



# Victorian Rock Lobster Fishery

## Stock Assessment Report

2019/20 Season





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# Contents

<b>1.</b>	<b><u>EXECUTIVE SUMMARY</u></b> .....	<b>7</b>
<b>2.</b>	<b><u>INTRODUCTION</u></b> .....	<b>8</b>
<b>3.</b>	<b><u>TRANSITION TO VIC ECATCH</u></b> .....	<b>9</b>
<b>4.</b>	<b><u>IMPACT OF COVID-19 AND EXPORT LIMITATIONS</u></b> .....	<b>10</b>
<b>4.1</b>	<b><u>TIMING OF CATCH</u></b> .....	<b>10</b>
<b>4.2</b>	<b><u>OTHER FACTORS</u></b> .....	<b>10</b>
<b>5.</b>	<b><u>WESTERN ZONE ROCK LOBSTER FISHERY</u></b> .....	<b>12</b>
<b>5.1</b>	<b><u>Fishery Statistics</u></b> .....	<b>12</b>
<b>5.2</b>	<b><u>Stock structure data</u></b> .....	<b>17</b>
<b>5.3</b>	<b><u>Model Outputs</u></b> .....	<b>21</b>
<b>5.4</b>	<b><u>Application of the Harvest Strategy</u></b> .....	<b>24</b>
<b>6.</b>	<b><u>EASTERN ZONE ROCK LOBSTER FISHERY</u></b> .....	<b>25</b>
<b>6.1</b>	<b><u>Fishery Statistics</u></b> .....	<b>25</b>
<b>6.2</b>	<b><u>Stock structure data</u></b> .....	<b>30</b>
<b>6.3</b>	<b><u>Model outputs</u></b> .....	<b>33</b>
<b>6.4</b>	<b><u>Application of the Harvest Strategy</u></b> .....	<b>36</b>
<b>7.</b>	<b><u>METHODS</u></b> .....	<b>37</b>
<b>7.1</b>	<b><u>Catch Rate Standardisation</u></b> .....	<b>37</b>
<b>7.2</b>	<b><u>Stock Assessment Model</u></b> .....	<b>37</b>
<b>8.</b>	<b><u>REFERENCES</u></b> .....	<b>38</b>
<b>9.</b>	<b><u>SUPPLEMENTARY WESTERN ZONE DATA</u></b> .....	<b>39</b>
<b>10.</b>	<b><u>SUPPLEMENTARY EASTERN ZONE DATA</u></b> .....	<b>47</b>



# Victorian Rock Lobster Fishery

## Stock Assessment Report for the 2019/20 Season

### 1. EXECUTIVE SUMMARY

#### Overview

This report details the results of the 2019/20 stock assessment for the Victorian Rock Lobster Fishery. The assessment includes analysis of the fishery against the stock performance indicators and limit reference points set out in the harvest strategy. The primary objective of the harvest strategy is to ensure that the stocks continue to rebuild. The strategy uses standardised catch rate, egg production levels, pre-recruit abundance and a set of decision rules to determine the total allowable commercial catch (TACC) for each zone in the fishery. This 2019/20 assessment will be used to support the TACC setting process for 2021/22.

#### Western Zone Rock Lobster Fishery

The TACC for the Western Zone in 2019/20 was 246 tonne (t), this was a 1t increase from the previous TACC due to a revision of the CPUE-TACC table in the harvest strategy. The subsequent 2020/21 TACC was also set to 246t.

Overall, the stock indicators in the Western Zone show a marginal improvement. The standardised catch per unit effort (CPUE) improved from 0.64kg/pot-lift in 2018/19 to 0.67kg/pot-lift in 2019/20. The numbers of undersize lobsters have continued to increase from the recent historical low, but are still at very low levels. The pre-recruit index has been below the reference point of 1.81 in the previous six seasons. In 2019/20 the fixed site component of the PRI was above the reference point with a value of 1.99. Due to COVID impacts on observer coverage, the observer component of the PRI index was incomplete and a meaningful combined index could not be calculated.

Egg production has been relatively consistent at 23-24% in the last seven years, in 2019/20 egg production was at 23.0% which is above the 20% limit reference point. Biomass has been increasing slowly from a recent low in 2008/09 to a level 85% higher than this in 2019/20. Recruitment has been below the long term average since 2007/08. The 2019/20 assessment report indicated the first sign of a slightly higher level of recruitment since 2010/11. This occurred in 2014/15 and is linked to the recent rise in PRI, however this higher level was still below the long term average level of recruitment.

#### Eastern Zone Rock Lobster Fishery

The 2019/20 TACC for the Eastern Zone was set at 40t following a reduction to 47t from four previous years of 59t TACCs. This reduction occurred because standardised CPUE reduced further from a recent high of 0.64kg/pot-lift in 2012/13 to 0.36kg/pot-lift in 2017/18. Direct application of the harvest strategy would have resulted in a TACC of 32t in 2019/20, however, as a result of industry consultation a lesser reduction to 40t was implemented. The 40t TACC was retained in the 2020/21 season.

The 2018/19 standardised CPUE increased to 0.41kg/potlift, supporting the rationale used for the previous 2019/20 TACC setting process, however it has reduced back to 0.37 kg/potlift in 2019/20. PRI increased to 0.20 undersize/potlift in 2019/20, a significant increase from the 2018/19 level of 0.08 which was the lowest level since 2005/06, however PRI remains well below the reference point of 0.32 undersize/potlift.

Egg production has fallen from a recent high of 27.2% in 2013/14 to 24.0% in 2019/20 – however remains above the 20% limit reference point. Biomass has followed a similar trajectory decreasing 44% from the recent 2013/14 high. Compared to the previous season, biomass in 2019/20 decreased a further 3%. Recruitment has been below the long term average since 2008/09 but there is some evidence of recent higher recruitment in 2015/16 and 2016/17 which is also apparent in the PRI.

## 2. INTRODUCTION

The *Victorian Rock Lobster Fishery Management Plan* requires annual assessment of the southern rock lobster (*Jasus edwardsii*) stock in Victoria to enable a review of the stock and setting of the annual TACC (Victorian Fisheries Authority 2017).

The Victorian Rock Lobster Fishery is divided into two separately managed zones; the Western Zone and the Eastern Zone. The two zones are assessed separately and a TACC for each zone is determined using the fishery's harvest strategy. Each licence holder is then assigned a proportion of the zonal TACC based on the quota units attached to their licence. The quota units are transferable, through permanent sale or temporary lease, throughout the zone.

The data collected to assist in the assessment of the fishery against the reference points includes data from commercial catch and effort logbooks, a fixed-site survey program, an on-board observer program, puerulus sampling, in-port sampling of legally-sized rock lobsters (discontinued in 2016/17), and a voluntary sampling program (which has been expanded from 2016/17 onwards).

The performance of the fishery is evaluated against the stock performance indicators and associated limit reference points specified in the fishery's harvest strategy (refer to Appendix 1 for more detail). The key indicators are egg production, standardised CPUE and pre-recruit abundance. The annual TACC is determined using a set of decision rules:

1. **Egg production** - the model estimated egg production must be above the limit reference point of 20% of unfished levels, with a 90% probability.
2. **Standardised CPUE** – to maintain the predetermined exploitation rates (26.3% and 20.5% of the available biomass in the western and eastern zones, respectively) the standardised CPUE must be above 0.40kg/pot-lift. If the standardised CPUE falls below this, exploitation rates are decreased. If the lower limit of 0.25kg/pot-lift is reached, the zone is closed to all fishing.
3. **Pre-recruit index** – to be eligible for a TACC increase, the PRI for that stock assessment period must be above the PRI threshold level for that zone. The PRI thresholds are:
  - a. 1.81 undersize per pot-lift in the Western Zone, and
  - b. 0.32 undersize per pot-lift in the Eastern Zone.

Available biomass is used as a secondary reference point. Whilst not used in the TACC determination it is monitored as part of the overall stock health. As the harvest strategy uses standardised CPUE, all references in this report (unless specified otherwise) are therefore standardised values.

The PRI is determined using data from fixed-site surveys and on-board observations and is averaged, weighting regions by their past commercial catch. The calculated PRI is then compared against the PRI threshold level, calculated from a reference period 2005-2014.

This report summarises the fishing activity and stock status of each zone for the 2019/20 season and provides the outputs from the southern rock lobster stock assessment model, including estimated egg production and available biomass.

### 3. TRANSITION TO VIC ECATCH

Both Western and Eastern Zone fisheries transitioned from paper logbooks to electronic reporting via Vic-eCatch in July 2020. To ensure that the reporting of rock lobster catch and effort data was consistent throughout this transition, a number of fishers were asked to continue using paper logbooks, whilst also reporting using the Vic-eCatch App. A total of nine fishers from across the Eastern and Western Zone provided this additional data between July and September 2020. It was shown that the data from the two sources was very similar, with less than a 1% difference between most parameters (Table 1).

Table 1: Comparison of rock lobster catch and effort data reported in paper logbooks, with that reported in Vic-eCatch by a sample of 9 fishers between July and September 2020.

Variable	Paper logbook	Vic eCatch	% difference
<b>Potlifts</b>	37,168	37,012	↓ 0.4%
<b>Number lobsters</b>	19,505	19,568	↑ 0.3%
<b>RL dead</b>	4,114	4,078	↓ 0.8%
<b>RL undersize</b>	15,899	15,804	↓ 0.6%
<b>Berried</b>	12,482	12,691	↑ 1.7%

## 4. IMPACT OF COVID-19 AND EXPORT LIMITATIONS

### 4.1 TIMING OF CATCH

The combined effect of COVID-19 and export limitations resulted in a dramatic beach price reduction from late January 2020 onwards. In response, quota roll-over provisions were introduced allowing fishers to delay catching some 2019/20 quota until the 2020/21 season. In the Western Zone a total of 18,269.55t was rolled over, in the Eastern Zone 2,862.72t was rolled over. This corresponds to 7.4% and 7.1% of the TACC respectively.

This issue is further complicated by the fact that the assessment year is different to the quota season, consequently there can be compounding additional shifts within a season. For the Western Zone the 2019/20 fishing season (November to September) catch was 217t which is notably lower than the 225-254t catches seen in recent years (excluding the year where quota was bought back). For the Eastern Zone the catch for the fishing season (November to September) was 36t, this is notably lower than recent years, however this is almost entirely due to the reduction in TACC and the proportion of catch caught in the fishing season is not atypical.

Potential seasonal shifts of catch and their impact on CPUE due to seasonal catchability changes are correctly addressed by the CPUE standardisation process. The effect that is of concern is the robustness of the harvest control rule due to the delay.

For the Western Zone, the shift in catch is relatively minor in the context of applying the harvest control rule as the PRI has been restraining the TACC and CPUE is presently higher than that corresponding to the current TACC.

For the Eastern Zone, the 2019/20 CPUE is on the threshold to a lower band than the current TACC corresponds to. Hence any effect needs to be considered carefully. However, given the small amount of roll-over and the minimal change in catch between fishing seasons this is unlikely to have had a notable effect.

### 4.2 OTHER FACTORS

The change in markets has resulted in other changes in fishing behaviour that may influence the collected data and the assessment of the stock. This change is through market drivers such as altered demand for different grades of lobster following a shift to new markets (e.g. increased supply to domestic Australian market).

Many factors are addressed through the CPUE standardisation process ensuring that the index is robust to changes in fishing patterns from season to season. These factors are:

- The vessel and skipper
- Depth (deeper/shallower than 40m)
- Catch month
- Region

Changes in fishing behaviour that are not incorporated in the CPUE standardisation process or that occur at a finer resolution may cause changes in the CPUE index that are not related to changes in the underlying biomass. Examples of the latter include changes in the depth fished within the shallower than 40m depth band and changes in spatial fishing patterns within a region.

A potentially important change in fishing behaviour that is not included in the CPUE standardisation process is more sporadic fishing due to unstable market demand which may result in decreased efficiency. This change was identified by fishers as the first shots after a pause in fishing are often exploratory and less efficient until productive fishing grounds are identified. Consequently, an increase in fishing interruptions may lower CPUE independent of any changes in biomass.

## 5. WESTERN ZONE ROCK LOBSTER FISHERY

### 5.1 Fishery Statistics

#### Trends in catch, effort and CPUE

The TACC for the Western Zone in 2019/20 was 246 tonne (t), this was a 1t increase from the previous TACC due to a revision of the CPUE-TACC table in the harvest strategy (*Table 3*). This follows on from four years of 230t TACCs.

The 2019/20 TACC was retained in the same CPUE band from application of the harvest strategy to the 2018/19 season – despite increasing CPUE, low PRI prevented an increase in the CPUE band (see 2018/19 assessment for more details). However, the CPUE-TACC table in the harvest strategy was revised to include the latest information from the stock assessment model, this resulted in the TACC for that CPUE band increasing from 245t to 246t and the 2019/20 TACC was therefore set at 246t. Following the same rationale the 2020/21 TACC remained at 246t.

The effort required to take the catch was 270,096 pot-lifts, which is a substantial reduction from 206,661 in 2018/19 (*Table 2, Figure 1*). The reduction in this season was attributable to a reduction in catch, both due to the quota roll-over provisions and altered timing of fishing within the quota season (the fishing season does not coincide with the quota season). Separate to this, rising nominal catch rates over the last decade have resulted in potlifts decreasing by over 50% during this period. The reduction in the number of potlifts required to catch the TAC drove the consolidation of the fleet from approximately 100 active vessels through the 1990s to 43 active vessels in 2019/20.

Trends in nominal and standardised catch rates have been consistent since the 1980's. A record low of 0.34 kg/pot-lift (standardised) was reached in 2009/10. Since then, standardised CPUE has been increasing and has reached 0.67kg/pot-lift in 2019/20. Notably, the fishery has previously fluctuated around this level from the mid-1980s through to the decline in the mid-2000s (*Table 2, Figure 2*). Nominal and standardised CPUE have diverged in recent years – this is primarily due to a shift to a more efficient fleet that will have higher CPUE for the same biomass. The standardised CPUE removes this effect to provide the best index of stock abundance.

When examined by region, the breakdown of catch is similar to previous years. The highest catch in 2019/20 came from the Portland region at 123t, followed by Apollo Bay at 49t and Warrnambool at 45t. Compared to the previous 2018/19 season, Warrnambool standardised CPUE was stable at a high level, while Portland CPUE has continued to increase and after eight years of increases Apollo Bay had a CPUE reduction for the second year in a row (*Figure 3*).

#### Recreational Catch

On 1 July 2017, the VFA implemented a three-year pilot program requiring all recreational fishers to tag the lobsters they catch and keep and report the use of tags. The objective of the program is to obtain an estimate of the annual recreational catch by using the number of tags used in that season to represent the number of rock lobsters removed from the stock.. Recreational catch estimates produced by this program are now used in the assessment model.

In the 2019/20 season 4343 kg were caught and retained by recreational fishers in the Western Zone. This is a substantial reduction from 6346 kg in the previous season and is largely due to fishing restrictions related to COVID lockdowns. Since commencement of the program the recreational catch has varied from a high of 2.8% of the TACC in 2017/18 to 1.8% in the COVID affected 2019/20 season.

A comprehensive report on this program “Victorian Recreational Rock Lobster Tagging Program Summary Report Season 3: November 2019 – September 2020” is available from VFA.

### **Trends in the commercial fleet**

The number of active fishing vessels decreased from a high of 141 in 1988/89 to approximately 100 through the 1990s, and further to a record low of 41 vessels in 2017/18, increasing again to 43 active vessels in 2019/20 (*Figure 4*). During the same period the average annual catch increased from a record low of 2.4t per vessel in 1988/89 to a record high of 5.9t per vessel in 2000/01 (5.1t in 2019/20) (*Figure 5*). The number of days fished also increased from a record low in 1988/89 at 28 days per vessel to 48 days in 1993/94 as the fleet contracted and the catch per vessel increased (*Figure 5*).

In the last six years the average annual catch has been consistently between 4.7t and 5.7t (5.1t in 2019/20) whilst the average number of days fished decreased from a record high of 60 days in 2012/13 to 48 days in 2019/20. This trend in increased fishing activity among a smaller number of vessels is consistent with fleet consolidation and efficiency gains expected from an individual transferrable quota (ITQ) system, however, in this fishery this has also largely been driven by changes in catch and TACC.

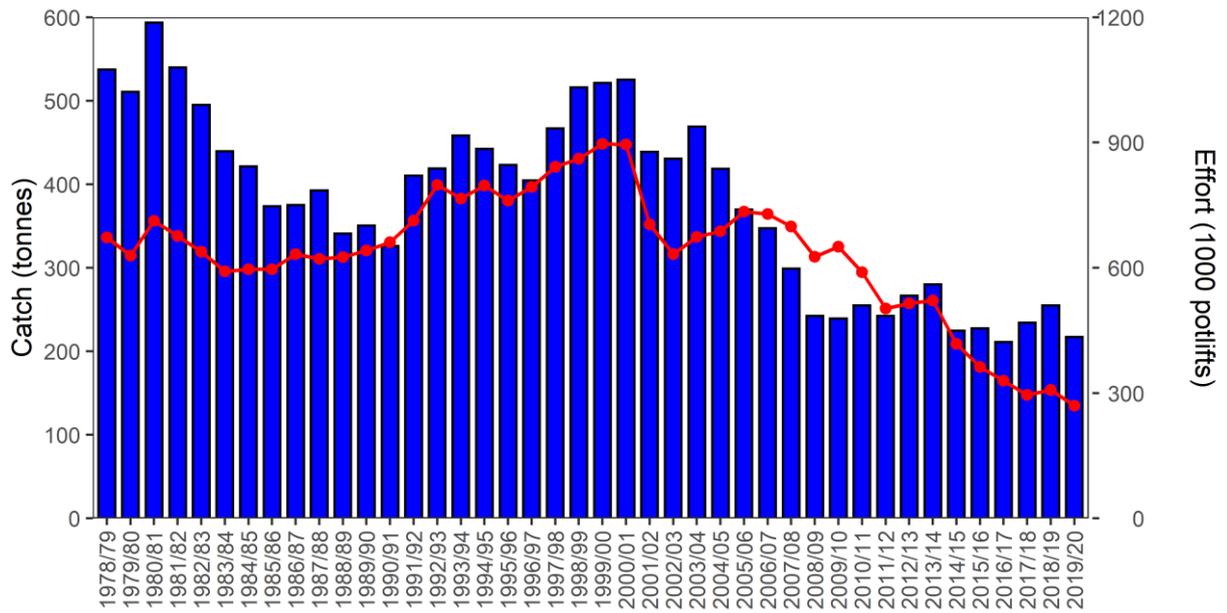


Figure 1: Total catch (blue bars; tonnes) and nominal effort (red line; x1000 pot-lifts) in the Western Zone.

