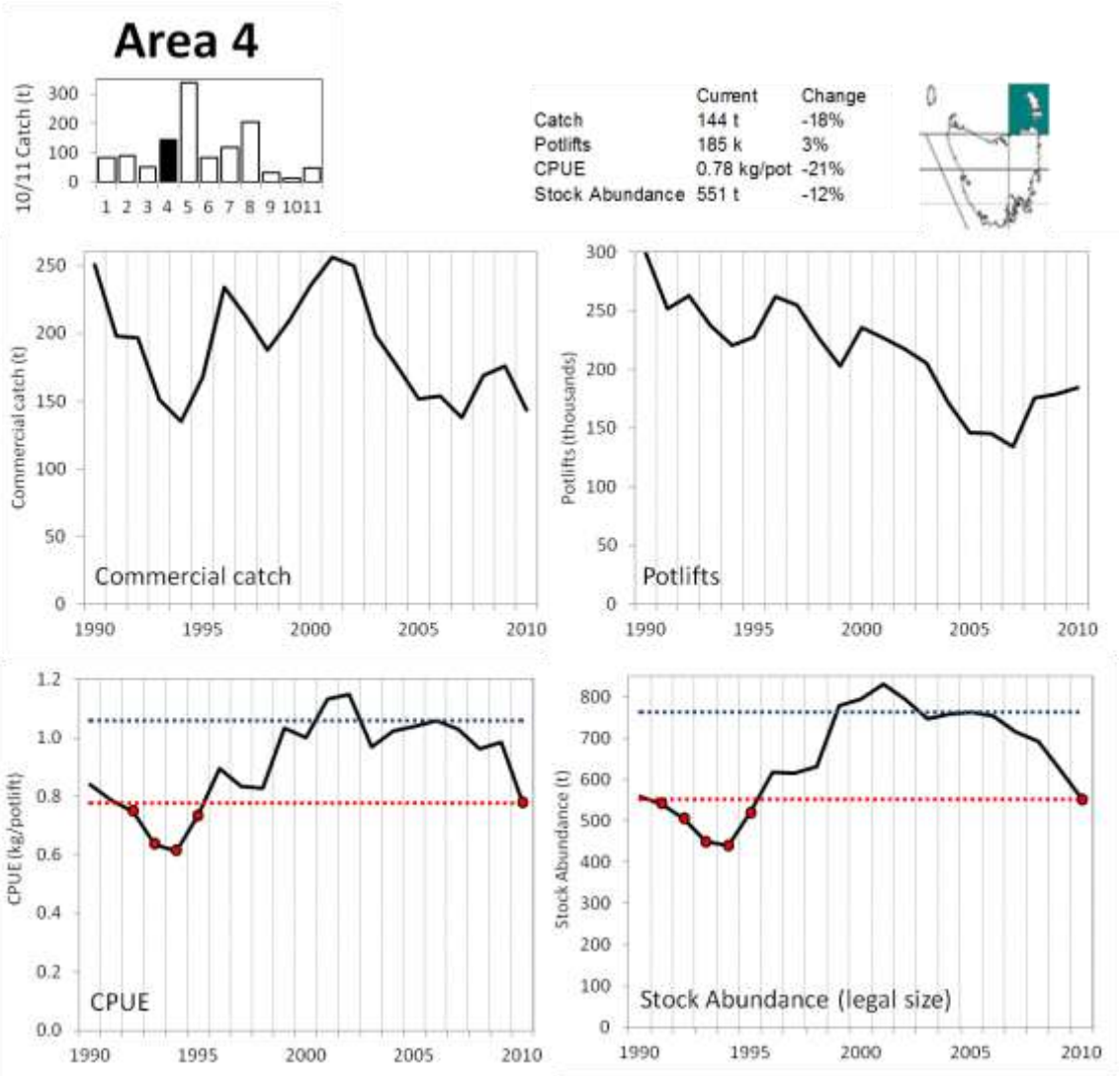


Figure 13. Area 4 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

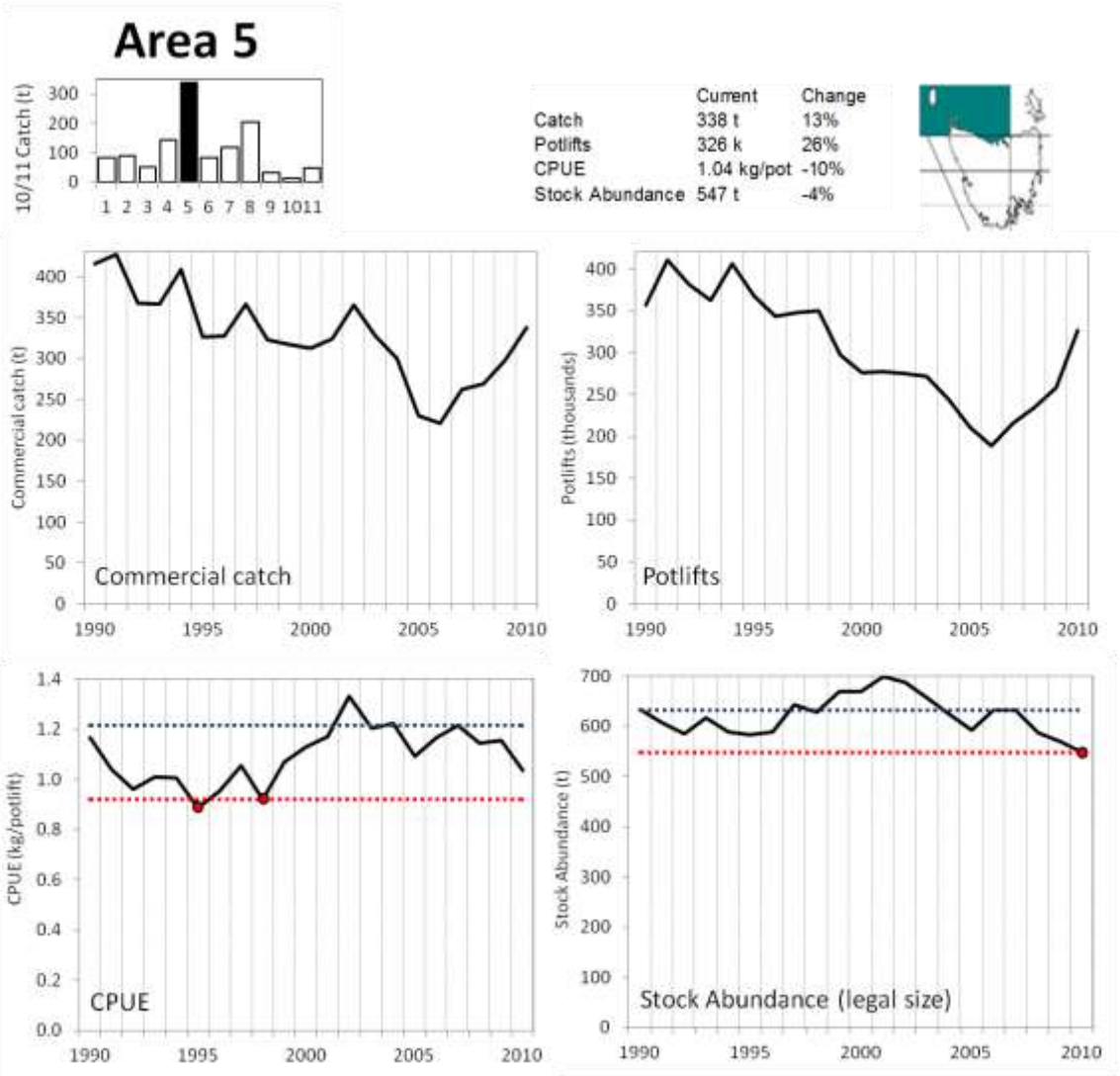


Figure 14. Area 5 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

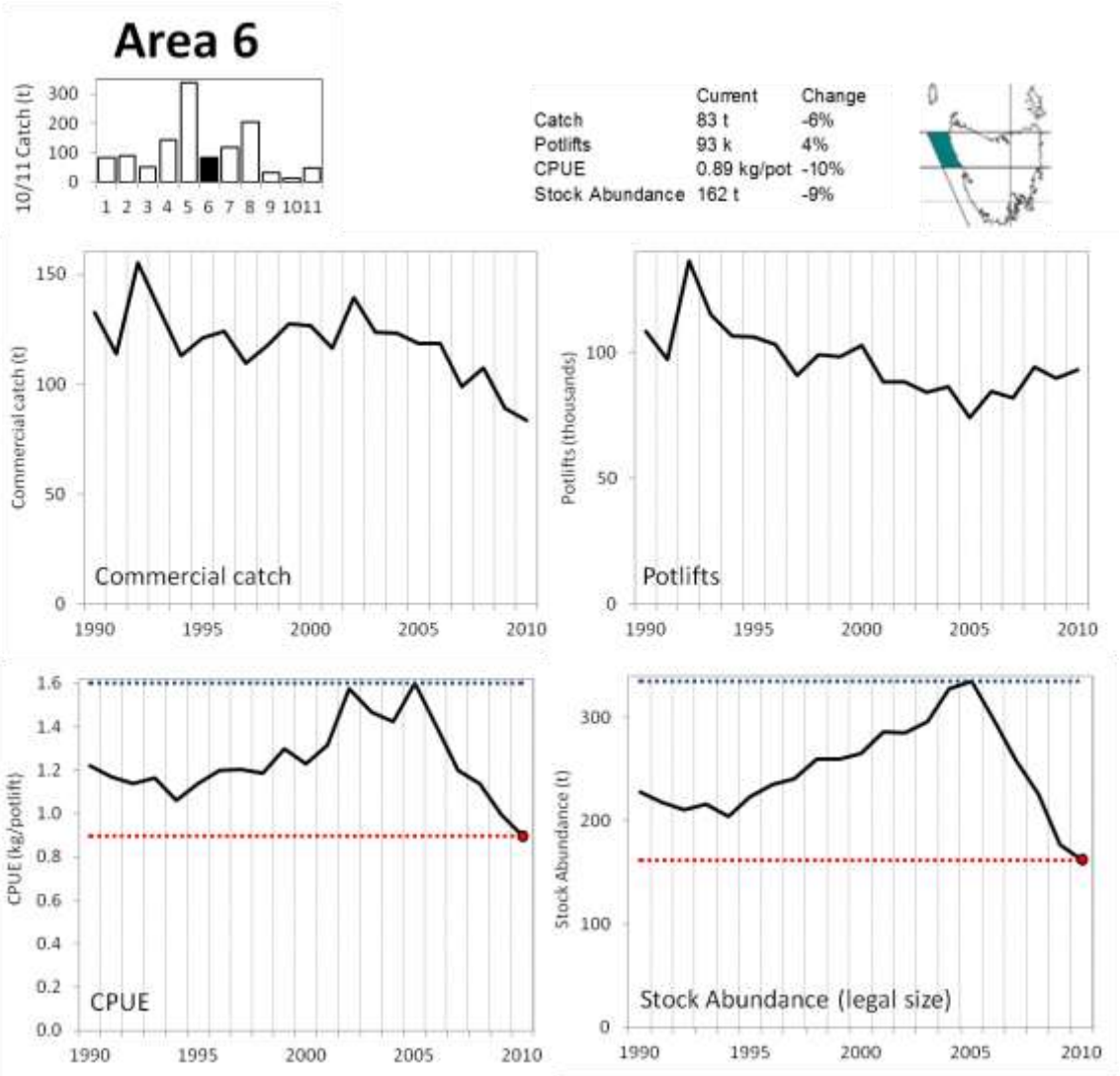


Figure 15. Area 6 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

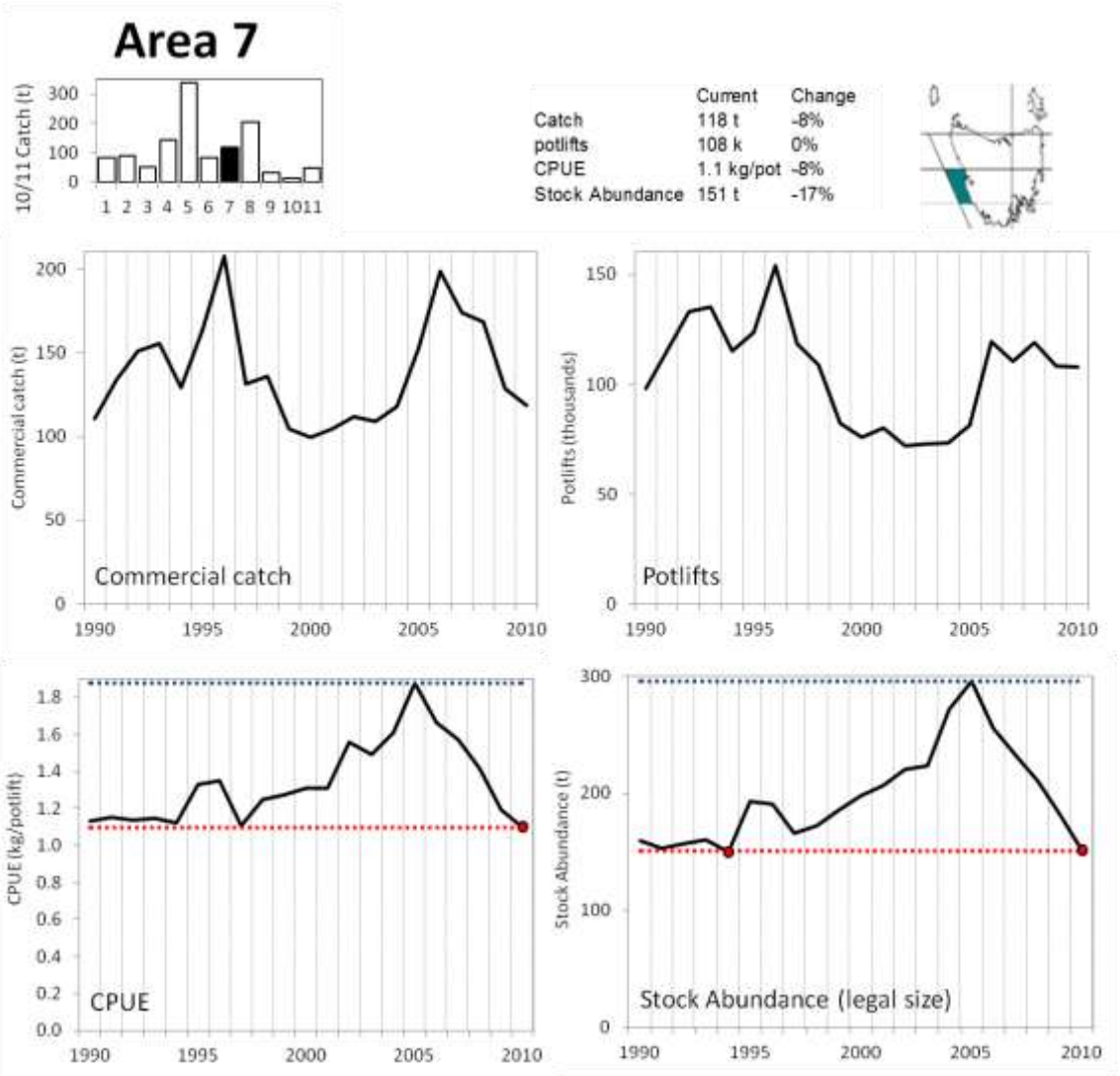


Figure 16. Area 7 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

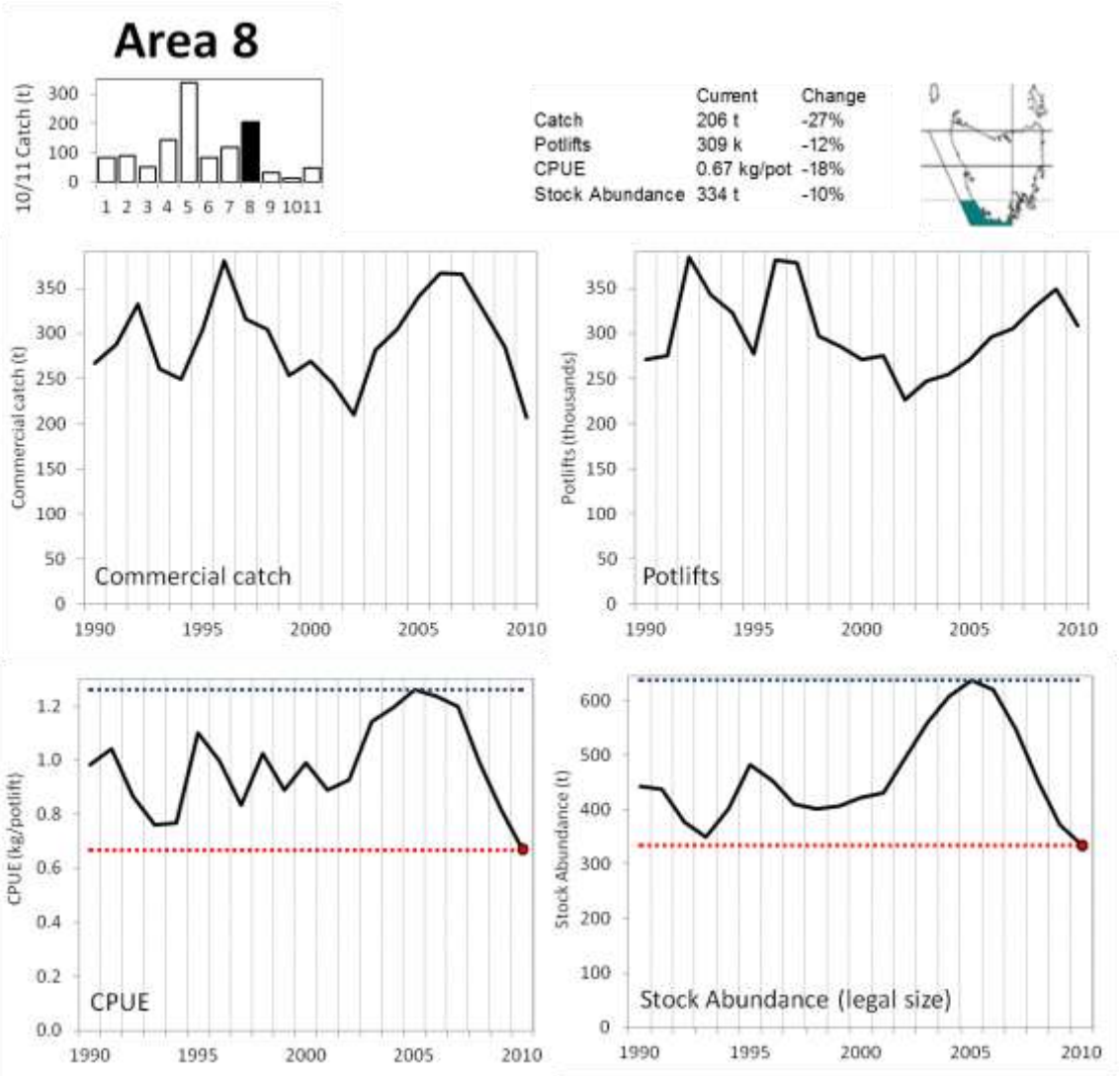


Figure 17. Area 8 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

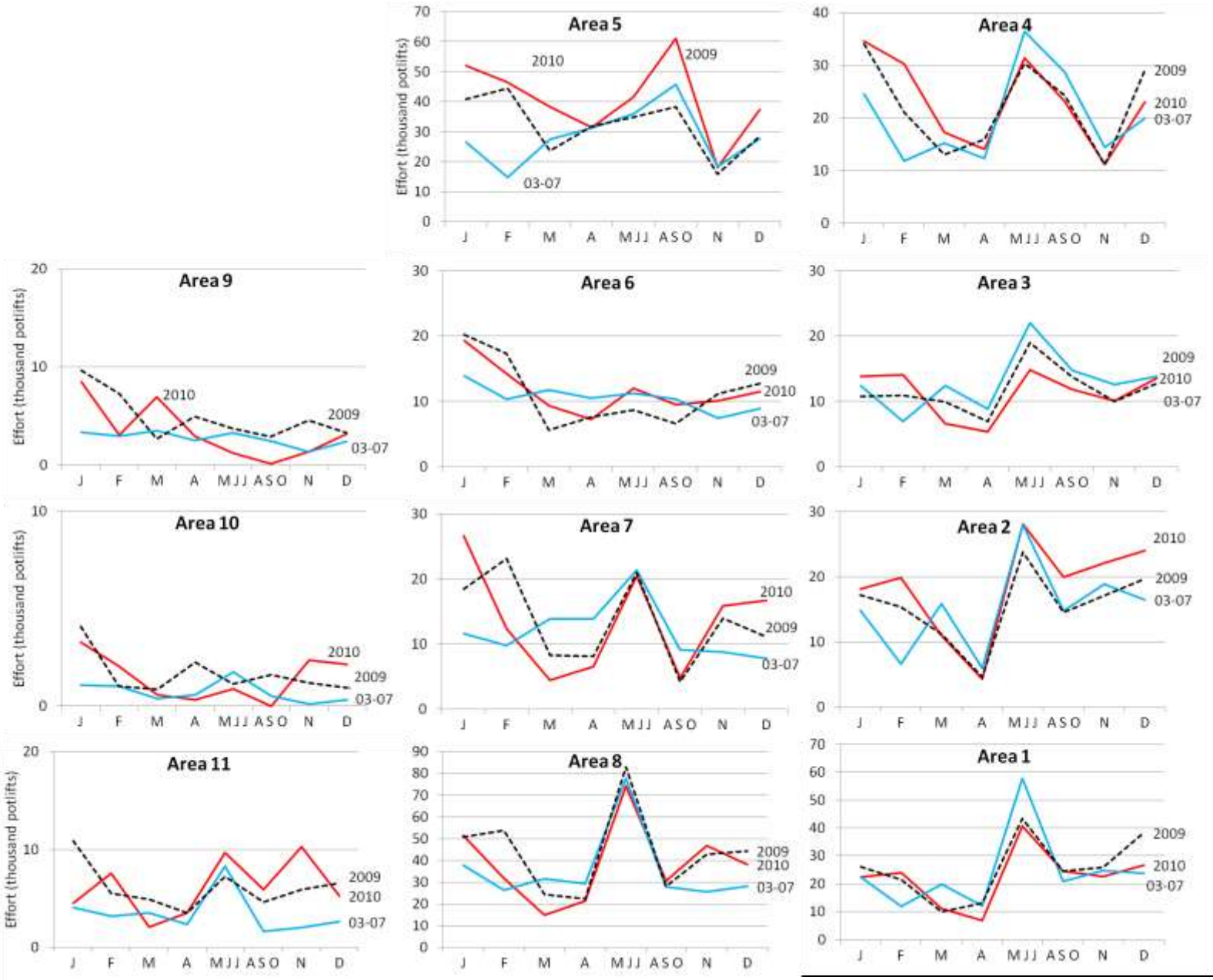


Figure 18. Monthly regional commercial effort (thousand pot lifts) for three time periods; 2010/11 (red line), 2009/10 (dashed line) and the mean of the quota years 2003/04 – 2008/09 (blue line).

