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Victorian Rock Lobster and Giant Crab Fisheries
Fishery Status Report - 2012/2013 Fishing Year

A. Linnane, R. McGarvey, J. Feenstra, D. Reilly and L. McLeay

Fishery Status Report to Fisheries Victoria

SARDI Publication No. F2012/000434-3
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South Australian Research and Development Institute
SARDI Aquatic Sciences
2 Hamra Avenue
West Beach SA 5024

Telephone: (08) 8207 5400
Facsimile: (08) 8207 5406
http://www.sardi.sa.gov.au

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Author(s):	A. Linnane, R. McGarvey, J. Feenstra, D. Reilly and L. McLeay
Reviewer(s):	B. Stobart and J. Earl
Approved by:	S. Mayfield Science Leader – Fisheries
Signed:	
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EXECUTIVE SUMMARY

This status report is the third South Australian Research and Development Institute (SARDI) assessment for the Victorian Rock Lobster (RLF) and Giant Crab (GCF) Fisheries, and was undertaken on behalf of the Department of Environment and Primary Industries, Victoria (DEPI).

The RLF and GCF are divided into two separately managed zones, the Eastern Zone (EZ) and Western Zone (WZ). Currently, however, fishing for giant crabs only occurs in the WZ. Within each fishery, the quota year extends from 1 July to 30 June and the fishing year extends from 16 November to 14 September of the following year.

A Total Allowable Commercial Catch (TACC) and individual transferable quota management system has been in place since 2001.

Western Zone Rock Lobster Fishery (WZRLF)

During the 1990s and early 2000s, catches in the WZRLF ranged between 408 and 525 tonnes (t). With the implementation of quota management in 2002/03, an initial TACC of 450 t was set and the TACC remained at this level until 2006/07. By 2009/10, catch had declined to 230 t and the TACC was reduced to 240 t. Catch over the last three years has been relatively stable and in 2012/13 was 258 t with a corresponding TACC of 260 t.

In contrast to catch, effort in the WZRLF has remained relatively stable at an average of 657,000 potlifts since the introduction of quota management in 2002/03. However, over the last three years, effort has decreased and in 2012/13 was 483,000 potlifts, representing a 26% decrease since 2009/10 (650,000 potlifts).

Throughout the 1990s, nominal catch per unit effort (CPUE) was stable at between 0.51 and 0.59 kg/potlift for each fishing year. In 2001/02, CPUE had increased to 0.62 kg/potlift and continued improving to 0.70 kg/potlift in 2003/04 before declining to 0.37 kg/potlift in 2009/10 , the lowest CPUE in the history of the fishery. Over the past three fishing years, nominal CPUE has increased and in 2012/13 was 0.53 kg/potlift, reflecting a 45% increase from 2009/10.

Patterns of catch, effort and CPUE among the three regions of the WZRLF (Portland, Warrnambool and Apollo Bay) are similar to those of the whole fishery. Most notably, the 2012/13 CPUE estimate in Warrnambool (which contributes approximately 30% to total catch) of 0.67 kg/potlift was the highest on record since 1984/85 (0.69 kg/potlift).

Puerulus settlement indices (PSIs) within Victoria and across South Australia indicate large-scale consistent patterns in settlement, with peaks in 2002, 2005 and 2006. Model estimated levels of recruitment to 60 mm carapace length (CL) were strongly correlated to PSIs lagged two years. Growth data indicate that it takes another four years for lobsters to reach legal size from 60 mm CL, indicating a total period of approximately six years from settlement to legal-size within the WZRLF. These data indicate that current increases in catch rates in 2012/13 reflect the strong PSIs observed across South Australia and Victoria in 2005 and 2006.

While CPUE of legal-size lobsters has recently increased, pre-recruit indices obtained via fixed-site surveys have decreased in 2011/12, 2012/13 and 2013/14, indicating reduced settlement levels post-2006. Combined with the low model-estimated recruitment in 2009/10 (to 60 mm CL), these data suggest that recruitment to the fishery will most likely be reduced in 2013/14. Monthly CPUE estimates, based on Interactive Voice Response (IVR) data, indicate that catch rates from August to December in 2013 were below 2012 estimates.

The model-estimated level of egg production in 2012/13 was 74% of that in 2001/02 (the reference year) and above the reference limit point of 35%. The level of available biomass was 75% of that in 2001/02 and below the target reference point of 159%. Therefore, while model outputs indicate that biomass is increasing, based on historical recruitment trends, biomass will not rebuild to the target by 2020/21 at the current TACC level of 260 t.

A forward projection of the biomass model indicates, with 50% probability, that a 230 t TACC is required for the 2014/15 quota year to maintain biomass rebuilding on the modelled target trajectory and reach the target prescribed in the Management Plan.

Eastern Zone Rock Lobster Fishery (EZRLF)

Annual catch in the EZRLF declined from 143 t in 1982/83 to 40 t in 2008/09. An initial TACC of 60 t was introduced in 2001/02, where it remained until 2006/07. In 2007/08, the TACC was increased to 66 t. Catch increased from 2008/09 reaching 65 t in 2010/11 but has declined to 48 t in 2012/13 in response to implementation of a reduced TACC (48 t).

Between 2001/02 and 2011/12, annual effort has reflected levels of catch and has averaged approximately 132,000 potlifts/yr. However, in 2012/13 effort was 94,000 potlifts.

Nominal CPUE was at its lowest in 1995/96 at 0.26 kg/potlift. By the time quota was introduced in 2001/02, CPUE had increased to 0.35 kg/pot lift and remained between 0.35 and 0.44 kg/potlift until 2010/11. In 2011/12, CPUE increased to 0.54 kg/potlift and was 0.51 kg/potlift in 2012/13

Patterns of catch, effort and CPUE among the three regions of the EZRLF (Queenscliff, San Remo and Lakes Entrance) are similar to those for the whole fishery. The 2012/13 CPUE estimate in Queenscliff (which contributes approximately 60% to total catch) of 0.54 kg/potlift was the highest on record since 1983/84 (0.58 kg/potlift).

PSIs within Victoria and across South Australia indicate large scale consistent patterns in settlement, with peaks in 2002, 2005 and 2006.

Model estimated levels of recruitment to 60 mm CL were strongly correlated to PSIs when lagged by two years. Growth data indicate that it takes another two to three years for lobsters to reach legal size from 60 mm CL, indicating a total period of four-five years to reach legal-size from settlement within the EZRLF.

These data indicate that the current increases in CPUE between 2010/11 and 2012/13 reflect the strong PSIs observed across South Australia and Victoria in 2005 and 2006. Overall, as with the WZRLF, this suggests that the EZRLF is currently experiencing a recruitment pulse.

The model estimated level of egg production in 2012/13 was 152% of that in 2001/02 (the reference year) and above the limit reference point of 104% of that in 2001/02. The level of available biomass was 136% of that in 2001/02 and below the target reference point of 184%.

A forward projection of the biomass model indicates, with 50% probability, that a TACC of 59 t/yr will rebuild the available biomass to the target reference point by 2020/21 assuming stable long-term average levels of recruitment.

Giant Crab Fishery (GCF)

The GCF currently only operates in the WZ and the possession of both a RL and GC licence is required to access the fishery. There has been no reported catch of giant crab in the EZ for the past decade and there are no licences, however EZRLF licence holders are able to apply for a developmental fishing permit should they wish to explore the EZ fishery for giant crab.

Based on quota year data (July to June), the total annual catch (targeted and non-targeted) of giant crab peaked at 170 t in 1993/94. Since then, catches have generally declined to a record low level (8.0 t) in 2001/02.

Quota management was introduced in 2001 and the TACC was set at 25 t. Total catch averaged around 20 t per year between 2004/05 and 2009/10, and then began to decline. TACCs have been reduced accordingly, and in 2012/13 the total catch was 10.2 t, of which 8.0 t was targeted.

Based on the fishing year (November to September), CPUE (kg/24 hr potlift) has been calculated from targeted fishing by fishers with more than 1 t catch/yr. CPUE peaked in 1993/94 at 1.7 kg/24 hr potlift; before declining to 0.22 kg/24 hr potlift in 2002/03. In 2003/04, CPUE increased to 0.53 kg/24 hr potlift but has since declined to 0.24 kg/24 hr potlift in 2012/13, which represents one of the lowest estimates on record, and the fourth consecutive year that CPUE has been below the trigger reference point prescribed in the Management Plan.

1. INTRODUCTION

This is the third fishery status report undertaken as part of the South Australian Research and Development Institute (SARDI) - Aquatic Sciences assessment program for the Victorian Rock Lobster Fishery (RLF; Western Zone and Eastern Zone; hereafter the WZRLF and EZRLF, respectively) and Giant Crab Fishery (GCF). This report complements two Victorian Rock Lobster and Giant Crab fishery stock status reports published in 2012 and 2013 (Linnane et al. 2012; 2013). The aim of this report is to assess the current status of the Victorian rock lobster and giant crab resources. These assessments include data to the end of the 2012/13 fishing year (i.e. 14 September 2013), as well as monthly catch rate data to June 2014 based on data from the Fisheries Integrated Licensing and Quota Monitoring Interactive Voice Response (IVR) systems. The report is divided into five sections, including this introduction which (1) outlines the structure of the report; and (2) provides a brief description of the extent and structure of both the RLF and GCF.

Section 2 provides an overview of the methods used in the report. Sections 3 and 4 summarise the information available for the WZRLF and EZRLF, respectively, and provide assessments of their current status in relation to the performance indicators, biological reference points, triggers, rebuild rates, and risk levels associated with uncertainty described under *Objective 1, Strategy 1 – 'Rebuild the stock biomass'*, in the *Victorian Rock Lobster Fishery Management Plan* (VicDPI 2009) and as modified following review by the Rock Lobster Resource Assessment Group (RLRAG). Where appropriate, this includes spatial and temporal analyses of catch, effort and catch per unit effort (CPUE), indices of recruitment and pre-recruitment, length-frequency distributions of all rock lobsters measured from fixed-site surveys and outputs from the Southern Rock Lobster (SRL) stock assessment model, including trajectories of estimated egg production and available biomass.

Section 5 presents information available for the GCF and assesses its current status in relation to the performance indicators described under Objective 1, Strategy 1 – 'Rebuild the stock biomass', in the *Victorian Giant Crab Fishery Management Plan* (VicDPI 2010). The information presented includes catch and targeted and non-targeted CPUE.

1.1. Rock Lobster Fishery

The Victorian RLF is divided into two separately managed zones, the Western and Eastern Zones (Figure 1.1). The WZRLF extends east from the Victorian border with South Australia to Apollo Bay and incorporates the three separate regions of Portland, Warrnambool and Apollo Bay. The EZRLF extends east from Apollo Bay to the Victorian border with New South Wales and incorporates the three regions, Queenscliff, San Remo and Lakes Entrance. In November 2001, the RLF became quota managed with principal management controls including an annual Total Allowable Commercial Catch (TACC), which is divided into individual transferable quota

units, and restrictions on the number of licences and pots allocated within a zone. For both zones, there exists a difference between the allocated quota year (prior to 2009 it was 1 April - 31 March; from 2009 it is 1 July - 30 June) and the fishing year or season (16 November - 14 September).

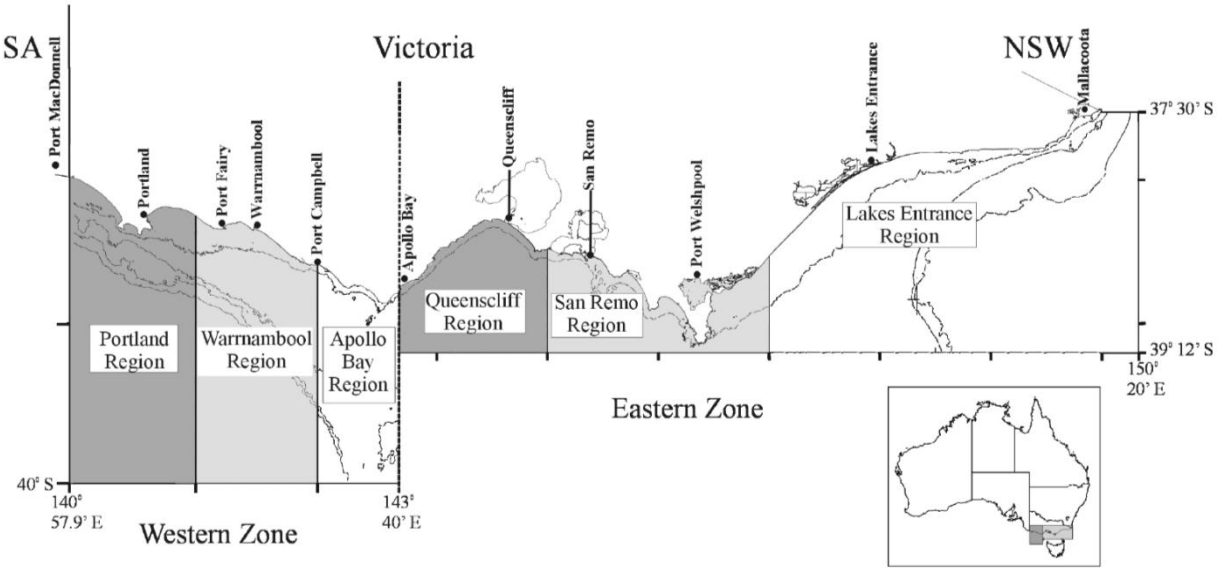

Figure 1.1 Extent and spatial structure of the Victorian Rock Lobster Fishery. Source: VicDPI (2009).

The number of licences and vessels operating in the WZRLF has decreased over the last decade, in part due to the structural adjustment program undertaken during 2008/09 (VicDPI 2009). In the quota year 2012/13, there were 47 active licences and 46 vessels operating in the WZRLF, with a TACC set at 260 tonnes. In the same quota year in the EZRLF, there were 25 active licences and 26 vessels, with a TACC of 48 tonnes.

The RLF Management Plan describes the policy and management arrangements for the fishery. Principal among these arrangements are the objectives and strategies of the RLF Management Plan that are assessed against a series of performance indicators and associated limit and target reference points. Performance indicators are used within a management decision framework and hierarchical decision tree to establish the TACC (VicDPI 2009).

1.2. **Giant Crab Fishery**

The GCF is closely linked to the RLF and defined to operate within the same two zones, i.e. the Western and Eastern Zones (Figure 1.1). However, the commercial fishery is only active in the Western Zone, with little effort reported from the Eastern Zone (VicDPI 2010). Commercial access to the resource is through the issue of a GCF licence to Western Zone fishers. In the Eastern Zone, access is provided by a general permit, and the fishery is managed as a developing fishery (VicDPI 2010). In November 2001, the GCF became quota managed and a

logbook, separate to that of the RLF, was initiated. Prior to 2001, the catch of giant crabs was reported as by-catch in the RLF and targeted effort on giant crabs was defined using decision rules on the depth of pot-sets and where giant crab comprised >70% of the total catch. To further improve measures of fishery performance, subsequent reporting criteria have been implemented to assess catch and effort data from those licences landing >1 tonne per year only.