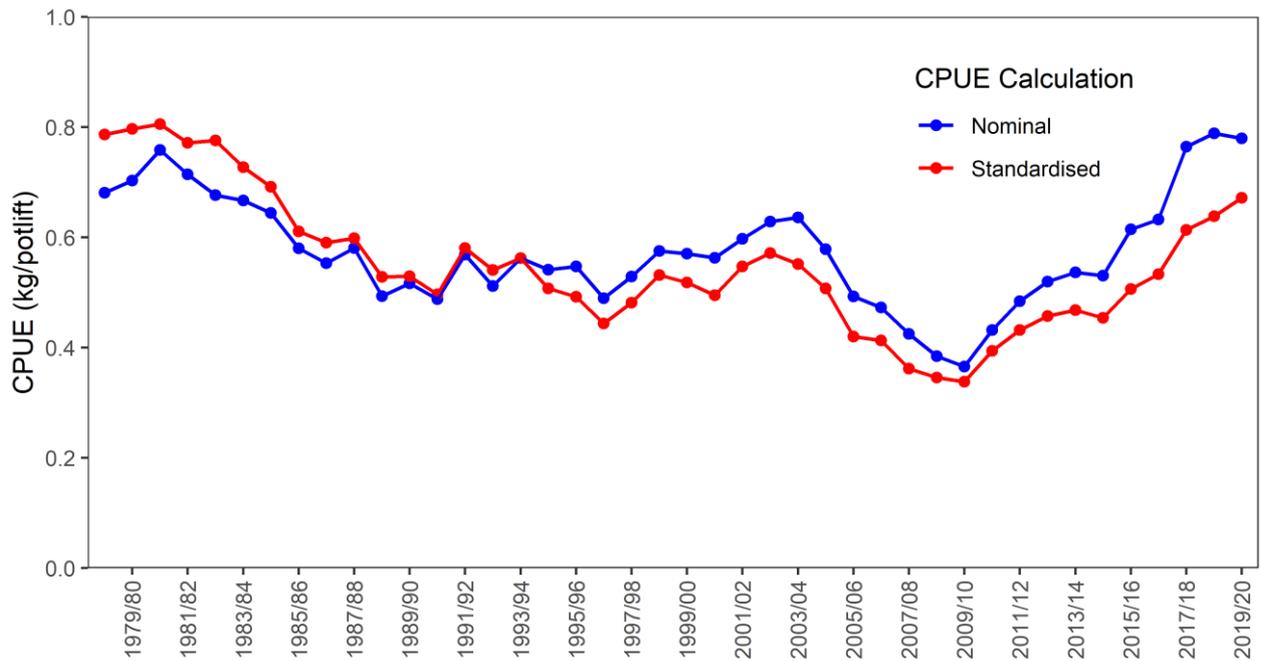
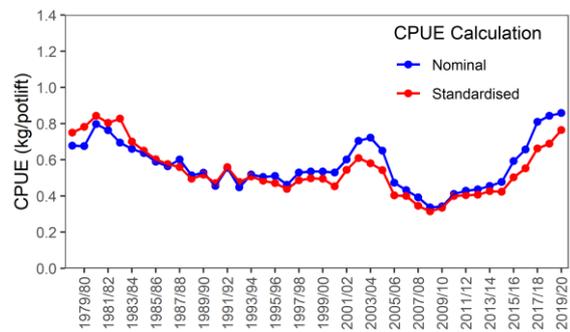
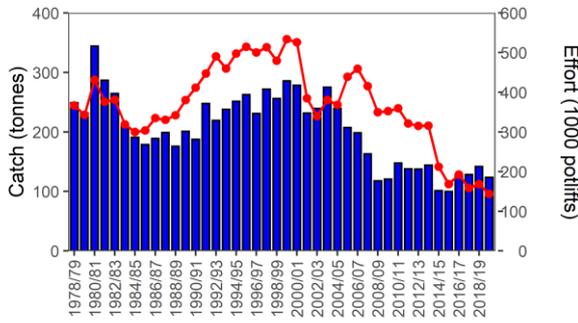
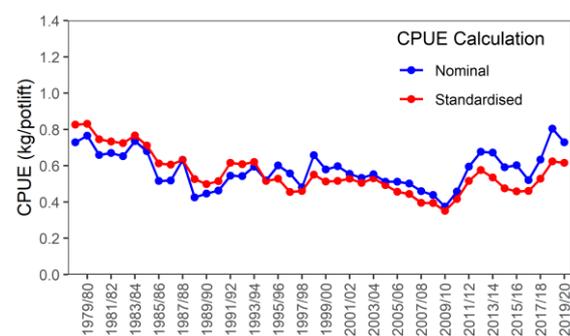
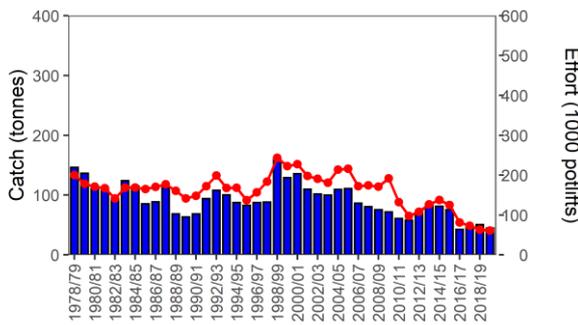


Figure 2: Standardised versus nominal CPUE (kg/potlift) in the Western Zone. Note that standardised CPUE values differ slightly from one assessment to the next as the depth, seasonal and fisher coefficients are shared across years and are re-estimated including the new data.

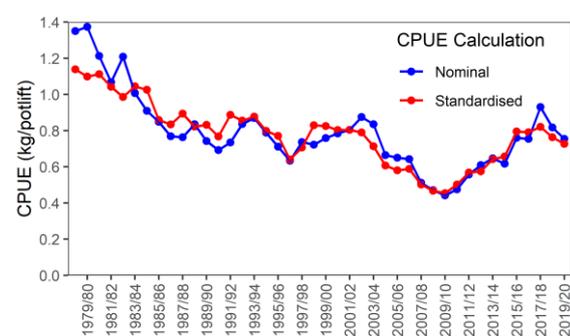
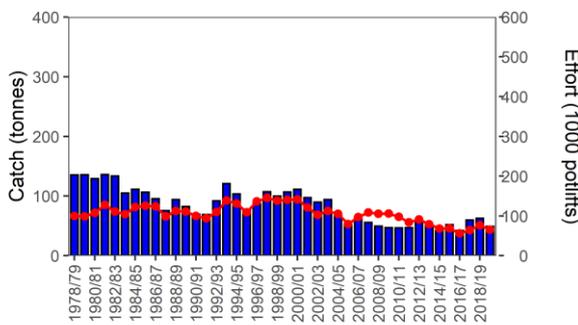
**PORTLAND**



**WARRNAMBOOL**



**APOLLO BAY**



Fishing Year (Nov – Sept)

Figure 3: Regional catch (blue bars), effort (red line), and standardised CPUE (kg/potlift) in the Western Zone.

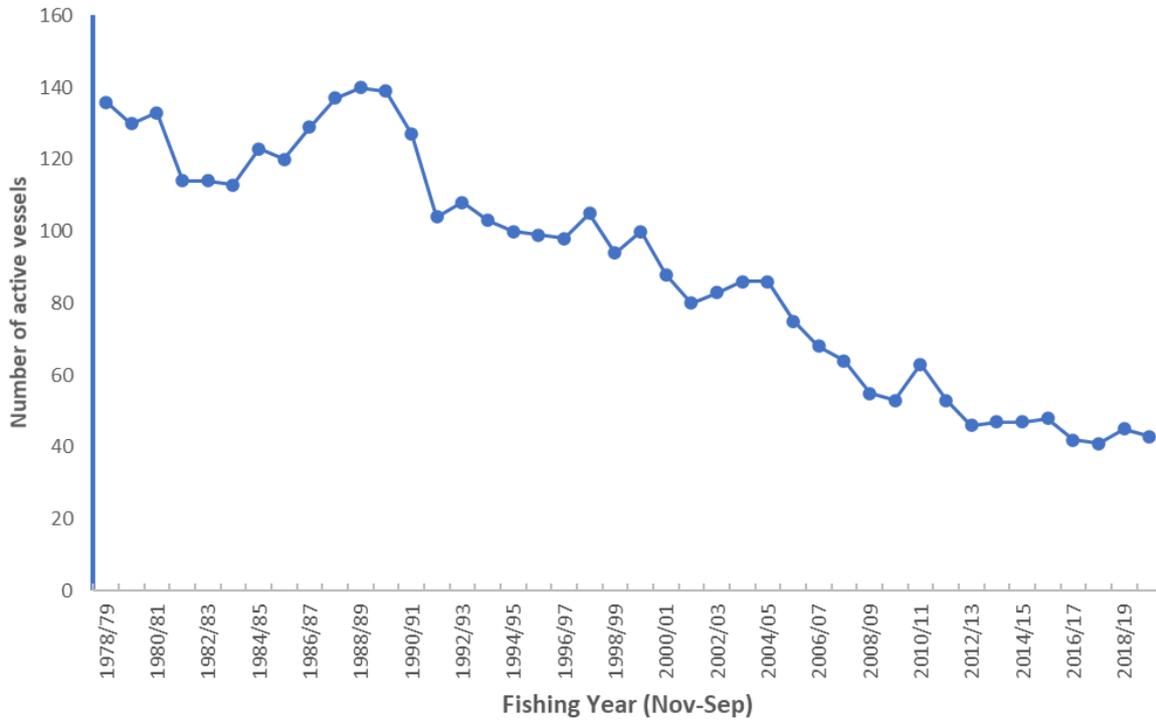


Figure 4: The number of active vessels in the Western Zone in each fishing year.

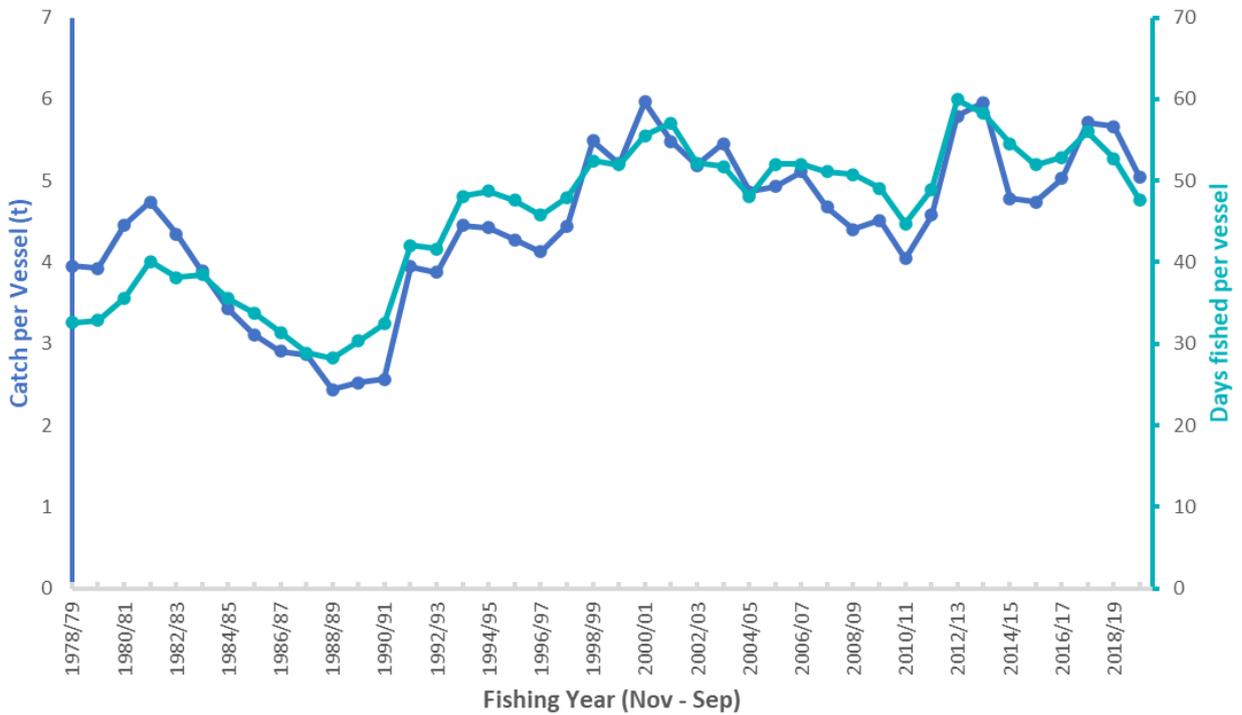


Figure 5: The annual mean catch and mean number of days fished per active fishing vessel in the Western Zone

## 5.2 Stock structure data

### Trends in recruitment

Catch rates of undersized lobsters (animals between approximately 80mm carapace length (CL) up to the legal minimum lengths (LML)) are estimated from the fixed-site surveys (closed escape gaps) and the on-board observer program (open escape gaps). The fixed-site surveys have been conducted each year since 2001/02 and the on-board observer program has been in place since 2004/05.

The PRI indices calculated from both these data sources show similar trends with a rapid decline from the recent peak in 2011/12 to record or near record low levels over the last four years. Since the lowest value was attained in 2015/16, PRI has been slowly trending upwards. PRI from the fixed sites saw a substantial increase in 2019/20 (*Figure 6*). Observer and fixed site PRI have previously been highly correlated with the observer PRI typically having higher values.

As a consequence of COVID restrictions, full coverage was not obtained in the observer program. The observer sites that were completed are by chance those with typically the lowest PRI (Port Fairy and Warrnambool), consequently the observer based PRI is not representative and substantially negatively biased. The combined PRI index is obtained from the average value of the fixed site and observer based index, consequently this is also negatively biased. The combined PRI is therefore considered incomplete for the assessment period.

Whilst not formally considered in application of the harvest strategy, the following data sets were considered in assessing likely changes in undersize abundance:

#### Undersize returns from logbooks

Undersize returns from logbooks indicated a similar increase in 2019/20 as the fixed site survey. However, completion of this component of the logbook has changed substantially through time, hence some of the observed change may be due to differences in fisher recording of this information as opposed to changes in biomass.

To address the potential bias in recording, a group of fishers self-identified as having consistently reported undersize returns in their logbooks for many years. This allows a consistent undersize return rate to be calculated from these fishers and provides the best ancillary data in addition to the PRI. This index rose only marginally in 2019/20.

#### Voluntary length frequency sampling

Voluntary sampling of length frequency data was at an 18 year high in 2019/20 with 1630 lobsters measured. The undersize index calculated from this data rose substantially in 2019/20 comparable to the increase in the fixed site survey. However, participation in this program has changed substantially with very few fishers having participated for more than the last two years, consequently at present the use of this data to investigate temporal trends is limited.

### Mean weight

The mean weight of legal sized lobsters has increased over the last nine seasons (*Figure 7*), although this rate of increase has slowed in the last three seasons. The overall increase is an additional indicator of low recruitment to the fishery. However, it has been noted that mean weight may also be increasing as a result of lower yearly effort and therefore lower levels of exploitation on the stock, which may be allowing lobsters to survive longer prior to being harvested. Additionally, there has been a disproportionate increase in the beach price of large lobsters. Anecdotal reports suggest this has influenced fishing behaviour and selectivity, thereby contributing to an increase in mean lobster weight.

### Length-frequency distributions

In addition to numbers of undersize lobsters, the fixed-site surveys and observer program collect data on the length-frequency distribution of lobsters in the population. The trends in the length-frequency data are consistent with the trends in pre-recruits and legal-size commercial catch rates. From the late 2000s to present there has been a substantial decrease in the abundance of small lobsters including both animals below the LML and animals within approximately 10mm of the LML. The CPUE has been maintained at a high level through an increase in abundance of larger animals. This dramatic change is highlighted in *Figure 8* with full length-frequency details provided in *Figure 25* to *Figure 28*. The one exception to this general trend is females from the observer program which have showed an increase across most size classes.

The effect of lobster growth contributing substantially to the CPUE trend was considered by the RAG which also examined a CPUE index using numbers per potlift. The RAG concluded that standardised CPUE expressed in kg per potlift remains the best proxy for biomass and is consequently the best index to use in the harvest strategy as the TAC is set around a target exploitation rate of that biomass. Changes in length-frequency should be taken into account separately and through the stock assessment model results for biomass and egg production.

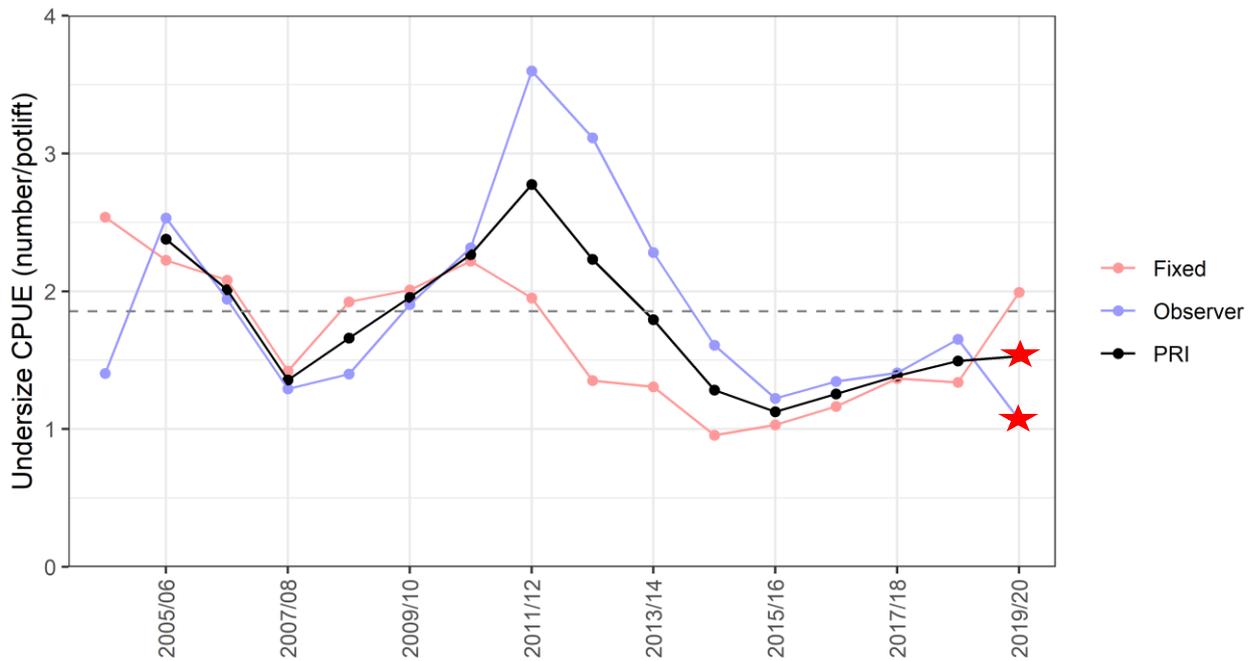


Figure 6: The undersize catch rate (kg/potlift) for the Western Zone as calculated from fixed sites, observer coverage and the final combined PRI. The dashed line shows the trigger point (1.81 undersize/potlift). The 2019/20 observer PRI was based on two sites only, hence that value and the combined PRI value are inconsistent with previous years, these values are highlighted with a star.

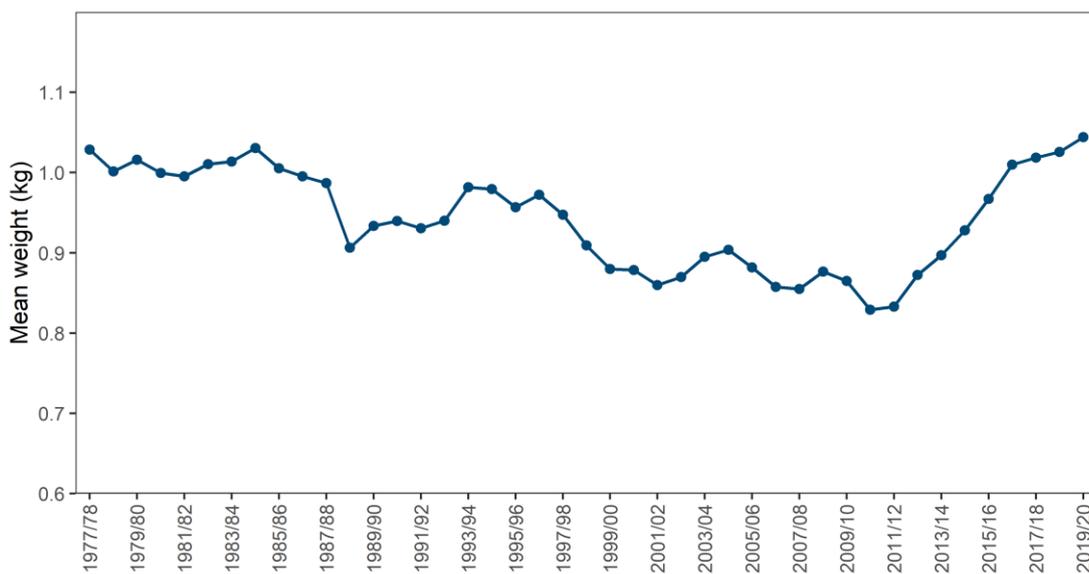


Figure 7: Mean weight of legal sized lobster in the Western Zone fishery.

