FISHERY ASSESSMENT REPORT

TASMANIAN ROCK LOBSTER FISHERY

2011/12

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May 2013

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Executive Summary

Current Stock Status

Biological Sustainability

- Biological sustainability is measured through egg production and recruitment. Egg production declined over the last year but, at an estimated 40% of virgin production, is still at very high levels and thus well above the limit reference point of 25%. However, 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 weights of lobsters in northern areas (4 and 5) and south and south west areas (1, 8 and 7) are declining, signalling an improvement in the balance between recruitment to the fishery and catch removed by harvesting. Average weight has stabilised in all other areas except 6.
- In most areas the number of new pre-recruits (sub legal lobsters larger than 60mm) has been below the decadal average for several years except area 7, indicating poor recruitment since 2007.
- Puerulus settlement off eastern Tasmania improved during 2011 to average and was above average levels, which is a positive sign for future recruits to the fishery.

Economic benefit

- Economic benefit is affected by changes in the legal sized portion of the stock only. The daily catch per vessel increased for the first year since 2007/08 and resulted in a decrease in vessel days. Daily revenue per vessel declined slightly.
- The 2011/12 commercial catch was 1,104 tonnes and was constrained by the TACC at a level lower than any of the previous 60 years of the fishery.
- Effort during 2011/12 fell to 1.35 million potlifts, equivalent to the levels prior to the stock decline in 2006.
- The State-wide catch rate (CPUE) was 0.79 kg/potlift, which is the lowest on record (since 1947) but was stable and had not declined from the previous year.
- Catch rates increased in southern areas (1, 8, 9 and 11) by 10-20%, were stable in area 7, and declined in remaining areas. The broad pattern here is of stock improvement in the south but decline in the north so that there was no overall statewide change.
- Both the catch rate and stock abundance (exploitable biomass) for the 2011/12 quota year were at or below the limit reference in three of the areas (2, 4 and 5) and abundance was below the reference in area 10. This was an improvement from the previous year when six areas were below the limit reference for catch rate and abundance.
- 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 TACC reductions. An interim target for stock rebuilding of 1.2 kg / potlift by 2019 is in place which is on the path towards maximum economic yield. Trends in the stock in this year were consistent with rebuilding to that target.

Ecosystem effects of fishing

- There were no notable trends in by-catch or by-product data.
- There were no reported protected species interactions.

Evaluation of Future Harvest Strategies

The harvest strategy evaluation indicated that TACCs of 105 kg / unit (equivalent to a TACC of 1103 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 (including periods of both high and low recruitment) noting that undersize length frequency data contributes information on future recruitment in projections;
(ii) no expansion of catch beyond changes in the TACC (i.e. 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 don’t include gains in stock productivity from the commercial scale translocations operations that commenced in 2012 – this equated to stock rebuilding roughly equivalent to what would occur with a reduction in the TACC of 5 kg / quota unit).

These assumptions exist because of the inability to predict future values of factors such as coverage of MPAs and urchin barrens or change in catch of other sectors. This uncertainty is appropriately included in the decision making process where the probability of meeting reference points in the future is required to be either 70% or 90%, depending on the reference point. This conservative approach provides protection against declines in productivity that could occur through processes such as expansion of urchin barrens, increase in natural mortality or decline in recruitment.

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	99% probability with TACC = 105 kg / unit; 95% probability with TACC =110 kg / unit
	• Target reference point: 70% probability of rebuilding to 05/06 peak in 8-10 years	91% probability at TACC =105 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: 70% probability of 1.2 kg per pot lift by 2019	80% probability at TACC = 105kg / 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 1.2 million animals. In the 2011/12 season 235 licensed vessels reported catches of rock lobster, a decrease of one from the previous year. In addition, there were 19,285 licensed recreational fishers during 2012 which was down from 19,530 the previous year. The recreational catch and regional distribution data used in modelling for this assessment was taken in 2008/2009 when an estimated 107 tonnes were 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. Following this period the stock began to decline which resulted in reductions in the total allowable commercial catch (TACC) by 420 tonnes (28%) since 2008/09 (Figure 3, Table 2).

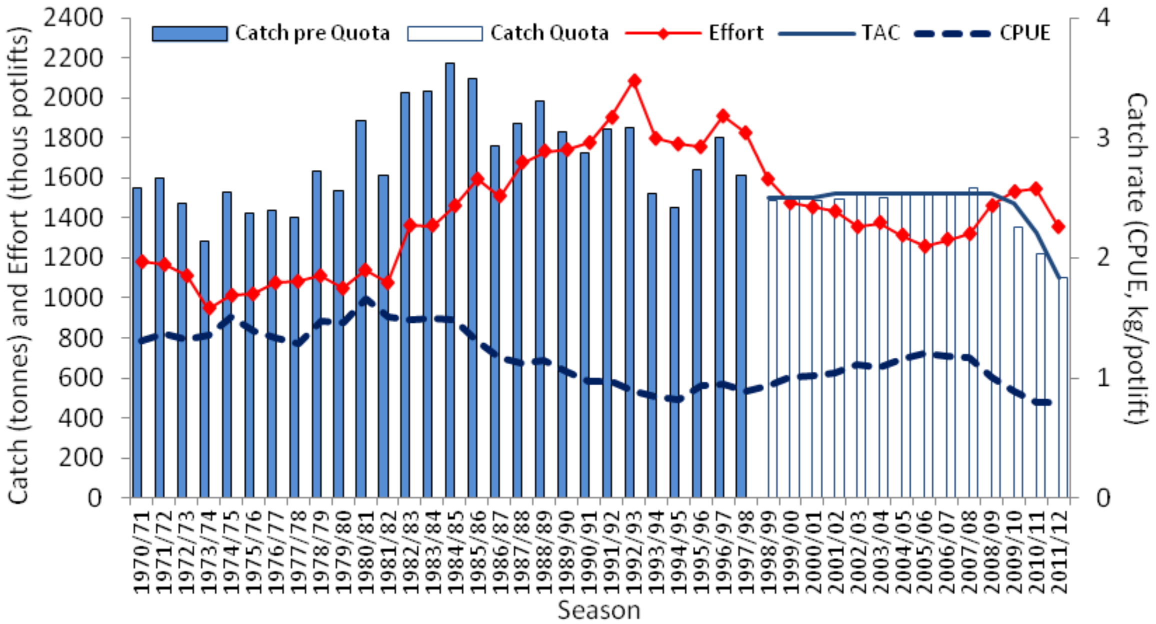


Figure 1. Historical commercial fishing effort (pot-lifts), catch (pre and post quota, tonnes), CPUE (kg/potlift) and TACC (tonnes).

The post quota recovery can be seen in the historical trends in the fishery (Figure 1 and Figure 2). The estimated total legal biomass showed a decline from 2006/07 to 2010/11 but showed no change in the past season. Trends in legal biomass and catch rates are roughly similar although with some important differences. In the period of stock re-building 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 was 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 constrained the catch with only 1-2% un-caught. In 2008/09 the TACC was not taken but this was not a true “under-catch” because carry-over provisions were in place at that time which allowed fishers to catch some of their allocated quota in the following year. Those provisions have now been removed. During the 2009/10 and 2010/11 quota period the percentage of the TACC caught declined to 92%, which was partially due to low catch rates but also influenced by the dynamics of the quota lease market. Fishers can operate profitably at much lower catch rates than occurred in these years, as evidenced by the adjacent fishery in Victoria where catch rates fell to around half of those here. In a quota-managed fishery the fisher’s decision to go to sea and catch quota is influenced by the market price for lease quota. Thus the functioning of the quota lease market and the price demanded also contributed to the under catch in the two years. The TACC was fully caught in the 2011/12 season (Figure 3).

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).

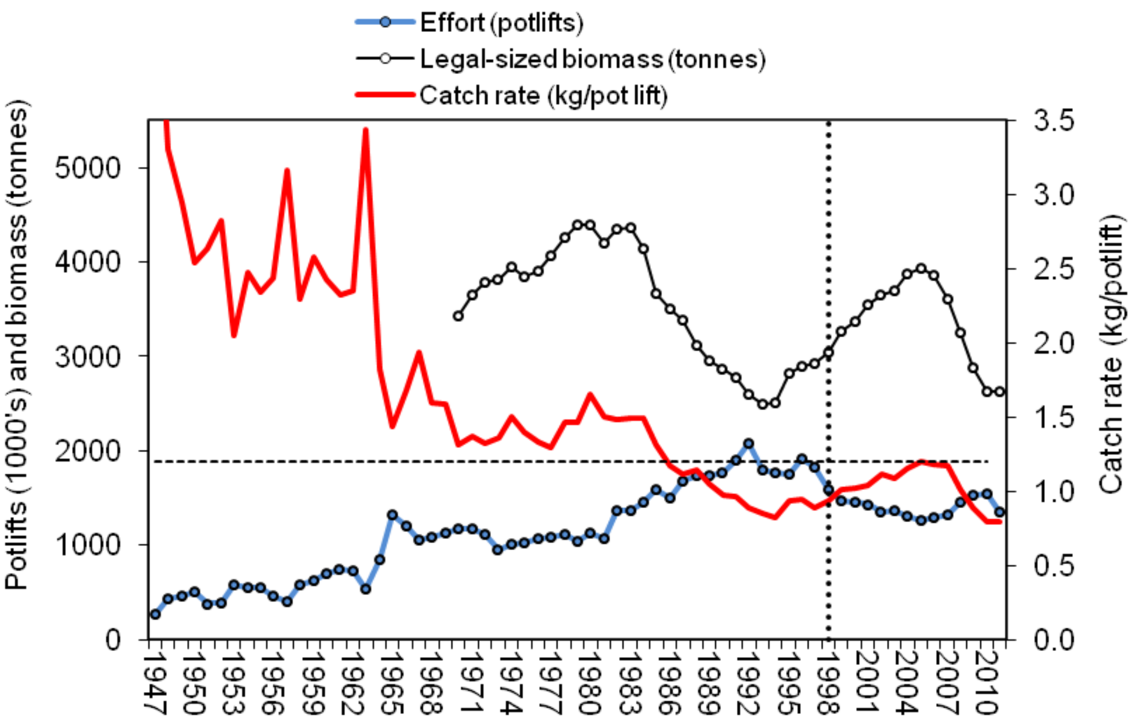


Figure 2. Historical trends in estimated fishing effort (pot-lifts), estimated catch-rate (kg/pot-lift) and estimated legal-sized biomass (tonnes). Data is in quota years (Mar to Feb) from 1970 onwards. Catch rate and effort are inversely correlated through the series. Dashed lines indicate the introduction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

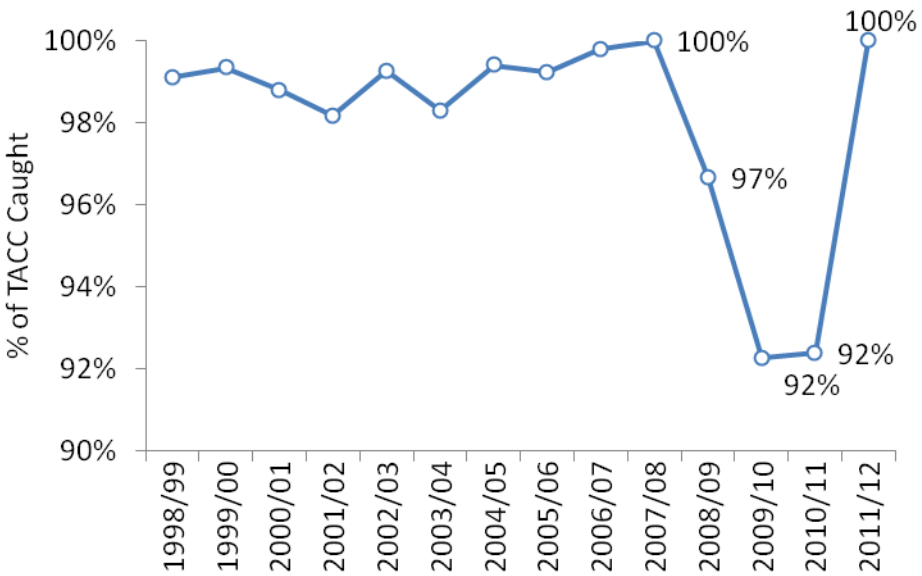


Figure 3 Percentage of the TACC caught during each quota period. The 2008/09 under catch was largely function of carryover provisions in place at that time. In 2009/10 and 2010/11 the TACC did not constrain the catch.

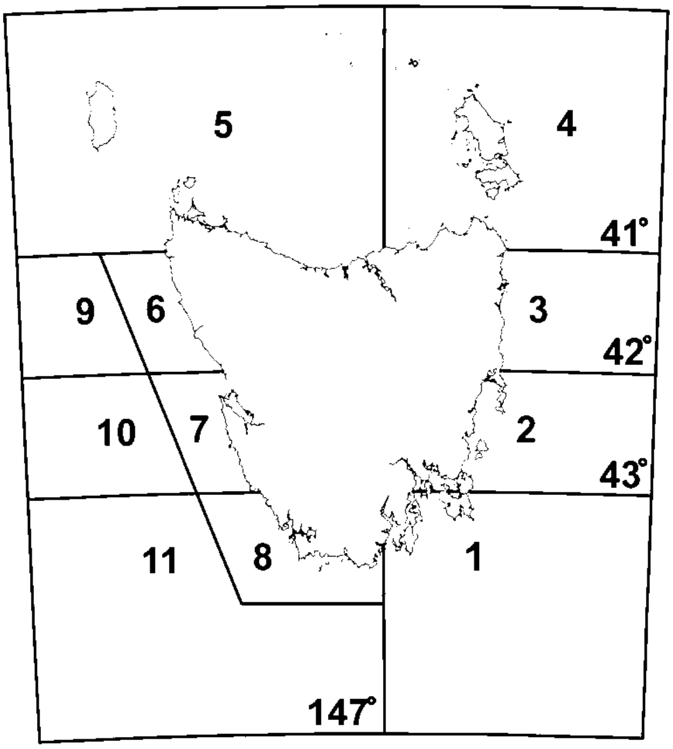


Figure 4. Schematic boundaries of the Stock Assessment areas and indicative area of State waters for the rock lobster fishery, provided by the offshore constitutional settlement (OCS).

1.1 Performance measures

A summary of outcomes against formal performance measures is presented 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.

LRPs tend to be associated with management objectives related to biological sustainability. For some performance measures only the LRP is relevant. For example, it would be illogical to have a target for optimal egg production because egg production is reduced with any level of fishing mortality – hence highest egg production occurs when there is no fishery. So in this case we accept that egg production will be reduced by fishing but use a LRP with the objective of preventing depletion to the point that recruitment could become reduced. The use of LRPs to prevent recruitment overfishing is consistent with the National Status of Australian Fish Stocks report which defined the status of "recruitment overfished":

"*the spawning stock biomass has been reduced through catch, so that average recruitment levels are reduced"* (ABARE, 2012).

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

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

Management action is intended to be more forceful in achieving LRPs than TRPs 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 Tasmanian lobster fishery at present, although data is collected and reported for protected species interactions, by-catch and by-product.

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 it was unclear what level was of concern and could be used as an 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. 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 (e.g. Frusher *et al.*, 2003). Change in the fleet distribution had 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 held stable for the first decade but was lowered by 13% over the two seasons 2009/10 and 2010/11and a further 17% reduction for the 2011/12 quota season 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 is required 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%	**0%**
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 of 1104t for 2011/12 was equivalent to and thus constrained by the TACC (Figure 5). This followed three consecutive years where the TACC was substantially undercaught with the uncaught proportion around 8% despite reductions in the TACC (Table 2).

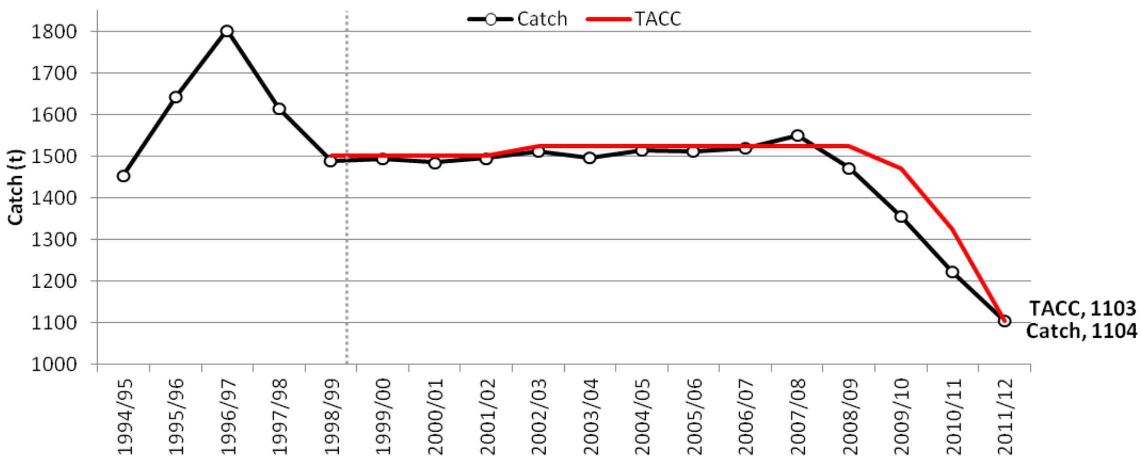


Figure 5. Commercial catch reported through catch and effort logbooks. These differ slightly from the TACC because of carry-over provisions and under-catch.

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 2011/12 quota year of 0.76 kg/potlift was at the lowest level in the recorded history of the fishery (Table 3). Monthly catch rate for 2011/12 was close to the previous year's catch rate throughout the season (Figure 6). Although catch rate was low, the decline has stabilised which was consistent with the expectation from previous stock modelling. Catch rates can thus be influenced by factors unrelated to abundance and for this reason trends in biomass derived from the assessment model shown later in the report provide 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 2011/12 the level of effort was 76% of the effort expended in 1996/97 and a decrease from the previous year (Table 3). This indicates that there was further capacity to expand effort if the catch rate fell.

