FISHERY ASSESSMENT REPORT

TASMANIAN ROCK LOBSTER FISHERY

2009/10

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January 2011

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Executive Summary

Current Stock Status

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

The TACC for 2009/10 was reduced from 1524 t in the previous year to 1471 t, yet was substantially under-caught with a total catch of only 1356 t - a deficit of 114 t. Part of the 2009/10 catch was carry-over of quota from the previous year, thus the true deficit in catch from quota allocated in 2009/10 was 162 t. A further reduction in the TACC occurred in the 2010/11 season to 1324 t and early signs are that this will also be substantially under-caught.

As of 10 September 2010, the catch in the 2010/2011 quota year was at a record low of 337 tonnes. On the same date the catch was 394 t in 2009, 544 t in 2008 and 639 t in 2007. Based on the 2009/2010 catch profile (which most closely resembles the current year), the total catch for 2010/2011 was estimated to be 1163 t, which means that we expect the TACC of 1324 t will not be taken.

This assessment conducts harvest strategy evaluations that estimate probable outcomes of different management options, such as different TACCs. Recruitment is a key input into this process and outputs will be biased if the recruitment process has fundamentally changed, for example due to changing oceanic currents with climate change. Consequently, this assessment used recruitment from the last ten years to address concerns that there may be a fundamental change in recruitment processes.

Key observations from this assessment are:

- The 2009/10 commercial catch was 114 tonnes less than the TACC, due to falling catch rates.
- The TACC has not constrained the commercial catch for the past two seasons.
- State-wide catch rate for day shots declined by 19% and at 0.8 kg/potlift is the lowest on record (7% lower than 1994), indicating that the stock rebuilding that occurred since QMS management commenced has now been undone.
- State-wide catch rates for both day and night shots combined was 0.87 kg/potlift which is a decline of 13% from the previous year and 26% from 2005. It remains 7% above the worst year on record (1994).
- The fishery continued to exhibit strong regional trends with effort and catch concentrated in the SW in response to changes in production around the State.
- Puerulus settlement returned to more average levels during 2010.
- State-wide fishing effort has continued to rise as catch rates fall and is now equivalent to 1998 when QMS was introduced. Effort increased in Areas 1,2,5,8,9,10 and 11 and showed small declines in areas 3,4,6 and 7 (NE and mid west). Areas

1 and 8 (far south) are now at effort levels equivalent to the early 1990's when the stock was most depleted.

- The average weight of lobsters in Areas 3 and 4 (NE) has been increasing while catch rates have been falling, which signals a prolonged decline in recruitment. Average weight in the deep water areas 9-11 and in area 1 have shown some declines and may indicate some improvement in recruitment.
- Areas 8 and 9 (SW) have been significant contributors to the state-wide catch but have steadily declined over the past 2-3 years in line with similar declines in catch from 1,2,3,6. Catches from the North (4,5) and North West deepwater (9) have increased over the same time.
- Declines in catch rate occurred in almost all areas and were larger than the previous year. Declines were most pronounced in the SE with areas 1-3 declining by 21-29% to 0.54 kg/potlift. Area 1 is the most important to the recreational sector so declines are affecting both sectors. Only two areas had small increases in catch rate (Area 5 at 2% and area 9 at 1%).
- Fishers have expressed a concern that an increase in multiple night shots may be masking real trends in catch rate data. When data was restricted to day shots only, declines in catch rate were more pronounced with a 19% decline state-wide catch rate over the last year.
- Early data on catch rate in the current year indicates that rapid stock decline is continuing with a 15% fall in catch rate for March and April 2010 compared to the same months in the 2009/10 quota season.
- Egg production appears adequate for the State as a whole and for southern areas but is below target levels in northern areas. This may be unrelated to future stock stability because of the imprecise relationship between egg production and future recruitment and because of our reliance on egg production in other States.
- There were no notable trends in by-catch and by-product data.

Evaluation of Future Harvest Strategies

Analyses of alternative TACCs are summarised in Table 1. These analyses included some important assumptions which were:

(i) future recruitment will broadly reflect that observed from 1998-2007 (included periods of both high and low recruitment), actual recruitment over the last five years tended to be lower;
(ii) no expansion of catch beyond changes in the TACC (e.g. recreational and illegal catch was assumed to be constant);
(iii) no loss of productivity through expansion of no-take MPAs;
(iv) no loss of productivity through expansion of urchin barrens; and
(v) no loss of productivity through increase in natural mortality (e.g. through increase in octopus mortalities).

These assumptions present risk of lower productivity and thus worse outcomes than those presented in this report.

The conclusion of the harvest strategy evaluation process summarised in Table 1 is that only TACCs equating to 100 kg / unit (1050.7 t) or less appear to have reasonable probability of meeting most target and limit reference points.

Table 1. Evaluation against formal performance measures

Performance measure	Reference point	Assessment
Exploitable biomass (state)	· Limit reference point: 90% probability of remaining above 10 year low over next 5 years · Target reference point: 70% probability of rebuilding to 05/06 peak in 8-10 years	TACC <= 110 kg / unit 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 · Target reference point: 70% probability of rebuilding to 05/06 peak in 8-10 years	TACC <= 113 kg / unit TACC <= 100 kg / unit
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	Not met by any TACC scenario examined (TACC = 100 kg / unit fails areas 2-5)
CPUE (State-wide)	· Limit reference point: 90% probability of remaining above 1999 CPUE over next 5 years · Target reference point: 50% probability of 1.1 kg per pot lift by 2018	TACC <= 100 kg / unit TACC <= 100 kg / unit
CPUE (Regional) *5 out of 8 areas to meet these reference points including key areas of 1, 5, 7 and 8*	· Limit reference point: 90% probability of remaining above 1999 CPUE over next 5 years · Target ref point: 50% probability of returning to 2005/06 level by 2020	Not met by any TACC scenario examined (TACC = 100 kg / unit fails on area 8)
Combined Licence holder Profitability	Net present value over 15 years to be significantly better than status quo (real discount rate = 7.5%)	NPV highest @ 100 kg / unit but similar between 100 – 113 kg / unit

Table 2. DEH recommendations for Ecosystem Based Fisheries Management (EBFM) of the Tasmanian rock lobster fishery applicable to this assessment.

Recommendation	**Status**
Recommendation 1: *The DPIPWE to advise the DEH of any material change to the TRLF management arrangements that could affect the criteria on which Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) decisions are based, within three months of that change being made.*	The annual fishery assessment document and management documentation provides these requirements.
Recommendation 2: *Reports to be produced and presented to DEH annually, and to include:* · *Information sufficient to allow assessment of the progress of DPIPWE in implementing the recommendations made in the Assessment of the Tasmanian Rock Lobster Fishery 2007;* · *A description of the status of the fishery and catch and effort information;* · *A statement of the performance of the fishery against objectives, performance indicators and measures; and* · *Research undertaken or completed relevant to the fishery.*	The annual fishery assessment document provides these requirements.
Recommendation 3: *Within 2 years, DPIPWE to develop and implement an education program for fishers on species recognition, mitigation measures to minimise interactions and the requirement to accurately report interactions under the EPBC Act.*	Fishers are able to report protected species interactions through logbooks.
Recommendation 4: *DPIPWE, in collaboration with industry, to continue to encourage the adoption of programs that minimise protected species interactions and pot loss. DPIPWE, in collaboration with other jurisdictions, to investigate and implement, where appropriate, the use of seal exclusion devices other than seal spikes to reduce the impact of the fishery on seal species.*	Ongoing implementation and coverage of the Clean Green Program.

Recommendation 5: *DPIPWE to ensure that there is ongoing data collection of by-catch species in the fishery and that by-catch data analysis includes information on temporal and spatial patterns relevant to the TRLF.*	Results from by-catch and by-product data collection programs is documented in this assessment.
Recommendation 6: *Within 3 years, DPIPWE to review the stock assessment model and model predictions for the TRLF to ensure that TAC levels continue to permit significant stock rebuilding for the rock lobster stock. DPIPWE to consider environmental factors, such as urchin barrens, when setting the TAC annually for the TRLF.*	The stock assessment model was externally reviewed in 2009 and significantly altered. Capability to evaluate harvests in terms of biomass of large lobsters was developed to allow the development of performance measures relevant to managing lobster – urchin interactions.
Recommendation 7: *DPIPWE to continue to monitor egg production levels in northern regions and to develop and implement management measures to assist with increasing rock lobster egg production levels in this zone.*	Egg production estimates are reported here on a state-wide and on a regional basis. New performance measures relating to egg production are included in this assessment.
Recommendation 8: *DPIPWE to continue to monitor the level of fishing effort in shallow waters and determine whether further management measures are required to decrease fishing pressure on inshore rock lobster stocks.*	This assessment includes 3 new assessment regions resulting from splitting deep and shallow areas on the west coast. Further separation of data from deep and shallow areas is planned, in particular for the east coast to better examine issues related to recreational fishing and also urchin barrens.

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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 1.5 million animals. In the 2009/10 season 230 licensed vessels reported catches of rock lobster, down from 314 in 1994/95 but an increase of 20 from the previous year. In addition, there were approximately 21,000 licensed recreational fishers (taking an estimated 107 tonnes in 2008/2009; Lyle, 2010).

Commercial harvests have been controlled by a quota management system since March 1998, which resulted in substantial stock rebuilding in all assessment areas. This rebuilding can be seen in the historical trends in the fishery (Figure 1 and Figure 3), however, the estimated total legal biomass has now shown a decline for the last three years. In addition, State-wide catch rates have continued to decline as the effort (cost) required to catch the TACC continues to increase to pre-quota levels with the TACC not constraining the catch for the past two years. During 2009/10 around 8% of the TACC was uncaught (Figure 1 and Figure 2).

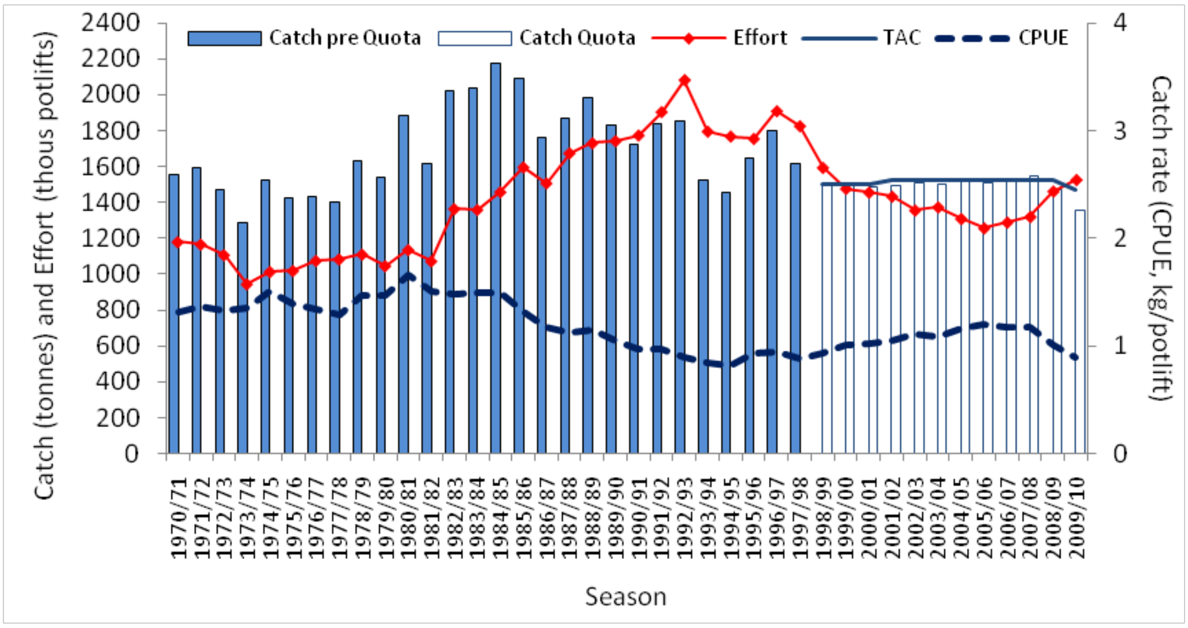


Figure 1. Historical commercial fishing effort (pot-lifts), catch (pre and post quota management, tonnes), CPUE (kg/potlift) and TACC (tonnes). From 1998 to 2005 the amount of effort required to take the catch diminished. This trend has reversed in recent years so that effort and catch in the most recent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

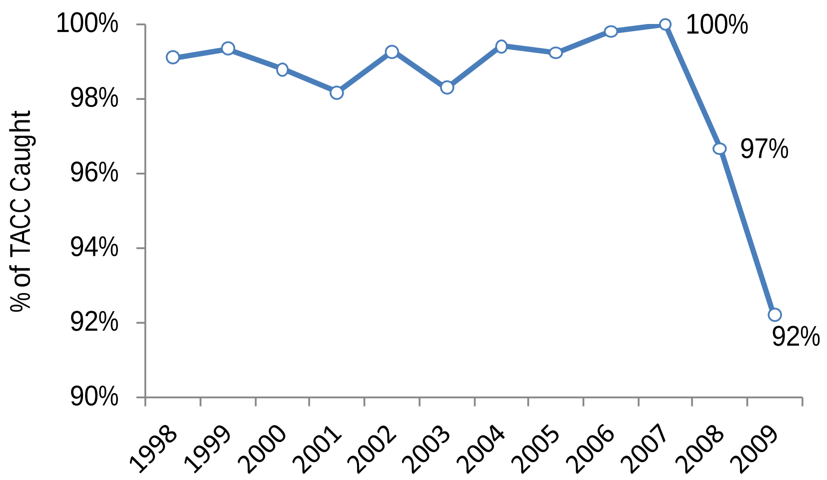


Figure 2 Percentage of the TACC caught during each quota period.

Trends in legal biomass and catch rates are roughly similar although with important differences. In the period of stock rebuilding from 1995 to 2005, catch-rates recovered slower than biomass due to a changing fishery dynamics. For example, fishers increased their effort in locations and months when catch rates are lower but the value of the lobsters taken is higher. In recent years, catch rates have declined faster than estimated biomass, possibly again due to similar effects of the fleet. Prior to the 2008/09 quota period, the TACC was confining the catch with only 1-2% uncaught. During the 2008/09 and 2009/10 quota periods the percentage of the TACC caught has declined to 92% (Figure 2).

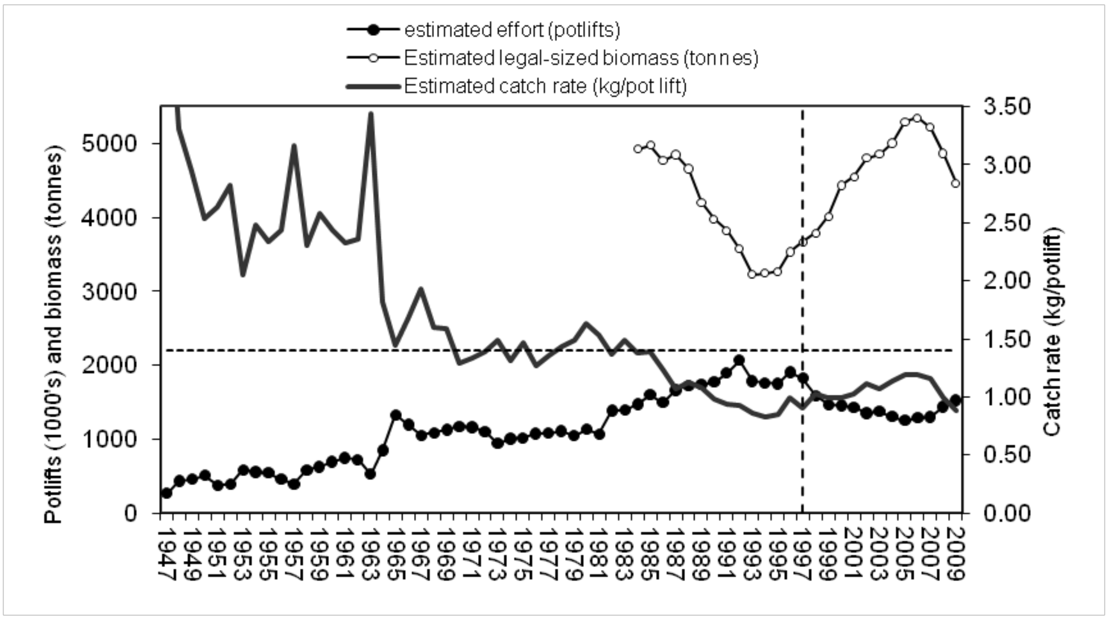


Figure 3. Historical trends in estimated fishing effort (pot-lifts), estimated catch-rate (kg/pot-lift) and estimated legal-sized biomass (tonnes). Data is in quota years (Mar to Feb) from 1970 onwards. Catch rate and effort are inversely correlated through the series. Dashed lines indicate the introduction of ITQ management and the current commercial industry catch rate target of 1.4 kg/pot lift.

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 (Figure 4).

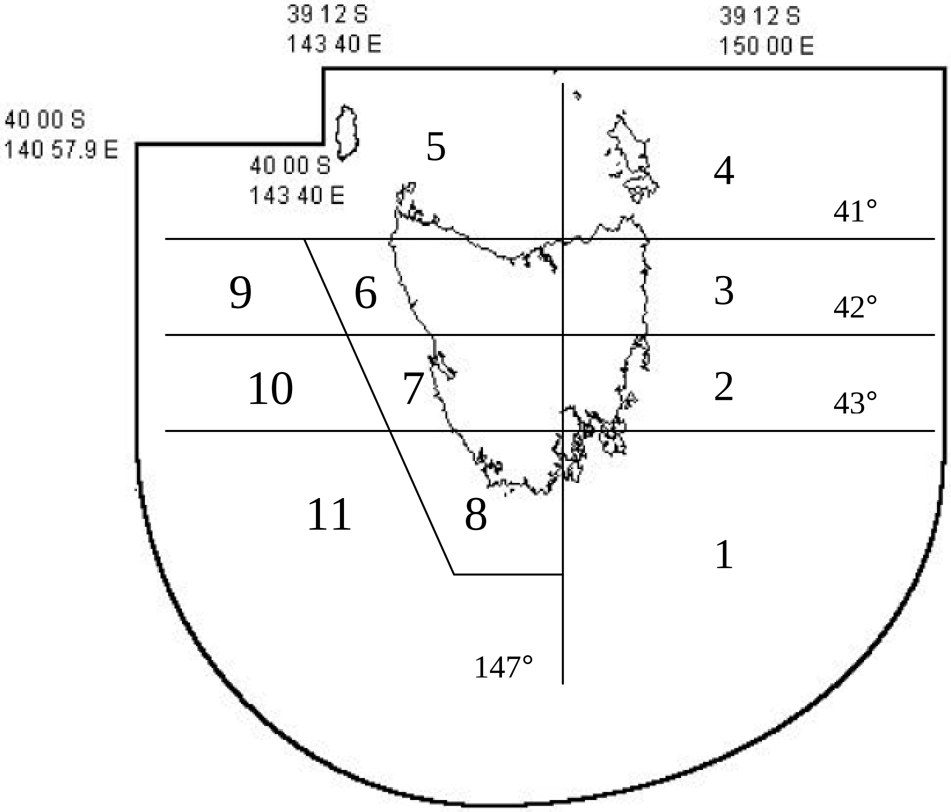


Figure 4. Schematic boundaries of the Stock Assessment Areas and indicative area of State waters for the rock lobster fishery, provided by the offshore constitutional settlement (OCS). Changes to the assessment model over the last two years have enabled information to be presented separately for water shallower or deeper than 35 fathoms off the west coast. These areas have been assigned numbers of 9, 10 and 11.

1.1 Performance measures

A summary of outcomes against formal performance measures is presented at the front of this report in Table 1. These measures were developed through the CFAC and RecFAC process in 2009 and 2010. The values for each of these performance measures are compared to standards, termed Limit Reference Points (LRPs). Limit Reference Points define undesirable states for the fishery, and if breached initiate a management review. Ideally, Limit Reference Points are paired with Target Reference Points (TRPs). 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%.

Numerous other non-formal performance measures have been proposed to describe the status of the fishery and are summarised in **Table 3**. Most of these are described in this report although some are under development with the aim of presentation in future assessments.

