TASMANIAN GIANT CRAB FISHERY - 09/10

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1 Executive summary

This assessment of the Tasmanian giant crab fishery covers the period from 1st March 2008 to 28th February 2010, and provides forecasts of the likely response of the fishery to the total allowable commercial catch (TACC) set at a range of values.

Total catch reported in the quota allocation system for the 2008/09 season was 52.6 tonnes, representing only 84.7% of the 62.1 tonne TACC. In the 2009/10 season the catch was 46.3 tonnes, which was 89.5% of the reduced 51.75 tonne quota.

A limit reference pointing relating to a catch rate decline of $> 20\%$ over two years is in place. The limit point was triggered on the West coast with a decline of 32%, representing the lowest catch rate on record at 36% of the standardised 1995/96 catch rates. On the East coast the catch rate rose to 41% of the standardised catch 1995/96 catch rate – the highest since 2001/02. The statewide catch rate declined by 19% triggering the limit reference point, furthermore, the statewide catch rate has been at record lows over the past two years at 32% and 34% of the standardised 1995/96 catch rate.

Catch rates of undersize crabs (which are released) provide an indication of undersize abundance and consequently the strength of future recruitment to the exploitable biomass. The catch rate of undersize giant crabs has been declining since 04/05 on the East coast and in 09/10 was at 28% of the 04/05 peak. On the West coast undersize catch rates have declined dramatically since 07/08 and in 09/10 were at 17% of the 07/08 value. The reduction in the male size limit for the 09/10 season can explain some of the reduction in undersize catch rates, however there was already a substantial reduction in catch rate in 08/09 (prior to the size limit change). This dramatic reduction in undersize catch rates causes concern about the future health of the exploitable biomass.

Reference points relating to the weight structure of the catch landed at processors are no longer assessed due to the availability of a stock assessment model. The stock assessment model uses the length frequency data collected by fishers in addition to commercial catch and effort data, to provide more reliable and higher resolution size structure and biomass data.

The stock assessment model estimates that the state wide exploitable biomass has declined from a maximum of approximately 1500 tonnes in the early 1990s to 244 tonnes in 2009/10. This equates to 16% of the original unfished exploitable biomass. Total biomass and egg production have both decreased to 19% of their initial levels. This level of egg production (down from 30% in 08/09) is of concern

for a crustacean fishery. Due to a reduced catch, estimated harvest rates have remained steady at 19% state wide.

Results for the West coast are indistinguishable from the state wide results when considered relative to the virgin stock state.

The East coast stock is smaller but has had proportionately lower catches. Consequently the stock is slightly less depleted at 21% of Virgin exploited biomass and 25% egg production. The exploitation rate has risen to 18% (the same as the West coast). There is more uncertainty about the East coast stock due to the limited availability of length frequency data. Length frequency data from the East coast is urgently required to reduce uncertainty in the assessment.

The risk assessment projections were less positive than in the last assessment and indicated that the current TACC is expected to lead to lower catch rates during the next five years due to an under abundance of sub-legal giant crabs. Unless atypically strong recruitment occurs, any stock recovery is predicted to take a long time even under reduced catch levels due to the slow growth of giant crab.

Due to the stock decline, no TACC (including cessation of fishing) is able to meet the reference points proposed in Ziegler et al. (2009). There is a clear need for concern about this stock, and sensible achievable reference points are required to guide the management of the fishery.

Table 1: Summary of performance indicators for giant crab.

Performance indicator	Reference point	Triggered	Status in 2009/10
Total yearly catch	Yearly catch $< 90\%$ of TAC	Yes	89.5%
State-wide commercial catch rates	Decline in two consecutive years	Yes	19% decrease
Regional commercial catch rates	Total decline by 20% in 2 years	Yes	West Coast 32% decrease
Bycatch by lobster fishers	Catch > 5 tonnes		
Proportion of catch over 5 kg	Varies $> 30\%$ from reference year	N/A	Size structure data now derived from catch sampling and used in estimation of biomass
Proportion of catch below 3 kg	Varies $> 30\%$ from reference year	N/A	Size structure data now derived from catch sampling and used in estimation of biomass

Table 2: Status of possible alternative performance indicators, currently under review for a revised management plan.

Model performance indicator	Probability	
Total biomass in current year above 40% of highest historical levels:	State-wide	0%
	West	0%
	East	0%
Egg production in current year above 40% of highest historical levels:	State-wide	0%
	West	0%
	East	0%
Total biomass in 5 years above 40% of highest historical levels:	State-wide	0%
	West	0%
	East	0%
Egg production in 5 years above 40% of highest historical levels:	State-wide	0%
	West	0%
	East	1%
Harvest rate in 5 years below current levels:	State-wide	0%
	West	0%
	East	3%

Performance indicator	Evaluation
Giant crab bycatch from all sectors above 5% of TAC:	Less than 0.1% (130 kg reported as taken in 08/09 and 87kg in 09/10)
Protected species and byproduct:	No protected species interactions reported. 131kg of byproduct retained, primarily Ling and Morwong.
Undersize abundance:	Undersize catch rates have decreased concerningly over the last three years to 28% of the 04/05 peak value on the East coast and 17% of the 07/08 peak on the West coast.

2 Introduction

This assessment of the Tasmanian giant crab fishery covers the period between 1989/90 to 2009/10. It considers the performance of the fishery against the agreed set of reference points defined in the giant crab management plan (DPIPWE, 1999) and updates the annual assessment for the period from 1 March 2008 to 28 February 2010. Other information is provided to assist in assessing the state of the resource including results from the giant crab stock assessment model, and forecasts of the likely outcome of alternative total allowable commercial catches (TAC).

The commercial fishery for giant crab began in Tasmania in the mid 1990s after a live export market to Melbourne, Sydney and Asia was established (Gardner, 1998). Giant crabs had previously been landed as byproduct of rock lobster fishers operating in deeper waters but were generally regarded more as a nuisance than a target. Once giant crab became a targeted species, catches increased dramatically. By 1994/95, total reported catch in Tasmanian waters peaked at 291 tonnes (Figure 1). While some of this catch may be attributable to over-reporting of catch in anticipation of a change in management (moving to quota), it is certain that large quantities of crabs were taken as the virgin stock was being fished down.

By the end of the 1997/98, the total catch had fallen to just 110 tonnes and some concerns were expressed about the downward trajectory of catch rates. At this time quota management was introduced to the associated rock lobster fishery. There was concern that this would displace effort from the rock lobster fishery to the giant grab fishery. In response a giant crab management plan introduced an Individual Transferable Quota (ITQ) system and an initial TAC of 103.5 tonnes in November 1999. The quota year mirrored that for rock lobsters running from 1 March to the end of the following February (DPIPWE, 1999). Along with the introduction of a TAC, a maximum size limit was set at 215 mm carapace length for both males and females, while the minimum legal length of 150 mm for both sexes, introduced in 1993, was retained.

In response to ongoing declines in catch per unit effort (CPUE) across much of the fishery and poor performance against indicators (Gardner et al., 2004), the TAC was reduced to 62.1 tonnes for the 2004/05 quota season and again to 51.75 tonnes in 2009/10. On the basis of a bioeconomic analysis (Gardner et al., 2009) both the TAC and the minimum legal size limit for males (to 140mm) were reduced for the 2009/10 season. This aimed to increase biomass, catch rates and profitability.

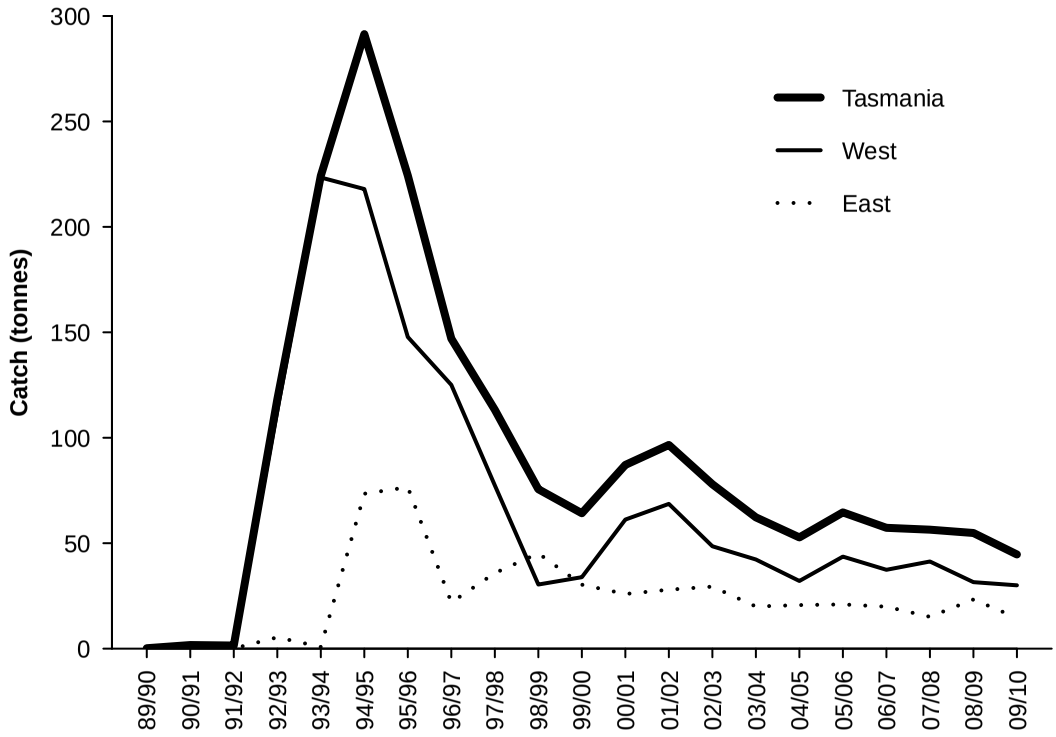

Figure 1: Historical giant crab catches in Tasmania. Catches in 1998/99 and 1999/00 were from partial fishing years due to an extended seasonal closure. East and West are divided by longitude 147°E.