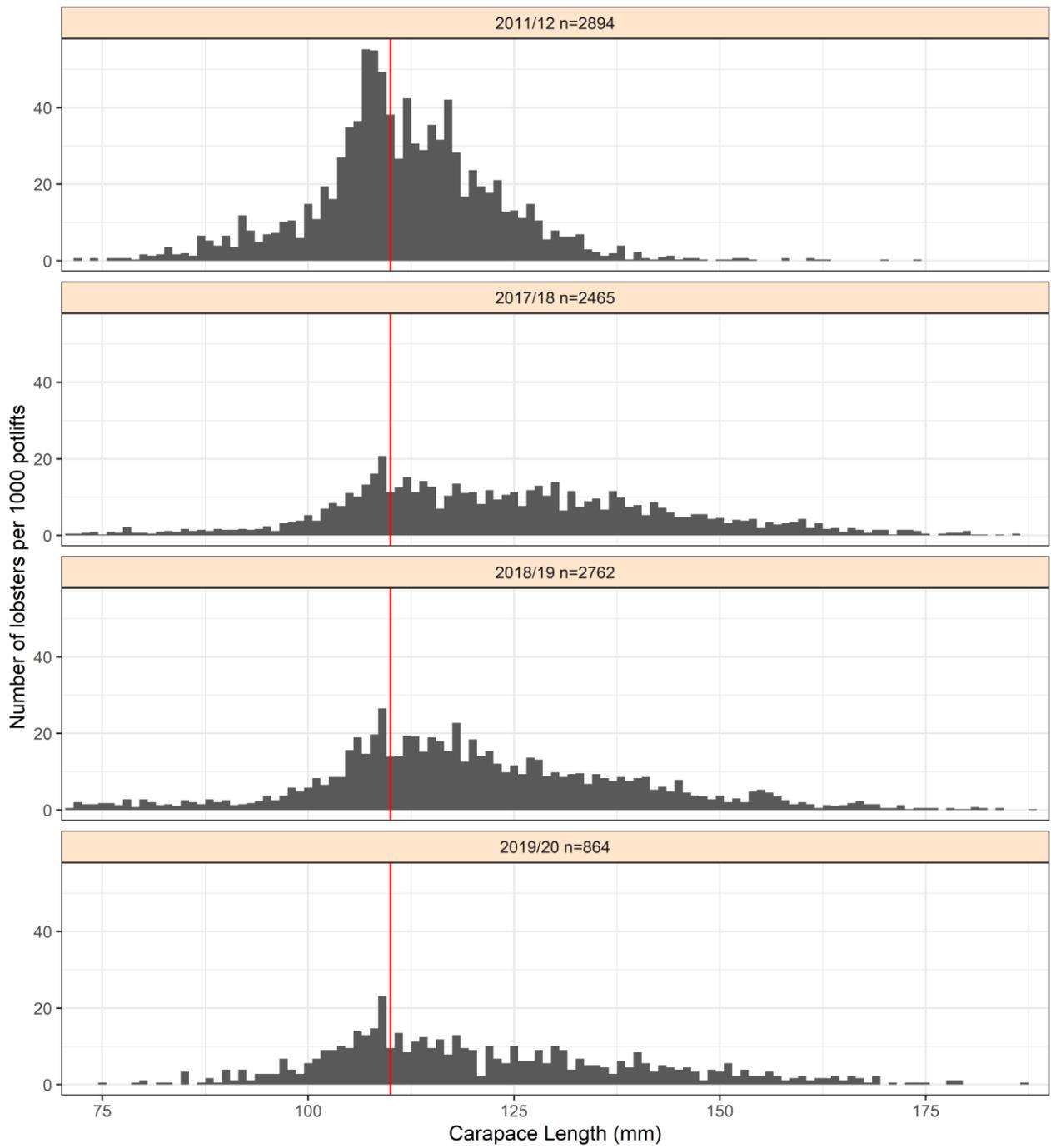


Figure 8: Length-frequency plots for 2011/12 and the last two seasons for male lobsters measured by the Western Zone observer program to highlight the changes that have occurred.

## 5.3 Model Outputs

### Estimated recruitment

Model estimated recruitment to 60mm CL has been highly variable over the past 30 years, with a distinct change in the relative abundance over the length of the time series. Between 1988/89 and 1999/00, recruitment was mostly above the long-term average. Conversely, from 2001/02 onwards, with the exception of 2007/08 and 2008/09, recruitment has been well below the average (*Figure 9*). It is therefore likely that the recent increases in catch rate are due to the animals from 2007-09 growing and becoming part of the available biomass, with comparatively little recruitment since that time. The exception to this is that in this assessment the new length frequency data indicates that there was an increased level of recruitment to the 60mm size class in 2015/16, as seen in the fixed site PRI.

### Estimated egg production

The harvest strategy sets a model estimated egg production limit reference point of 20% of unfished levels. The Western Zone egg production has never fallen below the limit reference point. In 2019/20 egg production was at 23.0%, which is above the 20% limit reference point (*Figure 10*). There has been a gradual decline in egg production over the last two years from a high of 23.6% in 2017/18 (revised from previous assessment).

Egg production was also found to have a greater than 90% probability of being above the limit reference point as required by the harvest strategy.

### Estimated available biomass and exploitation rate

It should be noted that whilst trends in biomass and exploitation rate are consistent across stock assessments, the absolute values may all scale up or down as different parameter estimates are obtained.

Under the increasing exploitation rates experienced between 1980/81 and 2000/01, the modelled available biomass indicates a downward trend for the first decade before entering a phase of stability fluctuating around 820t between 1987/88 to 2003/04. Exploitation rates dropped in 2001/02 with the introduction of quota, but steadily increased to a historical high of 65% in 2006/07. The corresponding available biomass decreased and reached a low of 451t in 2008/09. After 2006/07, the exploitation rate dropped significantly, and the available biomass improved. In 2019/20, the estimated available biomass decreased by 1% to 834t, with a corresponding fishing exploitation rate of 26.6% (*Figure 11*).

### Model diagnostics and potential biases

Two key datasets that the stock assessment model is fitted to are the standardised CPUE data and length-frequency data. Selected model diagnostics for both data sets are shown in *Figure 29* and *Figure 30*. These show that the model generally fits well to both datasets (note that CPUE fits in the lower catch periods (e.g. period 10) are of less importance). However as shown in *Figure 12*, CPUE in the most recent year is slightly under-estimated and consequently the 2019/20 biomass and egg production estimates are likely to be similarly slightly under-estimated.

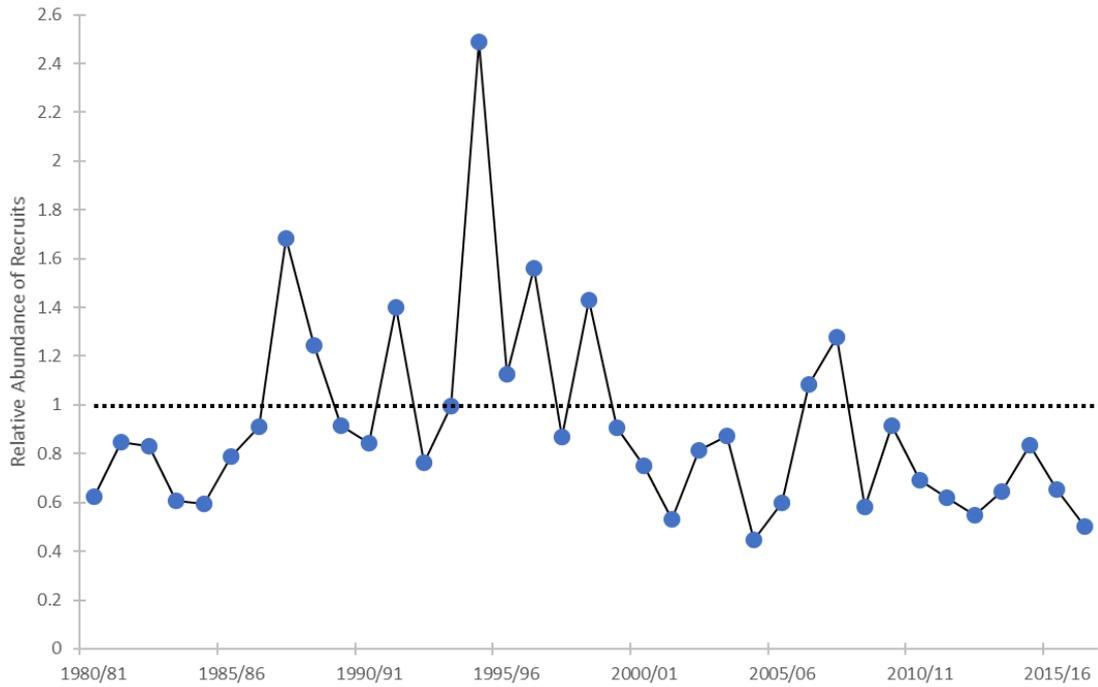


Figure 9: Relative number of recruits (to 60 mm in CL) in the Western Zone Fishery. These results are generated by the stock assessment model. The long-term average is indicated by the dotted black line.

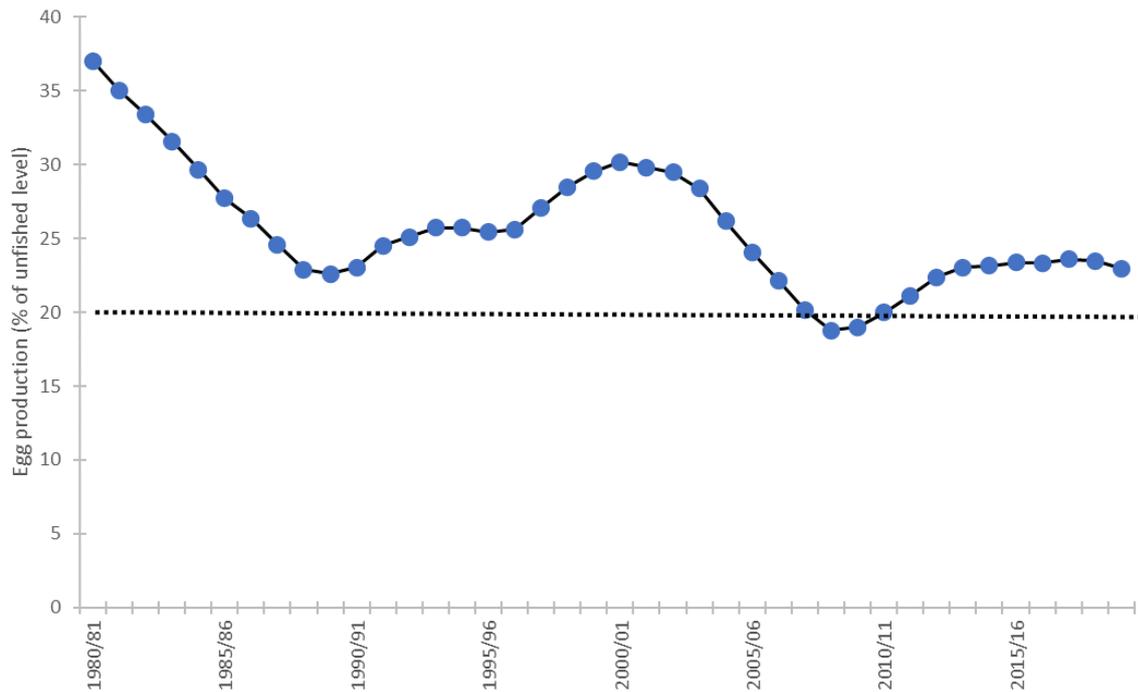


Figure 10: Model estimated level of egg production through time in the Western Zone fishery. The limit reference point (dotted line) is 20% of unfished levels.

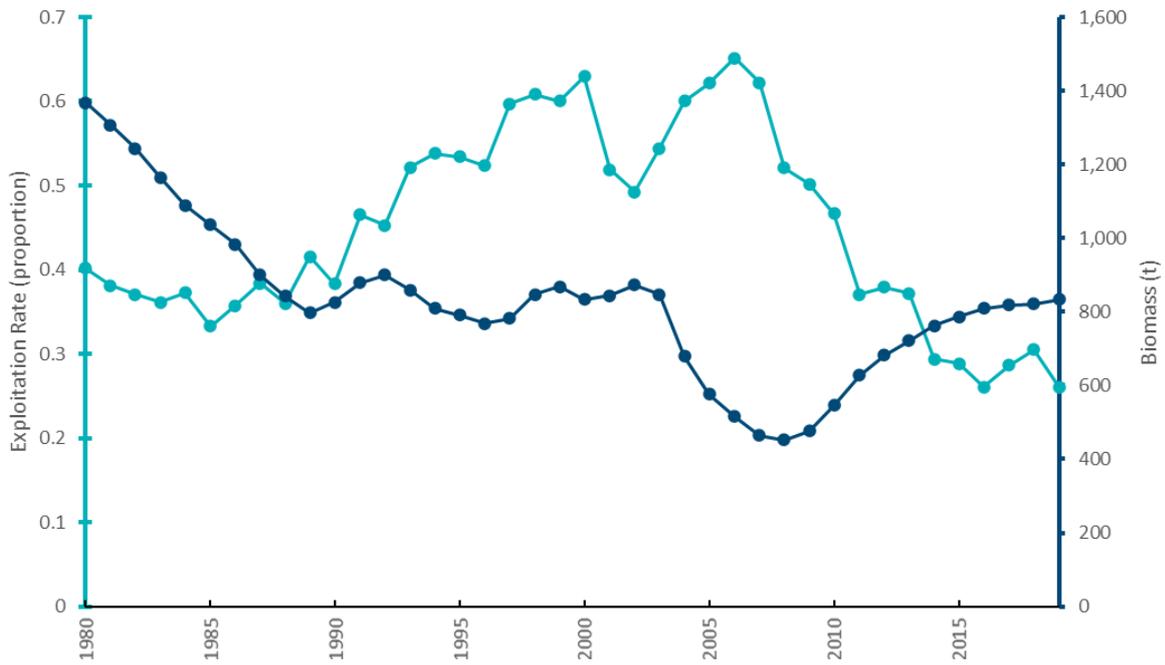


Figure 11: Model estimated levels of available biomass and associated fishing exploitation rates in the Western Zone fishery.

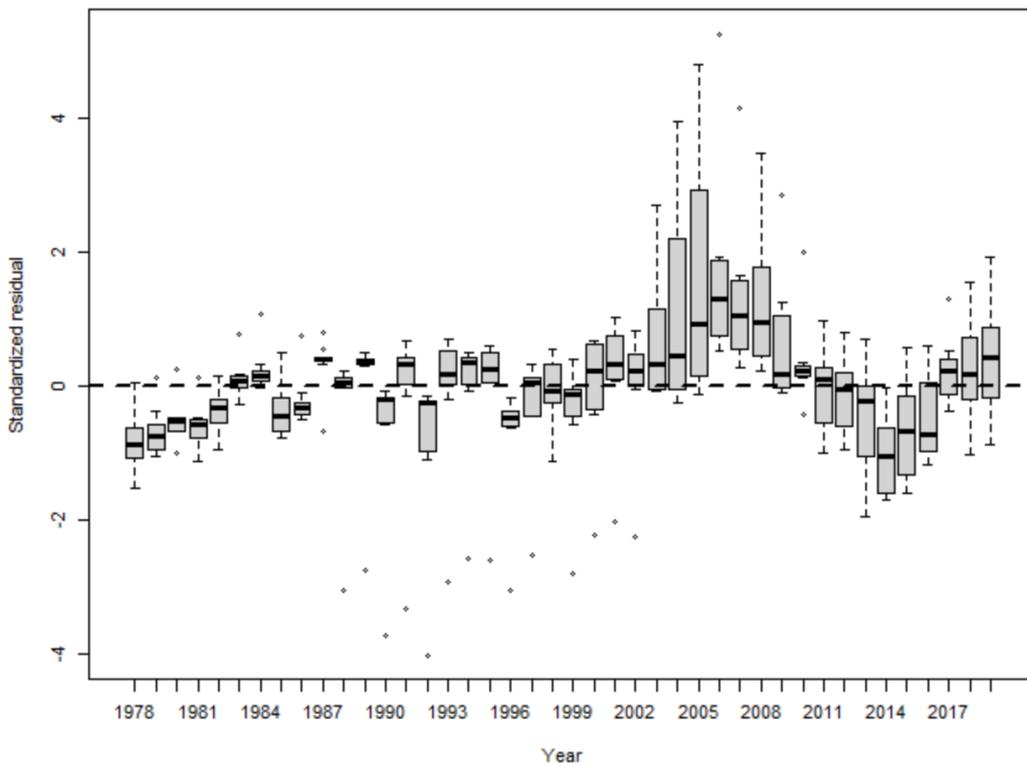


Figure 12: Standardized residuals for CPUE in the Western Zone. Positive values indicate that the model is under-estimating CPUE.

## 5.4 Application of the Harvest Strategy

The annual TACC is set on the basis of the response to the decision rules contained within the new harvest strategy (Appendix 1) as described below:

Decision Rule	2019/20 Stock Indicator Level	Outcome
<b>1. <u>Egg Production</u></b> <b>Is the model estimated egg production above the limit reference point of 20% of unfished levels?</b>	The 2019/20 egg production level is estimated at 23% of unfished levels.	Decision rule has been met. Go to Rule 2
<b>2. <u>TACC Determination</u></b> <b>a. What is the standardised CPUE relative to the preceding season</b>	Standardised CPUE is 0.67kg/pot-lift in 2019/20	Standardised CPUE has increased from 0.64 in 2018/19 to 0.67 in 2019/20
<b>b. Is the 2019/20 PRI at or above the reference point of 1.81 undersize/pot-lift?</b>	Fixed site PRI was above the reference point for the first time in seven years. Observer based PRI was unavailable due to COVID-19. The combined PRI value is incomplete.	The decision rule could not be fully evaluated.
	<b>RESULT</b>	<b>No increase to TACC</b>

### Establishing the WZ TACC for 2021/22

The decision rules in the harvest strategy specifies that the TACC will remain unchanged.

**A TACC of 246t for the 2021/22 season is recommended through the application of the harvest strategy.**

## 6. EASTERN ZONE ROCK LOBSTER FISHERY

### 6.1 Fishery Statistics

#### Trends in catch, effort and CPUE

In 2019/20, the Eastern Zone TACC was 40t (*Table 5*) following a reduction to 47t in 2018/19 from a TACC of 59t which was in place for the previous four years. This reduction was due to a further CPUE decline in 2018/19. Direct application of the harvest strategy would have resulted in a TACC of 32t in 2019/20, however as a result of industry consultation and early positive indications in CPUE a lesser reduction to 40t was implemented.

Standardised CPUE reached a twenty year peak of 0.63kg/pot-lift in 2012/13 but has since fallen rapidly to a record low of 0.36 in 2017/18. From this record low the CPUE rose for the first time in six years to 0.41kg/pot lift in 2018/19, however it fell back to 0.37 in 2019/20 (*Figure 14, Table 4*).

Regionally, in 2019/20 most of the catch reduction (due to the decreased TACC and COVID-19 and export price impacts) took place in the San Remo area. The majority of catch was taken in the Queenscliff region (19.9t), followed by San Remo (11.1t) and 5.2t in Lakes Entrance. In 2019/20 standardised CPUE declined notably in San Remo, whilst Queenscliff decreased slightly and Lakes Entrance increased slightly (*Figure 15*).

It should be noted that the reduction to the current fleet size of 18 vessels increases the potential for biased reporting. This could arise from operational changes from a small number of vessels that collectively hold a large proportion of the quota, and which due to their large catches may have changed their fishing behaviour (e.g. fishing in deeper water). An analysis of the CPUE standardisation method was undertaken for the 2017/18 assessment and found that the index was robust in this aspect.

#### Recreational Catch

On 1 July 2017, the VFA implemented a three-year pilot program requiring all recreational fishers to tag the lobsters they catch and keep and report the use of tags. The objective of the program is to obtain an estimate of the annual recreational catch by using the number of tags used in that season to represent the number of rock lobsters removed from the stock. Recreational catch estimates produced by this program are now used in the assessment model.

In the 2019/20 season 4864 kg were caught and retained by recreational fishers in the Eastern Zone. This is a substantial reduction from 6202 kg in the previous season and is largely due to fishing restrictions related to COVID lockdowns. Since commencement of the program the recreational catch has varied from a high of 15.5% of the TACC in 2018/19 to 9.7% in the COVID affected 2019/20 season.

A comprehensive report on this program “Victorian Recreational Rock Lobster Tagging Program Summary Report Season 3: November 2019 – September 2020” is available from VFA.

#### Trends in the commercial fleet

The number of active fishing vessels decreased from 90 in 1978/79 to approximately 50 through the 1990s and further declined to the current record low of 18 vessels in 2019/20 (*Figure 16*). The average annual catch increased from a record low of 1t per vessel in 1988/89 to a record high of 2.7t per vessel in 2014/15 (*Figure 17*). The number of days fished was also at a record low in 1988/89 at 18 days per vessel (*Figure 17*). This subsequently increased as the fleet contracted and the catch per vessel increased. In

2019/20 the average annual catch was 2.0t / vessel whilst in the last five years the average number of days fished per vessel has decreased from a record high of 38 days to 33 days.

It should be noted that these statistics include only the Eastern Zone catch, but include vessels that fish both zones, thereby the catch per vessel is lower than may be expected.