Table 3. Proposed non-formal performance measures

Commercial fishery catch and effort

- Total commercial catch (total and by area)
- Total commercial effort (total and by area)
- CPUE total, all shots and day shots only
- Catch per vessel per day
- Well mortalities, octopus mortalities and personal use
- Active days per vessel
- Catch and catch rate trends in key blocks
- Mean weight of lobster (by area)
- Legal size discards (total and by area)
- Harvest rate (by area)

Recreational fishery catch and effort

- Total recreational catch (total and by area)
- Total recreational effort (total and by area)
- Success rate of recreational fishing by area and gear
- Recreational participation and licensing trends
- Seasonality of recreational catch
- Size composition of catch/area/method
- Weight of recreational caught lobsters /area/method
- Fisher satisfaction
- Attitudes to management arrangements

Recruitment and Sustainability

- Spawning biomass (by area)
- Estimated recruitment (by area)
- Undersize abundance (by area)
- Puerulus settlement

Ecosystem[1]

- Discarded by catch
- Retained by product
- Protected species interaction data
- Biomass of large lobsters (>140 mm CL) by region

Economics

Commercial

- Market capitalisation of quota units
- Economic yield
- Gross value of product
- Commercial price
- Revenue per vessel per day
- Trends in quota ownership data
- Number of active commercial vessels
- Number of vessels taking 100%, 50%, 20% of the catch
- Trends in use of regional ports (home base and unloading)

Recreational

- Recreational fishing satisfaction

[1] DEWHA have previously recommended the development of performance measures based on monitoring of non-fished sites. 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; and (iii) no meaningful thresholds could be developed (for example, the purple sea urchin *Heliocidaris erythrogramma* was more abundant outside reserves, presumably through release from lobster predation, but what level is of concern and can be used a performance measure?).

2 Recent developments

2.1 Management history of the fishery

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

The total allowable commercial catch was stable for the first decade but has been lowered in recent years in response to decline in the exploitable biomass.

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

Table 4 Total allowable commercial catch and kilos per unit for each quota year and for future years under the current harvest strategy.

Quota year	TACC	kilos per unit
1998/99	1502.5	143
1999/00	1502.5	143
2000/01	1502.5	143
2001/02	1502.5	143
2002/03	1523.5	145
2003/04	1523.5	145
2004/05	1523.5	145
2005/06	1523.5	145
2006/07	1523.5	145
2007/08	1523.5	145
2008/09	1523.5	145
2009/010	1470.98	140
2010/011	1323.9	126
Future path proposed in 2009		
2011/012	*1250.3*	*119*
2012/013	*1187.3*	*113*

2.2 Developments in stock assessment analyses

2.2.1 Logbook changes

Commercial catch and effort logbooks are regularly reviewed to ensure the effectiveness of assessment data collection. A recent significant change was the introduction of protected species interaction and better by-product reporting. These data are reported under “Ecosystem Interactions”.

2.2.2 Research catch sampling operations

The analyses in the assessment are based on a variety of data sources. Information about temporal changes in lobster stocks are mainly driven by commercial logbook data, research catch sampling surveys, and recreational surveys. The research surveys currently provide data on the size- and sex-structure of lobster catches.

The assessment and catch sampling operations were externally reviewed in 2007 and more extensive sampling occurred as a result since in 2008. The main changes were:

1. The catch sampling program was extended with the use of casual observer staff sampling aboard commercial vessels.
2. Improving the spatial and temporal resolution of growth estimates is a high priority and was addressed with tagging of discarded lobsters by observers.
3. Existing tag recapture data was analysed for spatial patterns in growth and this was used to update the model.
4. Spatial and temporal resolution of data on undersized lobsters was increased and contributed to assessment of the stock through the model.
5. Long term monitoring sites were expanded to include sites in each assessment area.

2.2.3 Changes to the stock assessment model

Substantial changes to the assessment model have been made over the last two years and reviewed externally. The model used for analyses shown here now has the same structure as the Victorian and South Australian model. This allows greater collaboration between agencies and sharing of analytical methods such as for analysing growth or movement.

The 2008/2009 stock assessment was the first to report modelling that used recruitment from the last ten reliable years (1998 to 2007). In this assessment, projections are also presented using a five year time series (2002-2007). This was in response to concerns that there had been a fundamental change in recruitment which was only apparent in recent years. The reasonable levels of puerulus settlement observed in 2010 suggest that restricting projections to recruitment for the last 5 years is overly pessimistic.

The most substantial changes in the model over the last two years were:

- Standardisation with SA and Victoria, which allows collaboration (e.g. sharing of analytical methods for growth estimation). The model has been externally reviewed in Tasmania, and reviewed through publication of specifications of the standardised model for Victoria and South Australia
- Spatially split into 11 rather than 8 areas
- Estimates of movement between deep and shallow areas are updated each run

- Growth data now updated to give greater accuracy in areas where growth data was previously lacking
- Capacity to include MPAs
- Time series of recreational catch
- Time series of illegal catch
- Projections have updated fleet dynamics model
- Projections now include economics data
- Generalised with vastly expanded capacity (e.g. 3 methods for estimating growth)
- Expanded output capacity (e.g. biomass estimates of large lobsters)
- Expanded projection capacity (e.g. translocation)

Model runs are now supported with standardised automated data extracts. This accounts better for problematic data (e.g. catch records without an associated location, or data errors within the database) and minimises the risk of inconsistent data extracts between years.

Catch in the Tasmanian lobster fishery occurs through a range of sectors / systems: commercial catch, recreational catch, research catch, commercial personal use provisions; non-quota well mortalities; indigenous catch; and illegal catch. Additional mortality occurs as a result of fishing through octopus mortality in traps and discard mortality.

Data is available on the scale of each of these sources of fishing mortality except for indigenous catch and illegal catch. Indigenous catch was assumed to be negligible and was not included in the assessment. Illegal catch was included in stock modelling at 2% of the total commercial catch, based on estimates by Tasmanian Police and DPIPWE quota audit staff.

3 Fishery assessment

3.1 Commercial catch and effort analysis

3.1.1 State-wide commercial catch and effort

Total commercial catch for 2009/10 taken through the quota management system was 1356 t (Figure 5) of the TACC of 1470 t (a deficit of 114 t). This catch included carry-over from the previous year, hence the true undercatch was more severe. This was the second consecutive year that the TACC was substantially undercaught with the un-caught proportion increasing to 8% of the TACC (Figure 2).

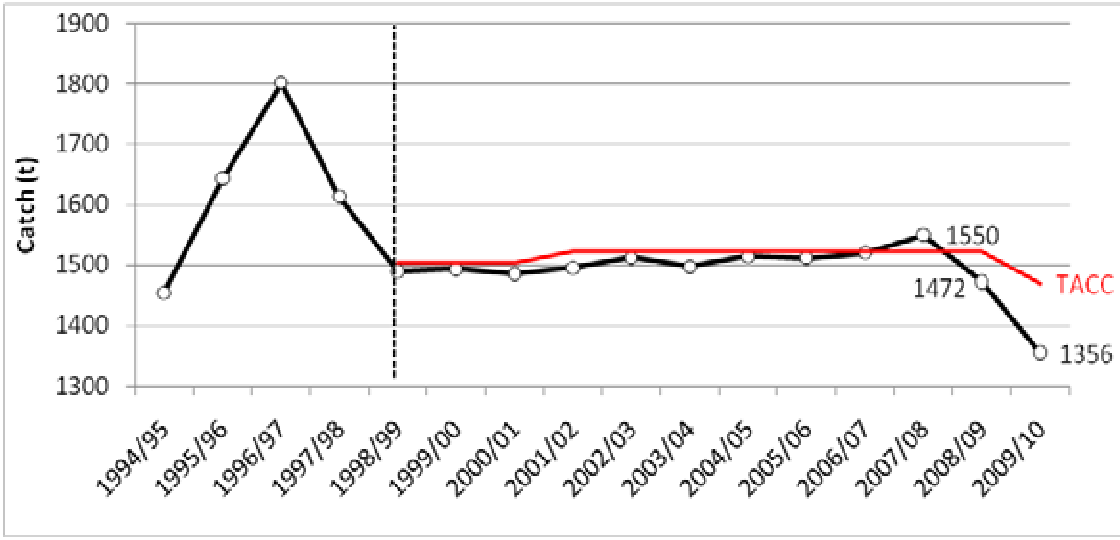


Figure 5. Quota year commercial catch reported through catch and effort logbooks. These differ slightly from the TACC because of carry-over provisions and under-catch. Red line shows TACC

Catch rate data from the commercial sector serves as a proxy for two very different factors of interest for fisheries management: the variable cost of fishing and the abundance of lobsters. State-wide commercial catch rate for the 2009/10 quota year was 0.89 kg/potlift, which is the lowest since the introduction of quota management (CPUE in the first year, 1998/99 was 0.94 kg/potlift). The 2009/10 CPUE is now approaching the lowest recorded catch rate of 0.82 kg/potlift in 1994 (Table 9).

As catch is limited by quota, changes in catch rate mainly affect effort (potlifts) required to take the catch. In 2009/10 the level of effort was 80% of the effort expended in 1996/97 an increase on the previous year of around three percent (Table 9). This indicates that there is further capacity to expand effort as the catch rate falls.

Change in effort is an important mechanism for social changes in the fishery as it drives the number of vessels required to take the catch. An increase in effort as seen over the last year would be expected to reduce demand for leased quota, lower the price of leased quota, and encourage new entrants.

Fishers report that there has been a change in fishing practices at night with more multiple night shots. Data is restricted to day shots only in Table 7 to exclude any bias from this effect. Data from **day shots only** show a more severe decline in the state-wide catch rate 19% over the last year to a new record low.

Apparent declines in mean catch rates can be caused by factors unrelated to abundance and for this reason trends in biomass derived from the assessment model shown later in the report provides a more reliable guide to stock changes.

3.1.2 Active vessels

When QMS was established, a reference point of 220 active licences was put in place at to track participation in the fishery (Figure 6, Table 5). As stocks and catch rates improved from 1994 to 2005, the number of vessels required to take the catch declined. In addition, an increase in the maximum number of pots per vessel from 40 to 50 in 1998, intended to increase efficiency, reduced the number of active vessels.

The deterioration of the stocks over the last few years has reversed the decline in number of active vessels. Thus there were 230 vessels that reported catch in 2009/10, up by 19 vessels from the previous year. These changes emphasise that vessel numbers respond in the opposite direction to rock lobster abundance. Under higher levels of stock, catch rates increased and the number of days a boat needed to fish decreased. This created an economic pressure on the fishing fleet to rationalise. Since the stock has declined over the last few years, vessels and fishers have needed to work more days to take the same catch. This created an undersupply of vessels and new vessels have entered the fleet (Table 5).

The decline in catch rate has led to lower daily catches, and more working days per active vessel. The average vessel is now working an extra 21 days per year (+17%) to take a reduced TACC compared to 2004/05 (Table 5). Fishers report that this increases the risk of accidents at sea as they are less willing to avoid bad weather. The number of active days per vessel actually fell slightly in the last year. This means that the extra effort going into the fishery over the last year is through more vessels operating, rather than the existing vessels fishing harder.

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

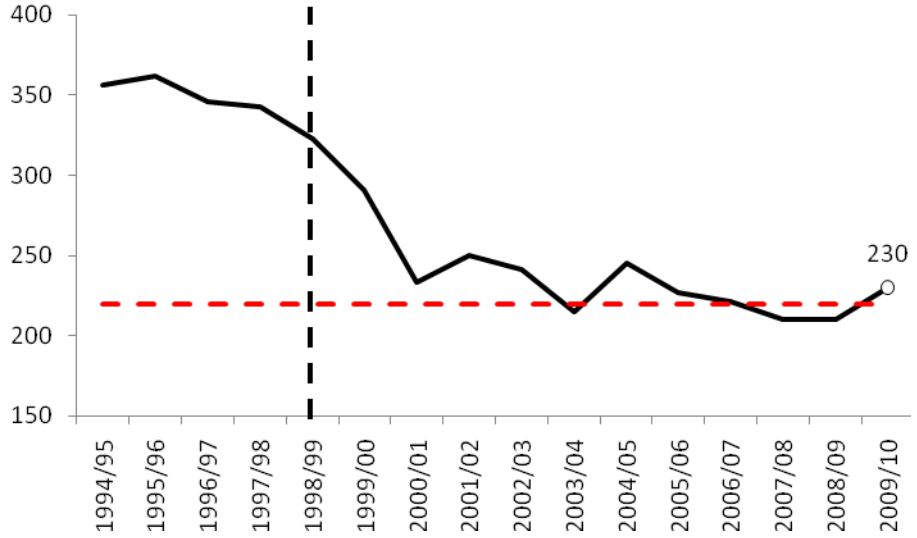


Figure 6. Number of vessels around the State reporting rock lobster catch. The dashed red line is the reference point (220) designed in 1998, while the dashed black line marks the start of the QMS.

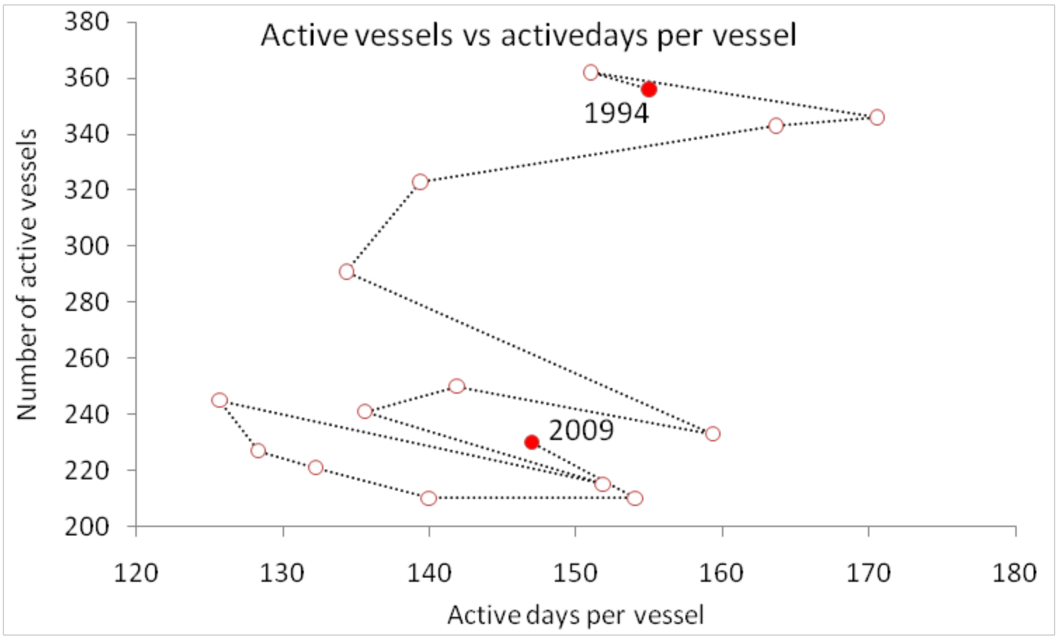


Figure 7. Number of vessels around the State reporting rock lobster catch in relation to the days fished per vessel. Upper and lower constraints on vessel activity affect the overall fleet size.

Table 5. Number of active vessels reporting catch of rock lobsters throughout the State.

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

3.1.3 Regional commercial catch and effort

Commercial catch has had clear regional trends over the last few decades with declining catch in the north (especially north-east) and an increase in the south west and south until 2005 followed by a decline in more recent years (Figure 8). Over the last three years this trend has reversed slightly in the north (Areas 5 and 4) where catch has continued to increase. Remaining eastern (Areas 1-3) and western (Areas 6-8) catches continued to decline (Figure 8).

Deep water (>35 fm) catch from the west coast has trended downwards since 1992, most rapidly since ITQ management in 1998. Catch in the deep north-west (area 9) has increased over the past two years and the other deep areas 10 and 11 have been relatively stable over the past two years (Figure 8). While fishers didn’t increase catch in deep water areas despite the failure to take the TACC in the 2008/09 year, the expectation that lower catch rates in the wider fishery in 2009/10 would lead to catch shifting offshore if fishers struggle to take the TACC was confirmed.

Regional effort increased across the north (areas 4 and 5), western deepwater (areas 9-11) and eastern area 2 and southern area 8 (Figure 9). The western areas 6 and 7 and eastern area 3 had slightly reduced effort while area 1 was stable (Figure 9).

Catch rates in the north were similar to the previous year but in all other areas catch rates continued to decline (Figure 10). Regional declines in catch rate were most pronounced in the south with greatest decline in the South and East (27%) (Table 6 and Figure 9).

Fishers report that there has been a change in fishing practices at night with more multiple night shots. Data restricted to **day shots only** (Table 7) to exclude any bias shows the state-wide decline in catch is more pronounced (19% over the last year) although appears more positive in the minor Area 3.

Apparent declines in mean catch rates can be caused by factors unrelated to abundance and for this reason trends in biomass shown later in the report provide a more reliable guide to stock changes.

Trends in regional catch and effort suggest the declines seen over the last few years have occurred throughout the state, with the exception of Area 3 which is stable at a very low catch rate. Catch rates have declined in deep (9-11) and shallow (1-8) assessment areas (Figure 9). The trends in catch rates in northern and eastern areas are especially concerning as they have occurred despite concurrent decline in effort. If recruitment to the fishery were stable, then this large decline in effort should result in higher catch rates instead of the observed decline.

On a finer scale, most of the state-wide catch comes from the fishing blocks in the south west (areas 1, 8 and 7) and King Island (area 5) with the highest catch rates in the north west (areas 5, 6) (Figure 14). During the past year catches and catch rates have increased in the north west and north east (areas 5 and 4) catch rates from all the south west blocks (area 8) have declined (Figure 15).

These declines were not a function of change in fishing depth because they occurred in both deep and shallow areas (Figure 9), or seasonal timing of catch because catch rates were below average for almost all months.

Analysis of monthly trends shows that January 2009 catches from deep water in the west (areas 5, 9-11) increased (Figure 11) along with effort in areas 5-11 (Figure 12) but in all areas except 5, the catch rate in January decreased (Figure 13).

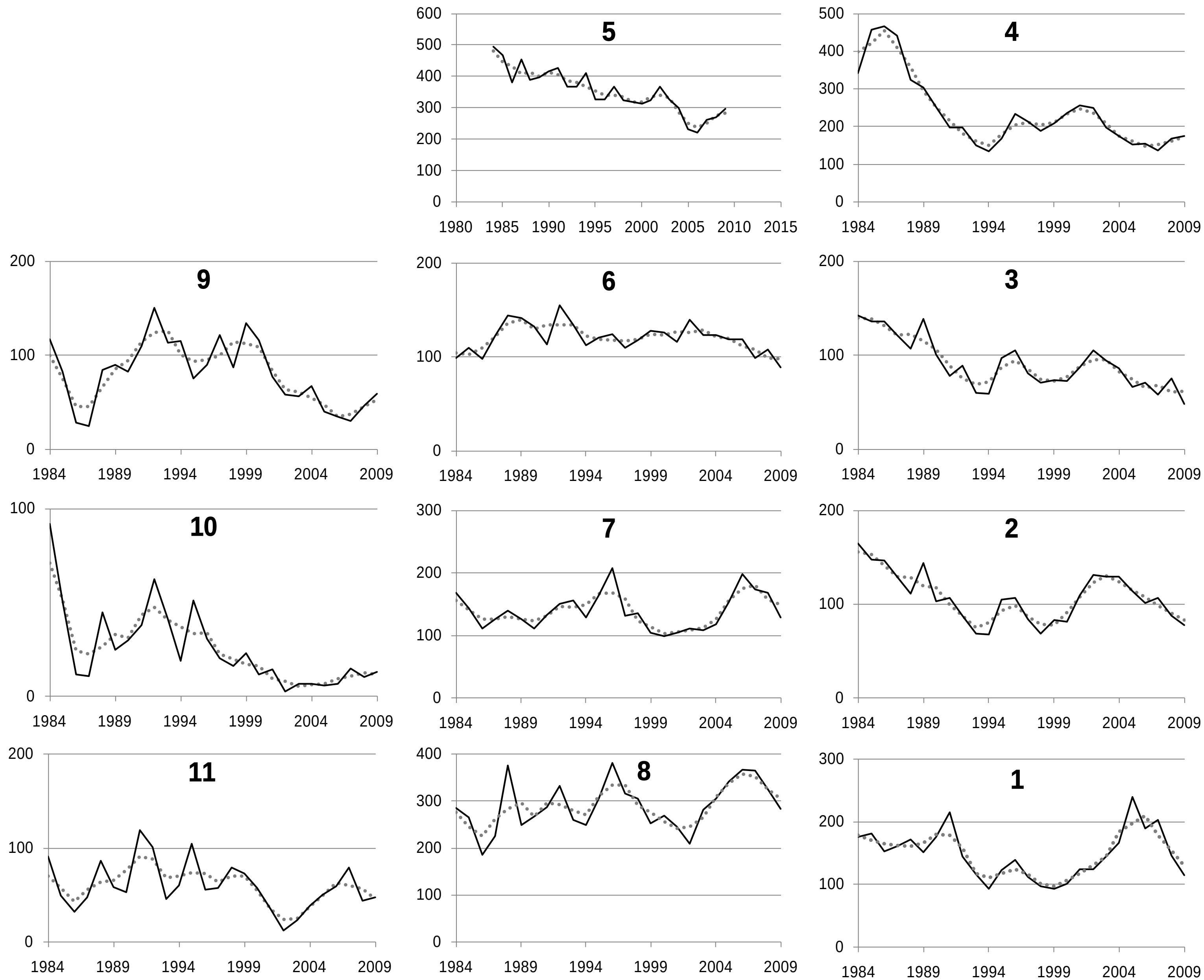


Figure 8 Regional catch in tonnes. Data is split by quota years with the first part of the year indicated. Each plot shows the 3 year moving average (heavy line) and yearly data (thin line).

