
Victorian Rock Lobster and Giant Crab Fisheries Status Report 2011/2012

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

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October 2012

Fishery Status Report to Fisheries Victoria

Government of South Australia

State Government Victoria

DEPARTMENT OF PRIMARY INDUSTRIES

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# EXECUTIVE SUMMARY

This status report is the first 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 1 November to 30 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)

Annual catches in the WZRLF have declined from 525 t in 2000 to 235 t in 2008, reflecting reductions in the TACC. Catches in the last three years have been stable (235-253 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. However, in 2010, it was 586,000 potlifts, the lowest level since 1989.

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. In 2010, nominal CPUE increased by 16% to 0.43 kg/potlift.

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.

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 2010 and 2011 reflect the strong PSIs observed across South Australia and Victoria in 2005 and 2006. Adherence to these relationships would suggest continued and increasing levels of relative abundance of legal-size lobsters through the 2012 fishing year.

However, 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 2010 was 72% of that in 2001 (the reference year) and above the reference limit point of 35% of that in 2001. The level of available biomass was 70% of that in 2001 and below the target reference point of 173% of that in 2001. Model projections indicate a TACC of 260 t/yr could, given stable long-term average recruitment, rebuild the available biomass to the target reference point by 2020.

## Eastern Zone Rock Lobster Fishery (EZRLF)

Annual catches in the EZRLF declined from 143 t in 1982 to 39 t in 2008. Annual TACCs have been set since the implementation of the Management Plan in November 2001 (60 t) and since 2007, have remained unchanged at 66 t/yr. Since 2008, catches have increased and in 2010 the total catch was 65 t. Since 2002, changes in effort have reflected those of catch.

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 two seasons, CPUE has increased and in 2010 it was 0.44 kg/potlift, the highest since 1988.

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, with the exception of a decrease in CPUE at Lakes Entrance in 2010.

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. Adherence to these relationships would suggest continued and increasing levels of relative abundance of legal-size lobsters through the 2012 fishing year.

However, while catch rates are currently increasing, it is important to highlight that under-sized numbers in the EZRLF decreased in 2011 reflecting reduced puerulus settlement post-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 2010 was 137% of that in 2001 (the reference year) and above the limit reference point of 104% of that in 2001. In contrast, the level of available biomass was 110% of that in 2001 and below the target reference point of 219% of that in 2001. Model projections indicate a TACC of 48 t/yr could, given stable long-term average recruitment, rebuild the available biomass to the target reference point by 2020.

## 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.

From November 2001, the GCF Management Plan was implemented and a TACC set (25 t/yr), that has remained unchanged. In addition, a separate logbook was introduced for the GCF and management changes required catches to be reported as either that from targeting giant crab or as by-catch from the rock lobster fishery. Prior to Nov. 2001, catch was reported as by-catch from the rock lobster fishery and targeted catch was derived from decision rules regarding the depth of 'pot-sets' and their soak-time or where >70% of the total catch (rock lobster and giant crab) was giant crab. After 2001, non-targeted catch reduced from about 40% to ≤10% of total catch.

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 11.3 t landed in 2010.

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 a historically low level of 0.22 kg/24 hr potlift in 2002. This estimate was below the trigger reference point of 0.29 kg/24 hr potlift. In 2010, it was 0.26 kg/24 hr potlift, the second lowest estimates on record and the second consecutive season that CPUE was below the trigger reference point.

# 1. INTRODUCTION

This fishery status report is the first in what is part of the South Australian Research and Development Institute (SARDI) - Aquatic Sciences ongoing 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 Victorian Rock Lobster and Giant Crab fishery stock assessment reports (Walker *et al.* 2012a, b, respectively). 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 2010/11 fishing season (i.e. 30 September 2011). 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 the commercial fishery onboard observer program 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 (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 three separate regions i.e. 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 (1 November - 30 September). In

this report all reference to a fishing year or season refers to the first year of the season (e.g. the season 2010 refers to the period from 1 November 2010 to 30 September 2011).

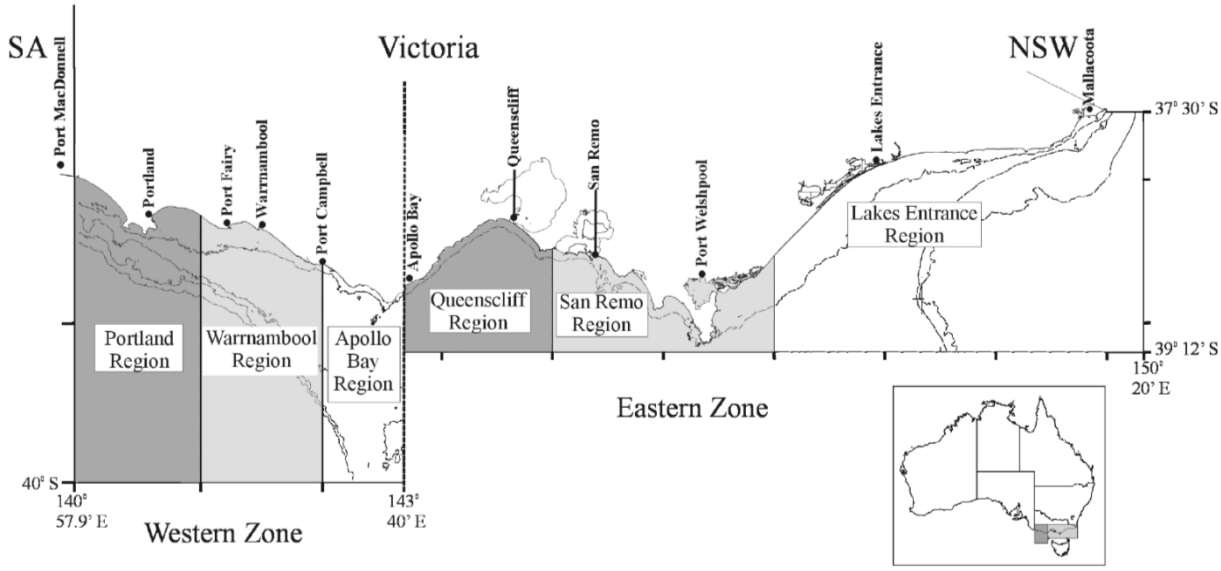


**Figure 1.1** Extent and spatial structure of the Victorian Rock Lobster Fishery. Source: VicDPI (2009).

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 42 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 21 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 1 November to 30 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 2010 refers to the period from 1 November 2010 to 30 September 2011). Despite there being 30 licences issued in the fishery (VicDPI 2010), only 9 licence holders reported catching giant crab in 2010 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, the TACC was 25 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 Fisheries Victoria, Department of Primary Industries (VicDPI). 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. Data including CPUE (number per potlift) and carapace length-frequency from rock lobster sampled from an onboard observer program (pots with escape gaps open) and from a fixed site survey program (pots with escape gap closed) also provide critical data for the assessment of the WZRLF and EZRLF. The 'Rock Lobster Fishery assessment model' provides 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 (i.e. the 2003/04 season), catch in the WZRLF decreased by 55% from 2000 (525 t) to 2008 (235 t; Figure 3.1). Over the last two seasons, catch has marginally increased and, in 2010, was 253 t. Total effort has not decreased 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. However, in 2010, it was 586,000 potlifts, the lowest level since 1989.

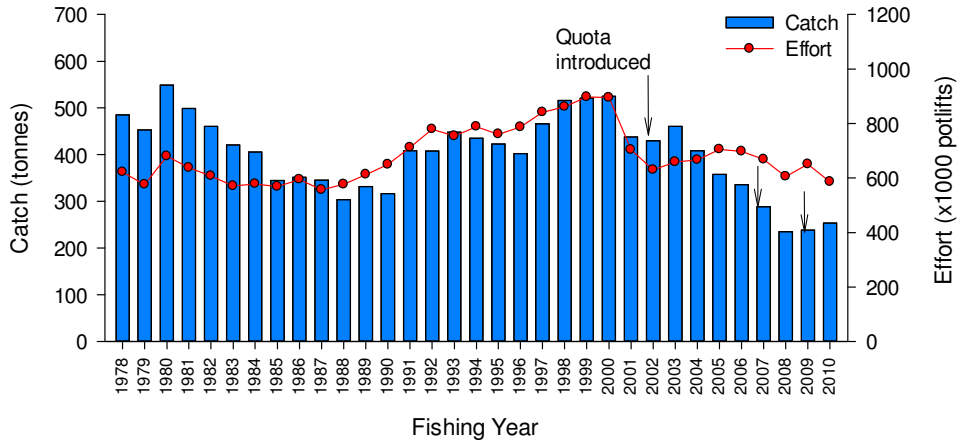


**Figure 3.1** Total catch (tonnes) and nominal effort (x1000 potlifts) in the WZRLF from 1978-2010. ↓ indicate TACC introduction (450 t) and ammendments in 2007 (380 t) and 2009 (240 t).

### 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 level in the history of the fishery. In 2010, nominal CPUE increased by 16% to 0.43 kg/potlift.