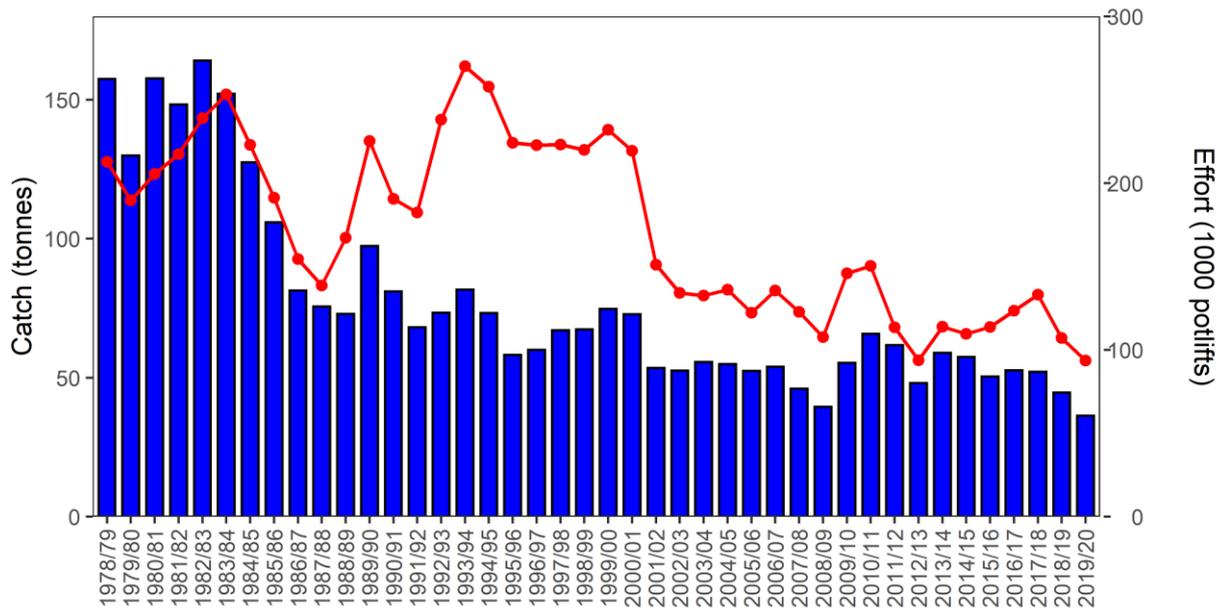


Figure 13: Total catch (blue bars; tonnes) and nominal effort (red line; x1000 pot-lifts) in the Eastern Zone.

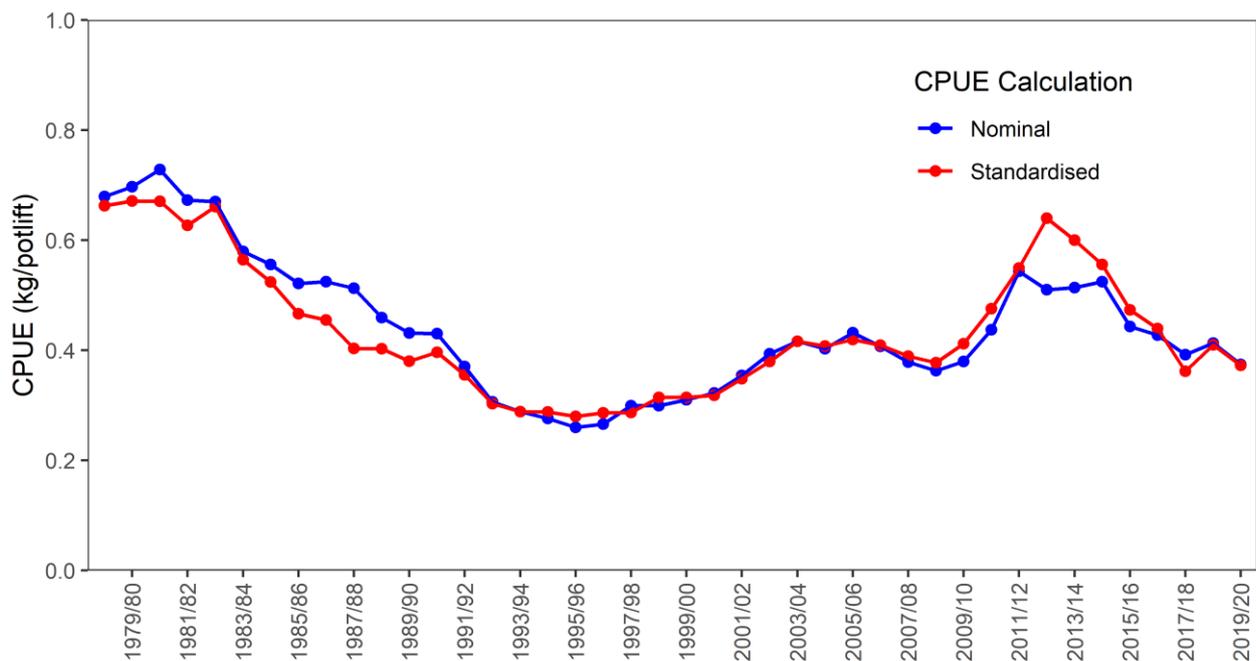
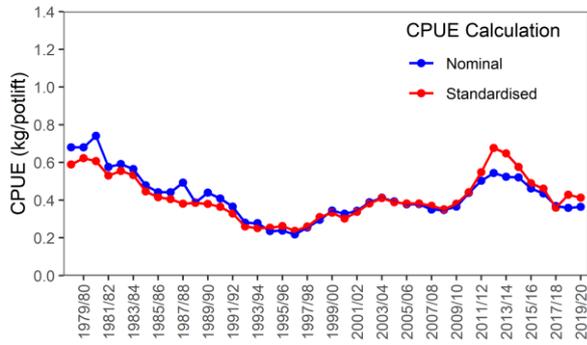
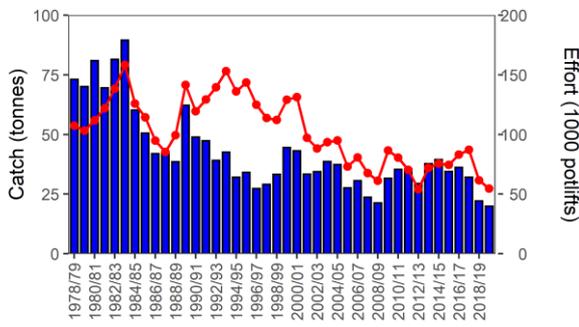
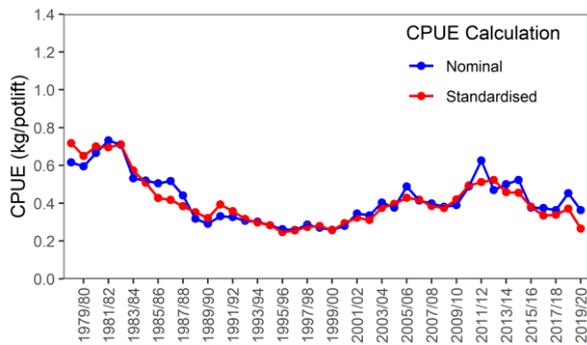
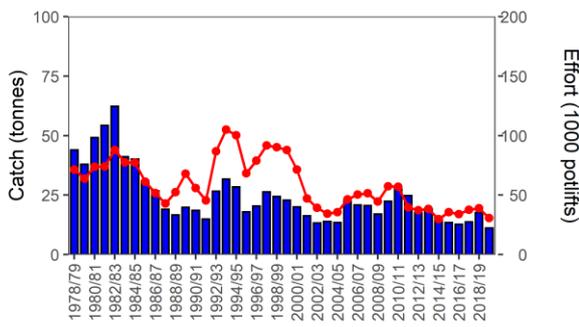


Figure 14: Standardised versus nominal CPUE (kg/potlift) in the Eastern Zone. Note that standardised CPUE values differ slightly from one assessment to the next as the depth, seasonal and fisher coefficients are shared across years and are re-estimated including the new data.

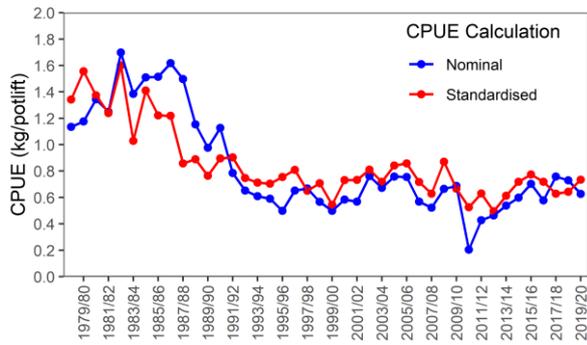
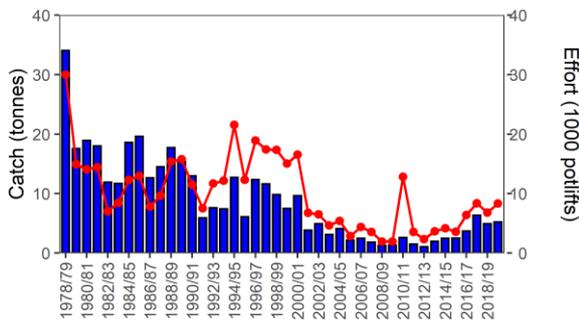
**QUEENSLIFF**



**SAN REMO**



**LAKES ENTRANCE**



Fishing Year (Nov – Sept)

Figure 15: Regional catch (blue bars), effort (red line), and standardised CPUE (kg/potlift) in the Eastern Zone.

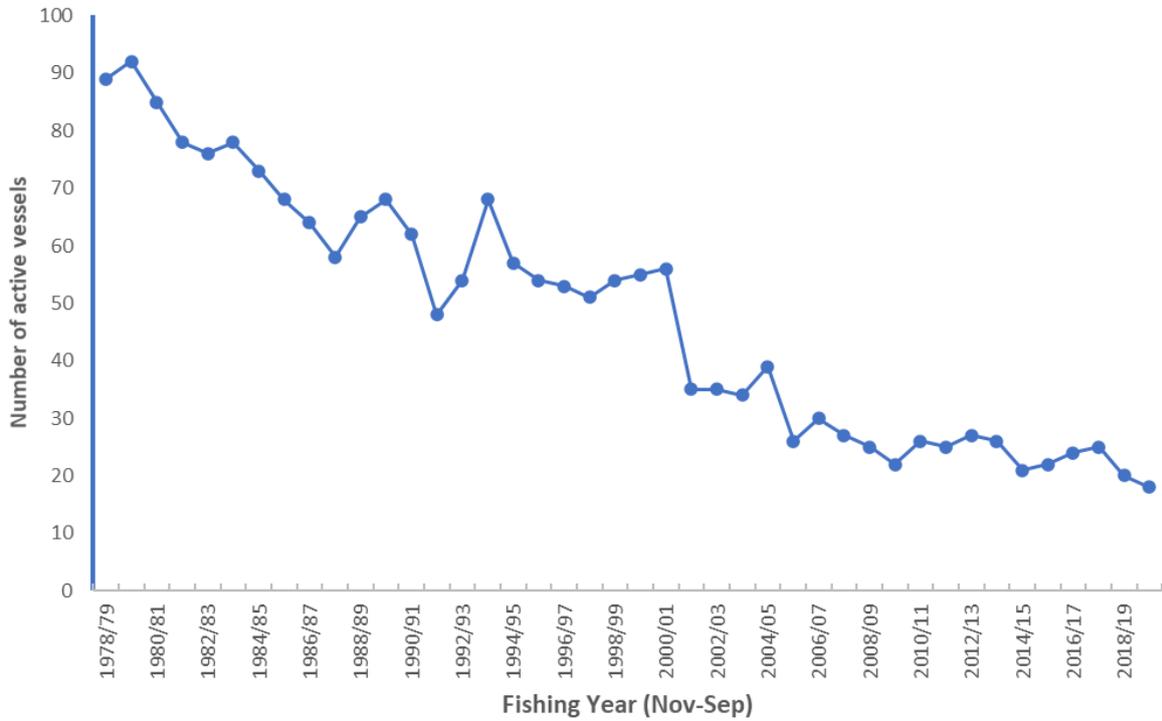


Figure 16: The number of active vessels in the Eastern Zone in each fishing year.

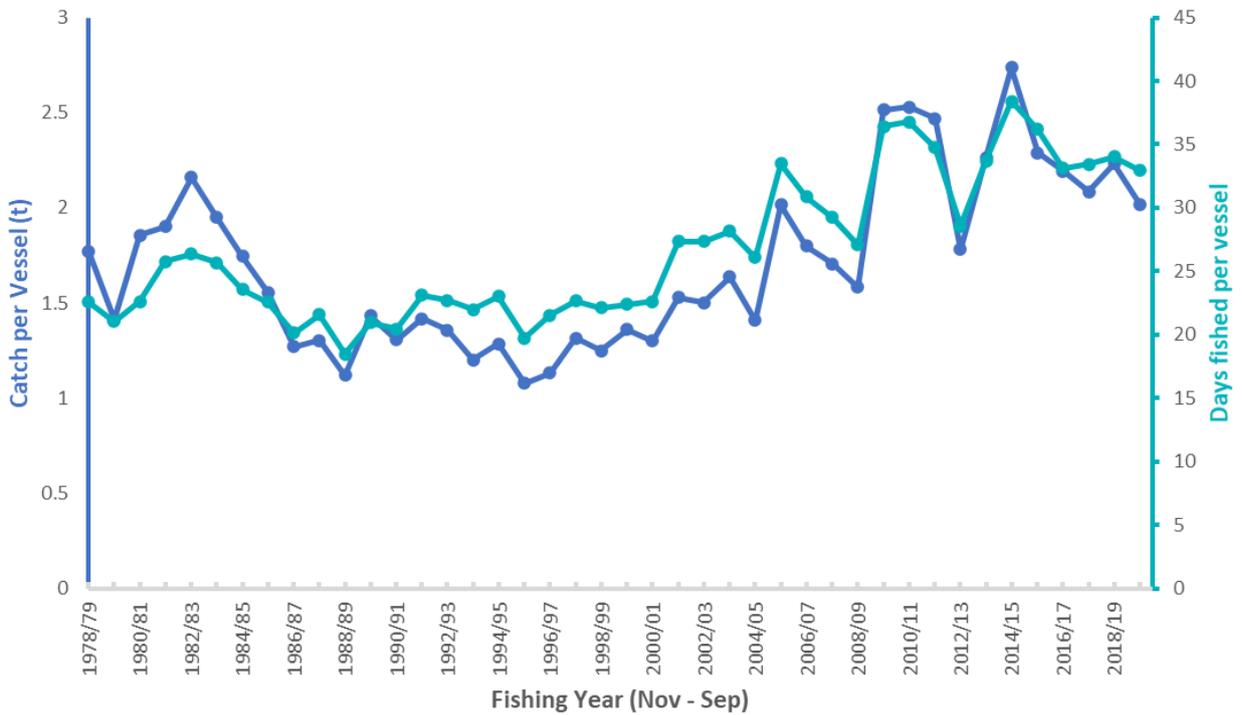


Figure 17: The annual mean catch and mean number of days fished per active fishing vessel in the Eastern Zone

## 6.2 Stock structure data

### Trends in recruitment

The PRI indices calculated from both fixed-site surveys and on-board observers show similar trends with a rapid decline from the recent peak in 2013/14 to a record low of 0.08 undersize/pot-lift in 2018/19. In 2019/20 there was a substantial increase in both PRI indices and consequently the combined PRI index rose to 0.20 undersize/potlift. This is the highest level in five years but remains below the reference point of 0.32 undersize/potlift (*Figure 18*).

### Mean weight

The mean weight of Eastern Zone lobsters has always been higher than those from the Western Zone due to faster growth rates in the eastern area. However, since 2012/13 (when CPUE peaked), the mean lobster weight has increased from 1.12 kg/lobster to 1.51kg/lobster in 2019/20 (*Figure 19*). This is the highest mean lobster weight on record for the Eastern Zone and in combination with the CPUE decline during this period is indicative of a lack of a recent recruitment to the legal biomass combined with a pulse of larger lobsters that are growing through the size classes.

It should also be noted that there has been a disproportionate increase in the beach price of large lobsters. Anecdotal reports suggest this has influenced fishing behaviour and selectivity, thereby contributing to an increase in mean lobster weight.

### Length-frequency distributions

Despite the small sample sizes in the Eastern Zone fixed-site surveys and observer program, the trends in the undersize lobsters support those observed in other data sets. Both programs have shown a dramatic decrease in catch rates of lobsters less than approximately 150mm. This change is highlighted in *Figure 20* and full details are given in *Figure 31* to *Figure 34*. The latter figures show that the 2019/20 increase in sub-legal abundance is consistent across lobster sexes and the fixed site and observer programs.

The effect of lobster growth contributing substantially to the CPUE trend was considered by the RAG which also examined a CPUE index using numbers per potlift. The RAG concluded that standardised CPUE expressed in kg per potlift remains the best proxy for biomass and is consequently the best index to use in the harvest strategy as the TAC is set around a target exploitation rate of that biomass. Changes in length-frequency should be taken into account separately and through the stock assessment model results for biomass and egg production.

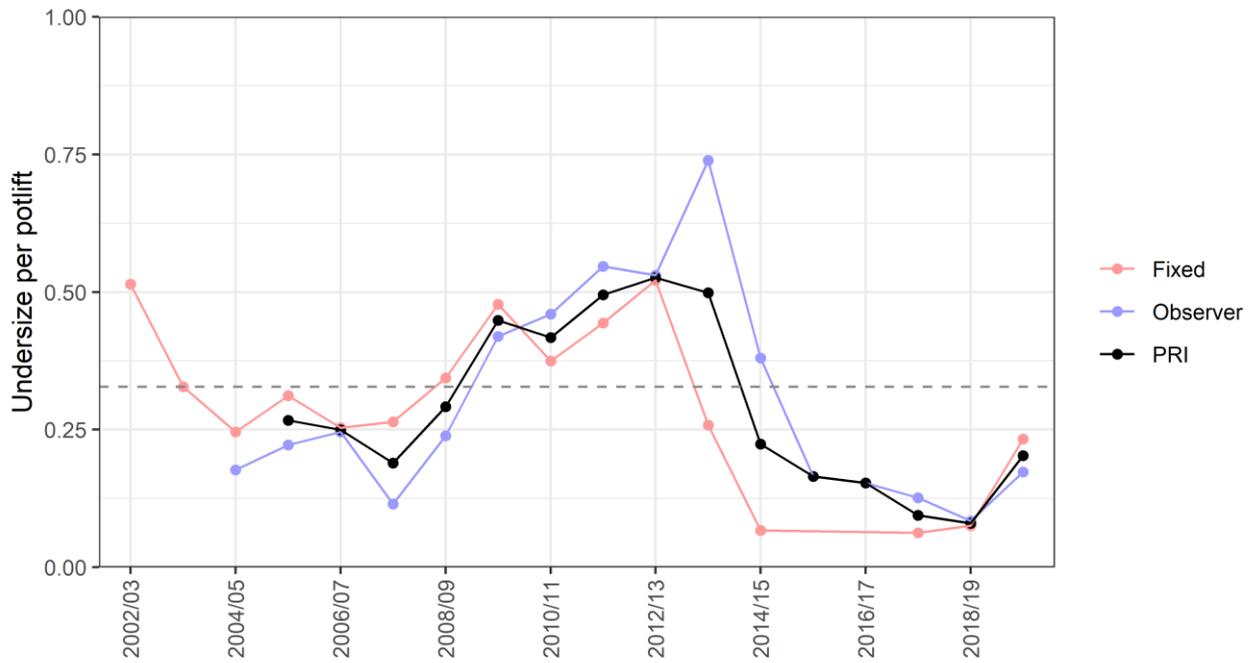


Figure 18: The undersize catch rate (kg/potlift) for the Eastern Zone as calculated from fixed sites, observer coverage and the final combined PRI. The dashed line shows the trigger point (0.32 undersize/potlift).

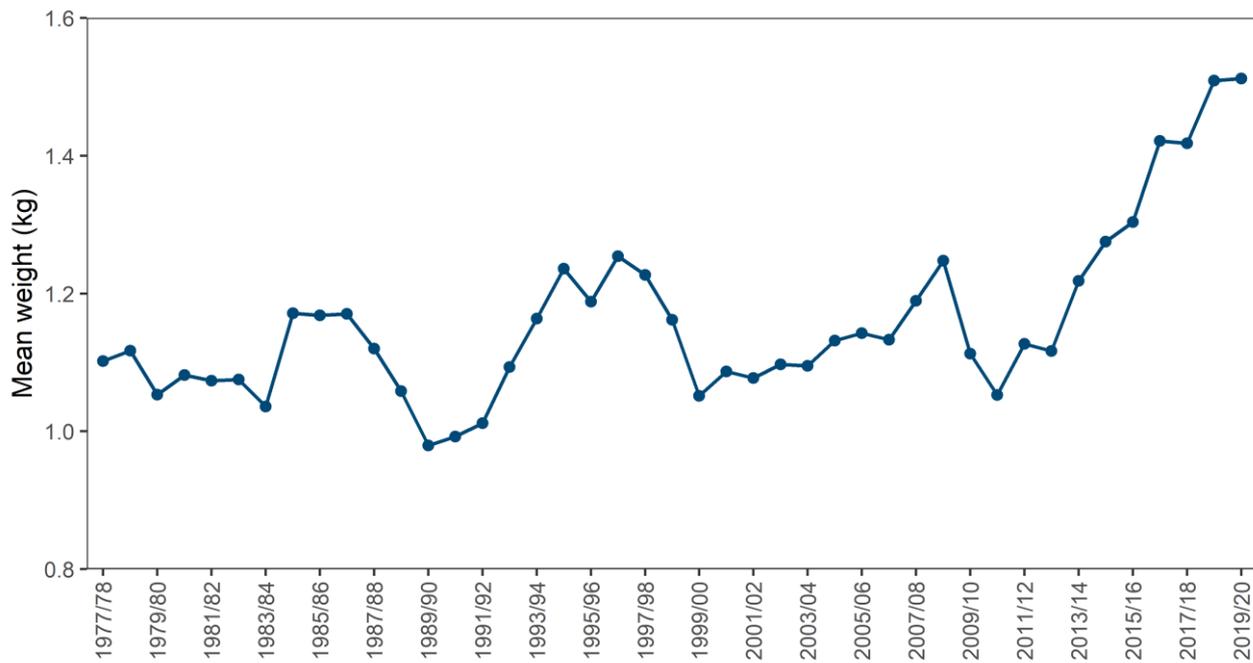


Figure 19: Mean weight of legal sized lobster in the Eastern Zone fishery.