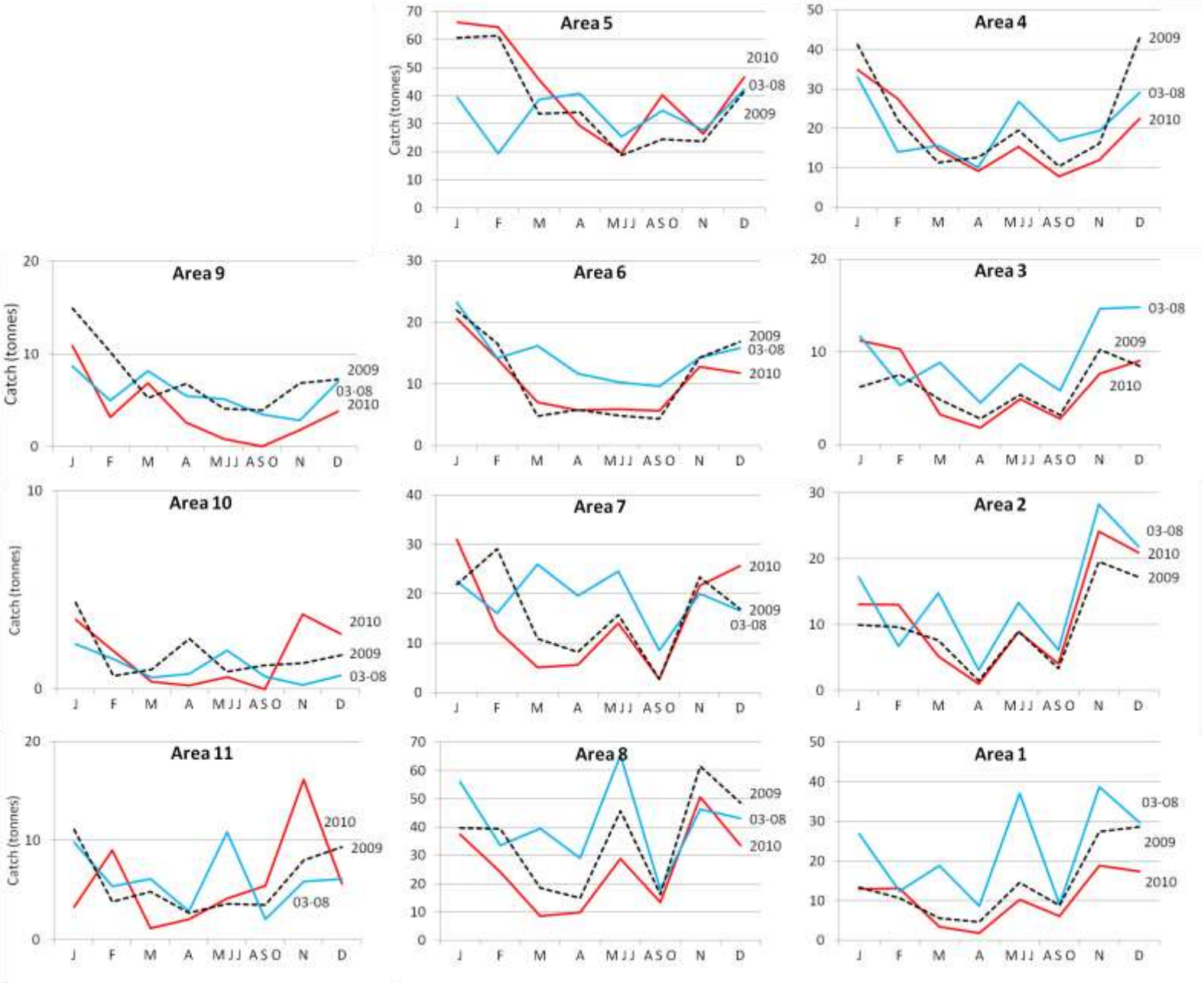


Figure 19. Monthly regional commercial catch (tonnes) for three time periods; 2010/11 (red line), 2009/10 (dashed line) and the mean of the quota years 2003/04 – 2008/09 (blue line).

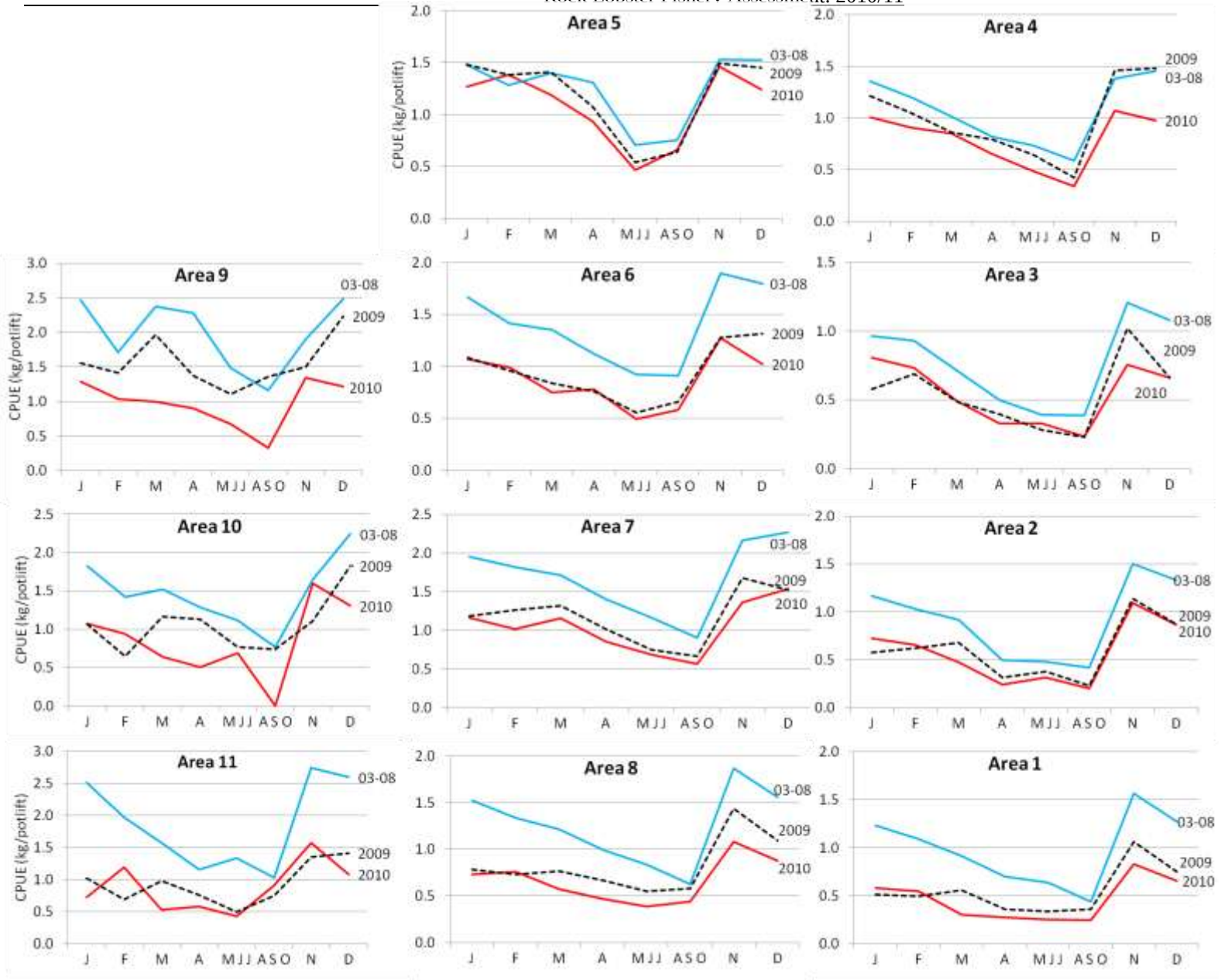


Figure 20. Monthly regional commercial catch rate (CPUE, kg/pot lift) for three time periods; 2010/11 (red line), 2009/10 (dashed line) and the mean of the quota years 2003/04 – 2008/09 (blue line).

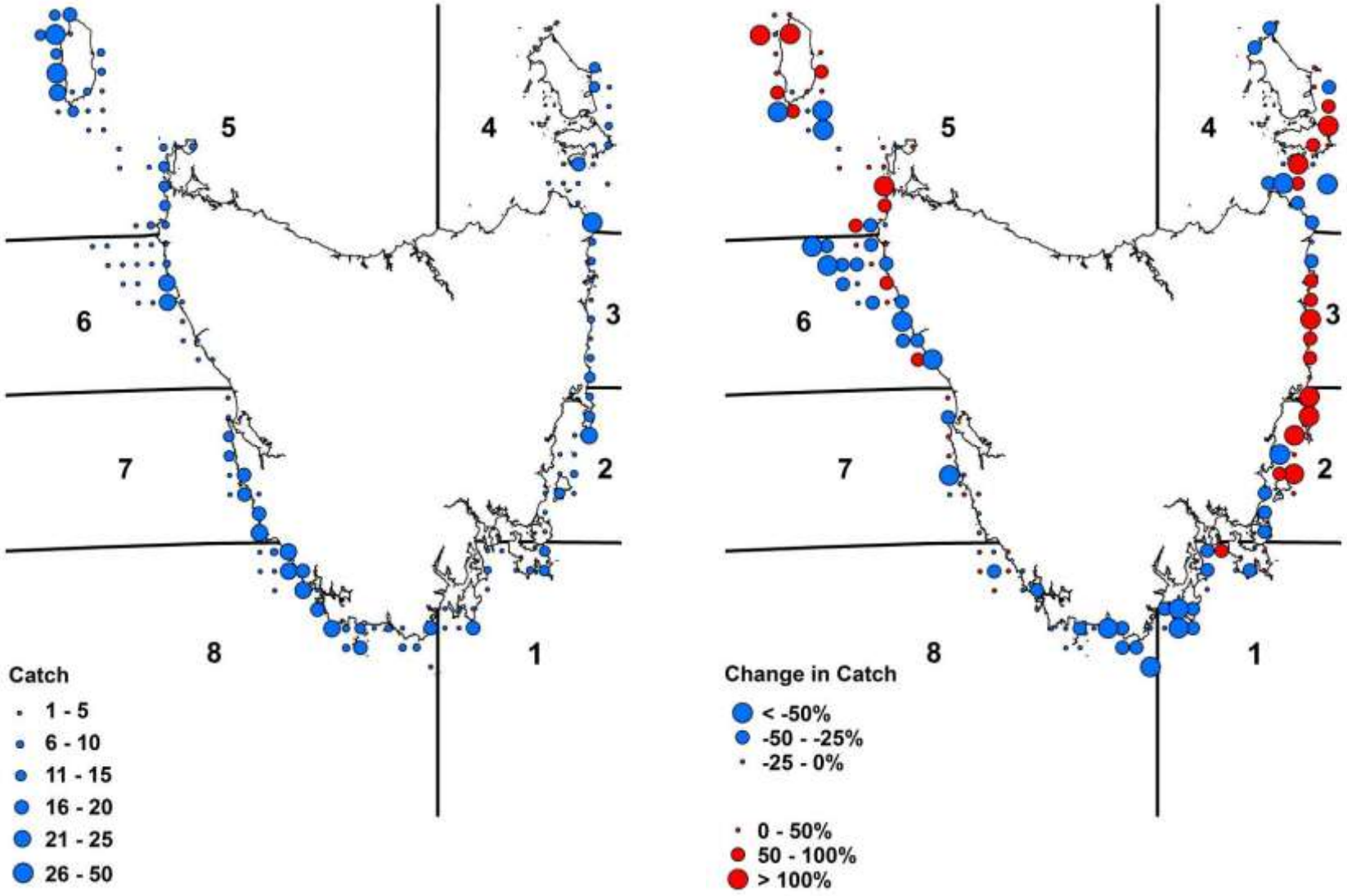


Figure 21 Left - catch in tonnes for fishing blocks during the 2010/11 fishing season. Right - percentage change in catch during the 2010/11 fishing season compared with the previous season for each fishing block. *Blocks with catch of less than 0.5 tonnes or fewer than 4 operators were excluded.*