The GCF fishing year extends from 16 November to 14 September the following year. Thirty licences were initially issued for the fishery, but by 2012/13 that number had declined to 20. In 2012/13, only five licence holders reported catch of giant crab and, with the exception of fishing years 2007/08 and 2009/09, fewer than 5 licences have landed >1 tonne of giant crabs in a fishing year since 2001/02 (Walker et al. 2012b). In 2012/13, the TACC was 12 t.

The GCF Management Plan (VicDPI 2010) details the policy and management arrangements for the fishery. Principal among these arrangements are the objectives and strategies of the Management Plan which are assessed against a series of performance indicators with associated limit and target reference points to inform the establishment of the TACC (VicDPI 2010).

2. METHODS

Fishery statistics for the WZRLF and EZRLF are provided at two spatial scales. These are: (1) the whole zone; and (2) regions within each zone. Fishery data for the GCF are presented at the scale of the area defined for the commercial fishery (i.e. that area describing the Western Zone of the RLF).

For the RLF, fishery-dependent data including catch (tonnes, t), effort (x1000 potlifts) and nominal catch per unit effort (CPUE; kg/potlift) are derived from all available logbook data managed by the Department of Environment and Primary Industries (DEPI, formerly Department of Primary Industries). CPUE was standardised for the main effects of fishing-year, fishing-month, region, depth category and 'vessel-fisher' (concatenation of vessel and fisher) using the statistical model detailed in Walker et al. (2012c) and is also used as an input into the stock assessment model. Data relating to carapace length-frequency and CPUE (number per potlift) of both pre-recruit (undersized) and legal-sized male and female lobsters are collected from rock lobster sampled in fixed site (pots with escape gap closed) and on-board observer programs (escape gaps open) since 2001 and 2004, respectively. Data relating to carapace length (CL) frequency are also collected from commercial processors. These data sets provide data for the model-based assessment of the WZRLF and EZRLF.

Puerulus monitoring is undertaken at sites in Victoria located at Port Campbell and Apollo Bay (Figure 1.1). The puerulus settlement index (PSI) is used as a potential fishery independent measure of future recruitment to the fishable biomass. The annual PSI is calculated as the mean monthly settlement of puerulus sampled from the collectors.

The 'Rock Lobster Fishery assessment model' provided outputs for assessment against the reference points (target and limit) and performance indicators (PIs), with described risk levels of uncertainty, as described in the RLF Management Plan and as modified following review by the Rock Lobster Resource Assessment Group (RLRAG).

3. WESTERN ZONE ROCK LOBSTER FISHERY (WZRLF)

3.1. Fishery statistics

3.1.1. Zonal catch and effort

With the exception of the 2003/04 fishing year, catch in the WZRLF decreased by 55% between 2000/01 (525 t) and 2008/09 (235 t; Figure 3.1). With the implementation of quota management in 2002/03, an initial TACC of 450 t was set but was reduced to 320 t in 2008/09. Over the last four years, catch has remained stable and in 2012/13 was 258 t (with a TACC of 260 t). Total effort did not decrease at the same rate as catch, remaining at around 657,000 potlifts from 2001/02 to 2008/09. Since 2010/11, effort has declined and in 2012/13 was 483,000 potlifts, representing a 26% decrease since 2009/10 (650,000 potlifts).

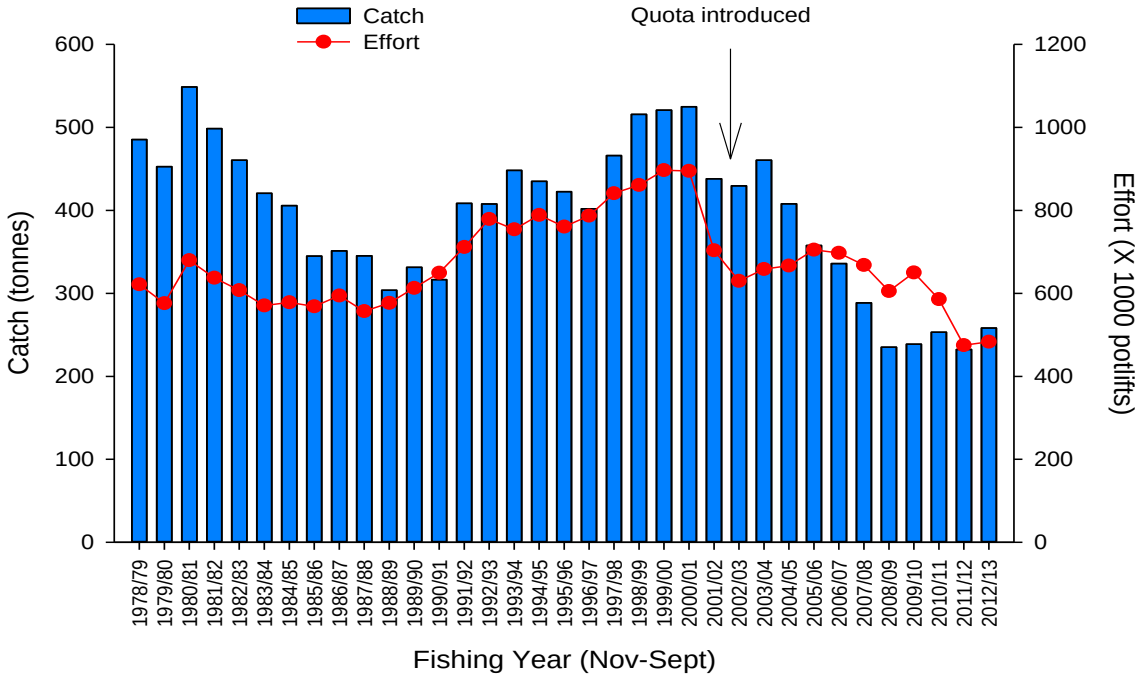

Figure 3.1 Total catch (tonnes) and nominal effort (x1000 potlifts) in the WZRLF from 1978/79–2012/13. Arrow indicates TACC introduction (450 t) in 2002/03.

3.1.2. Zonal catch per unit effort (CPUE)

Nominal and standardised CPUE (kg/potlift) show similar trends to those exhibited by catch over time. Since the 1992/93 fishing year, standardised CPUE has been lower than nominal CPUE (Figure 3.2). From 2003/04 to 2009/10, nominal CPUE decreased by 47% from 0.70 kg/potlift to 0.37 kg/potlift, the lowest on record. Nominal CPUE has increased in the last three years and in 2012/13 was 0.53 kg/potlift, representing a 45% increase from 2009/10 (0.37 kg/potlift). Standardised CPUE has increased by 30% from 0.33 kg/potlift to 0.43 kg/potlift over the same period (2009/10–2012/13).

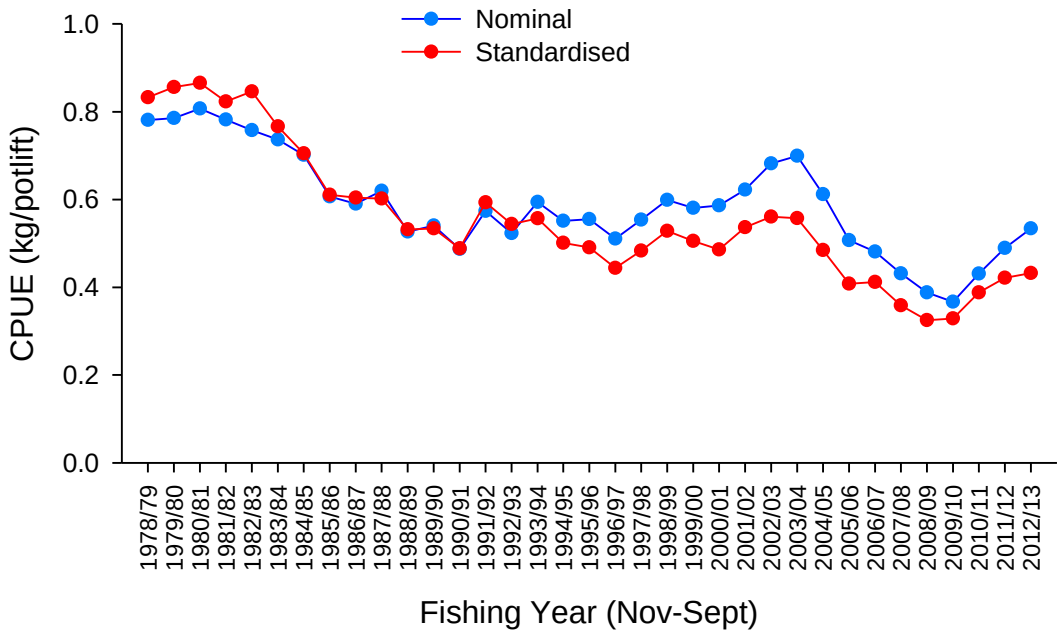

Figure 3.2 Nominal and standardised CPUE (kg/potlift) in the WZRLF from 1978/79–2012/13.

3.1.3. Within season trends in CPUE

Patterns of CPUE throughout the year were similar among the last two quota years (2012/13 and 2013/14; Figure 3.3). Lower catch rates were observed from May to September with the highest observed from November to February. Peak catch rates were typically 40-50% higher than those recorded from May to September. In 2013, CPUE slightly decreased between July and December compared to CPUE recorded for the same period in 2012. CPUE was lowest in both years during June at 0.28 kg/potlift (2012) and 0.21 kg/potlift (2013). CPUE was highest in November and December 2012 at 0.71 kg/potlift, and in January 2013 at 0.68 kg/potlift (Figure 3.3).

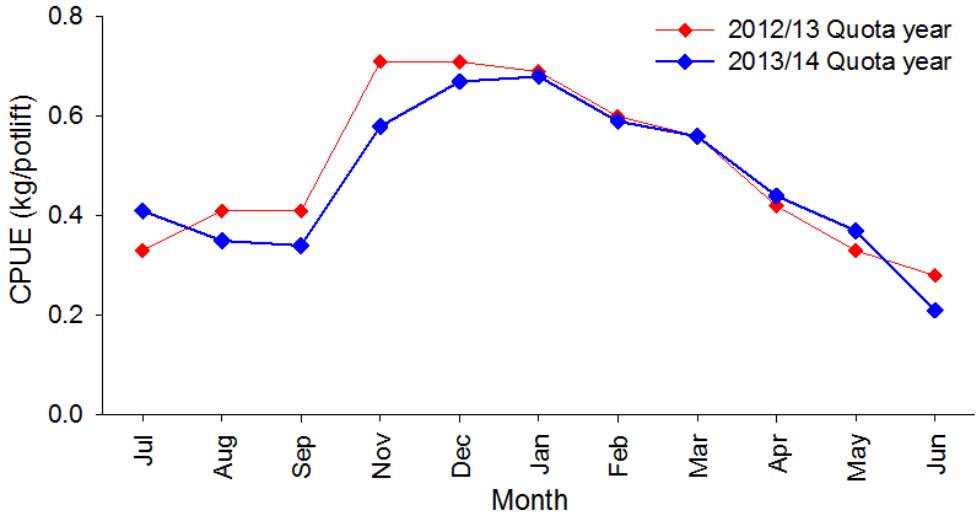

Figure 3.3 Within season trends in nominal CPUE (kg/potlift) for the quota years 2012/13 and 2013/14 in the WZRLF. Source: Monthly Victorian Rock Lobster catch based on data from the Fisheries Integrated Licensing System and Quota Monitoring Interactive Voice Response (IVR) system.

3.1.4. Spatial analyses

Regional (refer to Figure 1.1) trends in catch, effort and CPUE broadly reflect estimates for the whole zone (Figure 3.4). In all three regions, the last five fishing years (2008-2012) have seen catch decrease from the historically high levels taken during the late 1990s to some of the lowest levels of catch recorded.

Trends in effort among regions have generally reflected those of catch, with the exception of Portland. In Portland, from 2000/01 to 2004/05, effort decreased by approximately 34% to 348,000 potlifts while catch during the same period declined by approximately 18% to 229 tonnes. In 2012/13, levels of effort in Portland, Warrnambool and Apollo Bay had declined to historically low levels of 284,000 and 108,000 and 91,000 potlifts, respectively.

Regionally, levels of nominal and standardised CPUE generally declined from the late 1970s and from recent peaks in 2002/03 to be at, or near historically low levels of CPUE in 2009/10. However, over the last three seasons, CPUE has increased across all regions. Most notably, the 2012/13 nominal CPUE estimate in Warrnambool of 0.67 kg/potlift was the highest on record since 1984/85 (0.69 kg/potlift).

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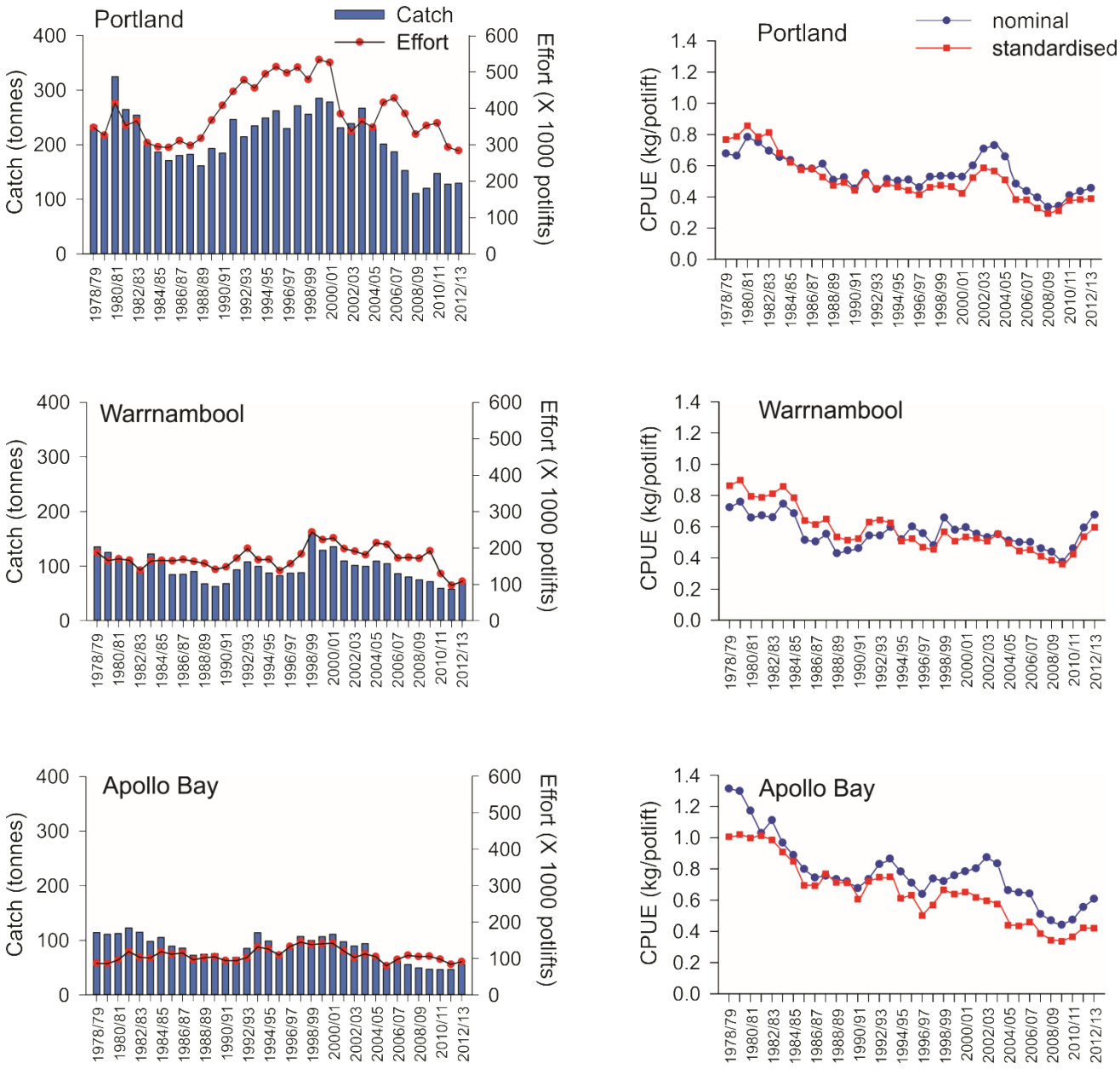

Figure 3.4 Regional catch (tonnes), effort (x1000 potlifts), and nominal and standardised CPUE (kg/potlift) in the WZRLF from 1978 to 2012.