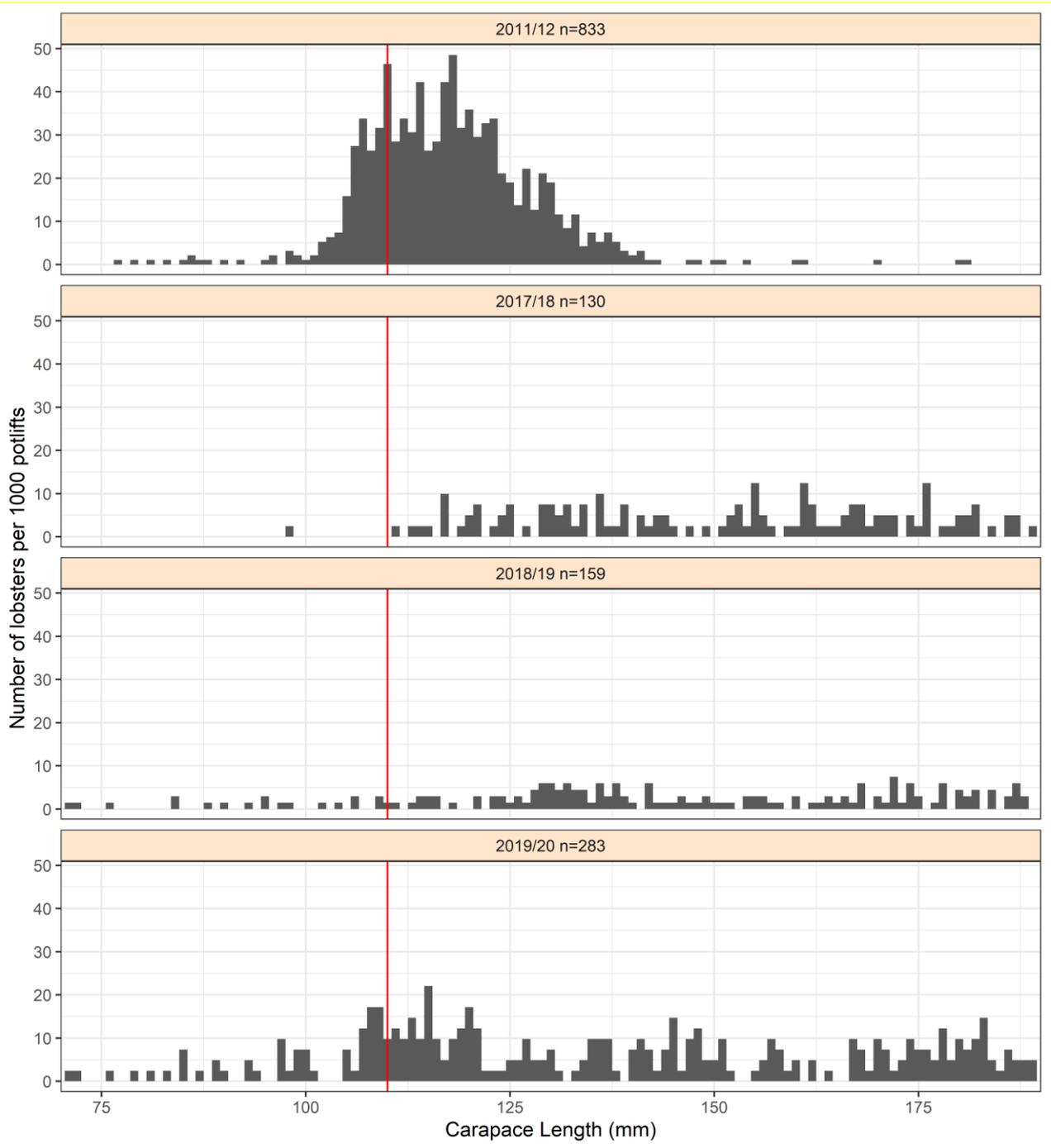


Figure 20: Length-frequency plots for 2011/12 and the last three seasons for male lobsters measured by the Eastern Zone fixed site program to highlight the changes that have occurred.

## 6.3 Model outputs

### Estimated recruitment

The long-term time series for the model estimated recruitment to the 60mm CL size class shows that recent recruitment has been below the long-term average more than it has been above it. Levels have been low since 2009/10 and reached a historical low of 24% of the long-term average in 2013/14. This increased notably to 75% in 2016/17 – the most recent year for which a reliable estimate is available (*Figure 21*). This is in line with the recent increase observed in PRI.

### Estimated egg production

Eastern Zone egg production levels reached a historical low in 1995/96 of 21% of unfished levels. After this time there was a steady increase to a recent high of 33% in 2013/14. Since 2013/14 there has been an ongoing decline to 24% in 2019/20, which is above the 20% limit reference point (*Figure 22*).

Egg production was also found to have a greater than 90% probability of being above the limit reference point as required by the harvest strategy.

### Estimated available biomass and exploitation rate

It should be noted that whilst trends in biomass and exploitation rate are consistent across stock assessments, the absolute values may all scale up or down as different parameter estimates are obtained.

After a long period of stability at around 210t, biomass increased between 2009/10 and 2013/14 to a peak of 289t. Over the past five years biomass has decreased back to 161t in 2019/20. As a result of the decreased biomass the exploitation rate rose to 27% in 2017/18; the subsequent TACC reduction resulted in this decreasing back to 22.5% in 2019/20. (*Figure 23*).

### Model diagnostics and potential biases

The length-frequency data input to the model (*Figure 31 to Figure 34*) is highly variable due in part to low sample sizes. Given this level of variability, the stock assessment model provides a reasonable fit to CPUE and length-frequency data (*Figure 35 and Figure 36*).

As shown in *Figure 24*, there has been a shifting bias through time in the stock assessment model CPUE estimates. This is unsurprising for a model of this complexity when fitted to a fishery like the Eastern Zone, which is comparatively small in production but large in spatial extent (hence has high variability) and for which only limited data is available. Notably recent estimates have a high degree of uncertainty partly due to the further reduction in data resulting from reduced catches.

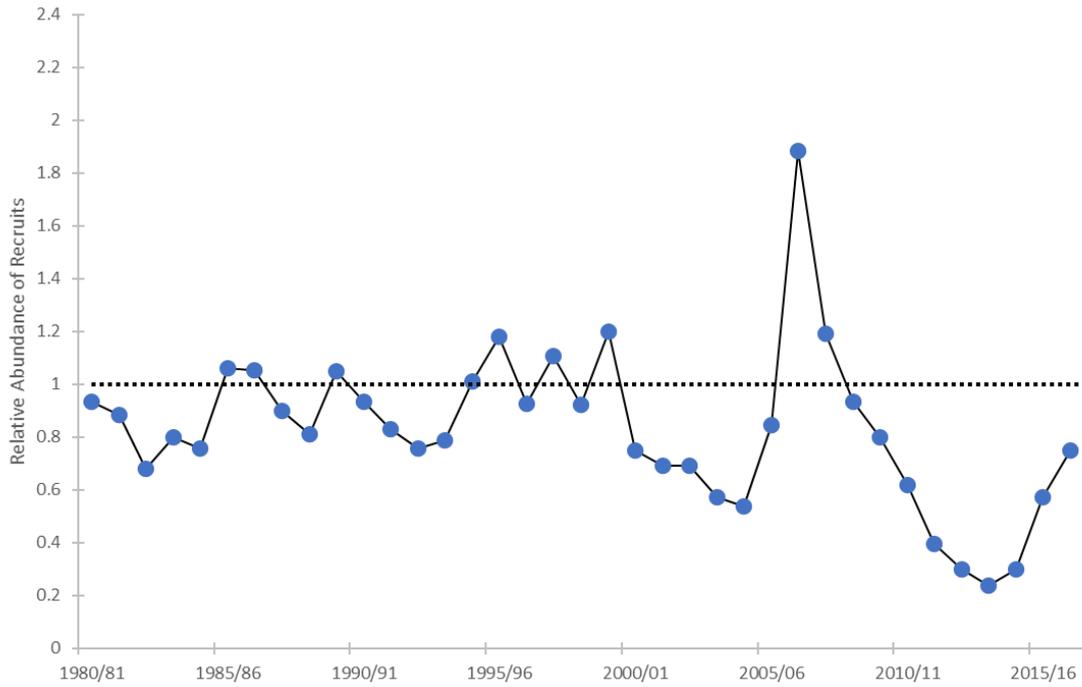


Figure 21: Relative number of recruits (to 60 mm in CL) in the Eastern Zone Fishery. These results are generated by the stock assessment model. The long-term average is indicated by the dotted black line.

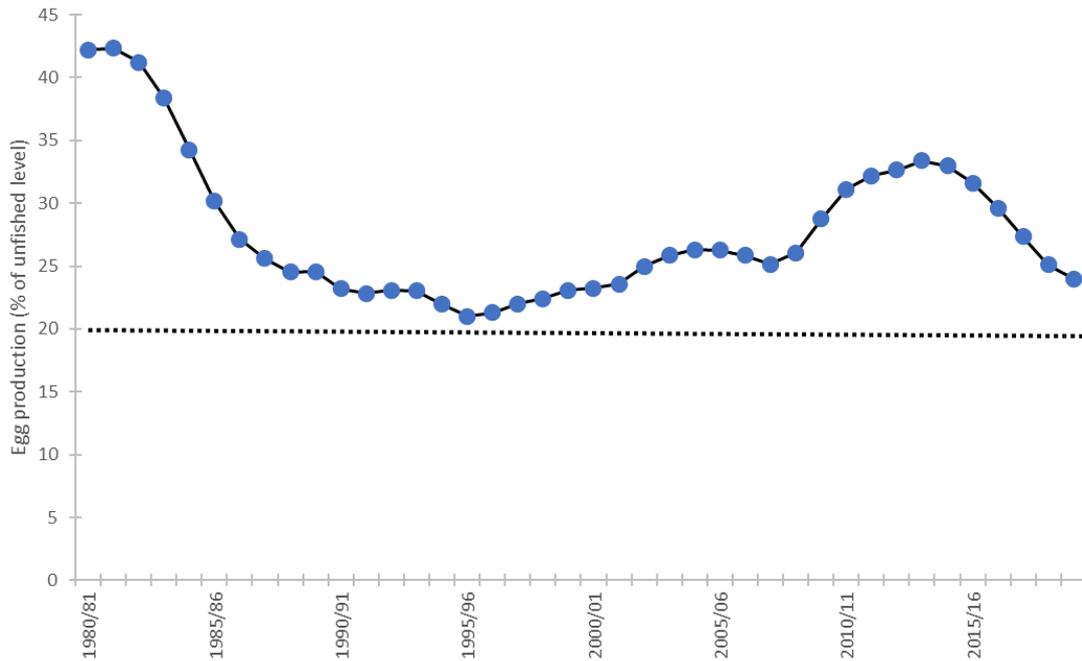


Figure 22: Model estimated level of egg production through time in the Eastern Zone fishery. The limit reference point (dotted line) is 20% of unfished levels.

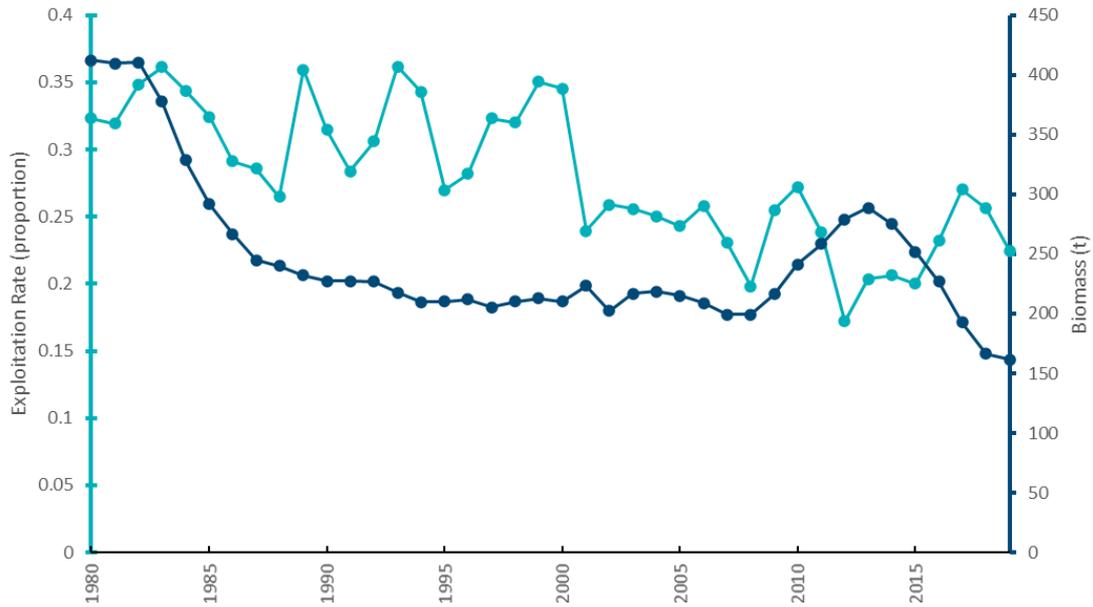


Figure 23: Model estimated levels of available biomass and associated fishing exploitation rates in the Eastern Zone

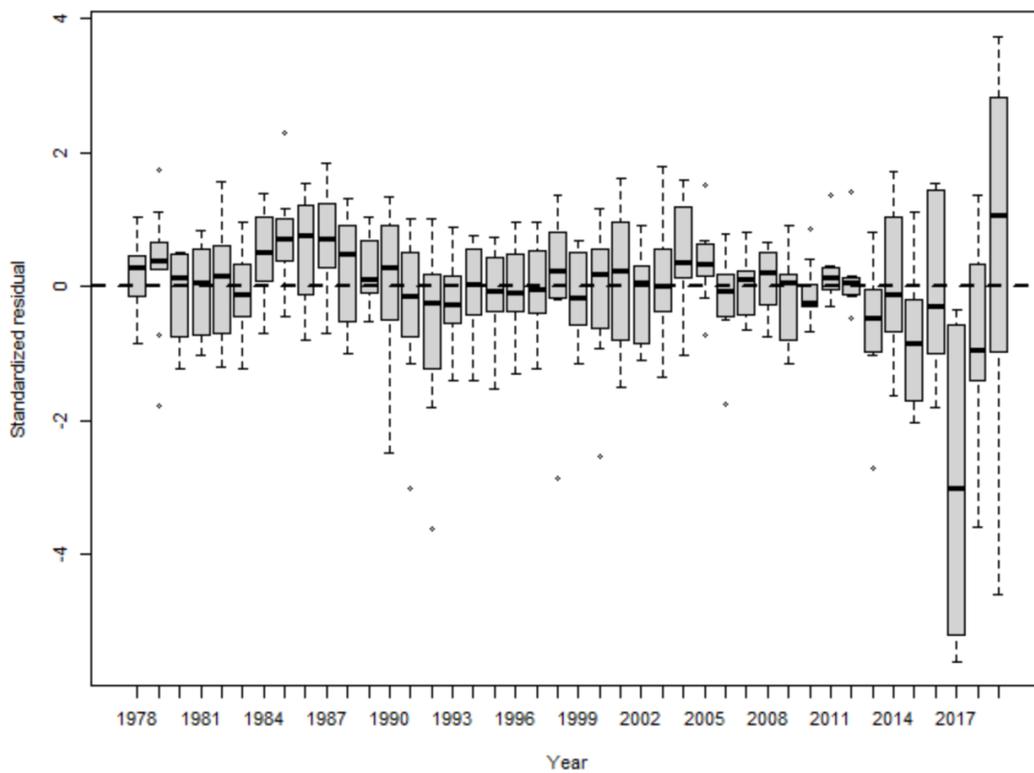


Figure 24: Standardized residual for CPUE in the Eastern Zone. Positive values indicate that the model is under-estimating CPUE.

## 6.4 Application of the Harvest Strategy

The annual TACC is set on the basis of the response to the decision rules contained within the new harvest strategy (Appendix 1) as described below:

Decision Rule	2019/20 Stock Indicator Level	Outcome
<b>1. <u>Egg Production</u></b>		
<b>Is the model estimated egg production above the limit reference point of 20% of unfished levels?</b>	The 2019/20 egg production level is estimated at 24% of unfished levels.	Decision rule has been met. Go to Rule 2
<b>2. <u>TACC Determination</u></b>		
<b>a. What is the standardised CPUE relative to the preceding season</b>	Standardised CPUE is 0.374kg/pot-lift in 2019/20	Standardised CPUE has <b>decreased</b> from 0.41 in 2018/19 to 0.374 in 2019/20.
<b>b. Is the 2019/20 PRI at or above the reference point of 0.32 undersize/pot-lift?</b>	The PRI is 0.20 undersize/pot lift	The PRI has increased from 0.08 in 2018/19 to 0.20 in 2019/20 however remains below the reference point. Decision rule not met. No further decision rules considered
<b>RESULT</b>		<b>Set 2020/21 TACC at CPUE range 0.35 - &lt;0.375</b>

### Establishing the EZ TACC for 2021/22

The PRI rule has not been met and the CPUE of 0.374kg/potlift is just below the 0.375kg/potlift threshold corresponding to a lower CPUE band than that for the current 40t TACC. Application of the harvest strategy indicates a 32t TACC for 2021/22.

**A TACC of 32t for the 2021/22 season is recommended through the application of the harvest strategy. However, further consideration and industry consultation is required to better understand COVID-19 influences on fishing behaviour and resulting implications for interpreting catch rate.**

## 7. METHODS

### 7.1 Catch Rate Standardisation

The stock assessment model uses standardised CPUE (Walker *et al.* 2012). All catch and effort data are obtained from mandatory logbook returns and are firstly checked for any errors before being entered into the Victorian Fisheries Authority rock lobster database. Prior to standardisation, the data are filtered to ensure that only data from fishers contributing returns in more than two separate fishing years and contributing 200 or more records are included in the CPUE standardisation. The CPUE is then standardised for each zone separately by adjusting for average long-term differences among the regions, depth ranges, fishing seasons, months, fishers and vessels. For standardisation, the regions are Portland, Warrnambool and Apollo Bay in the Western Zone, and Queenscliff, San Remo and Lakes Entrance in the Eastern Zone. The fishing depth ranges are <40 m and  $\geq$ 40 m. Only interactions between region and year are now included, which permits yearly estimates of standardised CPUE by region.

It should be noted that the approach taken to create the overall standardised index for a zone calculates the predicted CPUE for each region in each year and weights these by their relative catches.

Consequently, the standardised index contains trends due to spatial shifts in catch (at a region level) that are unrelated to biomass changes. For example, the increase in catch in Lakes Entrance in 2017/18 and 2018/19 (which has the highest CPUE out of the Eastern regions) had a small positive effect on CPUE.

### 7.2 Stock Assessment Model

The stock assessment uses a model that has been designed for rock lobster fisheries in Victoria, South Australia, and Tasmania. It was developed through CSIRO and a series of FRDC projects (Hobday and Punt 2001; Hobday and Punt 2009; Hobday *et al.* 2005). The model is length-structured and currently set up in Victoria to account for numbers of rock lobsters in 5-mm-carapace length-classes.

The model infers change and absolute levels of stock abundance from three principal data sources: (i) standardised CPUE, to which biomass is assumed to vary in direct proportion, (ii) catches in both weight and number, which provide a highly precise measure of mean weight of lobsters in the catch, and (iii) length-frequency data interpreted in combination with the length-transition matrices to yield estimates of mortality rate and absolute biomass.