3 Management objectives and strategies

The Tasmanian giant crab management plan was introduced in 1999 (DPIPWE, 1999) and provides the regulatory framework for the commercial fishery. The plan contains the following objectives, strategies and performance indicators.

3.1 Major objectives

Maintain fish stocks at optimum sustainable levels by constraining the total catch and the size of individual giant crabs taken by the commercial sector;

- Sustain yield and reduce incidental fishing mortality by taking fish at a size likely to result in the optimum yield from the fishery, protecting under-size giant crabs, and minimising incidental fishing mortality as a result of fishing operations;
- Manage commercial fishing interactions by mitigating any conflict that results from competition between different fishing methods for access to shared fishing grounds;
- Provide socio-economic benefits to the community;
- Provide high quality products.

3.2 Primary strategies

- Limit the targeted commercial catch by setting a total allowable commercial catch (TAC) and using individual transferable quotas (ITQs) to allocate proportions of the TAC;
- Limit access to by-catches of giant crabs.
- Maintain minimum and maximum size limits and closures of the fishery for female giant crabs during the peak spawning period to conserve egg production, restrict fishing mortality on spawning or berried female giant crabs, and ensure a proportion of large males and females are returned to the water;
- Maintain escape gaps to reduce incidental fishing mortality;
- Restrict the number of giant crab fishing vessels in the fishery and the number of giant crab traps that can be used from individual fishing vessels.

3.3 Performance indicators and reference points

The giant crab management plan identifies (but is not limited to) a number of fishery performance indicators. Reference ranges defined for these indicators are deemed to represent the normal variation of the stocks and fishery. When the observed value of a performance indicator falls outside this range, a limit reference point or trigger point is said to have been exceeded, implying that some management action may be required. Reference points are exceeded when one or more of the following criteria are met:

- The total yearly catch does not exceed 90% of TAC in any year;
- Catch per unit effort (CPUE) for the State declines for two consecutive years;
- Catch per unit effort (CPUE) for any region declines by a total of 20% in two years;
- The bycatch of giant crabs taken by rock lobster fishers exceed 5 tonnes in any year;
- The proportion of the catch above 5 kg or below 3 kg varies by more than 30% compared to the 1996/97 distribution.[1]

[1]This performance indicator was intended to provide information on changes in the size structure of the stock. Length-based information is now collected in much greater resolution through on-board catch sampling conducted by commercial fishers, and used as an input to the assessment model to provide more informative measures on biomass and egg production.

4 Fishery Assessment

4.1 Commercial catch

Giant crab catch is recorded by both the quota allocation system and through logbooks. However these records (as listed in Table 3) do not correspond completely. The quota is considered as taken only when animals are sold or landed, while an entry in a fisher's logbook records the date of capture, and it is quite common for a fisher to hold animals for extended periods. There will also be some transcription errors as evidenced by the need to adjust unrealistic weights and catch rates in the database.

In 2008/09 the total catch reported in logbooks was 54.9t whilst 52.6t was recorded by the quota monitoring system. This corresponds to 84.7% of the TAC. The catch in 09/10 was 44.6t in the logbooks and 46.3t from the quota monitoring system. In 09/10 the TAC was dropped to 51.75t, hence this reduced catch corresponds to an increased proportion of the TAC – 89.5% (Table 3, Figure 2). In both years, catches were lower than the catch limit reference point, set at 90% of the TAC . Industry members indicated that a factor contributing to the short-fall was fishers electing to target rock lobster instead of giant crab. This was due to a combination of high rock lobster beach prices, low rock lobster catch rates and consequent low rock lobster lease price. In the next stock assessment it will be important to consider the implications of the dramatic changes in Chinese rock lobster market conditions on the rock lobster fishery and, consequently, the giant crab fishery.

In the current assessment period 31.5t was taken from the West coast in 08/09 and 30.0t in 09/10. The remainder was taken from the East coast – 23.3 t in 08/09 and 14.6t in 09/10. These catches are the lowest since 91/92 (East coast) and 93/94 (West coast) (Table 3). The ratio in catch from the two regions appears to have stabilised over the last decade although this has been more variable during the last few years (Figure 3).

4.2 Commercial catch taken by other sectors

Giant crabs are also taken by SESS trawlers, but determining the catch of giant crabs from this sector is difficult. Catch records collected by AFMA identify most of the crab catches simply as 'crab' and without catch locations. Information on the species composition of this 'crab' catch is potentially available through observer data and species composition of reported landings where species is identified. Observer data on the species composition of crab catch has not be obtained, thus the

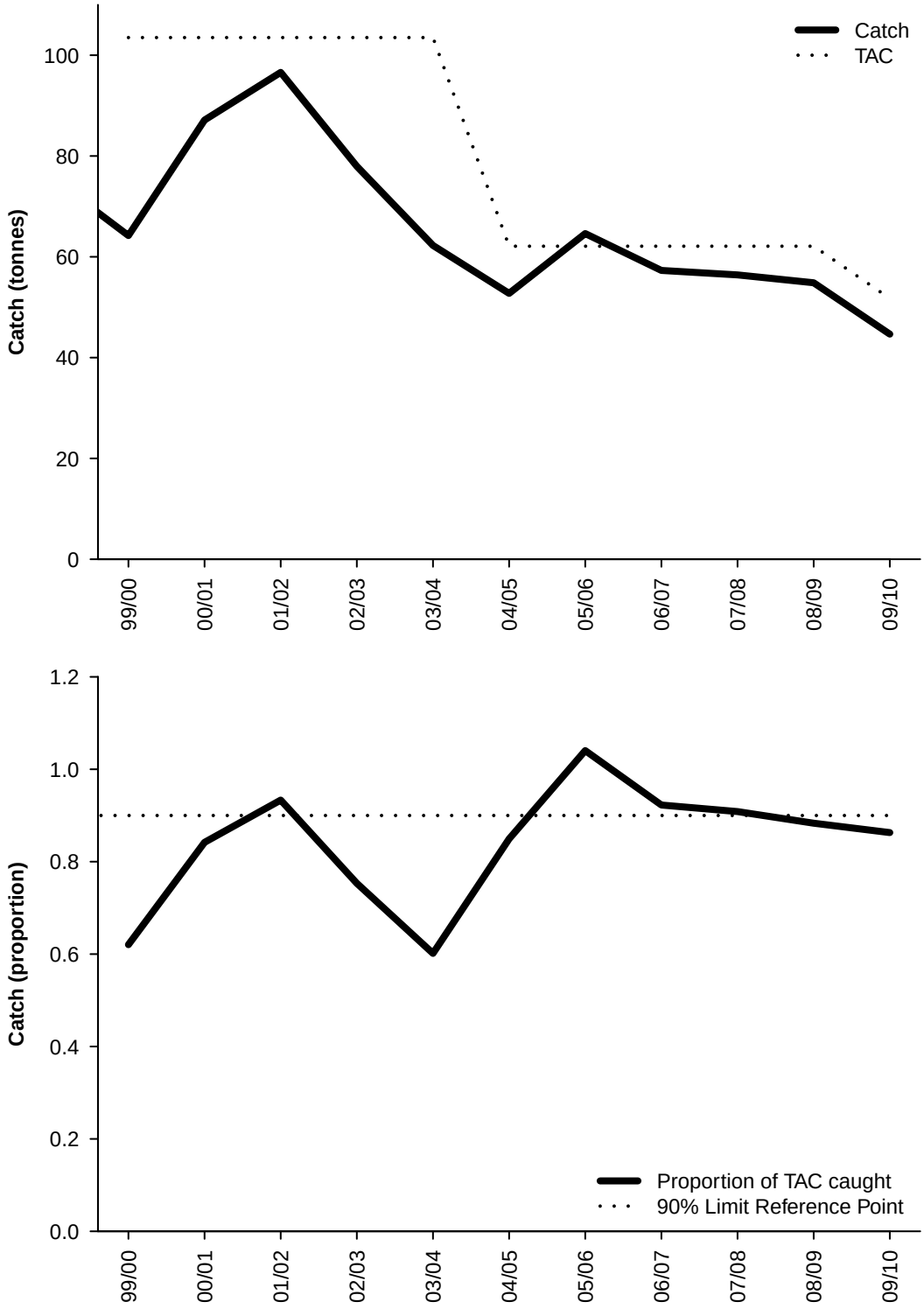

Figure 2: Total catches from logbook records and TAC since quota management was introduced (top), and the proportion of the TAC caught in each year (bottom). The dashed line marks the 90% limit reference point.

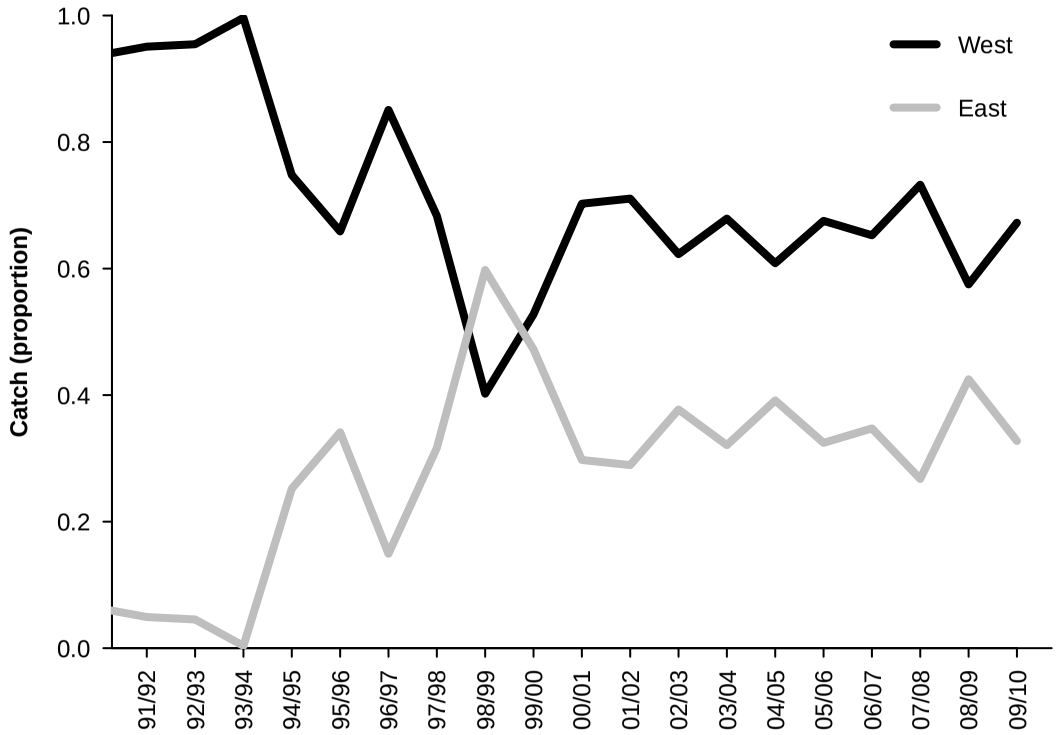

Figure 3: Relative catches coming from the East and West coasts in each quota year.