3.2. **Settlement and pre-recruit indices**

3.2.1. Puerulus settlement index

Puerulus sampling sites in Victoria are located at Port Campbell and Apollo Bay (refer to Figure 1.1). In this report, data from both sites were combined. Trends in the puerulus settlement index (PSI) in Victoria resemble those observed in both the Northern Zone (NZ) and Southern Zone (SZ) of South Australia (Figure 3.5), with higher levels of settlement in 2002, 2005 and 2006 in all three regions. From 2007 to 2012, the PSI has remained relatively stable, ranging between 0.31 and 0.53 puerulus/collector. In 2012, the PSI was 0.37 puerulus/collector.

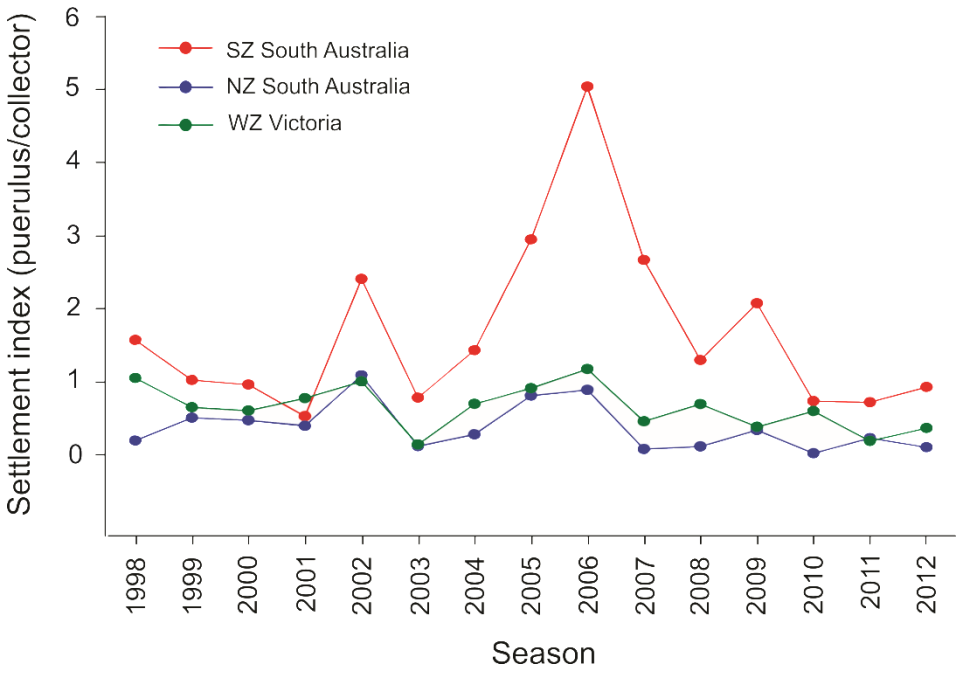

Figure 3.5 Puerulus settlement index in the Southern Zone (SZ), Northern Zone (NZ) rock lobster fisheries of South Australia and Western Zone (WZ) rock lobster fishery of Victoria from 1998-2012. Note: PSI data for WZ Victoria in 2005 and 2006 are from Port Campbell only, as collectors at Apollo Bay were removed during harbour redevelopment.

3.2.2. Pre-recruit indices

Catch rates of pre-recruits (undersized lobsters) are estimated from fixed-site surveys undertaken annually since 2001 and the onboard observer program since 2004. Catch rates of undersized male and female lobsters sampled in these surveys decreased by >50% from 2001/02 to 2007/08 (Figure 3.6). From 2007/08 to 2010/11, the catch rates of undersized lobsters of both sexes then increased, before declining over the next three seasons to 0.51 undersized/potlift (male) and 0.76 undersized/potlift (female) in 2013/14.

In the onboard observer program, the catch rates of undersized male and female lobsters increased between 2004/05 and 2005/06, decreased to low levels in 2007/08 and 2008/09, before increasing in 2011/12 to 0.43 and 0.59 undersized/potlift, for males and females, respectively. In 2012/13, the catch rates of undersized male and female lobsters decreased to 0.32 and 0.42 undersized/potlift, respectively.

From 2001/02 to 2009/10, the catch rates of legal-size male and female lobsters sampled in fixed-site surveys generally decreased (Figure 3.6). Since 2009/10, the catch rate of legal sized lobsters of both sexes has increased in fixed-site surveys. These trends generally reflect those seen for undersized lobsters lagged by two to three years.

Consistency in the relationship between catch rates of pre-recruits (undersize lobsters) and legal-size lobsters from the onboard observer program is less clear. From 2005/06 to 2009/10,

the CPUE of legal-sized lobsters of both sexes generally decreased (Figure 3.6). However, in 2011/12 CPUE of legal-size males and female lobsters increased to 0.52 and 0.37 lobsters/potlift respectively, the highest on record for both sexes. In 2012/13, the CPUE of legal-size male and female lobsters had declined slightly from 2011 to 0.49 and 0.35 lobsters/potlift, respectively.

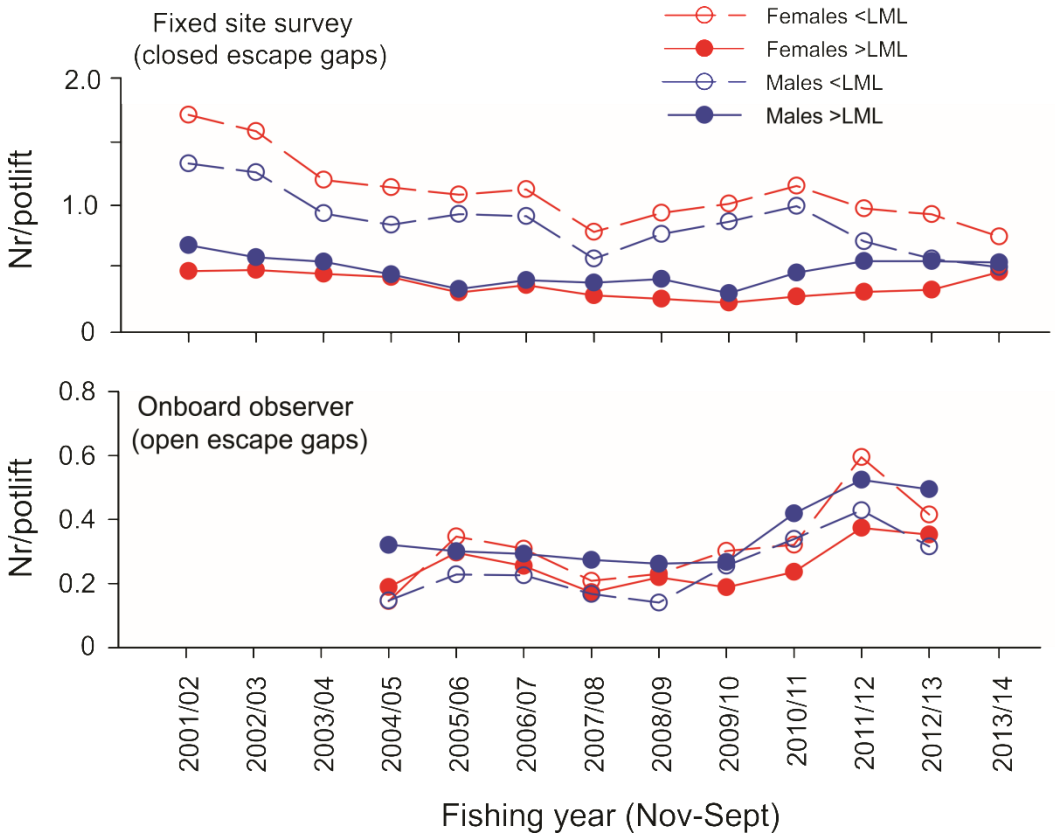

Figure 3.6 Number of legal-sized and undersized female (LML = 105 mm CL) and male (LML = 110 mm CL) lobsters per potlift in fixed-site surveys (top graph) and onboard observer program (bottom graph) in the WZRLF. Note: escape gaps open on pots for the onboard observer program and closed for the fixed-site survey.

3.2.3. Pre-recruit indices South Australia

Trends in the pre-recruit indices recorded for Victoria were compared with those recorded from logbook data within the SZ of South Australia for the fishing seasons between 2001/02 and 2012/13. In the SZ, catch rates of pre-recruits peaked in 2001 at 1.84 undersized/potlift (Figure 3.7), but generally declined over the next seven seasons to a historical low of 0.85 undersized/potlift in 2008. Catch rates of pre-recruits then increased over the next two seasons (2009/10 and 2010/11) before decreasing to 0.96 undersized/potlift in 2012. These results are broadly consistent with those recorded in the Western Zone of Victoria, where the catch rates of pre-recruits sampled in fixed-site surveys decreased between 2001/02 and

2007/08, increased to 2010/11, before subsequently declining over the next two seasons in 2011/12 and 2012/13 (Figure 3.7). The similarities in pre-recruit data in Victoria and South Australia support the occurrence of large scale recruitment events (Section 3.2.1) that are typical of crustacean fisheries worldwide.

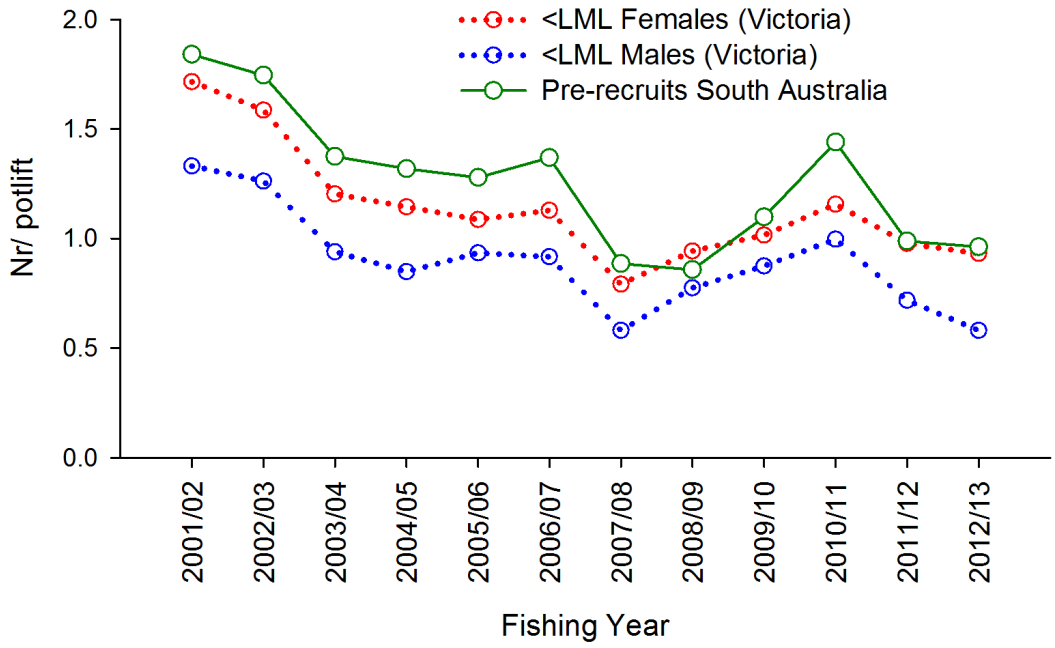

Figure 3.7 Comparison of South Australian Southern Zone and Victorian Western Zone pre-recruit indices.

3.3. **Zonal length-frequency distributions**

Length-frequency data of male and female lobsters obtained through fixed-site surveys support the observed trends in pre-recruit indices and legal-size commercial catch rates (Figure 3.8). Specifically, from 2008/09 to 2010/11, the number of lobsters sampled in size classes below the LML increased for both males and females, reflecting the increase in abundance of pre-recruits observed in both fixed site surveys and observer programs over the same period (Figure 3.6). The increased commercial catch rates seen across the fishery in 2011/12 and 2012/13 are likely to reflect the increase in abundance of legal-sized male lobsters (110-130 mm CL) recorded during both these seasons (Figure 3.2).

