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## Fishery Status Report - 2011/2012 Fishing Year

A. Linnane, R.C. Chick, T. Walker, F. Trinnie and D. Reilly

Fishery Status Report to Fisheries Victoria

SARDI Publication No. F2012/000434-2
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PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

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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.C. Chick, T. Walker, F. Trinnie and D. Reilly

Reviewer(s): S. Mayfield and B. Stobart

Approved by: S. Mayfield
Science Leader – Fisheries

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## EXECUTIVE SUMMARY

This status report is the second South Australian Research and Development Institute (SARDI) assessment for the Victorian Rock Lobster (RLF) and Giant Crab (GCF) Fisheries.

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

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

Western Zone Rock Lobster Fishery (WZRLF)

The annual catch in the WZRLF declined from 525 t in 2000 to 235 t in 2008, reflecting reductions in the TACC. Catch over the last three years has been stable and in 2011 was 233 t.

From 2000 to 2008, effort did not decrease at the same rate as catch. Since the introduction of quota in 2001, effort has remained relatively stable at an average of 657,000 potlifts. Over the last two seasons, effort has decreased and in 2011, was 475,000 potlifts, the lowest on record.

From 2003 to 2009, nominal catch per unit effort (CPUE) decreased by 47% from 0.70 kg/potlift to 0.37 kg/potlift, the lowest level in the history of the fishery. Nominal CPUE has increased over the last two seasons and in 2011 was 0.49 kg/potlift, reflecting a 32% increase from 2009.

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 2011 CPUE estimate in Warnambool of 0.59 kg/potlift was the highest on record since 2000 (0.60 kg/potlift).

Puerulus settlement indices (PSIs) within the WZRLF 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 2 years. Recruitment (to 60 mm CL) to legal-size was estimated to take another 4 years, indicating a total period of about 6 years from settlement to legal-size within the WZRLF.

Based on these data, this indicates that current increases in catch rates in 2011 reflect the strong PSIs observed across South Australia and Victoria in 2005 and 2006. Monthly CPUE estimates, based on Interactive Voice Response (IVR) data, indicate that catch rates have continued to increase during the 2012 quota year.

While legal-size CPUEs have recently increased, it is important to highlight that fixed-site pre-recruit indices decreased in 2011, reflecting reduced settlement levels post-2006.

The model estimated level of egg production in 2011 was 74% of that in 2001 (the reference year) and above the reference limit point of 35%. The level of available biomass was 75% of that in 2001 and below the target reference point of 173%. Model projections indicate that a TACC of 259 t/yr could, given stable long-term average recruitment, rebuild the available biomass to the target reference point by 2020, based on a 50% probability.

Eastern Zone Rock Lobster Fishery (EZRLF)

Annual catch in the EZRLF declined from 143 t in 1982 to 39 t in 2008. Over the last three seasons, catch has increased and in 2011, the total catch was 62 t.

Since 2002, annual effort has reflected levels of catch and averaged approximately 132,000 potlifts/yr. However, in 2011 effort was 114,000 potlifts, reflecting a 24% decrease from 2010 (150,000 potlifts).

Nominal CPUE increased from 0.26 kg/potlift in 1995 to 0.42 kg/potlift in 2003 but declined to 0.37 kg/potlift in 2008. Over the last three seasons, CPUE has increased and in 2011 was 0.54 kg/potlift, reflecting a 46% increase from 2008 (0.37 kg/potlift).

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. Most notably, the 2011 CPUE estimate in San Remo of 0.63 kg/potlift was the highest on record since 1982 (0.72 kg/potlift).

Together with consistent large scale patterns in PSIs, a strong correlation between estimated pre-recruit abundance in the WZRLF and EZRLF suggest WZRLF PSIs provide a valuable proxy of settlement for the EZRLF.

Model estimated levels of recruitment to 60 mm CL were strongly correlated to PSIs using a 2 year lag. Recruitment (to 60 mm CL) to legal-size was estimated to take 2-3 years, indicating a total period of 4-5 years from settlement to legal-size within the EZRLF.

Based on these data, this indicates that current increases in catch rates in 2010 and 2011 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 which should be protected in order to rebuild the available biomass.

The model estimated level of egg production in 2011 was 148% of that in 2001 (the reference year) and above the limit reference point of 104% of that in 2001. The level of available biomass was 126% of that in 2001 and below the target reference point of 219%. Model projections indicate a TACC of 51 t/yr could, given stable long-term average recruitment, rebuild the available biomass to the target reference point by 2020, based on a 50% probability.

Giant Crab Fishery (GCF)

The GCF operates in the WZ only. Catches of giant crab in the EZ are minimal and managed under developmental fisheries licences. Fishery-dependent data from the EZ, including catch of giant crab, are not considered in this assessment.

The total annual catch (targeted and non-targeted) of giant crab peaked at 226 t in 1992. Since then, catches have generally declined and to a record low level (8.4 t) in 2002. From 2002, catches increased to a recent peak of 28 t in 2007. Over the last three years catches have declined, with 12.6 t landed in 2011, of which 11 t was targeted.

CPUE (kg/24 hr potlift) has been calculated from targeted fishing by fishers with >1 t catch/yr. CPUE peaked in 1993 at 1.7 kg/24 hr potlift; before generally declining to 0.22 kg/24 hr potlift in 2002. In 2003, CPUE increased 0.53 kg/24 hr potlift to but has since declined to 0.20 kg/24 hr potlift in 2011 representing the lowest estimate on record and the third consecutive season that CPUE was below the trigger reference point.

# 1. INTRODUCTION

This is the second fishery status report in what is 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 the Giant Crab Fishery (GCF). This report complements the first Victorian Rock Lobster and Giant Crab fishery stock status report published in 2012 (Linnane et. al. 2012). The aim of this report is to assess the current status of the Victorian rock lobster and giant crab resources. These assessments includes data to the end of the 2011/12 fishing year (i.e. 14 September 2012) as well as monthly catch rate data to June 2013 based on data from the Fisheries Integrated Licensing System and Quota Monitoring System (IVR). WZRLF fixed site survey data from the 2012/13 fishing year are also provided. The report is divided into four 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.

Sections 2 and 3 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 RLF 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 4 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 GCF Management Plan (VicDEPI 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; 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). In this report all reference to a fishing year or season refers to the first year of the season (e.g. the season 2011 refers to the period from 16 November 2011 to 14 September 2012).

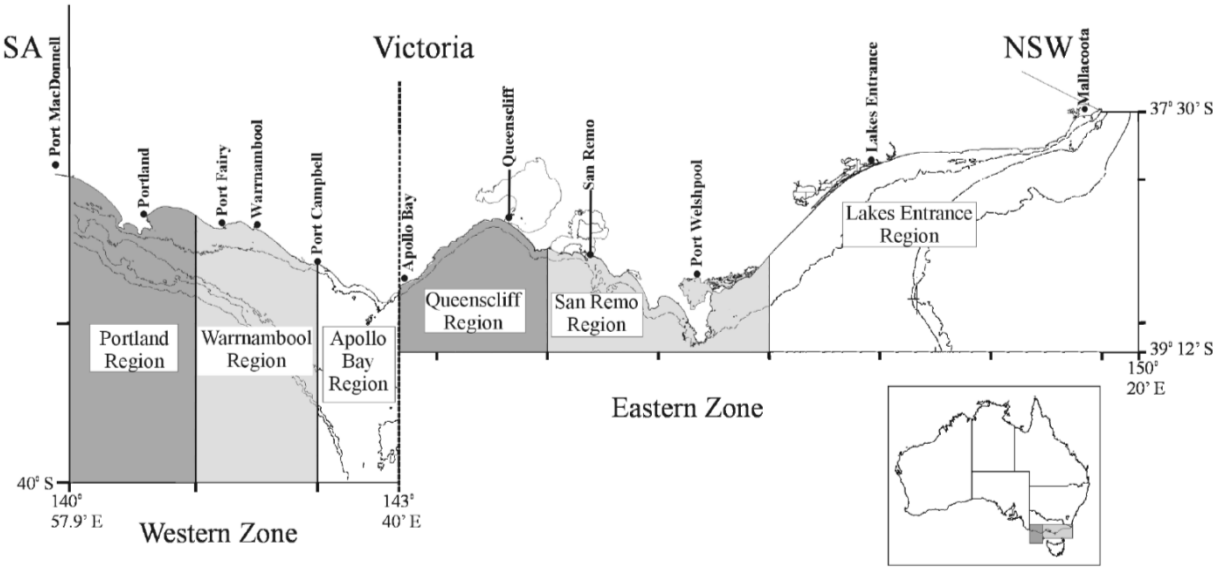


**Figure 1.1** Extent and spatial structure of the Victorian Rock Lobster Fishery. Source: VicDPI (2009).

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 2011/12, there were 50 licences and 54 vessels operating in the WZRLF, with a TACC of 240 tonnes (Walker *et al.* 2012a). In the same quota year in the EZRLF, there were 26 licences and 27 vessels, with a TACC of 66 tonnes.

The RLF Management Plan (VicDPI 2009) describes 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. Results from the analyses of the performance indicators are applied within a 'management decision framework'; a hierarchical decision tree, used to establish the TACC (VicDPI 2009).

## 1.2. **Giant Crab Fishery**

The GCF is closely linked to the RLF and is 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. This provided greater confidence in the

accuracy of fishery data, particularly effort. 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 consisted of >70% of total catch. Subsequent criteria, to further improve measures of fishery performance, have resulted in the use of targeted catch and effort data from those licences landing >1 tonne per year only (Walker *et al.* 2012b). The fishing year extends from 16 November to 14 September the following year. In this report all reference to a fishing year or season refers to the first year of the season (e.g. the season 2011 refers to the period from 16 November 2011 to 14 September 2012). Despite there being 30 licences issued in the fishery (VicDPI 2010), only 9 licence holders reported catching giant crab in 2011 and, with the exception of fishing years 2007 and 2009, fewer than 5 licences have landed >1 tonne of giant crabs in a fishing year since 2001 (Walker *et al.* 2012b). In 2011/12, the TACC was 18 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). 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 including CPUE (number per potlift) and carapace length-frequency from rock lobster sampled from fixed site survey programs (pots with escape gap closed) also provide critical data for the model based assessment of the WZRLF and EZRLF. 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 Management Plan and as modified following review by the RLRAG.

# 3. WESTERN ZONE ROCK LOBSTER FISHERY (WZRLF)

## 3.1. Fishery Statistics – catch, effort and catch per unit effort (CPUE)

### 3.1.1. Zonal catch and effort

With the exception of 2003 (the 2003/04 fishing year), catch in the WZRLF decreased by 55% from 2000 (525 t) to 2008 (235 t; Figure 3.1). Over the last three seasons, catch has remained stable and in 2011, was 233 t. Total effort did not decrease at the same rate as catch, remaining around 657,000 potlifts from 2001 to 2008. Over the last two seasons, effort has declined and in 2011 was 475,000 potlifts, reflecting a 27% decrease since 2009 (650,000 potlifts).