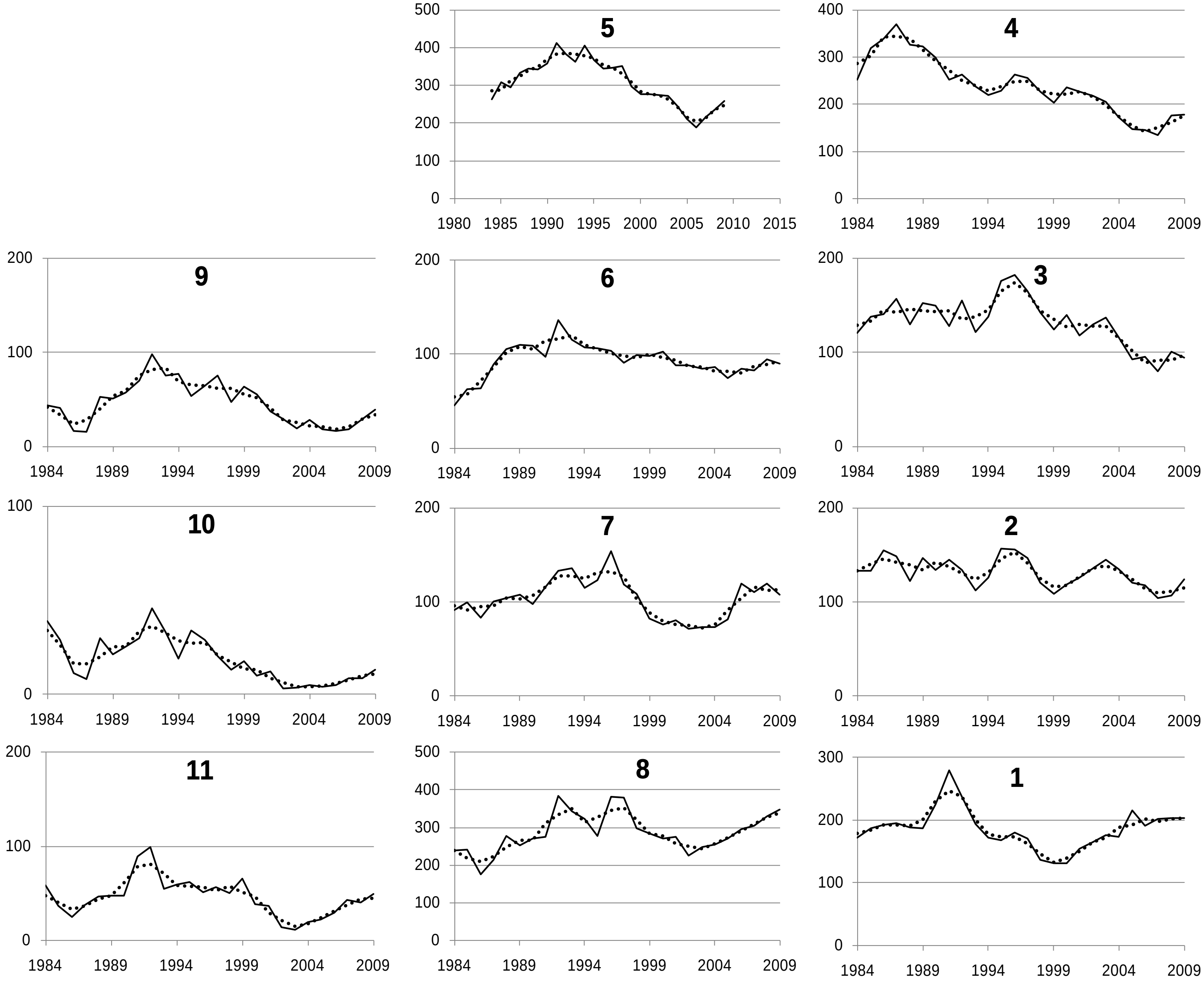


Figure 9. Regional effort (thousand potlifts). Data is split by quota years with the first part of the year indicated. Each plot shows the 3 year moving average (dashed line) and yearly total (solid line).

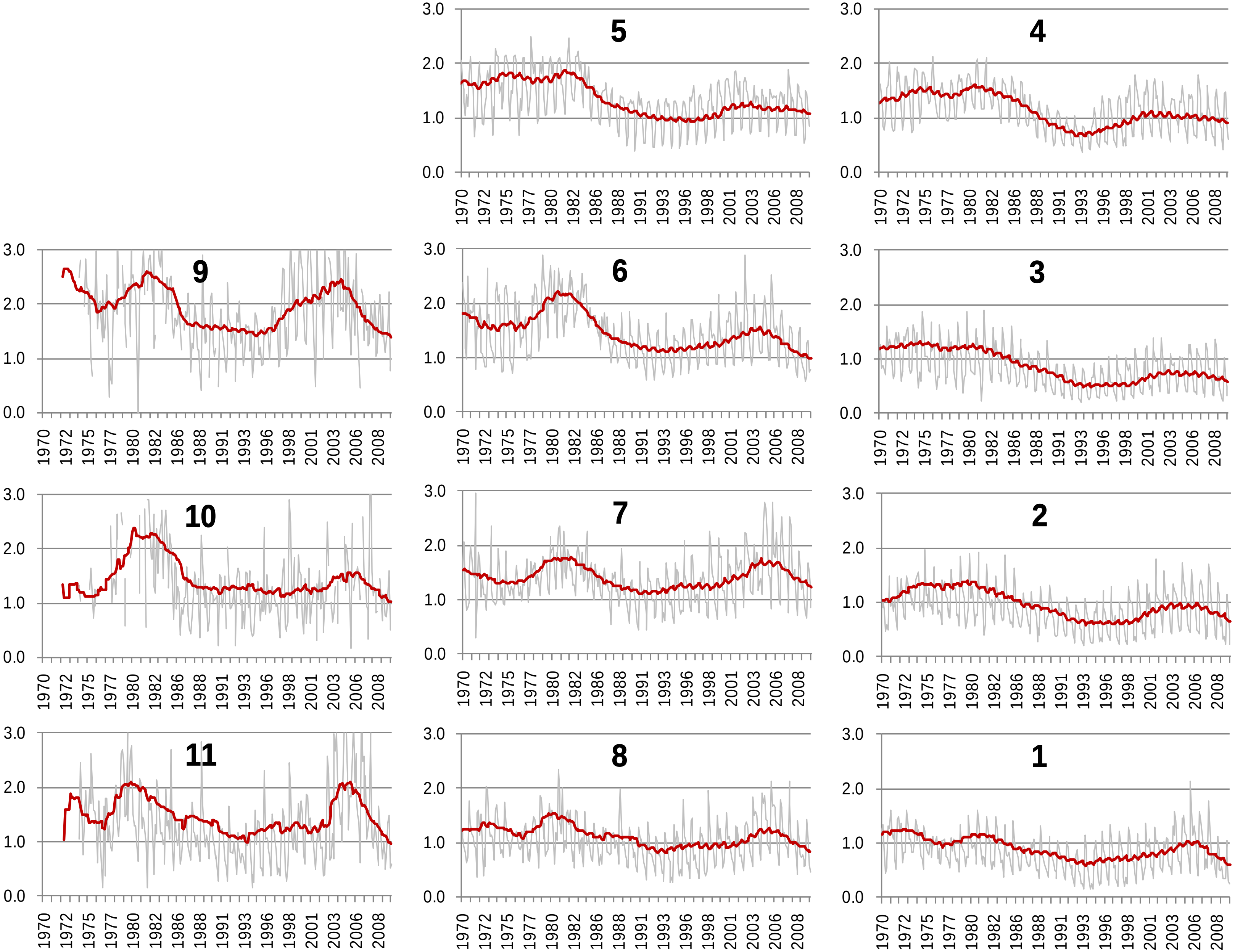


Figure 10. Regional commercial catch rates since 1970. Data is presented on a quota year basis (i.e. March to February), so the last data point is for February 2010. The monthly trend in catch rate is shown by the pale grey line with a 12 month average shown by the heavy line.

Table 6. Annual commercial catch-rates. Negative values of % change indicate a reduction. The reference year is defined as the year with lowest CPUE.

		Commercial catch rates (kg/pot lift)			% change		Catch stats (March 2009-Feb. 2010)	
Area	Lowest Year	Lowest Year	2008/09	2009/10	vs Ref. Year	vs 2008/09	Catch (t)	Effort (1000 pot lifts)
State-wide	1994	0.82	1	0.87	7	-13	1219	1394
1	1994	0.54	0.72	0.57	5	-21	111	194
2	1994	0.54	0.83	0.64	18	-23	77	120
3	1994	0.43	0.76	0.54	26	-29	43	80
4	1994	0.61	0.95	0.93	51	-2	152	163
5	1995	0.89	1.15	1.17	32	2	282	242
6	1994	1.06	1.11	1.01	-5	-9	88	87
7	1994	1.12	1.38	1.16	4	-16	115	99
8	1993	0.76	0.99	0.79	3	-21	265	337
9	1996	1.4	1.58	1.6	15	1	43	27
10	1994	1	1.22	1.08	8	-12	10	9
11	1993	0.83	1.12	0.94	14	-10	33	35

* estimated catch from logbooks (where effort is also recorded) as compared to total (QMS) landed catch

Table 7. Annual commercial catch-rates – **DAY SHOTS ONLY.** Negative values of change indicate a reduction. The reference year is defined as the year with lowest CPUE.

		Commercial catch rates (kg/pot lift)			% change		Catch stats (March 2009-Feb. 2010)	
Area	Lowest Year	Lowest Year	2008/09	2009/10	vs Ref. Year	vs 2008/09	Catch (t)	Effort (1000 pot lifts)
State-wide	1994	0.85	0.99	0.8	-7	-19	212	266
1	1994	0.57	1	0.67	17	-33	24	35
2	1994	0.45	0.77	0.73	61	-6	4	5
3	1994	0.51	1.14	0.71	39	-38	4	6
4	1994	0.51	0.83	0.75	47	-10	14	19
5	1991	0.92	1.05	0.95	4	-10	12	12
6	1991	0.74	1.07	0.87	18	-19	15	18
7	1997	0.76	1.04	0.8	6	-23	24	30
8	1993	0.7	0.89	0.7	0	-21	70	100
9	1991	1.25	1.47	1.55	24	5	19	12
10	1994	0.83	1.17	0.96	15	-18	5	5
11	1993	0.78	1.12	0.92	17	-13	22	24

Table 8. Annual mean commercial catch-rates- **partial year data for March and April 2010**. Negative values of change indicate a reduction. The reference year is defined as the year with lowest CPUE.

Area	Commercial catch rates (kg/pot lift)		% change	Catch stats (Mar - Apr 2010)	
	2009/10	2010/11	vs 2009/10	Catch (t)	Effort (1000 pot lifts)
State-wide	0.87	0.74	-15	154	209
1	0.47	0.29	-39	4	15
2	0.57	0.43	-25	6	14
3	0.51	0.43	-17	5	11
4	0.83	0.75	-10	21	28
5	1.22	1.04	-15	67	65
6	0.81	0.76	-6	12	15
7	1.19	0.97	-18	11	11
8	0.72	0.51	-29	18	36
9	1.63	0.88	-46	7	8
10	1.17	0.62	-47	0	1
11	0.92	0.57	-51	3	5

* estimated catch from logbooks (where effort is also recorded) as compared to total (QMS) landed catch.

Table 9. 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. Weight is from estimated catch weight rather than landed weight.

QYear	Catch (t)	Pot Lifts ('1000)	% effort of 96/97	State CPUE (kg/potlift)
1994/1995	1454	1768	92.63	0.822
1995/1996	1643	1755	91.93	0.936
1996/1997	1803	1909	100.00	0.945
1997/1998	1614	1826	95.64	0.884
1998/1999	1490	1594	83.49	0.935
1999/2000	1493	1477	77.35	1.011
2000/2001	1485	1456	76.26	1.020
2001/2002	1495	1433	75.09	1.043
2002/2003	1512	1356	71.06	1.115
2003/2004	1497	1374	71.97	1.090
2004/2005	1514	1309	68.59	1.156
2005/2006	1511	1257	65.86	1.202
2006/2007	1520	1289	67.55	1.179
2007/2008	1550	1320	69.18	1.174
2008/2009	1472	1462	76.60	1.007
2009/2010	1356	1527	79.97	0.888

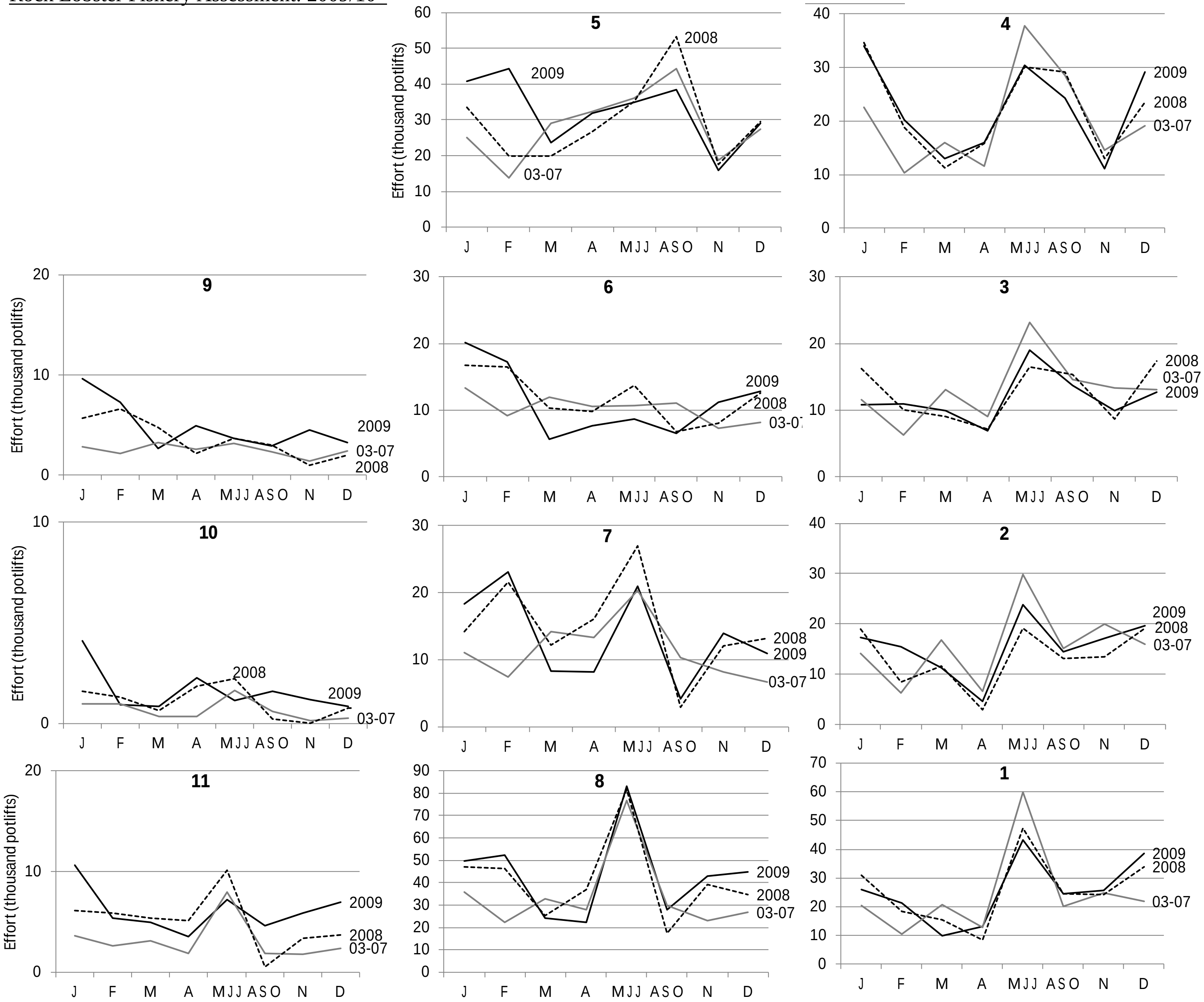


Figure 11. Seasonal distribution of regional commercial effort (pot lifts) between periods for 2009/10 (black line), 2008/09 (dashed line) and the mean of the quota years 2003/04 – 2007/08 (grey line).

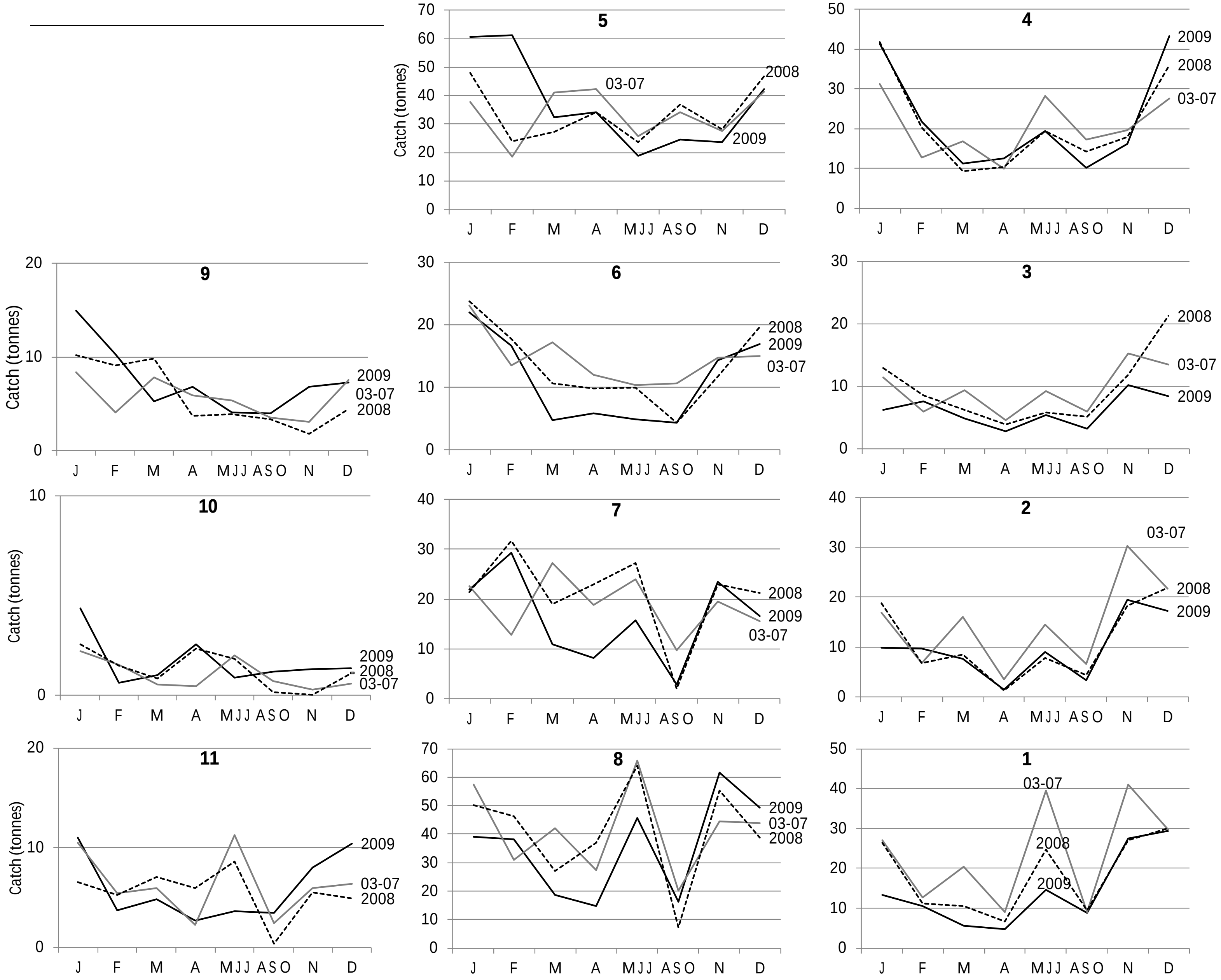


Figure 12. Seasonal distribution of regional commercial catch (tonnes) between periods for 2009/10 (black line), 2008/09 (dashed line) and the mean of the quota years 2003/04 – 2007/08 (grey line).