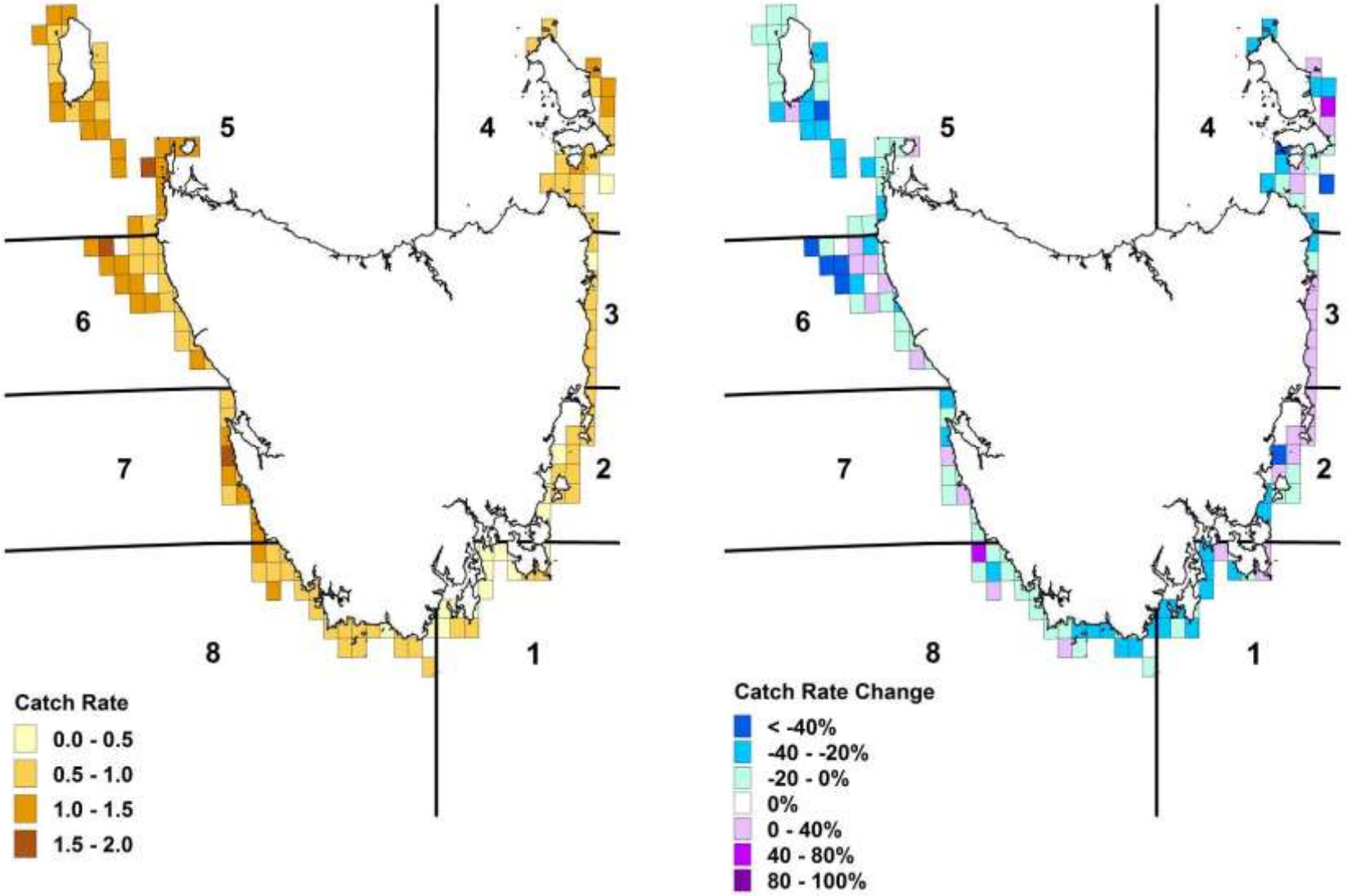


Figure 22 Left – catch rate (kg/potlift) for fishing blocks during the 2010/11 fishing season. Right - percentage change in catch rates during the 2010/11 fishing season compared with the previous season for each fishing block. *Blocks with catch of less than 0.5 tonnes or fewer than 4 operators were excluded.*

3.1.4 Mean weight

The mean weight of lobsters in catches has slowly increased in recent years in most areas, with minimum values sometime between the mid and late 1990s (Figure 23). This is a complex performance measure to interpret because an increase in average weight could be due to reduction of fishing mortality or reduction in recruits. Nonetheless, trends in the NE are consistent with the low recruitment discussed elsewhere.

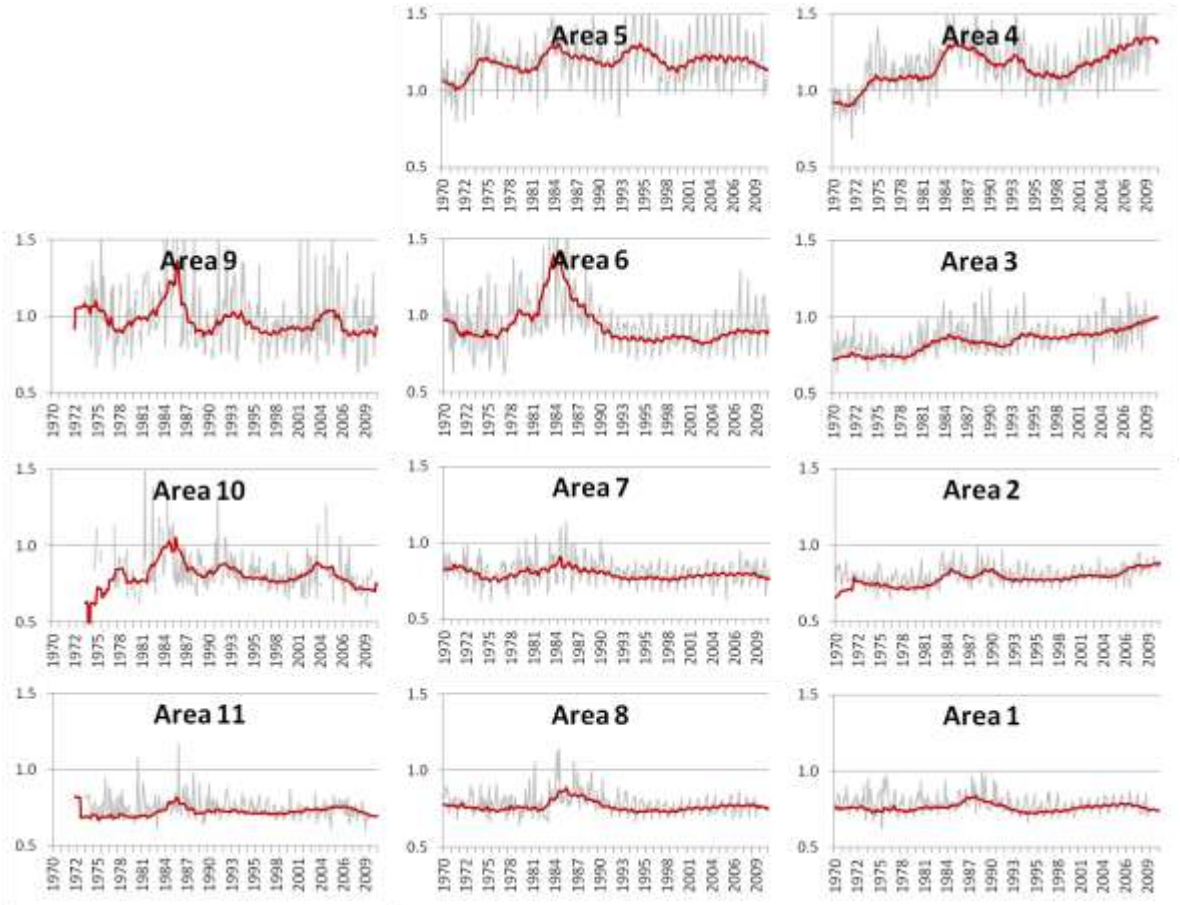


Figure 23. Mean weight of lobsters (red line) by quota year and assessment area. Monthly trend shown in grey with 12 month average in red.

3.1.5 Non-quota commercial catch

Non-quota commercial catch occurs in three ways: personal use provisions, well mortalities, and octopus mortalities. Formal reporting of personal use provisions and well mortalities was introduced in 2003/04, while octopus mortalities have been reported since 1992/93.

Reporting was introduced so that firm data could be collected on the scale of these activities. In particular, there were a few instances of well mortalities being discarded and the scale of this loss was questioned. This practice would lead to the under-estimation of commercial catch in the assessment process. The introduction of mandatory reporting of these discards without penalty provides a more objective basis for examining the scale of this potential source of mortality.

Personal use in 2010/11 was not significant at 2.6 t, down from 3.5 t in the previous year (Figure 24). These lobsters are mainly sick animals or octopus kills that were unsuitable for sale into the live market.

Reported well mortalities were trivial at 0.1 tonnes, down from 0.7 tonne in the previous year.

Octopus mortalities have been relatively steady since 2004 with an average of 42,800 lobsters per year, which equates to 2.35% of the number of lobsters retained. Total number of lobsters reported killed by octopus in the last year was 36875, which was a 16% decrease from the previous year but still average over the longer period (Figure 25).

Retained and sold commercial catch accounts for the majority of fishing removals followed by recreational catch and then mortality due to octopus in commercial pots. Other sources of mortality including discard mortality are essentially trivial and in the model assumed to be negligible. Non-quota well mortalities reported during 2010/11 was 131 individual lobsters.

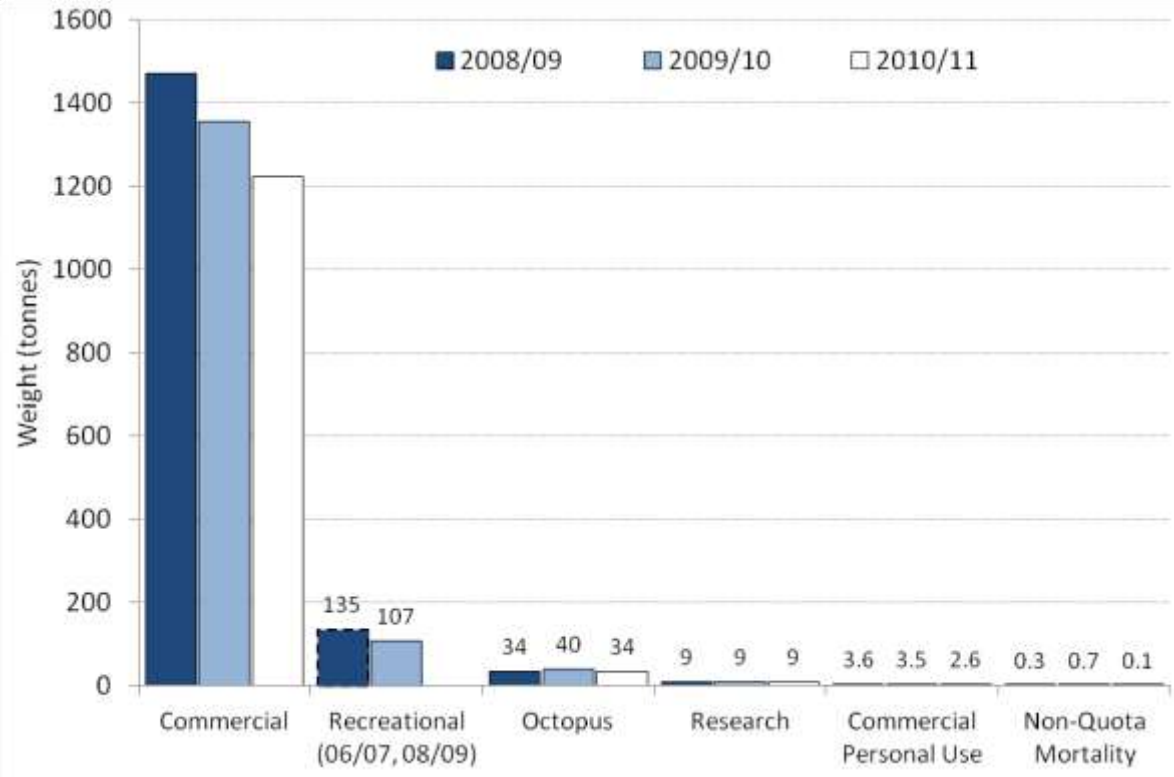


Figure 24. Different sources of lobster mortality during 2008/09, 2009/10 and 2010/11.

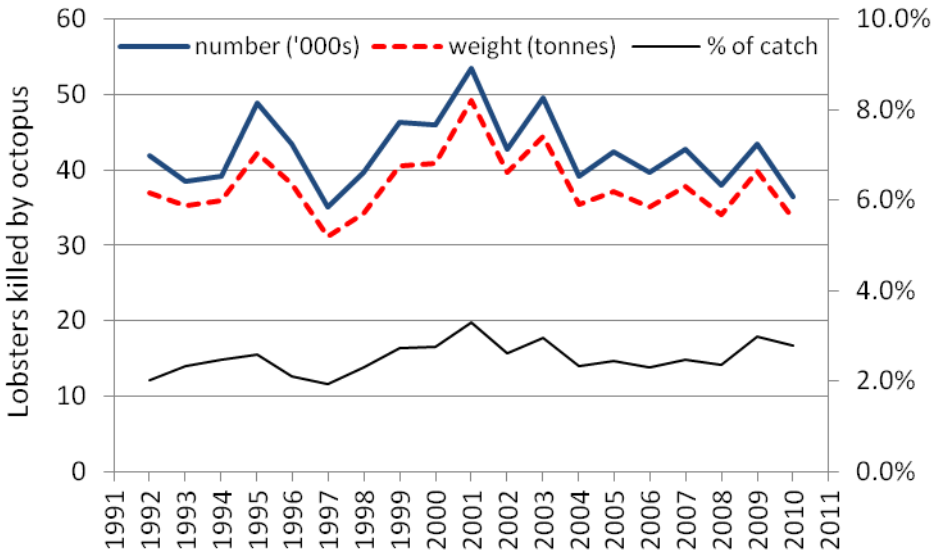


Figure 25. Trends in reported lobster mortalities due to octopus predation. The average mortality rate equates to 2.35% by number. Mortality in tonnes is calculated using the average weight of lobsters for each year.

3.1.6 Research quota

Research in the Tasmanian rock lobster fishery is partially funded through the allocation of 1% of the TACC. A total of 15 tonnes were utilised in 2008/09 and 2009/10. Of this, 10.5 tonnes were leased to fund at-sea data collection for fisheries research. The balance (4.5 tonnes) was leased to fund market research activities of the commercial sector.

3.2 Recreational catch

The most recent published recreational survey of rock lobster catches was for the 2008/09 fishing year (Lyle, 2010). The total number of recreational licenses for rock lobster decreased over the past year by 1,000 to 19,530 and this decrease was seen across the three licence types (Figure 26).

Estimated recreational catches increased steadily each survey from 1992 until 2002/2003 after which they appear to have increased in 2006/07 and declined to 107 tonnes in the latest survey in 2008/09 (**Error! Reference source not found.**). The majority of the recreational catch comes from the East coast.

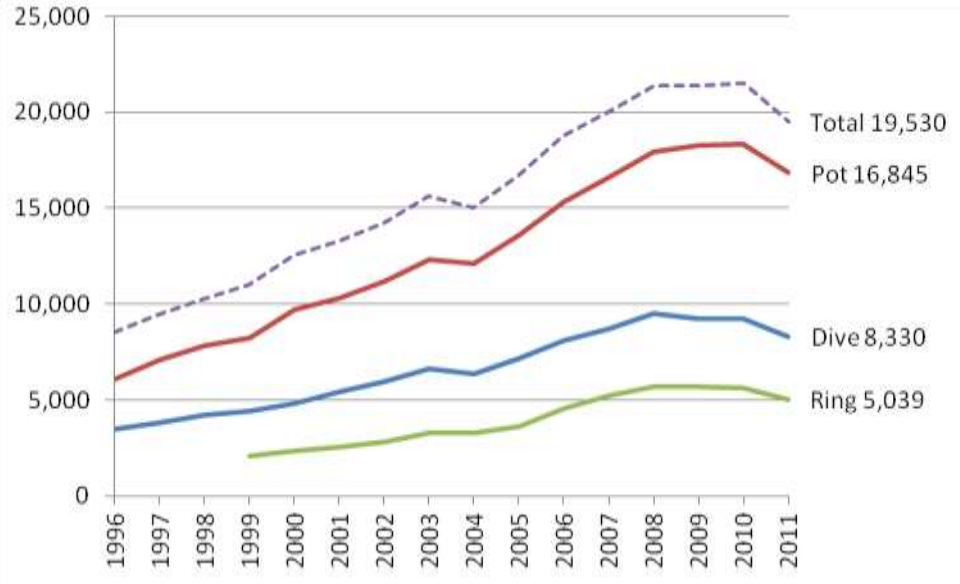


Figure 26. Trends in recreational rock lobster licenses. Fishers may hold licenses for more than one type of rock lobster gear type.

Table 7. Estimated total weight (tonnes) of recreational catches by area and season. The recreational surveys were usually conducted over a fishing year (November until October – with September and October assumed closed to recreational fishing). However, these figures have now been associated with given quota years. Spatial resolution of the surveys has increased through time.

Area	1996/97	1997/98	2000/01	2002/03	2004/05	2006/07	2008/09
1	39.533	35.355	51.891	43.596	42.777	51.271	24.506
2	20.403	13.173	26.988	29.211	16.113	13.520	18.702
3				21.318	15.781	16.246	18.648
4	6.0075	4.813	19.57	13.506	7.343	20.896	17.060
5	10.381	8.058	6.272	17.595	17.437	13.824	8.270
6	13.361	8.271	22.084	11.866	8.225	11.435	8.434
7				5.497	7.889	5.943	7.130
8				5.937	3.791	1.932	4.276
Total	89.686	69.670	126.805	148.526	119.356	135.067	107.027

3.3 Assessment model analysis

Risk assessments for the Tasmanian lobster fishery were conducted by projecting the dynamics of the stock forward under various TACC scenarios and determining the possible consequences. Economic information on cost and price data from 2010 is also included in these projections including economic yield or the earnings from the fleet after costs have been paid. This does not include lease payments in costs of fishing because these are a rent payment which increase as the fishery becomes more profitable.

Detailed documentation on the modelling procedure and data inputs is available from IMAS. Assumptions are listed in that documentation but critically include:

- recreational and illegal catch does not increase as catch rates rise through stock rebuilding;

- the commercial fleet continues to move between areas in response to catch rates in the same manner as they have done since 1998;
- the biology of lobsters (especially growth and mortality) is constant through time; and
- critically, future recruitment will fall within the range of previous observed recruitment levels for data fitted from 1984 to 2009, i.e. that the recent period of low recruitment was a random event rather than a regime shift.

Projections of the fishery are based upon a randomised recruitment series, taken from years of average recruitment from 1999-2008 (see 3.3.2). If such projections are repeated many times it becomes possible to address questions such as the proportion of legal biomass projections in five years that will be greater than the legal biomass in 2010/11, given a particular TACC. If the result is 50% this suggests that the chance of the stock rebuilding is equal to the chance of the stock declining.

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. This produces the legal size stock abundance estimates. Future TACC options from 90kg to 110kg were modelled for this assessment.

3.3.1 Reference Points

Reference points were chosen to enable a quantitative comparison between different TACC options against limits and targets. They help to define stock outcomes under various harvest strategies. Limit reference points are a defined point or 'bottom line' to keep the stock above and the target reference points are a goal to aim towards.

The lowest stock level was in 1993/4 and it would seem undesirable in relation to all the fishery management objectives to allow levels of catch that drive the stock towards this extreme low point, which prompted major management changes in 1998. The stock increased from this low point in response to a combination of constraints in the catch and above average-recruitment of juveniles. The stock decline since 2006 has been due to below average levels of recruitment and levels of catch that have eroded the previous stock rebuilding gains. Looking forward, there is no guarantee that recruitment levels will improve in the short – medium term. The Department considers it would be a high risk management strategy not to set catch levels that have a very high probability (> 90%) of keeping Statewide stocks (and in most areas) above the 11 year low point in 5 years (2016).