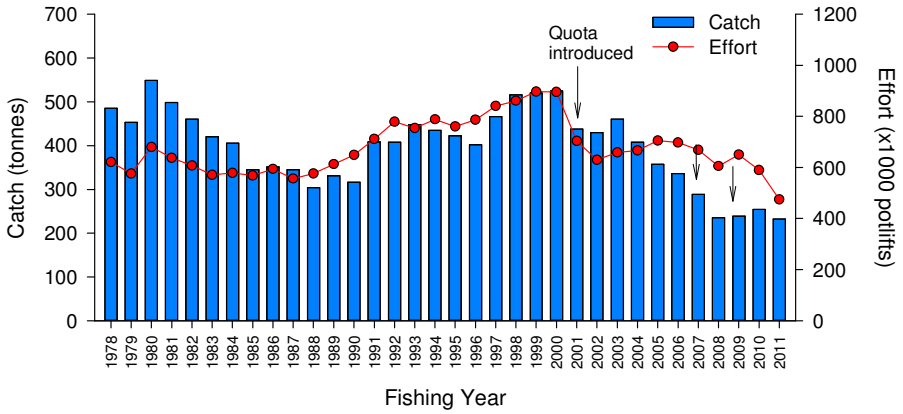


**Figure 3.1** Total catch (tonnes) and nominal effort (x1000 potlifts) in the WZRLF from 1978-2011. ↓ indicate TACC introduction (450 t) and ammendments in 2007 (380 t) and 2009 (240 t).

### 3.1.2. Zonal catch per unit effort (CPUE) – nominal and standardised

Nominal and standardised CPUE (kg/potlift) show similar trends through time, although standardised CPUE indicates a greater level of depletion from 1992 (Figure 3.2). From 2003 to 2009, nominal CPUE decreased by 47% from 0.70 kg/potlift to 0.37 kg/potlift, the lowest on record. However, nominal CPUE has increased over the last two seasons and in 2011 was 0.49 kg/potlift, reflecting a 32% increase from 2009 (0.37 kg/potlift).

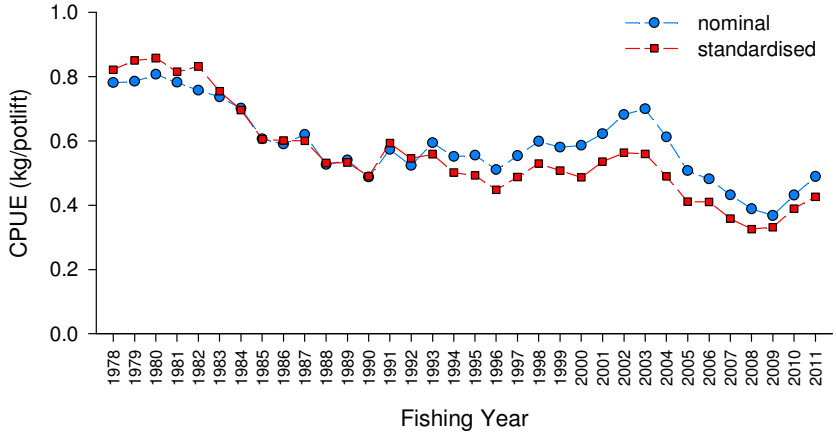


**Figure 3.2** Nominal and standardised CPUE (kg/potlift) in the WZRLF from 1978-2011.

### 3.1.3. Within season trends in CPUE

Patterns of CPUE through time were similar among the last three quota years (2010-2012; Figure 3.3). Lower catch rates were observed from May to September with the highest observed from November to February before declining thereafter. Peak catch rates were typically 40-50% higher than those from May to September. Over the last two years, CPUE has generally increased across all months. In 2012, catch rate was lowest in June at 0.28 kg/potlift and highest in November and December at 0.71 kg/potlift.

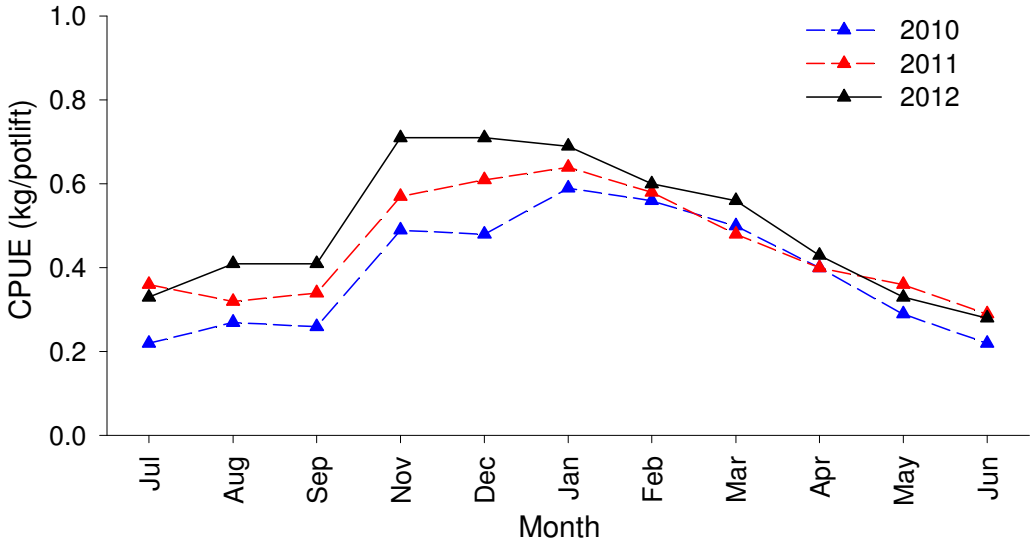


**Figure 3.3** Within season trends in nominal CPUE (kg/potlift) for the quota years 2010, 2011 and 2012 in the WZRLF. Source: Monthly Victorian Rock Lobster catch based on data from the Fisheries Integrated Licensing System and Quota Monitoring System (IVR).

### 3.1.4. Spatial analyses - regional catch, effort and CPUE

Regional (refer to Figure 1.1) trends in catch, effort and CPUE broadly reflect zonal estimates (Figure 3.4). Specifically, among the three regions of the WZRLF, levels of catch have generally decreased from historically high levels during the late 1990s to historically low levels within the last three fishing years (2009-2011).

Trends in effort among regions have generally reflected those of catch, with the exception of Portland. Here, from 2001 to 2004, effort decreased substantially more than the proportion of catch, with this trend reversing in the subsequent two years, as reflected in increasing and decreasing CPUE during this time. In 2011, levels of effort in Portland and Warnambool were at historically low levels at 293,000 and 97,000 poltifts, respectively.

Regionally, levels of nominal and standardised CPUE have generally declined from the late 1970s and from recent peaks in 2002-2003 (Portland); 1998 (Warrnambool); and 2002-1998 (Apollo Bay), respectively, to be at or among historically low levels in 2009. However, over the last two years, CPUE has increased across all regions. Most notably, the 2011 nominal CPUE estimate in Warnambool of 0.59 kg/potlift was the highest on record since 2000 (0.60 kg/potlift).

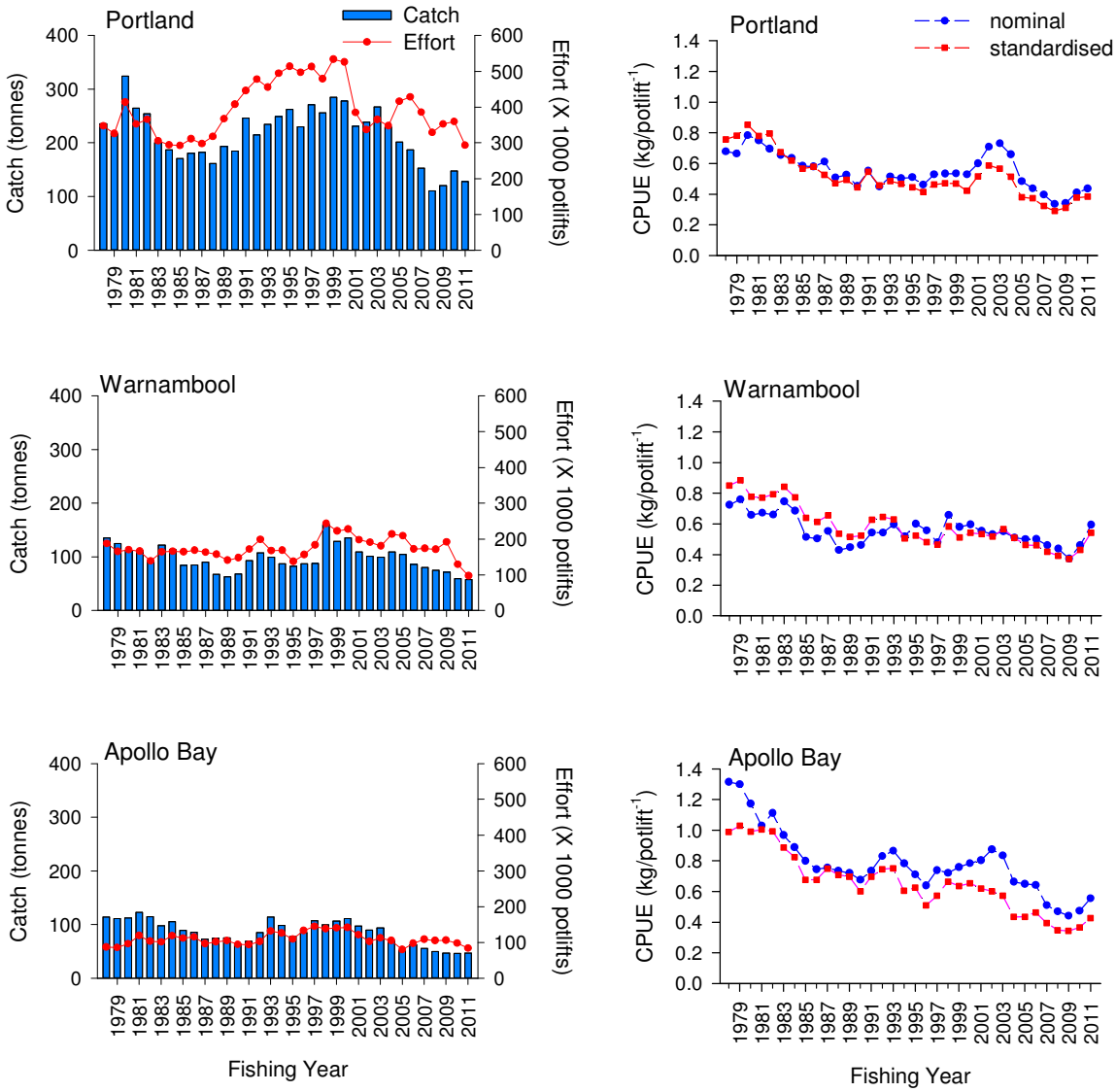


**Figure 3.4** Regional catch (tonnes), effort (x1000 potlifts) and nominal and standardised CPUE (kg/potlift) in the WZRLF from 1978 to 2011.

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

### 3.2.1. Puerulus settlement index

The puerulus settlement sites in the WZRLF 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 the WZRLF 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 2010, the PSI in the WZRLF has remained relatively stable, ranging between 0.31 and 0.53 puerulus/collector. In 2011, the PSI in the WZRLF was 0.15 puerulus/collector.