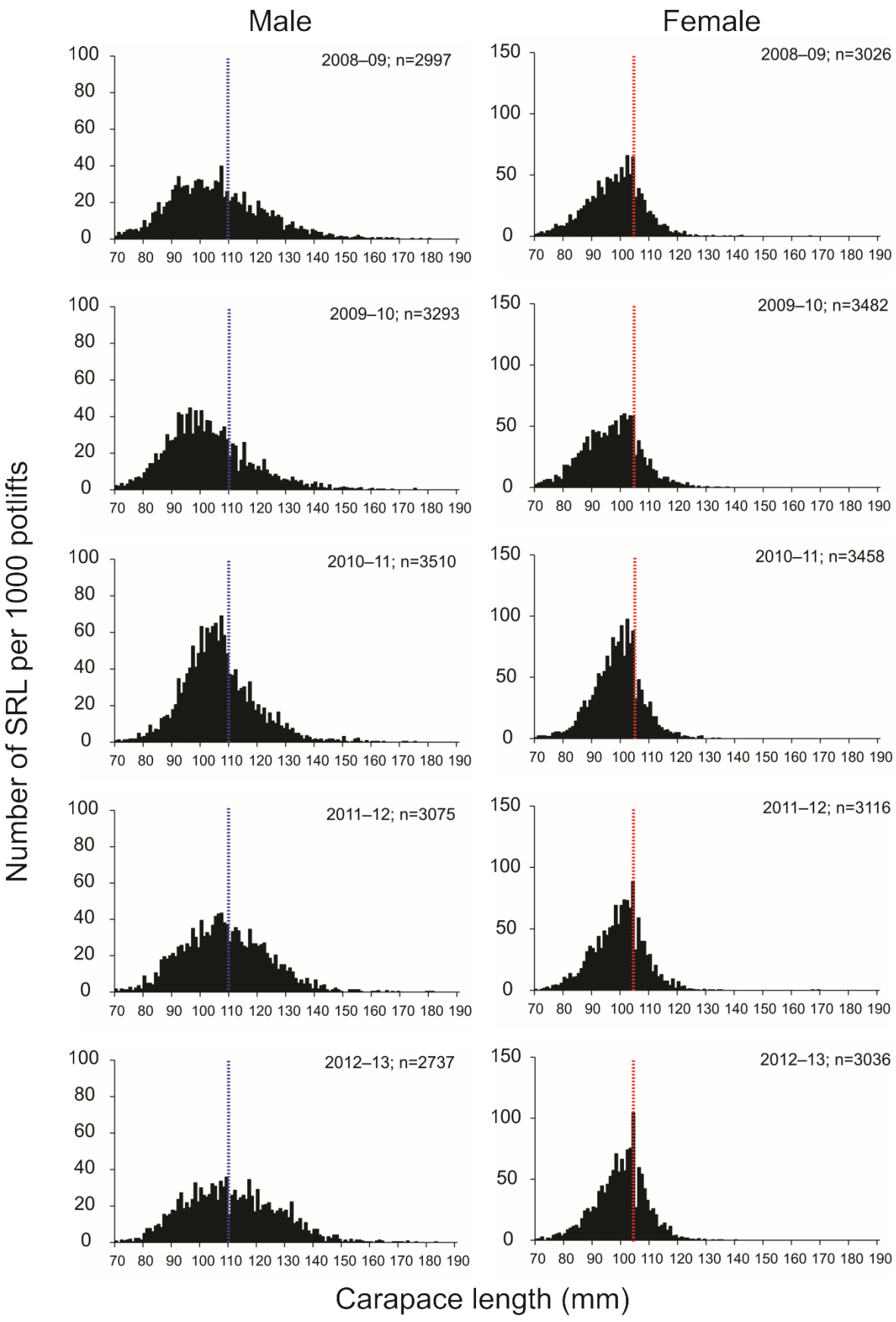

Figure 3.8 Length-frequency distributions of male and female lobsters sampled on fixed-site surveys from 2008/09 to 2012/13 in the WZRLF. Blue and red dashed vertical lines represent minimum legal sizes for male and female lobsters, respectively.

3.4. **Length-structured assessment model outputs**

3.4.1. Model estimated recruitment (to 60 mm carapace length (CL))

Model-estimated recruitment has been highly variable over the last 30 years (Figure 3.9). From the late 1980s to the late 1990s, recruitment was mostly above the long-term average, while, from 2000 to 2012, it was below average with the exception of 2007, 2008, 2010 and 2012. The estimated period from recruitment (to 60 mm CL) to legal size is four years in the WZRLF (see Section 3.4.2). As a result, the above average recruitment in 2007/08 and 2008/09 is likely to be reflected in the increases in commercial catch rates observed within the fishery in 2011/12 and 2012/13 (Figure 3.2, Figure 3.3). Importantly, recruitment (to 60 mm CL) in 2009/10 was considerably below average, indicating that the number of legal-size lobsters entering the fishery in 2013/14 is likely to be reduced.

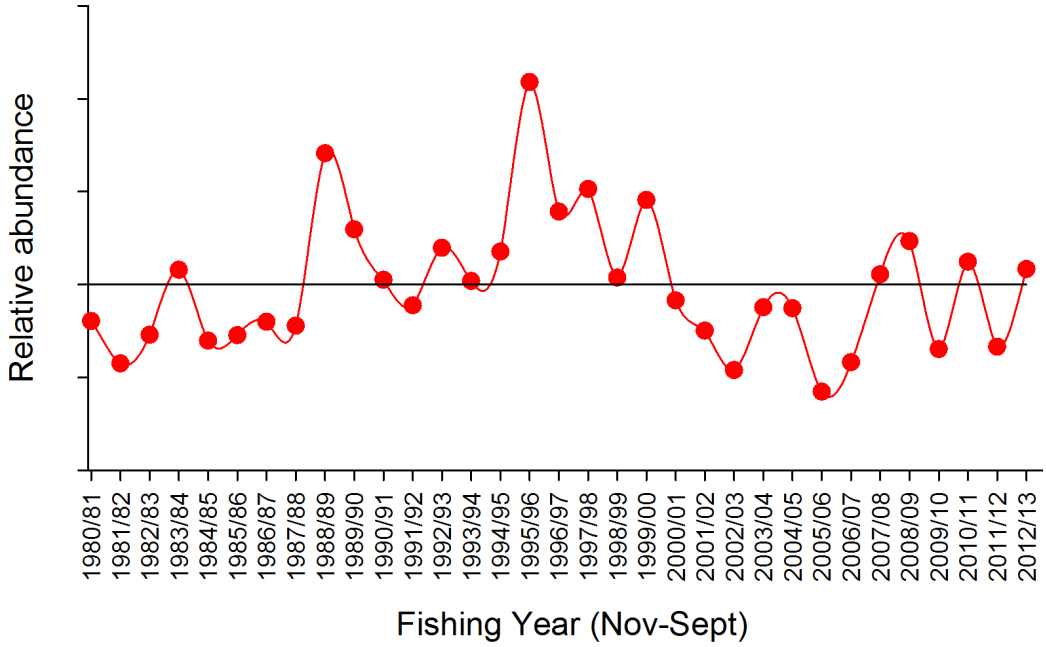

Figure 3.9 Relative abundance of recruitment to 60 mm CL in the WZRLF, as used in the length-frequency model. Long-term historical average (solid black line) also indicated.

3.4.2. Linking model estimated recruitment to puerulus settlement

Puerulus settlement indices (PSIs) from monitoring sites at Port Campbell and Apollo Bay are positively correlated through time (R^2 = 0.70) (Figure 3.10). Using a two year lag, PSI was also positively correlated with model estimated recruitment to 60 mm CL (R^2 = 0.63) (based on Port Campbell data only due to absence of Apollo Bay data in 2007/08 and 2008/09).

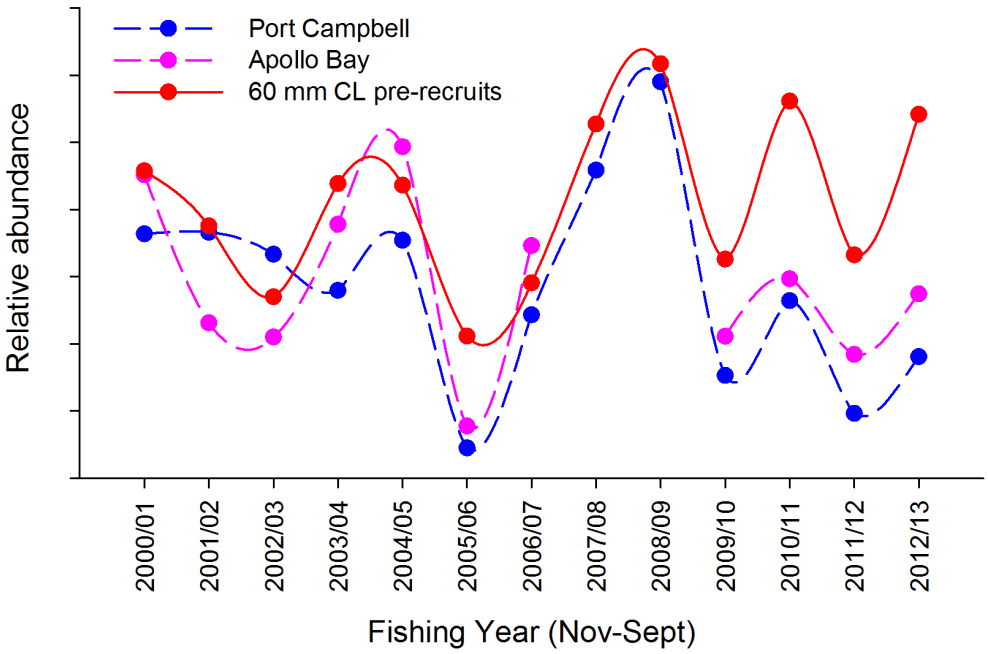

Figure 3.10 Model-estimated relative abundance of recruitment to 60 mm CL in the WZRLF (red line) with PSIs from Port Campbell (blue line) and Apollo Bay (pink line), lagged by two years. Note: Absence of PSI data at Apollo Bay (2007/08-2008/09) due to harbour development.

Fixed-site survey estimates of the relative abundance of legal-sized (lagged four years) lobsters provide support to the predictive capacity of the model-estimated recruitment levels (Figure 3.11). Specifically, the catch rate of legal-sized lobsters (lagged four years) from fixed site surveys increased from 2005/06 to 2008/09 in line with increases in model estimated recruitment over the same time period. Overall, this indicates a total period of approximately six years for lobsters to reach legal-size after settlement, with the high PSIs in 2005 and 2006 (Figure 3.5, Figure 3.10) resulting in increases in the catch rates of legal-size lobsters in 2011/12 and 2012/13 (Figure 3.2).

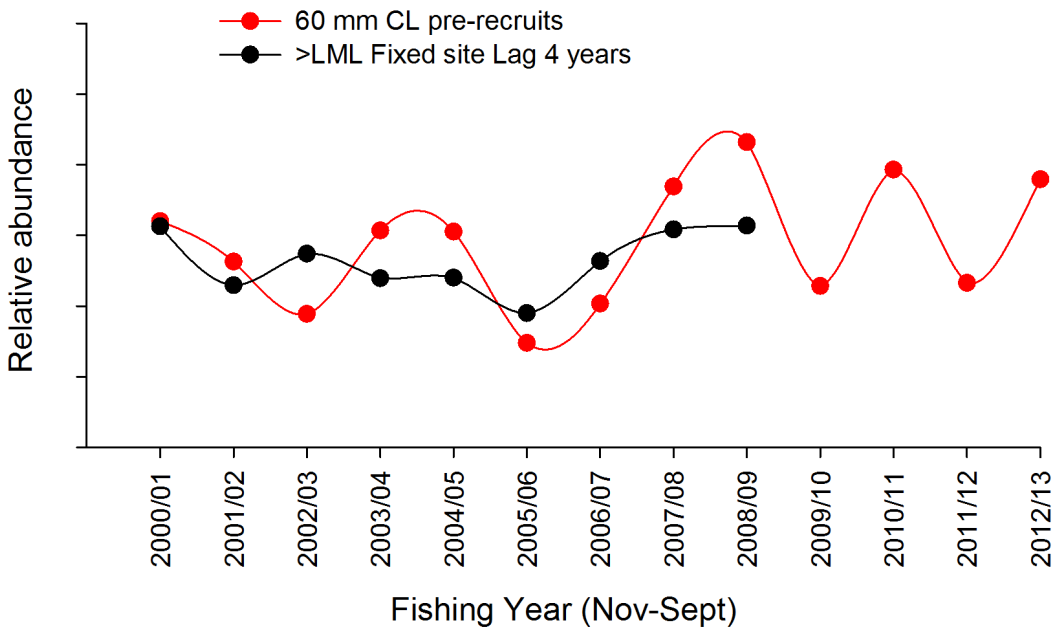

Figure 3.11 Model estimated relative abundance of recruitment to 60 mm CL in the WZRLF (red line) and legal-sized lobsters sampled in fixed-site surveys (lagged four years; black line).

3.4.3. Biological reference points

3.4.3.1. Egg production

The model estimated the level of egg production in 2012/13 to be 74% of the egg production occurring in 2001/02 with 75% probability. This estimate was substantially above the biological limit reference point of 35% of egg production in the 2001/02 reference year (Figure 3.12).

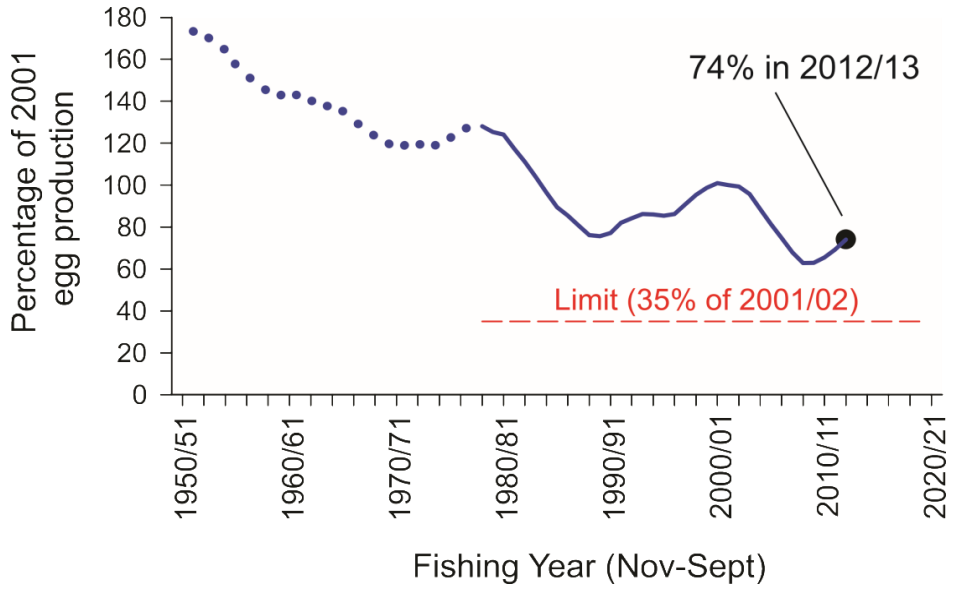

Figure 3.12 Model estimated level of egg production through time in the WZRLF (above, with 75% probability; blue line). Limit reference point (35% of egg production in 2001/02; red line).

3.4.3.2. Available biomass

The level of available biomass in 2012/13 was estimated to be 75% of that in 2001/02 (reference year), with 50% probability. This was below the target biological reference point (BRP) of 159% of 2001/02 (Figure 3.13). A forward projection of the model indicates with 50% probability that a TACC of 230 t for the 2014/15 quota year will maintain biomass rebuilding on the target trajectory.