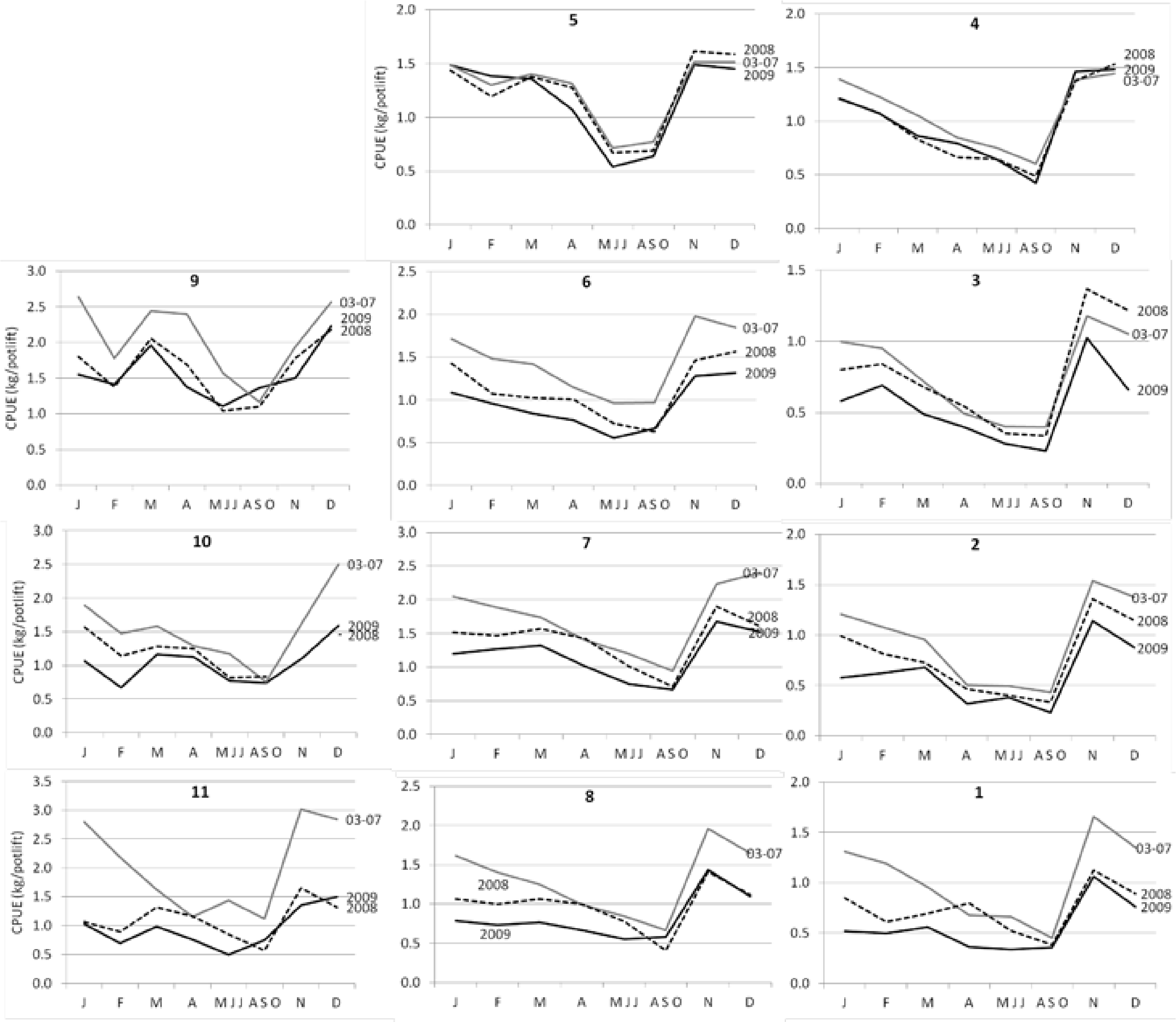


Figure 13. Seasonal distribution of regional commercial catch rate (CPUE, kg/pot lift) between periods for 2009/10 (black line), 2008/09 (dashed line) and the mean of the quota years 2003/04 – 2007/08 (grey line).

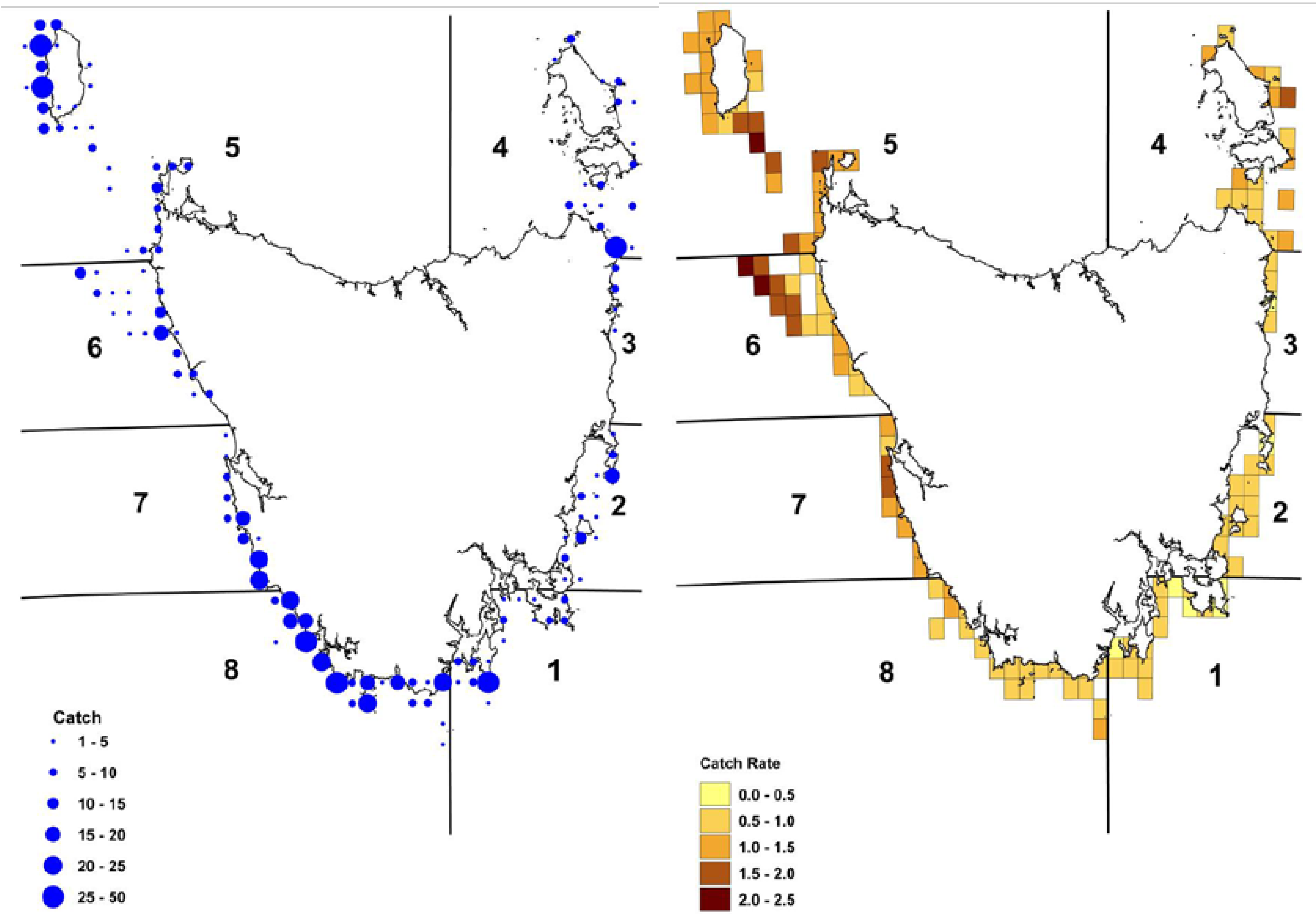


Figure 14 Catch in tonnes (left) and catch rates in kg/potlift (right) during the 2009/10 fishing season for each fishing block. Blocks with catch of less than 0.5 tonnes or fewer than 4 operators were excluded.

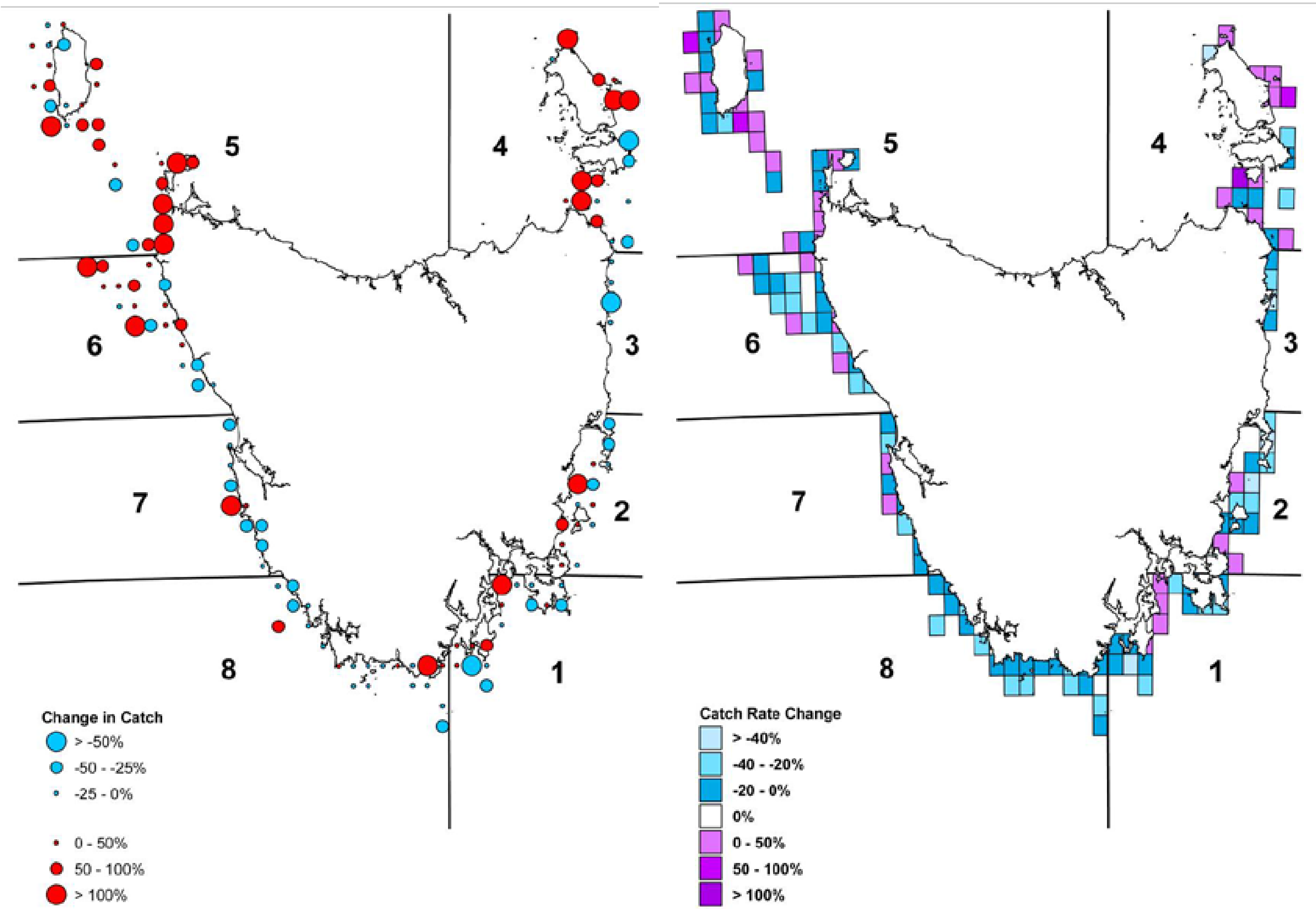


Figure 15 Percentage changes in catch (left) and catch rates (right) by fishing block during the 2009/10 fishing season compared with the previous season. Blocks with catch of less than 0.5 tonnes or fewer than 4 operators were excluded.

3.1.4 Mean weight

The mean weight of lobsters in catches has slowly increased in recent years in most areas, with minimum values sometime between the mid and late 1990s (
Figure 16). This is a complex performance measure to interpret because an increase in average weight could be due to either of increased landing of larger lobsters or reduction in recruits. Nonetheless, trends in the NE are consistent with the low recruitment discussed elsewhere.

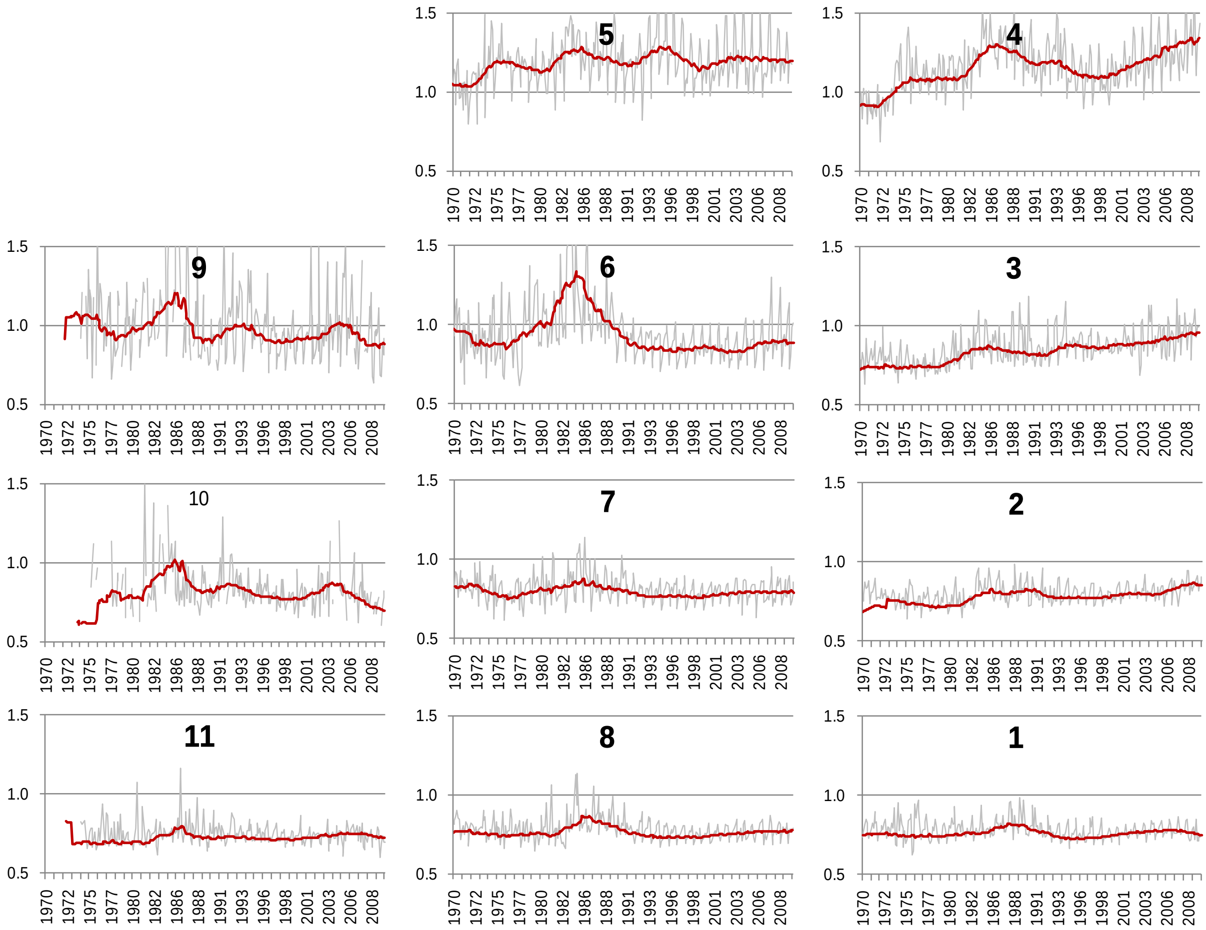


Figure 16. Mean weight of lobsters (red line) by quota year and assessment area.

3.1.5 Non-quota commercial catch

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

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

Personal use in 2009/10 was insignificant at 3.5 t, down from 4.0 t in the previous year (Figure 17). These lobsters are mainly sick animals or octopus kills that were unsuitable for sale into the live market.

Well mortalities were trivial at 0.6 tonnes, up from 0.3 tonne in the previous year.

Octopus mortalities have been steady through time with an average of 42,800 lobsters per year, which equates to an average mortality of 2.35% of the number of lobsters retained. Total number of lobsters reported killed by octopus in the last year was 40344, which was an increase on the previous year but average (**Figure 18**).

The commercial sector accounts for the majority of catch followed by the recreational catch and the mortality due to octopus. Other sources of mortality including discard mortality are essentially trivial and in the model assumed to be negligible. Non-quota well mortalities increased slightly during 2009/10.

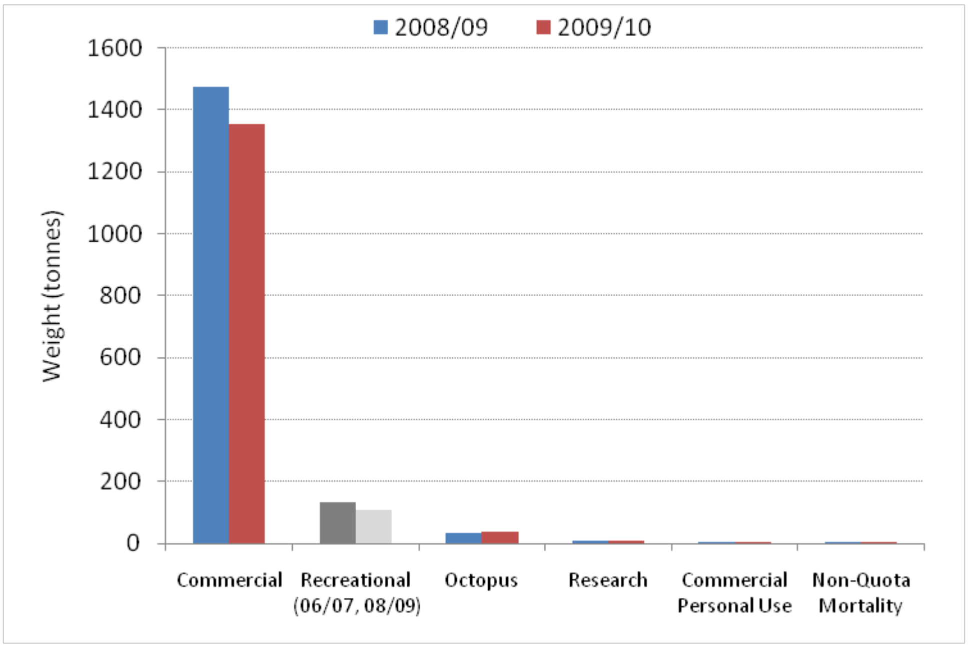


Figure 17. Different sources of lobster mortality during 2008/09 and 2009/10.

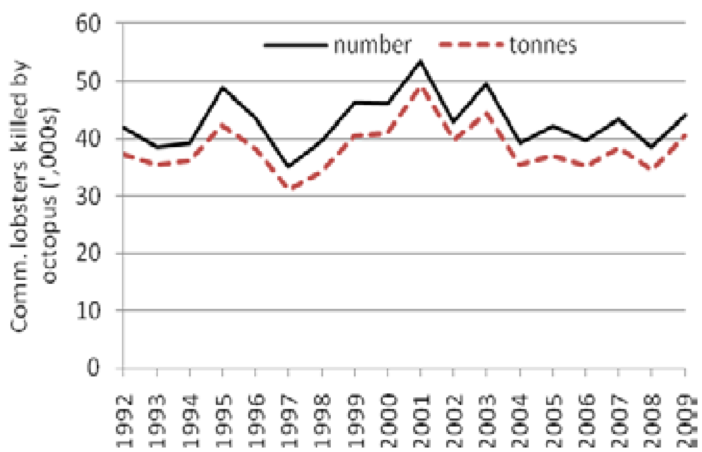


Figure 18. Trends in reported lobster mortalities due to octopus predation. The average mortality rate equates to 2.35% by number. Mortality in tonnes is calculated using the average weight of lobsters for each year.

3.1.6 Research quota

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

3.2 Recreational catch

The most recent published recreational survey of rock lobster catches was for the 2008/09 fishing year (Lyle, 2010). The number of recreational licenses for rock lobster has remained stable for the last 2 years at around 21,400 after average compound growth in license numbers of 7.7% per annum for the previous 9 years (
Figure 19). This represents a growth in the number of license holders, up from around 8500 in 1996.