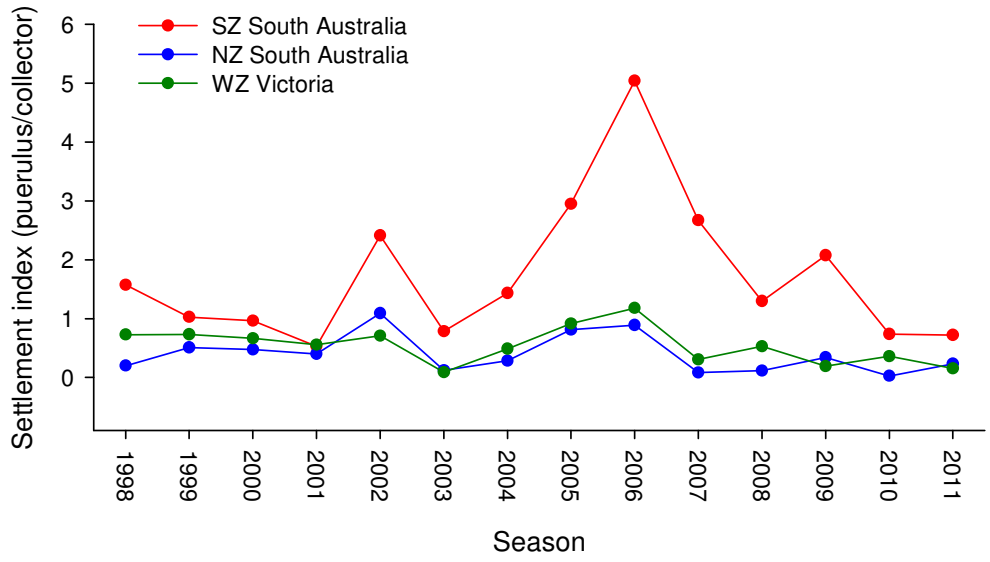


**Figure 3.5** Puerulus settlement index in the Southern Zone (SZ) and Northern Zone (NZ) of South Australia and the WZRLF from 1998-2011. Note: PSI data for WZ Victoria in 2005 and 2006 are from Port Campbell only, as collectors at Apollo Bay were removed during harbour redevelopment.

### 3.2.2. Pre-recruit indices (fixed-site surveys and onboard observer program)

Estimates of CPUE (number/potlift) in relation to both pre-recruit (undersized) and legal-sized male and female lobsters have been generated from both fixed-site surveys (escape gaps closed) and an onboard observer program (escape gaps open) since 2001 and 2004, respectively (Figure 3.6). In this report, data from the 2012 fixed site survey are also presented.

Pre-recruit catch rates for both males and females from fixed-site surveys decreased by >50% from 2001 to 2007. From 2007 to 2010, fixed-site pre-recruit catch rates for both sexes increased, before declining over the next two seasons to 0.58 undersized/potlift (male) and 0.93 undersized/potlift (female) in 2012.

In the onboard observer program, where the escape gaps are open, undersized catch rates of both male and females increased between 2004 and 2005, decreased to low levels in 2007 and

2008, before increasing in 2011 to 0.59 and 0.43 undersized/potlift, for males and females, respectively. Note that observer data for 2012 are not yet available.

From 2001 to 2009, fixed-site survey catch rates of legal-size male and female lobsters generally decreased, with the exception of a minor increase between 2005 and 2006 (Figure 3.6). Since then, catch rates of both sexes have increased. These patterns generally reflect those in pre-recruits lagged by 2-3 years. Consistency in the relationship between catch rates of pre-recruits and legal-size lobsters from the onboard observer program is less clear. From 2005 to 2009, the CPUE of legal-sized individuals of both sexes generally decreased. However, over the next two seasons, CPUE of legal-size males and females increased to 0.52 and 0.37 lobsters/potlift respectively, the highest on record for both sexes.

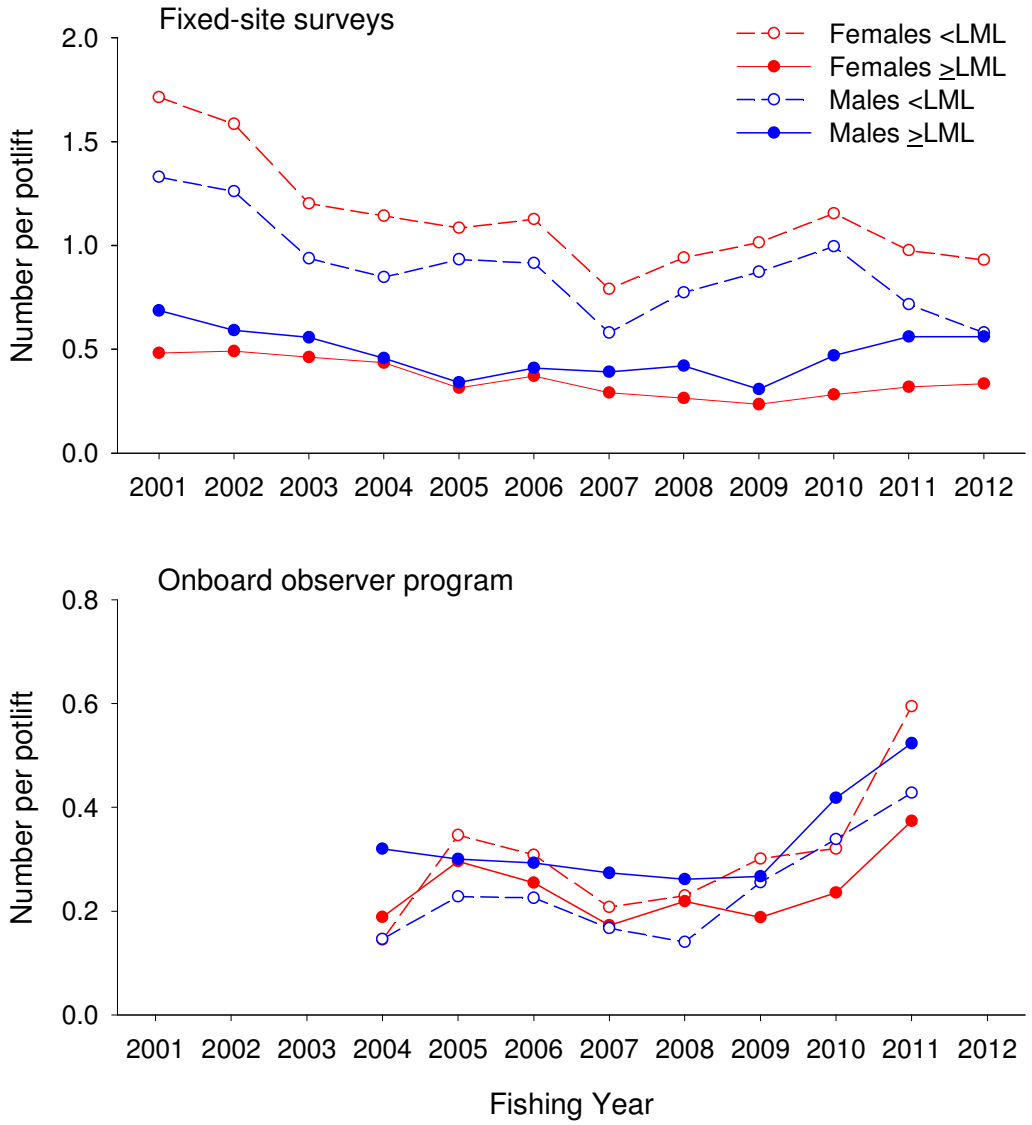


**Figure 3.6** Number of legal-sized and undersized female (LML = 105 mm CL) and male (LML = 110 mm CL) lobsters per potlift in fixed-site surveys and onboard observer program in the WZRLF. Note: escape gaps open on pots for the onboard observer program and closed for the fixed-site survey.

### 3.2.3. Pre-recruit indices South Australia

Victorian trends in pre-recruit indices were compared with those recorded from logbook data within the SZ of South Australia. The SZ pre-recruit index (number undersized/potlift) peaked in 1999 at 2.1 undersized/potlift (Figure 3.7) but generally declined over the next nine seasons to a historical low of 0.85 undersized/potlift in 2008. The pre-recruit index subsequently increased over the next two seasons before decreasing to 0.96 undersized/potlift in 2012. Overall, these results were broadly consistent with observations in the Western Zone of Victoria, where pre-recruit indices from fixed-site surveys decreased prior to 2008, increased up to 2010, before subsequently declining over the next two seasons in 2011 and 2012 (Figure 3.6). These patterns support the model of consistent large-scale recruitment events (Section 3.2.1) and the relatively consistent progression of settled lobsters through to pre-recruits at the same scale.

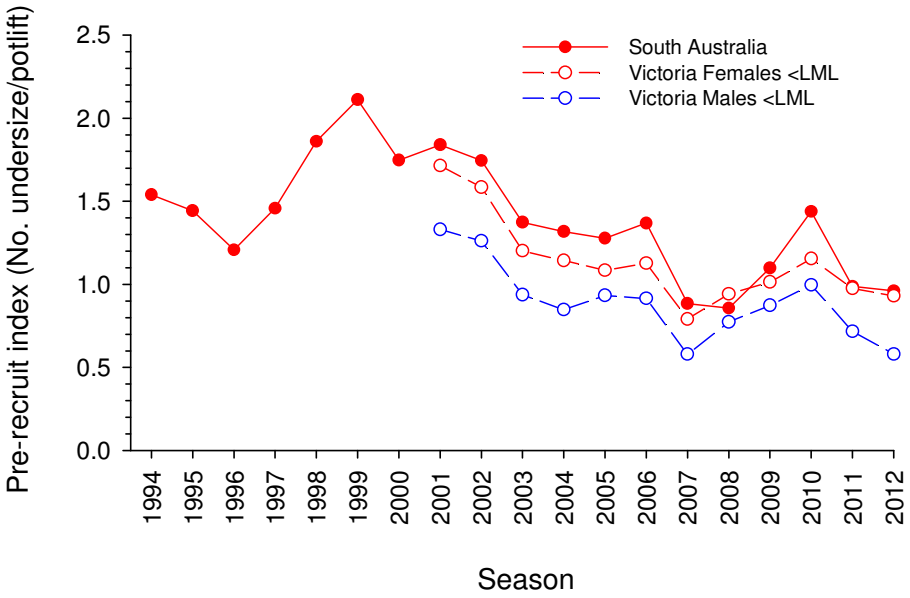


**Figure 3.7** Comparison of South Australian Southern Zone and Victorian Western Zone pre-recruit indices.

## 3.3. **Zonal length-frequency distributions**

Length-frequency data of both male and female lobsters as obtained through fixed-site surveys support changes in pre-recruit estimates and legal-size commercial catch rates (Figure 3.8). Specifically, from 2008 to 2010, the abundance of lobsters in the size classes below the minimum legal size 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). In addition, the increase in lobster abundance within the 110-130 mm carapace length (CL) size range, particularly in male lobsters, reflects the increase in legal size commercial catch rates observed across the fishery during the 2011 season (Figure 3.2).