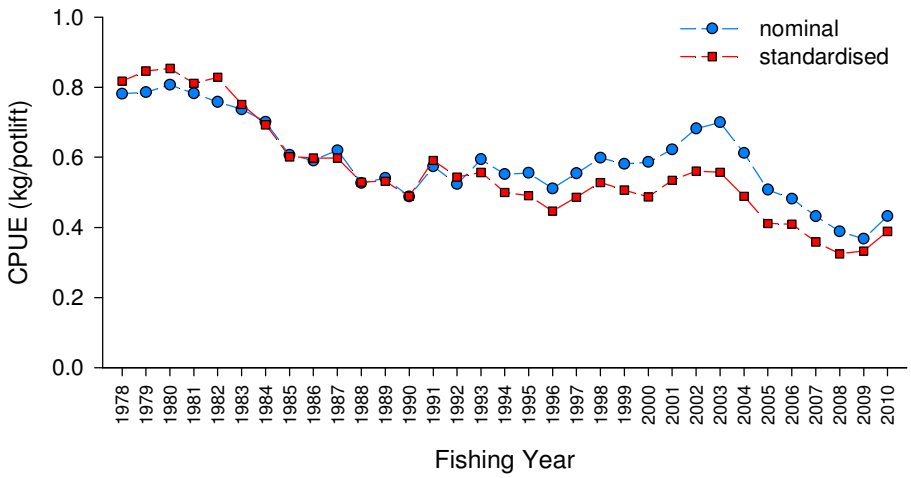


**Figure 3.2** Nominal and standardised CPUE (kg/potlift) in the WZRLF from 1978-2010.

### 3.1.3. Within season trends in CPUE

Patterns of CPUE through time were similar among the last three fishing years (2009-2011; Figure 3.3). Lower catch rates were observed from July to September with annual peaks observed during January. Peak catch rates were typically 40-50% higher than those from July to September. Over the last three years, levels of CPUE among months have been consistently higher, with the exception of March and April in 2011. In 2011, catch rate was lowest in June at 0.29 kg/potlift and highest in January at 0.64 kg/potlift.

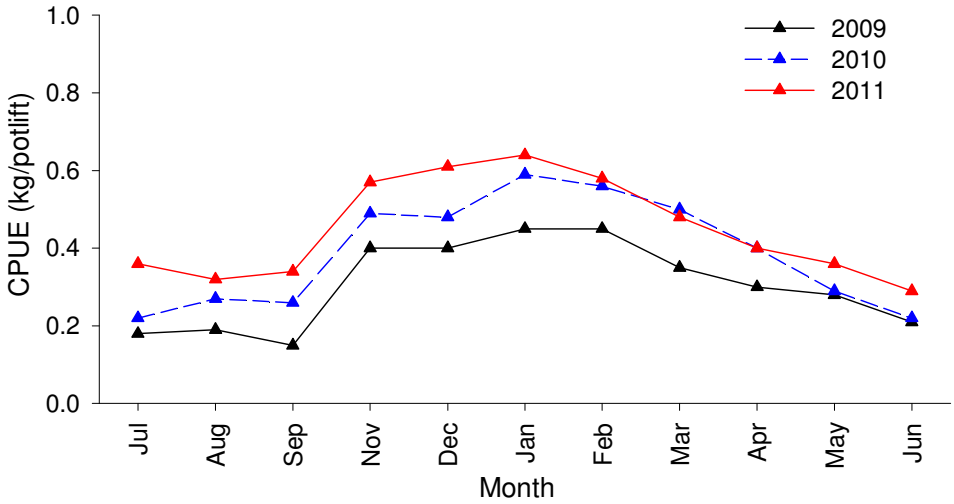


**Figure 3.3** Within season trends in nominal CPUE (kg/potlift) from July to March for the fishing years 2009, 2010 and 2011 in the WZRLF. Source: Monthly Victorian Rock Lobster catch update June 2012 – based on data from the Fisheries Integrated Licensing System and Quota Monitoring System (IVR).

### 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 (2008-2010).

Trends in effort among regions have generally reflected those of catch, with the exception of that at Portland from 2001 to 2006. At Portland, 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.

As described for patterns of catch among regions, levels of nominal and standardised CPUE (kg/potlift) 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 within the last three fishing years (2008–2010). However, within the last two years, levels of CPUE have either stabilised (Apollo Bay) or increased (Portland and Warrnambool).

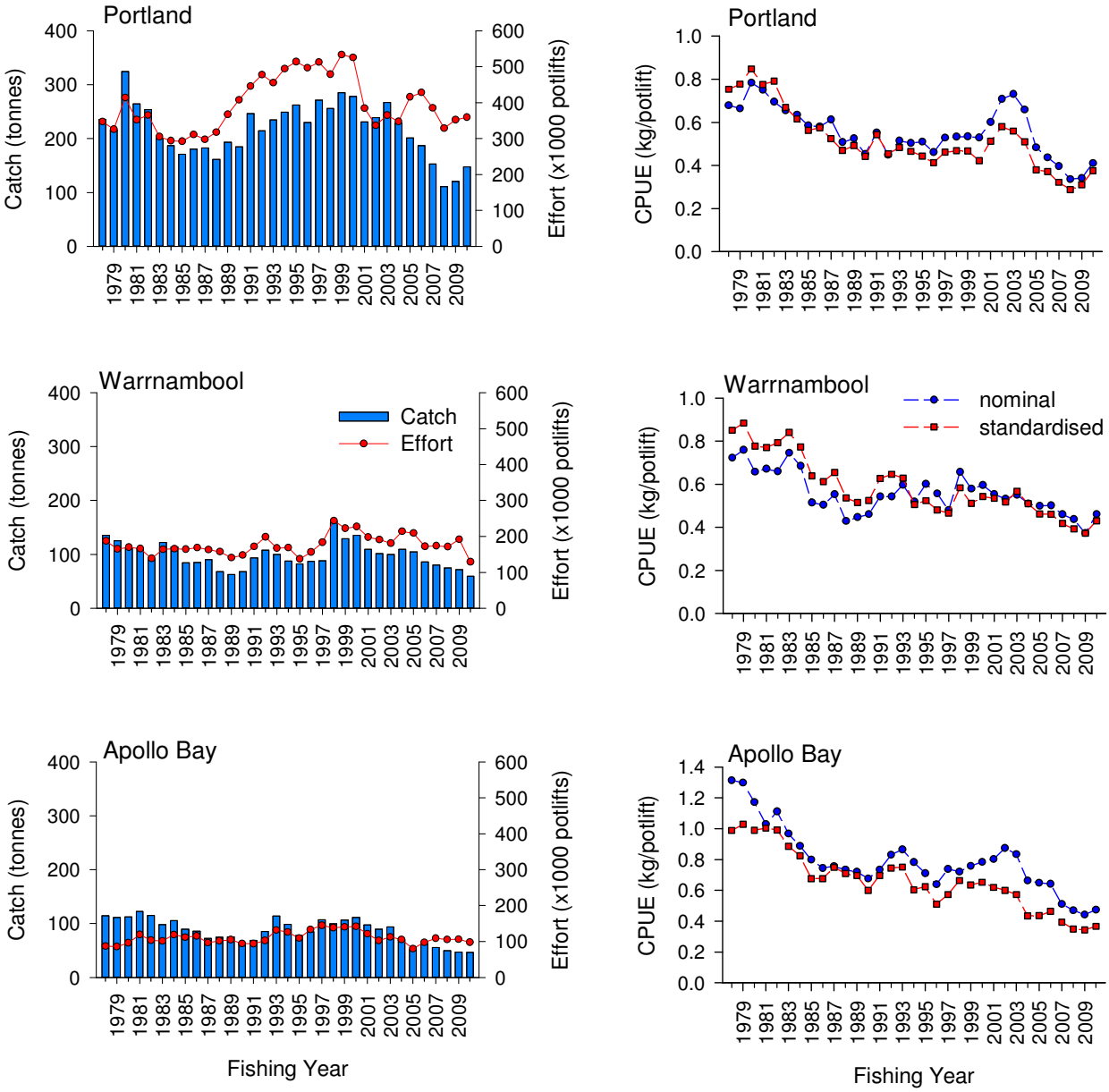


**Figure 3.4** Regional catch (tonnes), effort (x1000 potlifts) and nominal and standardised CPUE (kg/potlift) in the WZRLF from 1978 to 2010.

## 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 and ranging between 0.39 and 0.70 puerulus/collector. In 2010, the PSI in the WZRLF was 0.60 puerulus/collector.

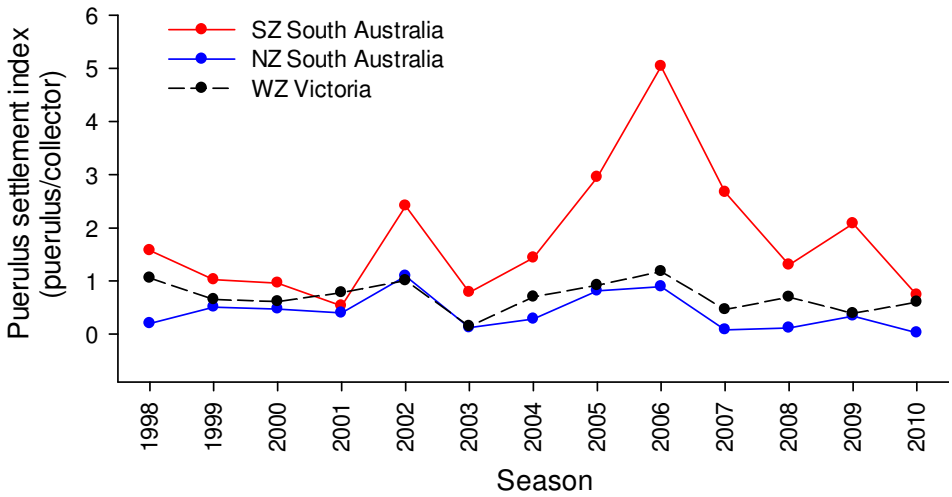


**Figure 3.5** Puerulus settlement index in the Southern Zone (SZ) and Northern Zone (NZ) of South Australia and the WZRLF from 1998-2010. Note: PSI data for WZ Victoria in 2005 and 2006 are from Port Campbell only, as collectors at Apollo Bay were removed during harbour redevelopment.