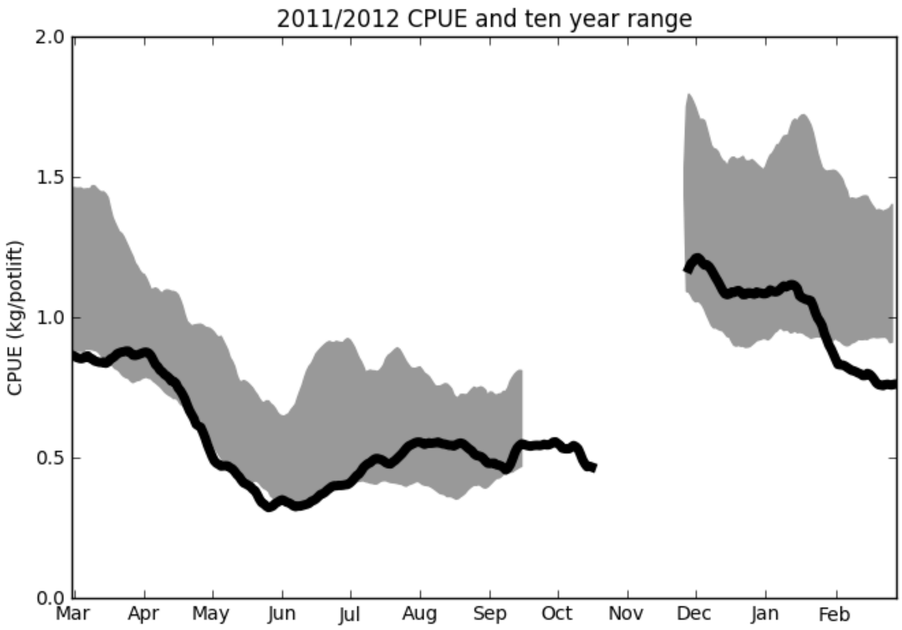


Figure 6 Monthly catch rate for 2011/12 (black line) compared with range from the previous decade.

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
2011/2012	1104	1452	76.0	0.79

3.1.2 Active vessels

A reference point of 220 active licences was established with the QMS 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 increased the profitability of lease fishers, which has attracted new entrants to the fishery. This has reversed the decline in number of active vessels seen during the early 2000's but stabilised during the last season with 235 vessels reporting catch, down one vessel from the previous year. The average number of days fished by vessels decreased to 128 days, a significant reduction (Table 4).

These changes show 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 creates an undersupply of vessels, improves business conditions for new entrants, and the number of active vessels increases.

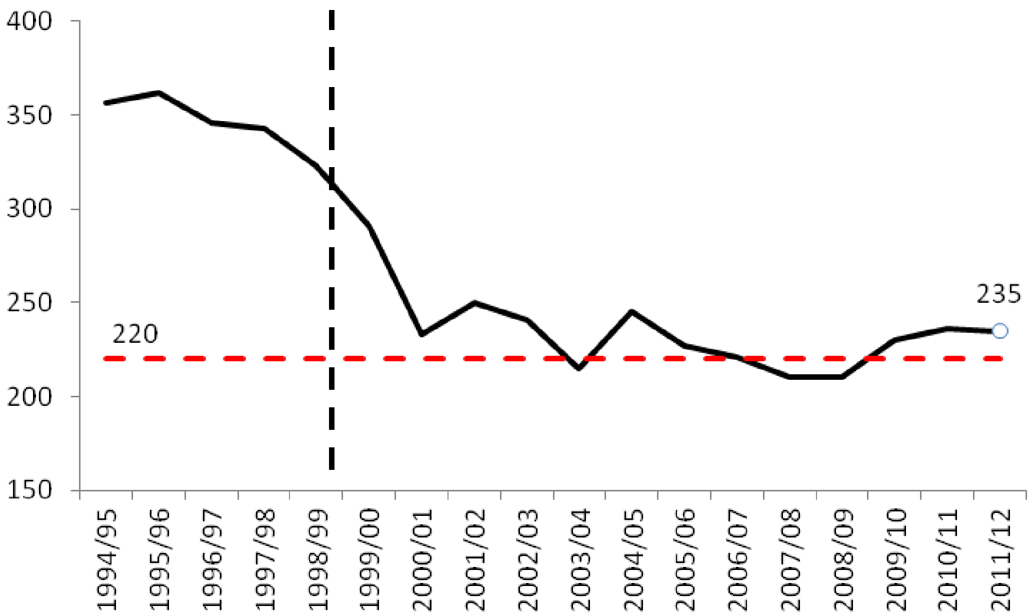


Figure 7. Number of active vessels reporting rock lobster catch. The dashed red line is the reference point (220) introduced at the start of the QMS in 1998 (dashed black vertical line).

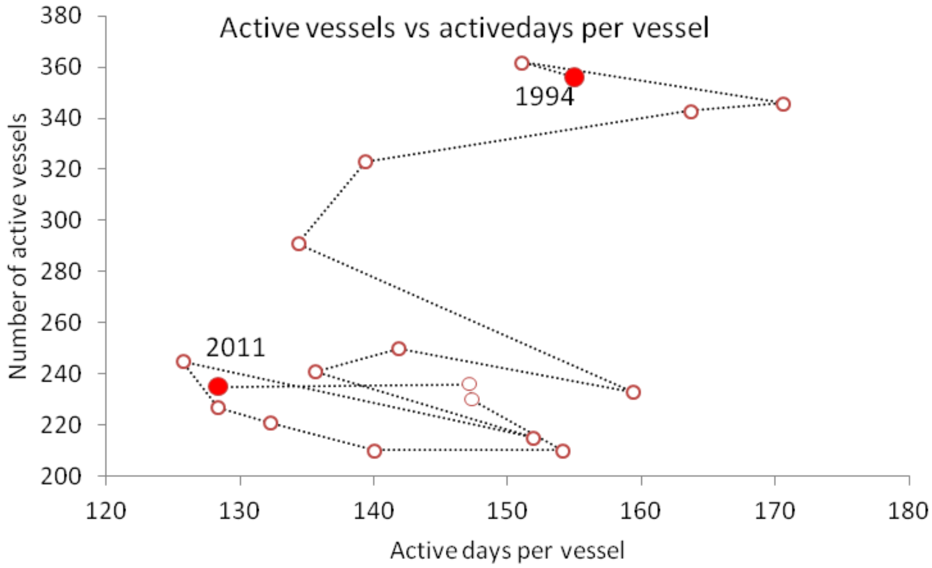


Figure 8. Number of vessels reporting rock lobster catch in relation to the days fished per vessel. Upper and lower constraints on vessel activity affect the overall fleet size.

Table 4. Number of active vessels reporting catch of rock lobsters 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
2011/12	235	128

3.1.3 Regional commercial catch and effort

During the 2011/12 quota year the TACC was reduced by 17% from the previous year and the State-wide catch decreased by 10%. Effort decreased by 11%, the first reduction in four years (Table 5). Catches from areas 2 and 10 were much reduced (27-39%) and corresponded to similar reductions in effort 22 – 33%). Effort declined by at least 7% in the north west and western areas (5–11) with the inshore west areas (5-7) showing reduced catches.

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	2011/12	2010/11	% change	2011/12	2010/11	% change
State-wide	1,068	1,207	-12%	1,355	1,529	-11%
1	76	84	-9%	147	179	-18%
2	56	90	-39%	99	147	-33%
3	52	51	3%	94	90	4%
4	123	144	-15%	187	185	1%
5	279	340	-18%	302	331	-9%
6	74	83	-11%	85	93	-9%
7	98	118	-17%	86	93	-7%
8	220	206	7%	261	275	-5%
9	31	30	2%	25	28	-11%
10	10	13	-27%	9	12	-22%
11	50	47	7%	45	49	-9%

State wide catch rate fell slightly to 0.76 kg/potlift and remains the lowest on record (Table 6). Catch rates from southern areas (1, 8 and 11) increased by 10-20% and all other areas except 9 showed decreases.

Table 6. Annual commercial catch-rates for the whole State and each area for the 2011/12 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 (2010/11). * 2011/12 is the lowest year.

	Commercial catch rate (kg/potlift)				% change	
AREA	Lowest Year	Lowest CPUE	CPUE 2010/11	CPUE 2011/12	vs lowest year	vs 2010/11
State-wide	2011	0.79	0.79	0.79	*	0%
1	2010	0.47	0.47	0.52	10%	10%
2	1994	0.54	0.61	0.56	4%	-8%
3	1994	0.43	0.56	0.56	30%	-2%
4	1994	0.61	0.78	0.66	7%	-16%
5	1995	0.89	1.03	0.93	4%	-10%
6	2011	0.87	0.89	0.87	*	-3%
7	2010	1.10	1.10	1.11	1%	1%
8	2010	0.67	0.67	0.80	20%	20%
9	2010	1.10	1.10	1.26	14%	14%
10	2002	0.94	1.13	1.06	13%	-6%
11	1993	0.83	0.96	1.13	36%	18%

The following assessment overviews (Figure 9 - Figure 14) 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 – 2011/12). 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 important observations were:

- catch declined in seven of the eleven areas;
- catch rate and abundance for the 2011/12 quota year were at or below the limit reference in three of the areas (2, 4 and 5) and abundance was below the reference in area 10. This was an improvement from the previous year when six areas were below the limit reference for catch rate and abundance.
- abundance decreased in areas 2, 4, 5, 10 and 11 by 3-17% and increased in areas 1, 6, 7 and 8 by 5-12%;
- Areas 8, 9, 10 and 11 had large increases in catch rate (22-45%).

Large increases in monthly regional effort were seen in areas 4, 5, 6 and 9 between August and October (Figure 15) while annual effort declined in the latter three. The decreases in effort from areas 1 and 2 occurred mainly between May and December. Similar effort decreases in areas 7-11 were during November and December (Figure 15). The August - October effort increases in areas 5, 6 and 9 resulted in higher catches (Figure 16). East coast areas 1-3 catches were lower during January and February as were all other inshore areas during January (Figure 16).

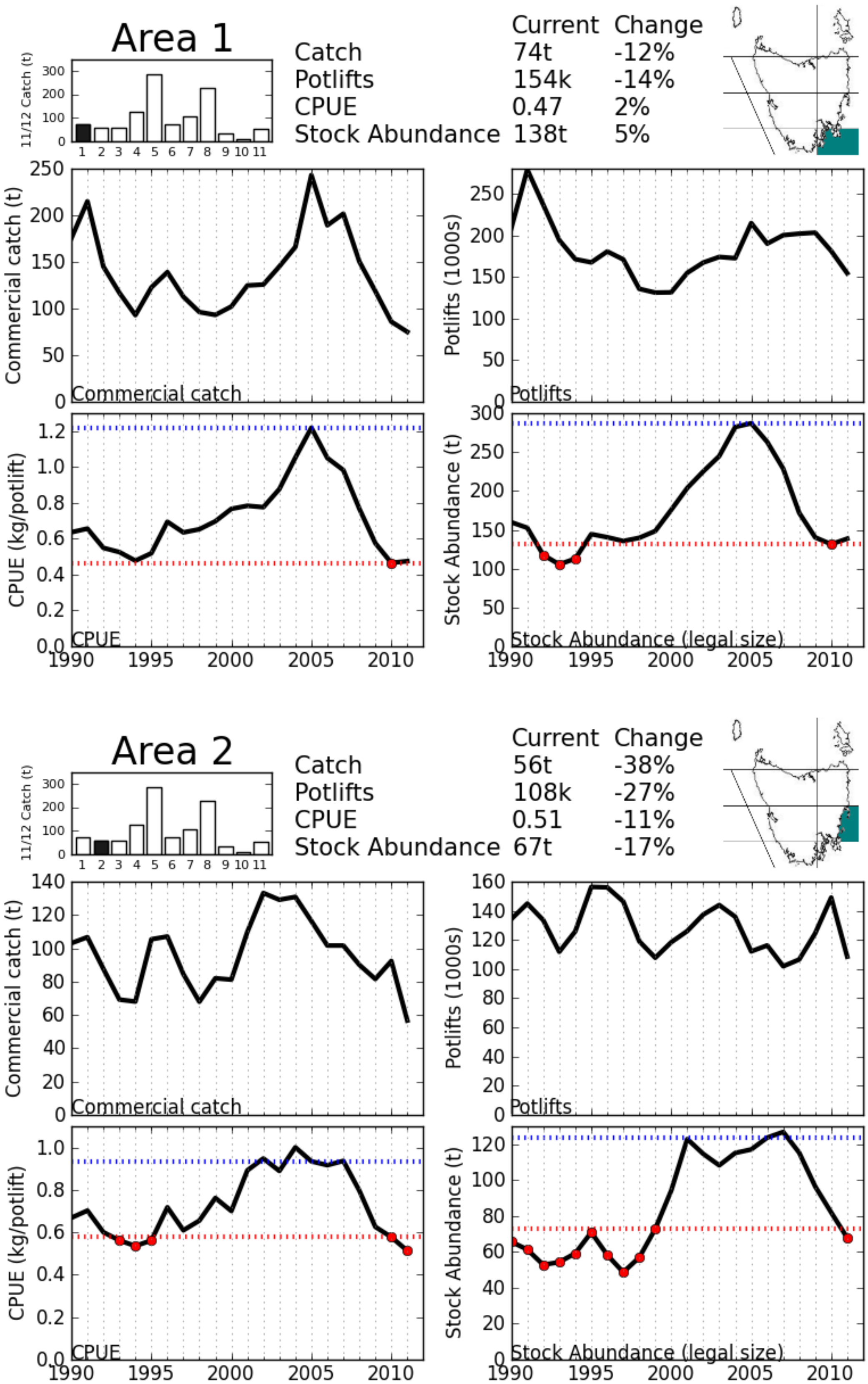


Figure 9 Areas 1 and 2 summary. In each, the top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

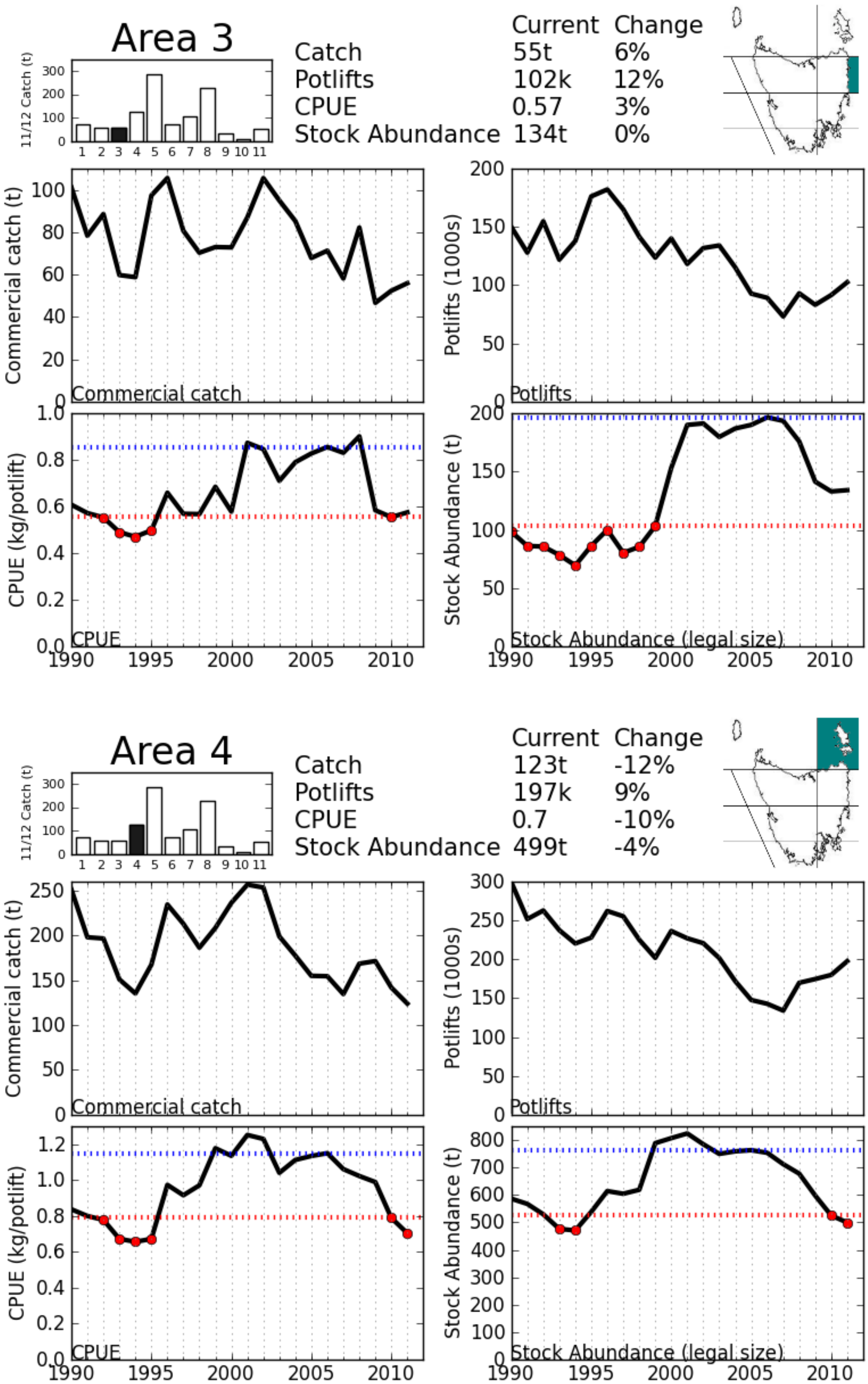


Figure 10 Areas 3 and 4 summary. In each, the top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