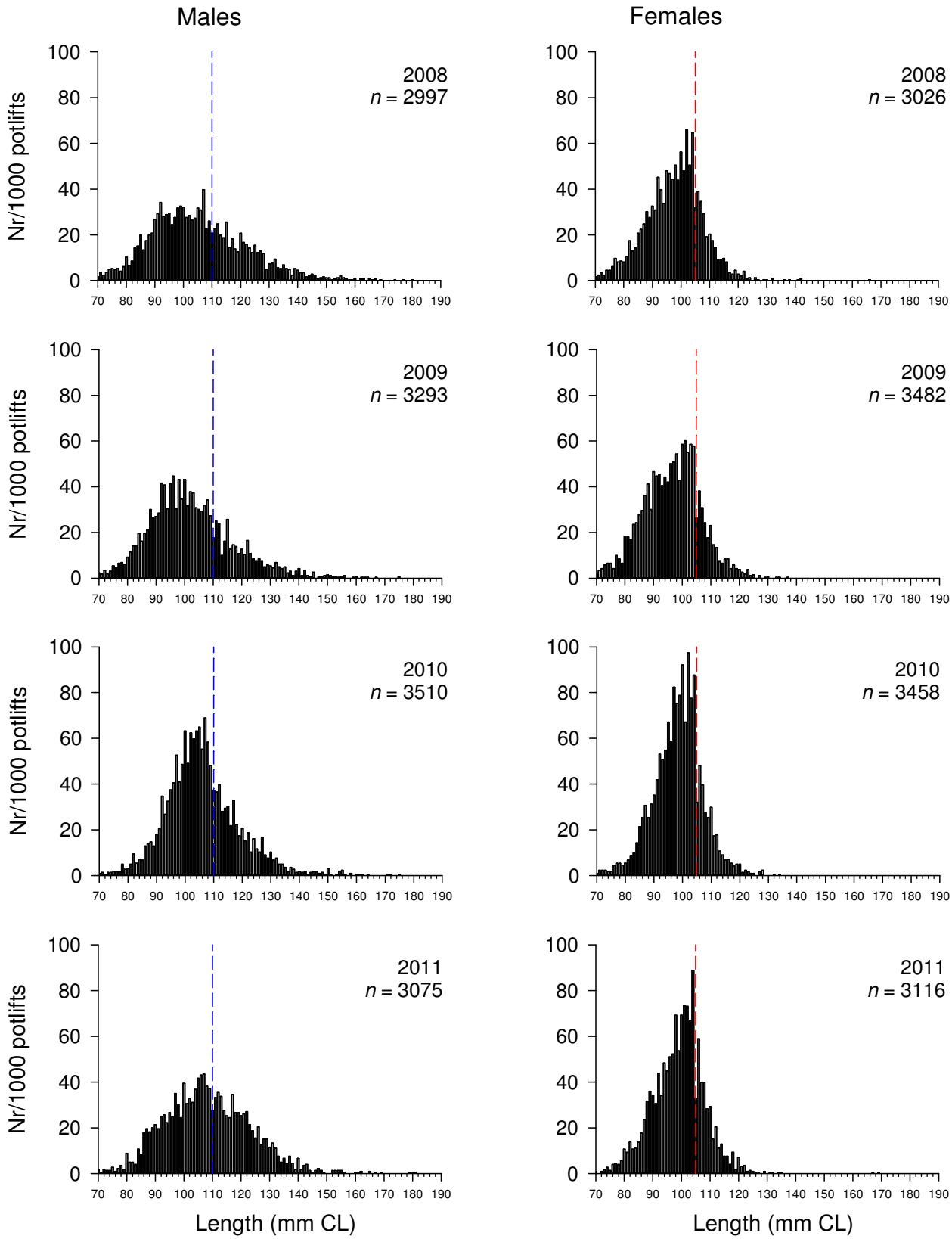


**Figure 3.8** Length-frequency distributions of male and female lobsters sampled on fixed-site surveys from 2008 to 2011 in the WZRLF. Blue and red dashed vertical lines represent minimum legal sizes for male and female lobsters, respectively.

## 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 2011, it was predominately below. High levels of recruitment to 60 mm CL in 2007, 2008 and 2009 are likely to reflect the increases to commercial catch rates observed within the fishery in 2010, 2011 and 2012 (Figure 3.2 and Figure 3.3).

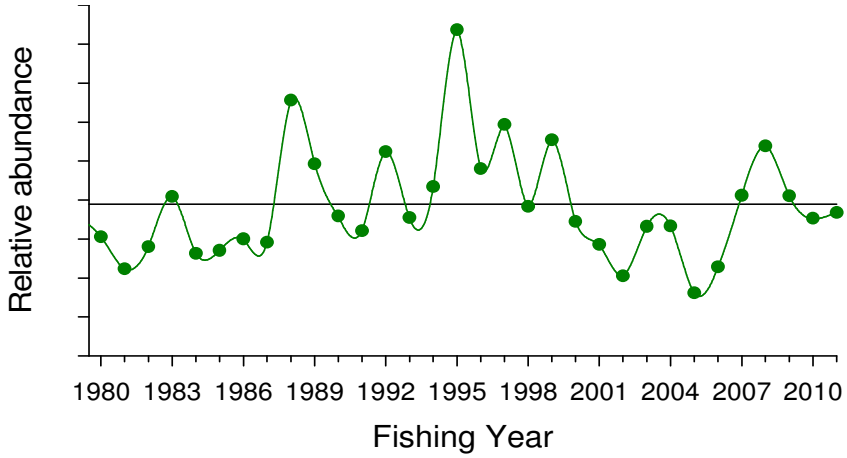


**Figure 3.9** Relative abundance of recruitment to 60 mm CL in the WZRLF, as used in the length-frequency model. Long-term historical average (solid black line) also indicated.

### 3.4.2. Linking model recruitment to puerulus settlement and pre-recruit indices

Puerulus settlement indices (PSIs) from monitoring sites at Port Campbell and Apollo Bay are positively correlated ($R^2$ = 0.76) through time (Figure 3.10). Using a two year lag, PSI was also positively correlated ($R^2$ = 0.56) with model estimated recruitment to 60 mm CL in the fishery.

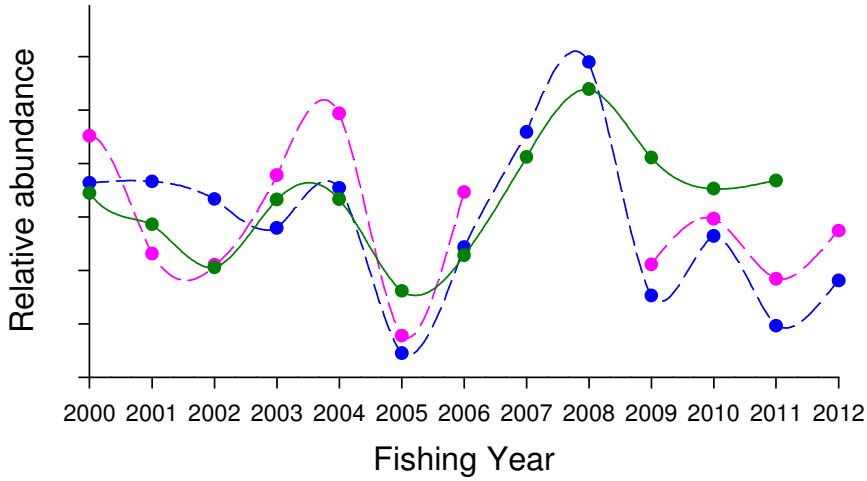


**Figure 3.10** Model estimated relative abundance of recruitment to 60 mm CL in the WZRLF (green line) with PSIs from Port Campbell (blue line) and Apollo Bay (pink line), lagged by two years. Note: Absence of PSI data at Apollo Bay (2007-2008) due to harbour development.

Fixed-site survey estimates of the relative abundance of pre-recruits (lagged 2 years) and legal-sized (lagged 4 years) lobsters also provide reasonable support to the predictive capacity of the model estimated recruitment levels (Figure 3.11). Peaks in the relative abundance of pre-recruits (lagged 2 years) in 2000, 2003 and 2008 and those in the relative abundance of legal-size individuals (lagged 4 years) in 2000 and 2003, coincide with peaks in the model estimated levels of recruitment to 60 mm CL. Overall, this indicates a total period of about 6 years from settlement to legal-size recruitment with the high PSIs in 2005 and 2006 (Figure 3.10) resulting in increases in legal size catch rate in 2011 and 2012 (Figure 3.2 and Figure 3.3).

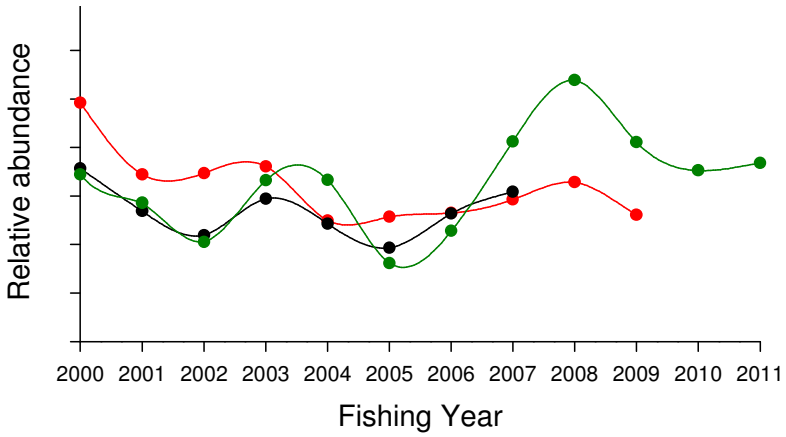


**Figure 3.11** Model estimated relative abundance of recruitment to 60 mm CL in the WZRLF (green line) with that from fixed-site survey levels of pre-recruit (lagged two years; red line) and legal-sized (lagged four years; black line) lobsters.

### 3.4.3. Biological reference points – Egg Production and Available Biomass

#### *3.4.3.1. Egg production*

The level of egg production in 2011 was estimated to be 74% of that in 2001, with 75% probability. This estimate was substantially above the biological reference point limit of 35% of egg production in the 2001 reference year (Figure 3.12).

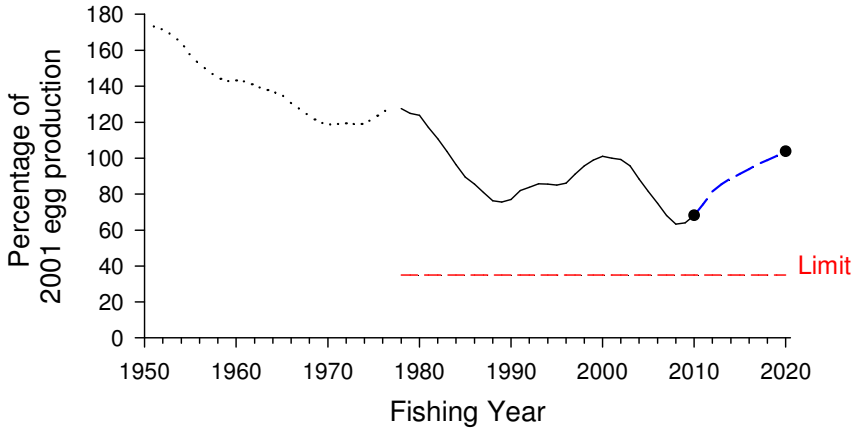


**Figure 3.12** Model estimated level of egg production through time in the WZRLF (above, with 75% probability; black line). Limit reference point (35% of egg production in 2001; dashed red line). Projected egg production (dashed blue line) given a TACC of 259 t/yr, to rebuild available biomass to the biological reference point target by 2020.