Table 3: Catch totals in tonnes by quota year (March to February) from 1989/90 until present as reported in logbook returns (Tasmania, West and East), landed catch from quota allocation system, and Total Allowable Commercial Catch (TAC). West and East are defined as either side of longitude 147°E.

Quota year	Tasmania	West	East	Landed catch	TAC
1989/90	0.2	0.1	0.1		-
1990/91	1.7	1.6	0.1		-
1991/92	1.5	1.4	0.1		-
1992/93	118.2	112.8	5.4		-
1993/94	224.2	223.4	0.8		-
1994/95	291.4	217.9	73.5		-
1995/96	224.3	147.8	76.6		-
1996/97	147.0	125.1	21.9		-
1997/98	113.3	77.4	35.9		-
1998/99	75.6	30.4	45.2		-
1999/00	64.2	33.9	30.3	61.3	103.5
2000/01	87.1	61.2	25.9	89.8	103.5
2001/02	96.6	68.6	28.0	94.5	103.5
2002/03	78.0	48.5	29.4	74.1	103.5
2003/04	62.3	42.3	20.0	61.6	103.5
2004/05	52.7	32.1	20.7	46.2	62.1
2005/06	64.6	43.6	21.0	59.7	62.1
2006/07	57.3	37.4	19.9	53.1	62.1
2007/08	56.4	41.3	15.1	49	62.1
2008/09	54.9	31.5	23.3	52.6	62.1
2009/10	44.6	30.0	14.6	46.3	51.75

only information on crab catch by trawlers comes from landings data.

From 2002-2010 inclusive, total landings of 93 tonnes of crabs were reported from trawlers into ports in Tasmania, SA, Victoria and NSW (Table 4). Most of these landings are for unspecified crabs (67t), while only two crab species were identified - giant crab with 25.4 tonnes and crystal crab (Chaceon bicolour) with 0.03 tonnes. Crystal crabs are fished commercially off Western Australia but are not found around Tasmania.

The fishing location is not recorded and the landing state provides a poor indication – e.g. NSW has 18% of the catch identified as giant crab, however giant crabs are rarely found in NSW. It is possible that the reported landings of unspecified crab

catch are predominantly, or even entirely, giant crab and caught in Tasmanian waters. Consequently giant crab catches SESS trawlers in 2004 could have been as high as 19.6 tonnes (31% of the Tasmanian giant crab TAC), and accounting for the trap fishery only would therefore mean a substantial underestimation of the total catch removed from Tasmanian waters. In recent years the total SESS crab catch has remained steady at 4-5.5t – approximately 10% of the Tasmanian TAC.

Table 4: Crab catches (t) in the SESS trawl fishery between 2002-2010 (2010 data incomplete) by landing state.

Species	State	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Giant crab	NSW	0.2	1.3	0.7	0.9	0.5	0.4	0.2	0.1	0.1	4.5
	SA	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.5
	TAS	0.9	1.2	1.5	1.4	1.2	0.8	1.1	0.6	0.4	8.9
	VIC	1.4	1.5	1.5	1.3	1.2	0.9	1.1	1.4	1.0	11.4
	Total	2.5	4.1	3.8	3.7	3.0	2.0	2.5	2.2	1.5	25.4
Crystal crab	TAS					0.01					
	VIC						0.01				
	Total					0.01	0.01				0.03
Unsp. crabs	NSW	2.7	5.9	3.8	3.1	3.9	1.9	0.7	1.2	1.4	24.7
	SA	0.1	0.2	0.1	0.0	0.2	0.0	0.0	0.1	0.0	0.6
	TAS	1.8	1.6	0.8	0.6	0.3	0.2	0.2	0.2	0.0	5.7
	VIC	5.0	8.2	8.6	4.8	4.4	0.8	1.7	1.9	1.0	36.5
	Total	9.6	15.9	13.2	8.5	8.8	2.9	2.7	3.3	2.4	67.4
Total		12.2	20.0	17.1	12.3	11.8	5.0	5.1	5.5	4.0	92.8

4.3 Commercial effort

Total fishing effort has remained within historical ranges. A shift in regional effort to the East coast appears to have reversed in 09/10 (Figure 4). Fishing was again mostly restricted to the start and end of the fishing season in autumn and summer, respectively. State-wide seasonal effort was elevated in April-July in 2008 and May 2009 whilst below the historic range in December and February 2010 (Figure 5).

Since crab fishers typically operate across different fisheries, these trends in seasonal effort tend to be a function of activity in other fisheries such as the scallop and rock lobster fishery. The low effort applied in February 2010 is likely to be linked to the low catch rates in the rock lobster fishery at this time.

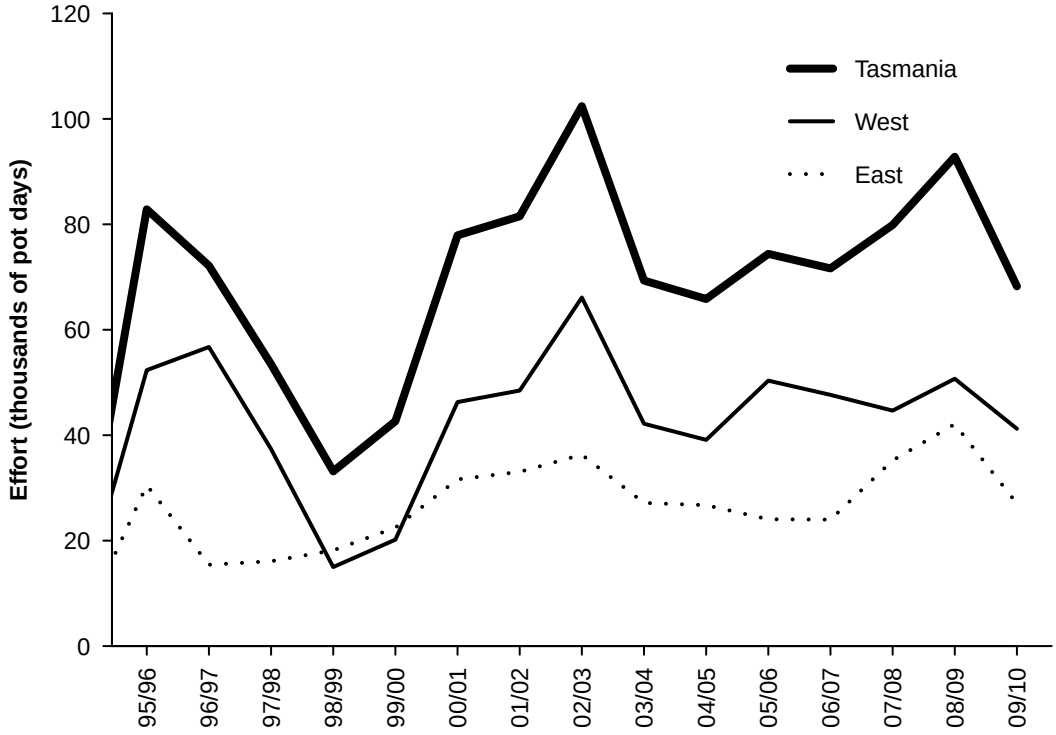

Figure 4: Total effort (pot days) and effort overall and for the West and East coast by quota year since 1995/96. Note that 1998/99 and 1999/00 were partial fishing years.