Recruitment in the model is dependent on changes in mean size and size distribution of the catch from length-frequency data, and on changes in standardised CPUE, where, for example, a rise in CPUE and a decrease in mean size signals an increase in recruitment and *visa-versa*. For males and females separately, the model tracks, for each month, the number of rock lobsters in the population of size equal to or larger than 60 mm carapace length. The model also accounts for both natural mortality and fishing mortality.

Growth is modelled using length-transition matrices that specify the proportion of lobsters in each length category that grow into larger length classes during each summer and autumn moulting period. Growth in the model is sex specific, as is length-selectivity. Catchability by month is non-sex specific. The length-transition matrices were estimated using extensive tag-recovery data.

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- Walker, T.I., Giri, K., Trinnie, F.I., and Reilly, D.J. (2012). CPUE data screening, selection and standardisation for stock assessment of southern rock lobster (*Jasus edwardsii*) in Victoria. pp 23–74. In 'Sustainability of the rock lobster resource in south-eastern Australia in a changing environment: implications for assessment and management.' Final report to Fisheries Research and Development Corporation. November 2012. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, South Australia, Australia.
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## 9. SUPPLEMENTARY WESTERN ZONE DATA

Table 2: Western Zone catch, fishing effort and CPUE (Fishing Year: Nov-Sep; CPUE: Catch per unit effort).

Fishing Year	Catch (tonne)	Catch ('000)	Nominal Effort ('000 potlifts)	Nominal CPUE (kg/potlift)	Standardised CPUE (kg/potlift)	Mean Mass (kg/lobster)
1978/79	485	485	621	0.78	0.79	1.00
1979/80	451	442	576	0.78	0.80	1.02
1980/81	546	546	679	0.80	0.81	1.00
1981/82	498	498	637	0.78	0.77	1.00
1982/83	460	455	608	0.76	0.78	1.01
1983/84	421	414	571	0.74	0.73	1.02
1984/85	406	394	578	0.70	0.69	1.03
1985/86	345	346	569	0.61	0.61	1.00
1986/87	351	353	595	0.59	0.59	0.99
1987/88	345	349	557	0.62	0.60	0.99
1988/89	303	321	577	0.52	0.53	0.94
1989/90	332	355	613	0.54	0.53	0.94
1990/91	317	337	650	0.49	0.50	0.94
1991/92	409	439	712	0.57	0.58	0.93
1992/93	408	433	779	0.52	0.54	0.94
1993/94	449	456	754	0.59	0.56	0.98
1994/95	435	444	789	0.55	0.51	0.98
1995/96	423	442	761	0.56	0.49	0.96
1996/97	402	414	787	0.51	0.44	0.97
1997/98	467	493	842	0.55	0.48	0.95
1998/99	517	569	864	0.60	0.53	0.91
1999/00	523	596	901	0.58	0.52	0.88
2000/01	526	599	898	0.59	0.49	0.88
2001/02	438	510	703	0.62	0.55	0.86
2002/03	431	495	631	0.68	0.57	0.87
2003/04	460	514	658	0.70	0.55	0.90
2004/05	410	452	667	0.61	0.51	0.91
2005/06	358	405	705	0.51	0.42	0.88
2006/07	336	392	698	0.48	0.41	0.86
2007/08	289	338	668	0.43	0.36	0.86
2008/09	235	267	605	0.39	0.35	0.88
2009/10	240	277	651	0.37	0.34	0.87
2010/11	255	307	590	0.43	0.39	0.83
2011/12	233	279	475	0.49	0.43	0.83
2012/13	259	296	485	0.53	0.46	0.87

Fishing Year	Catch (tonne)	Catch ('000)	Nominal Effort ('000 potlifts)	Nominal CPUE (kg/potlift)	Standardised CPUE (kg/potlift)	Mean Mass (kg/lobster)
2013/14	269	299	486	0.55	0.47	0.90
2014/15	225	242	418	0.54	0.45	0.93
2015/16	227	235	362	0.63	0.51	0.97
2016/17	211*	209	330	0.64	0.53	1.01
2017/18	234	230	296	0.79	0.61	1.02
2018/19	254	247	307	0.83	0.64	1.03
2019/20	217	208	270	0.80	0.67	1.04

\* The 2016/17 catch was reduced as a result of a compensation packaged offered to fishers by Origin Energy in recognition of the loss of access to fishing grounds during survey activity. A condition of accepting compensation was to retire an agreed amount of quota for the remainder of the 2016/17 season.

Table 3: Western Zone history of TACCs for each quota period from 2001-02 to 2019-20 (TACC: Total Allowable Commercial Catch).

Year	Season	TACC Set (t)	Catch (t)	% TACC Caught	Months Fished	Active Licenses	Vessels
2001-02*	1 Nov - 31 Mar	320					
2002-03	1 Apr - 31 Mar	450	440	98	12	79	83
2003-04	1 Apr - 31 Mar	450	436	97	12	80	79
2004-05	1 Apr - 31 Mar	450	421	94	12	79	86
2005-06	1 Apr - 31 Mar	450	405	90	12	75	77
2006-07	1 Apr - 31 Mar	450	329	73	12	71	68
2007-08	1 Apr - 31 Mar	380	319	84	12	68	64
2008-09	1 Apr - 31 Mar	320	244	76	12	61	60
2009	1 Apr – 30 Jun	55.2	36	64	3	54	53
2009-10	1 Jul – 30 Jun	240	230	96	12	54	55
2010-11	1 Jul – 30 Jun	240	237	99	12	54	58
2011-12	1 Jul – 30 Jun	240	237	99	12	50	53
2012-13	1 Jul – 30 Jun	260	258	99	12	47	46
2013-14	1 Jul – 30 Jun	260	260	100	12	47	47
2014-15	1 Jul – 30 Jun	230	230	100	12	48	47
2015-16	1 Jul - 30 Jun	230	230	100	12	47	48
2016-17	1 Jul - 30 Jun	230*	209*	100*	12	43	42
2017-18	1 Jul - 30 Jun	230	230	100	12	41	41
2018-19	1 Jul - 30 Jun	245	245	100	12	42	45
2019-20	1 Jul - 30 Jun	246	225.6	92	12	40	43

\* The 2016/17 catch was reduced from 230t to 209t as a result of a compensation packaged offered to fishers by Origin Energy in recognition of the loss of access to fishing grounds during survey activity. A condition of accepting compensation was to retire an agreed amount of quota for the remainder of the 2016/17 season.

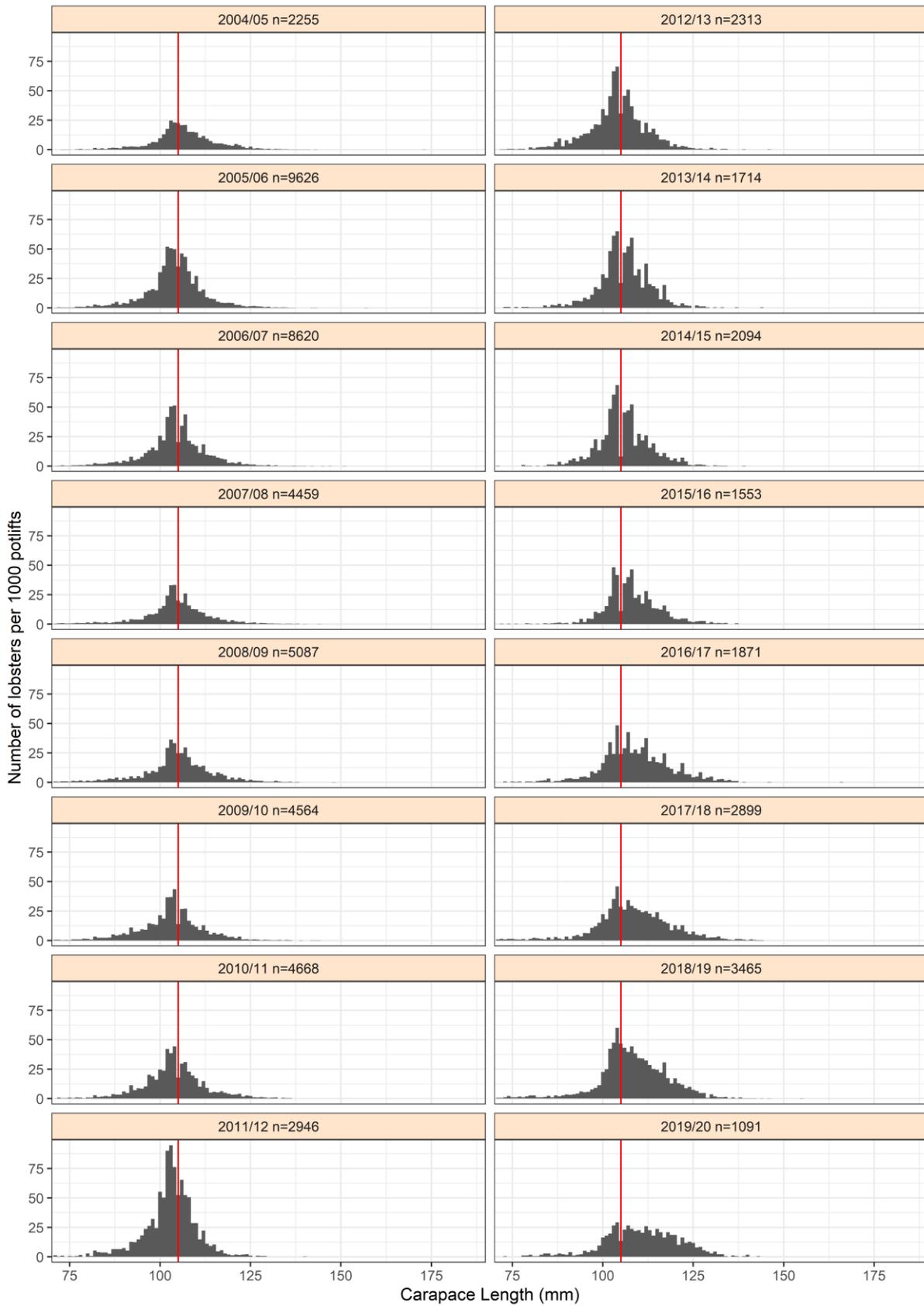


Figure 25: Length-frequency distribution of the number of female rock lobsters per 1,000 pot-lifts caught in the Western Zone on-board observer program from 2004–05 to 2019–20 fishing years (Nov–Sept). n, total number of lobsters measured.

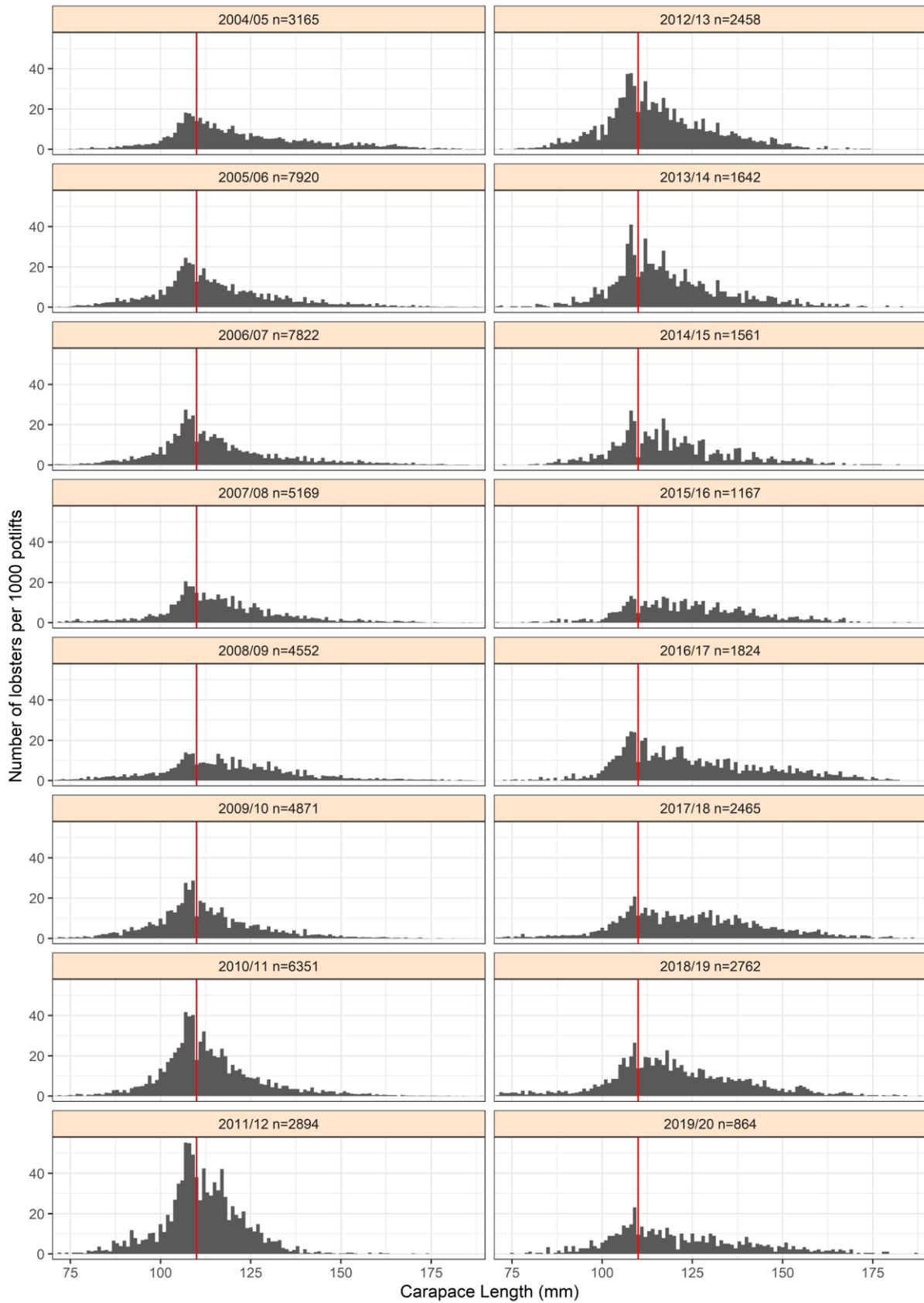


Figure 26: Length-frequency distribution of the number of male rock lobsters per 1,000 pot-lifts caught in the Western Zone on-board observer program from 2004–05 to 2019–20 fishing years (Nov–Sept). n, total number of lobsters measured.

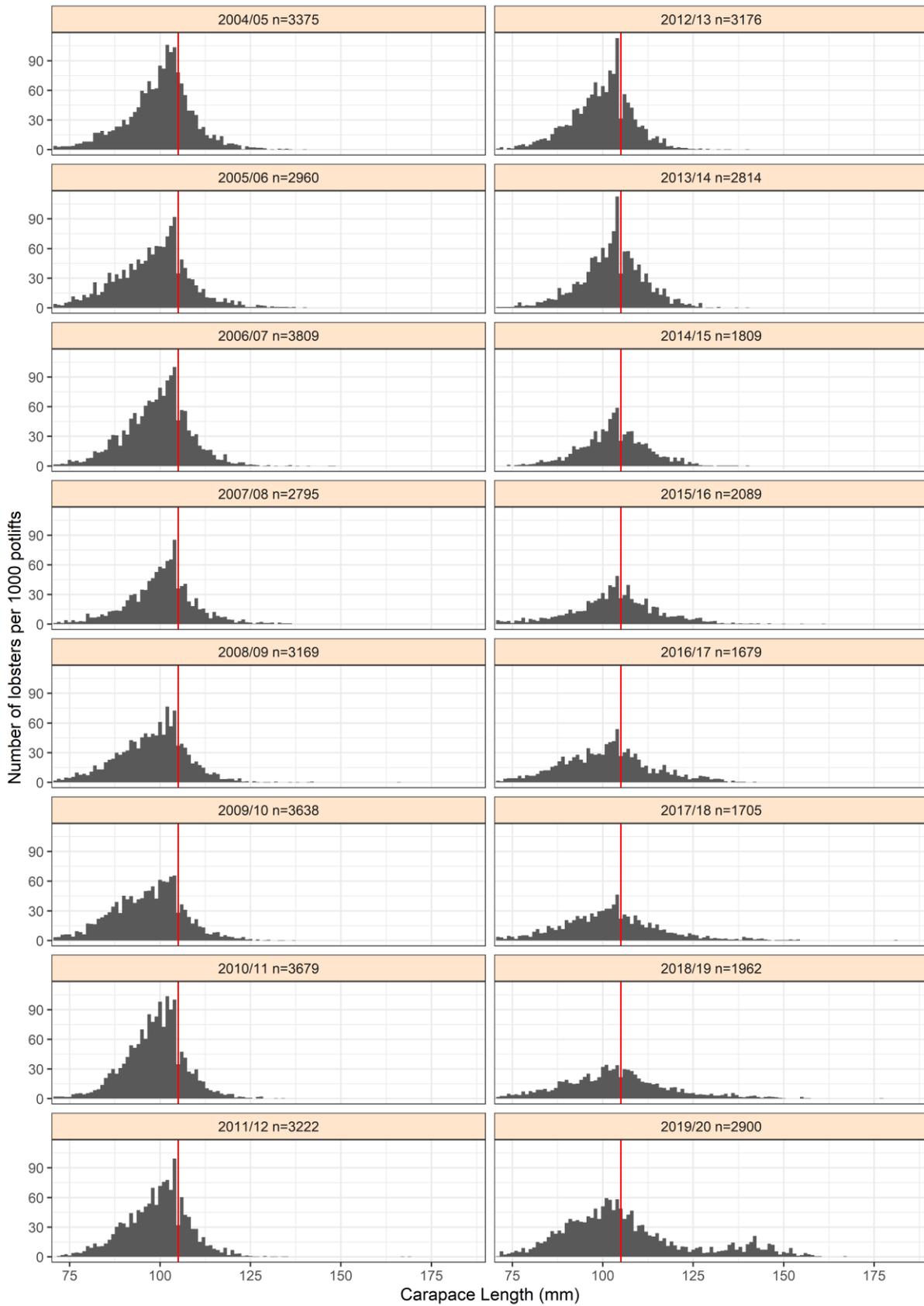


Figure 27: Length-frequency distribution of the number of female rock lobsters per 1,000 pot-lifts caught in the Western Zone fixed-site survey program from 1995–96 to 2019–20 fishing years (Nov–Sept). n, total number of lobsters measured.

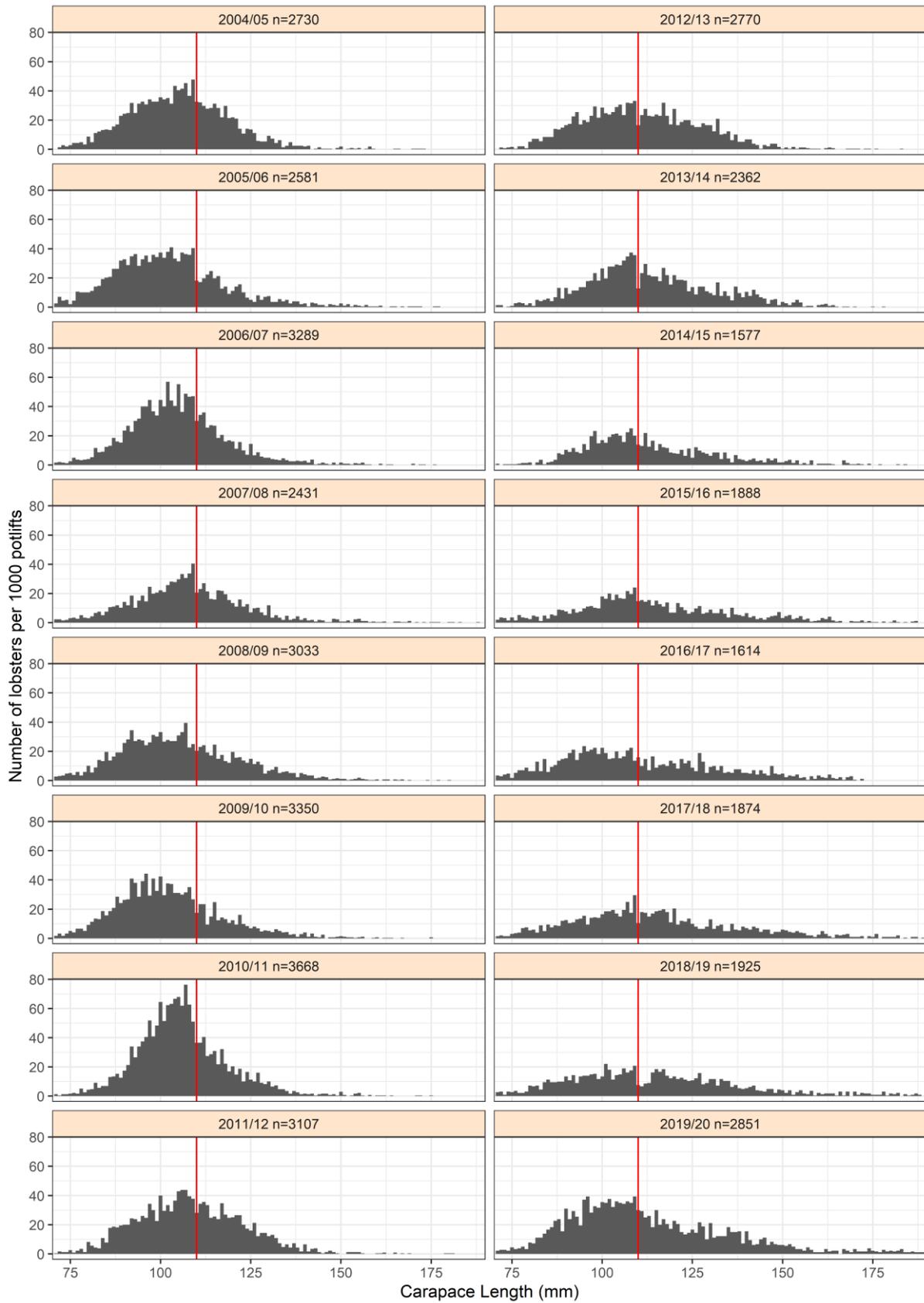


Figure 28: Length-frequency distribution of the number of male rock lobsters per 1,000 pot-lifts caught in the Western Zone fixed-site survey program from 1995–96 to 2019–20 fishing years (Nov–Sept). n, total number of lobsters measured.