*3.4.3.2. Available biomass*

The level of available biomass in 2011 was estimated to be 75% of that in 2001 (reference year), with 50% probability. This level of available biomass was substantially below the target biological reference point (BRP) of 173% of 2001 (Figure 3.13). Model projections indicate a TACC of 259 t/yr could allow the available biomass to rebuild to the BRP target by 2020.

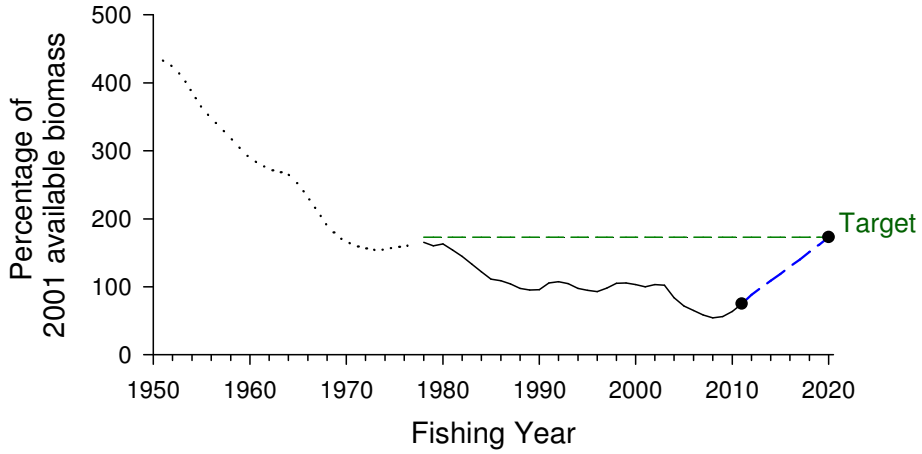


**Figure 3.13** Model estimated levels of available biomass in the WZRLF (black line). Target reference point (173% of available biomass in 2001; dashed green line). Projected available biomass (dashed blue line) given a TACC of 259 t/yr to rebuild available biomass to the biological reference point target by 2020 with 50% probability.

Effects of CPUE standardisation on model estimates of available biomass

Model estimated available biomass, derived from fitting standardised CPUE data, provided similar trends to unstandardised (nominal) CPUE from the WZRLF and that of nominal CPUE calculated from data extending from November to February in each fishing year (Figure 3.14). These data highlight the consistency between the model-estimated biomass outputs and nominal CPUE estimates.

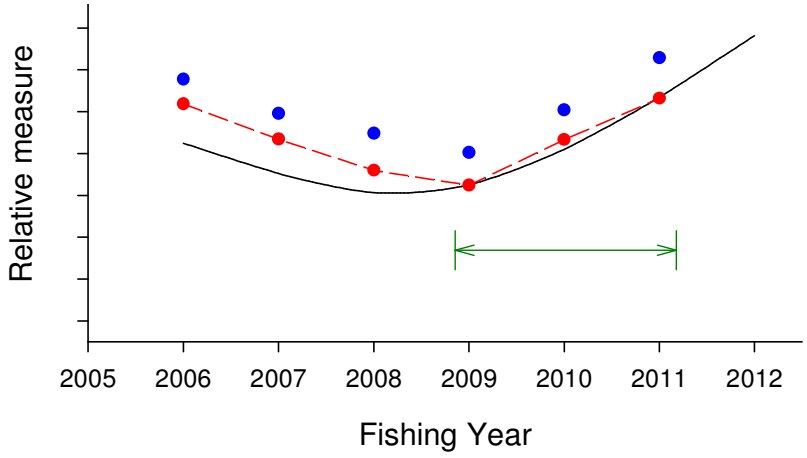


**Figure 3.14** Model estimated available biomass in the WZRLF (black line) from fitting standardised CPUE compared with measures of nominal CPUE (dashed red line) and nominal CPUE from November to February (inclusive; blue symbols) from 2006 to 2011. Two year period for model trend comparison with CPUE (green arrow).

### 3.5. **WZRLF – Summary**

From 2000 to 2008, 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 2002 (quota period 1 April to 31 March) to 240 t in 2009 (change in quota period; 1 July 2011 to 30 June 2012; Walker *et al.* 2012a). Over the last three seasons, catch has remained stable and in 2011, was 233 t. Effort did not decline at the same rate as catch and, as a result, from 2003 to 2009 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 two seasons and in 2011 was 0.49 kg/potlift, reflecting a 32% increase from 2009. Patterns of catch and CPUE among regions of the WZRLF are similar to those for the whole fishery. Most notably, the 2011 CPUE estimate in Warnambool of 0.59 kg/potlift was the highest on record since 2000 (0.60 kg/potlift).

Puerulus settlement indices (PSIs) across South Australia and the WZRLF indicate large-scale consistent patterns in settlement, with recent peaks in 2002, 2005 and 2006 evident in both States. In the WZRLF, there is a demonstrable relationship between PSIs, and the subsequent 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 current increases in catch rates in 2011 reflect the strong PSIs observed across South Australia and Victoria in 2005 and 2006. The continued increase in CPUE in 2012 based on monthly data also confirms this relationship. However, while legal-sized CPUEs have recently increased, it is important to highlight that fixed-site pre-recruit indices decreased in 2011 and 2012 reflecting declining settlement levels after 2006. Overall, this suggests that the WZRLF has experienced a recruitment pulse which, given recent declines in fishery performance, should be protected in order to rebuild the available biomass.

The model estimated level of egg production in 2011 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 173%. To rebuild to the 2020 target, the model estimated that a TACC of 259 t is required, based on a 50% probability and long-term average recruitment.

# 4. EASTERN ZONE ROCK LOBSTER FISHERY (EZRLF)

## 4.1. Fishery Statistics – catch, effort and catch per unit effort (CPUE)

### 4.1.1. Zonal catch and effort

From 1983 to 1988, catch in the EZRLF decreased annually from 137 t to 64 t (Figure 4.1). Over the subsequent 12 years (1989–2000), total catch averaged 69 t/yr (range 57–83 t/yr). In 2001, the total catch declined to 53 t. Since the implementation of a TACC in 2001, catches have ranged between 40 t (2008) and 65 t (2010). In 2011, it was 62 t. Total effort generally reflected changes in catch from 1978 to 1987. From 1988, effort increased substantially to a historical peak of 260,000 potlifts in 1993 and remained above 200,000 potlifts/yr until 2001. Since 2002, annual effort has reflected levels of catch and averaged approximately 132,000 potlifts/yr. Effort in 2011 was 114,000 potlifts, reflecting a 24% decrease since 2010 (150,000 potlifts).

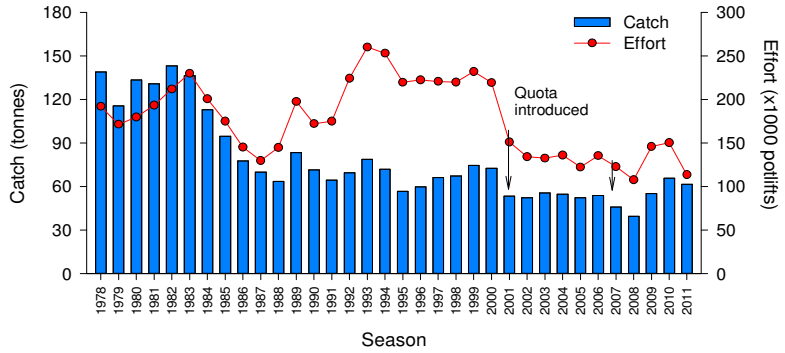


**Figure 4.1** Total catch (tonnes) and nominal effort (x1000 potlifts) in the EZRLF from 1978-2011. ↓ indicate TACC introduction in 2001 (60 t) and ammendment in 2007 (66 t).

### 4.1.2. Zonal catch per-unit-effort (CPUE) – nominal and standardised

Nominal and standardised CPUE show similar trends through time although standardised CPUE is consistently lower (Figure 4.2). Nominal CPUE decreased from 1978 (0.74 kg/potlift) to 1995 (0.26 kg/potlift), to the lowest level on record. Following annual increases from 1996 to 2003, nominal CPUE decreased from 2005 to 2008. It has increased in the last three years and in 2011 was 0.54 kg/potlift reflecting a 46% increase from 2008 (0.37 kg/potlift).

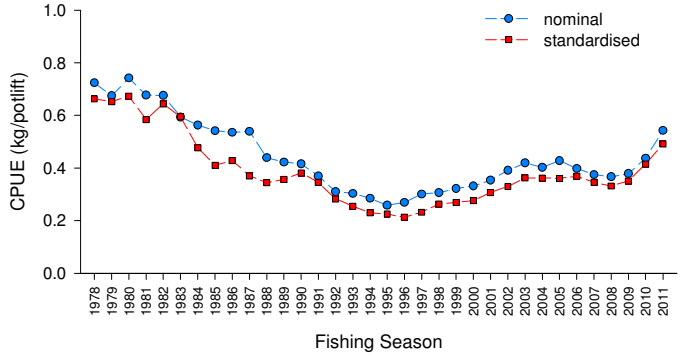


**Figure 4.2** Nominal and standardised CPUE (kg/potlift) in the EZRLF from 1978-2011.

### 4.1.3. Within season trends in CPUE

Over the last three quota years, monthly levels of nominal CPUE were generally highest from November to January with lower catch rates observed from May to July (Figure 4.3). In 2012, compared to 2011, catch rates were similar to or above 2011 estimates in all months with the exceptions of January and April. In 2012, the catch rate was highest in August at 0.71 kg/potlift and lowest in June at 0.26 kg/potlift.

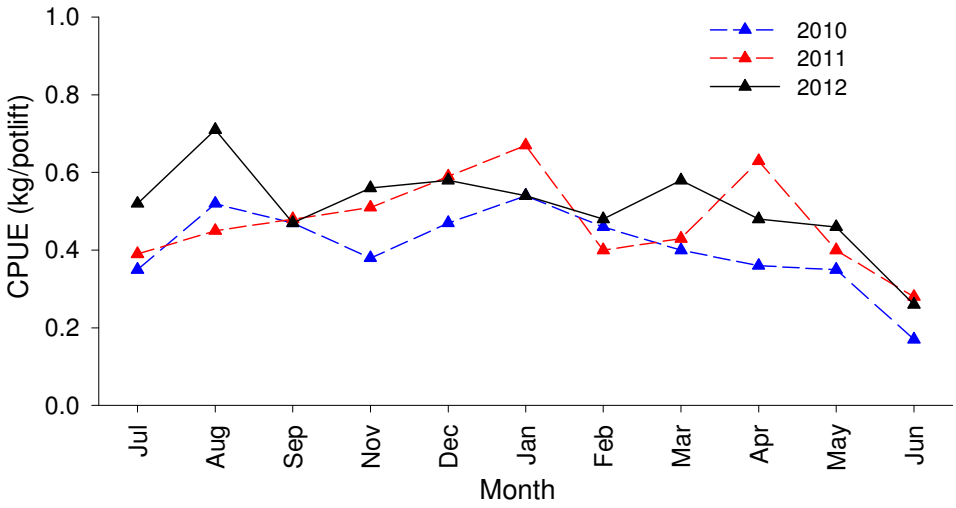


**Figure 4.3** Within season trends in nominal CPUE (kg/potlift) from July to June for the quota years 2010, 2011 and 2012 in the EZRLF. Source: Monthly Victorian Rock Lobster catch based on data from the Fisheries Integrated Licensing System and Quota Monitoring System (IVR).