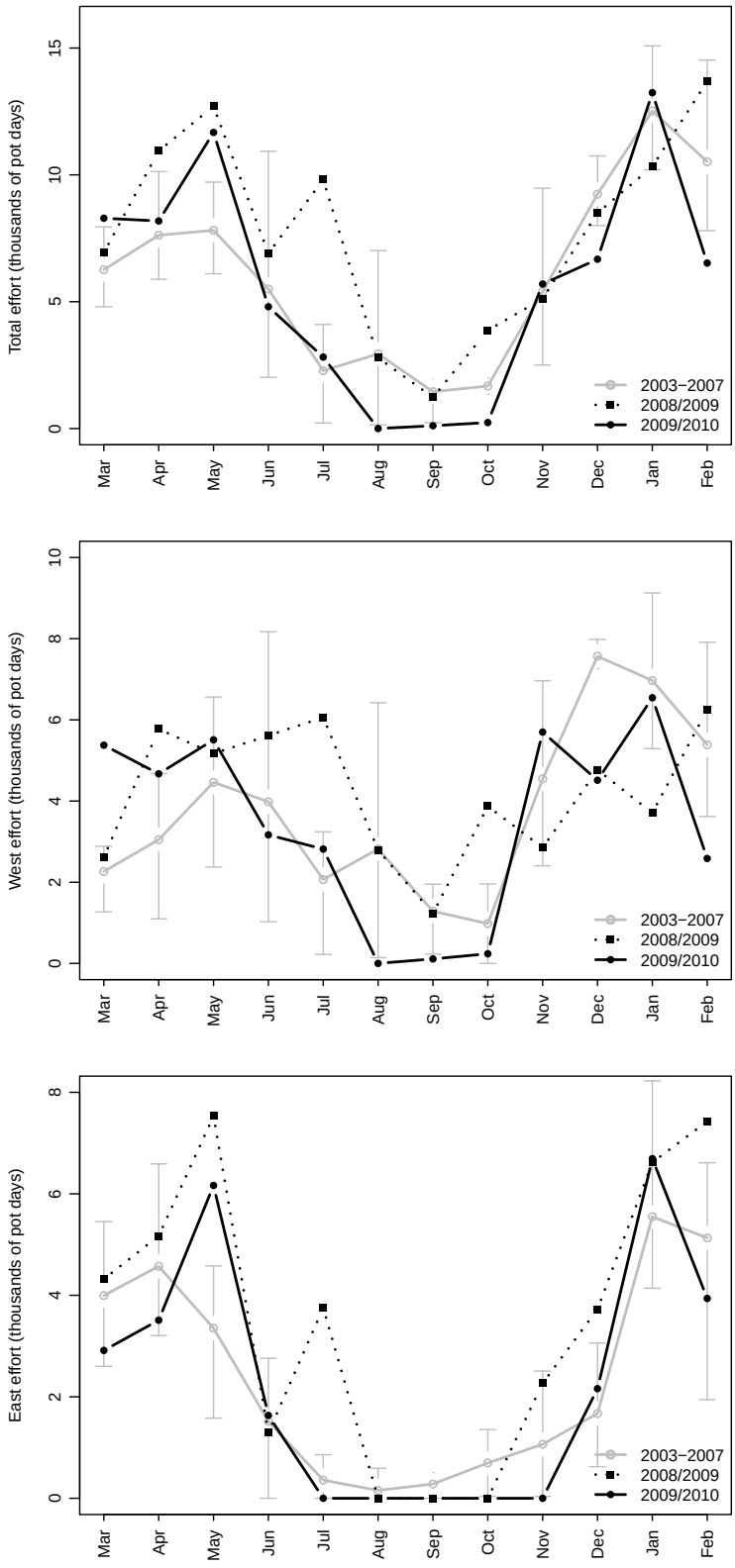

Figure 5: Seasonal trends in effort State-wide (top panel), on the West coast (middle panel) and the East coast (bottom panel). The 2008/09 and 2009/10 quota years are indicated by black dotted and black solid lines respectively. The average for the previous 5 years is indicated by the grey line; the error bars indicate the range of observed effort in that five year period.

4.4 Commercial catch rates

Commercial catch per unit effort (CPUE) or catch rates are drawn from commercial logbooks. Logbook data prior to January 1995 do not include a measure of effort (number of traps), so only data since the 1995/96 quota year can be used for calculating catch rates. The data have been processed for a range of factors:

- Misreporting of effort was a common problem early in the fishery. Records that were known to be false or appeared unreliable, e.g. low trap numbers or unrealistic high catch rates, have been excluded from the analyses.
- Crabs are often taken incidentally to lobster fishing and catch rates under these situations are believed to be quite different to when crabs are targeted. The analysis of catch rates here was restricted to targeted effort. Fishers note in the current logbooks whether their effort is targeted towards giant crab, but this was not the case prior to 2000. As an alternative approach to defining targeted effort and to perform an analysis for the whole of the period since 1995/96, logbook data were restricted to skippers that had reported a median catch of at least 1000 kg over a minimum of 2 years. This selected experienced fishers who use vessels and gear more suited to crabs and take most of the overall crab catch, while fishers that directed most of their fishing effort towards lobsters and tended to have lower catches and catch rates were excluded.

For seasonal catch rate trends, catch rates were estimated as kilograms per pot day for each record in the database as:

$$CPUE = \frac{\text{Weight of catch (kg)}}{\text{Number of traps} \times \text{Soak time}} \tag{1}$$

where pot days are defined as the number of traps multiplied with number of days the traps are in the water before being hauled (soak time). Although soak times greater than 7 days do not lead to increases in catch, capping soak times at 7 days had only minimal influence on the results and was not used.

Catch rates are used as a proxy for stock abundance in a fishery, however catch rates respond to a number of factors including the fishing block, month, skipper, depth and interannual variation in stock abundance. For example, a decrease in catch rates may be attributable to a new inexperienced entrant to the fishery or decreased stock abundance or a intra-annual shift in effort distribution. To address these concerns the catch rates here have been standardised using the methods

detailed in Appendix 2 in Ziegler et al. (2009). This standardisation gives the best estimate of inter-annual changes in catch-rates not due to the previously mentioned confounding factors.

4.4.1 Annual commercial catch rates

State-wide catch rates declined by 19% from 07/08 thereby triggering the reference point for a decline over two years (Table 5, Figure 6). Furthermore state-wide catch rates have shown no signs of increase over the last several years and are currently at about 34% of the 1995/96 catch rates.

Regionally, catch rates have been slightly higher in the West than the East for some years, however this trend was reversed in 09/10. Catch rates rose in the East from 23% in 07/08 to 41% whilst falling further in the West from 53% in 07/08 to 36% in 09/10. The catch rate limit reference point (a total decline by 20% over a 2-year period) was exceeded on the West coast with a decline of 32% and nearly exceeded Statewide with a decline of 19% (Table 5, Figure 6).

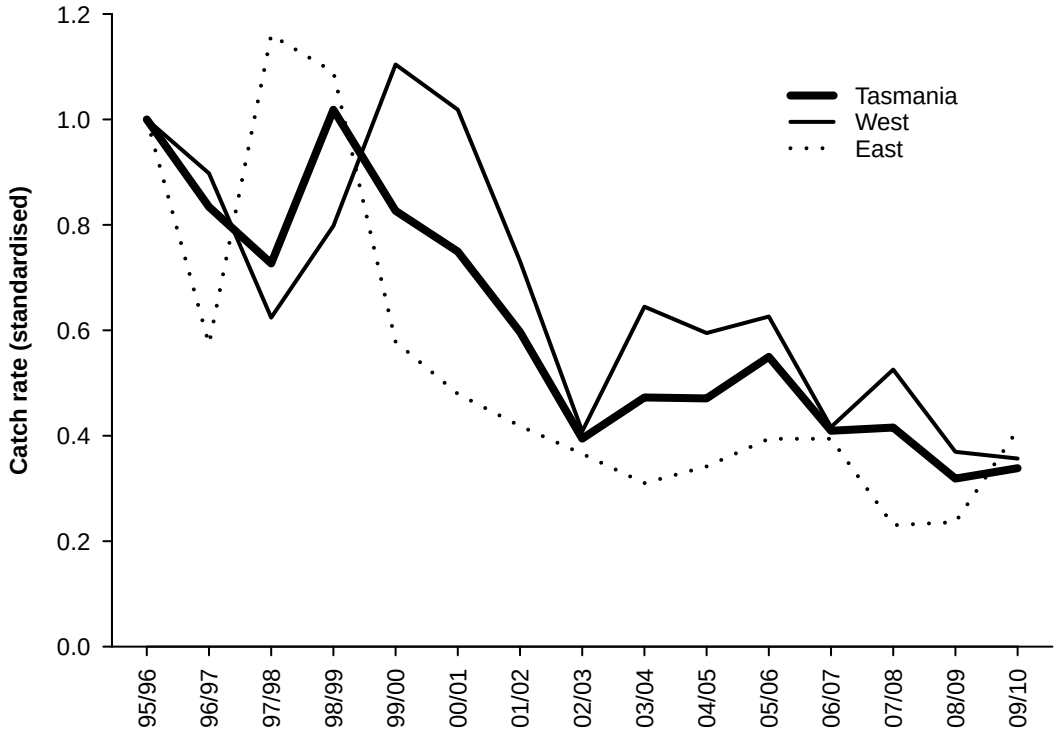

Figure 6: Trends in State-wide annual catch rates (standardised catch rates relative to 1995/96) by quota year, based on a selection of skippers that had reported a median catch of at least 1000 kg over a minimum of 2 years.

Table 5: Targeted State-wide and regional catch rates for the 09/10 quota year relative to catch rates 5, 2 and 1 year ago. The reference point relates to the 2-year period (07/08).

Quota year	Tasmania	West	East
95/96	1.00	1.00	1.00
96/97	0.83	0.90	0.57
97/98	0.73	0.62	1.16
98/99	1.02	0.80	1.09
99/00	0.83	1.10	0.58
00/01	0.75	1.02	0.48
01/02	0.60	0.73	0.42
02/03	0.39	0.41	0.37
03/04	0.47	0.64	0.31
04/05	0.47	0.59	0.34
05/06	0.55	0.63	0.39
06/07	0.41	0.42	0.39
07/08	0.42	0.53	0.23
08/09	0.32	0.37	0.24
09/10	0.34	0.36	0.41

Change in 09/10 catch rates (in %) compared to:			
04/05	-28%	-40%	20%
07/08	-19%	-32%	79%
08/09	6%	-3%	74%

4.5 Bycatch of crabs from the lobster fishery

The reference point relating to bycatch of crabs in the lobster fishery is set at 5 tonnes, which represents about 8% of the current TAC. Since the introduction of quota management, bycatch from the lobster fishery has not exceeded 1.1 tonnes (in 2000/01) and has been less than 200kg sines 2002/03 (Figure 7). Industry members considered that any reported bycatch would probably be an under-estimate, but whatever the true level of bycatch it was likely to be small relative to the targeted crab catch.