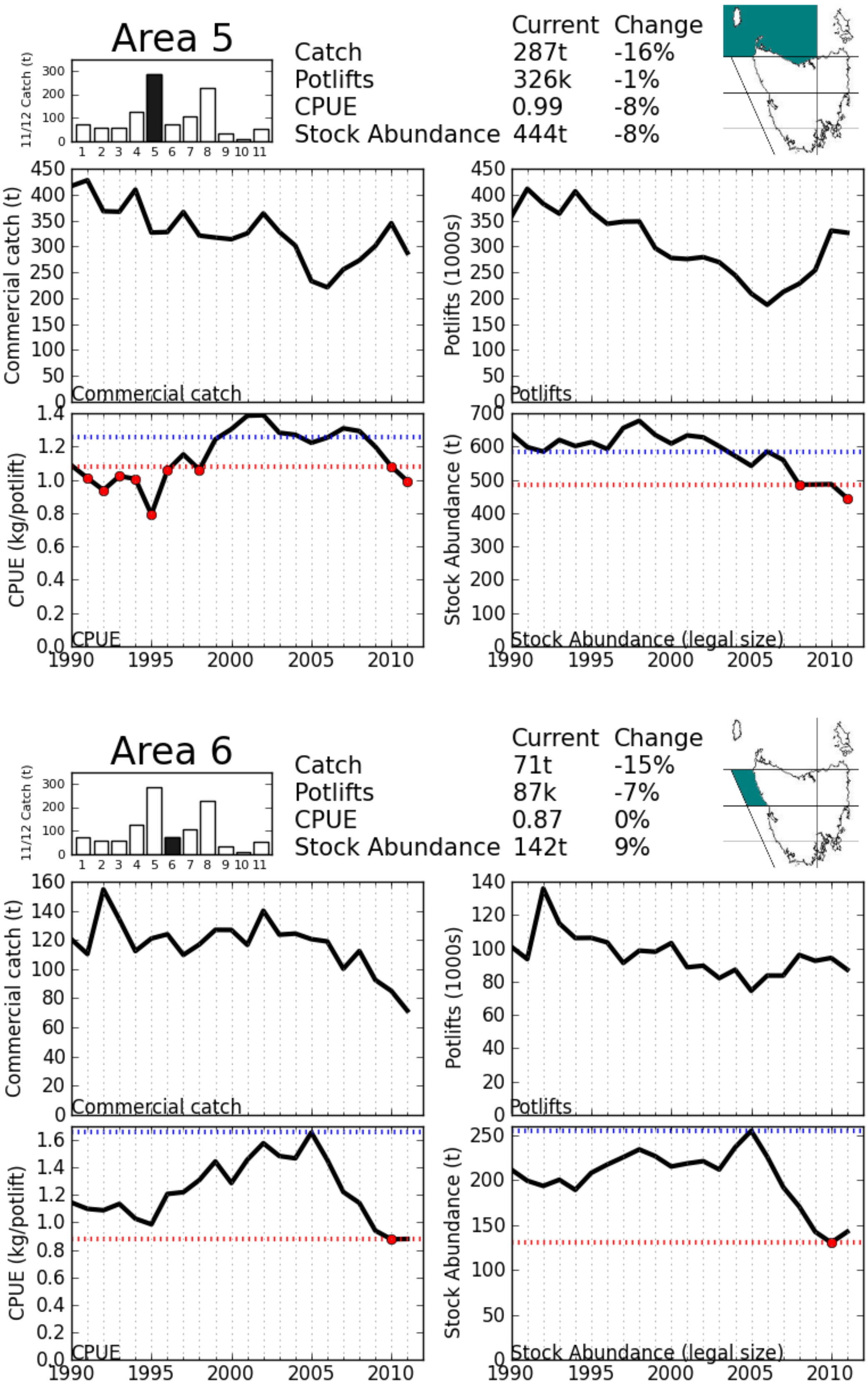
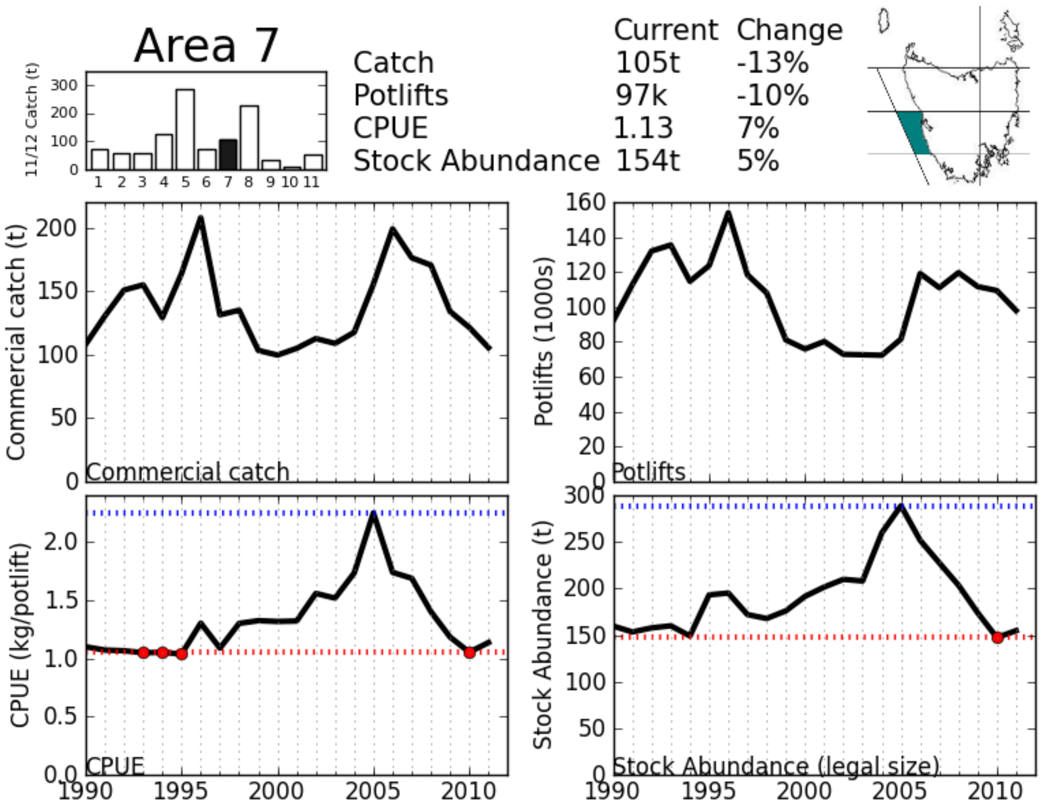


Figure 11 Areas 5 and 6 summary. In each, the top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.



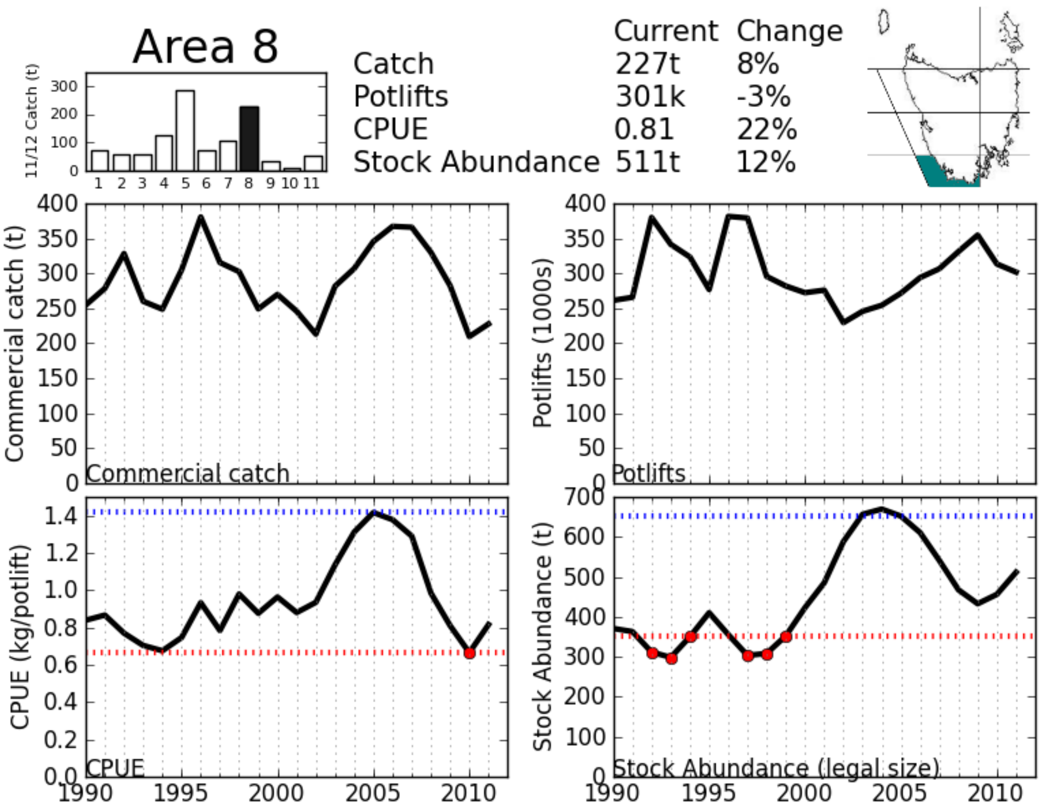


Figure 12 Area 8 summary. Top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

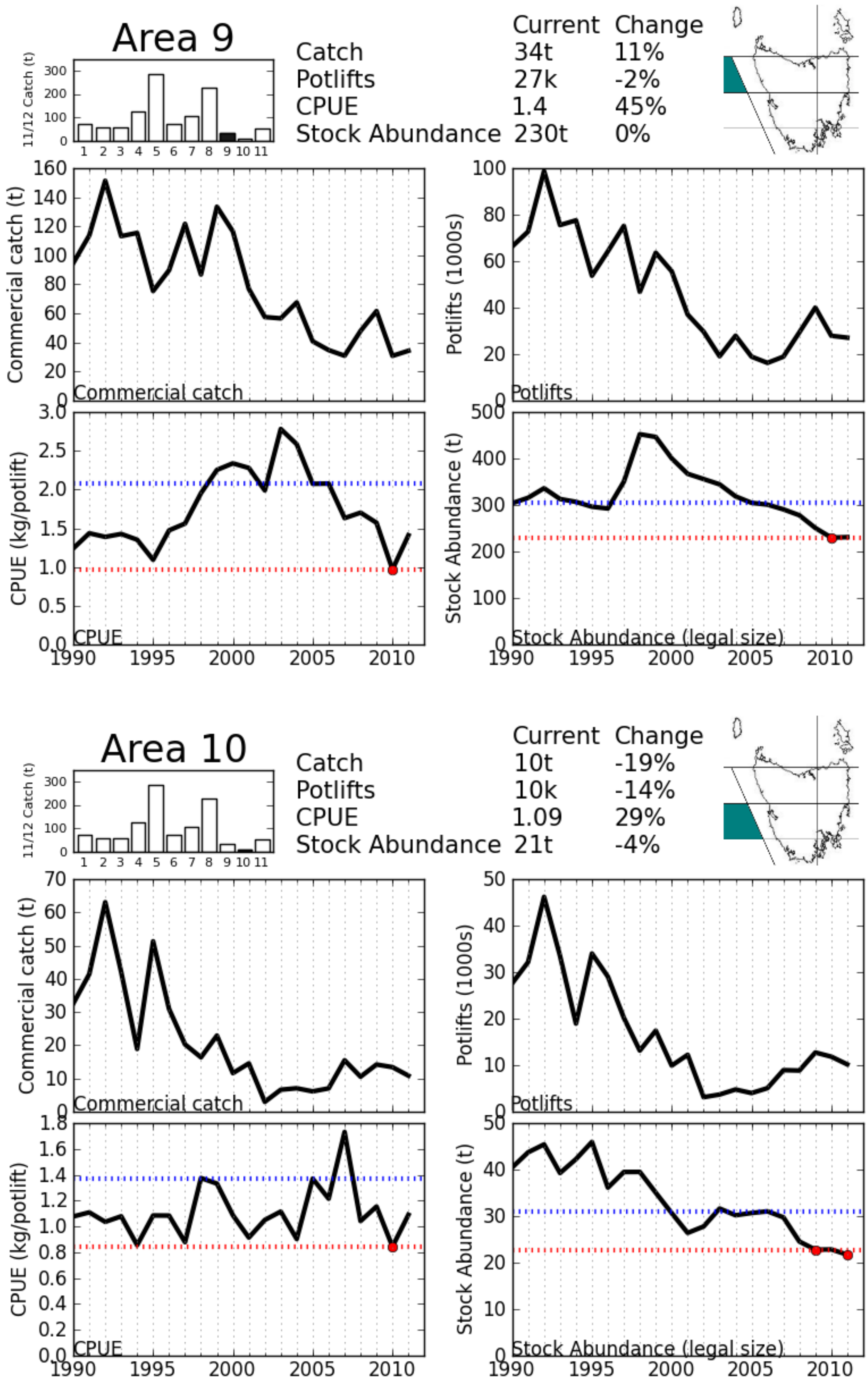


Figure 13 Areas 9 and 10 summary. In each, the top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

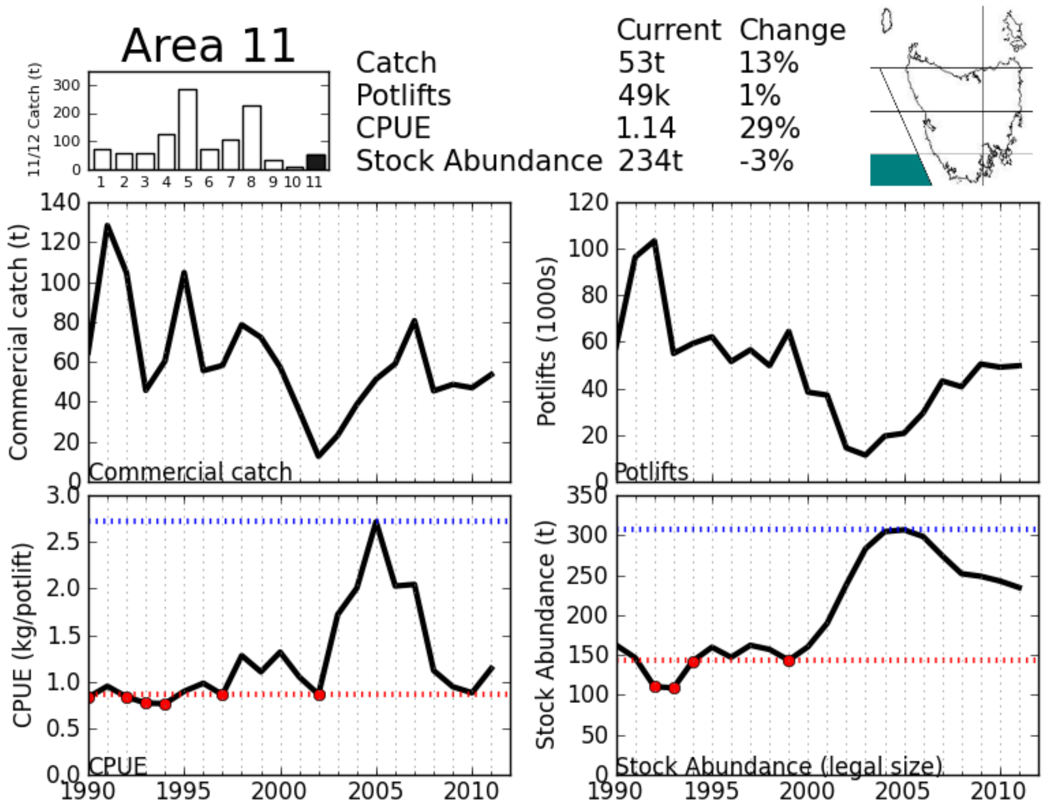


Figure 14 Area 11. The top left bar graph shows the Area's relative catch; centre table shows current statistics and change over the past year; the Area's location is shaded top right; blue and red dotted horizontal lines show target and limit reference points respectively.

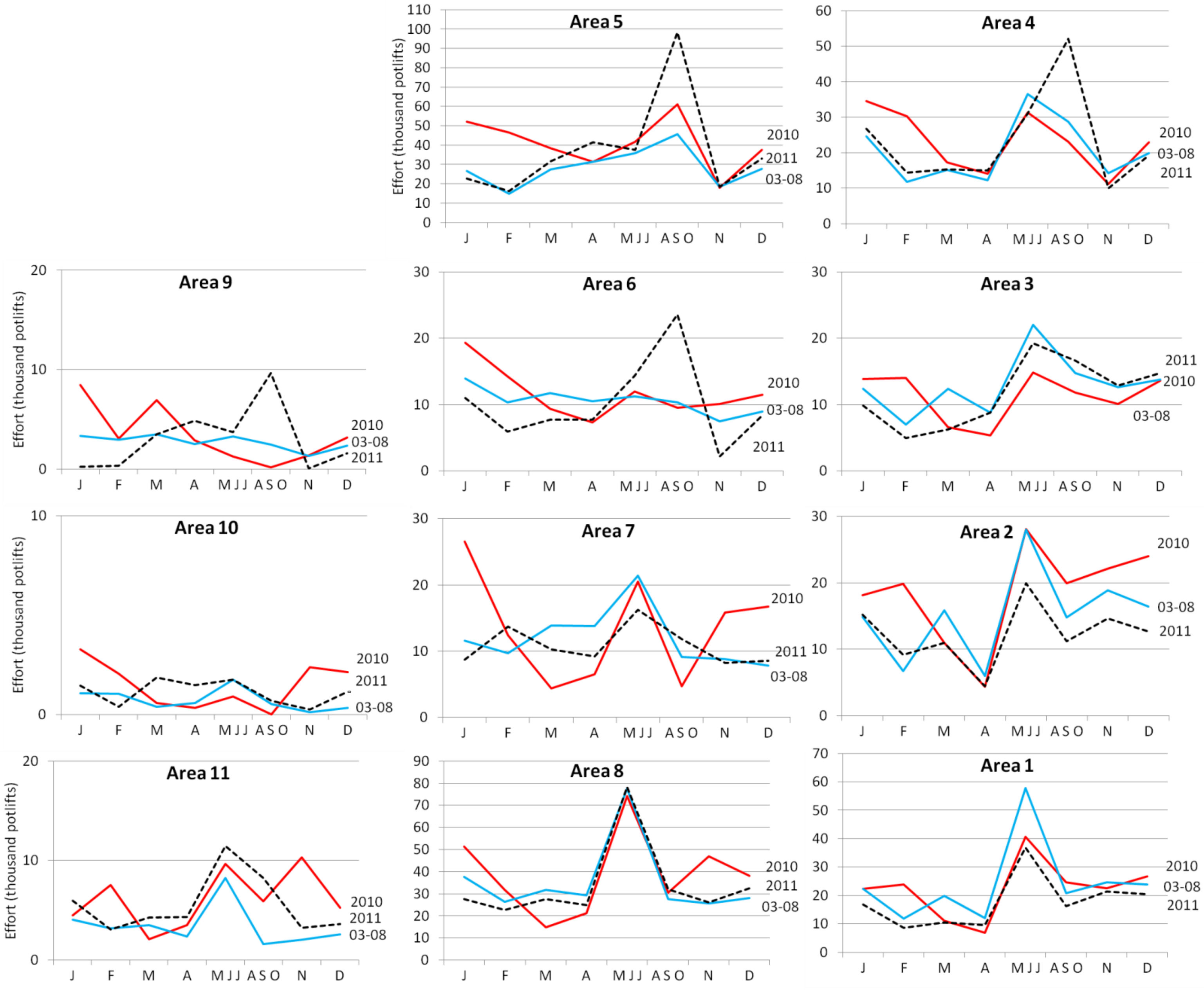


Figure 15. Monthly regional commercial **effort** (thousand pot lifts) for three time periods; 2010/11 (red line), 2011/12 (dashed line) and the mean of the quota years 2003/04 – 2008/09 (blue line).