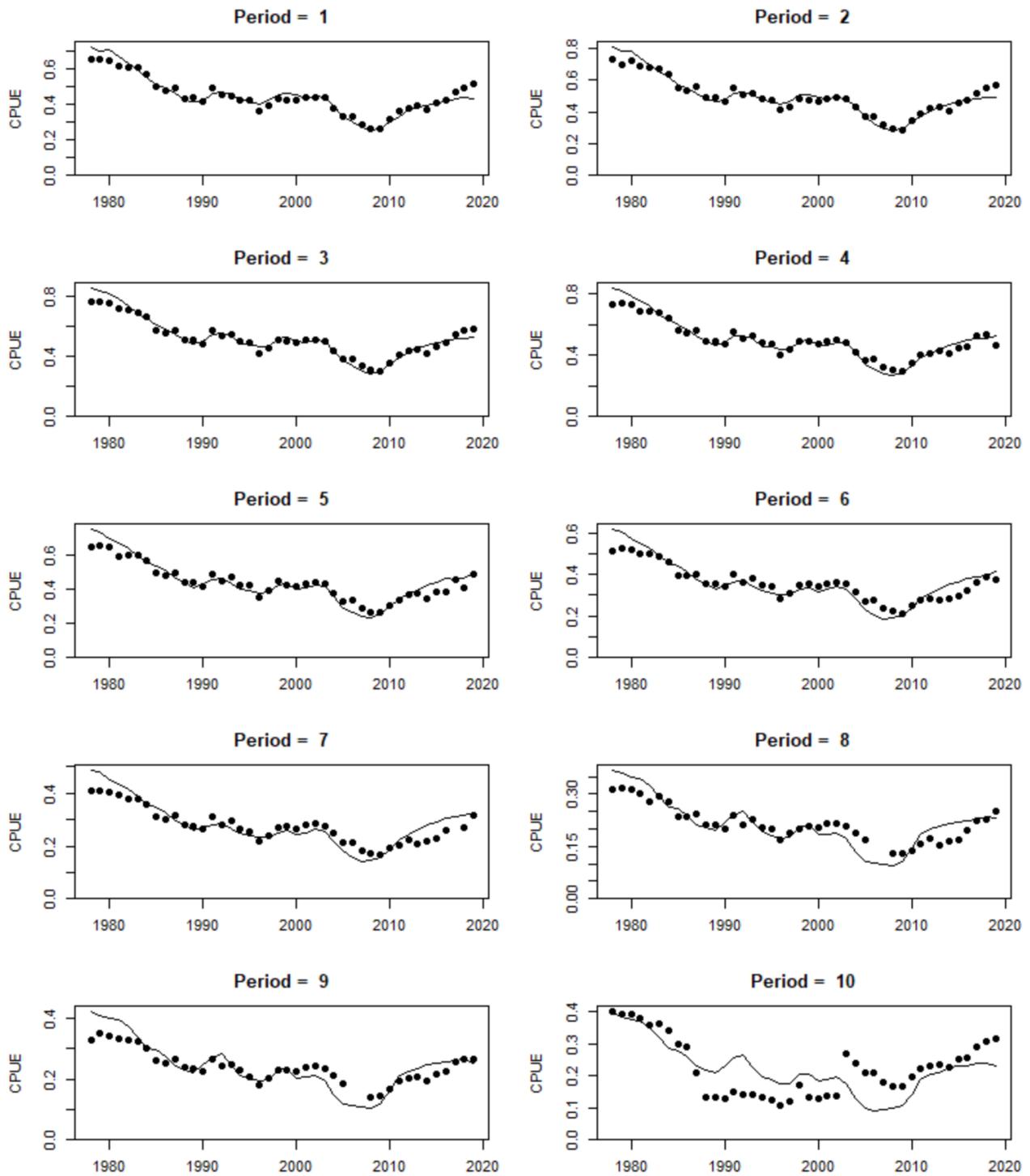


Figure 29: Comparison between standardised CPUE (dots) and CPUE estimated by the stock assessment model (line) for the Western Zone. Periods 1 to 9 are November to July, period 10 is August and September

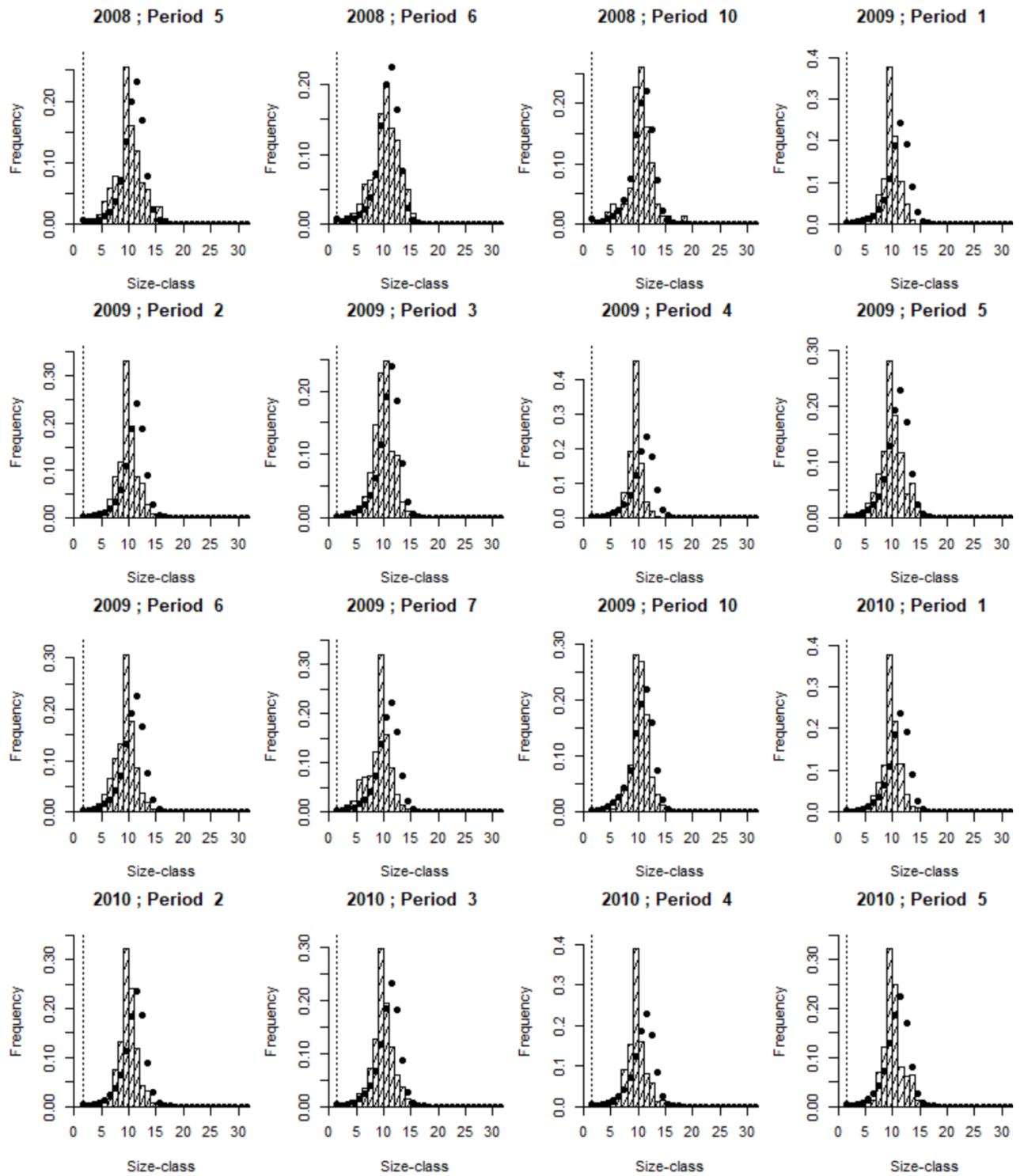


Figure 30: Comparison between length-frequency measurements (bars) and abundance estimated by the stock assessment model (dots) for a selection of years and periods for the Western Zone. Periods 1 to 9 are November to July, period 10 is August and September. Size classes are from 60mm increasing in 5mm increments.

## 10. SUPPLEMENTARY EASTERN ZONE DATA

Table 4: Eastern Zone catch, fishing effort and CPUE (Fishing Year: November-September; SRL: Southern rock lobster; CPUE: Catch per unit effort).

Fishing Year	Catch (tonne)	Catch ('000)	Nominal Effort ('000 potlifts)	Nominal CPUE (kg/potlift)	Standardised CPUE (kg/potlift)	Mean Mass (kg/lob.)
1978/79	139	123	192	0.72	0.66	1.13
1979/80	115	108	171	0.67	0.67	1.07
1980/81	133	123	180	0.74	0.67	1.09
1981/82	131	120	193	0.68	0.63	1.09
1982/83	143	132	212	0.68	0.66	1.09
1983/84	136	128	230	0.59	0.56	1.06
1984/85	113	96	201	0.56	0.52	1.18
1985/86	95	81	175	0.54	0.47	1.17
1986/87	78	66	145	0.54	0.45	1.18
1987/88	70	62	130	0.54	0.40	1.13
1988/89	65	61	145	0.45	0.40	1.06
1989/90	84	85	198	0.42	0.38	0.99
1990/91	72	72	172	0.42	0.40	1.00
1991/92	65	64	175	0.37	0.36	1.02
1992/93	70	63	224	0.31	0.30	1.10
1993/94	79	68	260	0.30	0.29	1.17
1994/95	72	58	253	0.29	0.29	1.24
1995/96	57	48	220	0.26	0.28	1.19
1996/97	60	48	222	0.27	0.29	1.25
1997/98	66	54	220	0.30	0.29	1.23
1998/99	66	57	217	0.30	0.31	1.16
1999/00	73	68	228	0.32	0.31	1.07
2000/01	72	66	217	0.33	0.32	1.09
2001/02	54	50	151	0.36	0.35	1.08
2002/03	52	47	133	0.39	0.38	1.10
2003/04	56	52	133	0.42	0.42	1.09
2004/05	54	47	136	0.40	0.41	1.14
2005/06	52	46	122	0.43	0.42	1.14
2006/07	54	48	136	0.40	0.41	1.13
2007/08	46	39	123	0.38	0.39	1.19
2008/09	40	32	108	0.37	0.38	1.25
2009/10	55	49	145	0.38	0.41	1.11
2010/11	66	62	150	0.44	0.48	1.05
2011/12	62	55	114	0.54	0.55	1.13

Fishing Year	Catch (tonne)	Catch ('000)	Nominal Effort ('000 potlifts)	Nominal CPUE (kg/potlift)	Standardised CPUE (kg/potlift)	Mean Mass (kg/lob.)
2012/13	48	43	94	0.51	0.64	1.12
2013/14	59	48	114	0.52	0.60	1.22
2014/15	58	45	110	0.52	0.56	1.28
2015/16	50	39	114	0.44	0.47	1.30
2016/17	53	37	124	0.43	0.44	1.42
2017/18	52	37	133	0.39	0.36	1.42
2018/19	45	30	107	0.42	0.41	1.51
2019/20	36	24	94	0.39	0.37	1.51

Table 5: Eastern Zone history of TACCs for each quota period from 2001-02 to 2019-20 (TACC: Total Allowable Commercial Catch).

Year	Season	TACC (t)	Catch (t)	% TACC Caught	Months Fished	Active Licenses	Vessels
2001-02	1 Nov - 31 Mar	42					
2002-03	1 Apr - 31 Mar	60	49.9	83	12	39	34
2003-04	1 Apr - 31 Mar	60	54.4	91	12	41	36
2004-05	1 Apr - 31 Mar	60	53.2	89	12	41	39
2005-06	1 Apr - 31 Mar	60	55.7	93	12	30	29
2006-07	1 Apr - 31 Mar	60	53.5	89	12	30	30
2007-08	1 Apr - 31 Mar	66	50.1	76	12	31	31
2008-09	1 Apr - 31 Mar	66	41.3	63	12	26	24
2009-09	1 Apr - 30 Jun	6.9	5.8	84	3	19	20
2009-10	1 Jul - 30 Jun	66	43.9	67	12	22	21
2010-11	1 Jul - 30 Jun	66	64.8	98	12	29	28
2011-12	1 Jul - 30 Jun	66	65.3	99	12	26	27
2012-13	1 Jul - 30 Jun	48	47.3	99	12	26	25
2013-14	1 Jul - 30 Jun	51	50.8	100	12	27	27
2014-15	1 Jul - 30 Jun	59	59	100	12	25	23
2015-16	1 Jul - 30 Jun	59	58	98	12	21	21
2016-17	1 Jul - 30 Jun	59	52.6	89	12	25	22
2017-18	1 Jul - 30 Jun	59	57.2	97	12	24	25
2018-19	1 Jul - 30 Jun	47	44.7	95	12	20	20
2019-20	1 Jul - 30 Jun	40	37.1	93	12	16	18

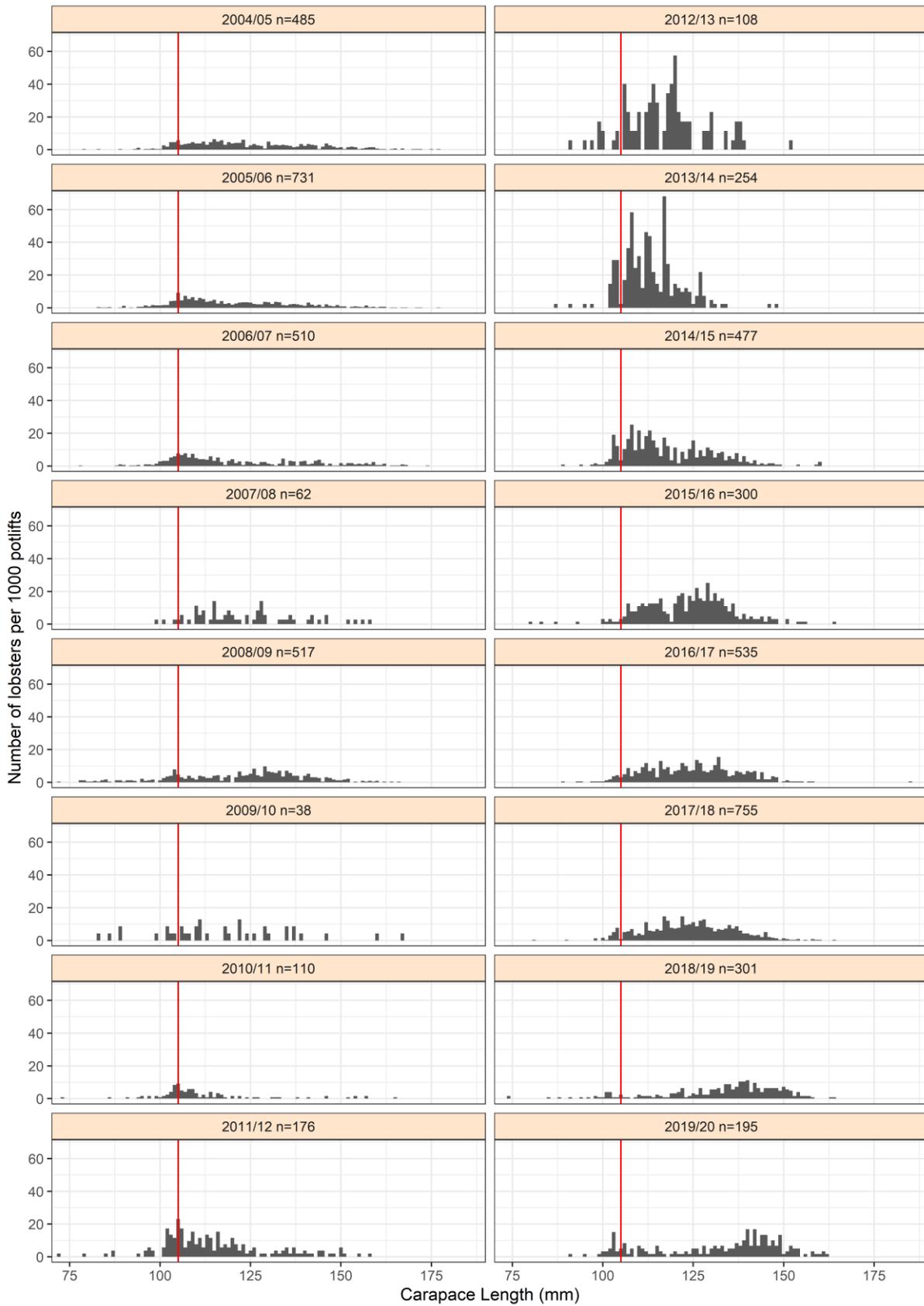


Figure 31: Length-frequency distribution of the number of female rock lobsters per 1,000 potlifts caught in the Eastern Zone onboard observer program from 2004–05 to 2019–20 fishing years (Nov–Sept). n, total number of lobsters measured.

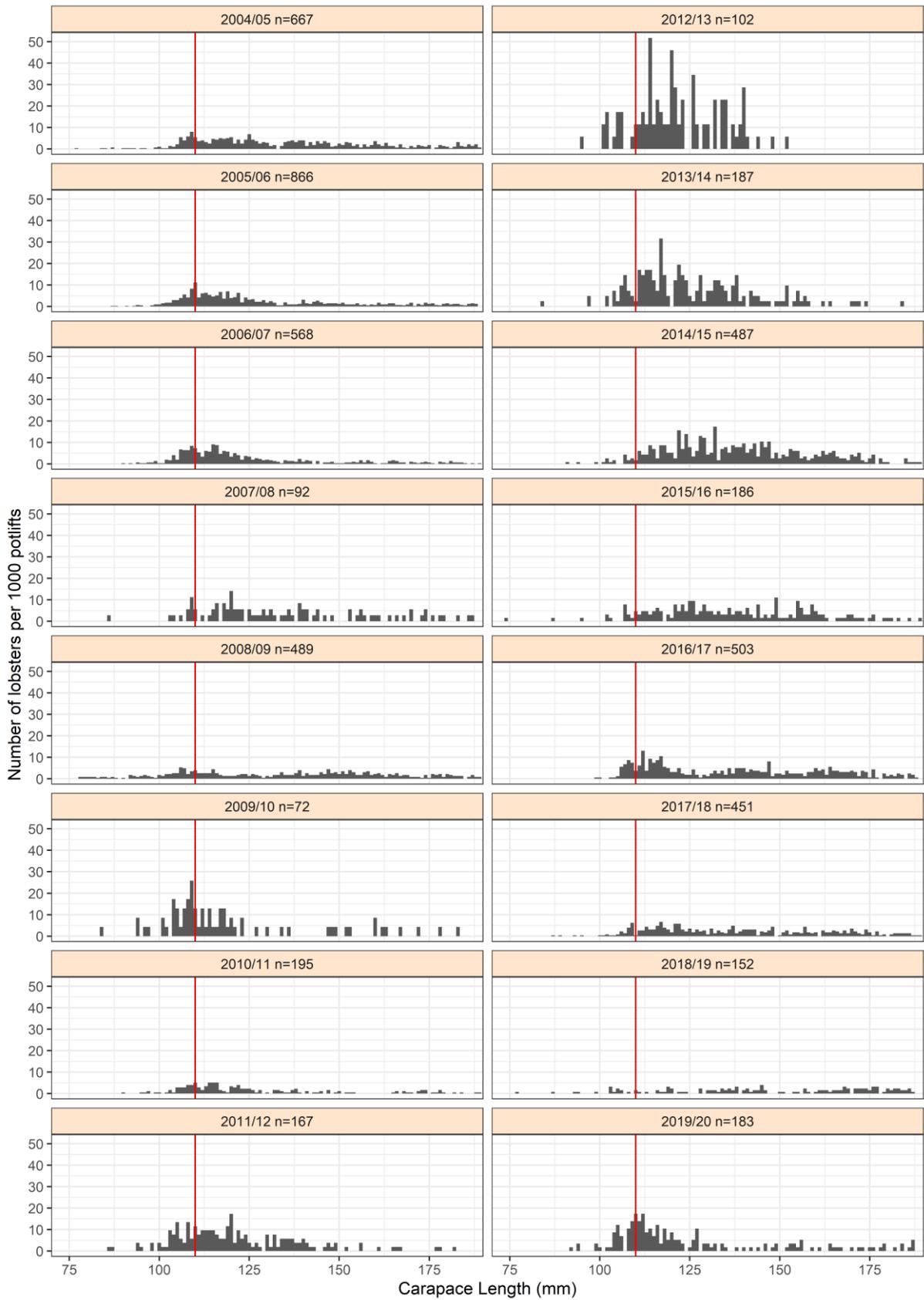


Figure 32: Length-frequency distribution of the number of male rock lobsters per 1,000 pot-lifts caught in the Eastern Zone on-board observer program from 2004–05 to 2019–20 fishing years (Nov–Sept). n, total number of lobsters measured.