The target chosen for this assessment is to build Statewide stocks back to the 2005/06 level (the most recent peak stock abundance), in a reasonable time frame 8 – 10 years, with a >70% probability. This target has been chosen on the basis that it is a point that most stakeholders have in recent memory as being 'good' in terms of the fishery. Aiming for a shorter time frame would require greater catch reductions for both sectors. Rebuilding over a longer timeframe comes at the cost of lost years of profitability, greater risk of future exposure to periods of low recruitment and reduced capacity for rock lobster stocks to help control the expansion of Centrostephanus urchin barrens.

Escalating effort and lower catches have led to significant declines in Statewide and regional catch rates. The resulting increase in costs of fishing impacts on the overall profitability of the catching sector as a whole and, therefore, the returns to the community associated with having a profitable commercial sector.

Catch rate is used as a performance measure because it has both a close relationship with legal size stock abundance and is a meaningful economic indicator for the commercial sector because it is a direct factor in costs and profit. The catch rate limit reference point in the assessment is defined as having a 90% probability of keeping the Statewide catch rate above an 11 year low point within 5 years time (by 2016). The catch rate target is a 70% probability of a Statewide catch rate of 1.2 kgs per pot lift in 10 years, and area catch rates equivalent to the 2005/6 period.

Tasmanian rock lobster egg production has no clear link to future recruitment but is an important management consideration because very low levels of egg production would be expected to affect recruitment at some point. For this reason only a limit reference point has been chosen. That is, Statewide egg production limit is to have a 90% probability of being above 25% of virgin egg production in 5 years. Area egg production limit is to have a similar limit expect for the northern areas (4 and 5) which have a 20% limit.

3.3.2 Recruitment assumption

The model projects forward in time to determine the effect of proposed management strategies on the fishery and this requires knowledge of 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 estimates historic recruitment data using commercial catch data and length-frequency data collected by observers and scientific sampling. An important consideration when projecting forwards is from what range of years historic recruitment should be used. 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 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.

The model cannot predict future recruitment, so to consider the future of the fishery with different management actions, an historic average level of recruitment is chosen. The recruitment time period chosen is the 10 year period 1999-2008. If actual recruitment in the future is less than the average chosen, future stocks and catch rates will be lower than projected by the model. Conversely if future recruitment is better than the average chosen, future stocks and catch rates will be higher than projected.

3.4 Assessment model results

3.4.1 Biomass

Statewide exploitable biomass has rapidly declined since the high reached in 2005 and 2006 and is now only 5% greater than the lowest level since 1984; is the lowest since the introduction of QMS; and is 9% lower than previous year (Table 8).

Table 8. Legal-sized biomass estimates from 2010/11 compared with a) the previous year 2009/10, b) the year with the lowest biomass since 1984 and c) the lowest biomass since 1998 (introduction of QMS). Negative values in last column show percentage reductions in biomass during the past year. * denotes that 2010 is lowest on record.

	Lowest		Lowest						
	Year		Year		Biomass (tonnes)		% change in 2010/11		
Area	Since 84	Bio-mass	Since QMS	Bio-mass	2009/10	2010/11	Vs >1984	Vs >1998	Vs 2009
State wide	1993	2,499	2010	2,621	2,879	2,621	5%	*	-9%
1	1993	111	2010	120	133	120	8%	0%	-10%
2	1994	54	1999	73	90	84	57%	14%	-7%
3	1994	66	1999	98	142	131	99%	34%	-7%
4	1994	439	2010	551	624	551	25%	*	-12%
5	2010	547	2010	547	570	547	*	*	-4%
6	2010	162	2010	162	177	162	*	*	-9%
7	1994	150	2010	151	182	151	1%	*	-17%
8	2010	334	2010	334	372	334	*	*	-10%
9	2010	179	2010	179	205	179	*	*	-13%
10	2010	21	2010	21	23	21	*	*	-7%
11	1993	173	1999	232	361	342	98%	47%	-5%

Statewide legal size biomass projections with 50% probability show that at all levels of TACC the biomass remains above the limit reference point however, at the required 90% probability, TACC's of 105 and 110 kg/pot failed to exceed the limit reference point within five years (2016; Figure 27). The Statewide target reference point was only met within the 10 years with TACC's of 90 and 95 kg/pot (bottom, Figure 27).

During 2010/11, estimated legal sized biomass only increased in areas 1 and 5 with areas 4,6,7 and 9 at the lowest levels since 2000 (Figure 28). Recent declines have undone all increases in legal size biomass observed since the start of the QMS system in 1998.

At the Statewide level, the current TACC of 105kg/pot does not meet the low level of risk (<10%) of stocks declining further towards historic lows and has less than a 50/50 chance of rebuilding stocks to a reasonable level in the medium term. A TACC of 100kg/pot has a very high probability of keeping stocks above the 11 year low point but does not meet the rebuilding targets at the defined 70% probability. A TACC of 90 kg/pot is the only option to meet the limit and target reference points (Table 9).

Areas respond differently to changes in the Statewide TACC with some rebuilding more rapidly (Figure 28). Area 1 remains above the limit reference point at all levels of TACC

however areas 4 and 6 fail to reach the limit at 90% probability even at the lowest TACC of 90 kg/pot (Figure 28, Table 9).

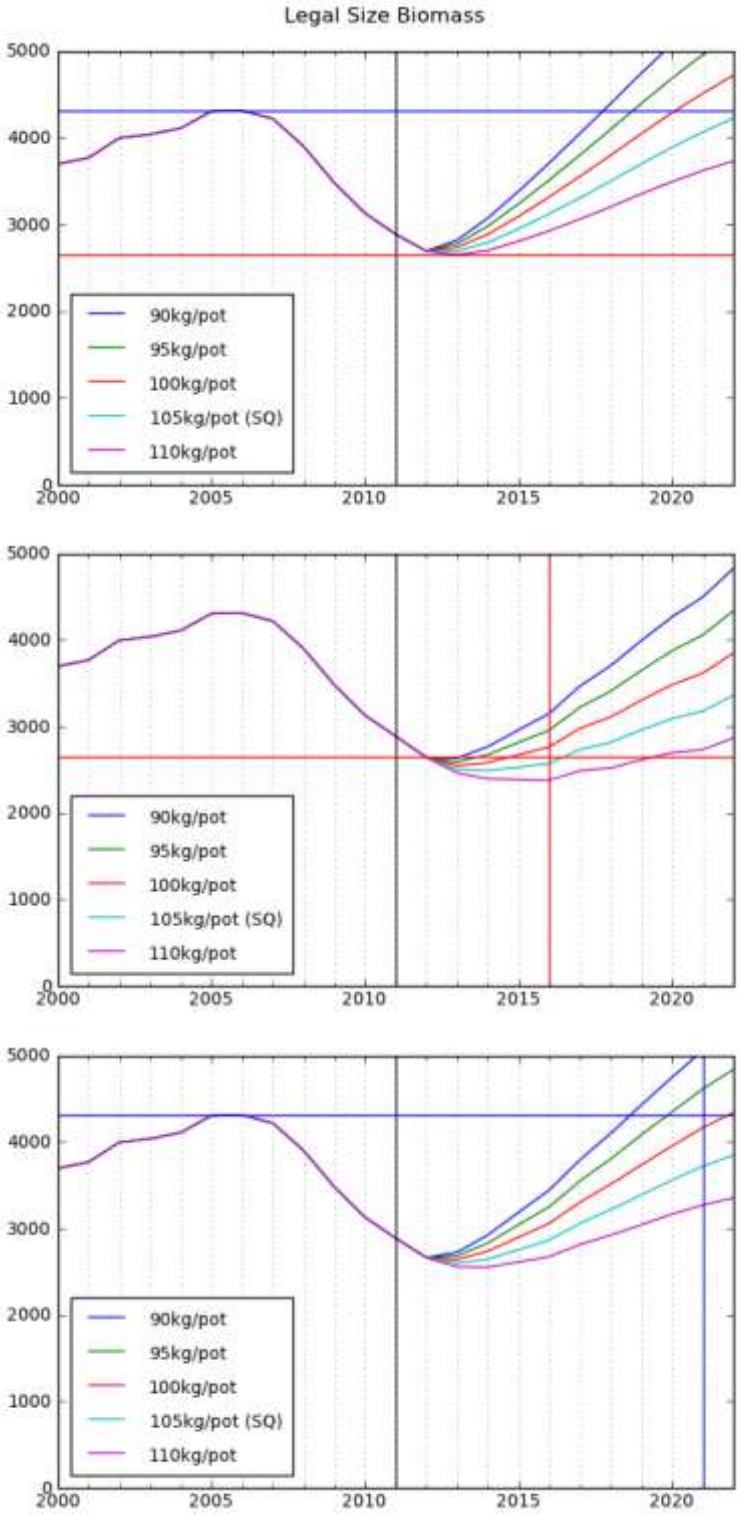
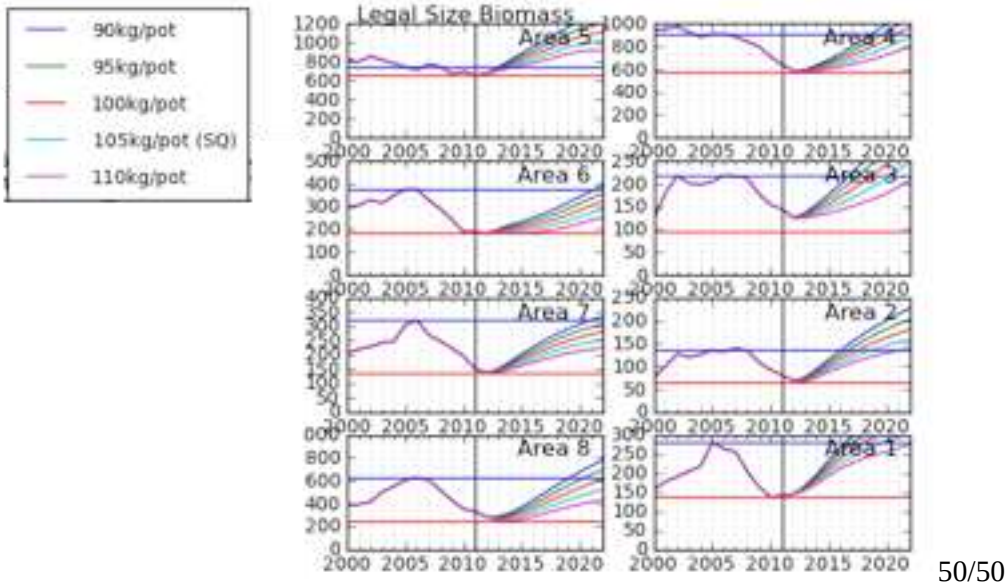


Figure 27 Statewide legal size biomass projections showing the limit and target reference points with 50% probability projections (top); limit reference points with 90% probability (middle); and target reference points with 70% probability (bottom). Horizontal lines – target (blue) and limit (red) reference points. Vertical black line – current year; vertical red and blue lines – timeline for limit and target.



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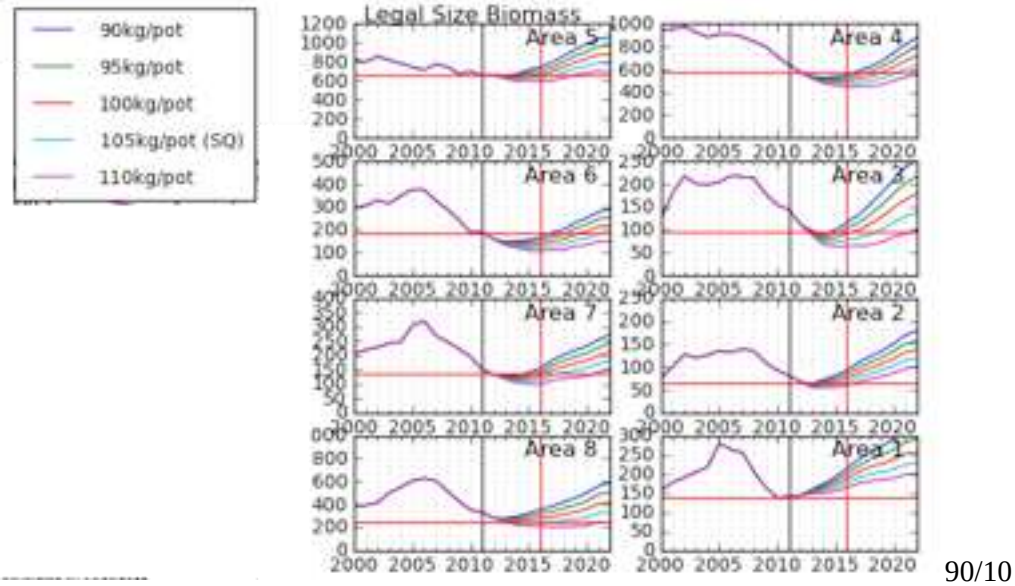

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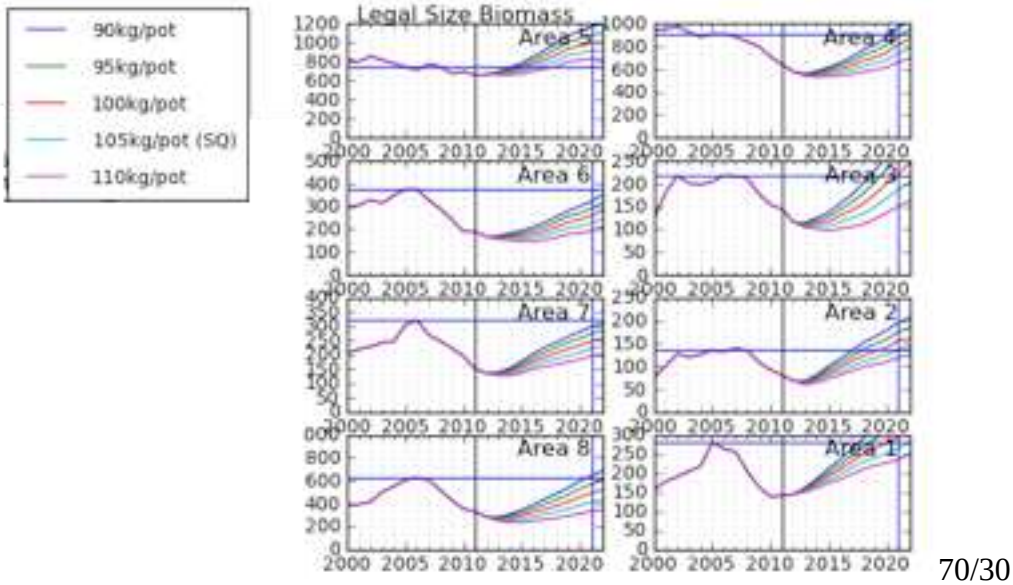

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Figure 28 Legal size biomass projections for each area with a TACC from 90-110 kg/pot. Vertical black line is the current year; vertical and horizontal red lines show limit reference points and blue line show target reference points. Plots show projections at 50% (top), 90% plotted against limit reference point (middle) and 70% probability plotted against target reference point (bottom).

Table 9. Probability of meeting the limit and target reference points in each stock assessment area. Note the west coast deepwater areas (9,10,11) have not been included in the area tables because a very low proportion of catch is currently taken from these areas.

	Legal Size Stock Abundance Reference Points (2016)									
	Limit Reference point					Target Reference point				
	90kg	95kg	100kg	105kg	110kg	90kg	95kg	100kg	105kg	110kg
State	100	99	94	85	69	95	83	58	39	14
Area 1	100	100	100	100	100	95	91	78	60	36
Area 2	100	100	97	92	87	96	95	88	72	48
Area 3	95	93	88	79	73	93	86	74	52	35
Area 4	85	81	74	65	56	75	66	48	34	19
Area 5	98	97	93	88	82	99	99	97	94	85
Area 6	85	76	68	60	47	44	31	19	10	6
Area 7	96	92	88	82	78	51	31	15	7	3
Area 8	100	97	90	71	48	74	56	34	22	9

3.4.2 Egg production

Rock lobster egg production has no clear link to future recruitment to the fishery but is nonetheless an important management consideration. This is because very low levels of egg production are expected to affect recruitment at some point. 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 Tasmanian recruits mainly originate from elsewhere (SA and Vic.)
- Variation in current movement between years suggests that no one region is consistently important for larval supply as this varies between years.

These points suggest that management of Tasmanian egg production may have little impact on future recruitment; certainly at the regional level (i.e. low egg production in a region does not mean it will have low future recruitment).

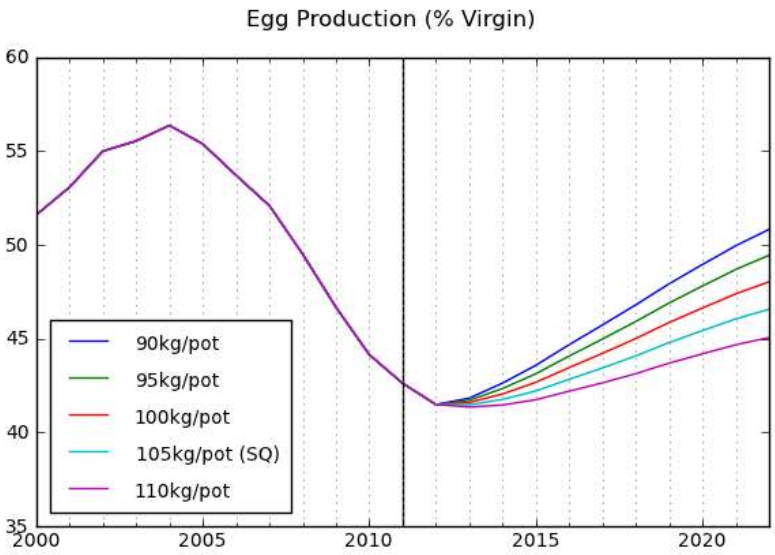
It is also true that lobster stocks can experience recruitment failure across broad regions at low levels of egg production. The accepted management response to this is to maintain egg production at reasonable levels in all regions of the State - the eggs in many baskets approach.

As with legal-sized biomass, Statewide spawning biomass or egg production has fallen over the last few years but is currently above 40% which is higher than the 25% reference point and is maintained at all levels of TACC (Figure 29). The decline in spawning biomass is less pronounced than the decline in legal-sized biomass because undersized lobsters contribute a considerable proportion of the total egg production.