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

Estimates of CPUE (number/potlift) in relation to both pre-recruit (under-sized) and legal-sized male and female lobsters have been generated from both fixed-site surveys and an onboard observer program since 2001 and 2004, respectively (Figure 3.6). While catch rates of both male and females (under-sized and legal-sized) tend to be higher from the onboard observer program, overall trends from both fixed-site surveys and observers are broadly similar through time. Pre-recruit catch rates for both males and females from fixed-site surveys decreased by >50% from 2001 to 2006, although this included two years of stable (female) or minor increased levels (male) of CPUE from 2003 to 2005. From 2006 to 2010, fixed-site pre-recruit catch rates for both sexes increased, before declining again in 2011 to 0.73 under-sized/potlift (male) and 0.99 under-sized/potlift (female). Similarly, in the onboard observer program, under-sized catch rates of both male and females increased between 2004 and 2005, decreased to low levels in 2007 and 2008, before increasing in 2010 to 0.29 and 0.30 under-sized/potlift, for males and females, respectively.

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 2006 and 2007 (Figure 3.6). These patterns 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, in 2010, CPUE of legal-size males increased to 0.38 lobsters/potlift, the highest on record while that of legal-size females increased to 0.22 lobsters/potlift, the highest since 2006.

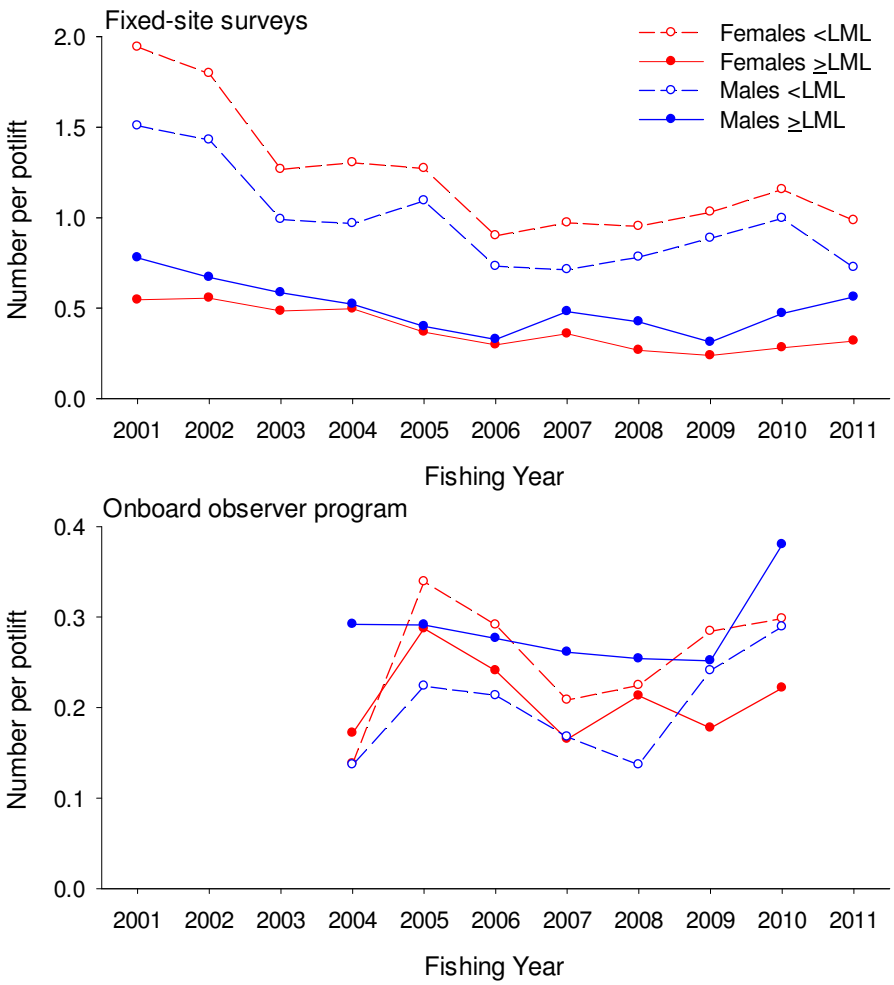


**Figure 3.6** Number of legal-sized and under-sized female (LML = 105 mm CL) and male (LML = 110 mm CL) lobsters per potlift in fixed-site surveys and onboard observer program in the WZRLF. Note: escape gaps open on pots for the onboard observer program and closed for the fixed-site survey.

### 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 under-sized/potlift) peaked in 1999 at 2.1 under-sized/potlift (Figure 3.7) but generally declined over the next nine seasons to a historical low of 0.85 under-sized/potlift in 2008. The pre-recruit index subsequently increased over the next two seasons before decreasing to 0.99 under-sized/potlift in 2011. Overall, these results were broadly consistent with observations in the Western Zone of Victoria, where pre-recruit indices from both fixed-site surveys and the onboard observer program decreased prior to 2008, increased up to 2010 and subsequently declined in 2011 (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.

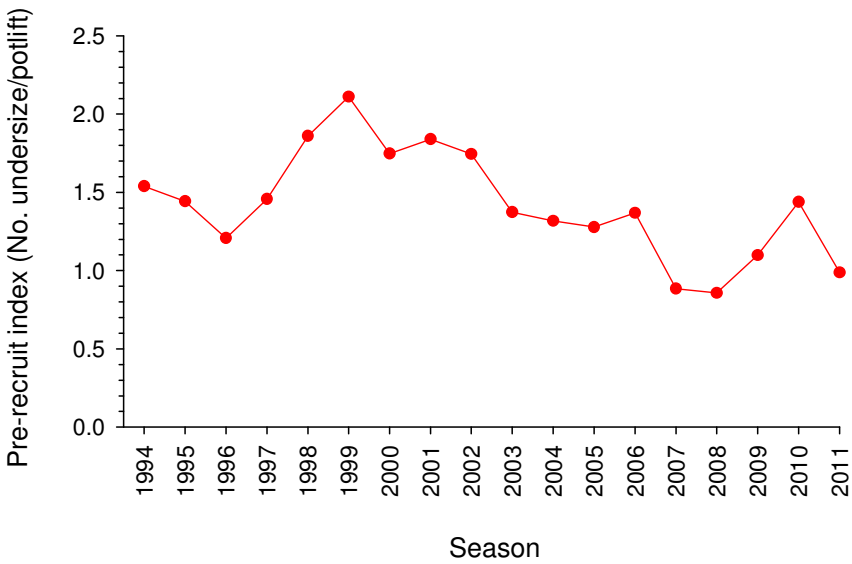


**Figure 3.7** South Australian Southern Zone pre-recruit index from 1994 to 2011.

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

Length-frequency data obtained through fixed-site surveys and the onboard observer program support changes in legal-size commercial catch rates and pre-recruit estimates from each program, respectively (Figure 3.8). In 2009, the frequency of legal-size individuals (105-130 mm carapace length; CL) from fixed-sites and onboard observer program was at its lowest level in the last four years but increased from 2009 to 2010, reflecting similar patterns to nominal CPUE (Figure 3.2) and catch rates from fixed-site surveys and the onboard observer program (Figure 3.6). The frequency of pre-recruit individuals (70-90 mm CL) has decreased since 2009, and by about 50% between 2009 and 2010.