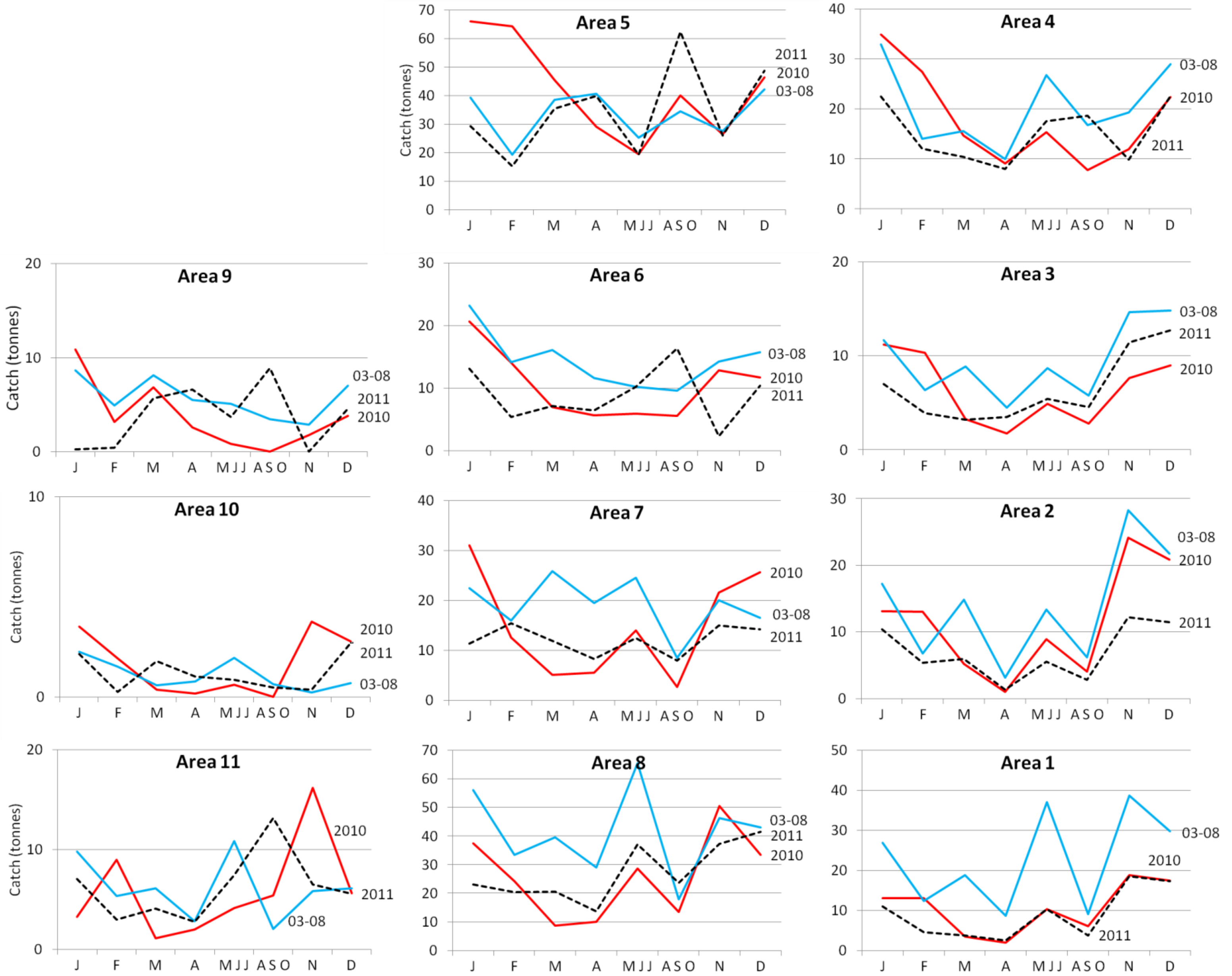


Figure 16. Monthly regional commercial **catch** (tonnes) for three time periods; 2010/11 (red line), 2011/12 (dashed line) and the mean of the quota years 2003/04 – 2008/09 (blue line).

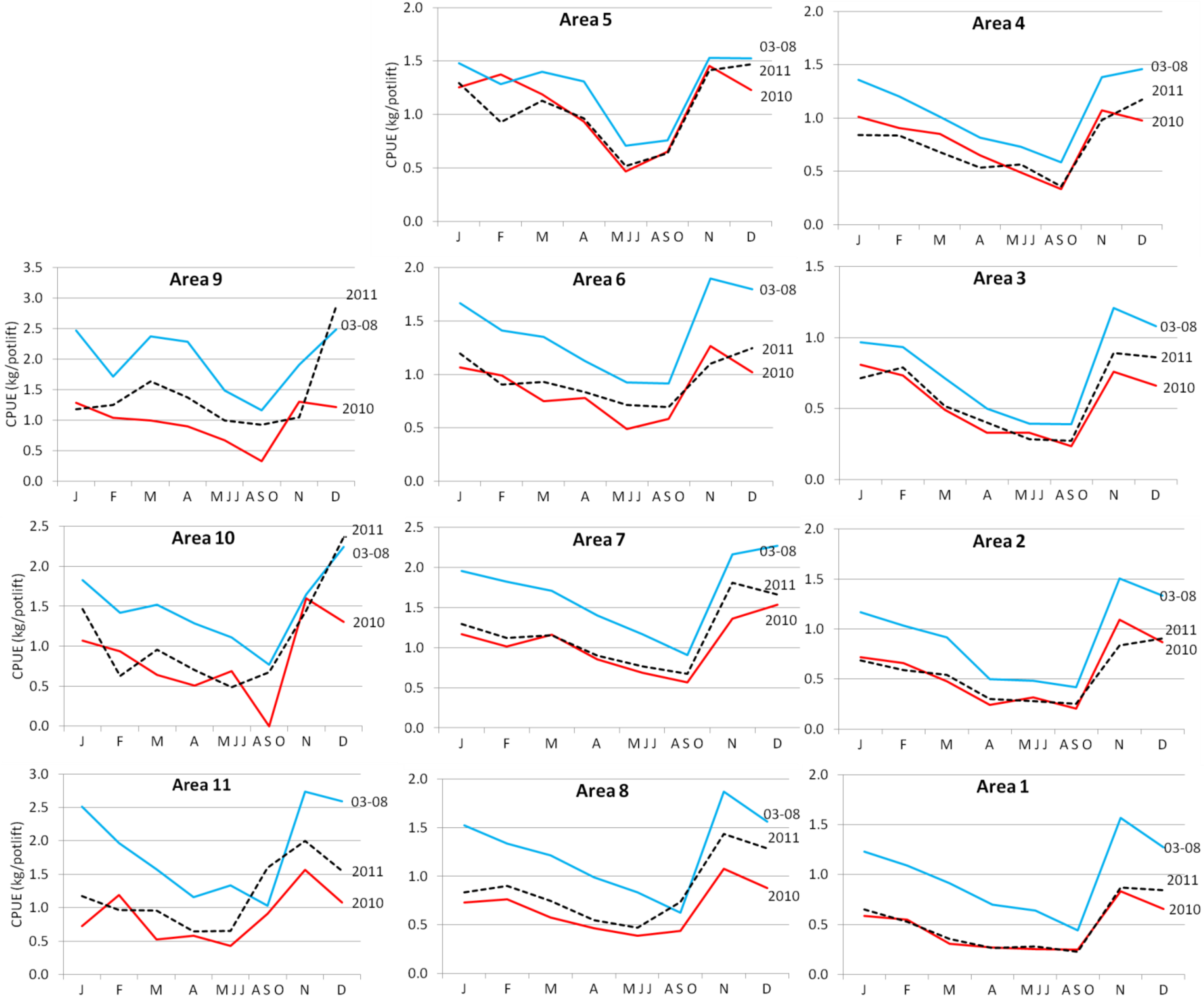


Figure 17. Monthly regional commercial **catch rate** (CPUE, kg/pot lift) for three time periods; 2010/11 (red line), 2011/12 (dashed line) and the mean of the quota years 2003/04 – 2008/09 (blue line).

3.1.4 Mean weight

The mean weight of lobsters in catches has slowly increased in recent years to maximum values around 2009 in most inshore areas (Figure 18). This is a complex performance measure to interpret because an increase in average weight could be due to either a reduction of fishing mortality or a reduction in recruits. Mean weight has declined markedly over the past couple of years in the northern higher growth areas 4 and 5. Mean weight also declined in areas 7, 8 and 1 while areas 2 and 3 and deep western areas 9-11 have stabilised.

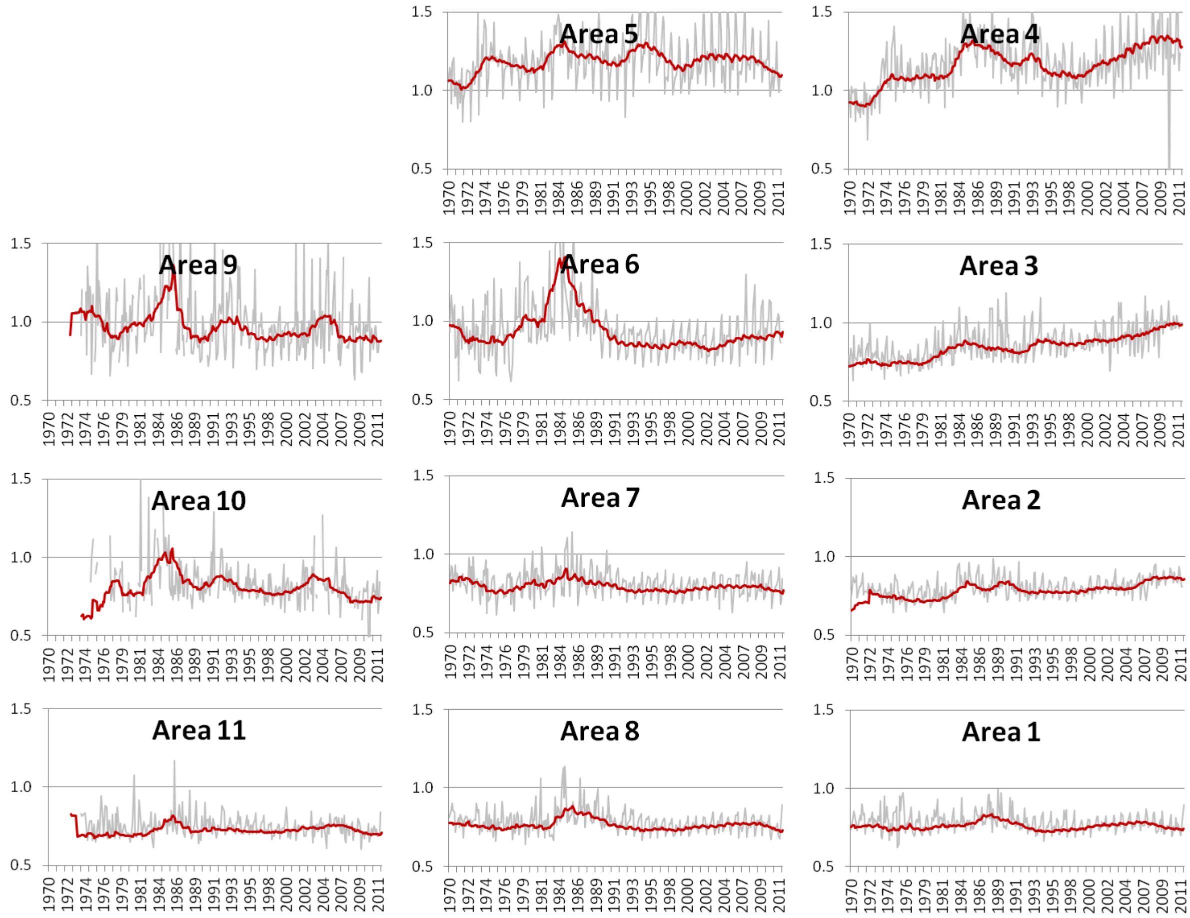


Figure 18. Mean weight of lobsters (red line) by quota year and assessment area. Monthly trend shown in grey.

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 because there were a few instances of well mortalities being discarded and the scale of this loss was questioned. This practice would lead to the underestimation 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 2011/12 was only 2.2 t and less than the previous year which was 2.6 t (Figure 19). These lobsters are generally sick animals or octopus kills that can't be sold into the live market.

Mortalities reported from wet wells were also trivial at 1.1 tonnes, up from 0.1 tonne in the previous year.

The commercial quota catch accounts for the majority of fishing removals followed by recreational catch, followed mortality due to octopus in commercial pots. Other sources of mortality including discard mortality are trivial.

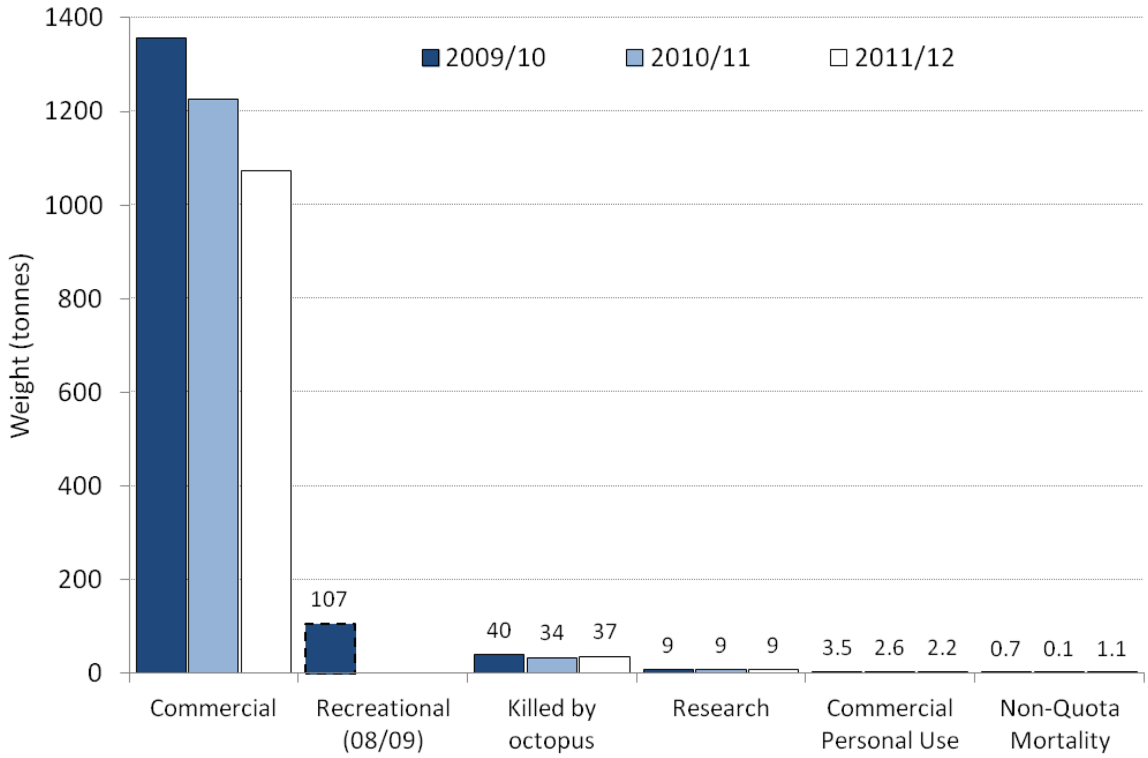


Figure 19. Different sources of lobster mortality during 2009/10, 2010/11 and 2011/12. The latest recreational catch estimate was in 2008/09; weights of octopus kills, commercial personal use and non-quota mortality estimated by multiplying reported numbers by average lobster weight.

Octopus mortalities have been relatively steady since 2004 with an average of 40,400 lobsters per year, representing 3.5% by number of lobsters retained (up from 2.8% previous year). Total number of lobsters reported killed by octopus in 2011/12 was 41,651, which was a 14% increase from the previous year but still within the normal range over the longer period (Figure 20). Higher mortalities occur in the north western area 5 and the southern areas 1 and 8 (Figure 21).

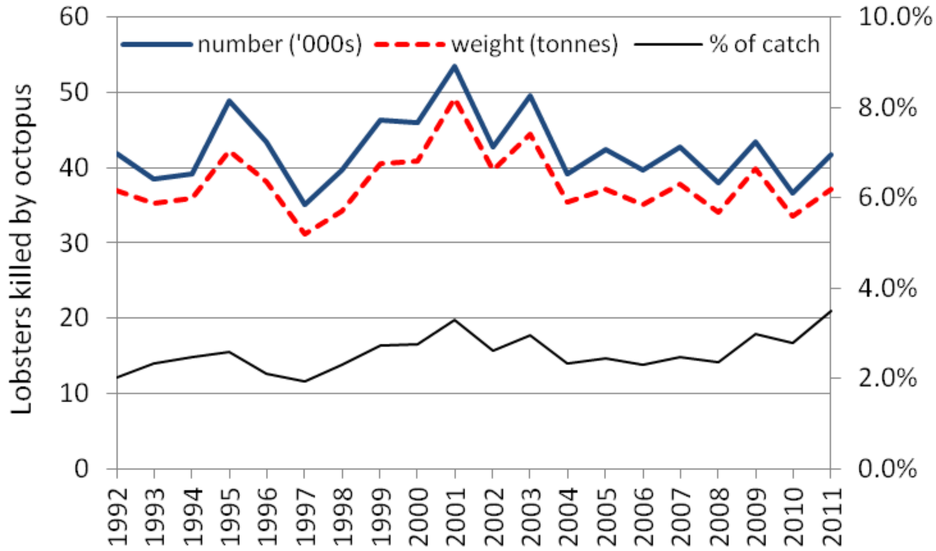


Figure 20. Trends in reported lobster mortalities due to octopus predation. Mortality in tonnes is calculated using the average weight of lobsters for each year.

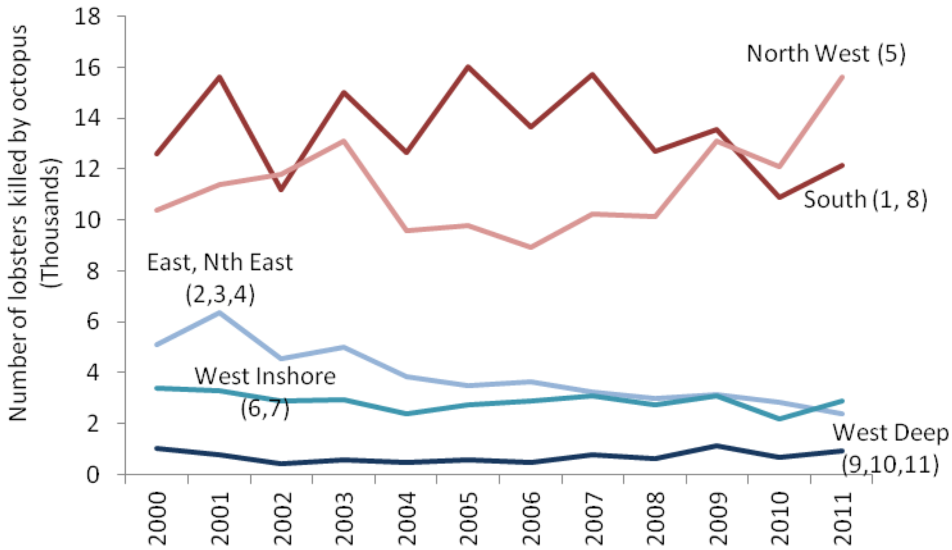


Figure 21. Number of lobster mortalities due to octopus predation by selected regions.

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). Estimated recreational catches increased steadily in each survey from 1992 until 2002/2003 and have since decreased to 107 tonnes in the latest survey in 2008/09. The majority of the recreational catch comes from the East coast (Table 7).

The total number of recreational licenses for rock lobster decreased over the past year by 245 to 19,285. However, each of the three licence types increased in number indicating that more fishers were using more than one gear type (Figure 22).

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. Last survey was conducted in 2008/09.