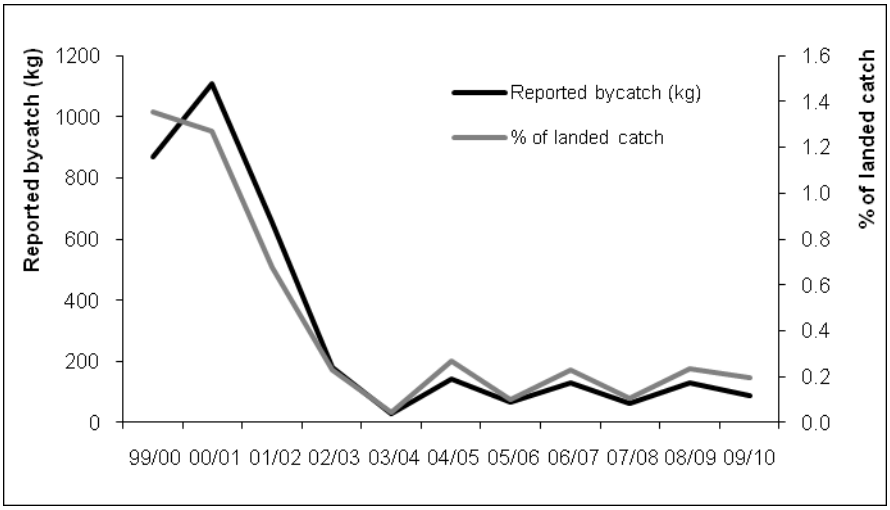

Figure 7: Total reported bycatch of crabs in the rock lobster fishery and percentage of the total giant crab catch.

4.6 Additional information on composition of catches

For each shot, Tasmanian giant crab fishers record the sex composition, the number of undersize returned and the estimated weight. Using accurate weights at landing permits the estimated weights to be corrected. This extensive information allows several important aspects of the catch to be calculated, in particular i) the average weight of retained crabs, ii) the proportion of females in the retained catch and iii) the number of undersized crabs per potlift. This data is shown in Figure 8 for the last decade.

Catch rates of undersize crabs (which are released) provide an indication of undersize abundance, and an indication of the strength of future recruitment. Undersize catch rates have traditionally been lower on the West coast than on the East coast and have reduced to record low levels in the last few years. This trend suggests there will be fewer crabs recruiting into the exploitable biomass over future years.

On both coasts the average weight of crabs has declined through time as larger crabs were removed and the fishery became more dependent on recruits. The increase in average weight over the last three years on the East coast is possibly due to low numbers of recruits. The decreasing trend in undersize catch rate on the East coast has lagged behind the West coast, suggesting an increase in average weight may occur in future years on the West coast.

The sex ratio of catches is very different between coasts with catches from the East strongly biased towards females while those from the West are strongly biased towards males. This difference has become more pronounced over time as males have increased in the catches on the West coast.

Two factors influence trends in undersize catch rates, firstly undersize crabs are not evenly distributed between regions and with depths (see Ziegler et al. (2009)). Consequently, change in the distribution of fishing effort may influence the trends in undersize catch rates. However this effect is highly unlikely to fully explain the observed consistent trend.

The second factor which will have decreased undersize catch rates is the change in male size limit for 09/10. The male size limit was reduced, thereby some crabs that would previously have been classified as undersize became legal sized. Note that the decreasing trend was evident prior to the change in size limit (in 08/09).

Large males that were over 216 mm CL were released under rules applied to end of the 08/09 season (end of Fenrurary 2009). The number of these animals being released was recorded for the first time in 07/08. The proportion of the catch in this category has remained below 2% of the catch by number on the West coast

and below 1% on the East coast. Only a small portion of the catch falls in this category with 1.7% of the catch (by number) being oversize males on the West coast and 2.7% on the East coast.

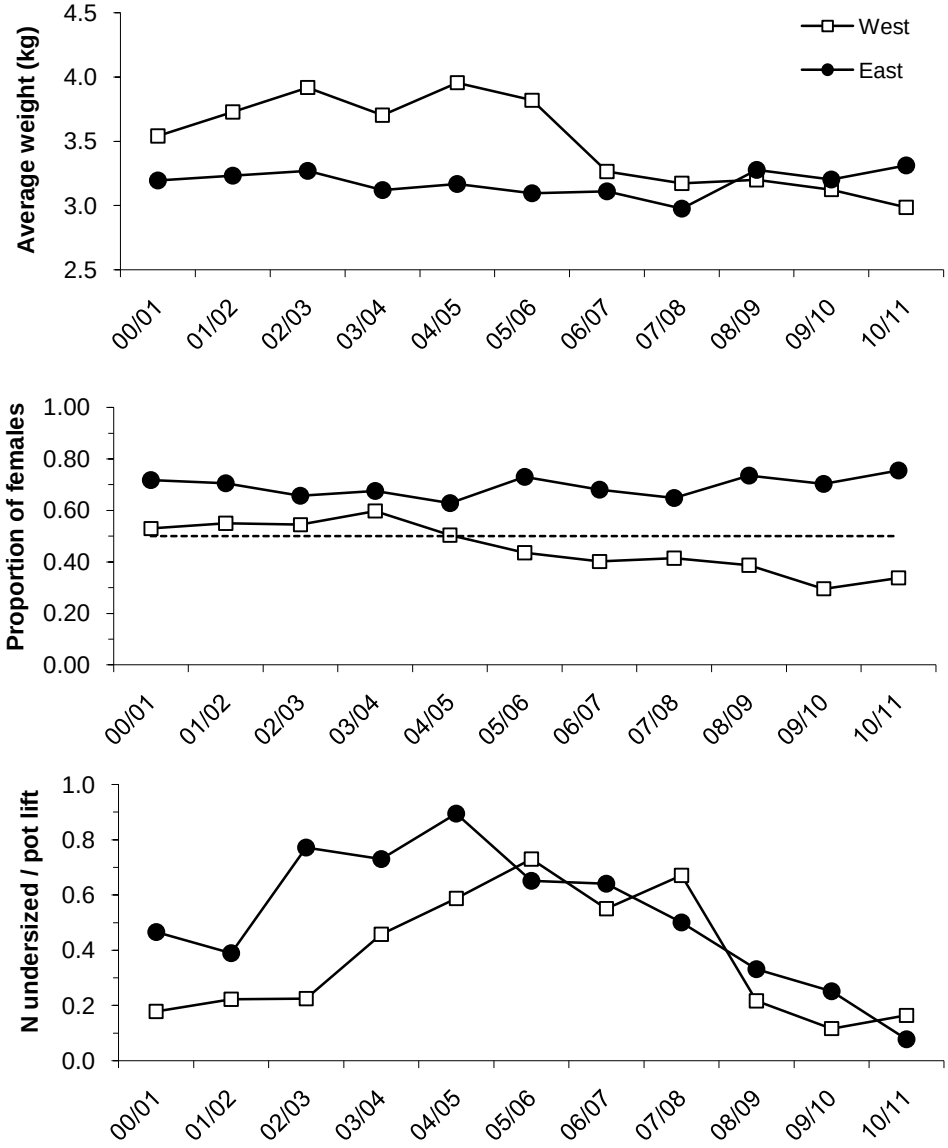

Figure 8: Top: Average weight of retained catch; Middle: the proportion of the retained catch that was female (the dotted line represents 50% or an equal spit between males and females); Bottom: catch rate of released undersize crabs.

4.7 Byproduct

The Tasmanian giant crab fishery uses both disposable and digital cameras to record bycatch. Photos are taken of every pot lift by the fishers and returned at the end of the trip. The following assessment was made on the data returned by two fishers over a 15 month period and thus represents a fraction of the total effort. However the results presented here are consistent with previous assessments in both Tasmanian and Victorian fishery.

A total of 17 non-target species were identified from over 1900 pot lifts from November 2009 to February 2010. The most common of these species the draughtboard shark (Cephalocyllium laticeps) and hermit crab (Trizopagurus strigimanus) make up 29% and 25% of the total bycatch (Table 6). Several species were caught at levels below 1% of the total bycatch, including starfish (unspecified), striped trumpeter (Latris linata), conger eel (Conger verreauxi), velvet leatherjacket (Meuschenia scaber), ocean perch (Helicolenus percodies), shrimp (unspecified) and Gummy shark (Mestelus antarcuicus).

The bycatch taken by the fishery is low compared with other fishing methods. The impact of giant crab fishing on non target species is considered negligible with the most common species draughtboard sharks and hermit crabs being returned to the water alive. Fishers may retain some bycatch species to be used as bait. In this instance such details will be recorded in the fishers' log (Table 7). Fishers are not permitted to retain southern rock lobsters while fishing for giant crab.

Table 6: Catch composition of Tasmanian giant crab fishery bycatch.

Species	% of total bycatch
Draughtboard shark	29
Hermit crab	25
Southern whiptail	10
Jackass morwong	9
Pink Ling	8
Antlered Crab	7
Brittle stat (unspecified)	2.3
Southern rock lobster	2.3
Bearded cod	2.1
Knifejaw	1.9

Table 7: Reported **retained** Tasmanian giant crab fishery bycatch.

Species	07/08 (kg)	08/09 (kg)	09/10 (kg)
Gummy shark	5	0	0
Cod	31	32	11
Ling	49	24	68
Morwong	25	36	44
Conger Eel	79	15	8
Striped Trumpeter	8	0	0

4.8 Protected species interaction

Protected species interactions are now recorded directly in the giant crab logbook. No protected species interactions were reported by fishers targeting crabs in 2008/09 and 2009/10. This would be expected given that the fishery operates in deep water away from coastal areas frequented by juvenile seals and cormorants, which interact with traps in the lobster fishery.

5 Stock Assessment Modelling

5.1 Introduction

A length-based stock assessment model for the Tasmanian giant crab fishery was introduced in Ziegler et al. (2009). In this assessment the same model has been used in conjunction with the new data available (new catch records and industry collected length frequency data). The model was applied to pooled data from the Western and Eastern side of the continental shelf ('Tasmania'), and to the data from the two fishing regions independently ('West' and 'East').

The results for the whole state allow the state of the entire fishery to be considered whilst the results for the two areas ('West' and 'East') permit spatial trends to be monitored. Current management arrangements such as TAC and size limits apply to the whole Tasmanian fishery, nevertheless considering the areas individually will highlight any spatial concerns and subsequent need for spatial management.

5.2 Current status

Figure 9 shows catch and model estimates of egg production, exploitable biomass, total biomass, catch rates and harvest rates at both a state level and for the East and West regions. The statewide the biomass has been substantially reduced since the commencement of the fishery and is now at 16% of the 1992 value.