### 4.1.4. Spatial Analyses - Regional catch, effort and CPUE

Among the three regions of the EZRLF (refer to Figure 1.1), catches have generally declined through time from historical peaks 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 (2001), with these levels recorded at Queenscliff (21.2 t) and Lakes Entrance (1.3 t) as recently as 2008. Minimum annual catch was recorded at San Remo in 2002 (13.2 t), with <14 t/yr caught in the following two years. From 2005 to 2011, annual catches at San Remo have averaged 22.3 t/yr, and in 2011 the annual catch was 24.8 t. Similarly, within the last three years, the catch in Queenscliff has increased and in 2011 was 35.3 t. The least amount of catch was taken in Lakes Entrance with just 1.5 t recorded in 2011.

Trends in effort ('000s potlifts) 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 at Lakes Entrance (22,000 potlifts) in 1994. Effort has decreased substantially since and to historically low levels in 2003 at San Remo (35,000 potlifts) and 2008 at Queenscliff (61,000 potlifts) and Lakes Entrance (2,000 potlifts). In

2011, the effort estimates for Queenscliff, San Remo and Lakes Entrance were 70,000, 40,000 and 4,000 potlifts, respectively, levels close to historical lows in all regions.

Nominal and standardised CPUE (kg/potlift) show similar tends through time at Queenscliff and San Remo. It has generally declined from 1979 to historically low levels in 1996 at both regions, whereafter it has increased to 0.50 kg/potlift (Queenscliff) and 0.62 kg/potlift (San Remo) in 2011. CPUE at Lakes Entrance has been more variable with less agreement between nominal and standardised CPUE through time. In 2011, levels of CPUE at Lakes Entrance were 0.43 kg/potlift (nominal) and 0.29 kg/potlift (standardised). Estimates of CPUE from this region should be viewed with caution, however, given the overall low levels of catch and effort in recent years.

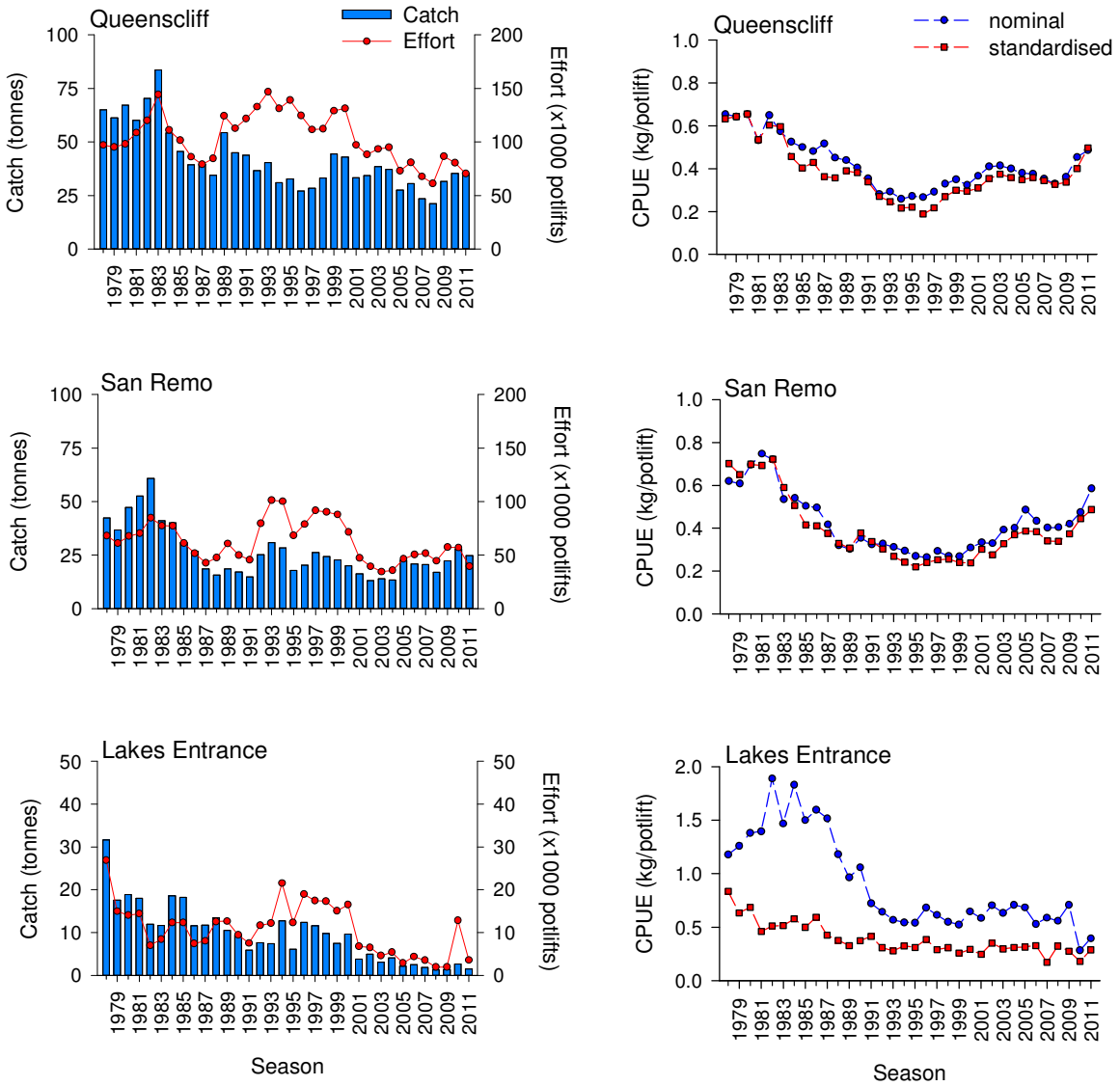


**Figure 4.4** Catch (tonnes), effort (x1000 potlifts) and nominal and standardised CPUE (kg/potlift) in the EZRLF from 1978 to 2011.

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

### 4.2.1. Puerulus settlement index

Puerulus settlement index (PSI) data are unavailable for the EZRLF as there are no puerulus collector sites established in this zone. However, recent trends in model estimated recruitment in both the EZRLF and WZRLF are broadly similar (Section 4.4.2). Further, lagged PSI data from sites in the WZRLF have a strong relationship with these recruitment data (Figure 3.10). These strong relationships suggest that PSI data from sites in the WZRLF provide a valuable proxy of puerulus settlement for the EZRLF and can be used to infer patterns of recruitment to the fishery.

### 4.2.2. Pre-recruit indices (fixed-site surveys and onboard observer program)

Levels of pre-recruit (undersized) catch rates have been generated from both fixed-site surveys undertaken annually from 2001 and the onboard observer program from 2004 (excluding 2009). Hence, data from the onboard observer program are more limited. Overall, catch rates of undersized appear to be about 50% greater in fixed-site surveys compared to the onboard observer program (Figure 4.5).

In both males and females, catch rates of undersized lobsters from fixed-site surveys showed peaks in 2002 and 2005 and have generally increased from 2006 to 2011. For females, the 2011 estimate of 0.13 undersized/potlift is the highest on record. In 2011, catch rates of both male and female lobsters from the onboard observer program were also the highest on record at 0.09 and 0.08 undersized/potlift, respectively. These patterns in CPUE are consistent with the progression of pre-recruit to legal-size over a period of 2-3 years and would account for increased levels of legal sized CPUE observed during the 2011 fishing season (Figure 4.2).

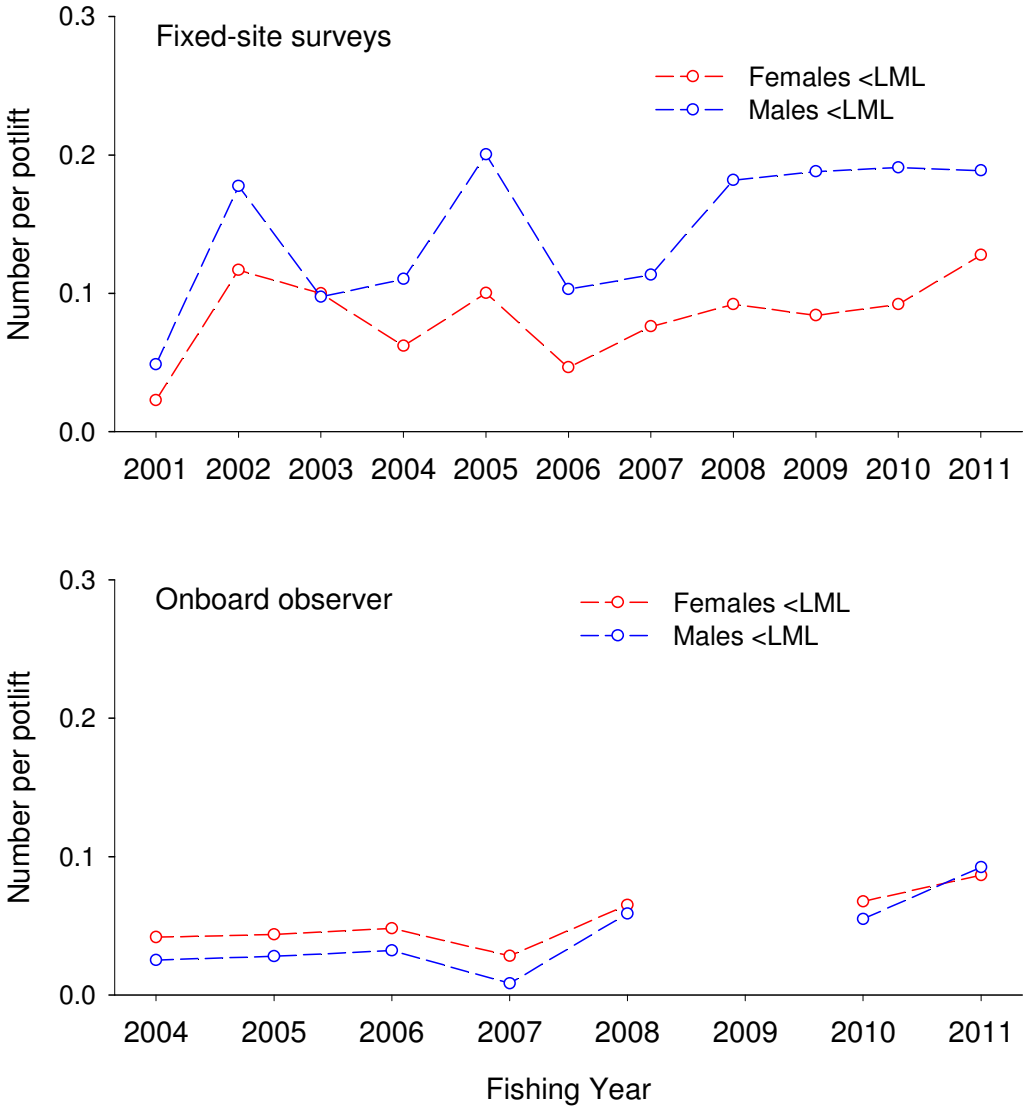


**Figure 4.5** Number of undersized female (LML = 105 mm CL) and male (LML = 110 mm CL) lobster per potlift in fixed-site surveys and onboard observer program in the EZRLF.