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

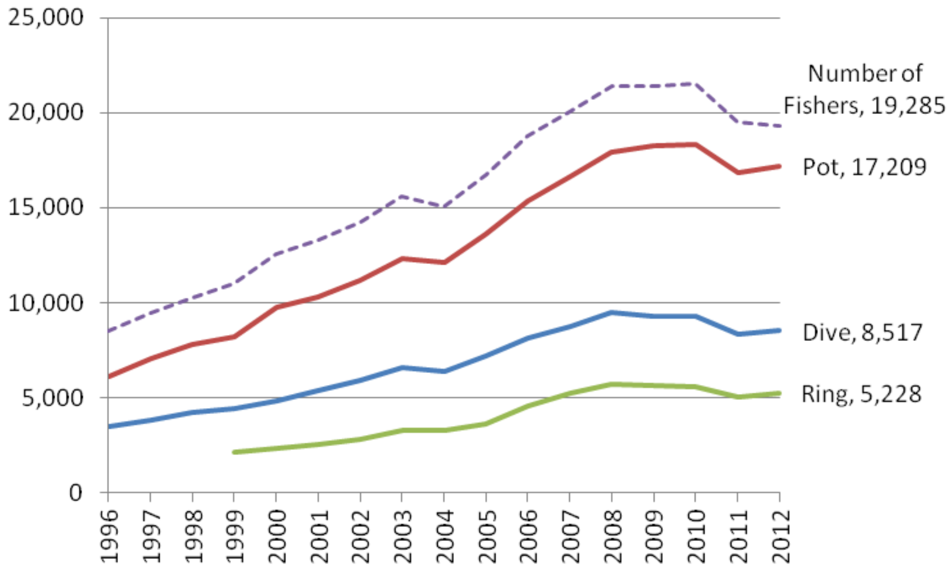


Figure 22. Trends in recreational rock lobster licenses. Fishers may hold licenses for more than one type of rock lobster gear type.

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 2011 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 do 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 2011, i.e. that the recent period of low recruitment was a random event rather than a regime shift. Note that future recruitment is constrained to some extent by the observed abundance of undersize lobsters recorded through observer sampling and fisher research pot surveys.

Projections of the fishery are based upon a randomised recruitment series, taken from years of average recruitment from 2000-2009 (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 2011/12, 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 100 kg to 110 kg 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', which the stock should be maintained above. Target reference points provide a goal to aim towards.

Stock levels were low in 1993/4 and it this year has been treated as an extreme low point, which should be avoided in the future. 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. 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 State-wide stocks (and in most areas) above the 11 year low point in 5 years (2016).

The target chosen for this assessment is to build State-wide 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. Modelling of the economic yield of the fishery shows that this is a step towards maximising the economic yield of the fishery although much higher levels of stock rebuilding should be targeted beyond that point.

Managing the stock to achieve more rapid stock rebuilding would require greater catch reductions for both sectors. Rapid change in catch leads to inefficient use of capital and adjustment can lead to economic loss – for example, vessel capital becomes underutilised and resale value of vessels plummet if the change is rapid. 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. In summary, the rate of stock rebuilding needs to be balanced to produce best outcomes for the industry.

Escalating effort and lower catches have lead to significant declines in State-wide 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 thus profit. The catch rate limit reference point in the assessment is defined as having a 90% probability of keeping the State-wide catch rate above an 11 year low point within 5 years time (by 2016). The catch rate target is a 70% probability of a State-wide catch rate of 1.2 kgs per potlift by 2019, 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, State-wide egg production limit is to have a 90% probability of being above 25% of virgin egg production in 5 years. The limits for egg production in each Area are the same except for the northern areas (4 and 5), which have an interim 20% limit. This limit is seen as an interim target with intent of eventually moving towards a limit of 25% in all areas.

3.3.2 Recruitment assumption

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

The model estimates historic recruitment data using commercial catch data and length-frequency data collected by observers and scientific sampling. An important consideration when projecting forwards is the range of years selected to represent historic recruitment. Characteristically, recruitment to this fishery occurs in infrequent large pulses with low levels of recruitment between these pulses.

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

The model uses undersize size structure data to provide information about future recruitment but there remains uncertainty about levels of future recruitment. To consider the future of the fishery with different management actions, an historic average level of recruitment is chosen, which is the 10-year period 2000-2009. 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

State-wide exploitable biomass rapidly declined since the high level reached in 2004 and 2005 and is now only 5% greater than the lowest level in 1993. It is the lowest since the introduction of QMS (Table 8).

During 2011/12, estimated legal sized biomass increased in areas 1, 3, 6, 7, 8 and 9 with areas 2, 4, 5 and 10 at the lowest levels since 2000 (Table 8).

Table 8 Legal-sized biomass estimates from 2011/12 compared with a) the previous year 2010/11, 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 2011/12 is the lowest on record.

	Lowest		Lowest		Legal size Biomass		% change in 2011/12		
Area	**Year Since 1984**	**Bio-mass**	**Year Since QMS**	**Bio-mass**	**2010/11**	**2011/12**	**since 1984**	**since 1998**	**vs 2010/11**
State	1993	2,456	2011	2,582	2,589	2,582	5%	*	-0.3%
1	1993	106	2010	131	131	139	31%	5%	5%
2	1997	49	2011	68	82	68	39%	*	-17%
3	1994	69	1999	103	133	134	93%	30%	1%
4	1994	471	2011	500	525	500	6%	*	-5%
5	2011	445	2011	445	487	445	*	*	-9%
6	2010	130	2010	130	130	143	9%	9%	9%
7	2010	147	2010	147	147	155	5%	5%	5%
8	1993	299	1999	353	456	512	71%	45%	12%
9	2010	230	2010	230	230	231	0%	0%	0.4%
10	2011	22	2011	22	23	22	*	*	-5%
11	1993	109	1999	144	243	235	115%	63%	-3%

State-wide legal size biomass projections against the limit reference point at the required 90% probability show that at each level of TACC tested (100, 105 and 110 kg/pot), the biomass is currently below the limit, but is rebuilding and will exceed the limit reference by 2016 (Figure 23). Projections for the target reference point at the required 70% probability show that TACC's of 100, 105 (status quo) and 110 kg/pot all exceed the target reference point within 10 years (top, Figure 23). In both projections the limit and target reference points are reached earlier with the 100 kg/pot TACC. The projections are based on the assumption of ongoing translocation of 100,000 lobsters per year.

Regional legal size biomass varies and areas respond differently to changes in the TACC with some rebuilding more rapidly (Figure 24). Areas 1, 8, and 11 remain well above the limit reference point at each level of TACC however areas 2 and 4 fail to reach the limit at 90% probability even at the lowest TACC of 100 kg/pot (Figure 24, Table 9).

The current TACC meets the exploitable biomass limits and targets while increasing the TACC to 110 kg/pot only marginally exceeds the target reference point (Table 9).

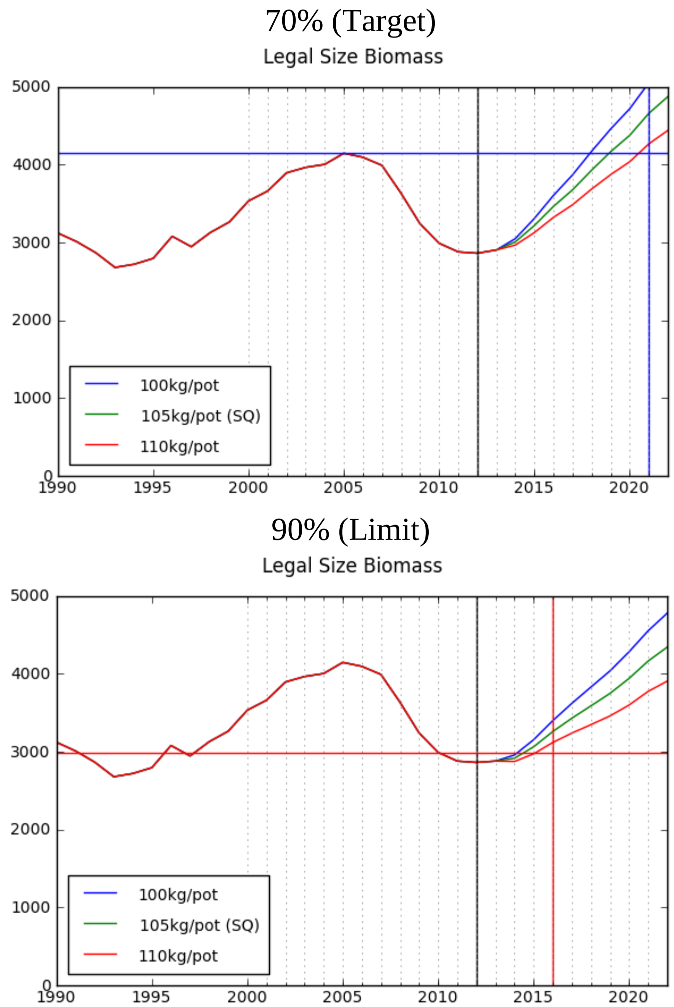
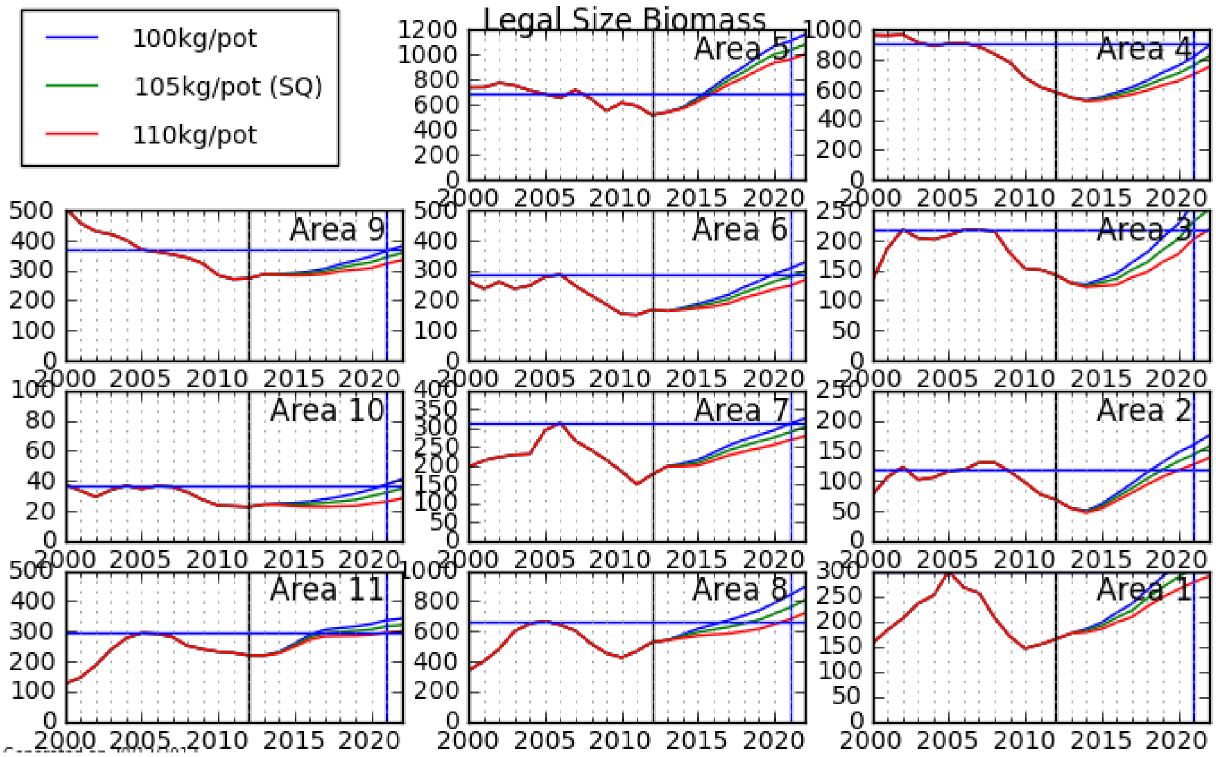


Figure 23 State-wide legal size biomass projections showing the limit and target reference points with 70% probability projections (top); limit reference points with 90% probability (bottom). Horizontal lines – target (blue) and limit (red) reference points. Vertical black line – current year; vertical red and blue lines – timeline for limit and target.

70% (Target)



90% (Limit)

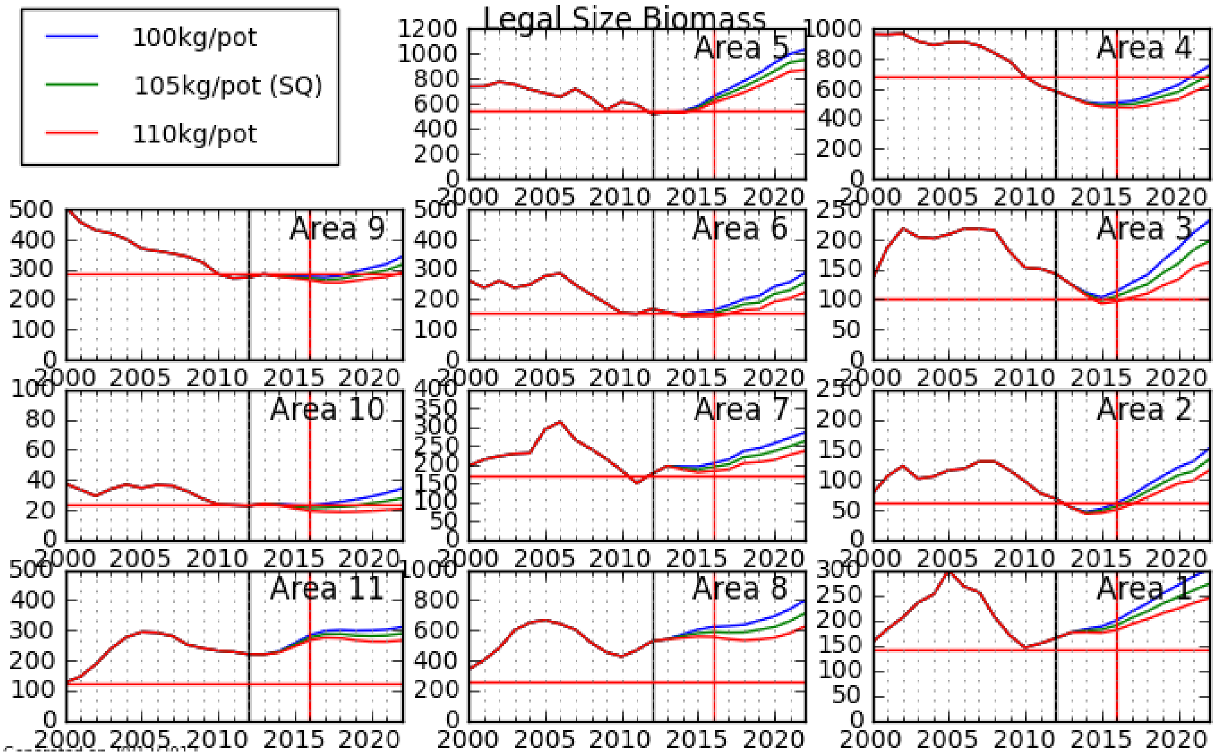


Figure 24 Legal size biomass projections for each area with a TACC from 100-110 kg/pot. Vertical black line is the current year; vertical and horizontal red lines show limit reference points and blue line show target reference points. Plots show projections at 70% target (top) and 90% limit (bottom).

Table 9. Probability of different TACC options meeting the defined reference points in the required time frame. Individual cells are coloured red/orange 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.

Reference Point	Level	Year	110kg/pot	105kg/pot (Status quo)	100kg/pot
Exploitable Biomass Limit	90%	2016	95	99	100
Exploitable Biomass Target	70%	2021	76	91	96
CPUE Target	70%	2019	63	80	93
Egg Production Limit	90%	2016	100	100	100

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 and thus the source of larvae seems to vary 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, State-wide spawning biomass or egg production has fallen over the last few years but is currently above 40% which exceeds the 25% reference point and is maintained at each level of TACC tested (Figure 25). 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. State-wide egg production is well above the limit reference point projections at each of the TACCs (Figure 25). Each of the TACC options met the State-wide egg production limit reference point (Table 9).

Spawning biomass in areas 2-5 is currently below the limit reference and does not reach the limit by 2016; areas 6, 7, 9 and 10 are close to the reference and show small improvements over time; areas 1, 8 and 11 well above the reference point (Figure 26). 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.

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).