The following trends were observed across all three spatial scales since the last stock assessment. The exploitable biomass has remained relatively stable, however this has been partly assisted by the reduction in the male minimum size limit for the 2009/2010 fishing season. The total biomass has continue to trend downwards, however due to the size composition, egg production is trending slightly upwards. The modelled catch rate has been increasing, however the observed catch rate is below the 90% confidence limit for both 08/09 and 09/10. The main possible causes are: i) an aspect of the CPUE data that has been unaccounted for (eg. bad weather) or ii) an unexpected effect on the giant crab population (eg. increased mortality). If the cause is the latter, the model will be providing overly optimistic current biomass estimates and future projections.

Recent size estimates are based entirely on commercial length-frequency data collection which is primarily collected by a single operator. This introduces a potential bias in the model due to the effect of fisher behaviour on giant crab size.

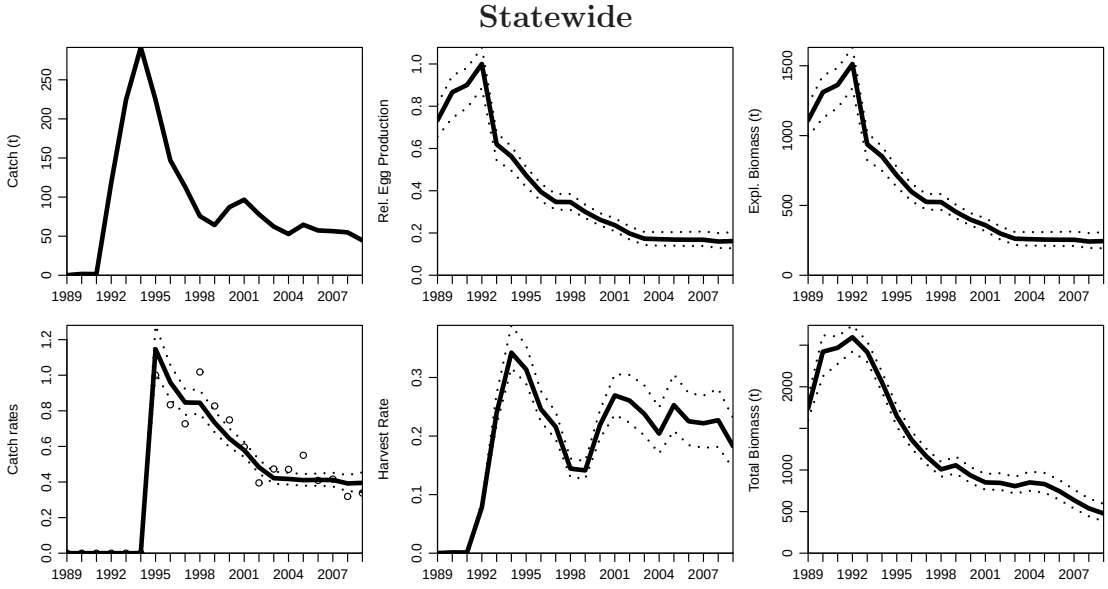

Figure 9: (continued on next page) State-wide results of the model fitted to the observed data since 1989/90 (first year of quota year given). Observed catch, observed standardised (black dots) and fitted predicted catch rates (line), relative egg production, estimated annual harvest rates, total biomass and exploitable biomass at the start of each quota year. Median values (heavy lines) and 90% confidence intervals (light lines) from the bootstrap procedure given.

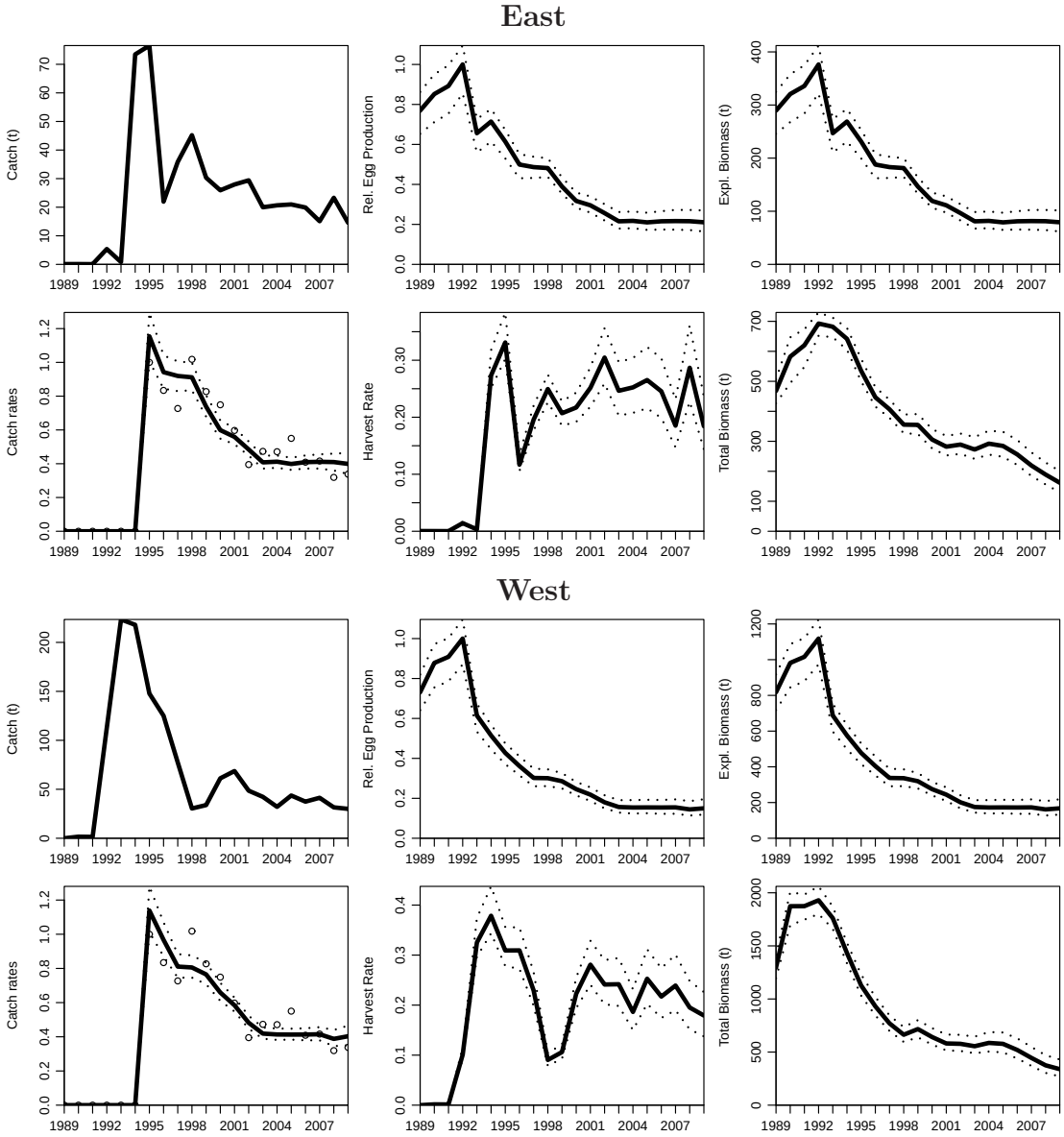

Figure 9: (continued) East (top panel) and West (bottom panel) results of the model fitted to the observed data since 1989/90 (first year of quota year given). Observed catch, observed standardised (black dots) and fitted predicted catch rates (line), relative egg production, estimated annual harvest rates, total biomass and exploitable biomass at the start of each quota year. Median values (heavy lines) and 90% confidence intervals (light lines) from the bootstrap procedure given.