Declines in spawning biomass over the past year have been widespread around the State (Figure 30). The south west areas 8 and 11 are near virgin spawning biomass due to the large number of mature females in that area which are below the legal minimum length.

All TACC options tested met the Statewide egg production limit reference point as do areas 1, 4 and 8 (Table 10). Egg production is below the limit reference point in areas 2 and 7 with a TACC greater than 95 kg/pot; area 6 greater than 100 kg/pt, and areas 3 and 5 fail to reach the limit at any of the TACC's tested (Figure 30).

Note that targets for spawning stock biomass differ between northern areas. The ultimate goal is for all areas to have production above 25% 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. 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. The 25% target used in Tasmania is different to that used in Victoria (20%) and South Australia (no formal limit).



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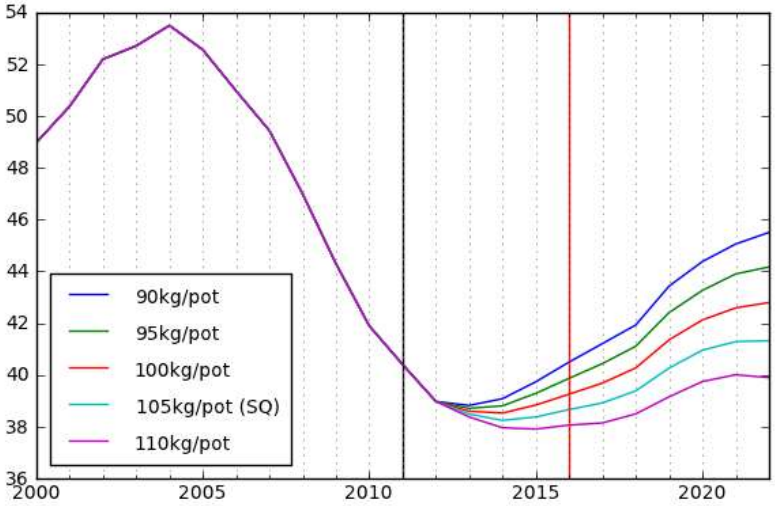

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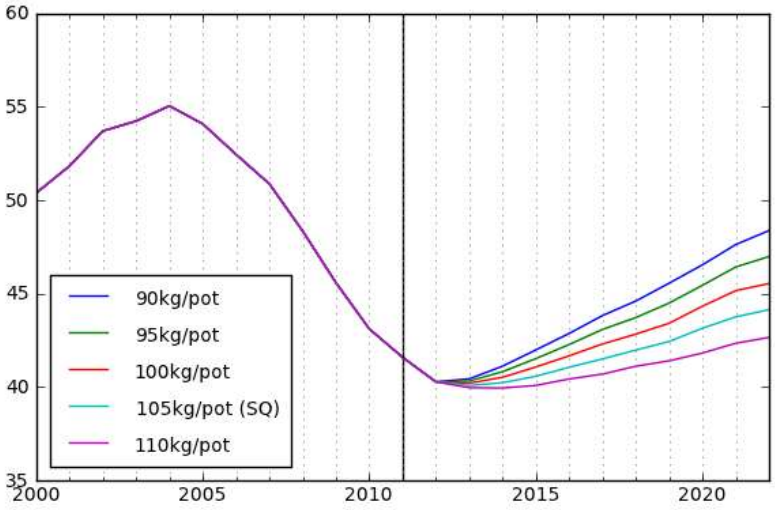

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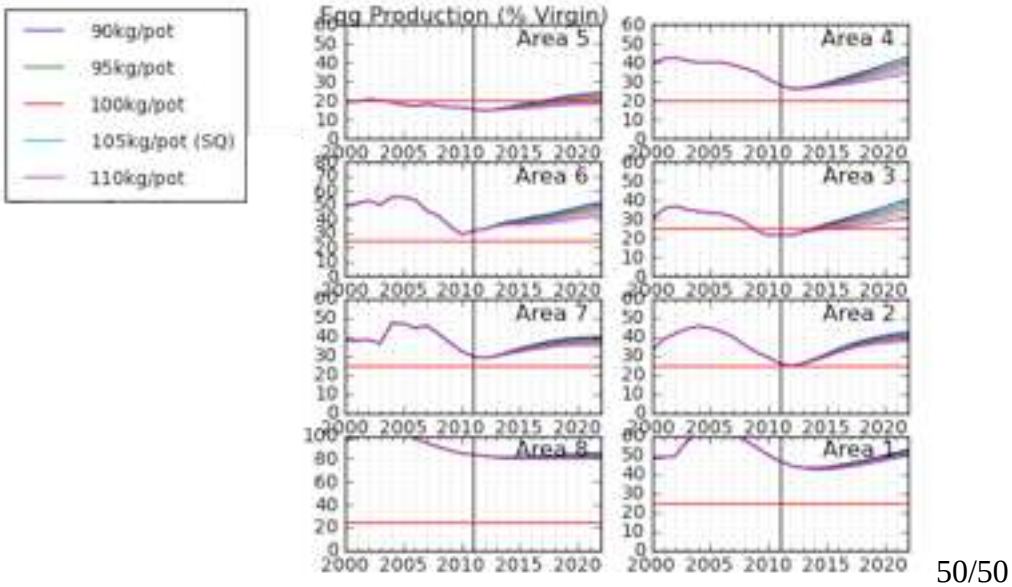
Figure 29 Statewide egg production projections. The limit reference point of 25% is below the range of the plots and no target was considered. The top plot shows 50% probability projections; limit reference points with 90% probability by 2016 (middle); and projections with 70% probability (bottom). Horizontal lines –limit (red) reference points (not shown). Vertical black line – current year; vertical red– timeline for limit reference point (2016).



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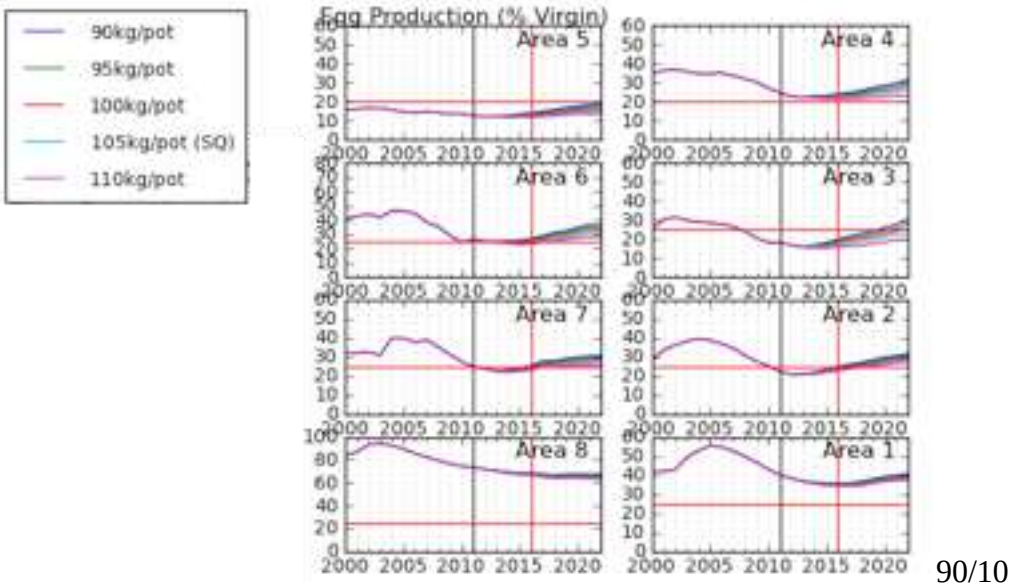

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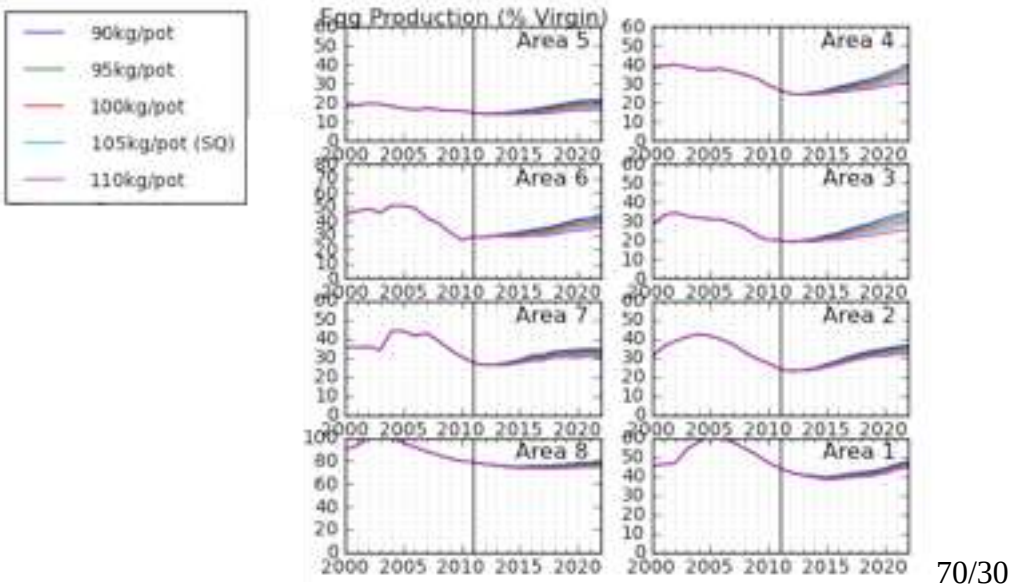

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Figure 30 Egg production projections for each area with a TACC from 90-110 kg/pot. Vertical black line is the current year; vertical and horizontal red lines show limit reference points. Plots show projections at 50% (top), 90% plotted against limit reference point (middle) and 70% probability plotted against target reference point (bottom).

Table 10 The probability of different TACC options meeting the defined egg production reference point. Individual cells are coloured red if they are below the required probability (90% for limit reference points), yellow if they are at the probability and green if they are significantly above the probability.

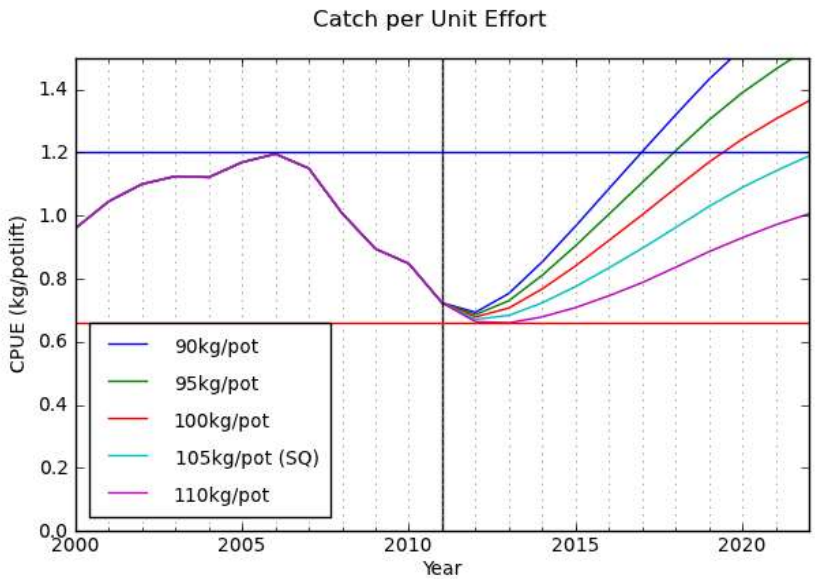
	Egg Production Limit Reference Point (2016)				
	90kg	**95kg**	**100kg**	**105kg**	**110kg**
Statewide	100	100	100	100	100
Area 1	100	100	100	100	100
Area 2	91	90	86	83	81
Area 3	66	62	57	51	47
Area 4	99	99	98	97	95
Area 5	39	31	27	21	17
Area 6	96	93	90	87	84
Area 7	91	91	88	86	85
Area 8	100	100	100	100	100

3.4.3 Catch rate trends (CPUE)

Catch rate projections at the 50% probability level remain above the limit reference for each TACC tested but at 90% probability the 105 and 110 kg/pot TACCs remain below the target in 2016 (Figure 31, Table 11). The target of 1.2 kg/potlift by 2021 is reached with TACC of 90 and nearly (89%) at 95 kg/pot (Figure 31, Table 11).

Catch rate projections by area at 50% probability are relatively optimistic showing rebuilding towards the target in all areas except area 11 (Figure 32). When looking at the limit (90%) projections, areas 4, 6 and 9 do not get above the limit by 2016 at any of the TACC options.

At each TACC option, Statewide catch rates are expected to decline over the next 2-3 years and will then start to rebuild with the 2010/11 catch rate exceeded in 2014 with a TACC of 90 kg/pot and in 2018 with a TACC of 110 kg/pot (Table 12).



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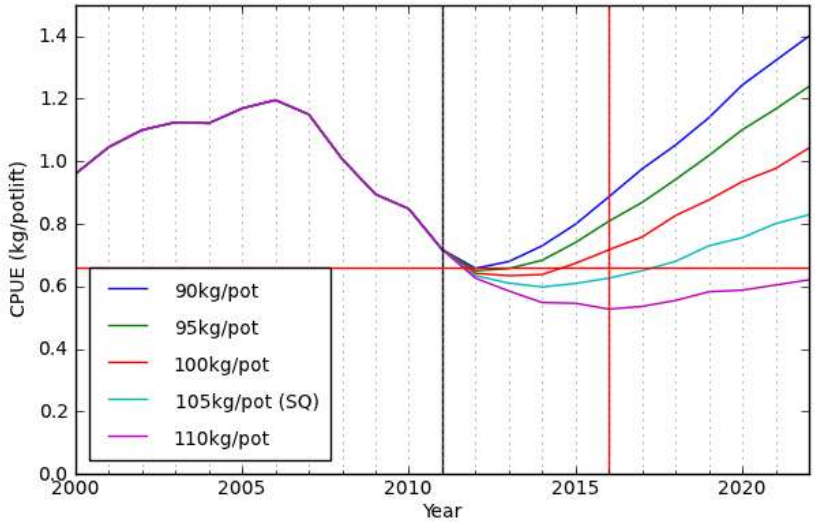
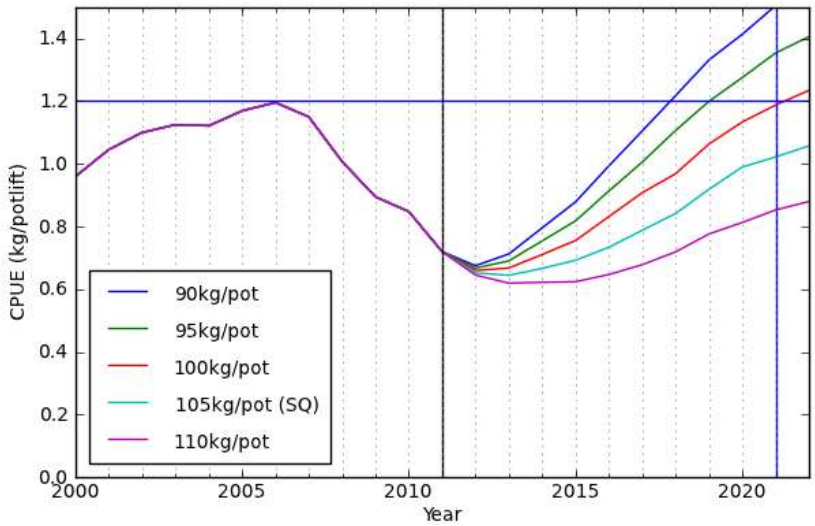
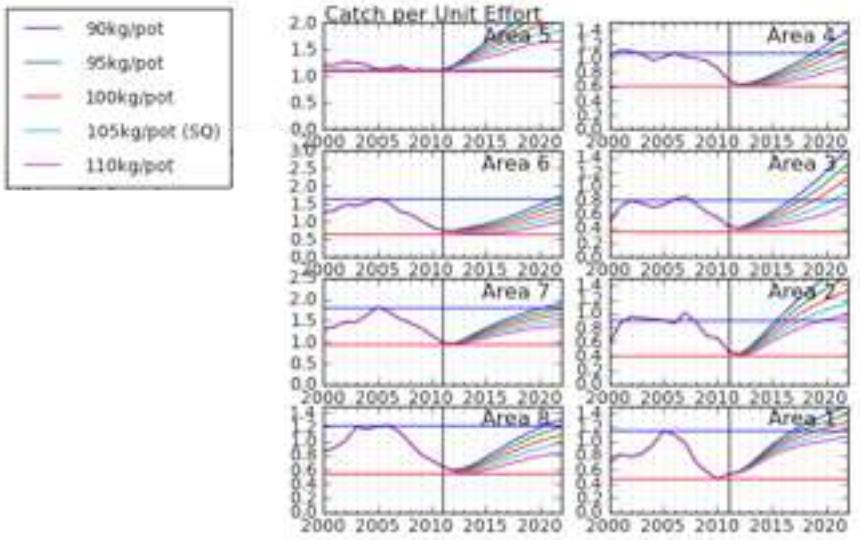


90%



70%

Figure 31 Statewide catch rate projections showing the limit and target reference points with 50% probability projections (top); limit reference points with 90% probability (middle); and target reference points with 70% probability (bottom). Horizontal lines – target (blue) and limit (red) reference points. Vertical black line – current year; vertical red and blue lines – timeline for limit and target.