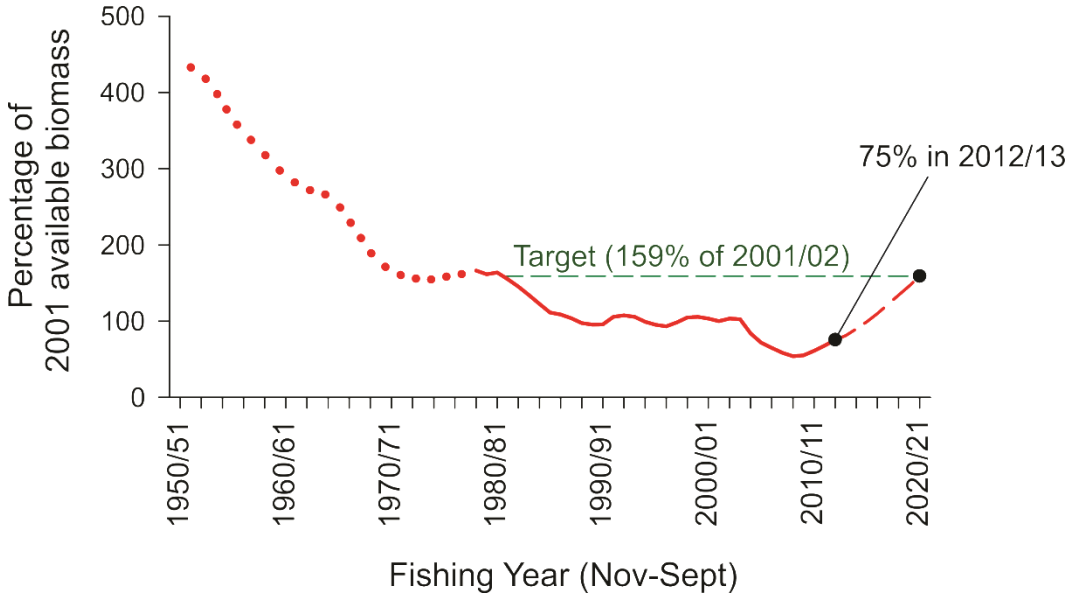

Figure 3.13 Model estimated levels of available biomass in the WZRLF (solid red line). Target reference point (159% of available biomass in 2001/02; green line). Projected available biomass (dashed red line) given a TACC of 230 t/yr to rebuild available biomass to the biological reference point target by 2020/21 with 50% probability. Backward projection of the biomass model (dotted red line).

Effects of CPUE standardisation on model estimates of available biomass

The current Decision Framework for the Victorian RLF states that modelled estimates of biomass are to be compared with trends in nominal (unstandardised or 'raw') CPUE over the most recent two year period. Modelled trends in available biomass for the WZRLF were similar to trends seen in nominal CPUE, and nominal CPUE collected in November to February of each fishing year (Figure 3.14). These data highlight the consistency between the model-estimated biomass outputs and nominal CPUE estimates.

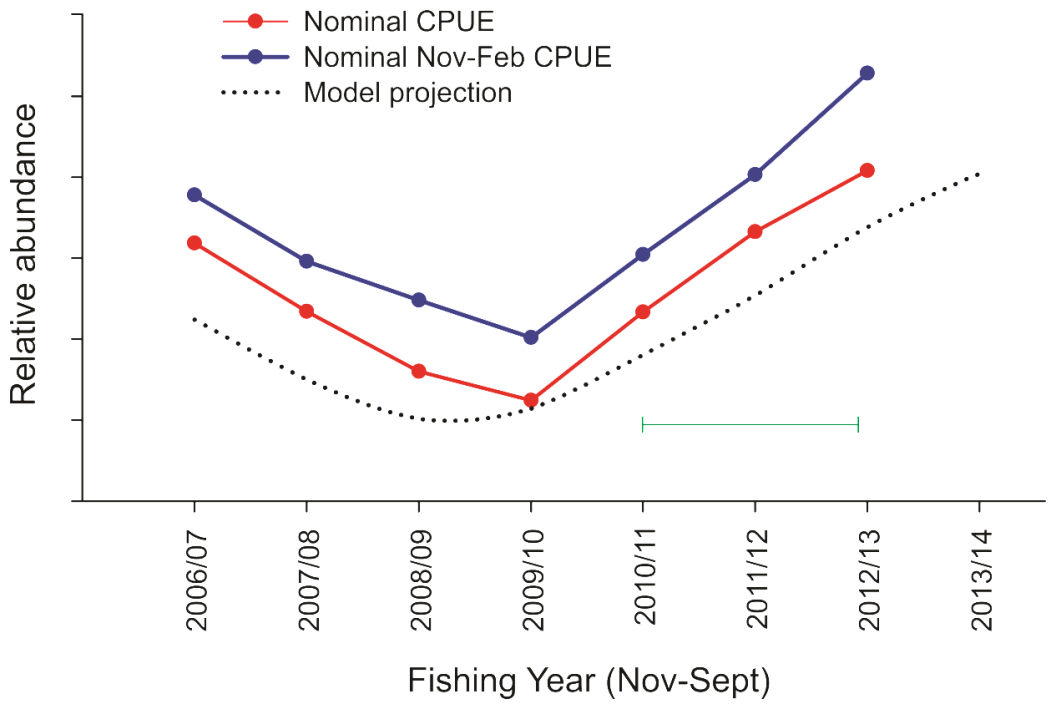

Figure 3.14 Model estimated available biomass in the WZRLF (black line) from fitting standardised CPUE compared with measures of nominal CPUE (red line) and nominal CPUE from November to February (inclusive; blue line) from 2006/07 to 2012/13. The most recent two year period for comparison of model and CPUE trends is indicated by the green line.

3.5. **Summary**

From 2000/01 to 2008/09, annual catches in the WZRLF decreased by 55% from 525 t to 235 t. This is consistent with reductions in the TACC over the same period, from 450 t in 2001/02 (quota period 1 April to 31 March) to 240 t in 2009/10 (change in quota period; 1 July to 30 June; Walker et al. 2012a). Over the last four seasons, catch has remained stable and in 2012/13, was 258 t. Effort did not decline at the same rate as catch and, as a result, from 2003/04 to 2009/10 nominal CPUE decreased by 47% from 0.70 kg/potlift to 0.37 kg/potlift, the lowest level in the history of the fishery. However, nominal CPUE has increased over the last three seasons and in 2012/13 was 0.53 kg/potlift, reflecting a 45% increase from 2009/10. Standardised CPUE has increased by 30% from 0.33 kg/potlift to 0.43 kg/potlift over the same period. Patterns of catch and CPUE among regions of the WZRLF are similar to those for the whole fishery. Most notably, the 2012/13 CPUE estimate in Warrnambool of 0.67 kg/potlift was the highest on record since 1984/85 (0.69 kg/potlift).

Puerulus settlement indices (PSIs) across South Australia and Victoria indicate large-scale consistent patterns in settlement, with recent peaks in 2002 and 2006 evident in both States. In the WZRLF, there is a demonstrable relationship between PSIs, and time-lagged relative abundance (CPUE) of both pre-recruit and legal-sized lobsters. Data indicate that the period from settlement to recruitment at 60 mm CL is approximately two years, with recruitment to

legal-size approximately four years later. Overall, this suggests that the total period from settlement to legal-size is approximately six years in the WZRLF. Based on these data, this indicates that the current increases in catch rates in 2012/13 reflect the strong PSIs observed across South Australia and Victoria in 2005 and 2006. However, while CPUE of legal-sized lobsters has recently increased, the fixed-site pre-recruit indices decreased in 2011/12 and 2012/13 reflecting declining settlement levels after 2006/07. Combined with low model estimated recruitment in 2009/10 (to 60 mm CL), these data suggest that recruitment to the fishery in 2013/14 will most likely be reduced. This pattern is supported by the monthly CPUE estimates, which are based on IVR data that indicate that the catch rates from August to December in 2013 are below those recorded in 2012.

The model estimated level of egg production in 2012/13 was 74% of the reference year and well above the reference limit point of 35%. In contrast, the level of available biomass was estimated to be 75% of that in the reference year and well below the reference target of 159%. Therefore, while model outputs indicate that biomass is increasing, based on historical recruitment trends, it is not expected to rebuild to the target by 2020/21 at a TACC level of 260 t. Model outputs indicate, based on a 50% probability forward projection, that a 230 t TACC would be required for the 2014/15 quota year to maintain biomass rebuilding on the target trajectory.

4. EASTERN ZONE ROCK LOBSTER FISHERY (EZRLF)

4.1. Fishery statistics

4.1.1. Zonal catch and effort

From 1982/83 to 1988/89, catch in the EZRLF decreased annually from 143 t to 64 t (Figure 4.1). Over the next 12 years (1989–2000), total catch was stable and averaged 69 t/yr (range 57–83 t/yr). In 2001/02, the total catch declined to 53 t. An initial TACC of 60 t was introduced in 2001/02, where it remained until 2006/07. In 2007/08, the TACC was increased to 66 t where it remained until a reduction in 2012/13 to 48 t.

Since the implementation of a TACC in 2001, catches have ranged between 40 t (2008/09) and 65 t (2010/11). In 2012/13, the TACC was fully taken with a catch of 48 t. Total effort generally reflected changes in catch from 1978/79 to 1987/88. From 1988/89, effort increased substantially to a historical peak of 260,000 potlifts in 1993/94 and remained above 200,000 potlifts/yr until 2000/01. Since 2001/02, annual effort has reflected levels of catch and averaged approximately 129,000 potlifts/yr. Effort in 2012/13 was the lowest on record (94,000 potlifts) and has decreased 37% since 2010/11 (150,000 potlifts).

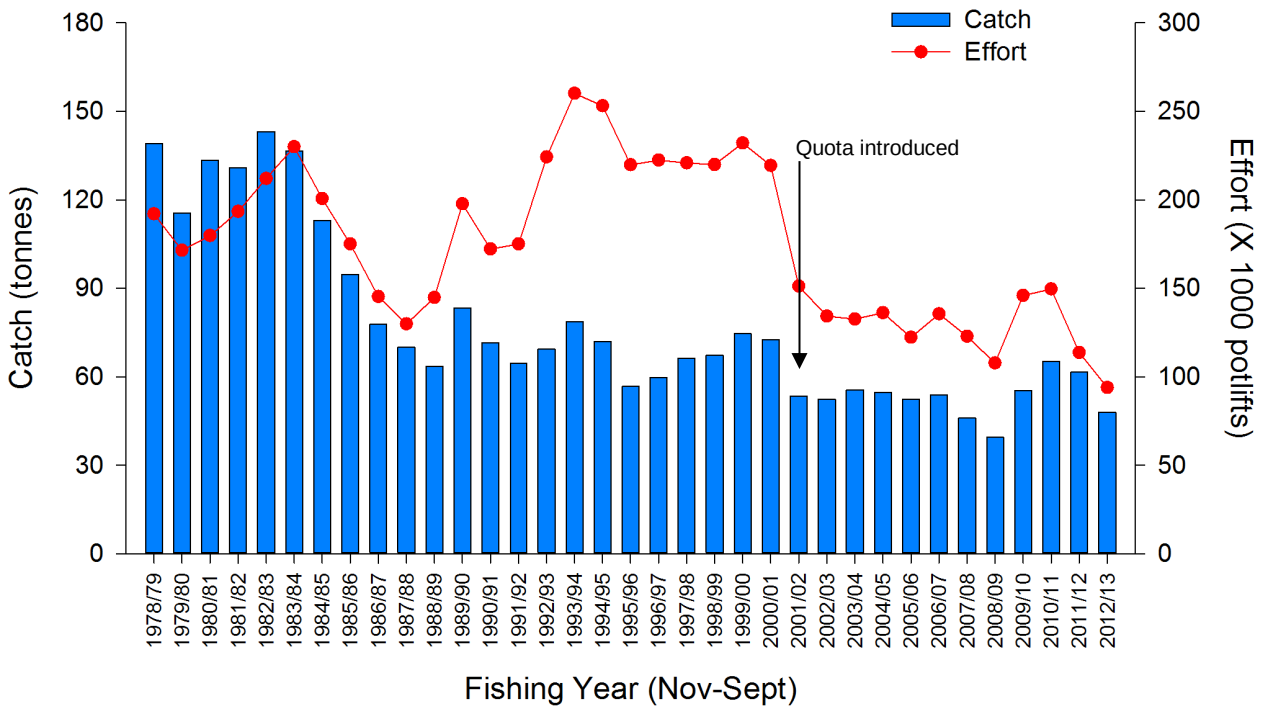

Figure 4.1 Total catch (tonnes) and nominal effort (x1000 potlifts) in the EZRLF from 1978-2012. ↓ indicate a TACC introduction in 2001 (60 t).

4.1.2. Zonal catch per-unit-effort (CPUE)

Nominal and standardised CPUE show similar trends through time although standardised CPUE is consistently lower (Figure 4.2). Nominal CPUE decreased from 1978/79 (0.72 kg/potlift) to 1995/96 (0.26 kg/potlift), the lowest level on record. Following annual increases from 1996/97 to 2003/04, nominal CPUE decreased from 0.43 kg/potlift in 2005/06 to 0.37 kg/potlift in 2008/09. Nominal CPUE has increased since 2008/09 and in 2012/13 was 0.51 kg/potlift reflecting a 38% increase from 2008/09. Standardised CPUE increased by 53% from 0.34 kg/potlift to 0.53 kg/potlift in the same four year period.

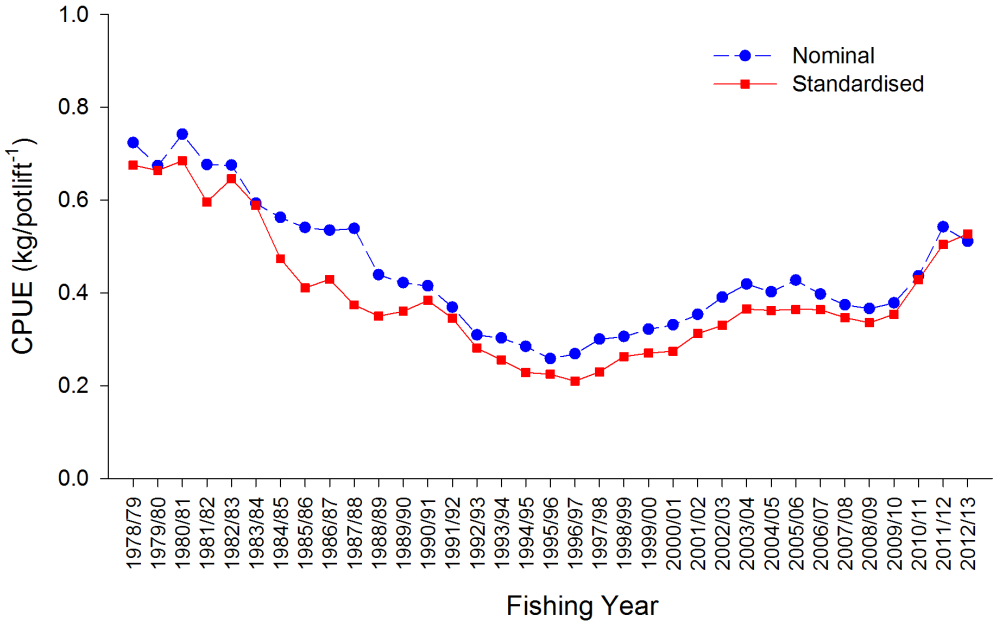

Figure 4.2 Nominal and standardised CPUE (kg/potlift) in the EZRLF from 1978/79-2012/13.

4.1.3. Within season trends in CPUE

Over the last two quota years monthly levels of nominal CPUE were variable, with lower catch rates generally observed from in May and June (Figure 4.3). In 2013/14, catch rates were similar to or above 2012/13 estimates in all months with the exceptions of March, May, July and August. In 2013/14, the catch rate was highest in December at 0.66 kg/potlift and lowest in June at 0.27 kg/potlift.