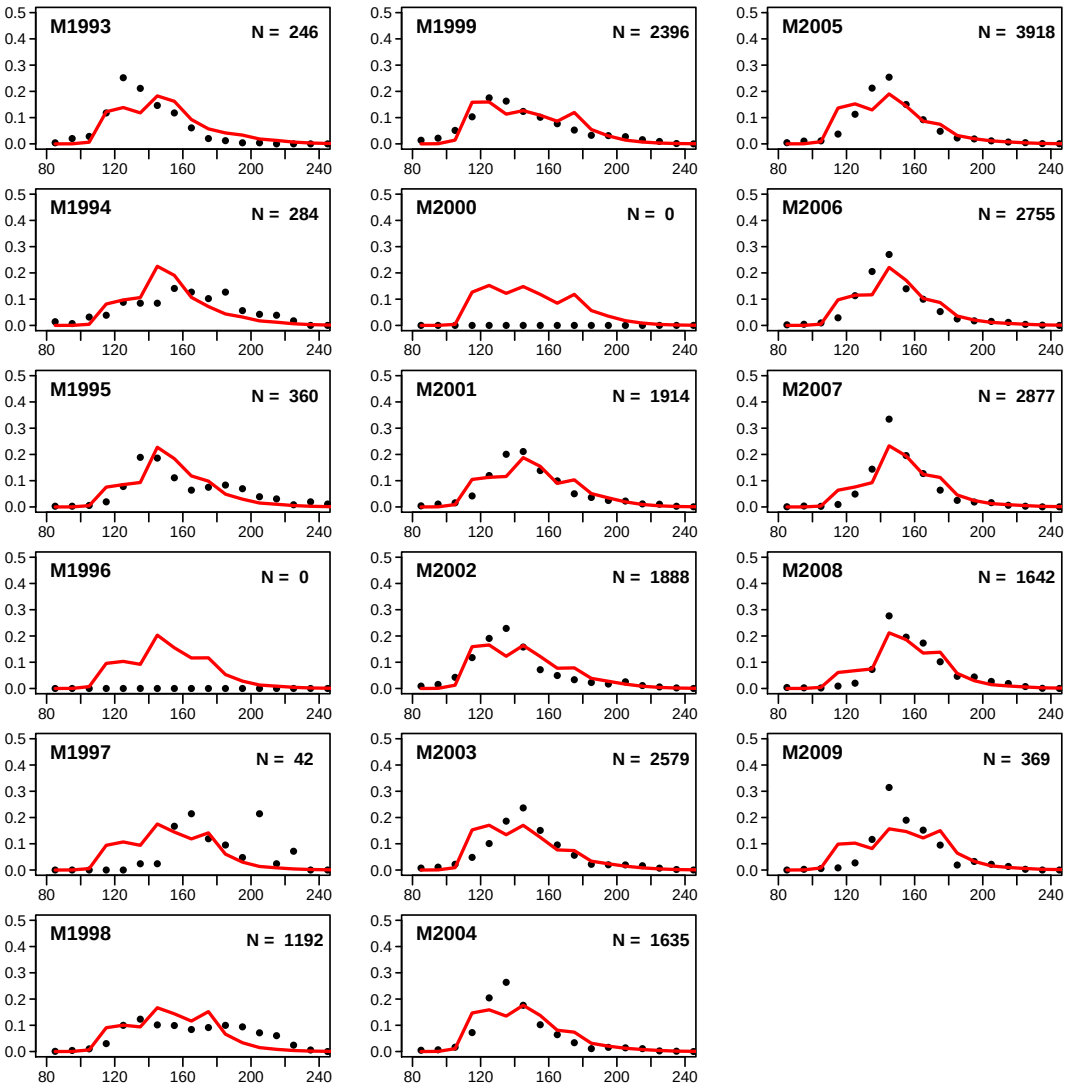

Figure 10: Observed (points) and predicted (lines) length frequencies in State-wide commercial catches since 1993/94 (M1993) for male giant crab with the observed sample sizes N

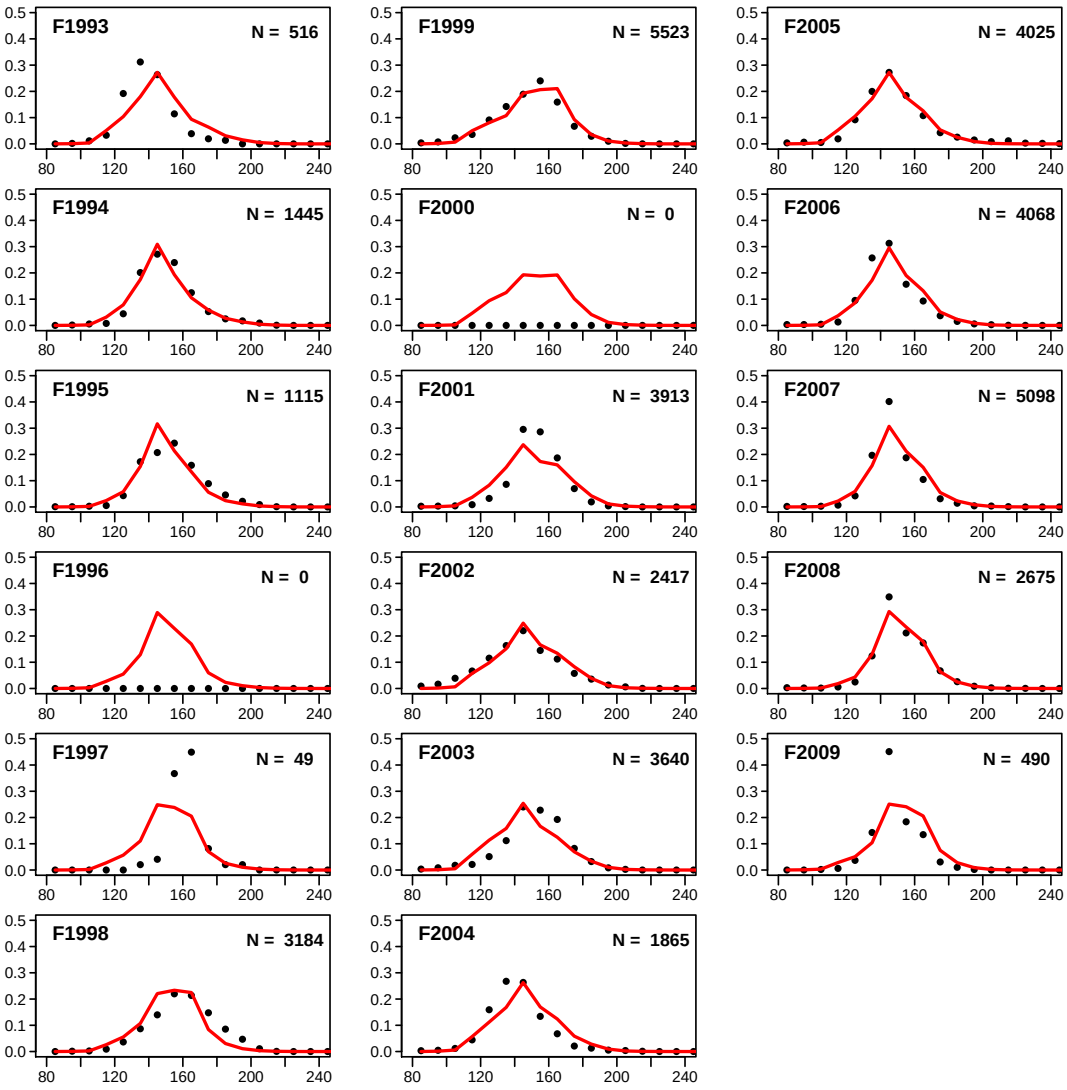

Figure 11: Observed (points) and predicted (lines) length frequencies in State-wide commercial catches since 1993/94 (F1993) for female giant crab with the observed sample sizes N

Table 8: Summary of model estimates for exploitable biomass, harvest rates and egg production. The median is given with the 90% confidence interval in brackets below).

	Exploitable biomass			Harvest rate	Total bio.	Egg prod.
	Virgin (t)	2009 (t)	% Virgin	In 2009	% Virgin	% Virgin
State	1513	244	16	18	19	19
	(1339-1631)	(193-308)	(13-20)	(14-23)	(15-22)	(16-22)
West	1118	168	15	18	18	18
	(973-1225)	(133-218)	(12-19)	(14-23)	(15-21)	(15-22)
East	376	79	21	18	23	25
	(322-412)	(62-102)	(17-26)	(14-24)	(19-28)	(20-29)

5.2.1 Virgin biomass

The current giant crab model provides a good fit after the initial high catches in the early 1990s. However the recruitment estimated for this period (beyond the early 1990s) is insufficient to account for the biomass that existed prior to the commencement of the fishery. Consequently, the model produces the initial biomass through a series of strong recruitment events in the first four years (1989-1992) this is evident in figure 9 which shows a strong growth in biomass prior to the full scale commencement of the fishery.

The initial strong recruitment events are likely to be model artefacts, resulting from the model inadequately capturing the difference between the relatively fished and unfished stock. Possible explanations are:

- A genuine change in recruitment – For example, the model does not include a stock-recruitment relationship and consequently average recruitment to the fished stock is assumed to be at the same level as average recruitment to the unfished stock.
- A misspecification of crab growth and mortality at old age – the understanding of giant crab growth and survival at old ages is poor. Since the fished population has far fewer old aged crabs, this will have much greater impact on the dynamics of the stock in the early stages of the fishery. To compensate for this mis-specification the model has needed to introduce some initial anomalously high recruitment events.

Recruitment estimates from the mid 90s onwards are consistent and the model is

appropriate for the fish stock in its exploited state. However, this problem complicates the estimation of virgin biomass (a current reference point for fisheries management). In particular, the virgin biomass corresponding to current recruitment estimates is significantly less than the biomass estimate prior to commencement of the fishery.

Despite these concerns, the model estimate of the peak biomass for the fishery is a reasonable estimate for the virgin biomass. Due to the large initial catches and slow growth of giant crabs, it is clear that the virgin biomass must be at least this high and may be underestimated by this method.

5.3 Projections

The giant crab model can be used to examine the future outcomes of the fishery under different TACC assumptions. This is achieved by taking the historic recruitment estimates and projecting the fishery forward with these recruitment estimates. As discussed previously recruitment estimates for the first few years are anomalous, consequently recruitment estimates from 1993 onwards were utilised.

Figure 12 provides detailed model projections with catches at present levels (45t) and at the present TACC (51.75t). These figures show the median value, a 90% confidence limit and the 20th percentile. The 20th percentile and lower confidence limit are useful measures for cautionary management – if the aim is to keep the fishery above eg. a certain catch rate, then a cautionary approach might choose a TACC that keeps the 20th percentile above this value or more cautiously, the lower confidence limit.

Table 9 considers a range of possible TACC options for the state and a range of possible catches for the east and west regions. This shows the probability of meeting the performance measures proposed in Ziegler et al. (2009) under each of the catch scenarios. Graphically the median of the projections are presented in Figure 13.