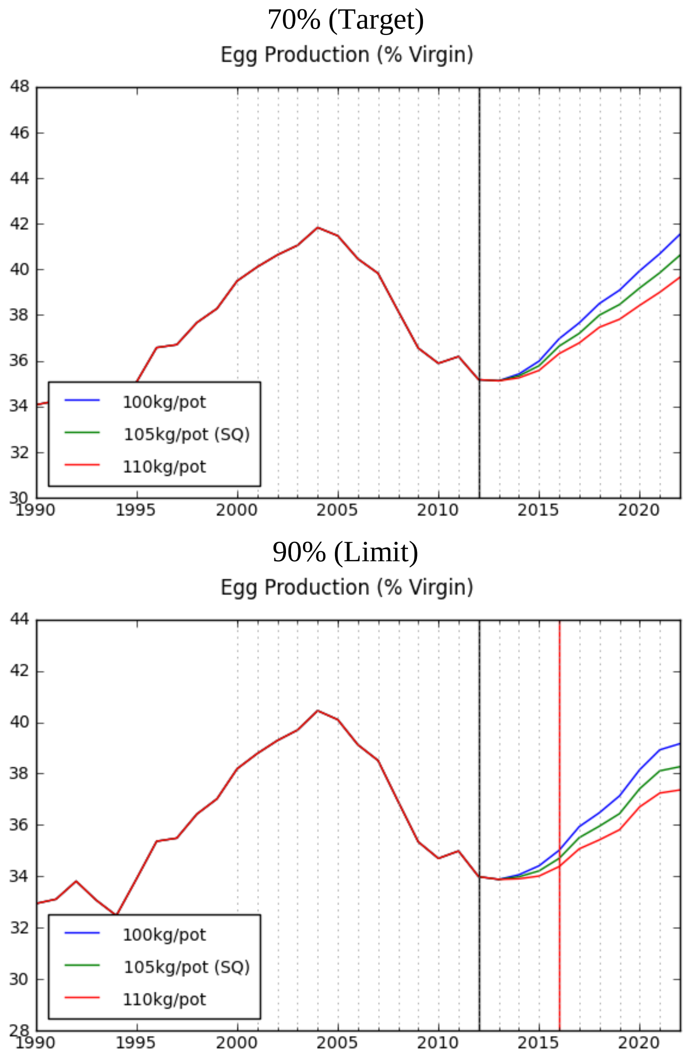
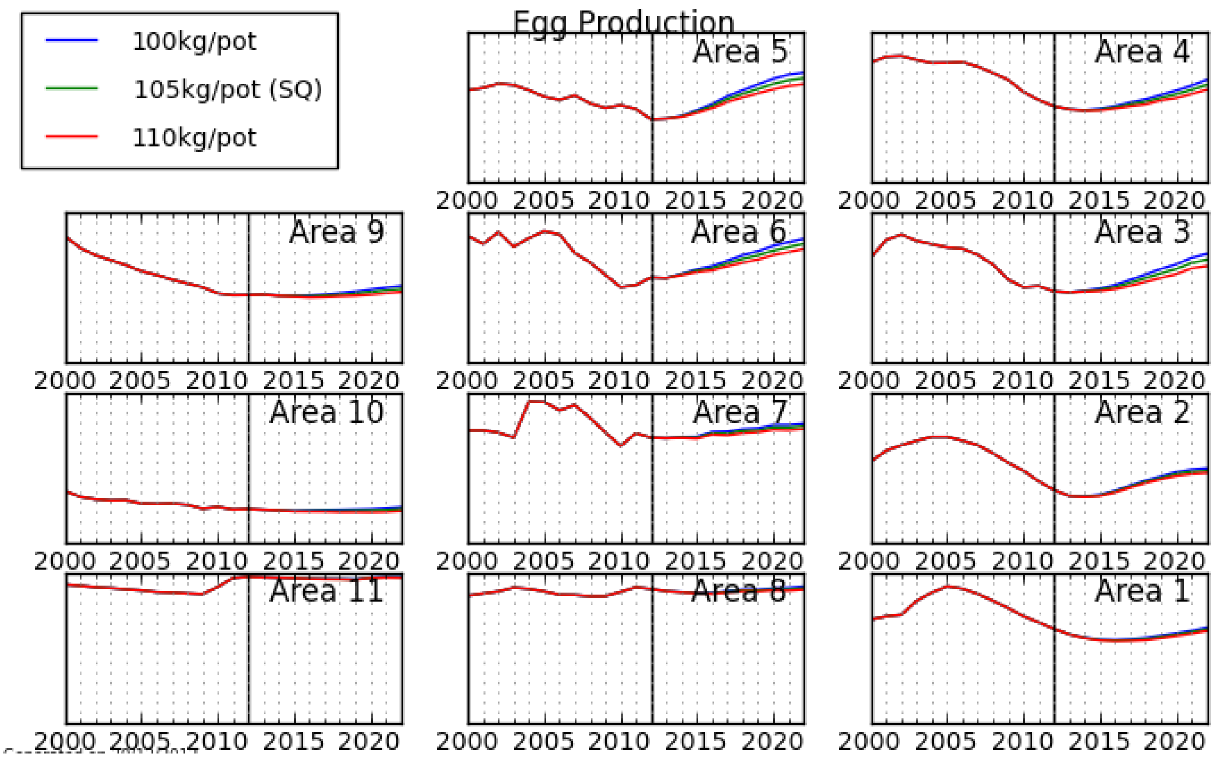


Figure 25 State-wide egg production projections. The limit reference point of 25% is below the range of the plots and no target was considered. The top plot shows 70% probability projections; limit reference points with 90% probability by 2016 (bottom). Vertical black line – current year; vertical red– timeline for limit reference point (2016).

70% (Target)



90% (Limit)

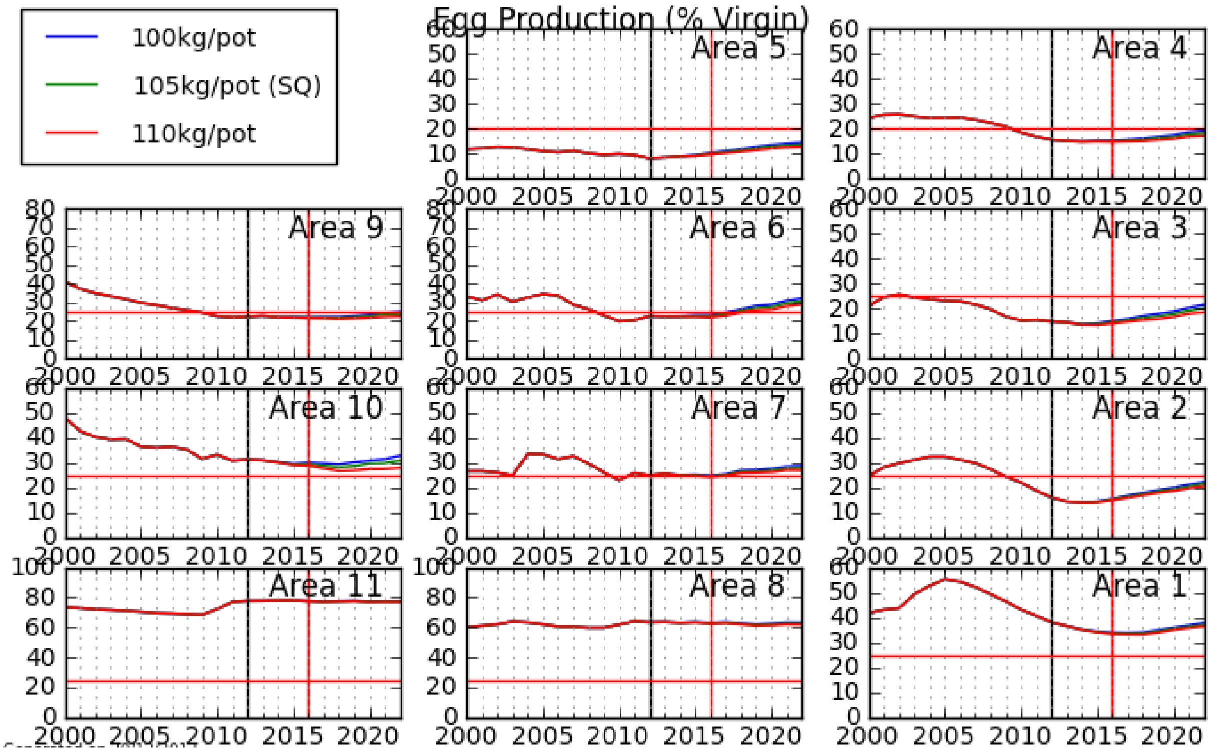


Figure 26 Egg production projections for each area with a TACC from 100-110 kg/pot. Vertical black line is the current year; vertical and horizontal red lines show limit reference points. Plots show projections at 70% target (top) and 90% limit (bottom).

3.4.3 Catch rate trends (CPUE)

The target catch rate (1.2kg/pot) is not reached (at the 70% probability level) by 2019 for 110kg/pot TACC and at 90% probability the 110 kg/pot TACC only just reaches the limit in 2016 (Figure 27,Table 9).

Catch rate projections at 90% probability show six areas with an initial decline below the limit reference and then rebuilding (Figure 28). The 70% projections show all areas reaching the target at under the three TACC options.

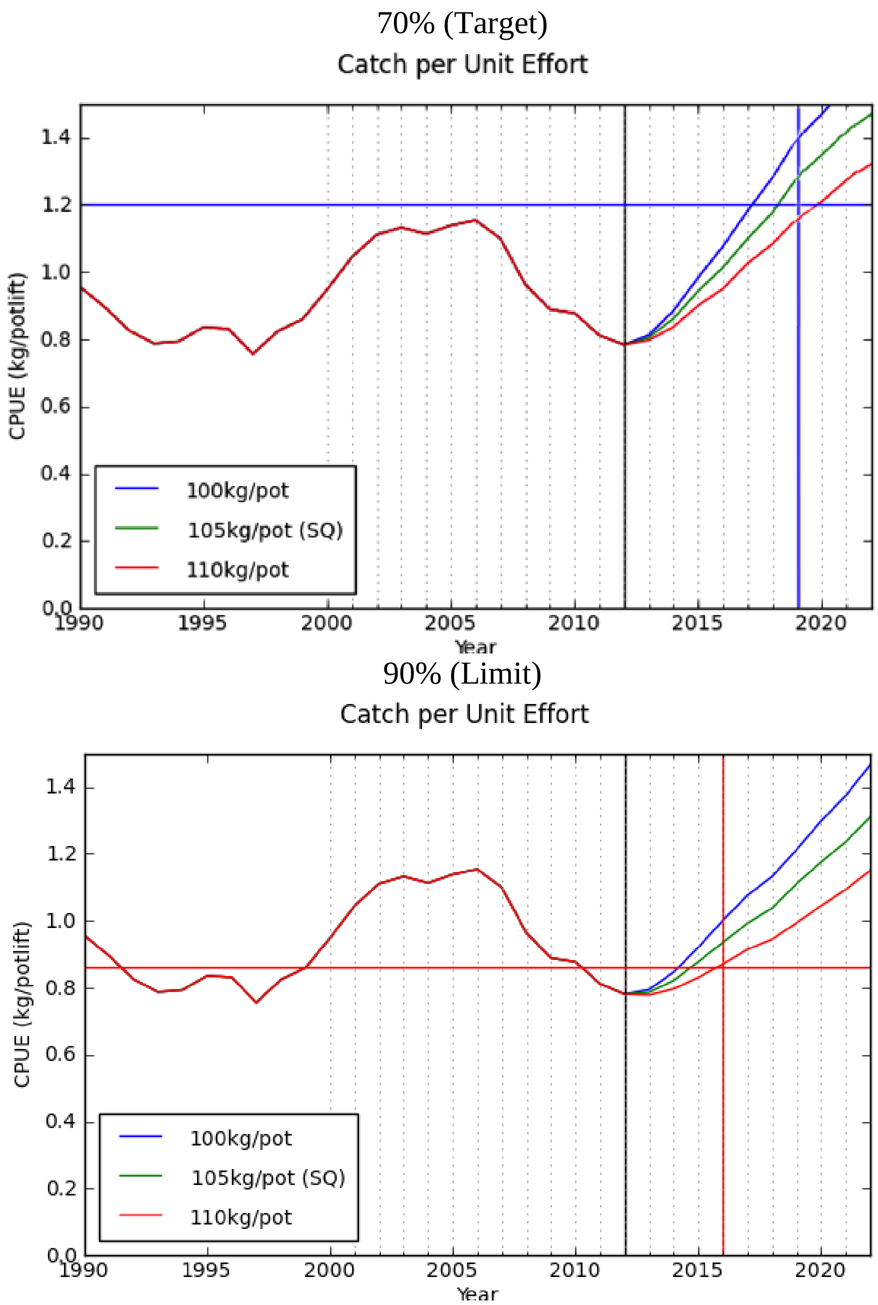
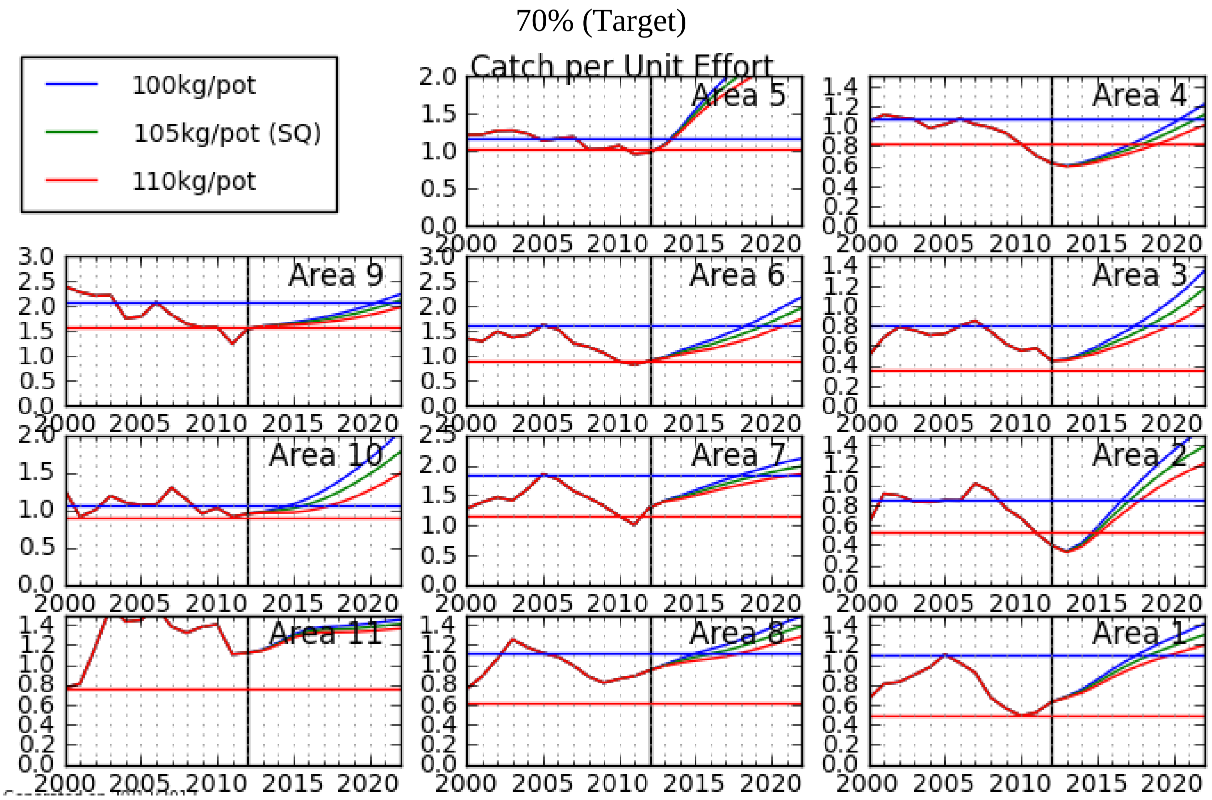


Figure 27 State-wide catch rate projections showing the limit and target reference points with 70% probability projections (top); limit reference points with 90% probability (bottom). Horizontal lines – target (blue) and limit (red) reference points. Vertical black line – current year; vertical red and blue lines – timeline for limit and target.



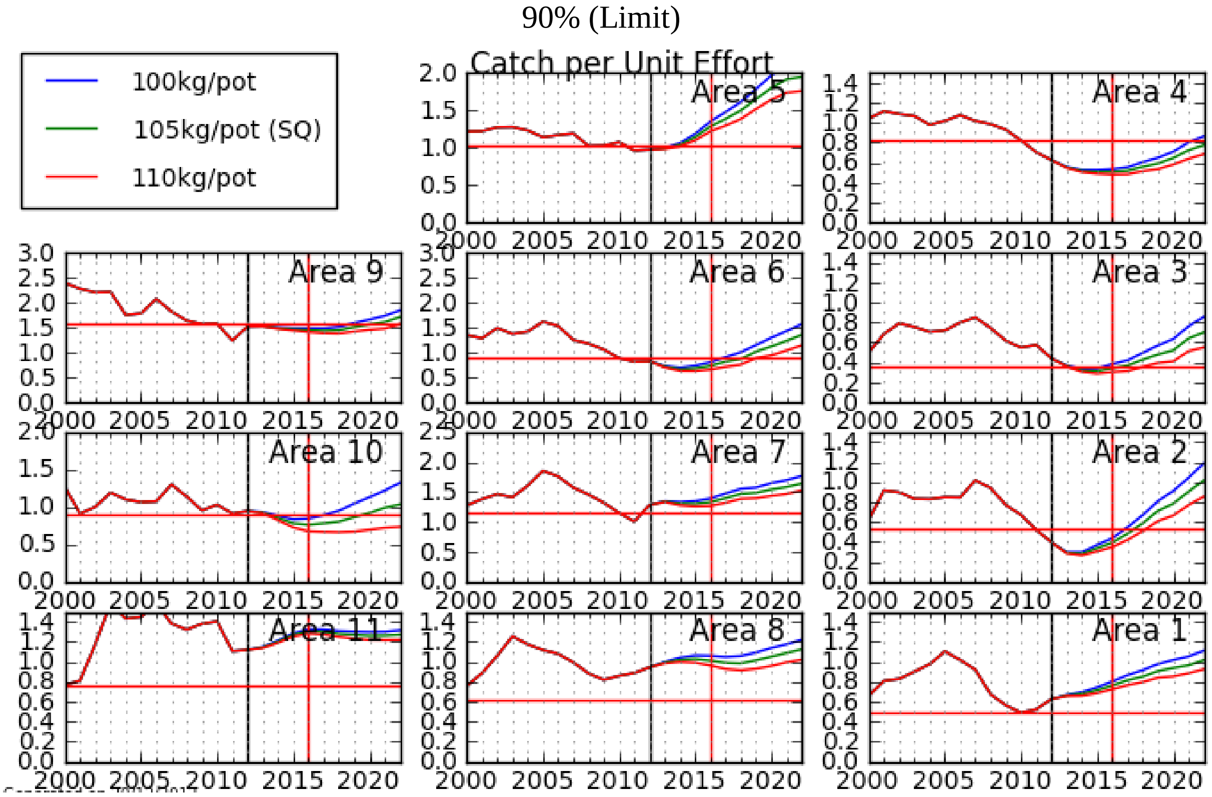


Figure 28 State-wide catch rate projections for each area with a TACC from 100-110 kg/pot. Vertical black line is the current year; vertical and horizontal red lines show limit reference points and blue line show target reference points. Plots show projections at 70% target (top) and 90% limit (bottom).

3.5 Recruitment

Recruitment to the fishery is an important determinant of future production and is thus of great interest to assessment and management of the fishery. Management regimes have limited ability to influence recruitment but can control 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 recent decline in the fishery was driven by a prolonged period of very low recruitment from 2006. This low recruitment to the fishery was exceptional and had 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. 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 except area 7 for recent years (Figure 29). This is an unusual pattern – historically low recruitment in one area tended to be offset by high recruitment elsewhere.

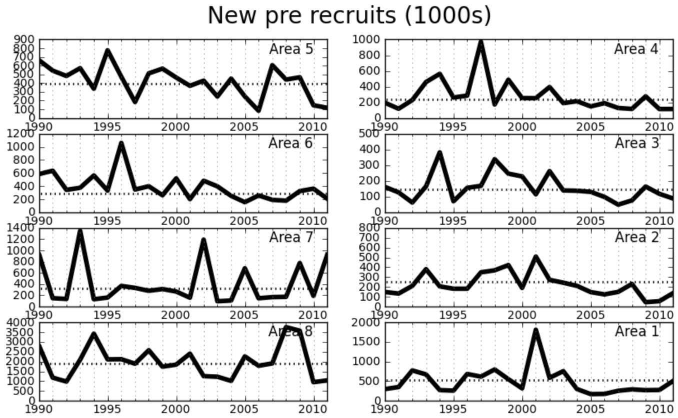


Figure 29. Model derived absolute recruitment to the 60 mm CL size class within each region over the last two decades. The dotted line shows the average number for each from 2000 to 2009, the period used for estimating recruitment in the model.

3.5.2 Recruitment from puerulus settlement monitoring

Very high settlement detected in puerulus collector sites in 1995 (Figure 30) 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, remaining below average for several years and returning to average/above average during the past two years (Figure 30).