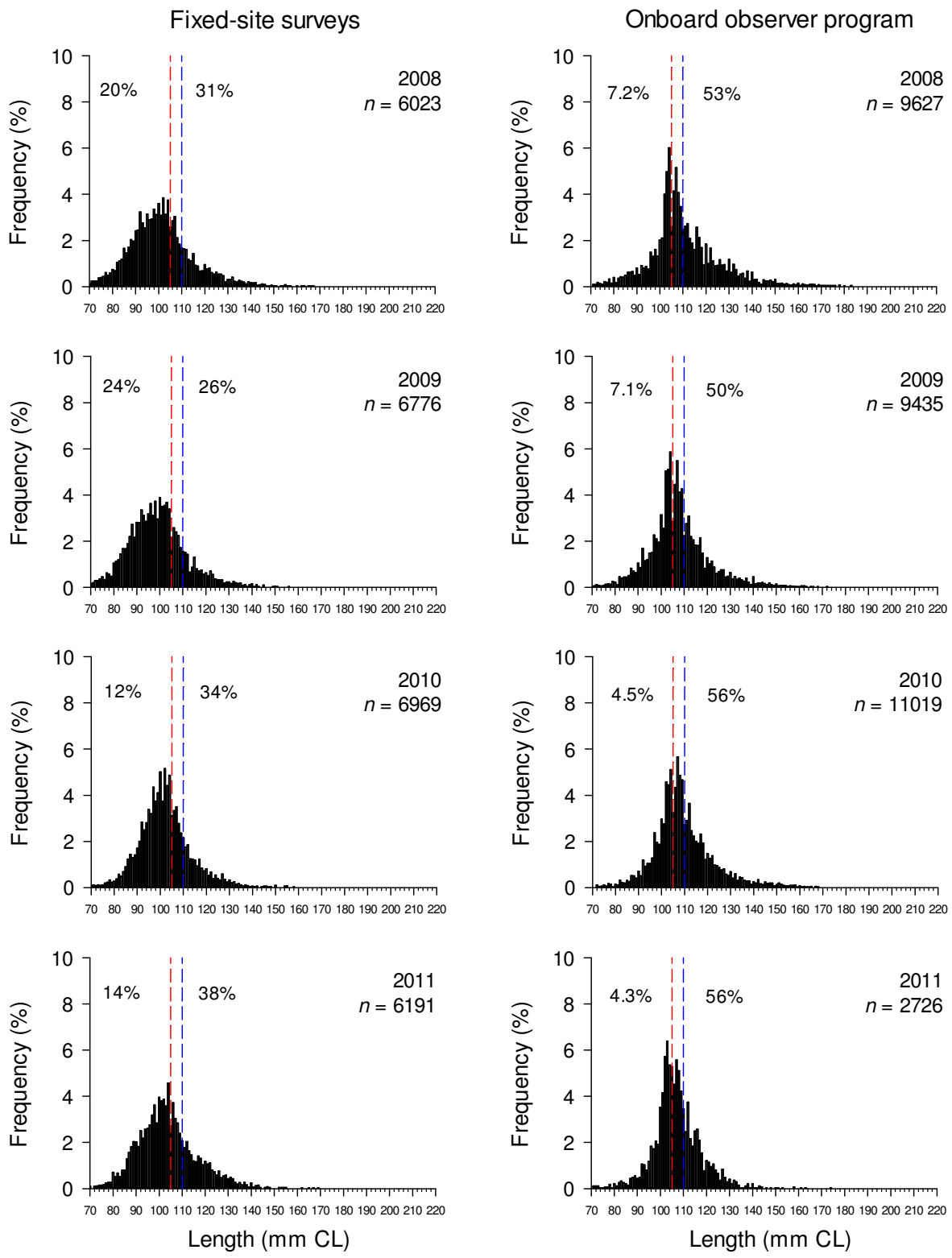


**Figure 3.8** Length-frequency distributions of rock lobsters sampled on fixed-site surveys from 2008 to 2011 in the WZRLF. The two percentage numbers on each figure represent the cummulative percent of lobsters between 70-90 and 105-130 mm CL, respectively. Red and blue dashed vertical lines represent legal minimum lengths for female and male lobsters, respectively.

## 3.4. Length-structured assessment model outputs

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

Model-estimated recruitment strength has been highly variable over the last 30 years (Figure 3.9). From the late 1980s to the late 1990s, average recruitment was above the long-term average, however, over the last decade (2000-2009) it was below. More recently, recruitment levels from 2007 to 2010 were above this average, except in 2009. Specifically, the high levels of recruitment to 60 mm CL in 2007 and 2008 are likely to reflect the increases to commercial catch rates observed within the fishery in 2010 and 2011 (Figure 3.2 and Figure 3.3).

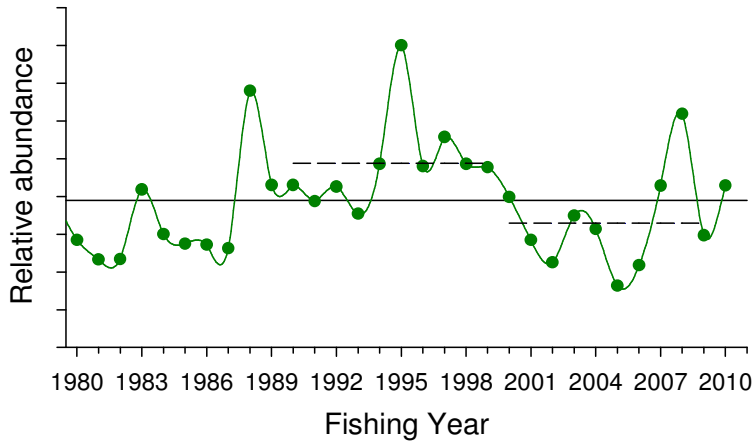


**Figure 3.9** Relative abundance of recruitment to 60 mm CL in the WZRLF, as used in the length-frequency model. Long-term historical average (solid black line) and ten year averages (dashed black lines) are also indicated.

### 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 ($R^2$ = 0.70) through time (Figure 3.10). Using a two year lag, PSI was also positively correlated ($R^2$ = 0.78) with model estimated recruitment to 60 mm CL in the fishery.

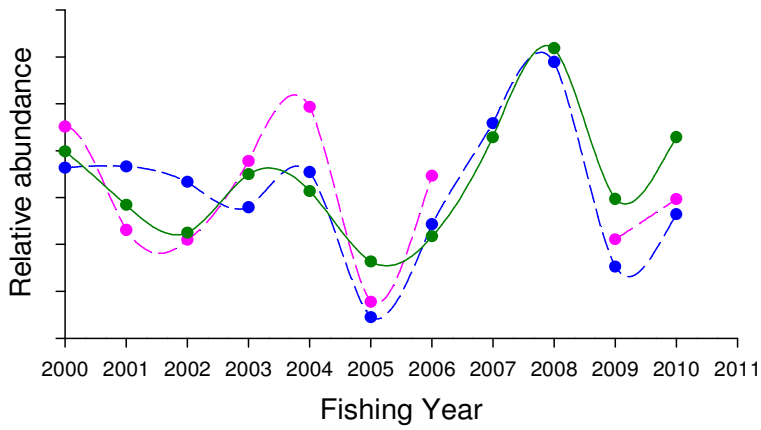


**Figure 3.10** Model estimated relative abundance of recruitment to 60 mm CL in the WZRLF (green line) with PSIs from Port Campbell (blue line) and Apollo Bay (pink line), lagged by two years. Note: Absence of PSI data at Apollo Bay (2007-2008) due to harbour development.

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. Adherence to these relationships would suggest continued and increasing levels of relative abundance of legal-size lobsters through the 2012 fishing year.

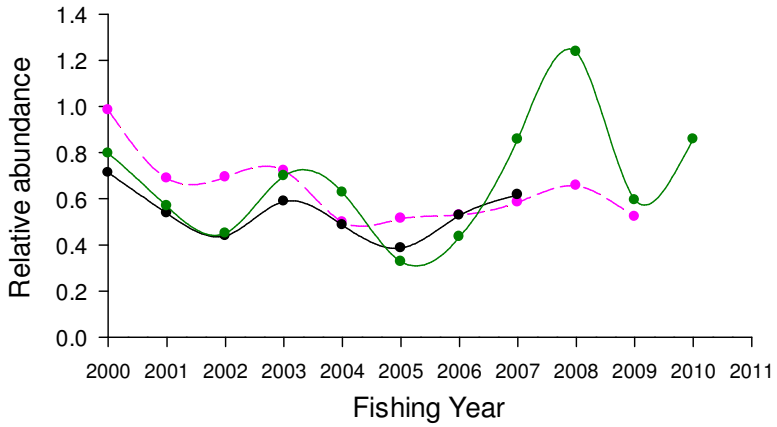


**Figure 3.11** Model estimated relative abundance of recruitment to 60 mm CL in the WZRLF (green line) with that from fixed-site survey levels of pre-recruit (lagged two years; dashed pink line) and legal-sized (lagged four years; black line) lobsters.

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

#### *3.4.3.1. Egg production*

The level of egg production in 2010 was estimated to be 72% 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)

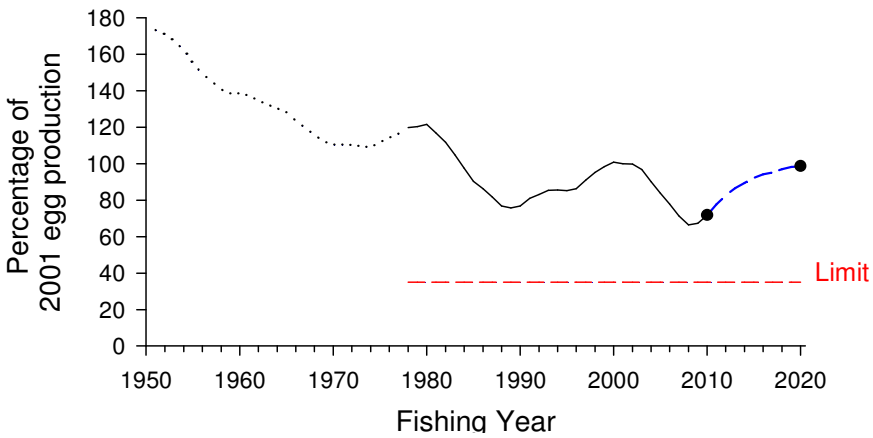


**Figure 3.12** Model estimated level of egg production through time in the WZRLF (above, with 75% probability; black line). Limit reference point (35% of egg production in 2001; dashed red line). Projected egg production (dashed blue line) given a TACC of 260 t/yr, to rebuild available biomass to the biological reference point target by 2020.

*3.4.3.2. Available biomass*

The level of available biomass in 2010 was estimated to be 70% of that in 2001 (the reference year), with 50% probability. This estimated 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 260 t/yr could allow the available biomass to rebuild to the BRP target by 2020.