Estimated recreational catches increased steadily each survey from 1992 until 2002/2003 after which they appear to have increased in 2006/07 and declined to 107 tonnes in the latest survey in 2008/09 (

Table 10). The majority of the recreational catch comes from the East coast.

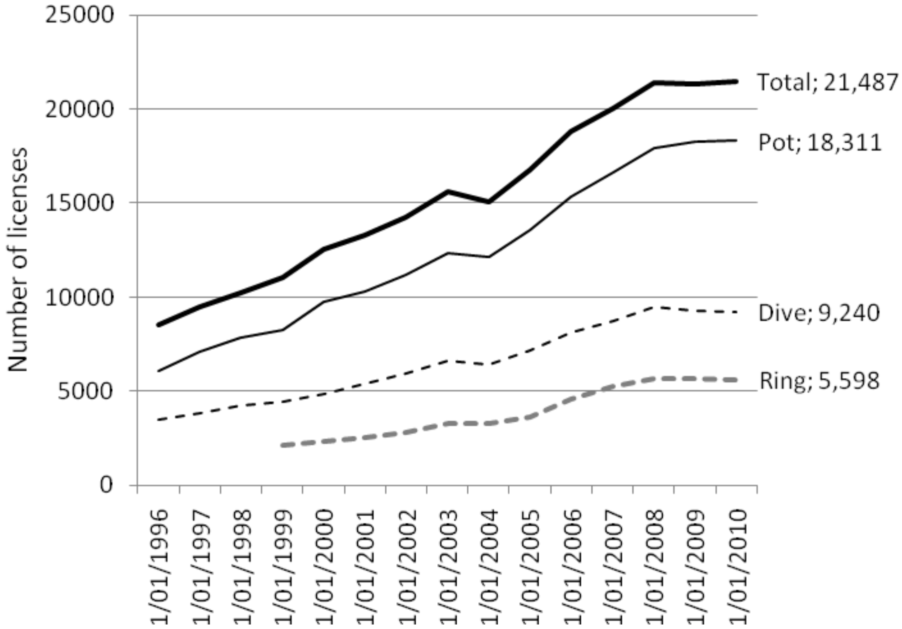


Figure 19. Trends in recreational rock lobster licenses. Fishers may hold licenses for more than one type of rock lobster gear type.

Table 10. Estimated total weight (tonnes) of recreational catches by area and season. The recreational surveys were usually conducted over a fishing year (November until October – with September and October assumed closed to recreational fishing). However, these figures have now been associated with given quota years. Spatial resolution of the surveys has increased through time.

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

3.3 Assessment model analysis

The assessment model firstly estimated biomass for each historical year to the present and these are shown in the following figures as values up to 2009. The model then projected biomass and catch rates into the future considering the following management strategies, which were proposed by stakeholders:

No cut:	The 2010 TACC is retained in 2011 and onwards
Status Quo:	A 5% cut to the TACC is implemented in both 2011 and 2012
Fast Status Quo:	The two 5% cuts are implemented immediately in 2011 so that this becomes a single 10% cut
x kg/pot:	The TACC is reduced to x kg/pot from 2011 onwards

Table 11 Management strategies considered in model projections and corresponding kg/pot and TACC values. Each row has been highlighted according to the probability that that TACC will constrain the 2011/2012 catch. Red indicates a TACC that is unlikely to constraint the catch, yellow indicates that it may constrain the catch and green that it is likely to constrain the catch. This uses the estimated catch for 2010/2011 (1163t) as an indicator of future catches.

	kg/pot	Resulting TACC (t)
No Cut	126	1323
Status Quo	120	1257
Fast Status Quo	114	1194
110kg / pot	110	1156
105 kg / pot	105	1103
100 kg / pot	100	1051
2009/2010 Actual Catch:		1358t
2010/2011 Predicted Catch:		1163t

3.3.1 Biomass

State-wide exploitable biomass has rapidly declined since the high reached in 2007 and is now only slightly greater than the lowest level of the last decade (1999/2000; Figure 20). Ten year projections of the various harvest strategies showed that the "no further cuts" option failed to rebuild to the 2000 level and that the time needed to reach the 2007 maximum was around seven years with the most severe reduction to 100 kg/pot (Figure 20).

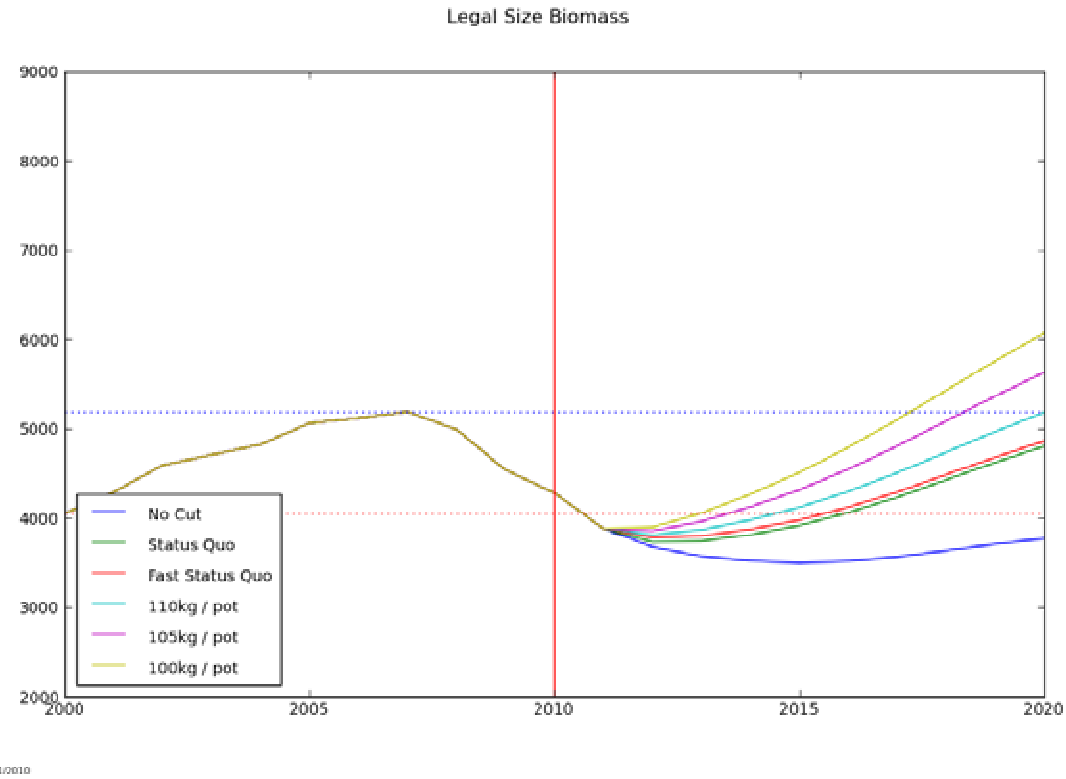


Figure 20 Estimated State-wide legal size (exploitable) biomass up to 2010 and projected legal size biomass according to various management strategies from 2010 to 2020.

During the last year, estimated legal sized biomass only increased in area 5 with areas 4,6,7 and 9 at the lowest levels since 2000 (Figure 21). Recent declines have undone all increases in legal size biomass observed since the start of the QMS system in 1998.

Model projections showed that the “no cut” harvest strategy provided the lowest level of biomass rebuilding with four areas (4,6,8 and 9) failing to rise above the lowest level between 2000 and 2010 (Figure 21). Rebuilding of biomass in area 5 was the most positive however most of the other areas started close to or below minimum and took 510^{+} years to exceed the maximum values observed between 2000 and 2010 (Figure 21).

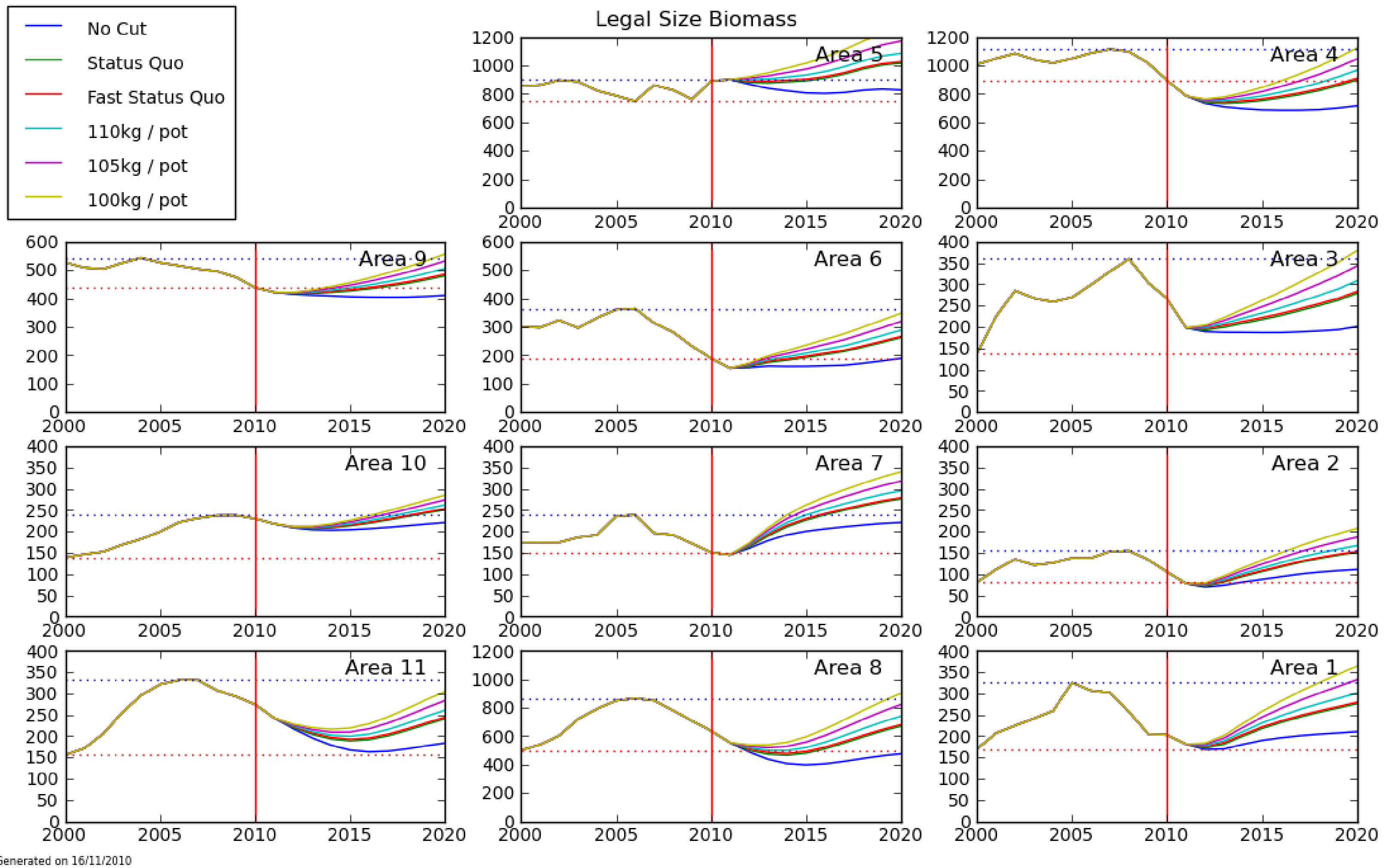


Figure 21 Estimated regional legal size (exploitable) biomass from 2000-2010 and projected legal size biomass according to various management strategies from 2010-2020. The lower dashed line is the lowest and the upper dashed line the highest estimated.

Table 12. Legal-sized biomass estimates from 2010 compared with estimates from 2009; the year with the lowest biomass since 1984; and the lowest biomass since introduction of QMS. Negative values in last three columns show percentage reductions in biomass.

Area	Lowest year: Since 1984	Lowest year: Since QMS	Exploitable Biomass (tonnes): Lowest since 1984	Exploitable Biomass (tonnes): Lowest since QMS	Exploitable Biomass (tonnes): 2009	Exploitable Biomass (tonnes): 2010	% Change in 2010: vs Lowest since 1984	% Change in 2010: vs Lowest since QMS	% Change in 2010: vs 2009
State-wide	1993	1999	235	313	359	350	48.6	11.8	-2.7
1	1994	1999	114	155	192	198	73.5	27.5	3.3
2	1994	1999	54	74	113	100	86.5	35.3	-11.2
3	1994	1999	73	100	261	219	199	119.1	-16.2
4	1994	1999	441	774	820	737	67	-4.7	-10.2
5	1995	2005	582	629	672	782	34.2	24.2	16.3
6	2009	2009	183	183	183	155	-15	-15	-15
7	1994	2009	135	138	138	127	-6.3	-8.3	-8.3
8	1993	1999	409	498	657	657	60.8	32.1	0.1
9	1996	2009	271	395	395	372	37.4	-5.9	-5.9
10	1993	1999	60	121	220	212	255.7	75.7	-3.8
11	1993	1999	128	171	298	286	123.1	66.8	-4.2

3.3.2 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)
- Larvae collected in plankton tows are not retained inshore but are invariably from off the continental shelf except for very early stages and the final puerulus stage
- There is no pattern in historical stock data between levels of egg production and future recruitment
- Modelling of larval dispersal suggest Tasmanian recruits mainly originate from elsewhere (SA and Vic.)
- Variation in current movement between years suggests that no one region is consistently important for larval supply as this varies between years.

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

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

As with legal-sized biomass, state-wide spawning biomass has fallen over the last few years but is currently well above the reference point at 61% (Table 13). 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 spawning biomass in 2010 was 9% higher than the lowest year in 1991, but 4.8% lower than at the start of QMS and 5.4% lower than in 2009 (Table 13).

Declines in spawning biomass over the past year have been widespread around the state except in area 5. Despite the declines in spawning biomass over the last few years, levels in southern areas remain very high to the unfished state with greater than 25% production in Areas 1, 2, 7, 8, 10, and 11. This suggests more than adequate egg production in these regions. 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.

Egg production is below target levels in northern Areas 3, 4, 5, 6 and 9. Further, each of these areas (except area 5) has declined over the last year so that the stock is moving away from the target level of spawning stock biomass. In Areas 3, 6, and 9 the spawning stock biomass is now at the lowest point since the introduction of the QMS.

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, but management consider the level of ~12% to be acceptable).

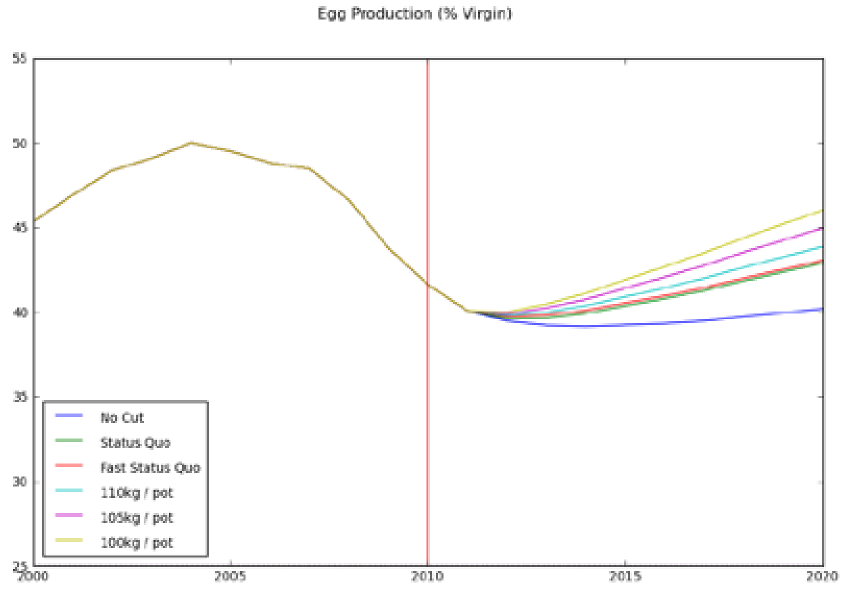


Figure 22 Estimated State-wide egg production from 2000-2010 and projected egg production according to various management strategies from 2010-2020. Egg production is shown as a percentage of virgin (unfished) production.

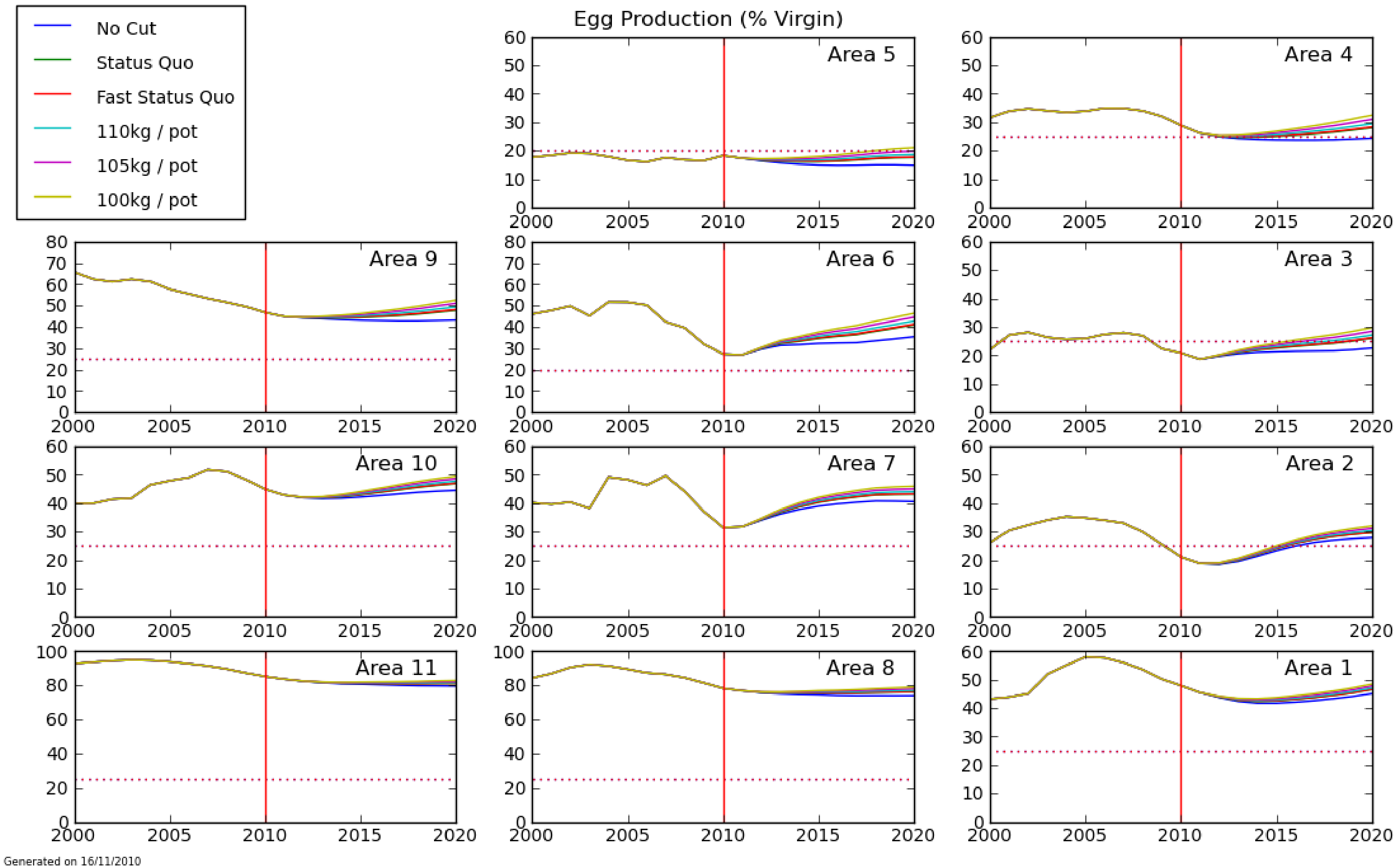


Figure 23 Estimated regional egg production up to 2010 and projected egg production according to various management strategies from 20102020. The dashed line is the limit reference level of 20% for areas 5 and 6 and 25% for the remaining areas.

Table 13. Spawning biomass estimates from 2010 compared with estimates from 2009; the year with the lowest biomass since 1984; and the lowest biomass since introduction of QMS. Percentage of virgin spawning biomass is bold for areas which are currently below the limit reference point of 20% for areas 5 and 6 and 25 for all other areas. Negative values in last three columns show percentage reductions in spawning biomass.