A zero catch option is included for reference purposes. This provides the highest rate of biomass increase and consequently the highest possible probability of meeting performance measures. If a performance measure has a low probability of being met by the zero catch option, it is unlikely to be useful for practical fisheries management, although it may still be something to strive for on a longer time scale. The proposed performance measures have a negligible chance of being achieved except on the East coast. This is because these performance measures use the highest historical stock state as a reference, however the model considers that stock state to be anomalous and unachievable with the current recruitment

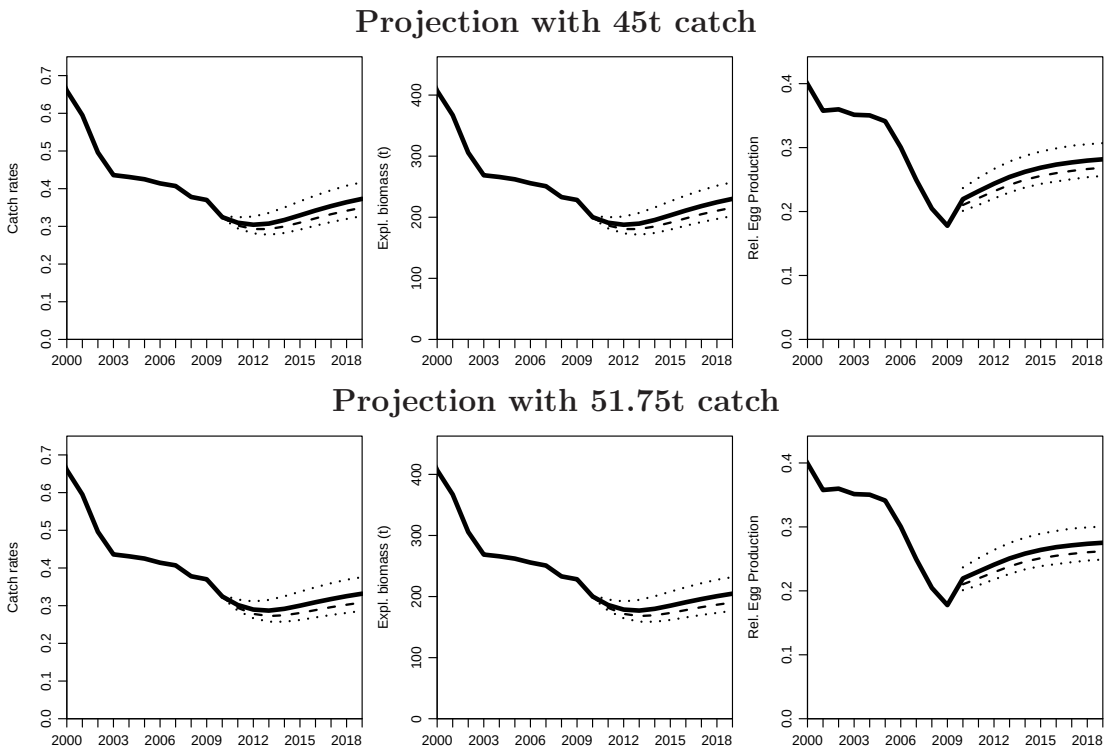

Figure 12: This figure considers the future of the fishery with current catches (top panel; approximately 45t) and if the TACC were to be caught annually (bottom panel; 51.75t). The solid line indicates median historic values to 2009 and projected values from 2010 onwards. The dashed line indicates a cautionary 20th percentile and the dotted lines give a 90% confidence interval.

estimate.

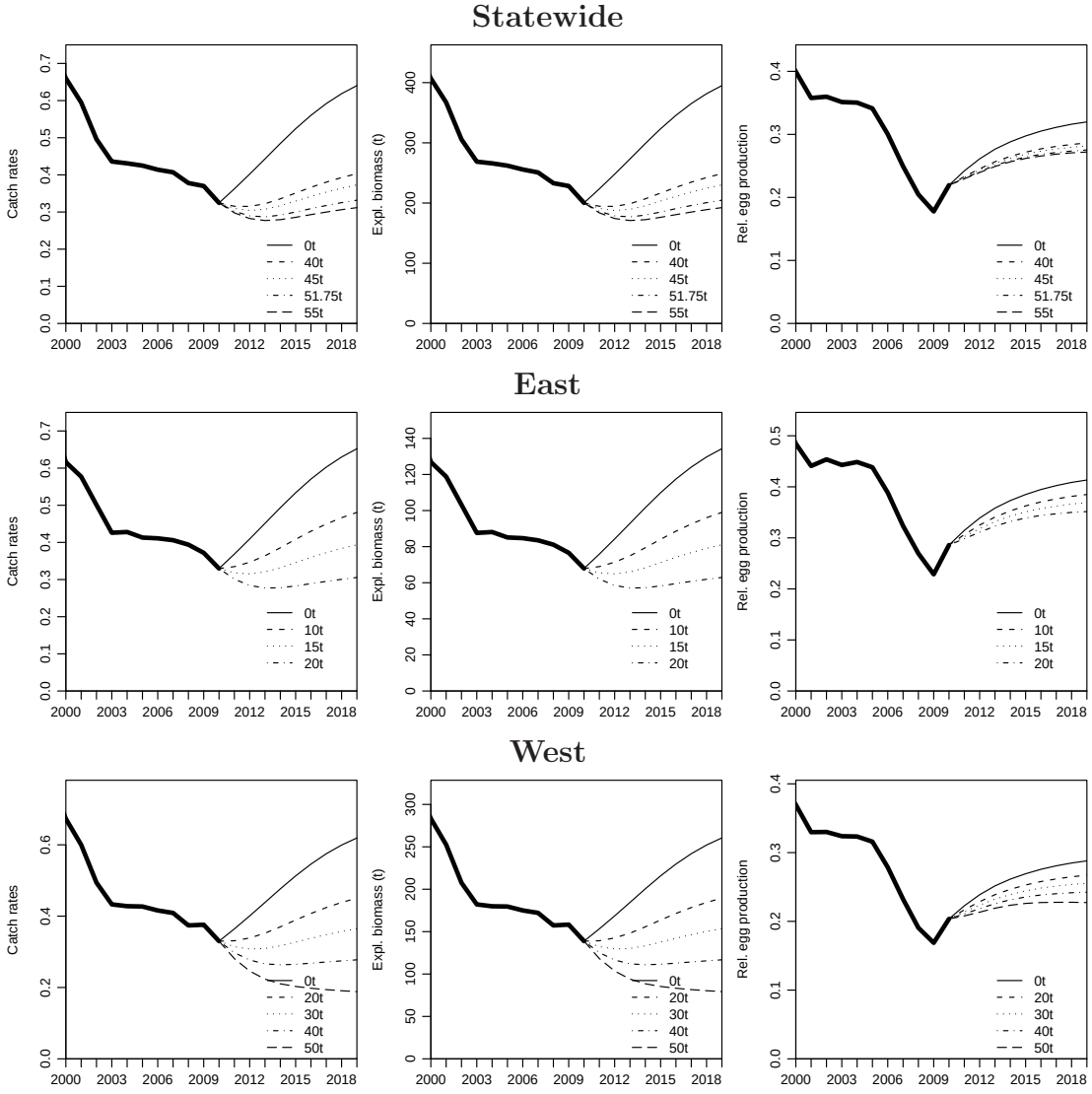

Figure 13: State-wide (top panel), East (center panel) and West (bottom panel) model projections under different catch regimes. The dotted lines project the fishery forward under 2009/2010 catches (45t statewide, 15t east and 30t west). The 51.75t line for the top, statewide panel, indicates the performance of the fishery if the 51.75t TACC is caught into the future.

Table 9: Estimated probability (%) that in 5 or 10 years catch rates will be above or harvest rate below current levels, or total biomass (TotBt) and egg production (EggProd) will be at a given percentage of their highest historical levels under different fixed catch scenarios.

		Catch rates	Harvest rates	Total biomass		Egg production	
	Catch	Current	Current	30%	40%	30%	40%
In 5 years							
State	0t	100	100	8	0	22	0
	40t	4	58	0	0	1	0
	45t	0	0	0	0	1	0
	51.75t	0	0	0	0	0	0
	55t	0	0	0	0	0	0
West	0t	100	100	0	0	0	0
	20t	37	100	0	0	0	0
	30t	0	0	0	0	0	0
	40t	0	0	0	0	0	0
	50t	0	0	0	0	0	0
East	0t	100	100	100	8	100	14
	10t	70	100	90	0	98	3
	15t	6	3	63	0	96	1
	20t	0	0	28	0	91	0
In 10 years							
State	0t	100	100	98	0	90	0
	40t	89	100	0	0	19	0
	45t	54	50	0	0	12	0
	51.75t	8	0	0	0	5	0
	55t	2	0	0	0	4	0
West	0t	100	100	39	0	17	0
	20t	100	100	0	0	0	0
	30t	31	32	0	0	0	0
	40t	0	0	0	0	0	0
	50t	0	0	0	0	0	0
East	0t	100	100	100	90	100	71
	10t	100	100	100	7	100	28
	15t	73	63	91	0	100	11
	20t	3	0	48	0	98	3

5.4 Modeling conclusions

The giant crab model provides a good fit to the fishery after the initial high catches. This makes it well suited for tracking recent changes in the fishery and projecting the future performance of the fishery under different management options. The model does not adequately explain the high biomass present prior to the commencement of the fishery. Despite this concern the peak biomass predicted by the model provides an appropriate estimate of virgin biomass for reference purposes. Note that this level may be a slight underestimate (in which case reference points based on this level should actually be slightly higher).

The model shows similar trends statewide and regionally in the west and east. Biomass has continued to decline over the last five years, as have catch rates and egg production. Total biomass has declined more than legal biomass which, combined with the length frequency plots shows that there is a concerning underabundance of under size giant crabs compared with previous years.

With current catch levels (approximately 45t - 15t East, 30t West) the statewide exploitable biomass is expected to decline by 5% over the next two years (this is due to the current estimated deficit in under size giant crabs). After this time, the stock is projected to rebuild to 15% greater than present levels in 2019. If the TACC (51.75t) is caught each year, the statewide exploitable biomass will decrease by 10% in the next two to four years before rebuilding to present levels in 2019. Regionally, the current distribution of catch between the east and west provides a good balance into the future, placing both regions on a similar biomass trajectory.

Combined with the decline in undersize abundance, it is concerning that egg production continues to fall and is estimated to be around or below 20%, which is often used as a limit for crustacean fisheries. In giant crabs a more conservative approach is needed because the species has unusually slow growth so depressing stock levels down to low levels of egg production carries greater risk of recruitment overfishing. Further, in minor fisheries such as these where this is less data available, more conservative limits are normally used.

Projections indicate that for any rebuilding of egg production or the exploitable biomass there needs to be further reduction in catch applied over a long period.

The reference points established in Ziegler et al. (2009) are essentially unachievable under any TACC (including cessation of fishing). This is unsurprising as the were difficult to meet in 07/08 assessment at which time it was anticipated that the biomass would continue to decline under the TACC that has been implemented. More appropriate reference points for this fishery clearly need to be developed, these reference points need to take into account the current state of the fishery

and the slow growth of the stock.

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