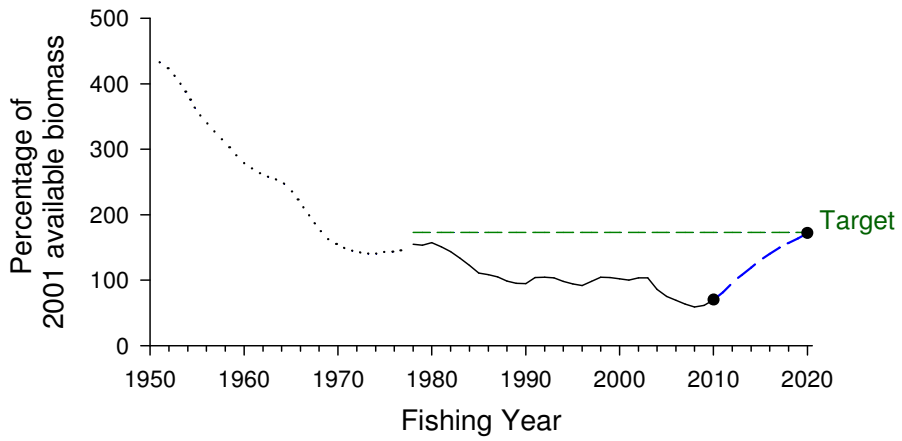


**Figure 3.13** Model estimated levels of available biomass in the WZRLF (above, with 50% probability; black line). Target reference point (173% of available biomass in 2001; dashed green line). Projected available biomass (dashed blue line) given a TACC of 260 t/yr to rebuild available biomass to the biological reference point target by 2020.

<u>Effects of CPUE standardisation on model estimates of available biomass</u>

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 later data also provide information for the 2011 fishing year and further highlight the consistency with the model-estimated, available biomass trajectory.

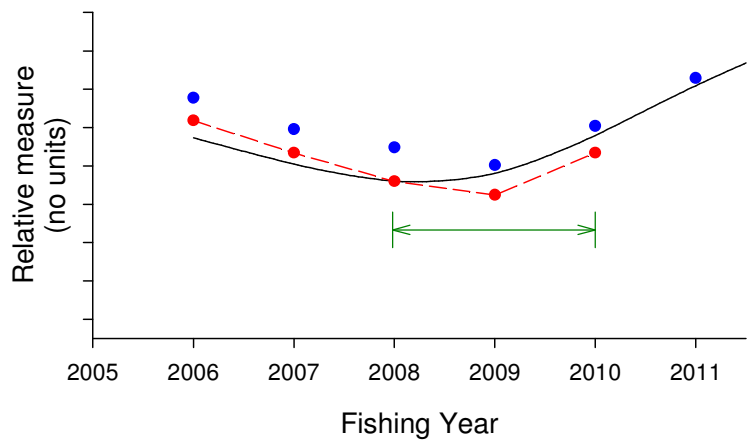


**Figure 3.14** Model estimated available biomass in the WZRLF (black line) from fitting standardised CPUE compared with measures of nominal CPUE (dashed red line) and nominal CPUE from November to February (inclusive; blue symbols) from 2006 to 2011. Two year period for model trend comparison with CPUE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

### 3.5. **WZRLF - Summary**

From 2000 to 2008, annual catches in the WZRLF have 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). However, over the last two seasons, catch has marginally increased and in 2010 was 253 t. Effort has not declined 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. In 2010, nominal CPUE increased by 16% to 0.43 kg/potlift. Patterns of catch and CPUE among regions of the WZRLF are similar to those for the whole fishery.

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 2010 and 2011 reflect the strong PSIs observed across South Australia and Victoria in 2005 and 2006. Adherence to these relationships would suggest continued and increasing levels of relative abundance of legal-sized lobsters through the 2012 fishing year. However, while legal-sized CPUEs have recently increased, it is important to highlight that fixed-site pre-recruit indices decreased in 2011, reflecting declining settlement levels after 2006. Overall, this suggests that the WZRLF is currently experiencing 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 2010 was 72% of the reference year and above the reference limit point. In contrast, the level of available biomass was estimated to be 70% of that in the reference year and below the reference target of 173% of that in 2001. Model projections indicate a TACC of 260 t/yr could, given stable long-term average recruitment, rebuild the available biomass to the biological reference point target by 2020.

# 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). 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. In 2010, it was 149,000 potlifts.

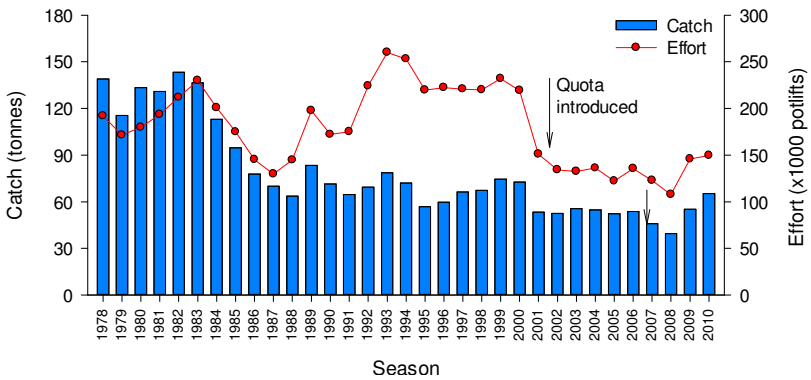


**Figure 4.1** Total catch (tonnes) and nominal effort (x1000 potlifts) in the EZRLF from 1978-2010. ↓ indicate TACC introduction (60 t) and ammendment in 2007 (66 t).

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

Nominal and standardised CPUE show similar trends through time although standardised CPUE indicates a slightly greater level of depletion (Figure 4.2). Nominal CPUE decreased from 1978 (0.74 kg/potlift) to 1995 (0.26 kg/potlift), to the lowest level in the history of the fishery. Following annual increases from 1996 to 2003, nominal CPUE decreased from 2005 to 2008. It has increased in the last two years and, in 2010, was 0.44 kg/potlift, the highest level since 1988.

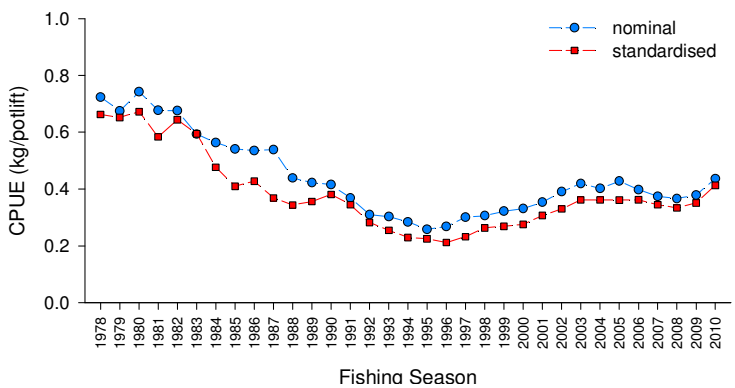


**Figure 4.2** Nominal and standardised CPUE (kg/potlift) in the EZRLF from 1978-2010.

### 4.1.3. Within season trends in CPUE

Over the last three fishing years, monthly levels of nominal CPUE indicate consistent peaks within December to January, with lower catch rates observed from June to November (Figure 4.3). In 2011, compared to 2010, catch rate was higher in all months with the exceptions of August and February. In 2011, the catch rate was highest in January at 0.67 kg/potlift and lowest in June (0.28 kg/potlift).

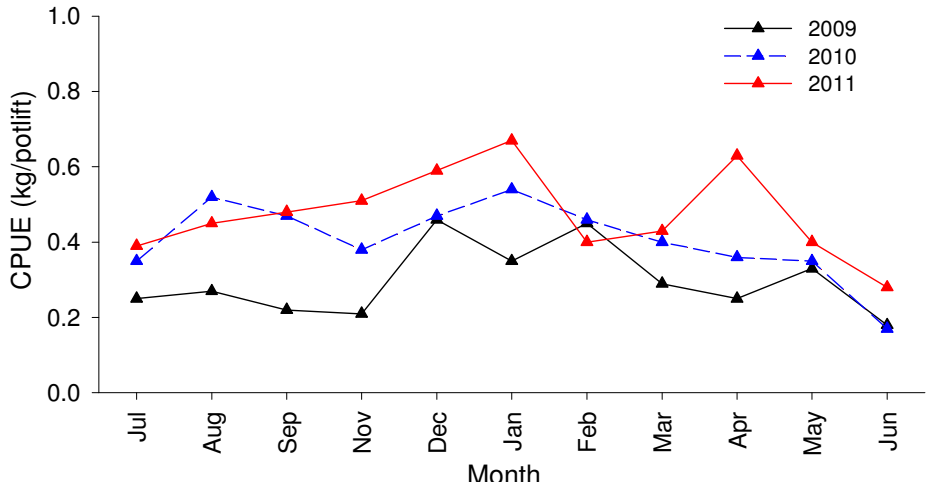


**Figure 4.3** Within season trends in nominal CPUE (kg/potlift) from July to June for the fishing years 2009, 2010 and 2011 in the EZRLF. Note: Data from 2011 are included. Source: Monthly Victorian Rock Lobster catch update June 2012 – based on data from the Fisheries Integrated Licensing System and 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 being 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 2010, annual catches at San Remo have averaged 21.8 t/yr, and in 2010 the annual catch was 27.7 t, the highest level since 1994. Similarly, within the last two years, catches at both Queenscliff and Lakes Entrance have increased and, in 2010, they were 34.9 t and 2.6 t, the highest levels since 2004, respectively.