	Lowest year		Spawning Biomass (tonnes)					% Change in 2010		
Area	Since 1984	Since QMS	Lowest since 1984	Lowest since QMS	2009	2010	% Virgin	Vs Lowest since 1984	Vs Lowest since QMS	Vs 2009
State wide	1991	1999	132	151	152	144	61%	9.2	-4.8	-5.4
1	1997	1999	167	176	208	198	69%	18.6	12.5	-4.9
2	1994	1999	50	59	63	52	32%	4.8	-12	-17.9
3	1994	1999	30	42	55	49	**18%**	64.1	14.8	-11.2
4	1994	1999	94	133	153	137	**18%**	46.7	3.3	-10.1
5	1995	1999	108	124	128	142	**15%**	31.1	14.3	10.5
6	2009	2009	53	53	53	45	**13%**	-16.4	-16.4	-16.4
7	1991	2009	76	82	82	69	53%	-8.6	-15.8	-15.8
8	1984	1999	470	597	598	573	98%	21.9	-4	-4.2
9	1987	2009	59	82	82	77	**14**%	30	-5.8	-5.8
10	1986	1999	28	42	51	48	57%	72.4	12.8	-7
11	1985	2009	187	197	197	192	100%	2.8	-2.4	-2.4

3.3.3 Risk assessments

Risk assessments for the Tasmanian lobster fishery were conducted by projecting the dynamics of the stock forward under various TAC scenarios and determining the possible consequences. Economic information on cost and price data from 2009 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 TAFI. Assumptions are listed in that documentation but critically include:

(i) that recreational and illegal catch does not increase as catch rates rise through stock rebuilding;

(ii) that the commercial fleet continues to move between areas in response to catch rates in the same manner as they have done since 1998;

(iii) that the biology of lobsters (especially growth and mortality) is constant through time; and

(iv) critically, that future recruitment will fall within the range of previous observed recruitment levels for data fitted from 1984 to 2009, i.e. that the recent period of low recruitment was a random event rather than a regime shift.

Projections of the fishery are based upon two randomised recruitment series, one of average recruitment from 1998-2007 and one of low recruitment 2002-07 (see 3.3.3.1). 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 2009/10, given a particular TACC. If the result is 50% or less this suggests that the chance of the stock rebuilding is equal to or less than the chance of the stock declining.

3.3.3.1 Recruitment assumption

The model projects forward in time to determine the effect of proposed management strategies on the fishery and this requires knowledge of future recruitment. The relationship between egg production and recruitment is highly dependent on environmental variables and poorly understood. Hence, the best indication of future recruitment is given by historic recruitment estimates.

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

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

The 2008/2009 stock assessment model was modified to use recruitment from the last ten reliable years (1998 to 2007) to address concerns regarding a change in recruitment. This choice has been confirmed as appropriate by Dr. Andre Punt, a leading international fisheries modeller, responsible for most of the development of the model used in Tasmania. In response to increasing concerns in 2010, regarding a possible fundamental change in recruitment, a five year time series (2002-2007) is also considered here.

3.3.3.2 Setting a profitable TACC

Profitability can increase when the TACC is lower despite lower catch and thus lower revenue. This is because lower TACCs also result in higher catch rates and thus lower costs.

The profitability of the fishery over coming years is a good indicator of the health of the fishery as a whole. If profitability is high then overall the fishery will be healthy (although there may be regional issues). Table 14 shows the profitability of the fishery under each of the management strategies. In contrast Figure 24 considers the profitability of the entire fishery as a function of the TACC. This indicates that if recruitment follows the pattern observed between 1998 and 2007, good profitability is obtained anywhere between 900 and 1200t. If recruitment follows the pattern observed between

2002 and 2007, reasonable profitability is obtained below 1100t TACC. A TACC below 1100t provides good profitability in both instances.

Table 14: Profitability of the entire fishery under each management strategy (values are NPV in millions of dollars). Each row corresponds to a different assumption about recruitment.

	TACC options considered					
	No Cut	**Status Quo**	**Fast Status Quo**	**110 kg/pot**	**105 kg/pot**	**100 kg/pot**
1998-2007 Recruitment Series	250	385	392	406	417	421
2002-2007 Recruitment Series	1552	32	58	197	292	334

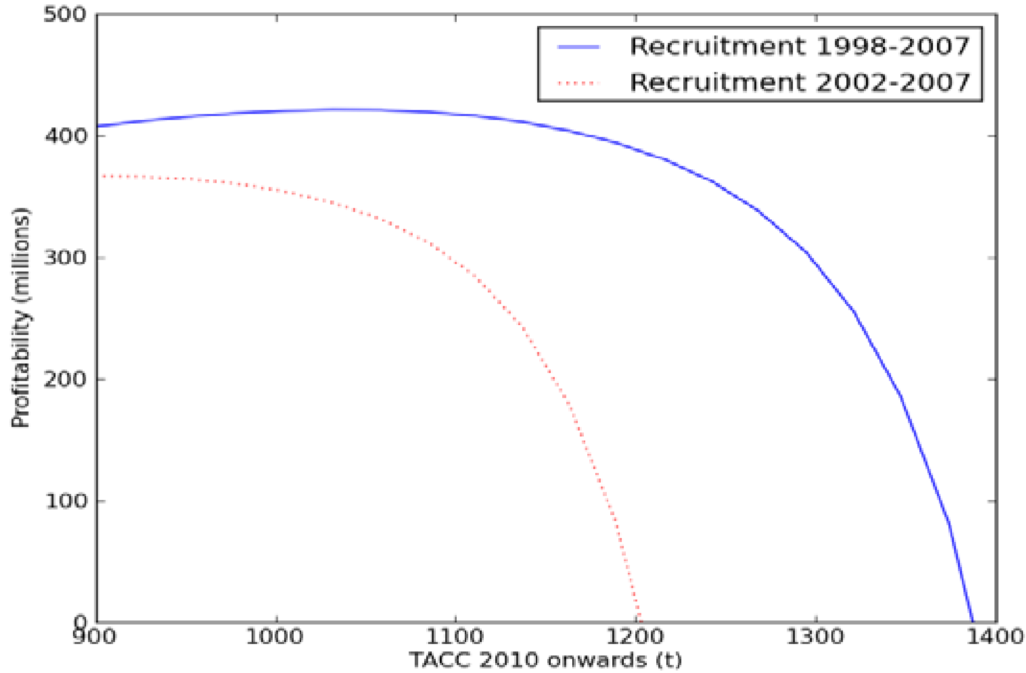


Figure 24: Profitability of the fishery (NPV; millions of dollars) as a function of the TACC from 2010 onwards. Results are shown for two different assumptions about the recruitment process (discussed later). For the 1998-2007 recruitment time series, profitability is >400million for TACCs between 1280t and 900t. For the 2002-2007 recruitment time series, maximum profitability is attained below a TACC of 900t although the additional gains are reduced as the TACC is reduced past 1100t.

3.3.3.3 Catch rate trends (CPUE)

Catch rate projections using 10 year (1998-2007) recruitment data showed drops in CPUE over the next 23 years under all TACC options. By 2015, the status quo and fast status quo options had returned to the current CPUE and all of the remaining options exceeded 0.93 kg/potlift (Table 15). The state-wide limit reference point is exceeded by a TACC of 105 and 100kg/pot and the target reference point by 100kg/pot.

Projections using the 5 year (2002-07) recruitment time series showed that CPUE for all options except the 100 kg/pot were still declining in 2020 with the status quo reaching a low of 0.35 kg/potlift in 2020 (Table 15).

Table 15 State-wide CPUE projected over the next ten years under the different management options shown as the kg per quota unit under each scenario. Each entry is colour coded with darker entries indicating a higher CPUE starting at the limit reference point of 0.9 kg/potlift CPUE. Results show the trends using a) 10 year recruitment estimates from 1998-2007 and b) 5 year recruitment estimates from 2002-2007.

a) 10 year recruitment time series.

State-wide CPUE	Status Quo	Fast Status Quo	110 kg / pot	105 kg / pot	100 kg / pot
2010	0.87	0.87	0.87	0.87	0.87
2011	0.78	0.79	0.79	0.80	0.81
2012	0.77	0.78	0.80	0.82	0.84
2013	0.79	0.81	0.84	0.87	0.91
2014	0.82	0.84	0.88	0.93	0.98
2015	0.87	0.89	0.93	1.00	1.07
2016	0.92	0.94	0.99	1.07	1.15
2017	0.97	0.99	1.06	1.15	1.24
2018	1.03	1.05	1.12	1.23	1.33
2019	1.08	1.09	1.18	1.29	1.41
2020	1.12	1.13	1.22	1.35	1.48

b) 5 year recruitment time series.

State-wide CPUE	Status Quo	Fast Status Quo	110 kg / pot	105 kg / pot	100 kg / pot
2010	0.87	0.87	0.87	0.87	0.87
2011	0.75	0.76	0.77	0.78	0.79
2012	0.69	0.73	0.75	0.76	0.78
2013	0.65	0.72	0.74	0.77	0.80
2014	0.59	0.71	0.73	0.77	0.82
2015	0.54	0.70	0.72	0.77	0.84
2016	0.50	0.69	0.71	0.77	0.86
2017	0.46	0.69	0.71	0.78	0.88
2018	0.43	0.69	0.71	0.79	0.90
2019	0.39	0.68	0.70	0.79	0.92
2020	0.35	0.67	0.68	0.78	0.92

Using the 10 year recruitment data, analysis of CPUE by assessment area without reducing the TACC indicate that the areas currently within the CPUE reference points (areas 1, 2, 3, 10 and 11) would experience little or slow improvements in catch rate with area 11 declining below the limit after 5 years and then returning to the limit by 2020 (Figure 25). For areas 4, 6, 7, 8 and 9 which are currently below the limit reference point, only area 7 would reach the CPUE limit by 2020. Area 5 is currently above the target reference point and under the no cut option would slowly declined approaching the target after 10 years.

For the remaining TACC reduction options using the 10 year recruitment data, the areas currently at or below the limit (areas 2, 4, 6, 7, 8 and 9), CPUE improved by 2020 with areas 2 and 7 expecting much higher increases (Figure 25). For the areas currently within the reference points, the TACC reduction options showed an initial decline in areas 1 and 11 followed by an increase and in areas 3 and 10, CPUE increased with some options exceeding the target in 10 years. Area 5, currently above the target CPUE showed continued improvement with all TACC reductions resulting in a catch rate at least 1.5 kg/potlift after 5 years (Figure 25).

CPUE projections based on the 5 year recruitment time series were more pessimistic. For the no cut option, the areas currently at or below the limit reference point (areas 2, 4, 6, 8, and 9), CPUE continued to decline with area 7 showing some increase in the first 5 years but then declining to approach the limit by 2020 (Figure 26). With TACC cuts, no options for areas 4, 6, 8, and 9 reached the limit reference point within 10 years while area 2 reached the limit at 100, 105 and 110 kg/pot and area 7 exceeded the target at all levels of reduction within 5 years.

Of the areas currently within the CPUE reference points, areas 1, 3, and 11 all declined to below the limit by 2020 and area 1 showed little change (Figure 26). With TACC cuts, areas 1 and 11 showed some slow increases with some options falling below the limit after 10 years. Some options in area 3 showed a small decline but remained within the reference points through the 10 years. Area 10 CPUE increased with the 100 and 105 kg/pot exceeding the target after 67 years.

Area 5, currently above the target CPUE, showed some increase at 100 and 105 kg/pot but the remaining reductions declined but were still above the target after 10 years.

Using the 10 year recruitment data, the 100 kg/pot TACC option was the only one which exceeded the State-wide limit reference probability of 90%, being above the limit CPUE reference point (Table 16) and was also the only option which exceeded the target reference point by 2015 (Table 17). Results for the 5 year recruitment time series showed that none of the TACC options exceeded state-wide CPUE limit or target reference points (Table 16, Table 17).

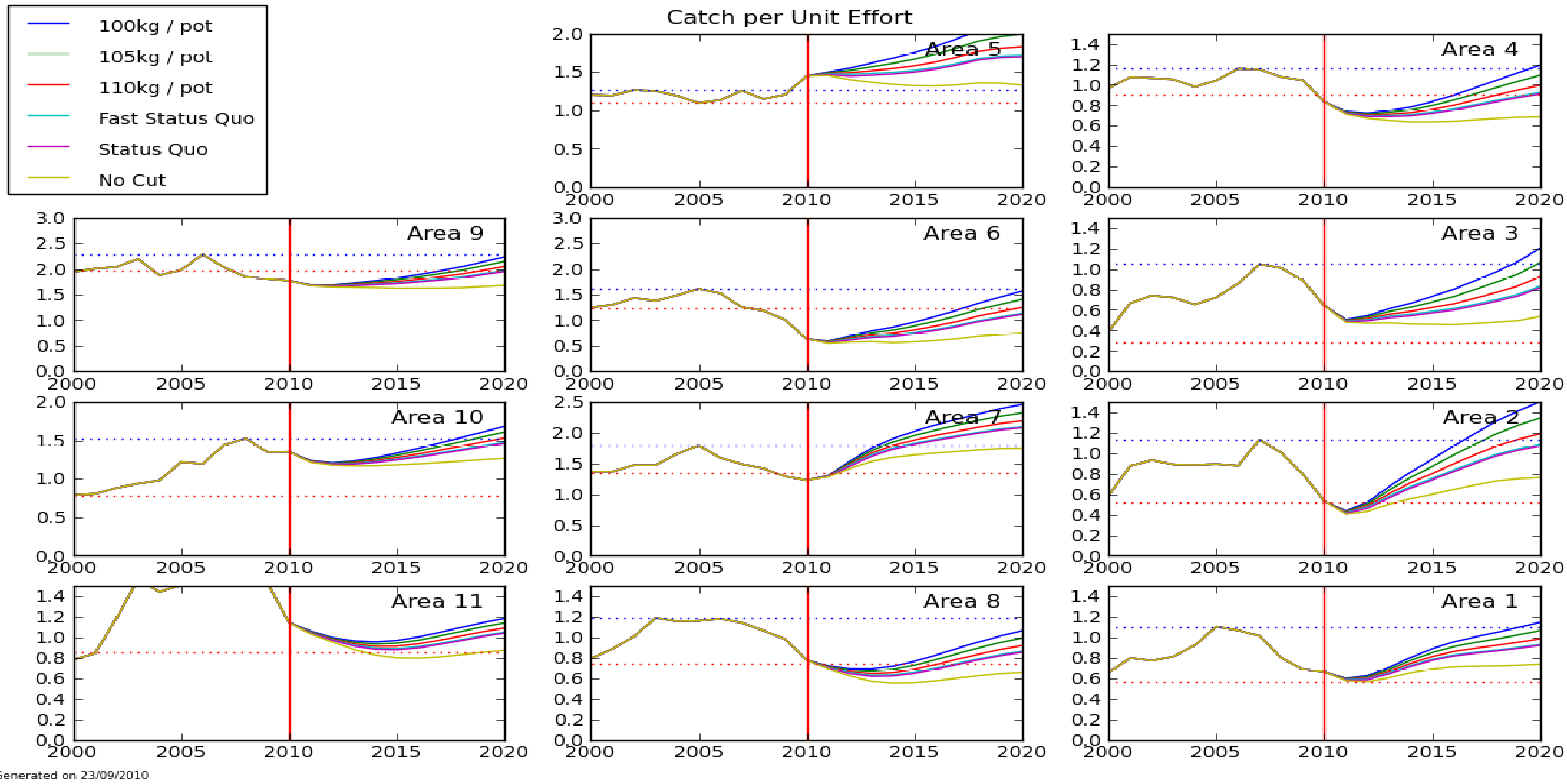


Figure 25 Forward projections of CPUE in each assessment area under each of the management strategies using the 10 year (1998-2007) recruitment time series. The solid red line indicates the current quota year. Dotted blue and red lines are, respectively, the target and limit reference points.

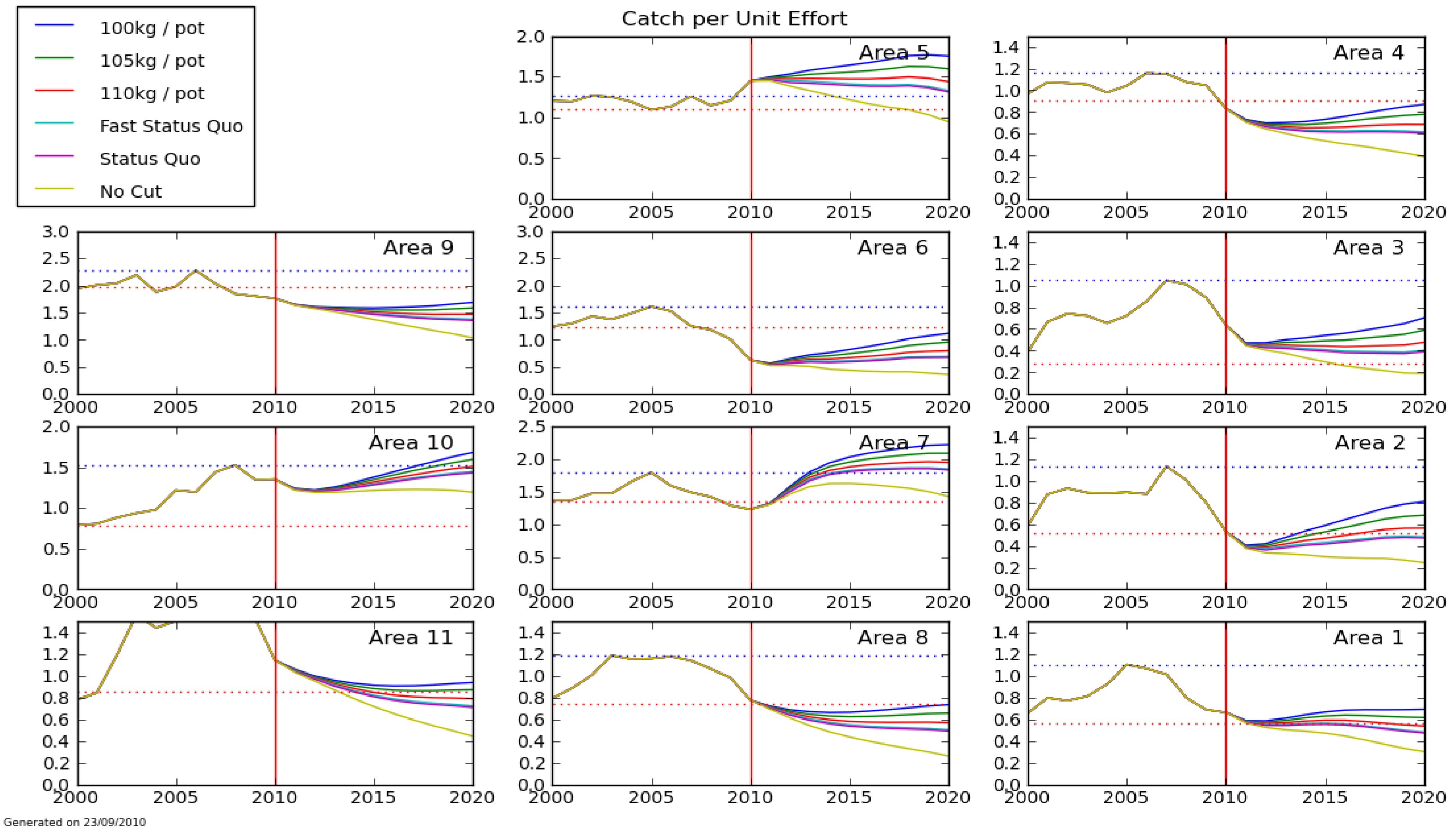


Figure 26 Forward projections of CPUE in each assessment area under each of the management strategies using the 5 year (2002-2007) recruitment time series. The solid red line indicates the current quota year. Dotted blue and red lines are, respectively, the target and limit reference points.

Table 16. The probability of exceeding CPUE **limit** reference point by 2015. Limit reference point is the 1999 CPUE; Target Probability: 90%

	1998-2007 Recruitment Time Series (10 y)						2002-2007 Recruitment Time Series (5 y)					
Area	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**
1	82	94	94	96	97	99	22	48	52	59	69	78
2	58	81	85	88	92	97	12	27	29	36	43	56
3	75	93	95	97	99	100	51	64	66	74	83	92
4	7	13	14	18	28	31	0	6	7	9	11	14
5	76	94	94	96	100	100	65	82	83	91	96	99
6	5	8	8	13	18	22	2	4	5	7	8	14
7	85	97	97	97	98	100	83	97	97	97	98	100
8	4	17	20	24	36	53	0	0	0	1	7	16
9	5	11	14	14	18	22	1	1	1	1	2	3
10	100	100	100	100	100	100	100	100	100	100	100	100
11	21	61	72	85	93	97	1	23	27	44	69	90
State-wide	27	64	66	77	88	**96**	3	20	25	37	58	72

Table 17 The probability of exceeding CPUE **target** reference point by 2020. Target reference point: 2005/2006 cpue for individual areas and 1.4 kg/potlift state-wide. Target Probability: 50%.