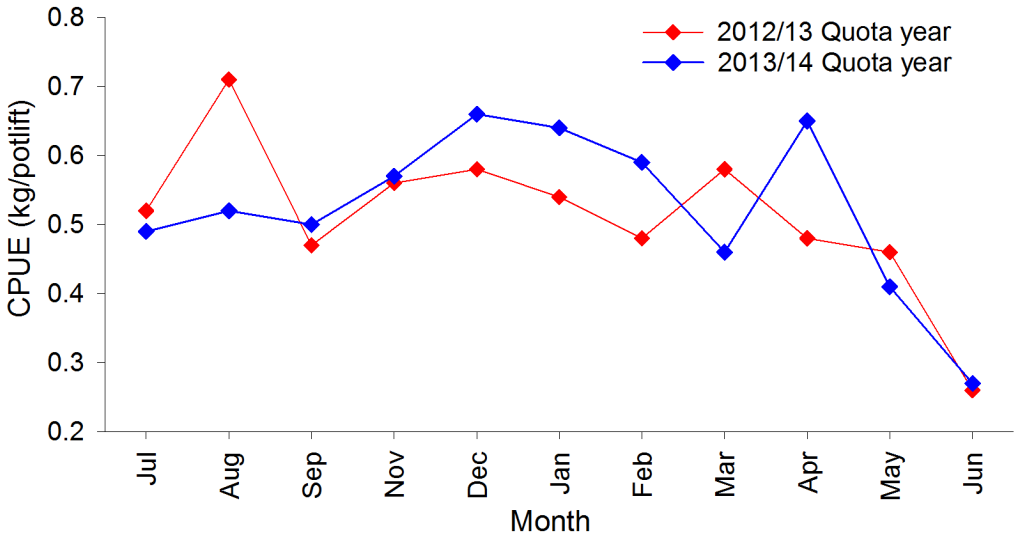

Figure 4.3 Within season trends in nominal CPUE (kg/potlift) from July to June for the quota years 2012 and 2013 in the EZRLF. Source: Monthly Victorian Rock Lobster catch based on data from the Fisheries Integrated Licensing and Quota Monitoring Interactive Voice Response (IVR) system.

4.1.4. Spatial analyses

Among the three regions of the EZRLF (refer to Figure 1.1) catches have generally declined from the historical peaks observed during the late 1970s and early 1980s (Figure 4.4). In each region, minimum annual catches have all been recorded after the implementation of quota in 2001, with some of the lowest levels in catch recorded at Queenscliff (21.2 t) and Lakes Entrance (1.3 t) as recently as 2008/09. At San Remo, the lowest annual catch recorded was 13.2 t in 2002/03, with <14 t/yr caught in the following two years. From 2005/06 to 2011/12, annual catches at San Remo averaged 22.3 t/yr, and in 2012/13 the catch was 17.5 t. Similarly, over the last three years, the catch in Queenscliff has increased and in 2012/13 was 29.4 t. The least amount of catch recorded in 2012/13 was 1.1 t from Lakes Entrance. This catch is the lowest on record for the region.

Trends in effort generally followed those of catch until the late 1980s and early 1990s, after which effort increased to historically high levels in 1993 at Queenscliff (147,000 potlifts) and San Remo (101,000 potlifts), and in 1994 at Lakes Entrance (22,000 potlifts). Since this time, effort has decreased to historically low levels at San Remo in 2003/04 (34,000 potlifts), and at Queenscliff

(61,000 potlifts) and Lakes Entrance (2,000 potlifts) in 2008/09. In 2012/13, the effort estimates for Queenscliff, San Remo and Lakes Entrance were 54,000, 37,000 and 2,000 potlifts, respectively, levels at, or close to, historical lows recorded in all regions.

Nominal and standardised CPUE (kg/potlift) show similar tends through time at Queenscliff and San Remo. CPUE has generally declined from 1979/80 to historically low levels in 1996/97 in both regions, where after it has increased to 0.54 kg/potlift (Queenscliff) and 0.47 kg/potlift (San Remo) in 2012/13. Of note is the 2012/13 CPUE estimate of 0.54 kg/potlift in Queenscliff, which is the highest on record since 1983/84 (0.58 kg/potlift). CPUE at Lakes Entrance has been more variable with less agreement between nominal and standardised CPUE through time. In 2012/13, levels of CPUE at Lakes Entrance were 0.46 kg/potlift (nominal) and 0.22 kg/potlift (standardised). Estimates of CPUE from this region should be viewed with caution considering the overall low levels of catch and effort in recent years.

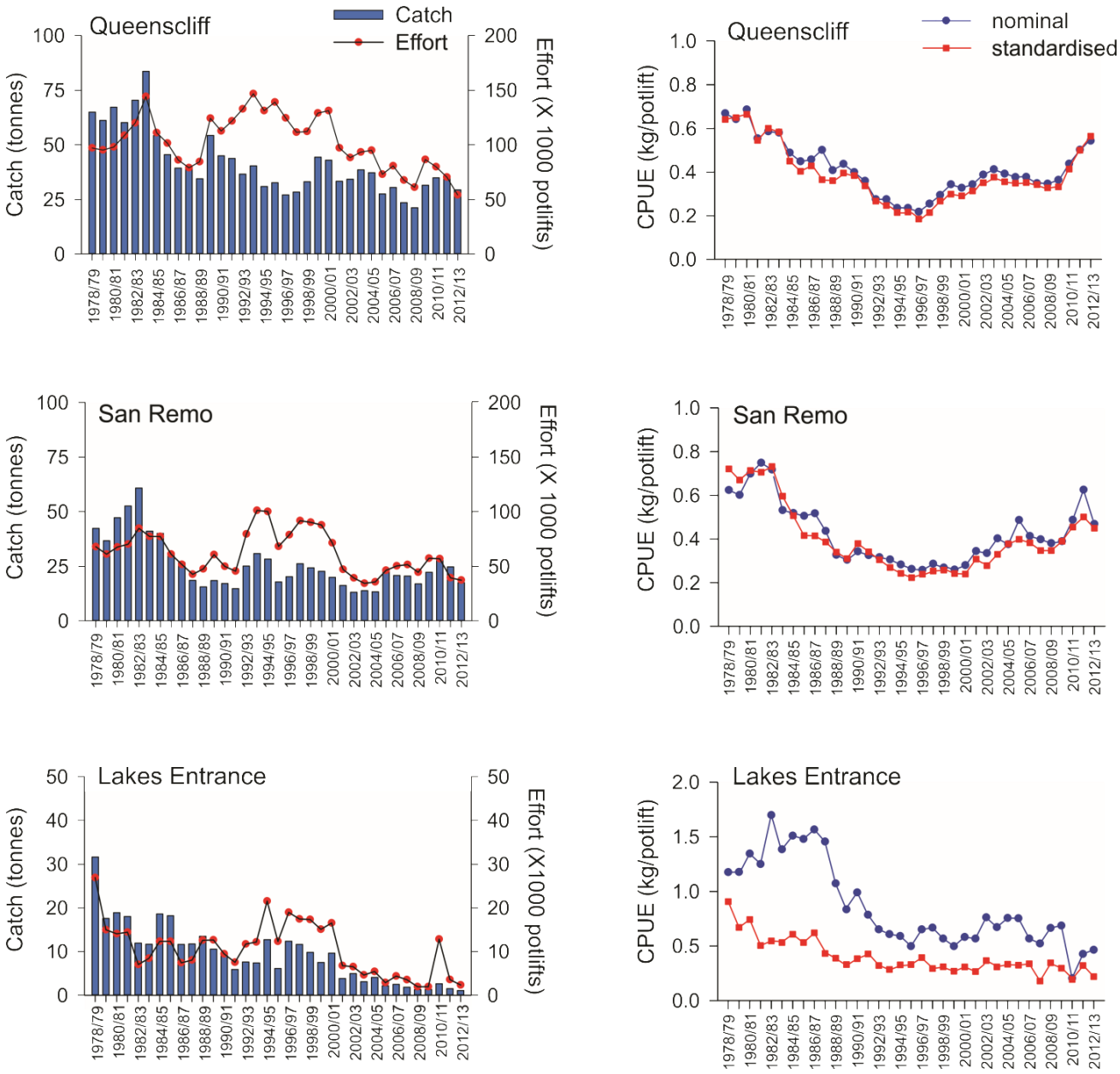

Figure 4.4 Catch (tonnes), effort (x1000 potlifts) and nominal and standardised CPUE (kg/potlift) in the EZRLF from 1978/79 to 2012/13.

4.2. **Recruitment and pre-recruit indices**

4.2.1. Puerulus settlement index

The sites for sampling the settlement of puerulus in Victoria are located at Port Campbell and Apollo Bay (refer to Figure 1.1). In this report, data from both sites were combined. Trends in the puerulus settlement index (PSI) in Victoria are highly correlated with those observed in both the Northern Zone (NZ) and Southern Zone (SZ) of South Australia (Figure 3.5), with higher levels of settlement in 2002, 2005 and 2006 in all three regions. From 2007 to 2012, the PSI remained relatively stable, ranging between 0.31 and 0.53 puerulus/collector. In 2012, the PSI was 0.37 puerulus/collector.

Recent trends in model-estimated recruitment in both the EZRLF and WZRLF are broadly similar (Section 4.4.2). Further, time-lagged PSI data have a strong relationship with these recruitment data (Figure 3.10). These relationships suggest that PSI data can be used to infer patterns of recruitment to the EZRLF and the WZRLF.

4.2.2. Pre-recruit indices

The catch rates of pre-recruits (undersized lobsters) are estimated from fixed-site surveys undertaken annually since 2001 and the onboard observer program since 2004 (excluding 2009) (Figure 4.5). Data from the onboard observer program are more limited. Overall, the catch rates of undersized lobsters are approximately 50% greater in fixed-site surveys compared to the onboard observer program.

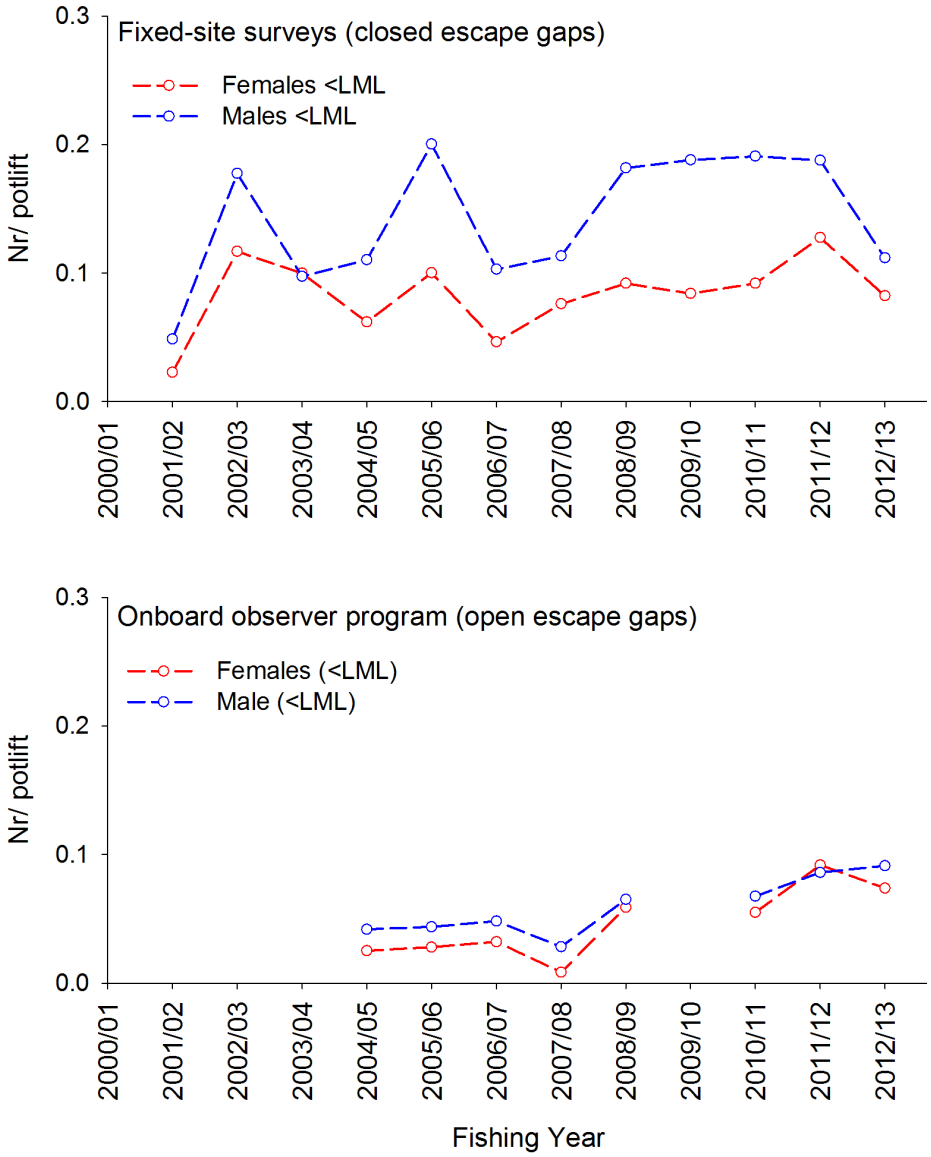

Figure 4.5 Number of undersized female (LML = 105 mm CL) and male (LML = 110 mm CL) lobster per potlift in fixed-site surveys and onboard observer program in the EZRLF.

The catch rates of undersized male and female lobsters in fixed-site surveys showed peaks in 2002/03, 2005/06 and 2011/12, and generally increased from 2006/07 to 2011/12. In 2012/13, the catch rates of undersized male and female lobsters declined to 0.11 and 0.08 undersized/potlift, respectively. In 2012/13, the catch rates of undersized male lobsters from the onboard observer program were the highest on record at 0.09 undersized/potlift. Catch rates of undersized female lobsters from the onboard observer program declined slightly between 2011/12 and 2012/13 from 0.09 to 0.07 undersized/potlift. These patterns in CPUE are likely reflected in the relatively high levels of CPUE observed for legal sized lobsters during the 2012/13 fishing season (Figure 4.2) and are consistent with the progression of lobsters from pre-recruit to legal-size over a period of two to three years.

4.3. **Zonal length-frequency distributions**

Length-frequency data obtained through fixed-site surveys support changes in commercial catch rates despite low sample sizes in some years (Figure 4.6). Specifically, the increase in lobster abundance within the 110-130 mm CL size range, in both male and female lobsters during 2011/12 and 2012/13 reflects the increase in catch rates of legal size lobsters observed across the fishery during these seasons (Figure 4.2).