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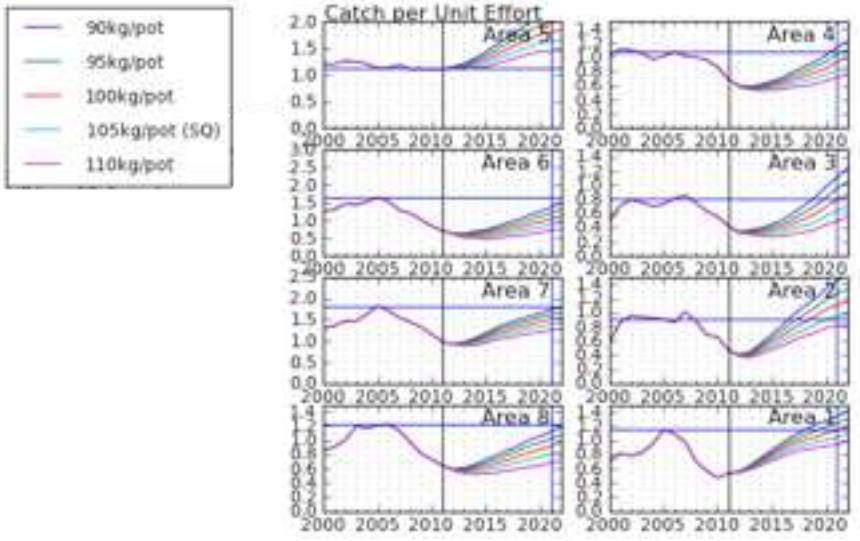

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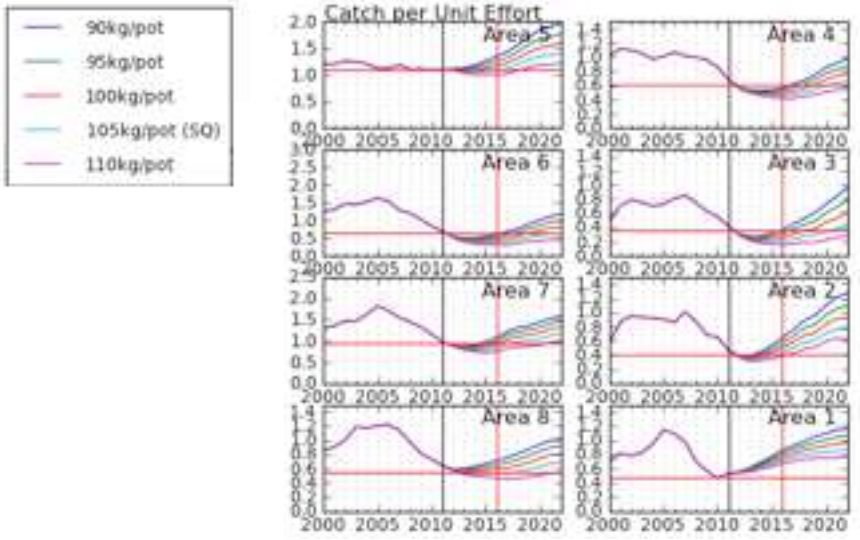

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Figure 32 Statewide catch rate projections for each area with a TACC from 90-110 kg/pot. Vertical black line is the current year; vertical and horizontal red lines show limit reference points and blue line show target reference points. Plots show projections at 50% (top), 90% plotted against limit reference point (middle) and 70% probability plotted against target reference point (bottom).

Table 11 Probability of different TACC options meeting the catch rate reference point. Individual cells are coloured red if they are below the required probability (90% for limit reference points, 70% for target reference points), yellow if they are at the probability and green if they are significantly above the probability.

	Catch Rate (CPUE) Limit Reference point (2016)									
	Limit Reference point					Target Reference point				
	90kg	95kg	100kg	105kg	110kg	90kg	95kg	100kg	105kg	110kg
Statewide	100	98	94	79	61	95	89	67	42	19
Area 1	100	100	100	100	100	91	85	68	46	27
Area 2	100	99	96	91	85	96	96	91	76	54
Area 3	92	84	78	66	60	91	82	66	48	30
Area 4	84	80	70	60	53	76	63	47	30	19
Area 5	100	99	95	90	83	100	100	99	98	93
Area 6	80	72	59	46	36	47	27	18	9	5
Area 7	95	94	89	84	77	52	34	15	8	3
Area 8	100	97	91	77	58	54	37	22	10	6

Table 12 Expected changes to Statewide catch rates each year from now to 2021 (probability 50%) with the different TACC options. Catch rates that are lower than the 10/11 catch rate (0.79) have been shaded darker.

Quota Year	90kg	95kg	100kg	105kg	110kg
2010/2011	0.79	0.79	0.79	0.79	0.79
2011/2012	0.72	0.72	0.72	0.72	0.72
2012/2013	0.69	0.69	0.68	0.67	0.66
2013/2014	0.75	0.73	0.71	0.68	0.66
2014/2015	0.85	0.81	0.77	0.72	0.68
2015/2016	0.97	0.90	0.84	0.77	0.71
2016/2017	1.08	1.00	0.92	0.83	0.75
2017/2018	1.20	1.10	1.00	0.90	0.79
2018/2019	1.32	1.21	1.09	0.96	0.84
2019/2020	1.43	1.30	1.17	1.03	0.89
2020/2021	1.53	1.39	1.24	1.09	0.93
2021/2022	1.62	1.46	1.31	1.14	0.97

3.5 Recruitment

Recruitment to the fishery drives future production and is thus of great interest to assessment and management of the fishery. Management regimes have limited ability to influence recruitment but large control on how the recruits are utilised. For example, different choices in TAC and size limits can produce vastly different outcomes with equivalent recruitment.

The increase in stock and improved catch rates which were seen from 1998 and lasting to 2006 has been attributed to the constraint of total catch under QMS management. It is now apparent that extremely high levels of recruitment contributed to this growth, and that the current decline in the fishery is being driven by a prolonged period of very low recruitment since 2006. This low recruitment to the fishery is exceptional and has traits unlike any downturn seen previously over the period of four decades from 1970 to 2010.

3.5.1 Model estimated recruitment

The stock assessment model estimates recruitment to its lowest size class (60 mm CL) using commercial catch and effort data plus onboard catch sampling of undersize lobsters (Figure 33). This means that estimates of recruitment can only be determined once the animals affect catch rates by growing into the minimum legal sizes (105 mm for females and 110 mm for males) from the size of recruitment represented in the model (60 mm). For this reason the recruitment levels in the most recent years appear to revert back to the average due to the fact that it takes several years for new recruits to enter the legal sized fishery. Because growth rates differ so much around the State each assessment area has a different time-lag between recruits entering the modelled stock at 60 mm and the animals growing into legal sizes. It takes the longest in Area 8 and the shortest time in areas 4 and 5. Note that the model assumes that growth is constant through time – increases in growth would appear to the model (and fishers) as a spike in recruitment.

Model estimated recruitment is below average for all areas for recent years. This is an unusual pattern – historically low recruitment in one area tended to be offset by high recruitment elsewhere.

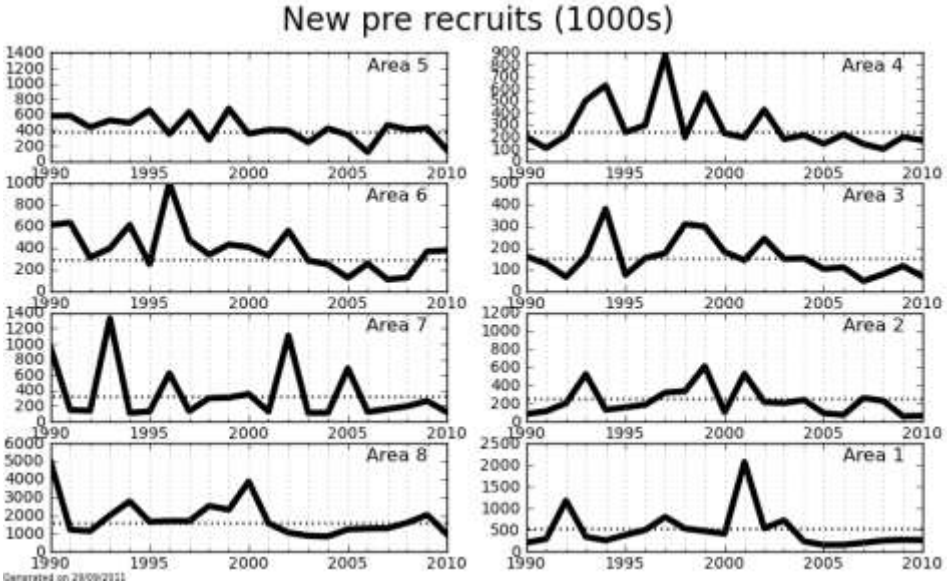

Figure 33. Model derived absolute recruitment to the 60 mm CL size class (this is the first size category in the stock model and the first size class where reasonable numbers are captured in catch sampling surveys) within each region over the last two decades. The dotted line shows the average number for each from 1999 to 2008, the period used for estimating recruitment in the model. This was moved forward one year from the previous assessment. More recent years are not used as the number of observations remains low.

3.5.2 Recruitment from puerulus settlement monitoring

Very high settlement detected in puerulus collector sites in 1995 (Figure 34) led to the high recruitment into the fishery after (QMS) was introduced. This affected catches first in the faster growth northern areas then later in the south. Constraint in catch under output controls (QMS) meant that this recruitment pulse led to good catch rates for several years peaking at 1.2 kg/potlift in 2005/06. The mid 90's recruitment pulse was evident at the Flinders and Bicheno sites and all sites saw a fall in annual settlement in 2003 and remaining below average for several years (Figure 35).

Monthly puerulus settlement at Bicheno and Recherche was very low from January 2003 to mid 2006. Recently Bicheno and Flinders have had above average settlement and Recherche Bay saw a very high settlement peak in January and March 2011 (Figure 36). The low settlement from 2003 at South Arm has slowly improved and is now approaching more average levels (Figure 36).

The 2003 decline in recruitment is extreme and unlike anything seen over the last few decades because: (i) it is at or near record lows in most areas; (ii) declines have occurred simultaneously in all areas (declines in one area are usually balanced by a pulse somewhere else); and (iii) the decline has been more protracted than previously.

The fact that settlement in collectors have returned to average to above average values in the last two years is positive for the future and highlights the need for management to include greater extremes of risk in assessment.

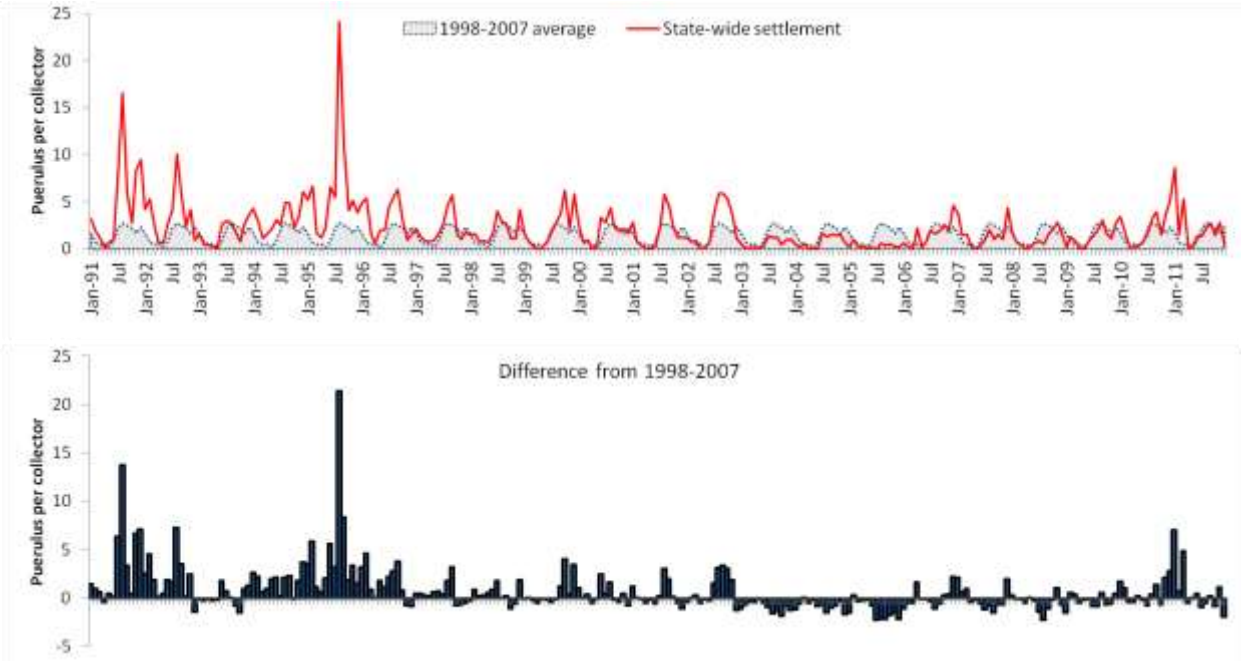

Figure 34 Top. Monthly combined settlement from all Tasmanian settlement sites (red line) compared to the average settlement for the period 1998-2007 (grey shading). Bottom. Difference in combined settlement from all sites compared to the 1998-2007 average.

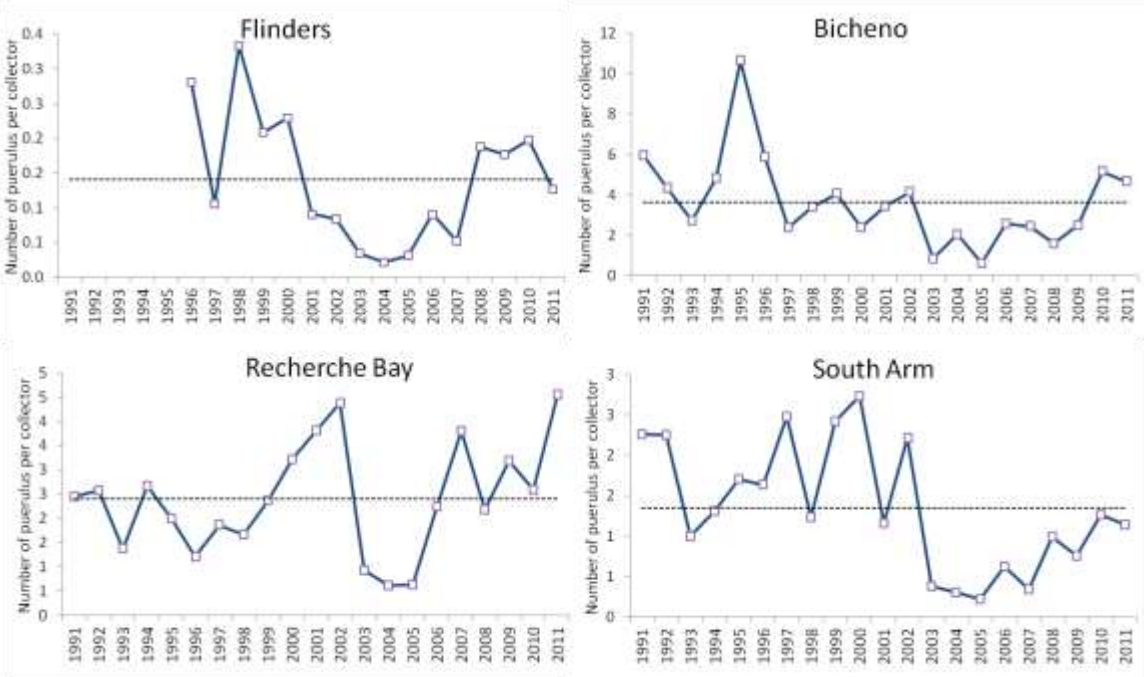

Figure 35 Annual puerulus settlement from long term monitoring sites around Tasmania.

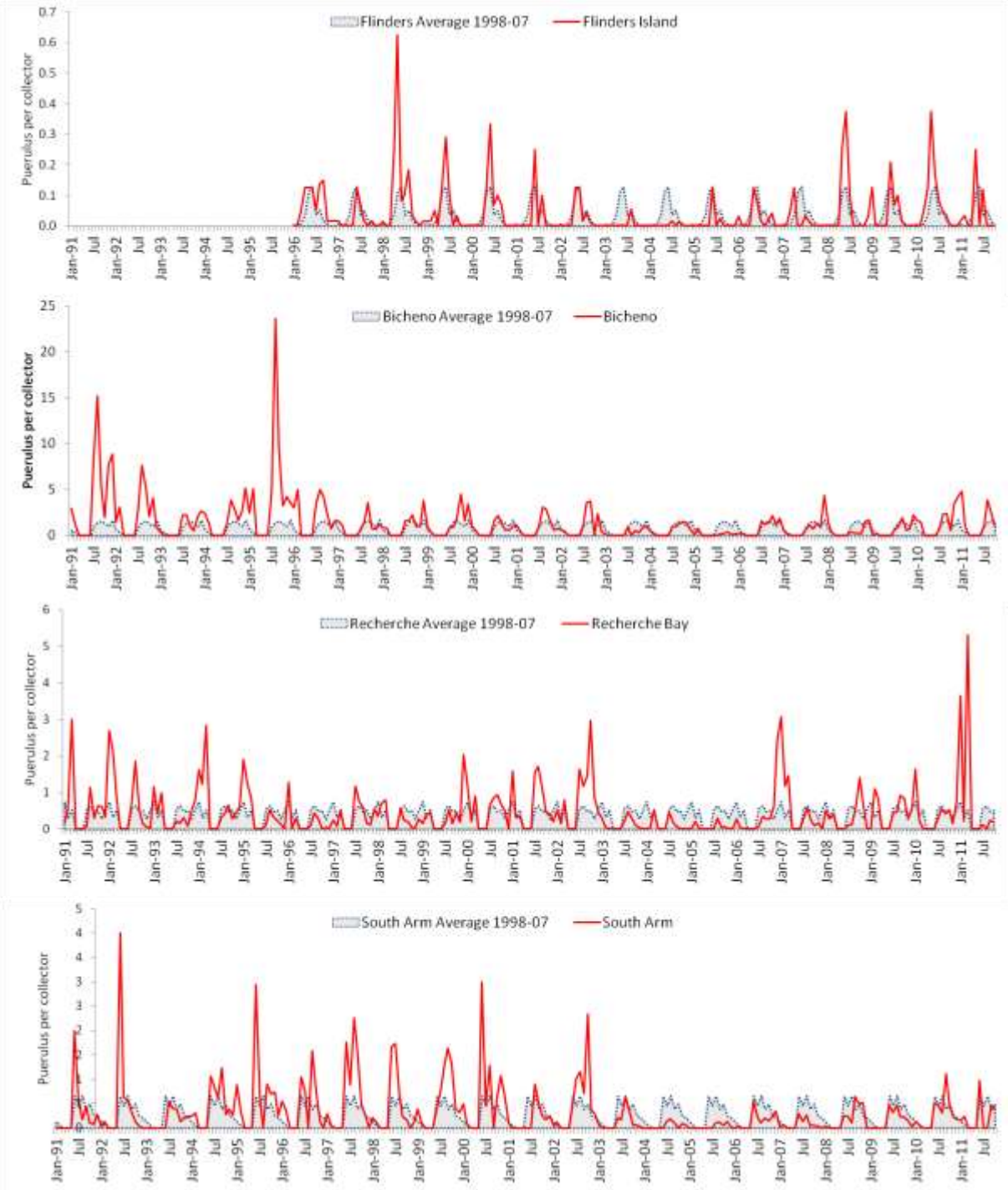

Figure 36 Long term settlement (red) compared to the average settlement for the period 1998-2007 (grey shading).