## 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 2010 and 2011 reflects the increase in legal size commercial catch rates observed across the fishery during these seasons (Figure 4.2).

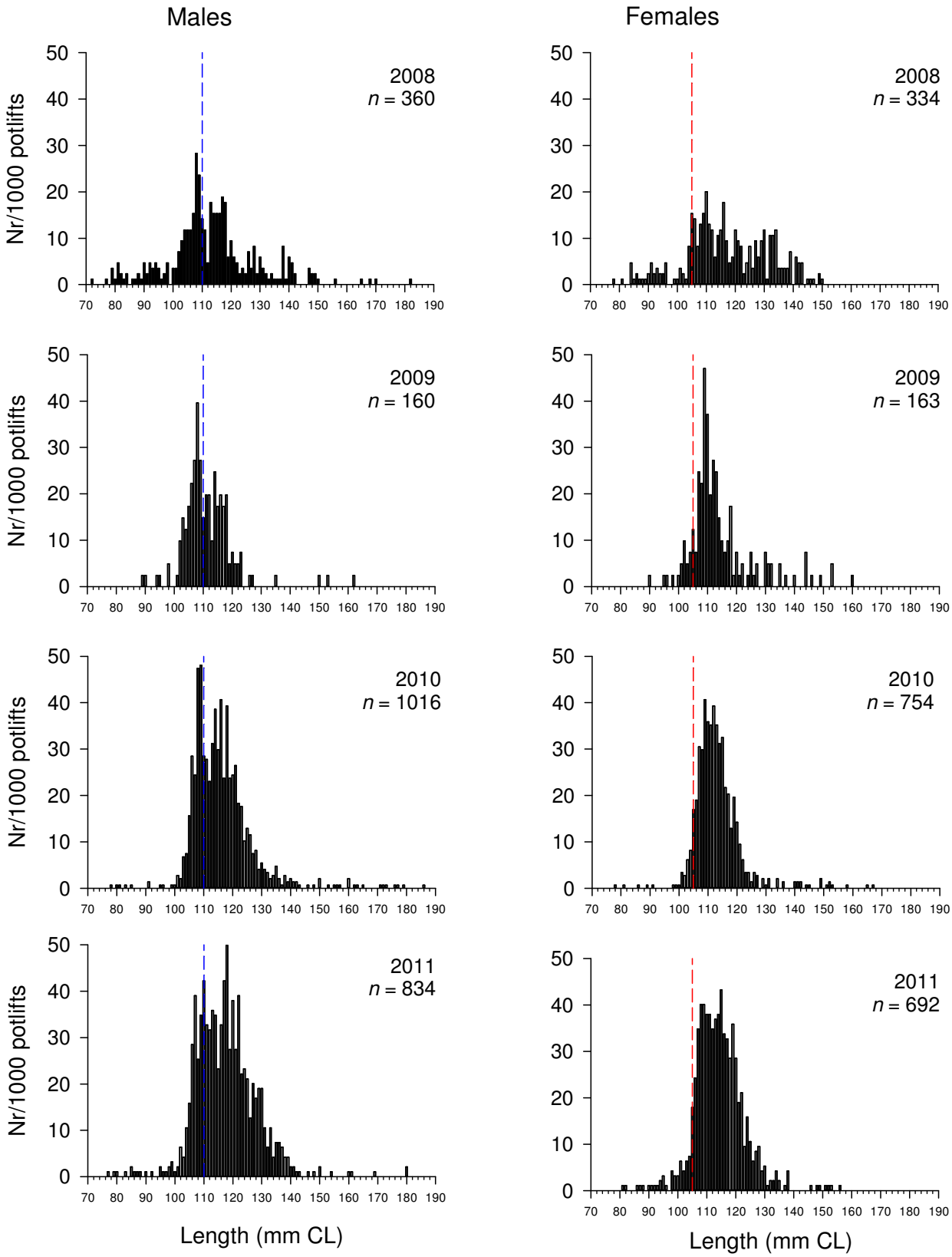


**Figure 4.6** Length-frequency distributions of male and female lobsters sampled on fixed-site surveys from 2008 to 2011 in the EZRLF. Blue and red dashed vertical lines represent minimum legal sizes for male and female lobsters, respectively.

## 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 to 2006, recruitment strength was below the long-term average for the fishery (Figure 4.7). However, levels in 2007 and 2008 were the highest on record which is likely to reflect the recent increases in CPUE over the last three seasons (Figure 4.3). Recruitment estimates from 2009-2011 were close to the long-term average.

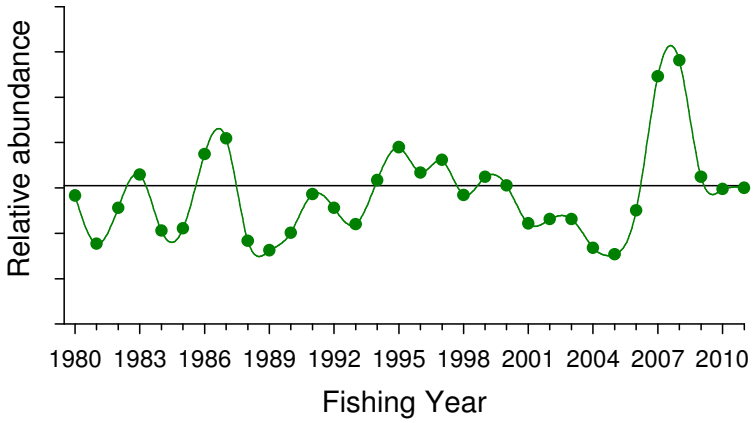


**Figure 4.7** Relative abundance of recruitment to 60 mm CL in the EZRLF, as used in the length-frequency model. Long-term historical average (solid black line) is also indicated.

### 4.4.2. Linking model recruitment to pre-recruit indices.

Model estimated recruitment indices between the EZRLF and WZRLF have been positively correlated ($R^2$ = 0.81) in recent years (Figure 4.8). Minor differences occurred in 2004, 2007 and 2008 when the magnitude of change in relative abundance of pre-recruits was greater in the EZRLF.

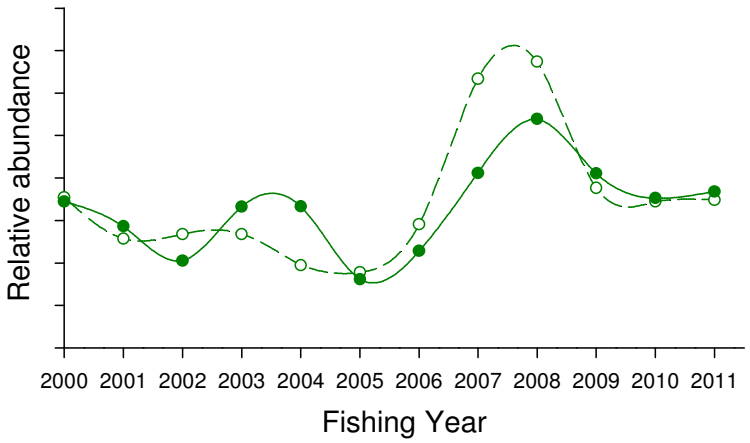


**Figure 4.8** Relative abundance of recruitment to 60 mm CL, in the EZRLF (dashed line) and WZRLF (solid line) from 2000 to 2010. Note plots are presented on different Y-axis scales.

Fixed-site survey estimates of relative abundance of pre-recruit and legal-sized lobsters, lagged between 1-3 years, also support the predictive capacity of the model estimated levels of recruitment in the EZRLF (Figure 4.9). The most consistent fits of recruit abundance with both undersized and legal-size abundance of lobsters from fixed-site surveys occur when the lag period is set at 2-years prior to 2005 and then 1-year for undersized and 3-years for legal-size lobsters post-2005 (Figure 4.9). Overall, this indicates a total period of 4-5 years from settlement to legal-size recruitment with the high PSIs in 2005 and 2006 (Figure 3.10) resulting in increases in legal size catch rate during the 2010 and 2011 fishing years (Figure 4.2).

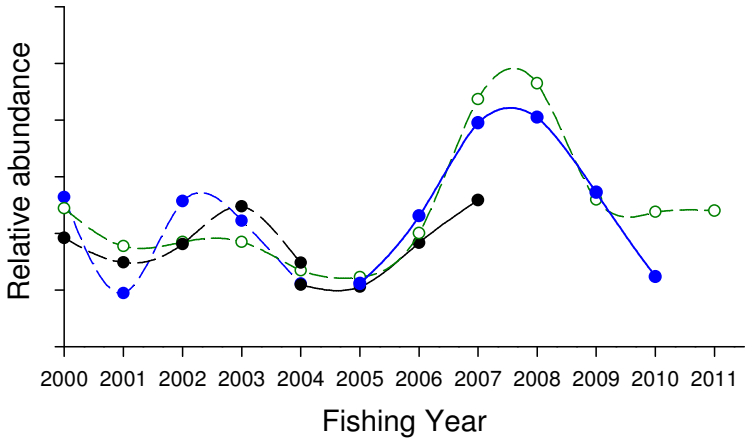


**Figure 4.9** Model estimated relative abundance of recruitment to 60 mm CL (green line) in the EZRLF with lagged fixed-site survey levels of CPUE (lobster/potlift) for pre-recruit (lagged 2 years, blue dashed line; lagged 1 year, solid blue line) and legal-size (lagged 2 years, black dashed line; lagged 1 year, solid black line).

### 4.4.3. Biological reference points – Egg Production and Available Biomass

#### *4.4.3.1. Egg production*

The level of egg production in 2011 was estimated to be 148% of that in 2001 (the reference year) with at least 75% probability. This estimate was above the biological reference point limit of 104% of egg production in 2001 (Figure 4.10).

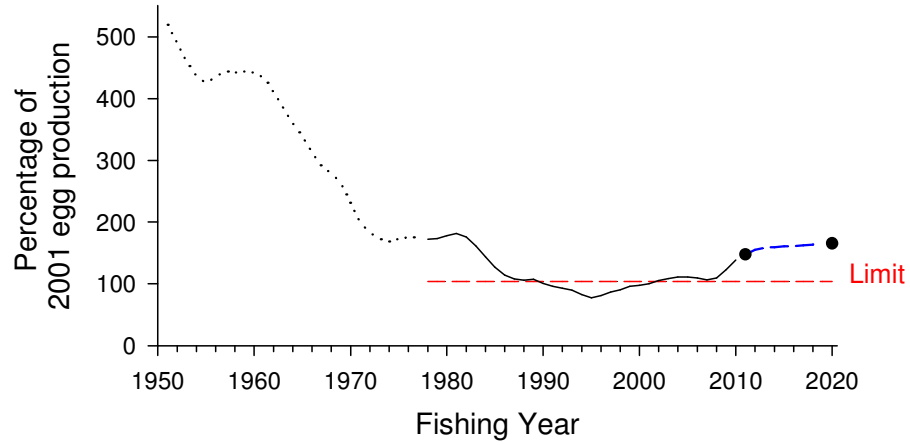


**Figure 4.10** Model estimated level of egg production through time in the EZRLF (above, with 75% probability; black line). Limit reference point is 104% of egg production in 2001 (dashed red line). Projected egg production (dashed blue line) given a TACC of 51 t/yr to rebuild available biomass to the biological reference point target by 2020.