Annual puerulus settlement at Bicheno and Recherche was very low from January 2003 to mid 2006. Recently Bicheno, Flinders and Recherche have had above average settlement (Figure 31, Figure 32). The low settlement from 2003 at South Arm has slowly improved and is now approaching more average levels (Figure 31).

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 or even above-average values in the last two years is positive for the future. It also implies that the current approach used in running projections using a 10 year recruitment series is appropriate because it includes years with good settlement in addition to the period of exceptional lows.

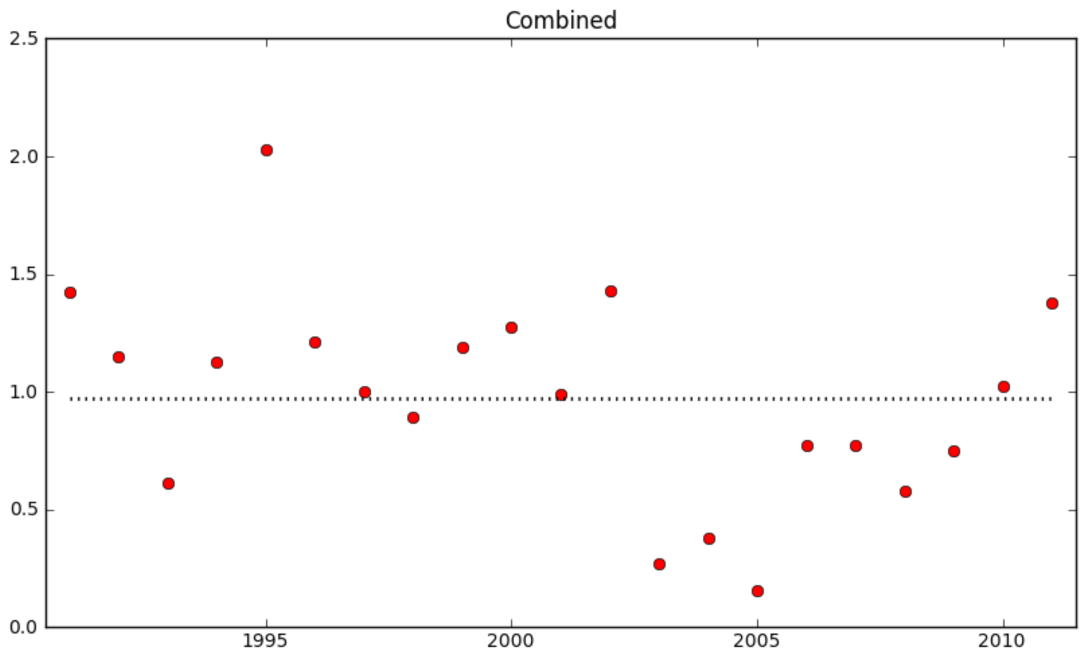


Figure 30 The east coast Puerulus settlement index. A value of 1 corresponds to average long term settlement (also shown by the black dotted line). The red dots indicate whether settlement was above or below average for a given year. Settlement was below average from 2003 to 2009, around average in 2010 and has been above average so far in 2011. Early indications for settlement in 2012 are also promising.

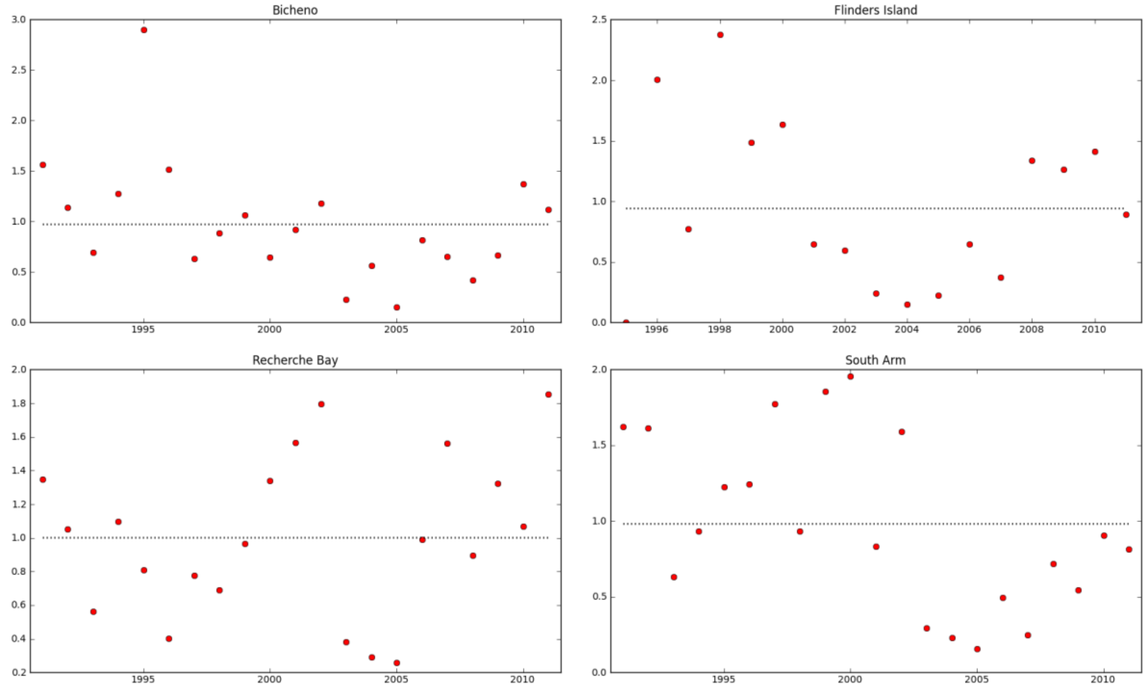


Figure 31 Annual puerulus settlement from long term monitoring sites around Tasmania.

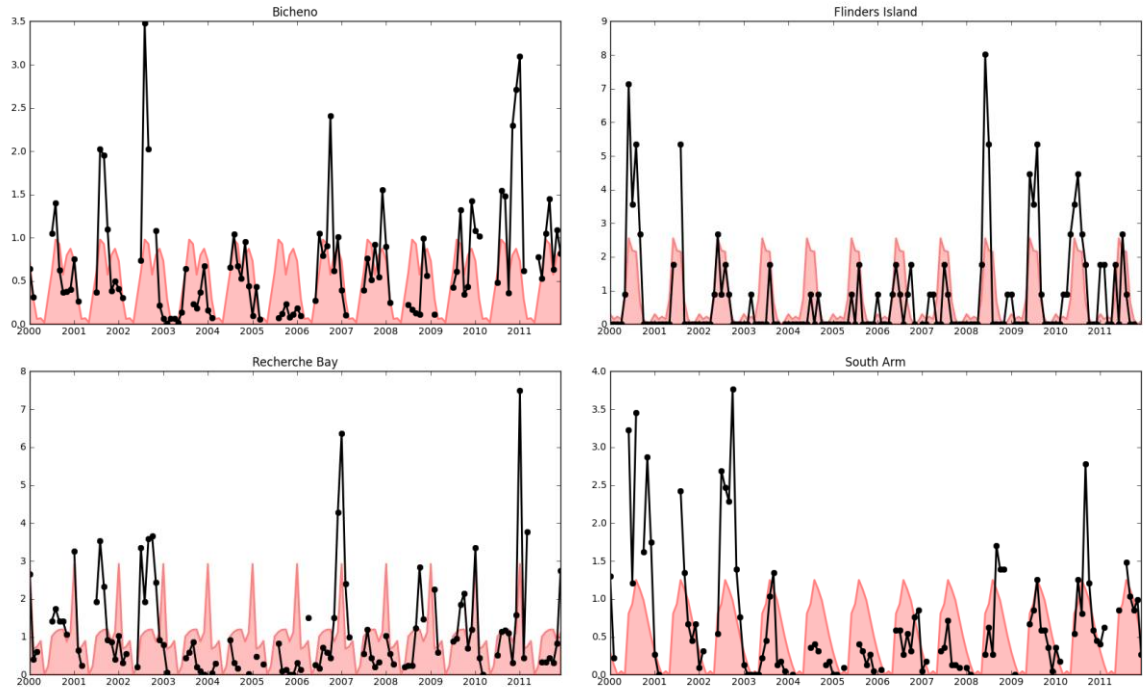


Figure 32 Long term monthly settlement (black line) compared to the average monthly settlement for the period 19982007 (red shading).

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 State-wide undersize index was calculated from areas 1, 2 and 8 which were the areas with no more than 2 years of missing data. Monthly catch rates of undersize lobsters are presented as the difference from the long term average for males and females (Figure 33). 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. Female index was above average in 2001.

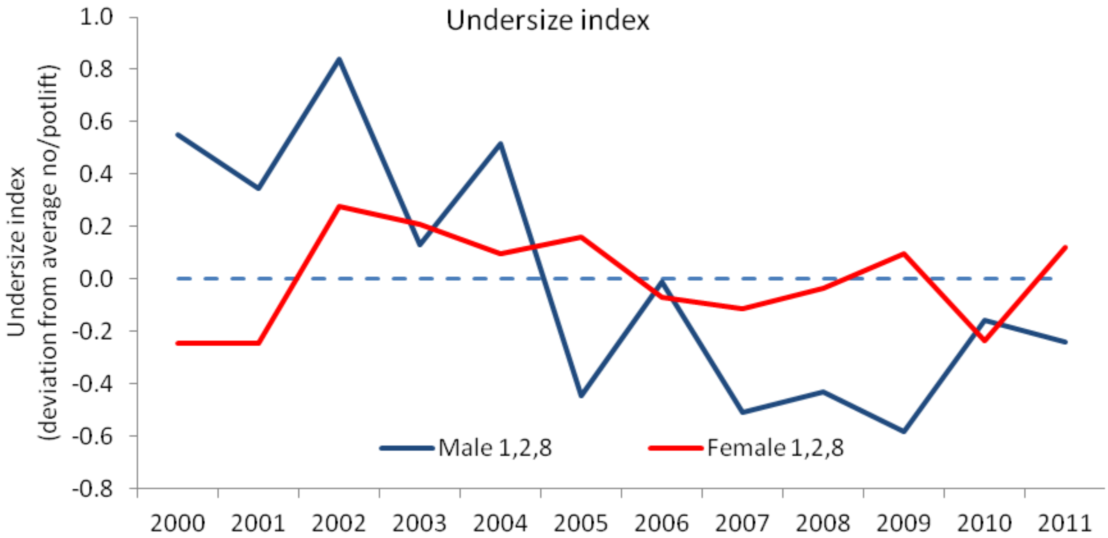


Figure 33 Average undersize index of male and female undersize lobsters observed in pots during observer and research surveys between 2000 and 2011. The index is the difference between the annual number of undersize per potlift from the long term average (blue dashed line) from areas 1, 2, and 8 which 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 between 5% and 10% depending on the measure of performance.

The first commercial scale translocation occurred earlier in 2011 with 60,000 of the planned 100,000 lobsters for moved. These were released at six inshore locations (Figure 34) with each location receiving 10,000 lobsters. All lobsters were collected from high density / slow growth locations in Area 8. A portion of these will become available to the fishery when the season opens in November. Further releases are scheduled in the new season. The aim is to complete translocations in the north-west, which is required to achieve the full scale of stock increases targeted through the initiative to produce stock outcomes equivalent to that which would be achieved by a 5kg/pot TACC cut.

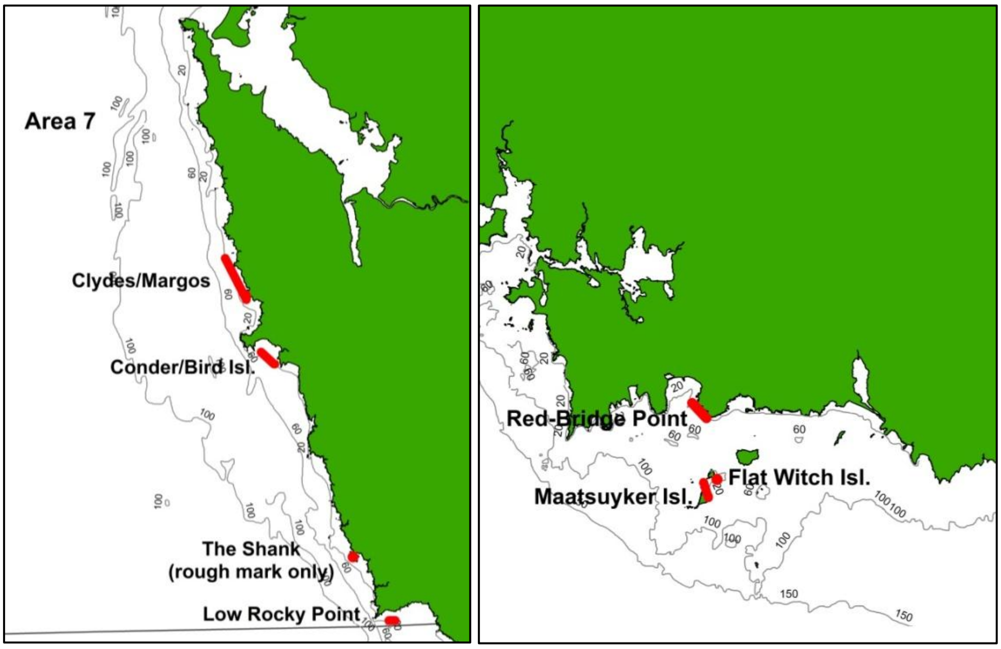


Figure 34 Translocation release locations shown in red.

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 link with urchin barren formation, which is the subject of current research. 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. 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. Continuation of translocation and the use of CPUE targets by management will increase the biomass of large lobsters by 2020 to higher levels than seen for decades.

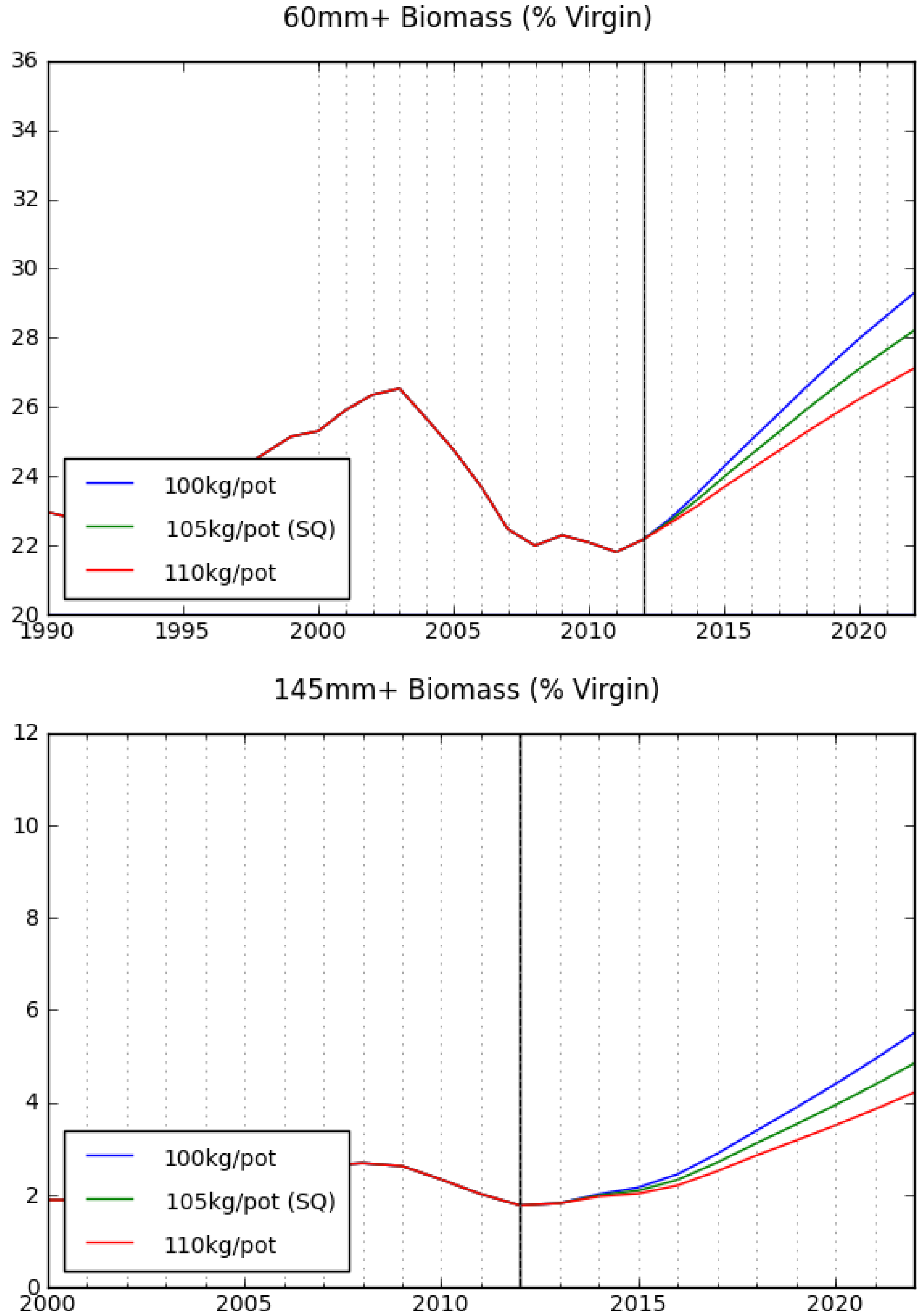


Figure 35 Expected trajectories for biomass of all lobsters (top) and biomass of large lobsters (bottom) assuming ongoing translocation.

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 domestic sales account for a greater proportion in recent years.

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 $59 million in 2011/12 (Figure 36). A wild fishery has constraints on production, which results in a “scarcity rent” similar to what can be achieved in other products where supply is controlled, such as by patents (eg pharmaceuticals) or market control (eg oil control by OPEC). This means that the economic yield is many times greater than can be achieved by primary industries where production by competing firms can expand. Economic yield in the lobster fishery is illustrated by the lease price of quota units, which traded in 2008/09 at around $14, fell to around $9 during 2010/11 and rose to over $14 in 2011/12. This implies an economic yield from the fishery of around $16 million dollars (Figure 36).

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 a low of $10 million (56%) at the same time as beach price rose by 9% (Figure 36). The fall in economic yield between 2006 and 2010, despite rising prices, was caused by the rapid rise in costs as a consequence of the fall in catch rates. Lower catch rates forced fishers to fish longer and use more potlifts to take the same catch. Conversely, the rise in economic yield over the past year was driven by the rise in beach price and the level of quota which constrained the catch, reducing effort and therefore fishing costs.

The daily catch per vessel increased for the first year since 2007/08 and the decline in effort was reflected in decreasing vessel days (Figure 37). Daily revenue per vessel declined slightly.