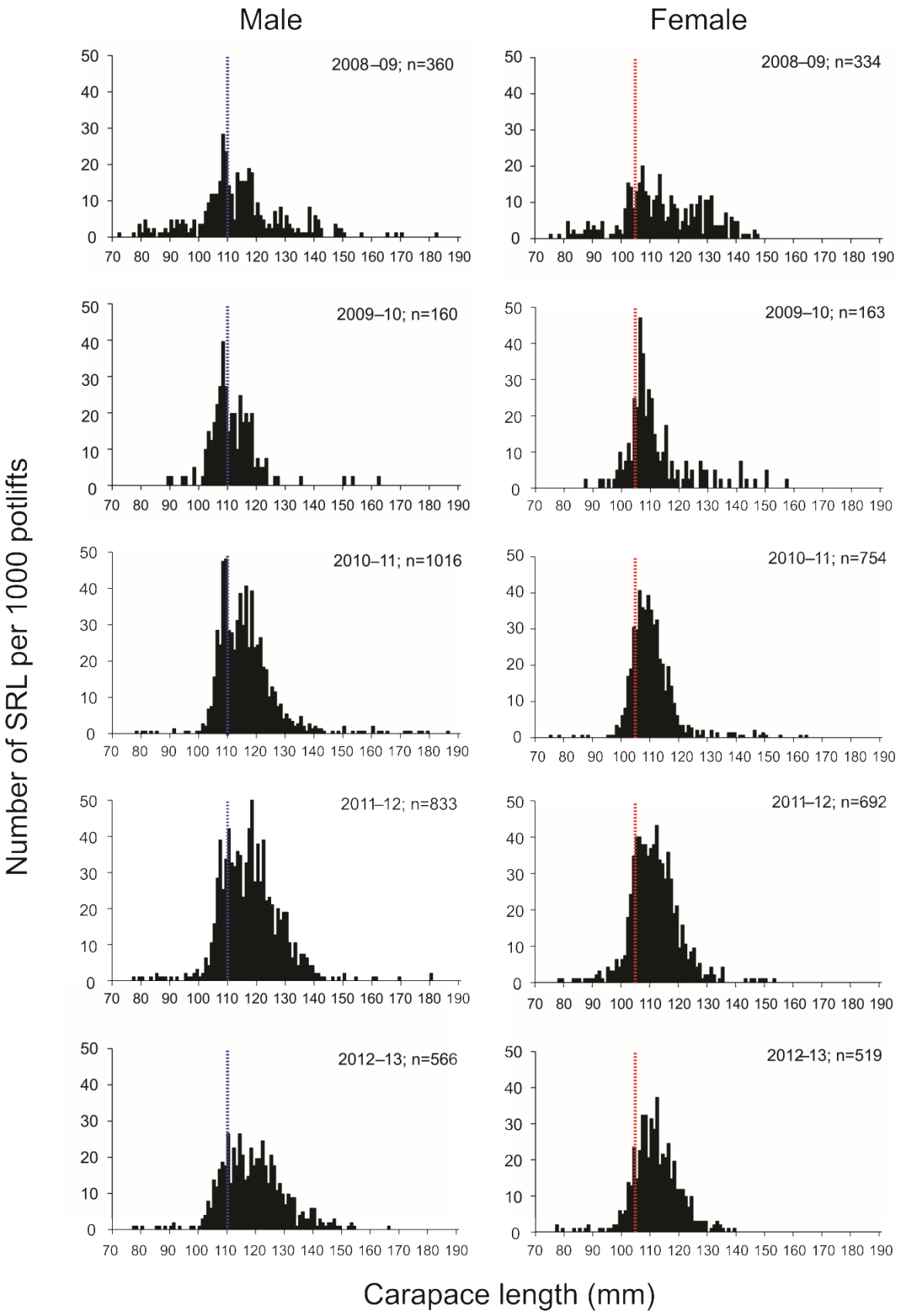

Figure 4.6 Length-frequency distributions of male and female lobsters sampled on fixed-site surveys from 2008/09 to 2012/13 in the EZRLF. Blue and red dashed vertical lines represent minimum legal sizes for male and female lobsters, respectively.

4.4. **Length-structured assessment model outputs**

4.4.1. Model estimated recruitment (to 60 mm carapace length; (CL))

Model-estimated recruitment has been highly variable over the last 30 years. From 2000/01 to 2006/07, recruitment strength was below the long-term average for the fishery (Figure 4.7). However, levels in 2007/08 and 2008/09 were the highest on record and have likely resulted in the recent increases in CPUE over the last three seasons (Figure 4.2). Recruitment estimates from 2009/10-2012/13 were close to the long-term average, with 2012/13 recruitment levels being the highest recorded in the last four years (Figure 4.7).

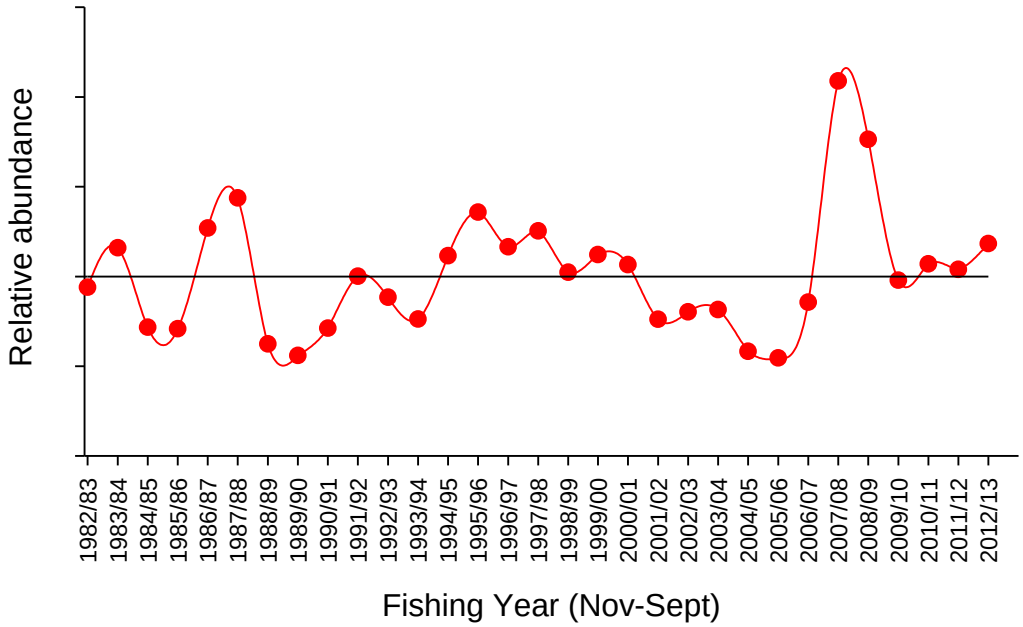

Figure 4.7 Relative abundance of recruitment to 60 mm CL in the EZRLF, as used in the length-frequency model. Long-term historical average (solid black line) is also indicated.

4.4.2. Linking model recruitment to pre-recruit indices.

Model estimated recruitment indices between the EZRLF and WZRLF were positively correlated (R^2 = 0.46) (Figure 4.8). Differences in recruitment to 60 mm CL in each zone over time are due to increased recruitment observed in the WZRLF in 2003/04, 2004/05, 2010/11 and 2012/13 that did not occur in the EZRLF.

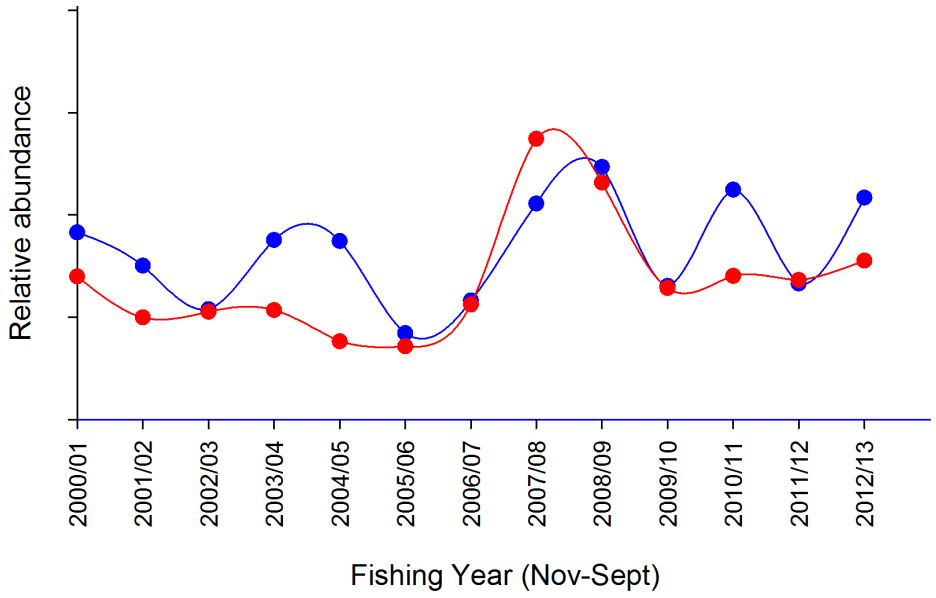

Figure 4.8 Relative abundance of recruitment to 60 mm CL in the EZRLF (red line) and WZRLF (blue line) from 2000/01 to 2012/13.

Fixed-site survey estimates of relative abundance of legal-sized lobsters, lagged between two to three years, also support the predictive capacity of model-estimated recruitment in the EZRLF (Figure 4.9). The most consistent fits of recruit abundance of legal-size lobsters occur when the lag period is set at two years prior to 2005 and then three years for legal-size lobsters post-2005/06 (Figure 4.9). Overall, this indicates a total period of four to five years from settlement to legal-size recruitment with the high PSIs in 2005/06 and 2006/07 (Figure 3.10) likely resulting in increases in the catch rate of legal size lobsters between 2010/11 and 2012/13 (Figure 4.2).

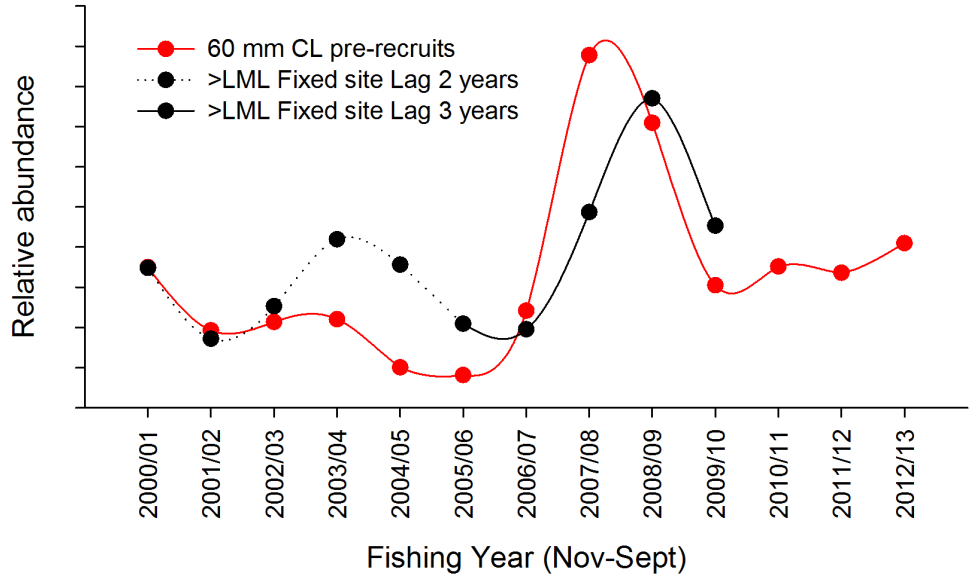

Figure 4.9 Model estimated relative abundance of recruitment to 60 mm CL (red line) in the EZRLF with lagged fixed-site survey levels of CPUE (lobster/potlift) for legal-size (lagged two years, black dashed line; lagged three years, solid black line).

4.4.3. Biological reference points

4.4.3.1. Egg production

The level of egg production in 2012/13 was estimated to be 152% of that estimated for 2001/02 (the reference year) with at least 75% probability. The 2012/13 estimate was above the biological reference point limit of 104% of egg production in 2001/02 (Figure 4.10).

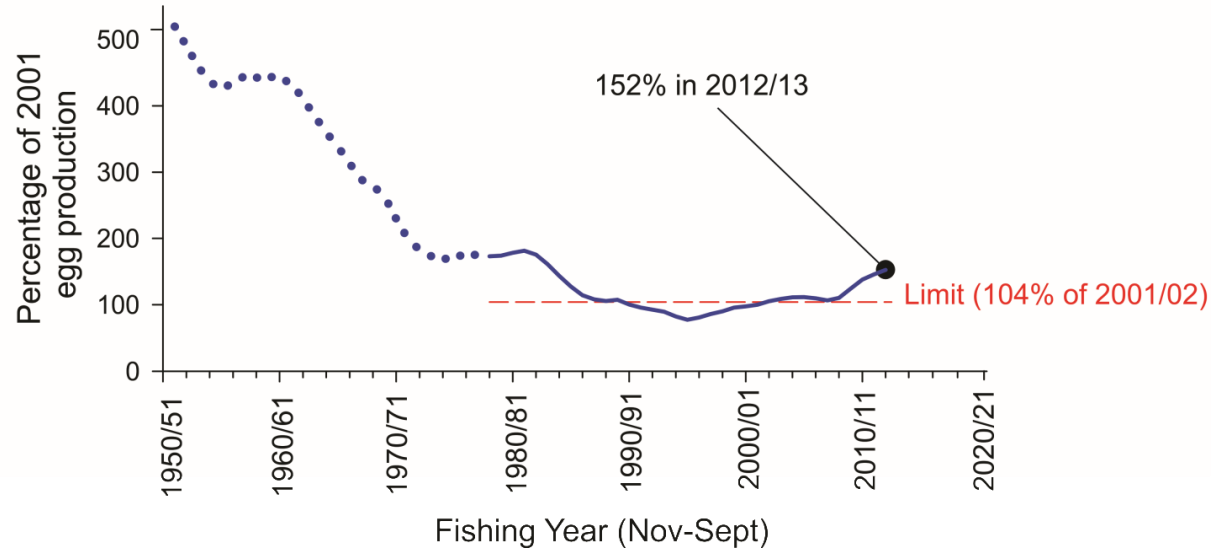

Figure 4.10 Model estimated level of egg production through time in the EZRLF (above, with 75% probability; blue line). Limit reference point is 104% of egg production in 2001/02 (dashed red line).

4.4.3.2. Available biomass

The model estimated level of available biomass in 2012/13 was 136% of that in 2001/02 (the reference year). This estimate was below the biological reference point target of 184% of the estimated available biomass in 2001/02 (Figure 4.11). A forward projection of the model indicated with 50% probability that a TACC of 59 t in the 2014/15 quota year is likely to continue rebuilding the available biomass of rock lobster to its target biomass by 2020/21.