3.5.2.1 Undersize from observer sampling

Observer sampling on commercial vessels and research cruises provides data on the number of undersize lobsters. A Statewide undersize index was calculated from areas with no more than 2 years with missing data. Monthly counts of undersize lobsters are presented as the difference from the long term average for males and females (Figure 37). Female undersize index shows less variation than males but was positive prior to the good recruitment years 2003-05. Males exhibited much greater variation with above average levels 2000-04 and a very low level in 2007 corresponding to similar abundances in the fishery.

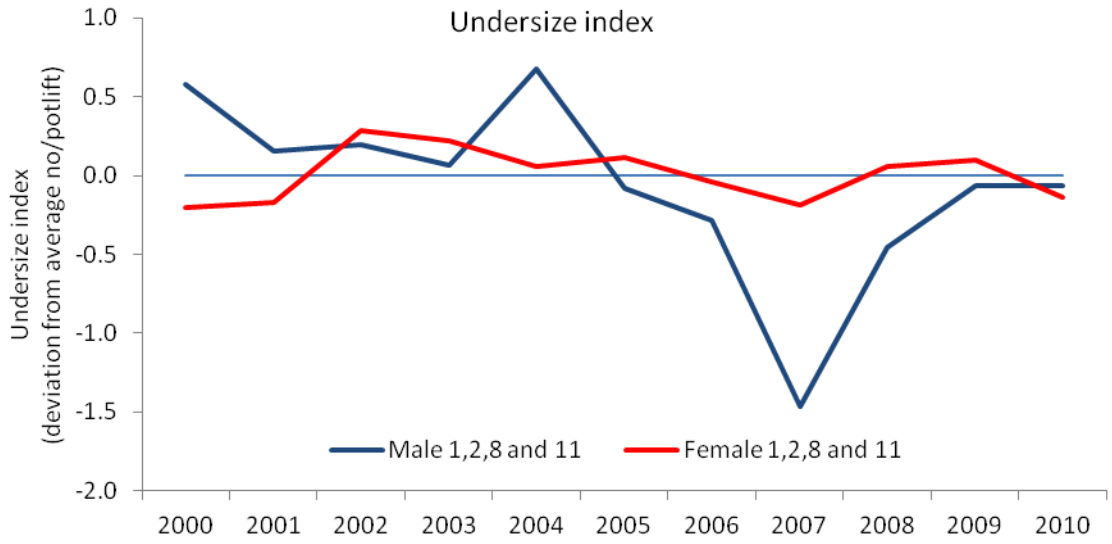

Figure 37 Average undersize index of male and female undersize lobsters observed in pots during observer and research surveys between 2000 and 2010. The index is the difference between the annual number of undersize per potlift from the long term average (black horizontal line) from areas 1,2,8 and 11 which had no more than 2 years missing data.

4 Outcomes of translocation of lobsters

Translocation involves catching lobsters in slow growth areas then shifting and releasing them in high growth areas (these can vary by 20 fold). If catch is limited by quota, and the stock of lobsters grows faster, then the total stock increases. The commercial industry voted to have their license fees increased in 2012 to fund translocation. This will create faster and more substantial stock rebuilding than would have been achieved by the cut in quota alone. The response to stock decline involves more than cutting commercial quota. The translocation strategy will produce also substantial stock rebuilding, equivalent to a further quota cut of around 10%.

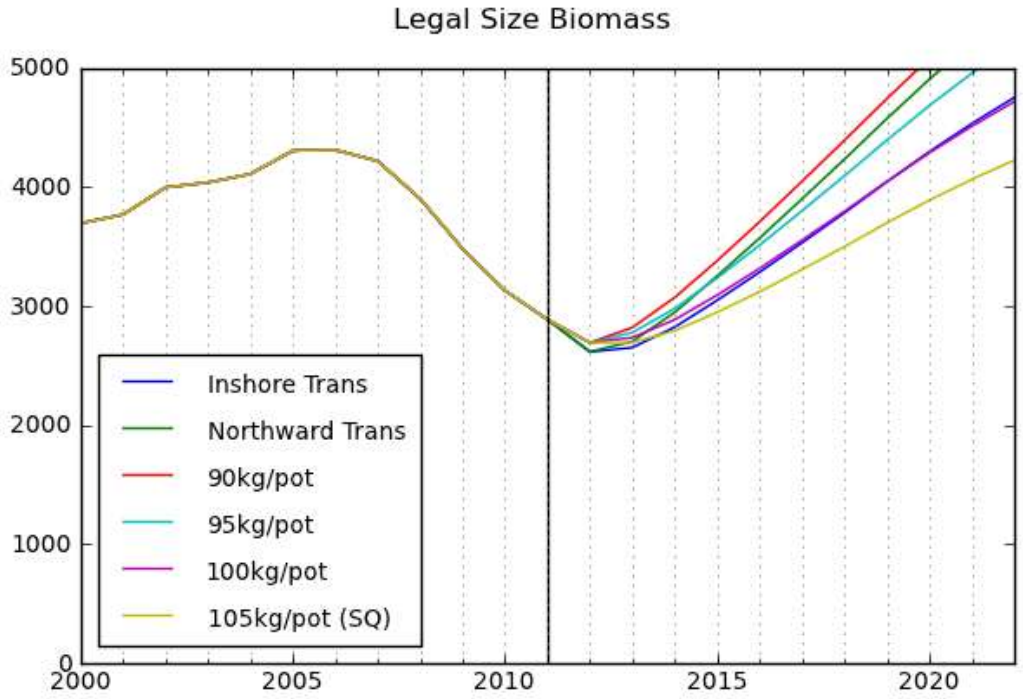

Figure 38 Projections of biomass of lobster under different quota levels and with translocation. The 2011/12 quota is shown by the yellow line. The green line is the expected trajectory for the fishery given the translocation strategy that has been adopted. It has a similar (slightly better) trajectory to a quota cut to 95 kg.

4.1 Ecosystem outcomes

There are no formal ecosystem reference points in place. This is because there is no evidence/information of ecosystem impact of lobster fishing on the ecosystem other than a possible link with urchin barren formation. This is not for want of investment with one of the most extensive marine reserve research sampling programs in the world. Research is underway to try to set limits around the ecosystem link between lobster predation of urchins and urchin barrens – but that is not complete. In the interim the default approach is to assume that a greater biomass of lobsters is more natural and more desirable and may be more important for eating urchins. The quota cuts implemented are expected to rebuild total lobster biomass (undersize plus legal sized lobsters). The translocation intervention will further restore the lobster stock. The management changes introduced are expected to lead to increase in the biomass of large lobsters by 2020 to higher levels than seen for decades. This is in response to the urchin predation concern.

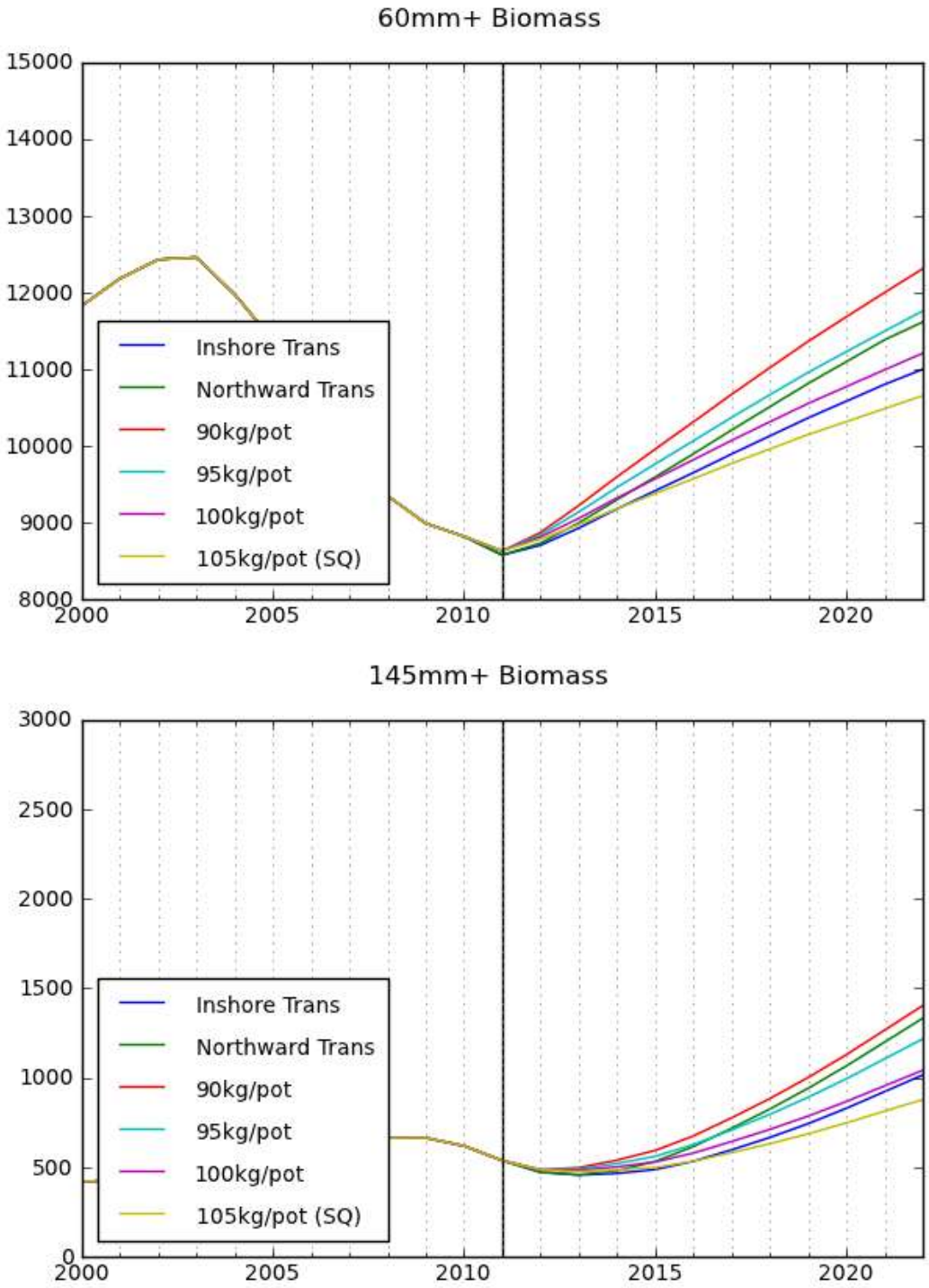

Figure 39 The figures below show expected trajectories for biomass of all lobsters (top) and biomass of large lobsters (bottom)

5 Economic and market status

The economic benefit from the Tasmanian commercial rock lobster fishery is well distributed around the State, with an estimated 1,350 jobs reliant on the fishery (EconSearch 2003). Lobsters are mainly sold into Asian markets although a marketing project is underway with the aim of expanding into markets in the USA.

The economic impact of the Tasmanian rock lobster fishery is far greater than would appear from simple comparisons of total annual revenue (*i.e.* the gross value of product GVP) which was around $63 million[2] in 2010/11 (Figure 40). Because a wild fishery has constraints on production, a "scarcity rent" is obtained and the economic yield is many times greater than can be achieved by most primary industries. Economic yield in the lobster fishery is illustrated by the lease price of quota units, which traded in 2008/09 at around $14 but fell to around $9 during 2010/11. This implies an economic yield from the fishery of around $10 million dollars (1,222,000 kg * $9, Figure 40).

Economic yield is thus an important concept to understand when examining community benefit from fishing because the GVP is only loosely related to economic impact. For example, over the last three years we have seen economic yield from the fishery fall sharply to $10 million (56%) at the same time as beach price has risen by 9% and GVP has fallen by 10% (Figure 40). The fall in economic yield despite rising prices has been caused by the rapid rise in costs over the last couple of years. Costs have been driven most significantly by the fall in catch rates – which means fishers now have to fish longer and use more potlifts to take the same catch.

Although daily catches per vessel have fallen over the last three years, the daily revenue per vessel has actually remained relatively high because of higher beach price (Figure 41). This increase in daily revenue has not been enough to overcome a slump in fishing profitability, as reflected in a decline in the market lease price (-47% over the last 3 years).

[2] Retained profits are actually much greater than this amount because a commercial fisher who leases quota and then goes fishing makes additional profit.

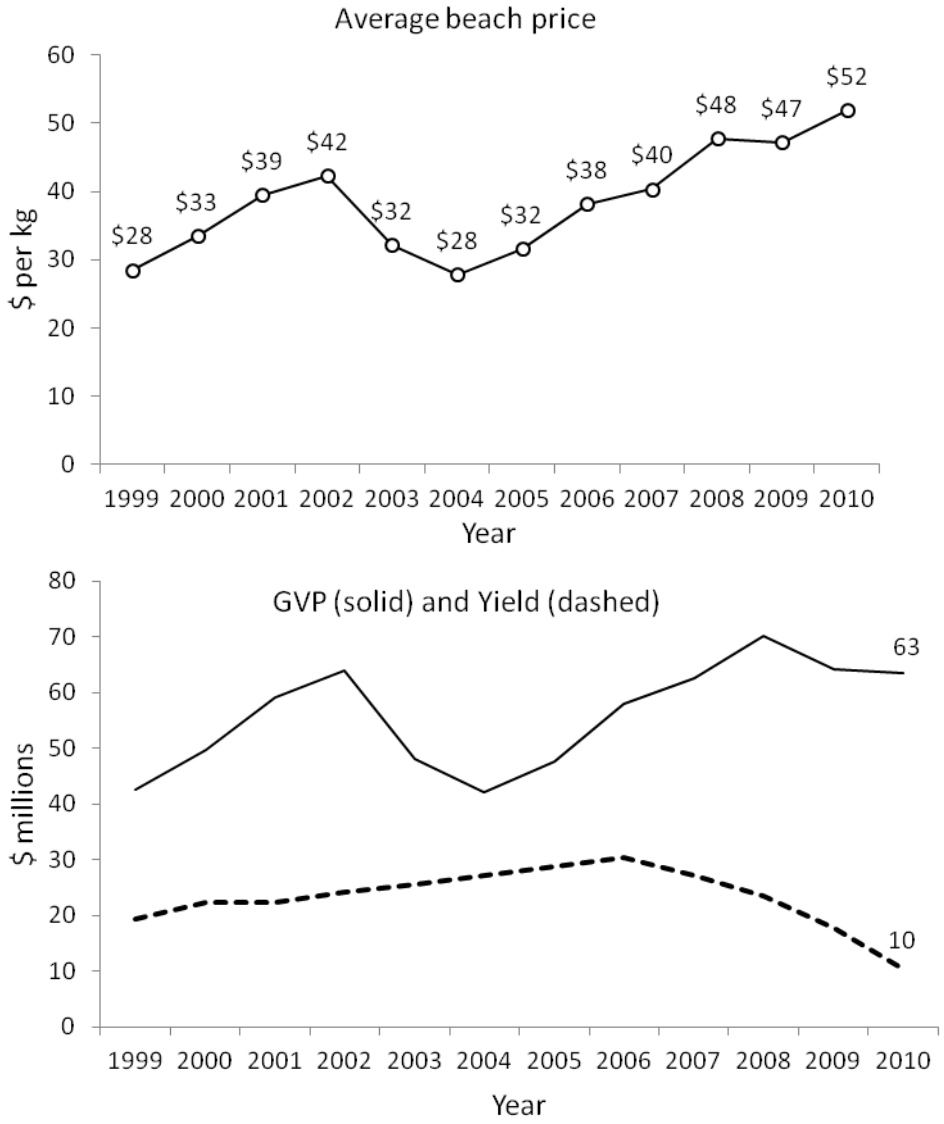

Figure 40. Economic trends in the commercial fishery since 1999. Beach price over the last three years has been high resulting in a very high gross value of product (GVP) of $63 million. However, economic yield from the fishery fell by $14 million or 56% over the last 3 years despite the price increasing, because costs of fishing increased (due to higher effort for the same catch). This decline in economic yield drove a decrease in the market price for lease quota.

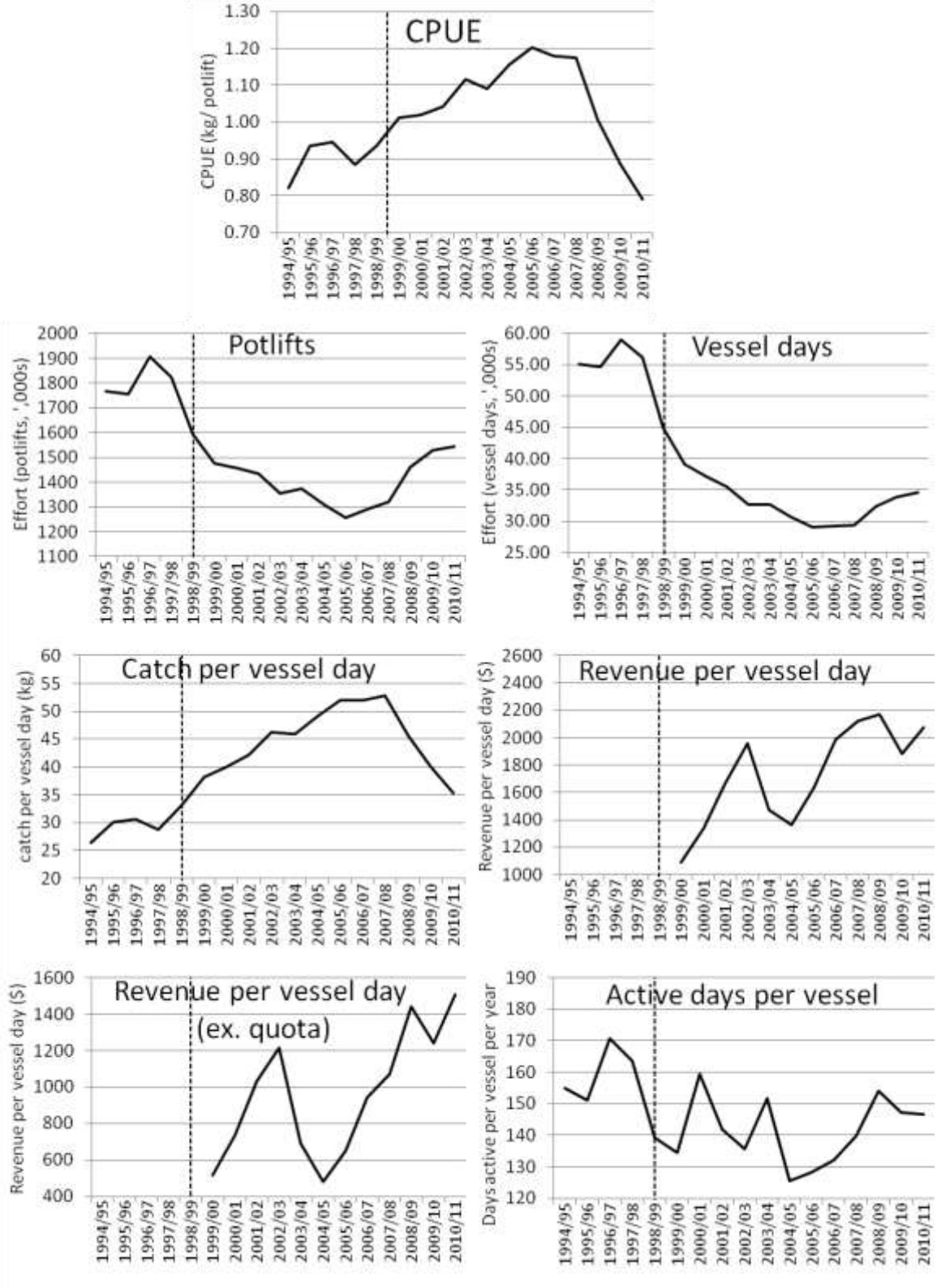

Figure 41. Trends in average State-wide commercial catch data since before the introduction of the quota system in 1998/99. Revenue per vessel day assumes average yearly beach price. Revenue per vessel day ex-quota excludes the opportunity cost of using quota which could otherwise be leased out.