Trends in effort ('000's 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).

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 0.44 kg/potlift (Queenscliff) and 0.49 kg/potlift (San Remo) in 2010, the highest levels since at least 1988. CPUE at Lakes Entrance has been more variable with less agreement between nominal and standardised CPUE through time. In 2010, levels of CPUE at Lakes Entrance were at 0.20 kg/potlift (nominal) and 0.18 kg/potlift (standardised), the lowest levels on record.

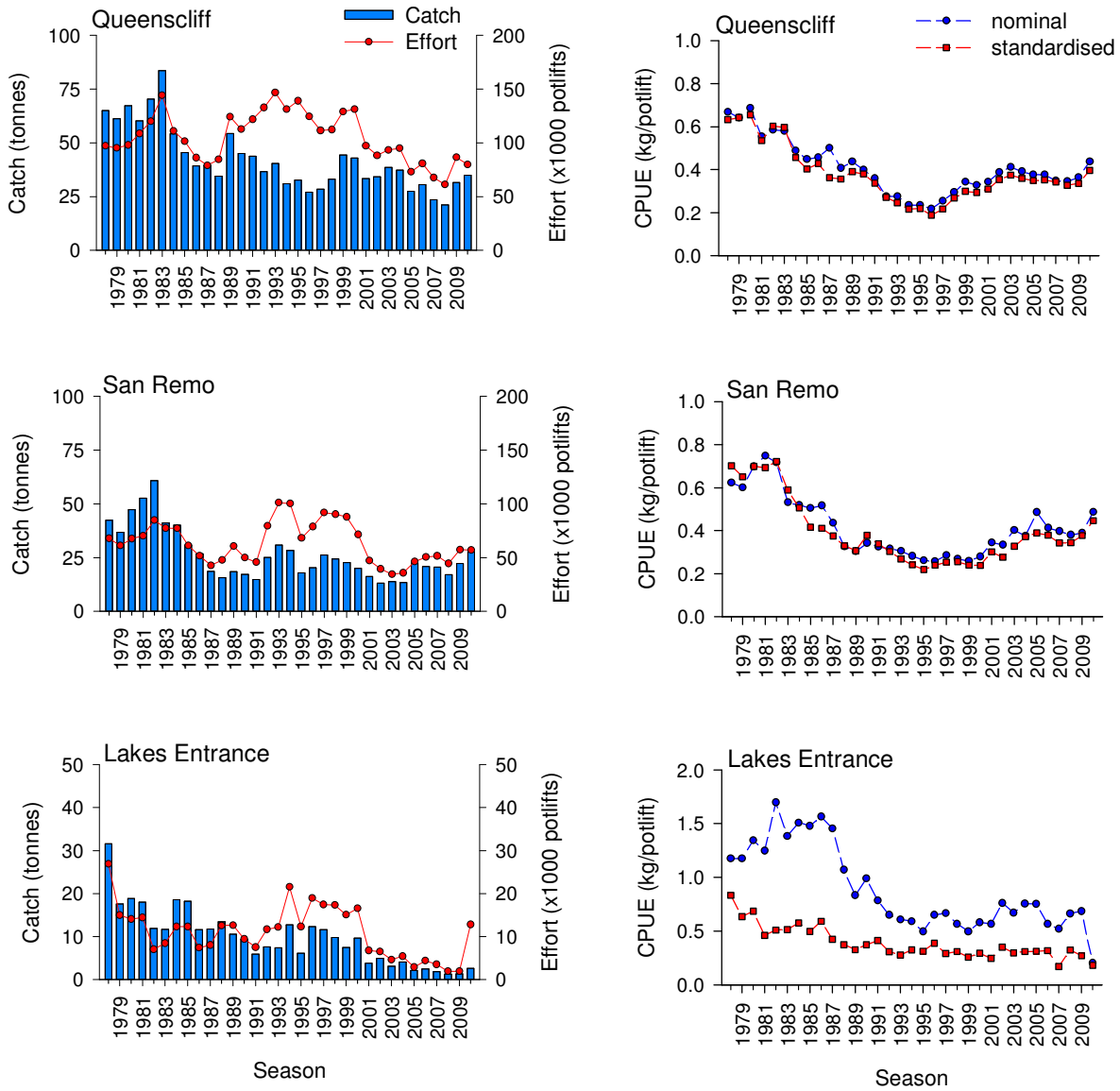


**Figure 4.4** Catch (tonnes), effort (x1000 potlifts) and nominal and standardised CPUE (kg/potlift) in the EZRLF from 1978 to 2010.

## 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 CPUE (number/potlift) in relation to both pre-recruit (under-sized) and legal-sized male and female lobsters 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. Temporal patterns of legal-size catch rates from fixed-site and onboard observer data are generally inconsistent but appear to be about 50% greater in fixed-site surveys compared to the onboard observer program (Figure 4.5).

Catch rates of under-sized lobsters from fixed-site surveys showed peaks in 2002, 2005 and 2008 (males) or 2009 (females), whilst legal-size individuals showed peaks in 2002, 2005, 2007 (females) and substantially increased levels in 2010. 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 further increased levels of CPUE observed during the 2011 season (Figure 4.3).

Catch rates of legal-size lobsters from the onboard observer program decreased between 2004 and 2006, increased in males from 2006 to 2007 and in females from 2007 to 2008, whilst in 2010, CPUE on both sexes decreased to among the lowest levels recorded. These patterns are in contrast with those from fixed-site surveys. Catch rates of under-sized lobsters from the onboard observer program were low (0.01-0.06 lobsters/potlift) and relatively stable.

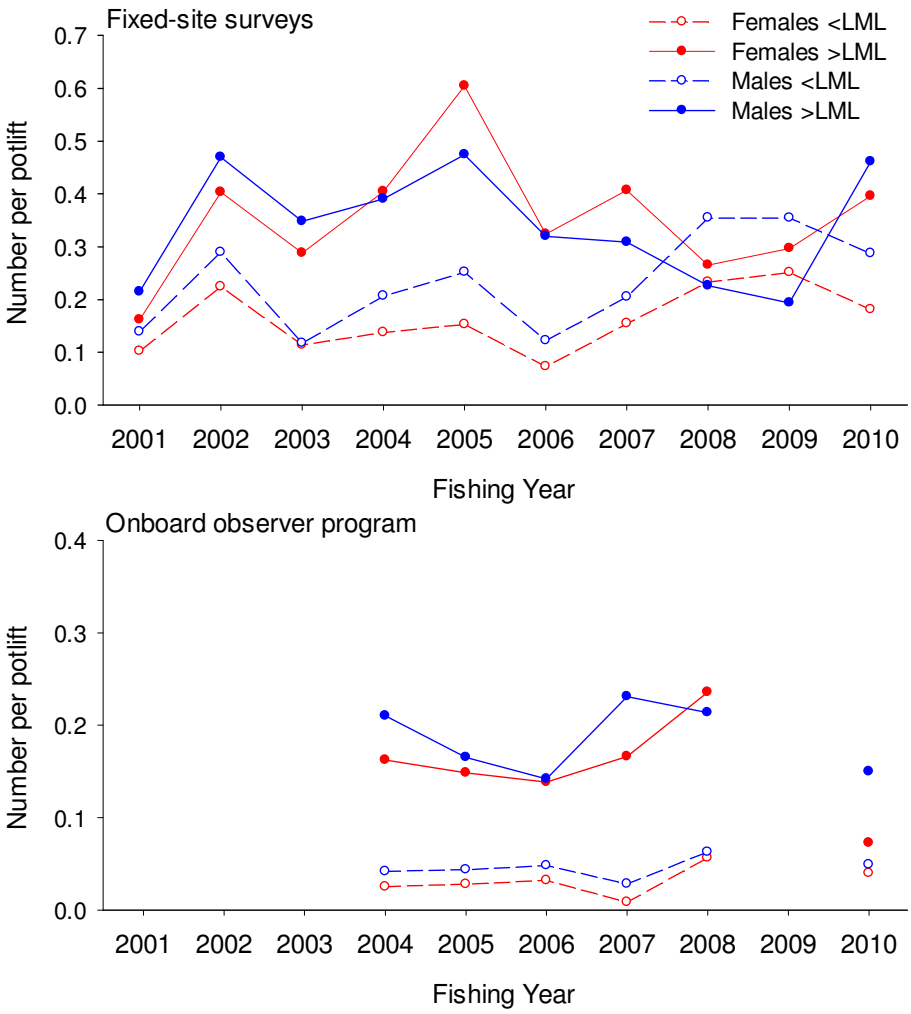


**Figure 4.5** Number of legal and under-sized female (LML = 105 mm CL) and male (LML = 110 mm CL) lobster per potlift in fixed-site surveys and onboard observer program in the EZRLF. Note: escape gaps open on pots for the onboard observer program and closed for the fixed-site survey.

## 4.3. Zonal length-frequency distributions

Length-frequency data obtained through fixed-site surveys and the onboard observer program support changes in commercial catch rates and those from fixed-site surveys, despite low sample sizes in some years (Figure 4.6). From 2008 to 2010, the frequency of legal-sized individuals (105-130 mm CL) increased by >30%, and reflected similar patterns in nominal CPUE (Figure 4.2) and catch rates from fixed-site surveys (Figure 4.5). The frequency of under-sized lobsters (70-90 mm CL) has decreased in the last three years, from between 5-7% (2008) to <2% (2010). These decreases reflect those of model estimated levels of pre-recruits (to 60 mm CL; Figure 4.8) and catch rates of pre-recruits from fixed-site surveys (Figure 4.5).