	1998-2007 Recruitment Time Series (10 y)						2002-2007 Recruitment Time Series (5 y)					
Area	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**
1	1	14	17	24	41	60	0	0	0	0	1	1
2	8	42	45	58	77	90	0	0	0	1	6	8
3	7	21	22	32	49	64	0	2	2	3	7	11
4	3	15	17	25	43	56	0	1	1	3	4	11
5	57	89	89	92	98	98	19	53	56	73	84	91
6	4	11	11	18	29	49	0	3	3	4	6	10
7	45	89	89	93	99	100	15	57	60	79	88	95
8	0	1	1	3	10	24	0	0	0	0	0	0
9	2	15	17	18	31	42	0	0	0	0	1	2
10	15	38	38	54	64	70	12	36	38	46	59	70
11	0	0	0	0	0	0	0	0	0	0	0	0
State-wide	0	11	11	19	38	**62**	0	0	0	0	3	8

3.3.3.4 Exploitable biomass

Ten year projections of exploitable biomass (Figure 21) provided the following two sets of results based on the recruitment time series used.

1. Under the 1998-2007 recruitment time series:
   - State-wide exploitable biomass in 2015 was above limit reference point with 110, 105 and 100 kg/pot options with the no cut option performing poorly at 36% probability (Table 18).
   - All areas except area 4 met the limit reference point with the 105kg/pot and 100kg/pot TACC options (Table 18).
   - The 105kg/pot and 100kg/pot TACC options exceeded the state-wide target reference point by 2015 as well as for the areas 1, 2, 5, 7 and 10 (Table 19).
2. Under the 2002-2007 recruitment time series:
   - The state-wide limit was only achieved by 100kg/pot (Table 18).
   - The state-wide target was not achieved by any of the TACC scenarios (Table 19).

Table 18 The probability of exceeding the exploitable biomass limit reference point in 2015 using 5 and 10 year recruitment time series.
Limit reference point: 10 year low, Target Probability: 90%

	1998-2007 Recruitment Time Series (10 y)						2002-2007 Recruitment Time Series (5 y)					
Area	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**
1	78	94	94	97	100	100	4	24	25	35	62	79
2	83	95	95	96	98	100	10	44	46	61	77	90
3	79	95	95	97	100	100	24	59	61	74	84	94
4	20	52	54	66	75	83	2	10	11	19	30	49
5	66	90	90	92	98	98	23	65	67	80	86	93
6	55	81	84	91	95	97	15	47	49	59	69	84
7	90	99	99	100	100	100	73	97	98	99	100	100
8	47	86	90	93	97	99	0	14	17	32	60	79
9	37	71	75	81	90	97	0	8	8	9	30	36
10	99	99	99	100	100	100	92	99	99	99	100	100
11	70	94	94	99	99	100	3	44	50	63	82	94
State-wide	36	83	86	92	96	97	1	13	18	30	60	80

Table 19 The probability of exceeding the exploitable biomass target reference point in 2015 using 5 and 10 year recruitment time series.
Target reference point: 10 year high; Target Probability: 70%

	1998-2007 Recruitment Time Series (10 y)						2002-2007 Recruitment Time Series (5 y)					
Area	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**
1	3	20	20	30	53	75	0	1	1	1	1	4
2	12	47	49	66	79	92	0	2	2	5	12	18
3	5	18	18	27	39	59	0	2	2	2	6	7
4	6	15	18	23	43	51	0	1	2	3	6	12
5	30	74	75	82	90	95	9	32	32	46	64	81
6	4	12	13	21	33	44	0	1	2	4	7	12
7	35	76	78	88	94	99	11	43	46	60	84	92
8	1	9	9	21	39	59	0	0	0	0	0	2
9	5	19	24	31	41	57	0	0	0	0	2	3
10	31	62	64	67	77	83	25	56	57	64	71	82
11	0	2	3	5	18	30	0	0	0	0	0	0
State-wide	5	28	31	54	72	88	0	1	1	5	7	19

3.3.3.5 Egg production

Ten year projections of egg production or spawning biomass (Figure 22) indicated that in 2015 under both the 5 and 10 year recruitment time series there would be a 100% probability of being above the limit reference point (Table 20). Similarly, all areas except 2,3,4 and 5 would be above the limit reference point for all TACC options.

Table 20 The probability of exceeding the egg production limit reference point in 2015 using 5 and 10 year recruitment time series.
Limit reference point: 25% virgin egg production in all areas except 5 and 6 which are set to 20%; Target Probability: 70%

	1998-2007 Recruitment Time Series (10 y)						2002-2007 Recruitment Time Series (5 y)					
Area	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**	**No Cut**	**Status Quo**	**Fast Status Quo**	**110kg / pot**	**105kg / pot**	**100kg / pot**
1	100	100	100	100	100	100	98	99	99	99	99	99
2	37	42	42	43	46	47	6	6	6	6	6	8
3	26	31	31	32	36	37	11	12	13	14	17	18
4	39	46	49	53	57	61	22	31	32	37	41	47
5	5	13	15	17	21	29	3	8	9	10	17	20
6	86	90	92	93	98	98	76	84	86	89	90	92
7	95	99	99	99	99	99	99	99	99	99	100	100
8	100	100	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	99	100	100	100	100	100
10	100	100	100	100	100	100	100	100	100	100	100	100
11	100	100	100	100	100	100	100	100	100	100	100	100
State-wide	100	100	100	100	100	100	100	100	100	100	100	100

3.3.4 Recruitment

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

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

3.3.4.1 Model estimated recruitment

The stock assessment model estimates recruitment to its lowest size class (60 mm CL) using commercial catch and effort data plus onboard catch sampling of undersize lobsters (Figure 27). This means that estimates of recruitment can only be determined once the animals affect catch rates by growing into the minimum legal sizes (105 mm for females and 110 mm for males) from the size of recruitment represented in the model (60 mm). For this reason the recruitment levels in the most recent years appear to revert back to the average due to the fact that it takes several years for new recruits to enter the legal sized fishery. Because growth rates differ so much around the State each assessment area has a different time-lag between recruits entering the modelled stock at 60 mm and the animals growing into legal sizes. It takes the longest in Area 8 and the shortest time in Areas 4 and 5. Note that the model assumes that growth is constant through time – increases in growth would appear to the model (and fishers) as a spike in recruitment.

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

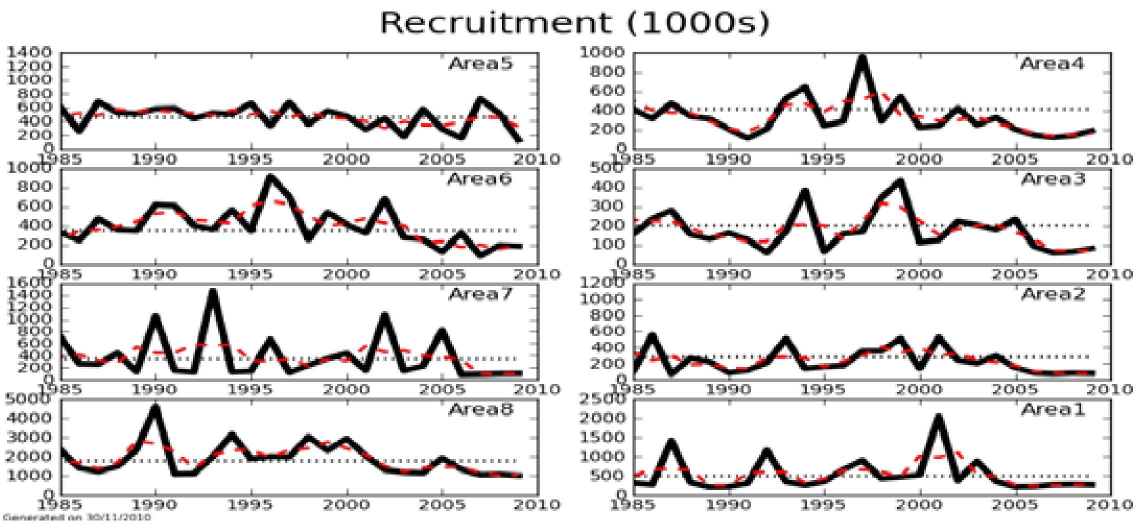


Figure 27. Model derived absolute recruitment to the 60 mm CL size class (this is the first size category in the stock model and the first size class where reasonable numbers are captured in catch sampling surveys) within each region through time. Note the y-axes vary greatly. The average recruitment for the time period is shown by the dashed line while the 3-year rolling average is shown by the dotted red line. Deep water Areas 9, 10 and 11 are included with the shallow water data here as the recruitment is shared for these areas.

3.3.4.2 Puerulus settlement

Very high settlement detected in puerulus collector sites in 1995 (Figure 28) corresponded with 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.

Puerulus settlement at Bicheno and Recherche was very low from January 2003 to mid 2006 and since then Bicheno has had close to average settlement although without strong spring settlements. Recherche Bay has had several summer settlement peaks in recent years (Figure 30). The low settlement from 2003 extended into early January 2008 at the Flinders Island and South Arm sites (Figure 30). Since then, South Arm has improved but is still below average while the last three years at Flinders have all been above average.

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 values in 2010 is positive for the future.

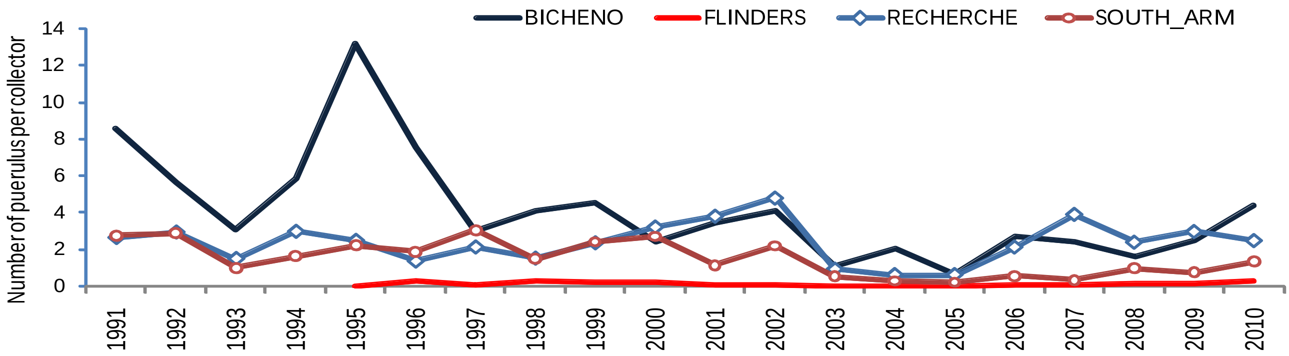


Figure 28 Annual puerulus settlement from long term monitoring sites around Tasmania.

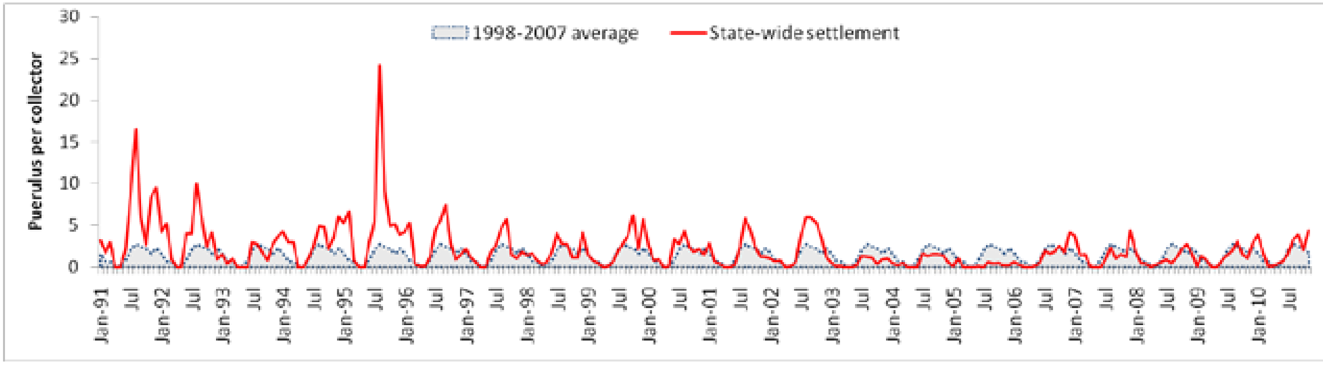


Figure 29 Monthly combined settlement from all Tasmanian settlement sites (red line) compared to the average settlement for the period 1998-2007 (grey shading).

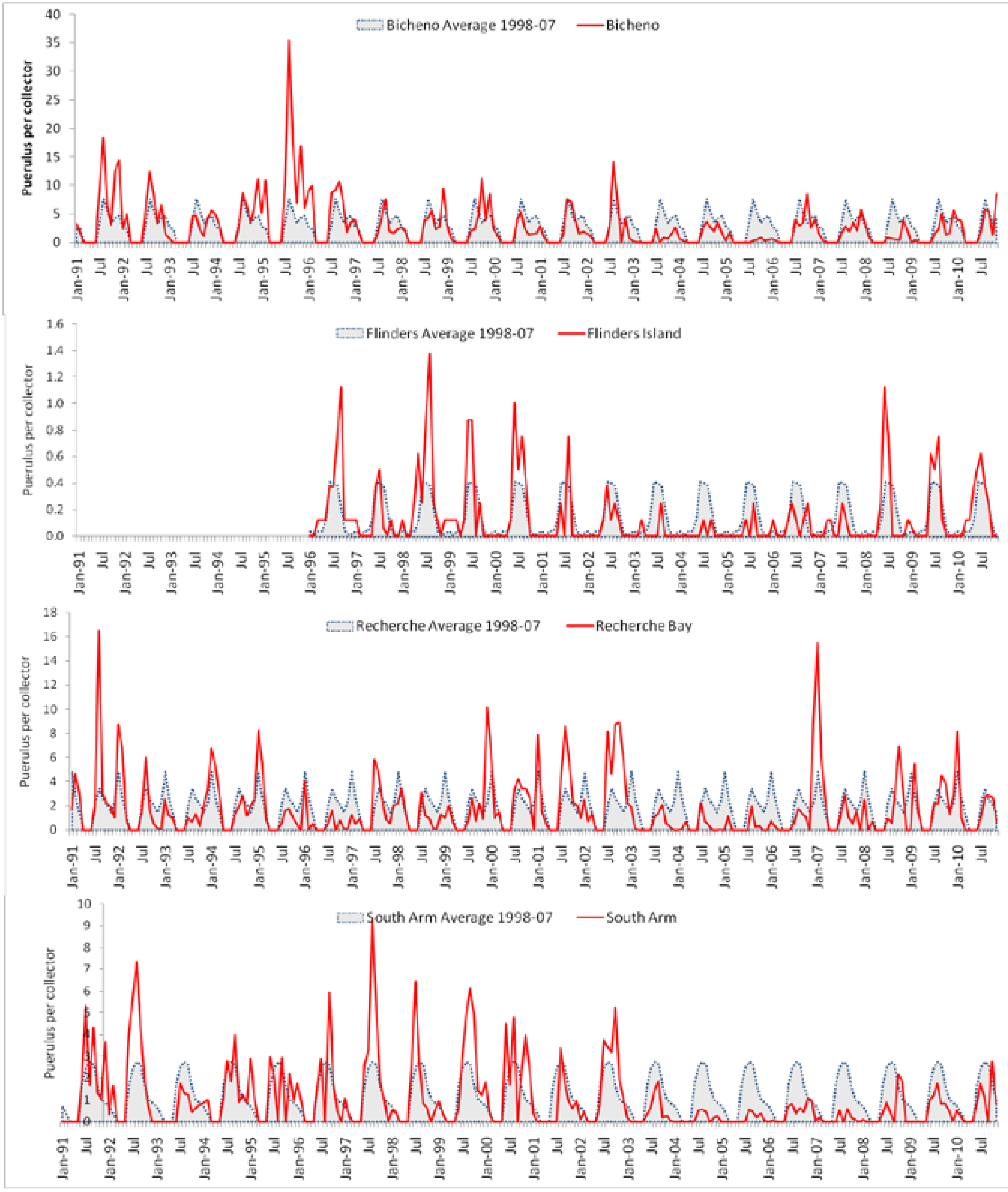


Figure 30 Long term settlement (red) compared to the average settlement for the period 1998-2007 (grey shading).

3.3.4.3 Juveniles observed by diving in east coast MPAs

Another source of recruitment data can be gained from dive transect surveys conducted within east coast Marine Protected Areas. The numbers of lobsters are counted within juvenile, mid and large undersize categories. These surveys indicate an increase in juvenile and mid undersize in 1999 and 2000 (Figure 31), consistent with the observed pulse of puerulus catches in 1995. This would have contributed to the higher catch rates in the commercial fishery around 2000. The absence of juveniles in 2007 and 2008 is a concern and probably mirrors the low settlement observed in the puerulus collectors from 2003 to 2007/08. Juvenile and mid undersize numbers dropped in 2010 but the abundance of large undersize was the highest throughout the 18 year survey period.

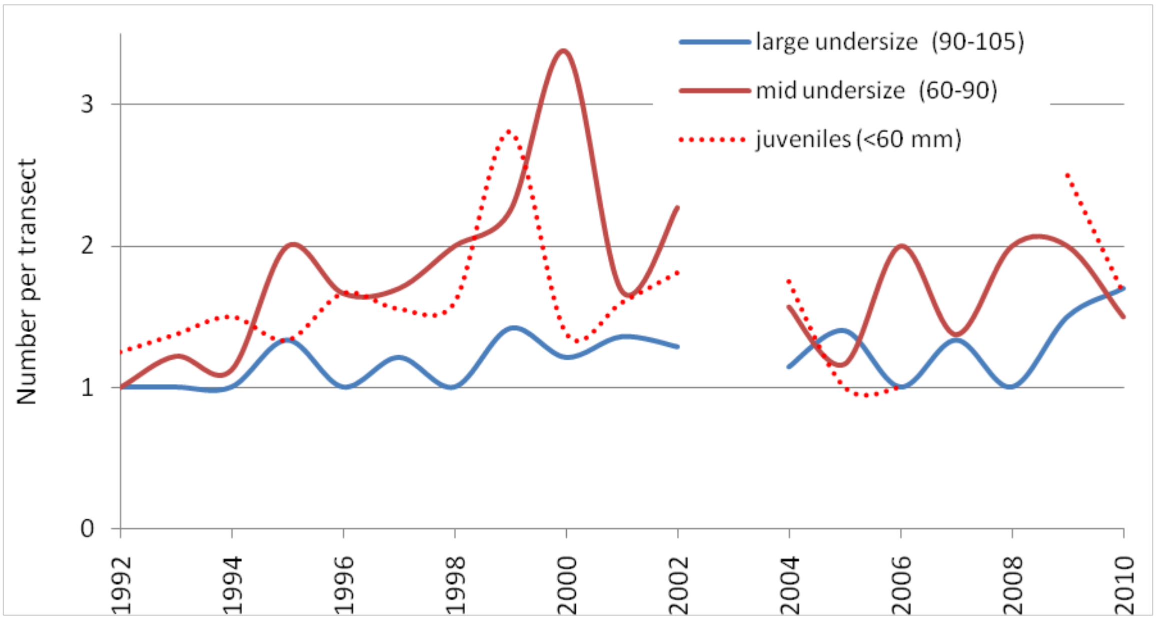
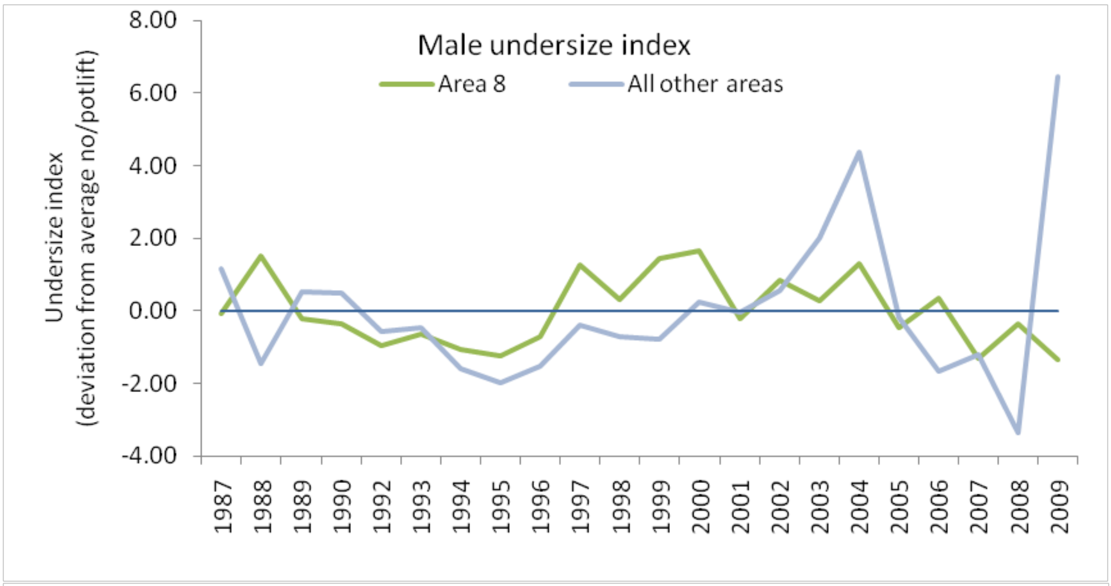


Figure 31 Number of undersize lobsters observed per transect in east coast Marine Protected Area dive surveys.