6 Discussion

The fishery continues to exhibit strong regional trends in the distribution of effort and catch in response to changes in production around the State. In some areas changes in the Statewide TACC are not enough to address stock declines and provide stock rebuilding and additional, more targeted measures for those areas may need to be considered. Regional effort changed in most areas responding to lower lobster abundance and catch rates. Catches from the north west of the State showed the biggest changes in catch and effort. Effort in Area 5, the most significant in terms of production, increased by 26% for a 13% increase in catch and a 10% decline in catch rate. North West deepwater (Area 9) saw a 31% decline in effort, a 49% fall in catch with a 28% drop in catch rate.

The increase in stock and improved catch rates which were seen from 1998 and lasting to 2006 has been attributed to the constraint of total catch under QMS management. It is now apparent that extremely high levels of recruitment contributed to this growth, and that the current decline in the fishery is being driven by a prolonged period of very low recruitment since 2006. This low recruitment to the fishery is exceptional and has traits unlike any downturn seen previously over the period of four decades from 1970 to 2010. Very high settlement detected in puerulus collector sites in 1995 led to high recruitment into the fishery after (QMS) was introduced. This affected catches first in the faster growth northern areas then later in the south. Constraint in catch under output controls (QMS) meant that this recruitment pulse led to good catch rates for several years peaking at 1.2 kg/potlift in 2005/06. Constraining the catch through this period not only spread the benefits of a recruitment pulse but also generated extra stock through growth of legal sized lobsters that were left uncaught between years. Improvements in puerulus settlement during the past year to average / above average levels provide some optimism for future recruitment but if this eventuates it won't be seen in the fishery for a number of years.

The continuing increases in effort, reduction of catch rates and increasing level of uncaught quota continue to raise serious concerns for the fishery. Without more normal levels of recruitment and a TACC which constrains the catch, the biomass and subsequent catch rates will continue to decline under the current total catch.

The same reference points are currently used for all areas. Next year, the Department intends to further consider each area's reference points to ensure that they are appropriate for measuring the performance of the area against Statewide and regional management measures.

7 Management advice

Catch and effort data from the commercial fishery indicates that there has been decline in the stock for the last five years. This is consistent with abnormally low recruitment – under long term average recruitment the observed decline in catch rate would not have occurred.

There thus appears to be need for unusually low TACCs to constrain the catch and thus prevent continued stock decline. Further stock decline would be expected to continue to erode profitability. Risk of recruitment overfishing however remains low due to the high level of egg production.

In summary, the signals in catch effort data point to the need for a reduction in total catch below 126 kg per unit and to the point where the TACC limits the catch. Regional management options should also be explored.

Performance measures developed by the FAC over 2009 and 2010 provided guidance on stakeholder goals for the fishery. The performance of the fishery was assessed against these targets in this assessment. This process indicated that the performance target and limits related to economic outcomes had reasonable probability of being met only with TACCs equating to values of 100 kg / unit or less.

All the harvest strategies discussed above assume no change to existing management other than variation in the TACC. Numerous changes to management are possible that would increase economic and biological yield per recruit. The most significant opportunities are the adoption of translocation and lowering the minimum size of harvest in the south west. Both of these would increase the long term productivity of the stock and lead to stock rebuilding when combined with a constraining TACC.

8 Ecosystem based management

8.1 Protected species interactions

Protected species interaction data is collected through the commercial logbooks. Observers deployed on vessels to collect size structure data also collect protected species interaction data on an ad-hoc basis.

8.1.1 Research sampling data

Research sampling data on protected species interactions has traditionally recorded only significant interactions where the protected species was harmed.

A total of seven harmful interactions with protected species have occurred in research sampling from 1990 to the end of 2007, each involving the drowning of a cormorant. This has occurred with a total of 69441 potlifts and thus represents an incidence of around 0.000101 cormorant deaths per potlift in research pots. If similar rates were experienced by commercial and recreational fishers then the average annual number of cormorant deaths in lobster pots would be around 140 (given estimated potlifts). However, this estimate presumably significantly overstates probable cormorant deaths as research sampling is biased to shallow water. Two sygnathids (a pipefish and a seahorse) have also been recorded as bycatch and both were released apparently unharmed.

8.1.2 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.

8.2 By-catch

By-catch information is collected though 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. The top ten by-catch species for 2010/11 are shown in Table 13. 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, octopus and leatherjackets, which are also reported under by-product.

Total by-catch has increased over the last 3 years due to the increased number of potlifts as lobster catch rates have declined. Hermit crabs are the main component of the by-catch followed by velvet crab and draughtboard shark (Figure 42). Most bycatch species are released unharmed.

No major changes were noted when historical by-catch was plotted for the main species groups (Figure 43).

Table 13 Top ten species of by-catch observed in research sampling during 2010/11 and numbers extrapolated for the commercial fishery.

Species	Number in research sampling	Number/potlift in research sampling	Estimated number from fishery
Hermit crab	16,624	4.752	7,344,424
Draughtboard shark	1,390	0.397	614,097
Velvet crab	739	0.211	326,488
Brown-striped leatherjacket	265	0.076	117,076
Blue-throat wrasse	260	0.074	114,867
Red bait crab	234	0.067	103,380
Southern conger eel	145	0.041	64,060
Barber perch	90	0.026	39,762
Rosy wrasse	83	0.024	36,669
Purple wrasse	26	0.007	11,487

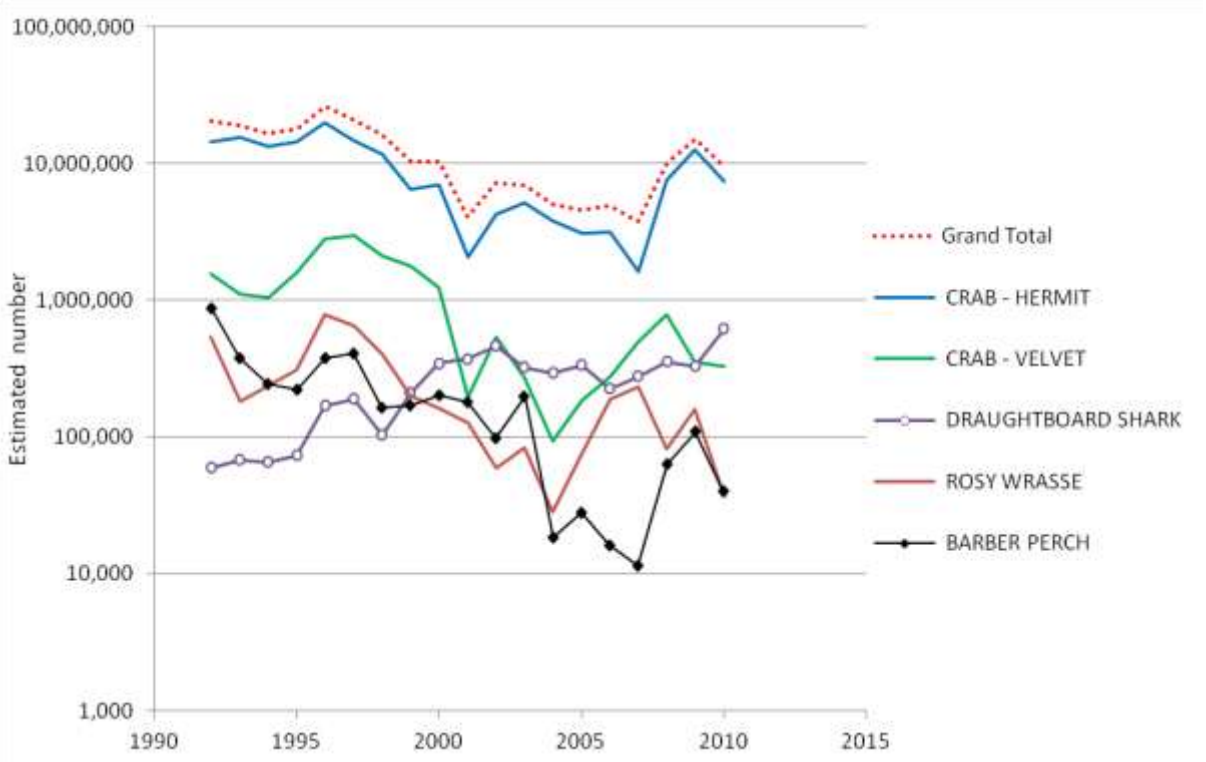

Figure 42 Total by-catch of top five species estimated by multiplying research sampling effort and catches up to the equivalent of the annual commercial effort.

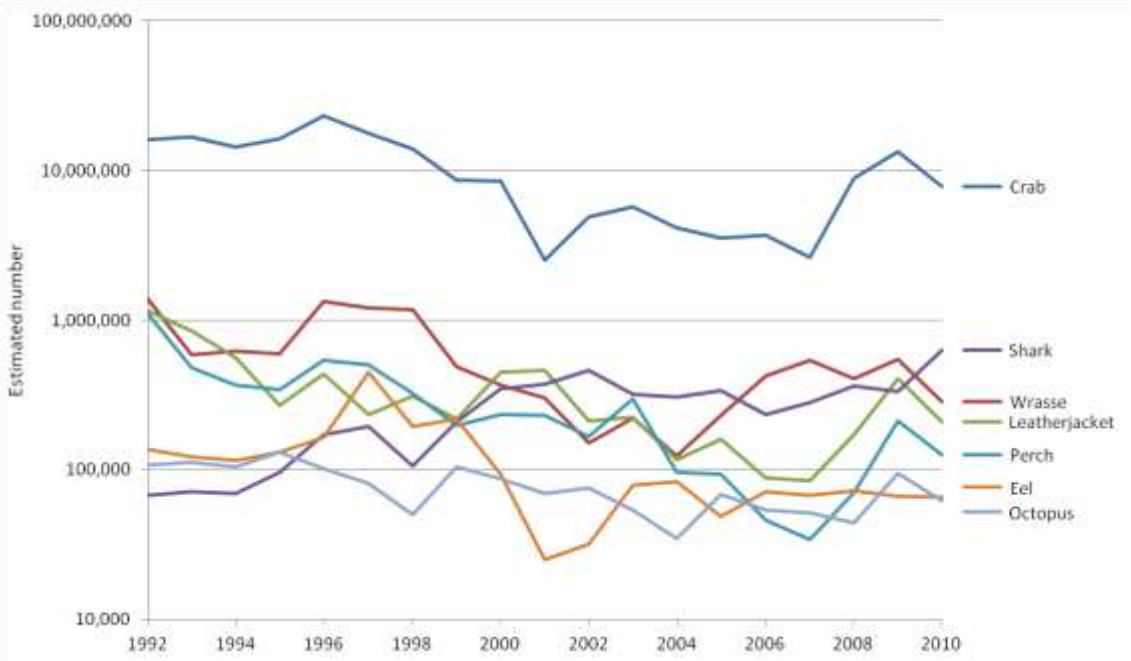

Figure 43 Estimated numbers of commercial catch of major by-catch species groups since 1992.

8.3 By-product

By-product has been reported within the lobster logbook since 2007/08, which improved the rate of reporting. Retained product is also differentiated into bait vs. product for sale. All reported by-product from lobster pots was of a trivial volume, the largest being octopus, draughtboard shark and conger eels, each with a total catch of less than 5 tonnes (Table 14).

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. Likewise research sampling indicates that catches of Maori octopus are under-reported. There is no apparent improvement in rate of reporting between years.

Table 14. By-product reported by the commercial fishery (tonnes). All species with catch less than 100 kg in any one year have been excluded.

	BAIT				CONSUMPTION			
SPECIES	**07/08**	**08/09**	**09/10**	**10/11**	**07/08**	**08/09**	**09/10**	**10/11**
Barracouta	0.1	0.5		0.4			0.1	
Bearded rock cod	2.1	2.3	2.2	2.3	0.2	0.1		
Cleft-fronted shore crab					0.3		0.1	0.1
Conger eel	1.8	2	1.8	2.3	0.6	0.6	0.3	0.7
Draughtboard shark	0.5	0.1			3.1	5.7	0.6	2.7
Giant crab					0.3	0.4	0.5	0.5
Gummy shark					0.1	0.2	0.1	0.1
Gurnard perch	0.4		0.2					
Leatherjacket	0.9	0.7	0.7	0.8	0.4	0.4	0.1	0.3
Morwong	0.1							0.1
Octopus	0.7	0.6	0.6	1.3	5.3	5.2	6.7	4.5
Striped trumpeter	0.1	0.2		0.2	0.4	0.9	0.6	0.7
Wrasse	0.9	0.6	0.7	0.7	0.2	0.6	0.4	0.2
Total	7.6	7	6.2	8	10.9	14.1	9.5	9.9

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10 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. Accounts of historical catches provide insight into the abundance of lobsters in conditions with very low fishing pressure. When James Kelly called at Port Davey in 1815 he traded swans he had shot for crayfish; the local Aborigines quickly collected 3 tons (at least 1000 lobsters) by hand from the waters edge. In 1905, James Rattenbury caught 480 lobsters from the *Rachel Thompson* in six hours using only 6 "cray" rings in Wineglass Bay.

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 le-

galised 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 a recent historical low of 1440 tonnes in 1994, a reduction of 400 tonnes from the 1992 year.

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.

11 Appendix 2: Management

Management regulations were first introduced in 1885 and included a minimum legal size, and a prohibition on taking soft shelled (recently moulted) lobsters or berried female lobsters. These input controls still play a role in management of the resource although soft-shelled lobsters are now largely protected by a seasonal closure.

Since the inception of catch records in the 1880's, the reported annual catch steadily increased in the commercial rock lobster fishery to a high in 1984 of over 2,250 tonnes. During this period of growth in catches, concerns were expressed about overfishing in the commercial fishery, which resulted in changes in regulations. The most important changes were the legislation of design of pots in 1926, introduction of closed seasons to limit the harvest of soft-shelled lobsters in 1947, the restriction of the number of licenses in 1966, and a ceiling on the number of pots in the fishery set at 10,993 in 1972. From the record high catch of 1984, the reported annual catch declined to a low of 1,440 tonnes in 1994 reflecting a decline in the available biomass. In recognition of the declining trend in biomass, an individual transferable quota (ITQ) management system was introduced for the commercial fishery in March 1998 following an industry ballot to decide whether to accept the system.

Management of the commercial fishery has remained relatively stable since the introduction of quota. Quota was initially set at 1503 tonnes for the 1998/99 fishing season. After three years of successive improvements in biomass, the quota was increased to 1523 tonnes for the 2001/02 fishing season. As catch is now constrained by quota, seasonal controls in the fishery have been relaxed. Lengths of seasonal closures have varied since their introduction in 1926 but complete closure of September and October was in place from 1963 to 1998. In 1998, the first 2 weeks of September were opened, to provide fishers with flexibility to take hard-shell lobsters that command a high price or fish for the lower priced soft new-shell lobsters that have a higher catchability after their moult. Timing of the September closure has changed regularly since 1998 with complete access in 2000. There remained some concern about fishing in September due to negative impacts on markets.

Management of the recreational fishery has proceeded in parallel with that for the commercial fishery. A rock lobster license is required to take lobsters recreationally or to deploy gear. Many regulations are shared by both sectors, such as size limits, closed seasons, and pot specifications. Key differences included the ability of recreational fishers to harvest lobsters by diving, a cap on the daily bag limit of 5 lobsters, and the absence of an output control mechanism.

12 Appendix 3: Summary of Rules

Table 15. Summary of rules for the Tasmanian Rock Lobster Fishery.

COMMERCIAL	
Management zone	one management zone for the State
Limited entry	314 licenses
Limited seasons	Males: season open from mid November to end September. Females: season open from mid November to end April. (Actual dates change slightly from year to year.)
Limits of pots on vessels	minimum of 15 pots, maximum of 50 pots
Quota	Total allowable catch of 1523 tonnes
Restrictions on pot size	maximum size of 1250 mm x 1250 mm x 750 mm.
Escape gaps	one escape gap at least 57 mm high and 400 mm wide and not more than 150 mm from the inside lower edge of the pot, or two escape gaps at least 57 mm high and 200 mm wide and not more than 150 mm from the inside lower edge of the pot
Minimum size limits	105 mm CL for females, 110 mm CL for males
Berried females	taking of berried females prohibited

RECREATIONAL	
License requirements	rock lobster potting licence - 1 recreational pot per person,rock lob
Daily limit	5 per recreational license holder
Limited seasons	Males: season open from start November to end September. Females: season open from start November to end April. (Actual dates change slightly from year to year.).
Restrictions on gear	Pots as per commercial fishers, rings no more than 1 m in diameter, capture by glove only when diving.
Escape gaps	as per commercial fishers
Minimum size limits	as per commercial fishers
Berried females	as per commercial fishers
Sale or barter of lobsters	prohibited
Marking	All recreational lobsters must be tail clipped within 5 minutes of landing. No tail-clipped lobsters to be sold.