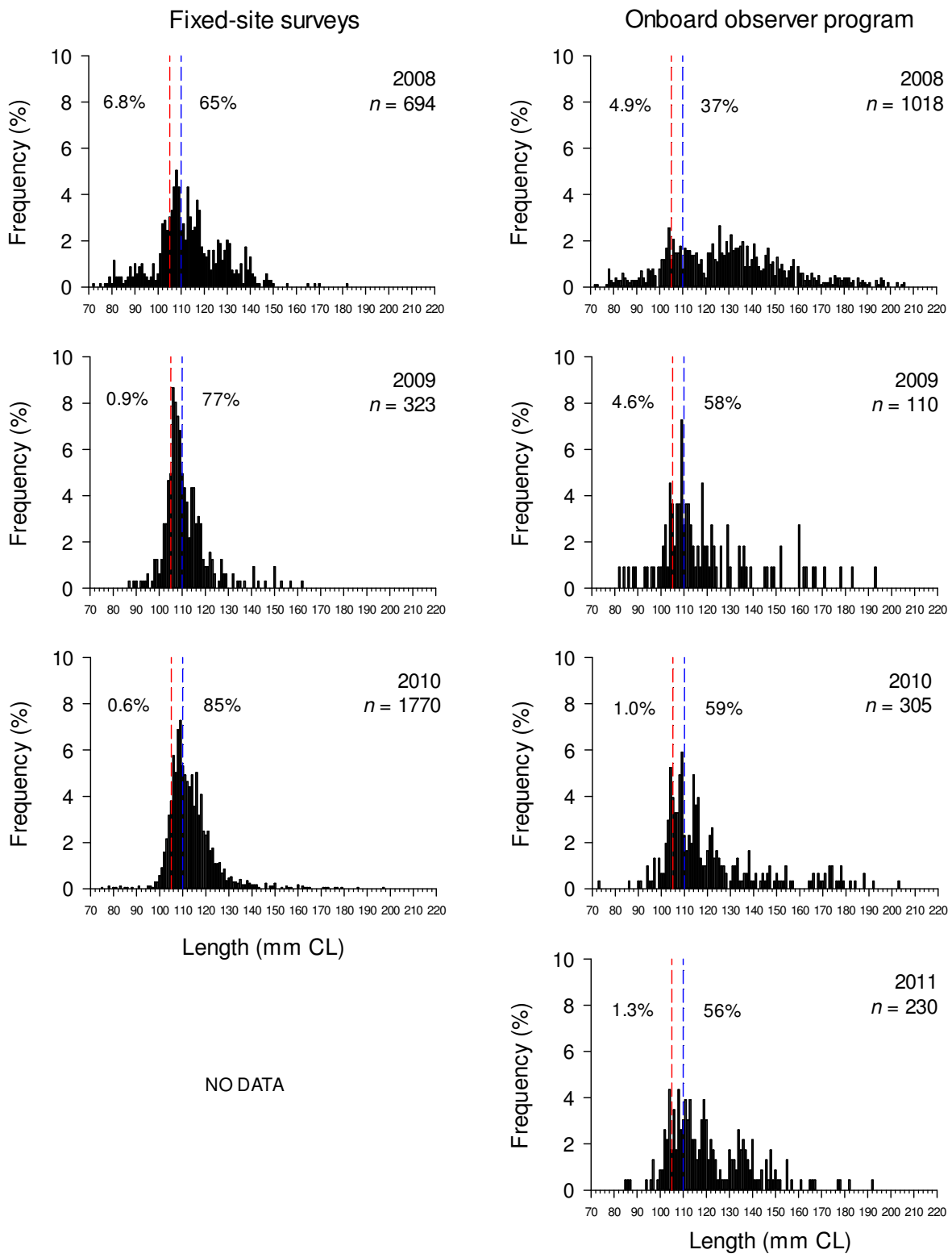


**Figure 4.6** Length-frequency distributions of rock lobsters sampled on fixed-site surveys and the onboard observer program in the EZRLF, from 2008 to 2010 and 2008 to 2011, respectively. The two percentage numbers on each figure represent the cummulative percent of lobsters between 70-90 and 105-130 mm CL, respectively. Red and blue dashed vertical lines represent legal minimum lengths for female and male lobsters, respectively.

## 4.4. Length-structured assessment model outputs

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

Model-estimated average recruitment strength over the last decade was marginally below the long-term average (dashed line 2000 to 2009, Figure 4.7). However, recruitment levels in 2007 and 2008 were the highest estimated and their recruitment to the fishery was supported by recent increases in CPUE (Figure 4.3). Given this relationship, sustained levels of CPUE would be expected to continue into the 2012/13 season. However, it is important to highlight that recruitment in 2009 was below, and in 2010, marginally above the long-term average suggesting that CPUE may be impacted in subsequent years.

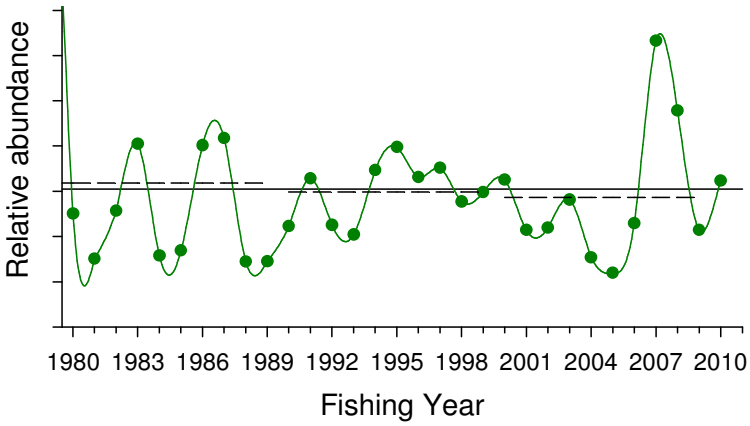


**Figure 4.7** Relative abundance of recruitment to 60 mm CL in the EZRLF, as used in the length-frequency model. Long-term historical average (solid black line) and ten year averages (dashed black lines) are also indicated.

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

Model estimated recruitment indices between the EZRLF and WZRLF have been positively correlated ($R^2$ = 0.67) in recent years (Figure 4.8). Minor differences occur in 2004 and 2007, when the magnitude of the change in relative abundance of pre-recruits is greater in the EZRLF.

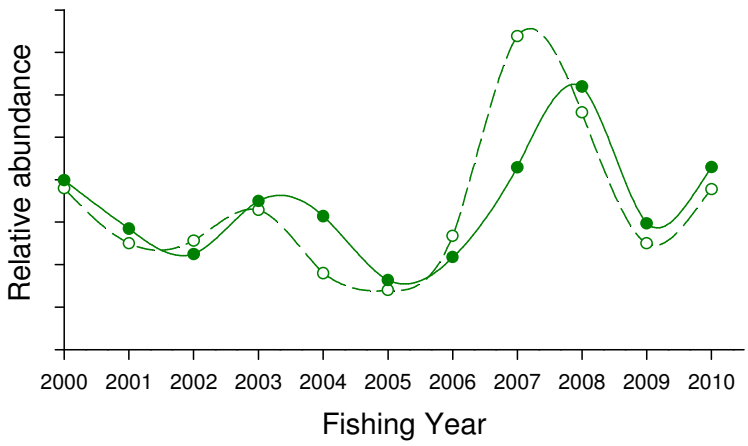


**Figure 4.8** Relative abundance of recruitment to 60 mm CL, in the EZRLF (dashed line) and WZRLF (solid line) from 2000 to 2010. Note plots are presented on different Y-axis scales.

Fixed-site survey estimates of relative abundance of pre-recruit and legal-sized lobsters, that are lagged between 1-3 years, also provide reasonable support to 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 under-sized 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 under-sized 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. Adherence to these relationships suggest increased abundance of legal-size lobsters through 2012/13 followed by a moderate reduction, as reflected by decreases in under-sized from relatively high levels in 2007 and 2008.

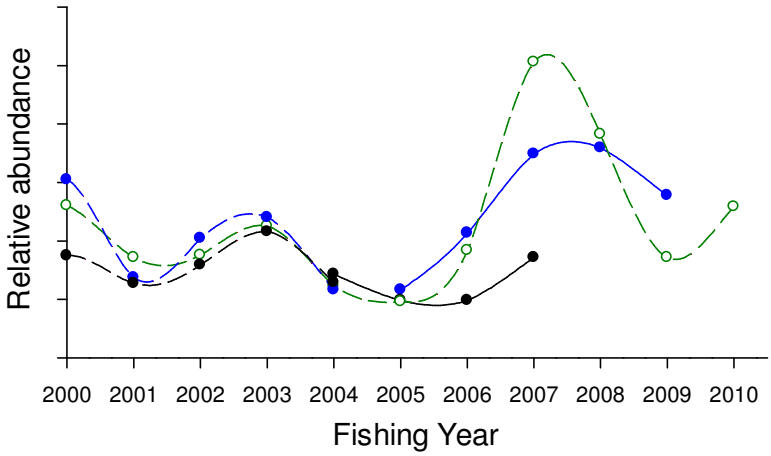


**Figure 4.9** Model estimated relative abundance of recruitment to 60 mm CL (green line) in the EZRLF with lagged fixed-site survey levels of CPUE (lobster/potlift) for pre-recruit (lagged 2 years, blue dashed line; lagged 1 year, solid blue line) and legal-size (lagged 2 years, black dashed line; lagged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

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

#### *4.4.3.1. Egg production*

The level of egg production in 2010 was estimated to be 137% 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).