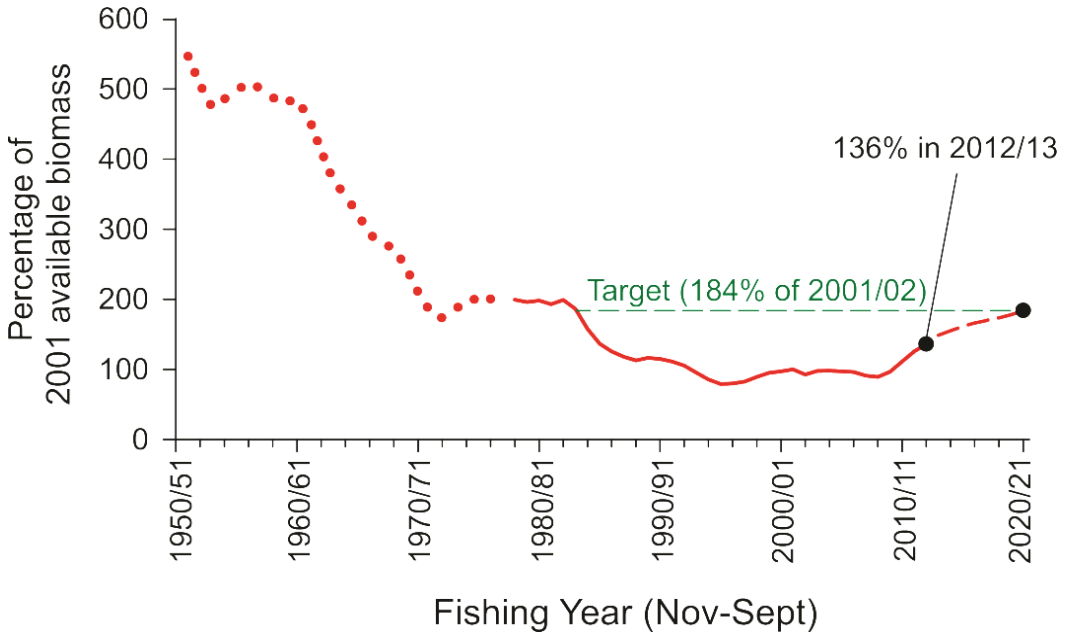

Figure 4.11 Model estimated levels of available biomass in the EZRLF (above, with 50% probability; solid red line). Target reference point is 184% of available biomass in 2001/02 (dashed green line). Projected available biomass (dashed red line post 2012/13) given a TACC of 59 t/yr to rebuild available biomass to the biological reference point target by 2020/21. Backward projection of the biomass model is represented by red dotted line.

Effects of CPUE standardisation on available biomass trajectories

The current Decision Framework for the Victorian RLF states that modelled estimates of biomass are to be compared with trends in nominal (unstandardised or 'raw') CPUE over the most recent two year period. Modelled trends in available biomass for the EZRLF were similar to trends seen in nominal CPUE, and nominal CPUE collected in November to February of each fishing year (Figure 4.12). These data highlight the consistency between the model-estimated biomass outputs and nominal CPUE estimates.

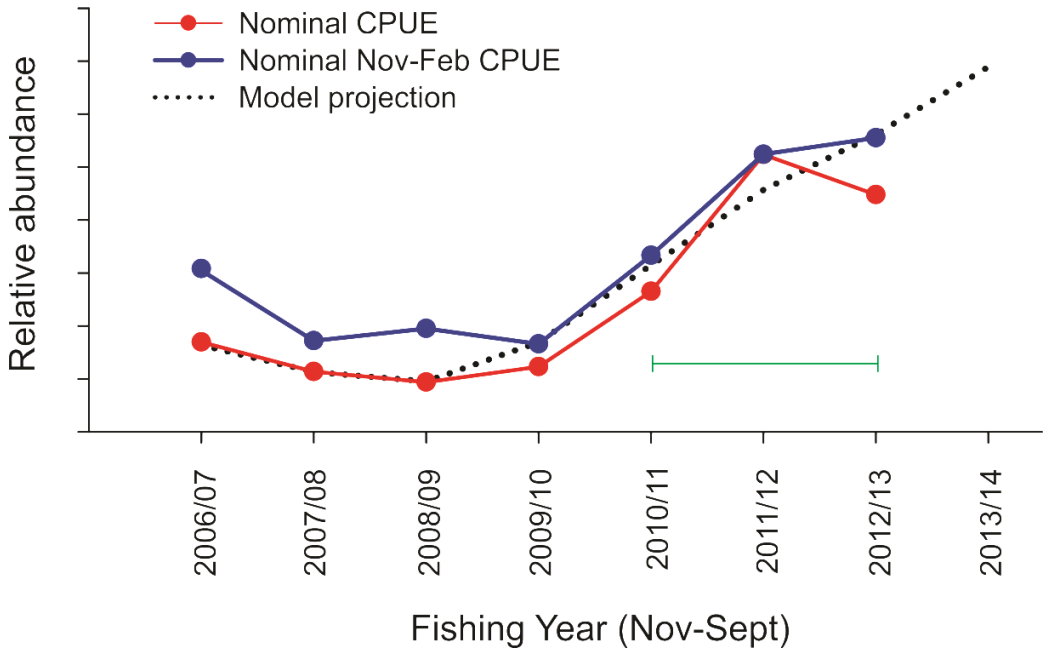

Figure 4.12 Model estimated available biomass in the EZRLF (black line) from fitting standardised CPUE compared with measures of nominal CPUE (red line) and nominal CPUE from November to February (inclusive; blue line) from 2006/07 to 2012/13. The most recent two year period for comparison of model and CPUE trends is indicated by the green line.

4.5. **Summary**

Annual catches have generally declined over the history of the fishery, to their lowest level in 2008/09 (39.5 t). Catch increased in 2010/11 to 65.3 t but declined to 48 t in 2012/13 in response to implementation of a reduced TACC (48 t). Since 2002/03, annual effort has reflected levels of catch. CPUE has generally increased since 1995/96, but declined from 0.43 kg/potlift in 2005/06 to 0.37 kg/potlift in 2008/09. Over the last three seasons it has increased and in 2012/13 was 0.51 kg/potlift. Patterns of catch, effort and CPUE among regions are similar to those for the whole fishery.

Consistent large-scale patterns in puerulus settlement indices (PSIs) in Victoria and South Australia have been recorded. The EZRLF and WZRLF also indicate broadly similar trends in model-estimated recruitment. Time-lagged PSI data have a strong relationship with these recruitment data indicating that PSI data are useful in inferring patterns of recruitment to the EZRLF. These data indicate that the period from settlement to recruitment at 60 mm CL is approximately two years, with recruitment to legal-size approximately two to three years later. Overall, this suggests that the total period from settlement to legal-size is approximately four to five years in the EZRLF.

The relative abundance of pre-recruits from fixed-site surveys was consistent with the progression of undersize lobsters to legal-size over two to three years. The observed increases in abundance of undersized lobsters between 2008/09 and 2011/12 are reflected in increased catch rates of

legal-size lobsters between 2010/11 and 2012/13. The continued increase in CPUE in 2013/14, based on monthly data, appears to confirm this relationship. Overall, as with the WZRLF, this suggests that the EZRLF is currently experiencing an increase in recruitment of legal-sized lobsters to the fishery.

The level of egg production in 2012/13 was 152% of that in 2001/02 and above the limit reference point of 104%. In contrast, the level of available biomass was estimated to be 136% of that in the reference year and below the target reference point of 219%. The forward projection model indicated with 50% probability that a TACC of 59 t in the 2014/15 quota year would most likely maintain the rebuild rate required to achieve the target biomass by 2020/21.

5. GIANT CRAB FISHERY

5.1. Fishery statistics

Based on licencing year data (July to June), the total annual catch (targeted and non-targeted) of giant crab peaked at 170 t in 1993/94 (Figure 5.1). Since then, catches generally declined to reach a record low of 8.0 t in 2001/02. Quota management was introduced in 2001 and the TACC was set at 25 t. Between 2004/05 and 2009/10, catches averaged around 20 t but then began to decline. TACCs have been reduced accordingly, and in 2012/13 the total catch was 10.2 t, of which 8.0 t was targeted.

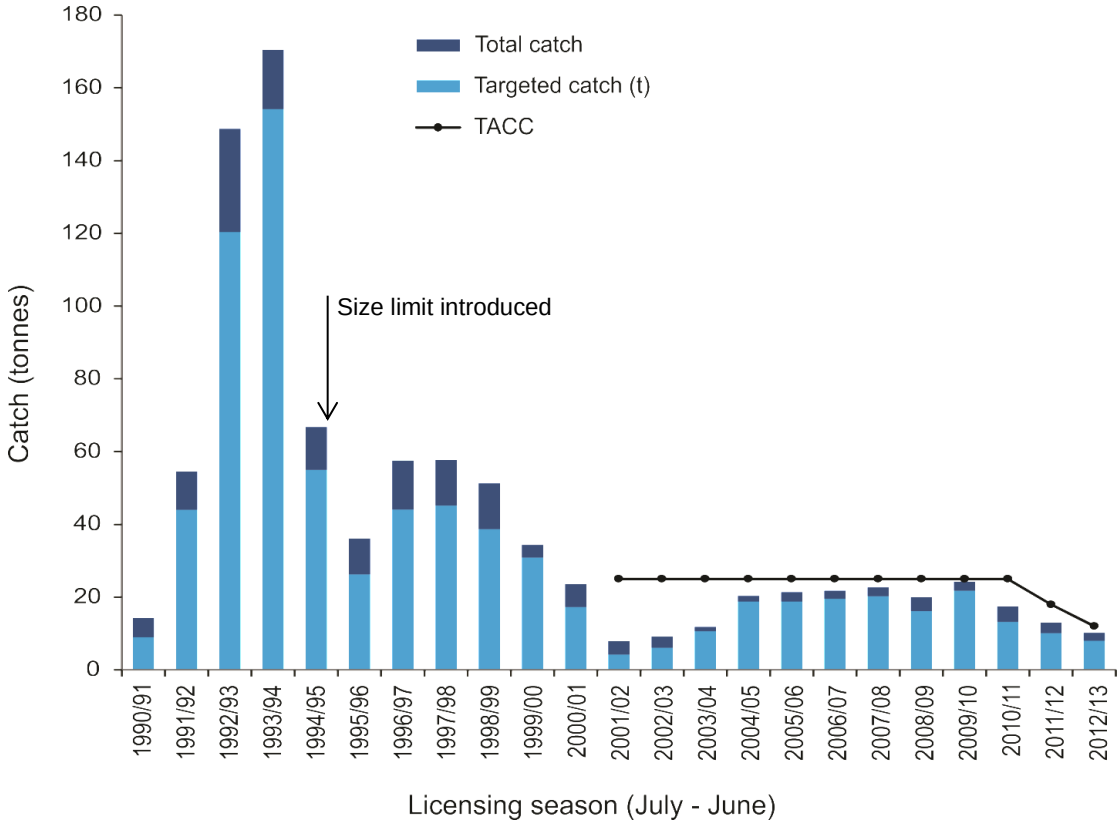

Figure 5.1 Total catch (t) and targeted catch history for the Victorian Giant Crab Fishery. (Black line indicates a TACC introduction in 2001 of 25 t).

Based on fishing year (November to September), CPUE (kg/24 hr potlift) has been calculated from targeted fishing i.e. by fishers with >1 t catch/yr (Figure 5.2). CPUE peaked in 1993/94 at 1.7 kg/24 hr potlift; before generally declining to 0.22 kg/24 hr potlift in 2002/03. In 2003/04, CPUE increased to 0.53 kg/24 hr potlift but has since declined to 0.24 kg/24 hr potlift in 2012/13 representing one of the lowest estimates on record and the fourth consecutive season that CPUE has been below the trigger reference point.

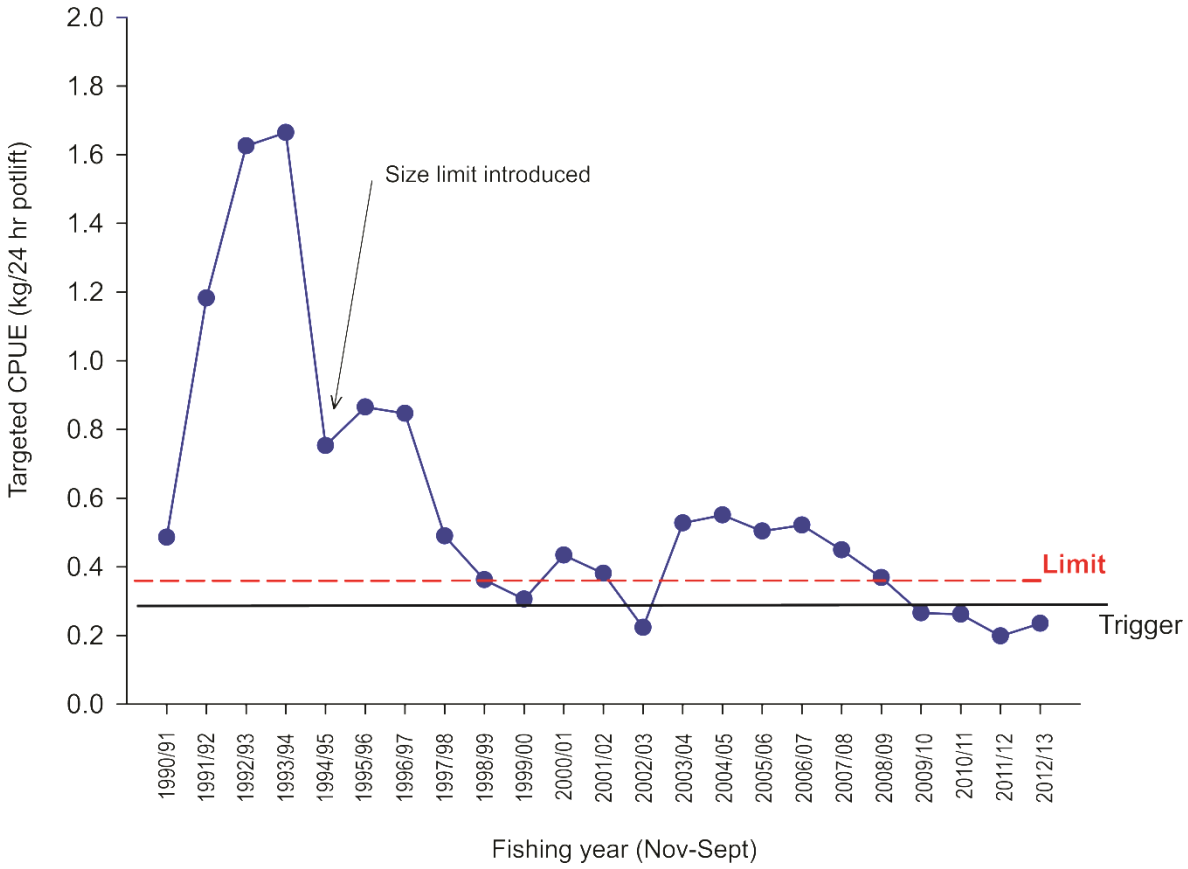

Figure 5.2 CPUE (kg/24 hr potlift) from targeted fishing by fishers with >1 t catch. Dashed red line and solid black line represent limit and trigger reference points, respectively.

5.2. **Summary**

A TACC and individually transferable quota was implemented in the GCF in 2001. Management changes required catches to be reported as either targeting fishing of giant crab or as by-catch from the Rock Lobster Fishery. Over the last three years, total catches have declined from 24.3 t in 2009/10 to 10.3 t landed in 2012/13. Catch rates (kg/24 hr potlift), as estimated from targeted fishing by fishers with >1 t catch/yr, have generally declined over the last decade. In 2012/13, the estimate of 0.24 kg/24 hr potlift was the third lowest on record and the fourth consecutive season that CPUE has been recorded below the trigger reference point.

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