*4.4.3.2. Available biomass*

The model estimated level of available biomass in 2011 was 126% of that in 2001 (the reference year). This estimate was below the biological reference point target of 219% of available biomass in 2001 (Figure 4.11). The model 50% probability forward projection indicates that for a fully taken TACC of 51 t, the available biomass would rebuild to the target by 2020.

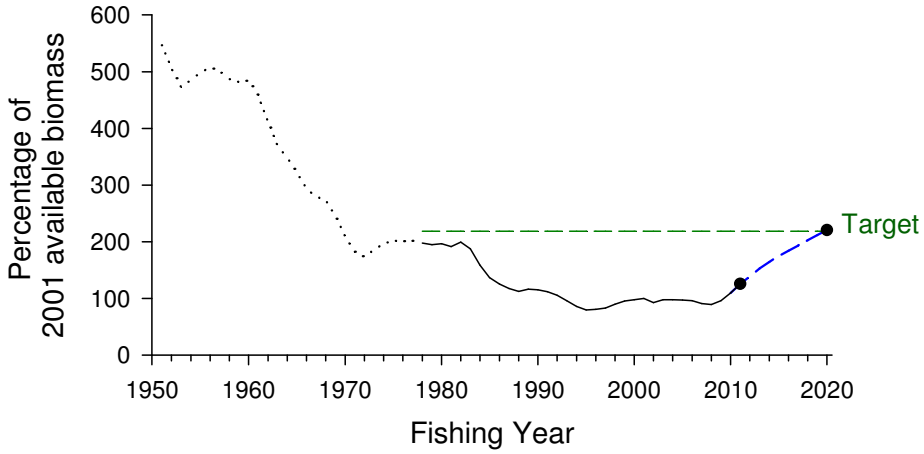


**Figure 4.11** Model estimated levels of available biomass in the EZRLF (above, with 50% probability; black line). Target reference point is 219% of available biomass in 2001 (dashed green line). Projected available biomass (dashed blue line) given a TACC of 51 t/yr to rebuild available biomass to the biological reference point target by 2020.

Effects of CPUE standardisation on available biomass trajectories

Model-estimated available biomass, derived from fitting standardised CPUE data, provided similar trends to unstandardised (nominal) CPUE from the EZRLF and that of nominal CPUE calculated from data extending from November to February in each fishing year (Figure 4.12). These data highlight the consistency between the model-estimated biomass outputs and nominal CPUE estimates.

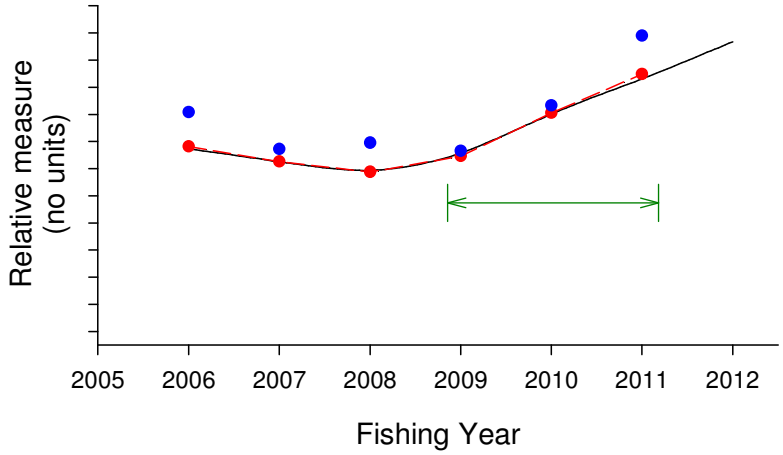


**Figure 4.12** Model estimated available biomass in the EZRLF (black line) from fitting standardised CPUE compared with measures of nominal CPUE (dashed red line) and nominal CPUE from November to February (inclusive; blue symbols) from 2006 to 2011. Two year period for model trend comparison with CPUE (green arrow).

## 4.5. **EZRLF - Summary**

Annual catches have generally declined over the history of the fishery, to their lowest level in 2008 (39.5 t). Over the last three years catch has increased and, in 2011, was 61.6 t. Since 2002, annual effort has reflected levels of catch. CPUE has generally increased since 1995, but declined from 0.43 kg/potlift in 2005 to 0.37 kg/potlift in 2008. Over the last three seasons it has increased and in 2011, was 0.54 kg/potlift, the highest since 1984. Patterns of catch, effort and CPUE among regions are similar to those for the whole fishery, with the exception of a decrease in CPUE at Lakes Entrance in 2010. Consistent large-scale patterns in puerulus settlement indices (PSIs) in the WZRLF and South Australia, together with a strong correlation between model estimated recruitment between the WZRLF and EZRLF suggest that settlement indices from the WZRLF provide a valuable proxy for settlement patterns in the EZRLF. Data indicate that the period from settlement to recruitment at 60 mm CL is approximately 2 years, with recruitment to legal-size approximately 2-3 years later. Overall, this suggests that the total period from settlement to legal-size is approximately 4-5 years in the EZRLF.

The relative abundance of pre-recruits from fixed-site surveys was consistent with the progression of individuals from undersize to legal-size over 2-3 years. As a result, increased abundances of undersized in 2008, 2009 and 2010 reflected increases to legal-size catch rates in 2010 and 2011. The continued increase in CPUE in 2012, based on monthly data, appears to confirm this relationship. Overall, as with the WZRLF, this suggests that the EZRLF is currently experiencing a recruitment pulse which should be protected in order to rebuild the available biomass.

The level of egg production in 2011 was 148% of that in 2001 and above the limit reference point of 104%. In contrast, the level of available biomass was estimated to be 126% of that in the reference year and below the target reference point of 219%. Model projections indicate a TACC of 51 t/yr would be required, given long-term average recruitment, to rebuild the available biomass to the biological reference point target by 2020.

# 5. GIANT CRAB FISHERY

## 5.1. Fishery Statistics – catch and catch per unit effort (CPUE)

The total annual catch of giant crab includes the catch from fishers targeting giant crab and that from non-targeted catch in the Rock Lobster Fishery (RLF). Total catch peaked at 226 t in 1992, with about 40 t consisting of non-targeted catch from the RLF. Catches generally declined thereafter to a historical low of 8.4 t in 2002 (Figure 5.1). Prior to the introduction of quota (2001), non-targeted catch averaged about 40% of total catch. Since 2001, total catches increased to 28 t in 2007 with non-targeted catch averaging ≤10% of total catch. In 2011, the total catch was 12.6 t, of which 11 t was targeted.

Changes in CPUE (kg/24 hr potlift) from targeted fishing by fishers with >1 t catch/yr, peaked in 1993 (1.7 kg/24 hr potlift; Figure 5.2). From 1993 to 2002, CPUE declined to a historic low (0.22 kg/24 hr potlift) and below the trigger point for this performance indicator. Since 2008, this indicator has been at the limit (2008) or below the trigger reference point (2009, 2010 and 2011). In 2011, the targeted CPUE was 0.20 kg/24 hr potlift, the lowest estimate on record.

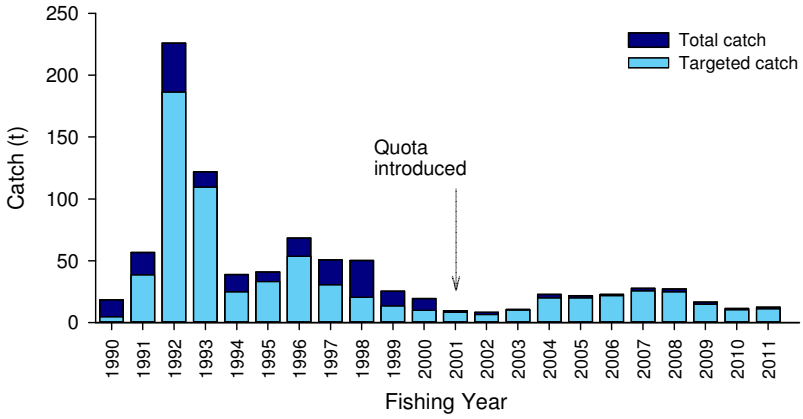


**Figure 5.1** Total catch (t) and targeted catch history for the Victorian Giant Crab Fishery. ↓ indicates TACC introduction in 2001 (25 t).

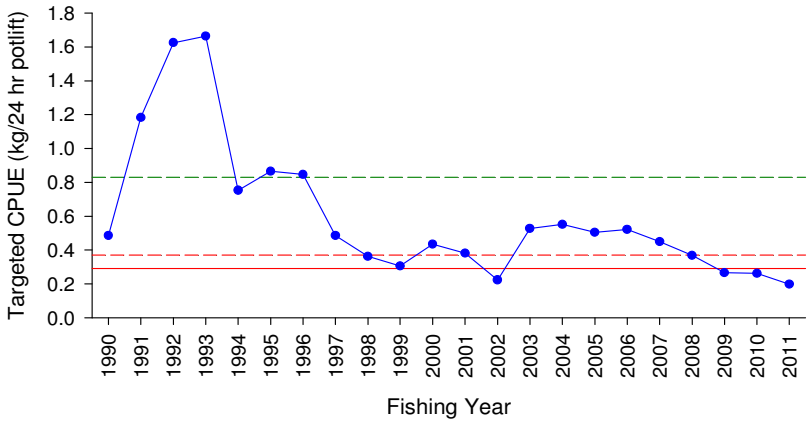


**Figure 5.2** CPUE (kg/24 hr potlift) from targeted fishing by fishers with >1 t catch. Green dashed line represents target reference point while dashed and solid red lines represent limit and trigger reference points respectively.

## 5.2. **Giant crab - Summary**

The total annual catch of giant crab peaked in 1992 when 226 t was landed, thereafter annual catches have generally declined to a record low level (8.4 t) in 2002. A TACC and individually transferable quota was implemented in 2001 and management changes required catches to be reported as either from targeting giant crab or as by-catch from the Rock Lobster Fishery. After the implementation of quota, non-targeted catch declined from about 40% to ≤10% of total catch. From 2002, catches increased to a recent peak of 28 t in 2007. Over the last three years catches have declined, with 12.3 t landed in 2011. Catch rates (kg/24 hr potlift) have been calculated from targeted fishing by fishers with >1 t catch/yr. CPUE peaked in 1993 and has since generally declined. In 2011, it was 0.20 kg/24 hr potlift, the lowest estimates on record and the third consecutive season that CPUE was below the trigger reference point.

# 6. REFERENCES

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