3.3.4.4 Undersize from observer sampling

Observer sampling on commercial vessels and research cruises provides data on the number of undersize lobsters. Due to high density of undersize in area 8, data from this region dominates so this analysis has split the results into area 8 and all the other areas combined. Monthly counts of undersize lobsters by sex are presented as the difference from the long term average (Figure 32). Males were more abundant between the late 1990's and 2004 and declined from 2005 following the poor larval settlements from 2003. The 2009 increase in males from all other areas may be due to low sample sizes in some areas but the increase in females in that year from both areas is promising. This analysis is confounded by varying growth rates in areas which lead to different lags from settlement to seeing undersize in pots and therefore more data from all areas is needed.



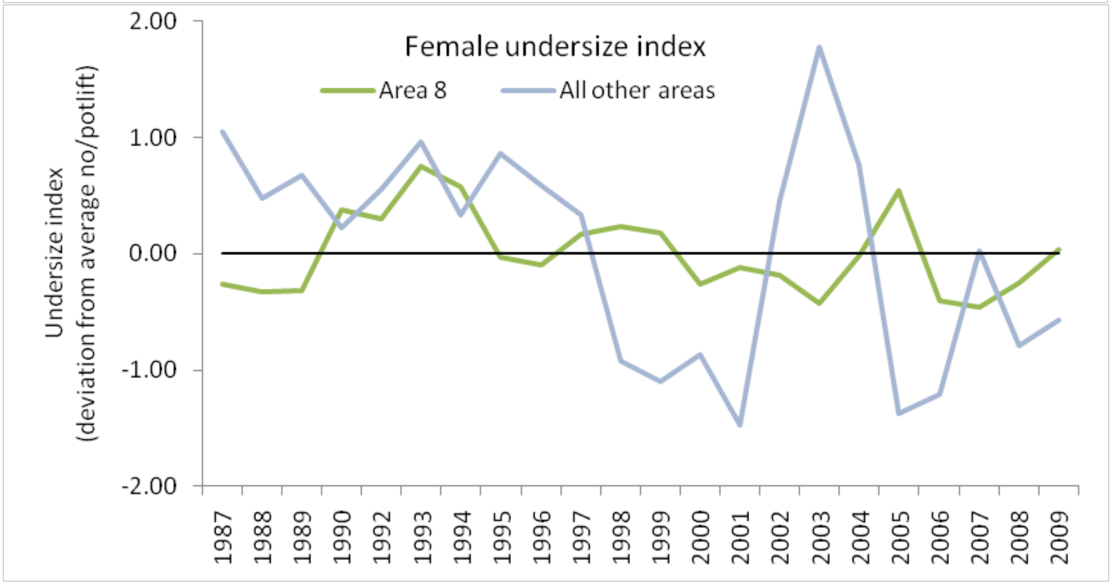


Figure 32 Undersize index of male and female undersize lobsters observed in pots during observer and research surveys between 19872009. The index is the difference between the annual number of undersize per potlift from the long term average (black horizontal line).

3.4 Economic and market status

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

The economic impact of the Tasmanian rock lobster fishery is far greater than would appear from simple comparisons of total annual revenue (*i.e.* the gross value of product GVP) which was around $64 million[2] in 2009/2010 (Figure 33). Because a wild fishery has constraints on production, a "scarcity rent" is obtained and the economic yield is many times greater than can be achieved by most primary industries. Economic yield in the lobster

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

fishery is illustrated by the lease price of quota units, which traded in 2008/09 at around $14. This implies an economic yield from the fishery of around $21 million dollars (1,470,000 kg * $14).

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 $17 million (20%) at the same time as beach price and GVP have risen by 18% (Figure 33). The fall in economic yield despite rising prices has been caused by the rapid rise in costs over the last couple of years. Costs have been driven most significantly by the fall in catch rates – which means fishers now have to fish longer and use more potlifts to take the same catch.

Although daily catches per vessel have fallen over the last two years, the daily revenue per vessel has actually increased in 2008/09 because of higher beach price but fell in 2009/10 because of continued increases in vessel days and potlifts and further depressed catch rate (Figure 34). This increase in daily revenue has not been enough to overcome a slump in fishing profitability, as reflected in a decline in the market lease price (-26% over the last 2 years).

In addition to the commercial fishery there is a significant recreational fishery. The objective of management of the recreational sector is enjoyment or utility rather than financial benefit. Nevertheless, the financial cost of recreational lobster fishing has been estimated at $50 million for all recreational fishing in Tasmania (lobsters, abalone, finfish etc.; Lyle *et al*., 2003).

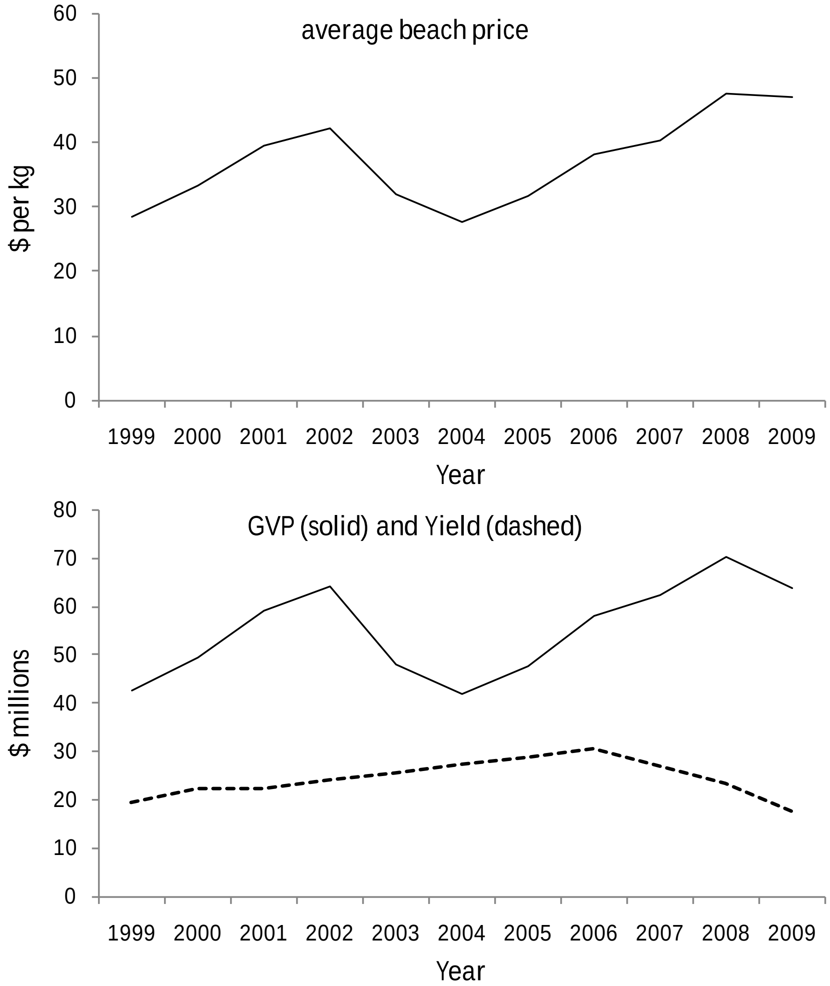


Figure 33. Economic trends in the commercial fishery since 1999. Beach price over the last two years has been high which resulted in a very high gross value of product (GVP) of $64 million. However, economic yield from the fishery fell by $13 million or 42% over the last 3 years despite the price increasing, because costs of fishing increased (due to higher effort for the same catch). This decline in economic yield drove a decrease in the market price for lease quota.

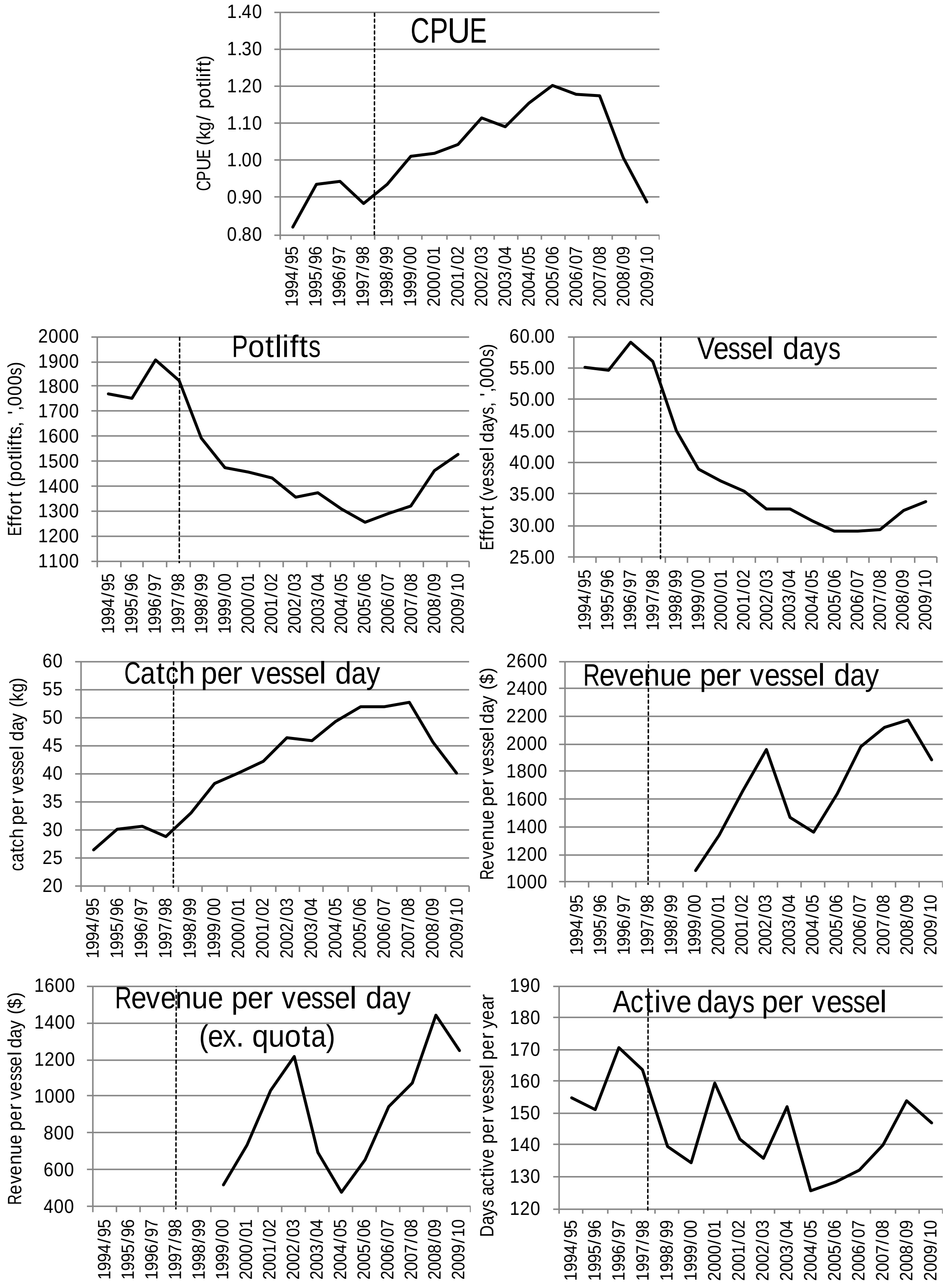


Figure 34. Trends in average State-wide commercial catch data since before the introduction of the quota system in 1998/99. The 1994/95 quota year was when catch rates (as sum of catch/sum of pot lifts) reached their lowest point state-wide. Revenue per vessel day assumes average yearly beach price. Revenue per vessel day ex-quota excludes the opportunity cost of using quota which could otherwise be leased out.

4 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. Responding to lower lobster abundance, regional effort increased in most areas. In the south (Areas 1 and 8) effort is equivalent to the high pre-quota levels of the early 1990's. Catches from the South West (Areas 8 and 9), which have been significant contributors to the State-wide catch have steadily declined over the past 2-3 years in line with similar declines in catch from the east coast. Catches from the north of the State (Areas 4,5) and North West deepwater (Area 9) were the only areas during the season where catches increased if only slightly.

State-wide catch rate for day shots is the lowest on record (7% lower than 1994 and 33% lower than the peak catch rate in 2005/06), indicating that much of the stock rebuilding that occurred since Quota Management System (QMS) commenced has now been undone. Catch rates in the north were similar to the previous year but in all other areas catch rates continued to decline. This was most pronounced in the south east with areas 1-3 declining by 21-29% to 0.54 kg/potlift. The 2010 assessment considered fishers concerns that a change in fishing practices with more multiple night shots may have been artificially depressing the catch rate. Further analysis of the March and April 2010 catch rates to see if any change in the declining catch rate trend was occurring since the end of the 2009/10 season showed a further decline to 0.74 kg/potlift compared to 0.87 kg/potlift for the same months in 2009.

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

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

5 Management advice

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

There thus appears to be need for unusually low TACCs to constrain the catch and thus prevent continued stock decline. Further stock decline would be expected to continue to erode profitability and increase risk of recruitment and ecological overfishing.

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

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

6 Ecosystem based management

6.1 Protected species interactions

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

6.1.1 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. A single pipefish has also been recorded as bycatch and this was released apparently unharmed.

6.1.2 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.

6.2 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. This difference in gear type allows the effect of escape gaps to be evaluated. Table 21 shows that escape gaps produce a large reduction in catches of most by-catch species. Discard mortality of individuals captured varies between species with very low or no mortality of velvet crabs, draughtboard sharks, conger eels and leatherjackets. Consequently the species of most impact for by-catch monitoring are wrasse, octopus and leatherjackets, which are also reported under by-product.

Total by-catch has increased over the last 3 years due to the increased number of potlifts as lobster catch rates have declined. Hermit crabs are the main component of the by-catch followed by velvet crab and draughtboard shark (Figure 35).

Table 21. By-catch observed in research sampling during 2009/10 and extrapolated to the commercial fishery for the ten most abundant taxa.

Species	Number in research sampling	Number / potlift in research sampling	Estimated total number from fishery
Hermit crab	15,538	8.793	13,423,768
Velvet crab	438	0.248	612,527
Draughtboard shark	377	0.213	325,702
Blue throat wrasse	327	0.185	282,506
Brown striped leatherjacket	244	0.138	210,799
Rosy wrasse	199	0.113	171,922
Leatherjacket – unidentified	161	0.091	139,093
Barber perch	135	0.076	116,631
Octopus	112	0.063	96,760
Red bait crab	108	0.061	93,305

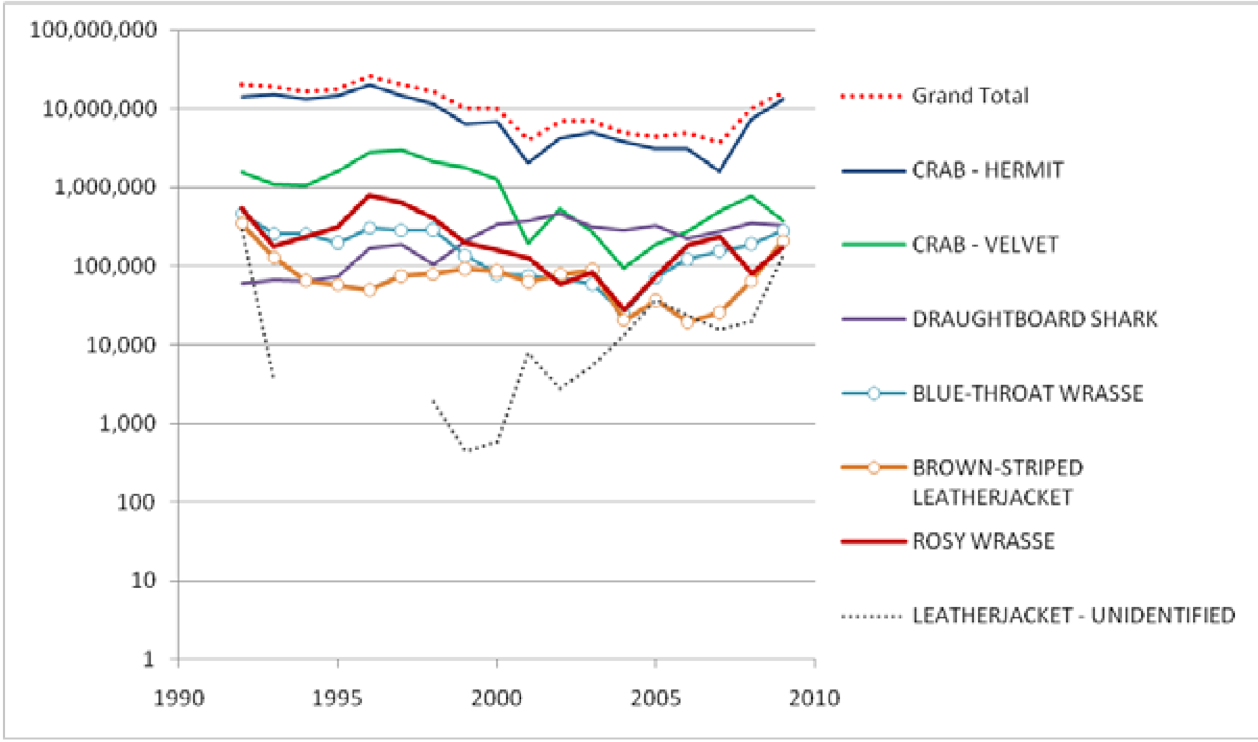


Figure 35 Total by-catch of main species estimated by multiplying research sampling effort and catches up to the equivalent of the annual commercial effort.

6.3 By-product

By-product is now reported within the lobster logbook, which has improved the rate of reporting. Retained product is also differentiated into bait vs. product for sale. All reported by-product from lobster pots was of a trivial volume, the largest being octopus, draughtboard shark and conger eels, each with a total catch of less than 5 tonnes (Table 22).

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 1t 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 22. 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	**2007/08**	**2008/09**	**2009/10**	**2007/08**	**2008/09**	**2009/10**
BARRACOUTA	0.1	0.5	0	0	0	0.1
BEARDED ROCK COD	2.1	2.3	2.2	0.2	0.1	0
CLEFT FRONTED SHORE CRAB	0	0	0	0.3	0	0.1
CONGER EEL	1.8	2	1.9	0.6	0.6	0.3
DRAUGHTBOARD SHARK	0.5	0.1	0	3.1	5.7	0.6
GIANT CRAB	0	0	0	0.2	0.3	0.5
GUMMY SHARK	0	0	0	0.1	0.2	0.1
GURNARD PERCH	0.4	0	0.2	0	0	0
LEATHERJACKET	0.9	0.7	0.7	0.4	0.4	0.1
MORWONG	0.1	0	0	0	0	0
OCTOPUS	0.7	0.6	0.6	5.3	5.2	6.7
STRIPED TRUMPETER	0.1	0.2	0	0.4	0.9	0.6
WRASSE	0.9	0.5	0.7	0.2	0.6	0.4

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8 Appendix 1: Historical overview

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

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

Aborigines fished lobsters around the State and a small indigenous harvest continues, mainly in the northeast. The resource has been harvested commercially since European settlement with fishing effort initially focused on the East Coast. Accounts of historical catches provide insight into the abundance of lobsters in conditions with very low fishing pressure. When James Kelly called at Port Davey in 1815 he traded swans he had shot for crayfish; the local Aborigines quickly collected 3 tons (at least 1000 lobsters) by hand from the waters edge. In 1905, James Rattenbury caught 480 lobsters from the *Rachel Thompson* in six hours using only 6 "cray" rings in Wineglass Bay.

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

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

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

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

In response to further pressure from northern commercial fishers, a Parliamentary enquiry conducted by Joseph Lyons considered that pots were not destructive and recommended that pots be legalised. However, it wasn't until 1925 that pots were finally 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.

9 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.

10 Appendix 3: Summary of Rules

Table 23. 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.