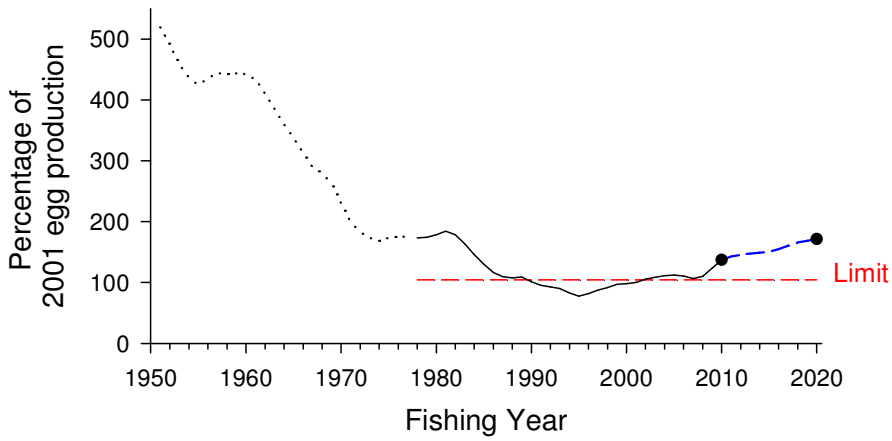


**Figure 4.10** Model estimated level of egg production through time in the EZRLF (above, with 75% probability; black line). Limit reference point (104% of egg production in 2001; dashed red line). Projected egg production (dashed blue line) given a TACC of 48 t/yr to rebuild available biomass to the biological reference point target by 2020.

*4.4.3.2. Available biomass*

The model estimated level of available biomass in 2010 was at 110% 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). Model projections indicate a TACC of 48 t/yr enable available biomass to rebuild to the BRP target by 2020.

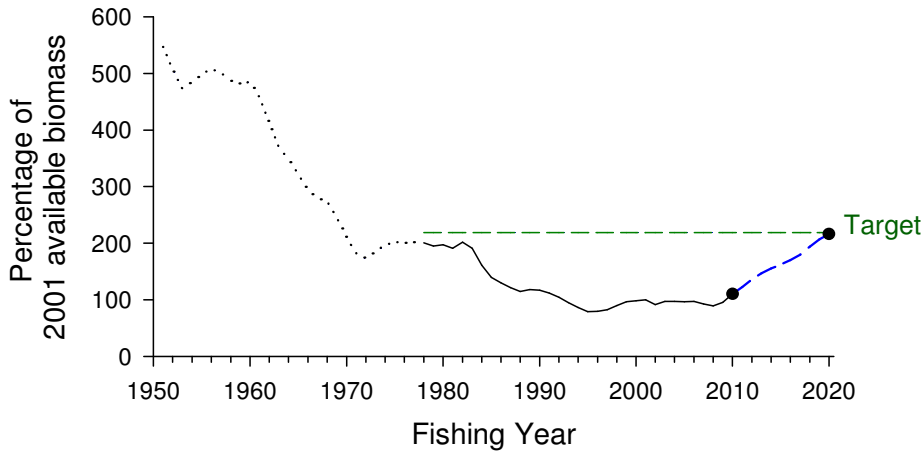


**Figure 4.11** Model estimated levels of available biomass in the EZRLF (above, with 50% probability; black line). Target reference point (173% of available biomass in 2001; dashed green line). Projected available biomass (dashed blue line) given a TACC of 48 t/yr to rebuild available biomass to the biological reference point target by 2020.

<u>Effects of CPUE standardisation on available biomass trajectories</u>

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. These later data also provide information for the 2011 fishing year and further highlight the consistency with the model estimated available biomass trajectory.

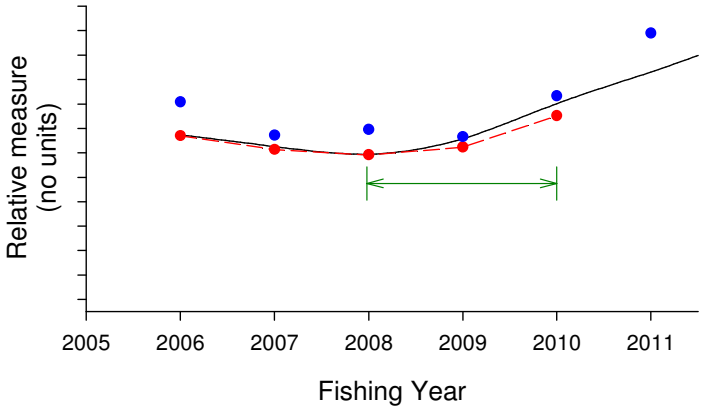


**Figure 4.12** Model estimated available biomass in the EZRLF (black line) from fitting standardised CPUE compared with measures of nominal CPUE (dashed red line) and nominal CPUE from November to February (inclusive; blue symbols) from 2006 to 2011. Two year period for model trend comparison with CPUE (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). However, catches over the last three years have increased and, in 2010, the catch was 65.3 t (TACC; 66 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. It has since increased and in 2010, was 0.44 kg/potlift, the highest since 1988. 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 under-size to legal-size over 2-3 years. As a result, increased abundances of under-sized in 2008 and 2009 were reflected as increases to legal-size catch rates in 2010 and 2011 which should continue into the 2012 season. However, it is important to highlight that under-sized numbers decreased in 2011 reflecting reduced puerulus settlement post-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 level of egg production in 2010 was 137% of that in 2001 and above the limit reference point. In contrast, the level of available biomass was estimated to be 110% of that in the reference year and below the target reference point. Model projections indicate a TACC of 48 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 2010, catch was 11.3 t, which was 5 t less than that in 2009 and less than half of that in 2007.

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. In 2010, CPUE was 0.26 kg/24 hr potlift, the second lowest estimate on record. Since 2008, this indicator has been at the limit (2008) or below the trigger reference point (2009 and 2010).

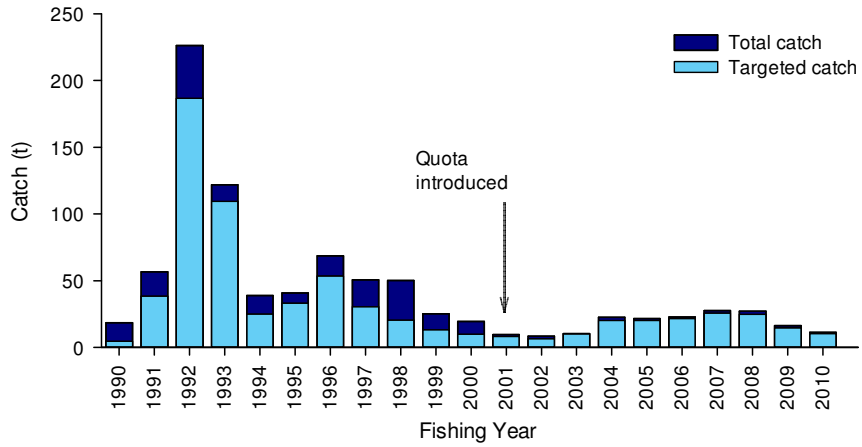


**Figure 5.1** Total catch (t) and targeted catch history for the Victorian giant crab fishery. ↓ indicates TACC introduction in 2001 (25 t).

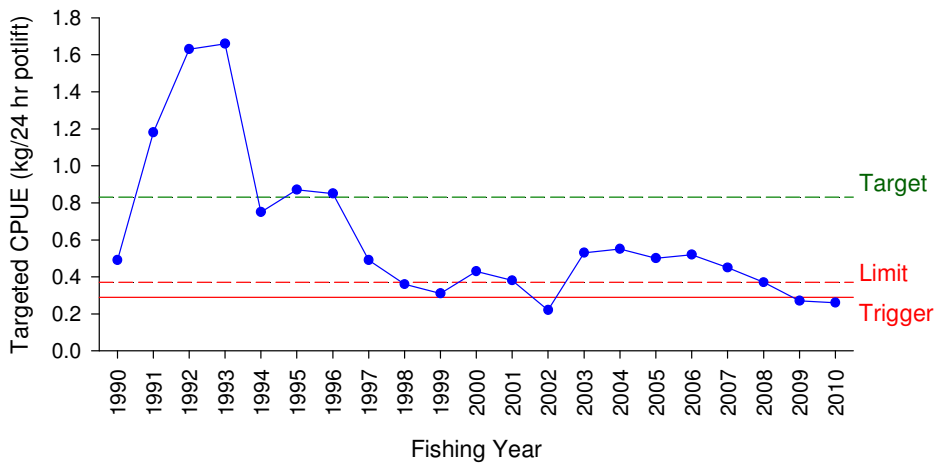


**Figure 5.2** CPUE (kg/24 hr potlift) from targeted fishing by fishers with >1 t catch.

## 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 11.3 t landed in 2010. 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 2010, it was 0.26 kg/24 hr potlift, the second lowest estimates on record and the second consecutive season that CPUE was below the trigger reference point.

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