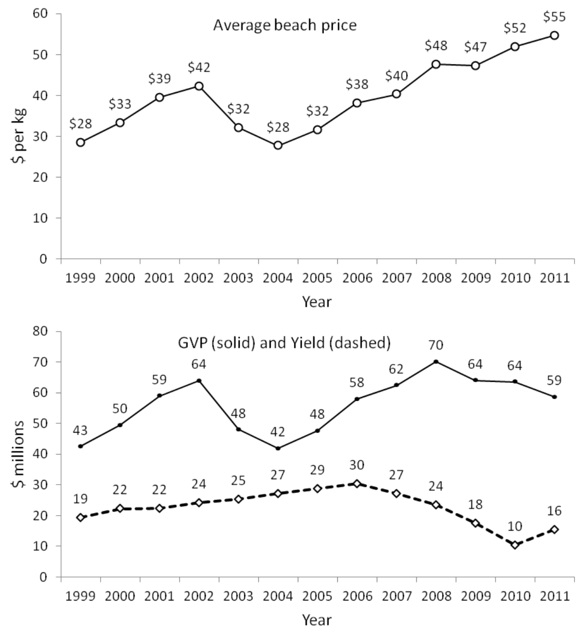


Figure 36. Economic trends in the commercial fishery since 1999.

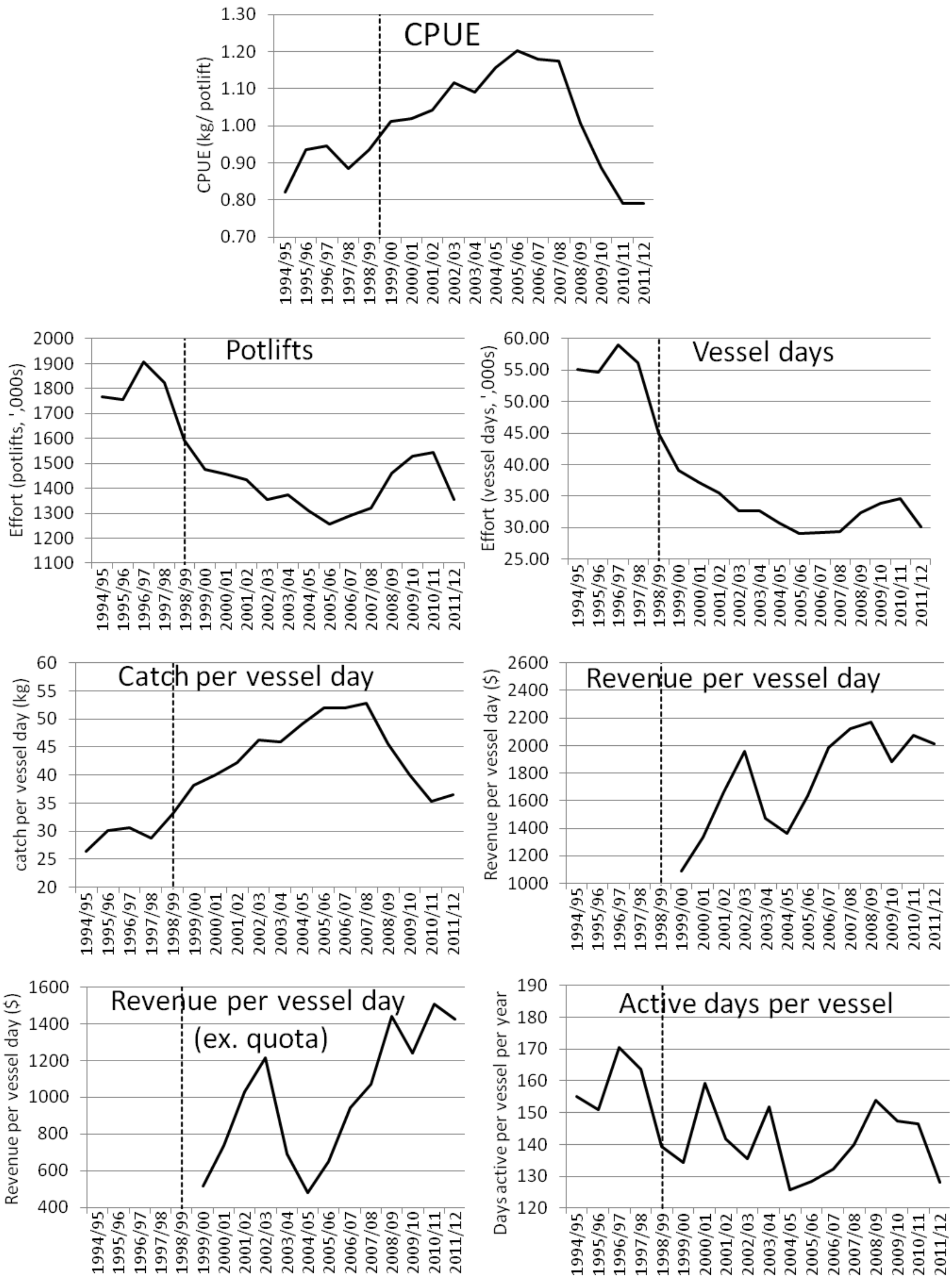


Figure 37. Trends in average State-wide commercial catch data since before the introduction of the quota system in 1998/99. Revenue per vessel day assumes average yearly beach price. Revenue per vessel day ex-quota excludes the opportunity cost of using quota which could otherwise be leased out.

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. Although the TACC limited the State-wide catch in 2011/12 the stock remains at very low levels. There were large regional changes with reduced catch rates on the east and north coasts (areas 2, 4 and 5) and increased catch rate in the south west (area 8).

The increase in stock and catch rates from 1998 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 recent decline in the fishery was driven by a prolonged period of very low recruitment from 2006-2011. This low recruitment to the fishery was exceptional and has traits unlike any downturn seen previously over the period of four decades from 1970 to 2010.

Very high larval 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.

The fact that the 2011/12 catch was constrained by the TACC is a positive sign for the rebuilding of the stock. Catch rate has now stopped falling and appears to have stabilised. Improvements in puerulus settlement during the past year to average / above average levels also provide some optimism for future recruitment but if this eventuates it won’t be seen in the fishery for several years.

Projections of the stock under current management suggest that rebuilding will occur and targets will be met. These projections assume that translocation will continue so lower TACCs would be required if translocations were to cease.

7 Management advice

This stock assessment indicates that decline in the stock has ceased and that stock rebuilding is expected with the current TACC.

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 would be achieved by the current TACC of 105kg/pot. Increasing the TACC to 110kg/pot does not meet the catch rate target and only marginally exceeds the exploitable biomass targets. Both of these targets relate to economic performance of the fishery. Reference points relating to the stock sustainability are easily met by any of the management scenarios examined.

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 while also addressing the problem of low egg production in some regions. The most significant opportunities are the ongoing use 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 throughout the year.

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 by-catch 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 2011/12 are shown in Table 10 with the major component hermit crabs. Discard mortality of individuals captured varies between species with very low or no mortality of crabs, draughtboard sharks, conger eels and leatherjackets. Consequently the species of most impact for by-catch monitoring are wrasse, octopus and leatherjackets, which are also reported under by-product.

Total by-catch increased over the past year and this was due to an increase in the catch of hermit crabs. All of the main species in the by-catch are within longer term ranges (Figure 38).

Table 10 Top ten species of by-catch observed in research sampling during 2011/12 and total numbers estimated for the commercial fishery.

Species	Number in research sampling	Number/potlift in research sampling	Estimated number from fishery
Hermit crab	6,821	6.56	7,247,313
Leatherjacket (all species)	577	0.55	613,063
Draughtboard shark	512	0.49	544,000
Barber perch	210	0.20	223,125
Velvet crab	187	0.18	198,688
Red gurnard perch	108	0.10	114,750
Red bait crab	86	0.08	91,375
Starfish (unidentified)	79	0.08	83,938
Blue throat wrasse	75	0.07	79,688
Speedy crab	55	0.05	58,438

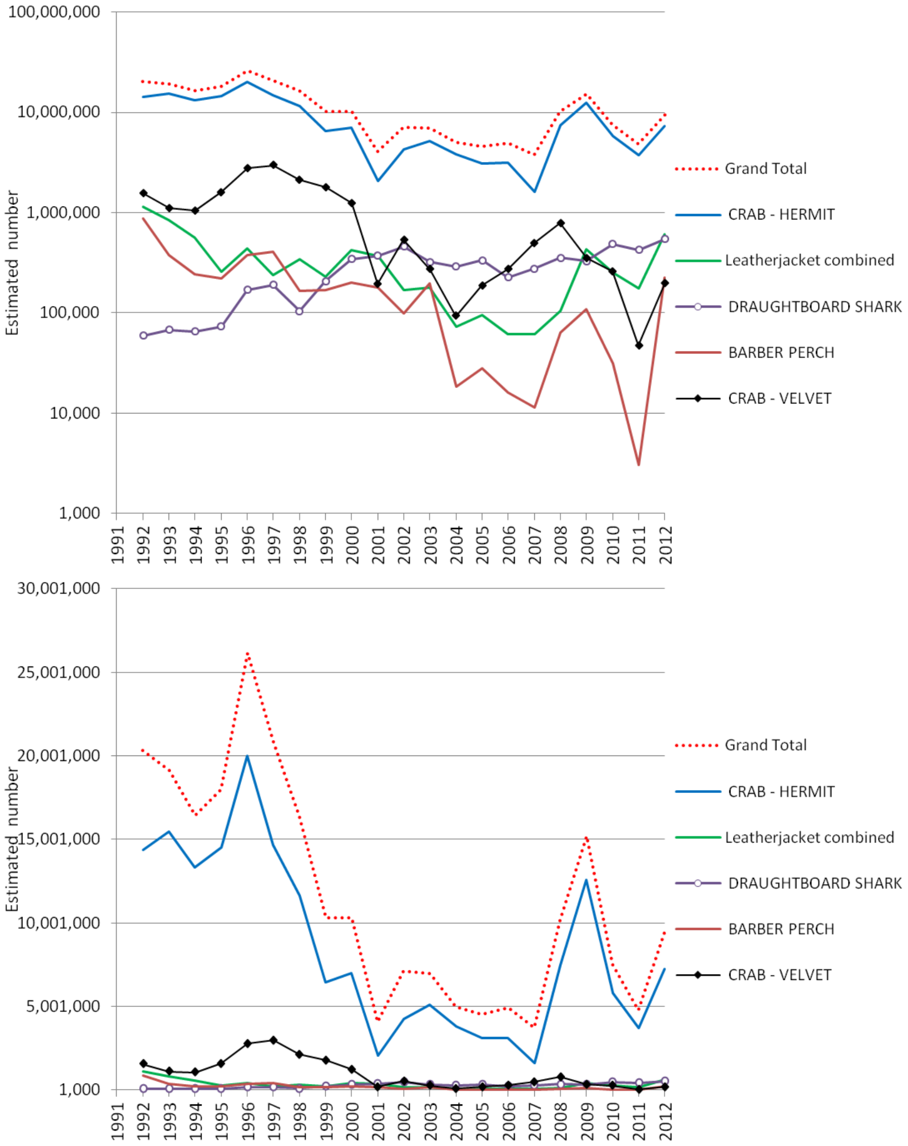


Figure 38 Total by-catch of top five species estimated by multiplying research sampling effort and catches up to the equivalent of the annual commercial effort. Both plots show the same data however, the top has number plotted on a log scale to highlight catches of the less abundant species in the catches.

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 and product for sale. All reported by-product from lobster pots was of a trivial volume, the largest being conger eel and octopus for bait and octopus for consumption (Table 11).

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 11. 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**	**11/12**	**07/08**	**08/09**	**09/10**	**10/11**	**11/12**
Barracuda	0.1	0.5	0	0.4	0.1	0	0	0.1	0	0
Bearded rock cod	2.1	2.3	2.2	2.3	2	0.2	0.1	0	0	0
Cleft fronted shore crab	0	0	0	0	0	0.3	0	0.1	0.1	0
Conger eel	1.8	2	1.8	2.3	1.6	0.6	0.6	0.3	0.7	0
Draughtboard shark	0.5	0.1	0	0	1.1	3.1	5.7	0.6	2.7	0.7
Giant crab	0	0	0	0	0	0.3	0.4	0.5	0.5	0.5
Gummy shark	0	0	0	0	0	0.1	0.2	0.1	0.1	0.1
Gurnard perch	0.5	0	0.2	0.1	0.2	0	0	0	0	0
Leatherjacket	0.9	0.7	0.7	0.8	0.7	0.4	0.4	0.1	0.3	0
Jack mackerel	0	0	0	0	0	0	0	0	0	0.4
Morwong	0.1	0	0	0	0	0	0	0	0.1	0
Octopus	0.7	0.6	0.6	1.3	1.4	5.3	5.2	6.7	4.5	6.3
Southern calamari	0	0	0	0	0.4	0	0	0	0	0
Striped trumpeter	0.1	0.2	0	0.2	0.1	0.4	0.9	0.6	0.7	0.5
Wrasse	0.9	0.5	0.7	0.6	0.4	0.2	0.6	0.4	0.2	0
Purple wrasse	0	0.1	0	0.1	0.6	0	0	0	0	0

8.4 Urchin predation by rock lobsters

Density of the long-spined sea urchin *Centrostephanus rodgersii* off eastern Tasmanian waters has increased over the last few decades. At high density urchins overgraze seaweeds and sessile invertebrates, which reduces the ecological integrity and fisheries productivity of parts of rocky reef in the 10-30 m depth band affected. Rock lobsters are a predator of urchins and thus the maintenance of rock lobster populations appears to be required to respond to the problem of expansion of urchin barrens.

A research project examining this problem and management responses to mitigate the threat of barren expansion has been underway since 2008 with final reporting due in 2013. (2007/045 Rebuilding Ecosystem Resilience: Assessment of management options to minimize formation of 'barrens' habitat by the long-spined sea urchin (*Centrostephanus rodgersii*) in Tasmania). That project is expected to provide guidance on management options including targets for biomass of large lobsters that could be used as reference points to guide management decision making.

In the interim, it should be noted that the existing harvest strategy has two important components that provide responsiveness to expansion of barren formation. The first is that recruitment is not assumed to be constant through time, rather, future projections of the stock use recruitment estimates that are based on more recent data for each additional assessment. This means that if productivity of the east coast declines because of barren formation, the assessment will adjust expectations of future productivity lower. That is, the assessment does not continue to base estimates of future productivity on old historical data prior to the problem of urchin barrens.

The second component of the harvest strategy that provides responsiveness to urchin barrens is that decision-making is based on 70% and 90% probability levels for future projections. This is an explicit response to the need to be cautious in setting catch limits due to possible lost productivity from climate change, urchin barrens or other processes that may reduce future production.

9 Bibliography

Bruce, B, R, Griffin, D., Booth, J., Gardner, C, , Hobday, D., Linnane, A., 2007. Oceanographic dispersal of southern rock lobster, Draft *Final Report to FRDC 2002/007*, CSIRO, Hobart.

Burnham, K.P. and D.R. Anderson (1989) *Model Selection and Inference. A Practical Information-Theoretic Approach*. Springer-Verlag, New York.

Frusher, S. D. (1997a). Stock Assessment Report : Rock Lobster. Dept. Prim. Ind. Fish. Internal Report No. 35, 79pp.

Frusher, S.D. (1997b,) Update to the July 1997 Rock Lobster Stock Assessment Report, December 1997. Dept. Prim. Ind. Fish. Internal Report No. 37, 25pp.

Frusher, S. and C. Gardner (1999) Tasmanian Rock Lobster Fishery 2001/02. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 43 p.

Frusher, S., Gardner, C., Hirst, A., MacKinnon, C., and M. Haddon (2003) Tasmanian Rock Lobster Fishery 2001/02. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 92 p.

Gardner, C. (1999) Tasmanian Rock Lobster Fishery 1998/99. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 58 p.

Gardner, C., Frusher, S., and L. Eaton (2001) Tasmanian Rock Lobster Fishery 1999/00. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 90 p.

Gardner, C., Frusher, S., Eaton, L., Haddon, M. and C. MacKinnon (2002) Tasmanian Rock Lobster Fishery 2000/01. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 117 p.

Gardner, C., Frusher, S., Barrett, N.S, Haddon, M. and C. Buxton (2006). Spatial variation in size at onset of maturity of female southern rock lobster *Jasus edwardsii* around Tasmania, Australia. *Scientia Marina* **70**(3): 423-430.

Gardner, C., MacKinnon, C., Haddon, M., and S. Frusher (2004) Tasmanian Rock Lobster Fishery 2002/03. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 81 p.

Gardner, C., Hirst, A., and M. Haddon (2005) Tasmanian Rock Lobster Fishery 2003/04. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 79 p.

Haddon, M. and C. Gardner (2007) Tasmanian Rock Lobster Fishery 2005/06. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 63 p.

Kimura, D.K. (1981) Standardized measures of relative abundance based on modelling log(cpue), and their application to Pacific Ocean perch (*Sebastes alutus*). *Journal du Conseil Permanent International pour l'Exploration de la Mer* **39**: 211-218.

Lyle, J.M. and Tracey, S.R. (2010) Tasmanian recreational rock lobster and abalone fisheries 2008-09 fishing season. Tasmanian Aquaculture and Fisheries Institute Report, 60p.

Maunder, M.N. and A.E. Punt (2004) Standardizing catch and effort data : a review of recent approaches. *Fisheries Research*. **70**: 141-159.

Neter, J., Kutner, M.H., Nachtsheim, C.J., and W. Wasserman (1996) *Applied Linear Statistical Models.* 4th edition. Irwin Chicago. 1408 pp.

Punt, A.E. and R.B. Kennedy (1997) Population modelling of Tasmanian rock lobster, *Jasus edwardsii*, resources. *Marine and Freshwater Research* **48**: 967-980.

Semmens, J., Haddon, M., and C. Mackinnon (2006) Tasmanian Rock Lobster Fishery 2004/05. *Fishery Assessment Report* Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. 78 p.

Venables, W.N. and C.M. Dichmont (2004) GLMs, GAMs, and GLMMs: an overview of theory for applications in fisheries research. *Fisheries Research*. **70**: 319-337.

Winstanley R.H. (1973) Rock Lobster fishing in Tasmania, 1904-1972. *Tasmanian Fisheries Research* **7**, 1-29.

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.

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

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

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

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

In response to further pressure from northern commercial fishers, a Parliamentary enquiry conducted by Joseph Lyons considered that pots were not destructive and recommended that pots be legalised. However, it wasn't until 1925 that pots were finally legalised as part of a new fisheries bill that placed responsibility for the management of sea fisheries with a newly appointed Sea Fisheries Board. The centrepiece of this new bill was the allocation of varying numbers of pots to commercial vessels depending on their size. For example, a limit of 30 pots was adopted for larger vessels with proportionately fewer pots allowed for smaller vessels. Inevitably, the use of pots led to dramatic increases in commercial catch due to greater efficiency, halted fleetingly by reduced market demand during the depression years (1930s) and the Second World War. Markets have adapted to change in technology throughout the development of the fishery.

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

The annual commercial catch reached its historical maximum in 1984 at 2250 tonnes, prior to falling to 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 12. 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.