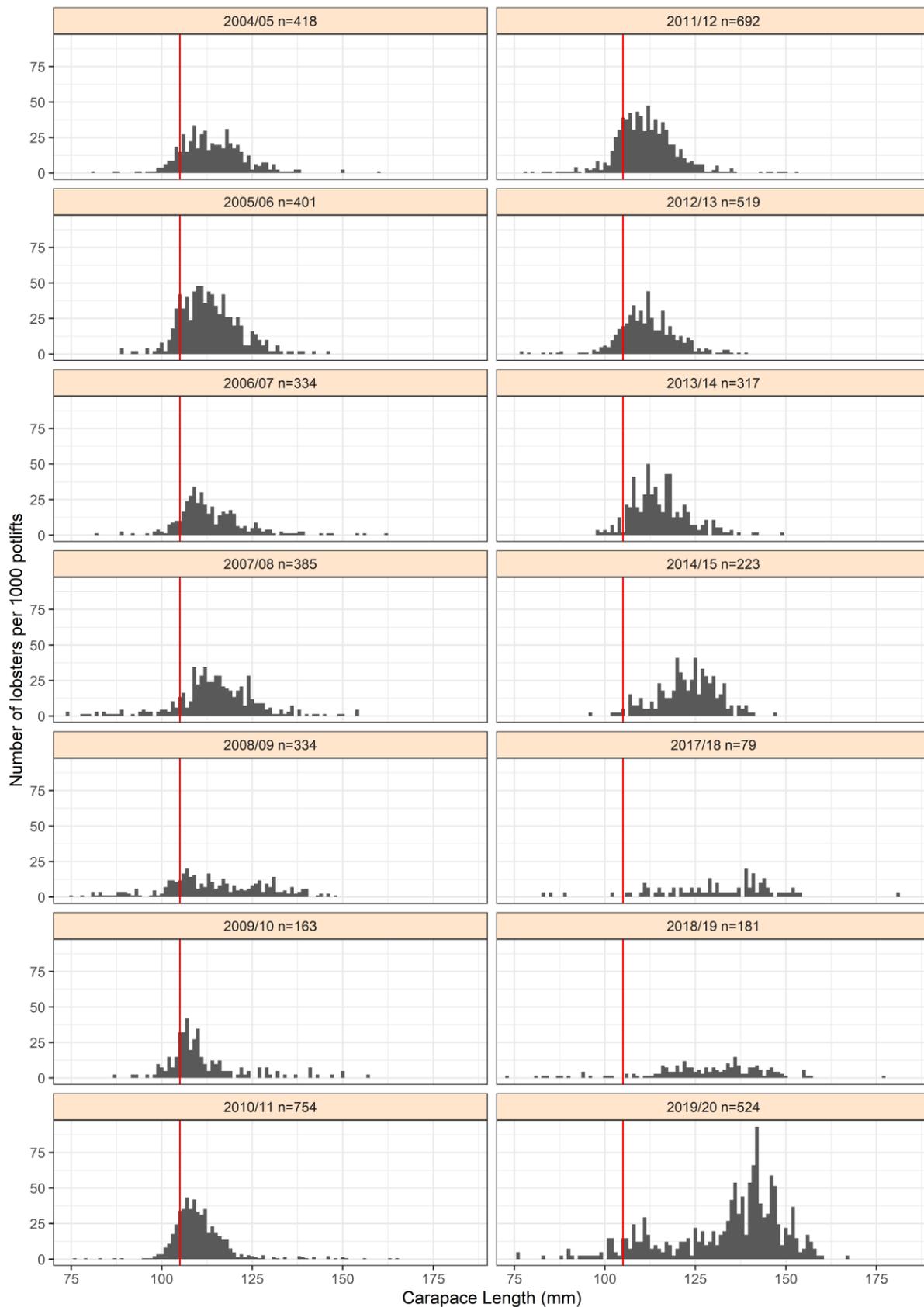


Figure 33: Length-frequency distribution of the number of female rock lobsters per 1,000 potlifts caught in the Eastern Zone fixed-site survey program from 1995–96 to 2019–20 fishing years (Nov–Sept), *n*, total number of lobsters measured.

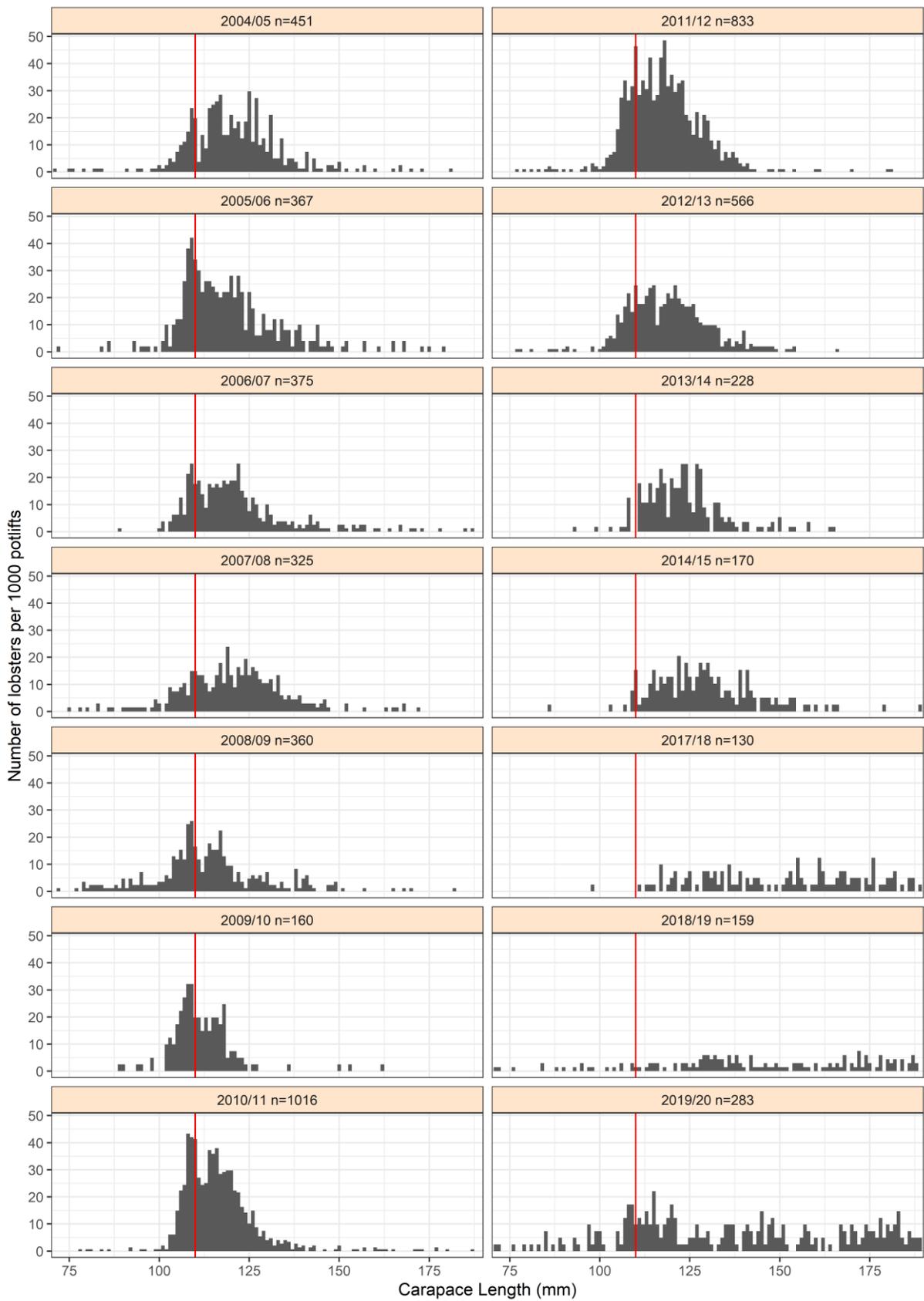


Figure 34: Length-frequency distribution of the number of male rock lobsters per 1,000 potlifts caught in the Eastern Zone fixed-site survey program from 1995–96 to 2019–20 fishing years (Nov–Sept), total number of lobsters measured.

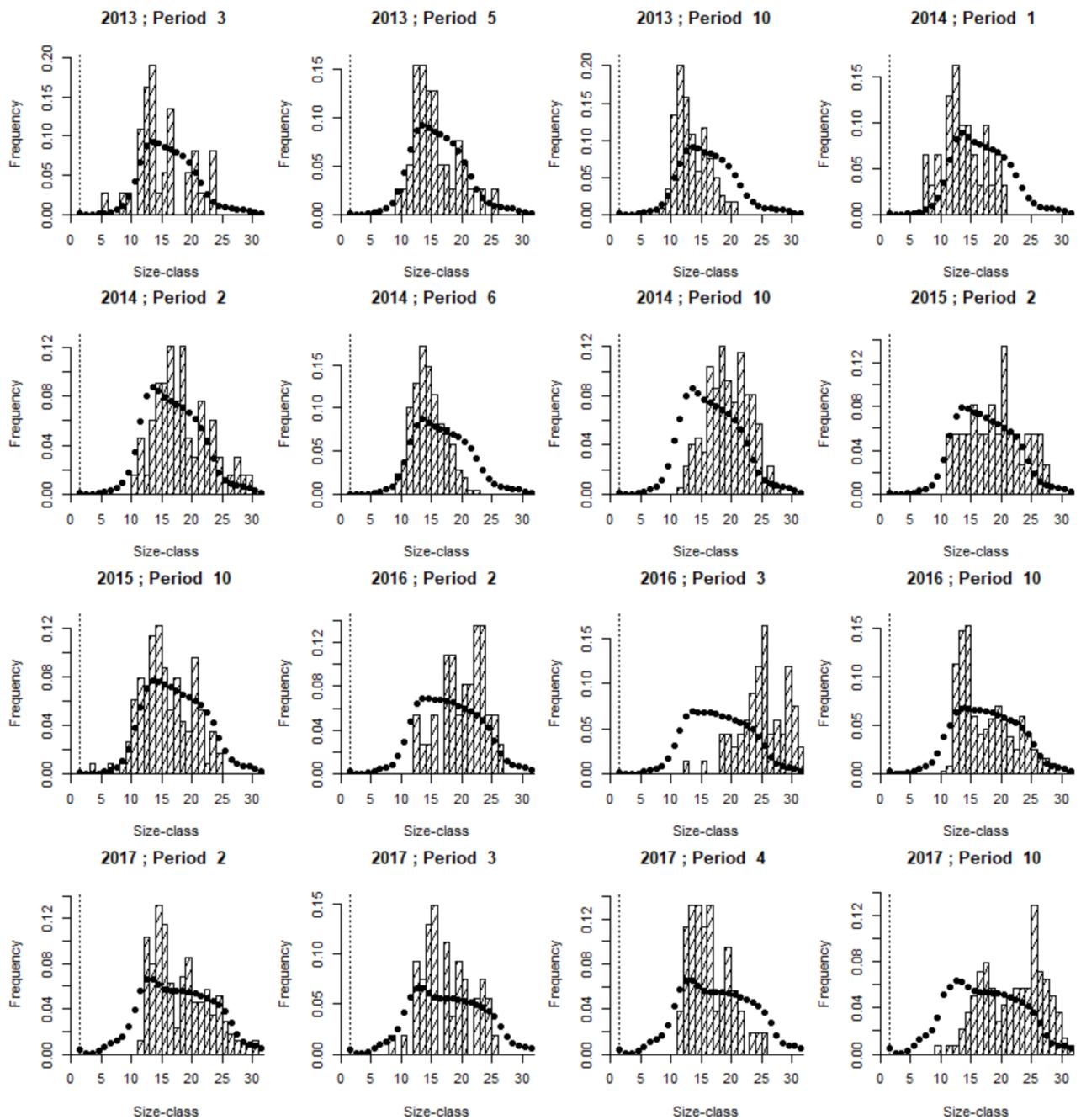


Figure 35: Comparison between length-frequency measurements (bars) and abundance estimated by the stock assessment model (dots) for a selection of years and periods for the Eastern Zone. Periods 1 to 9 are November to July, period 10 is August and September. Size classes are from 60mm increasing in 5mm increments.

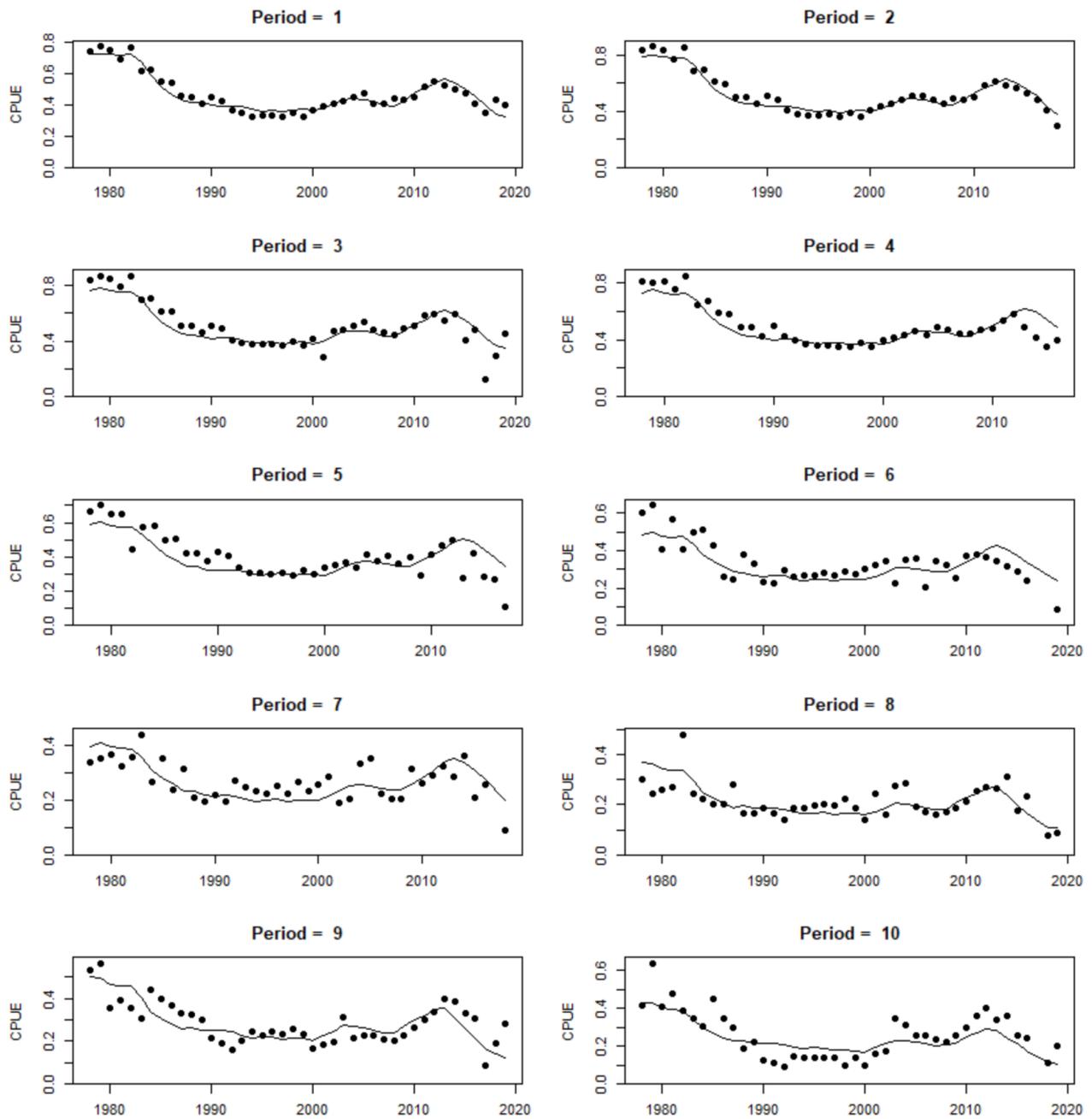


Figure 36: Comparison between standardised CPUE (dots) and CPUE estimated by the stock assessment model (line) for the Eastern Zone. Periods 1 to 9 are November to July, period 10 is August and September

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# Appendix 1: Rock Lobster Fishery Harvest Strategy

(excerpt from the Victorian Rock Lobster Fishery Management Plan 2017, amended to incorporate changes from 2019 and 2020)

Harvest strategies provide a structured framework for assessing the status of a fishery and a set of rules to determine what the annual catch limits will be. Decisions regarding catch limits are therefore set out in advance, ensuring that fishers, fishery managers and other relevant stakeholders know what action will be taken in response to the conditions in the fishery (Sloane et al 2014).

The foundation of this harvest strategy is the exploitation rate, which is the proportion of the available stock that can be caught. Unlike the previous harvest strategy used for the fishery, it does not include a rebuilding target so conservative exploitation rates that ensure that stocks rebuild, catch rates improve, profits are maximised and the objectives of this harvest strategy and management plan are met are used.

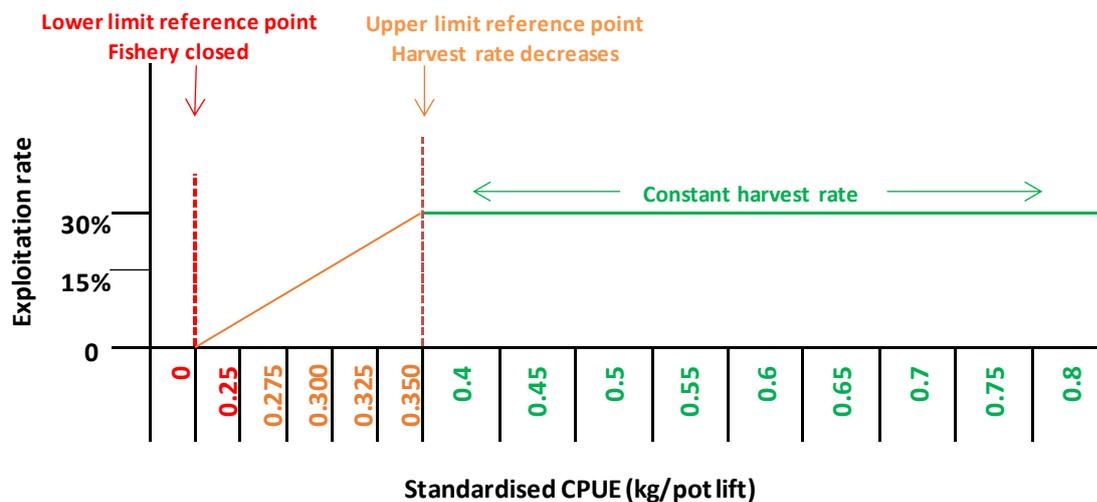
## 1. OPERATIONAL OBJECTIVES

This harvest strategy aims to achieve two main operational objectives, both of which link to the overarching objectives for the management of the fishery. These operational objectives are:

1. Continue to rebuild the rock lobster population by setting appropriately conservative TACCs on an annual basis.
2. Maintain catch rates above 0.40 kg/pot lift (standardised).

## 2. PRINCIPLES OF THE HARVEST STRATEGY

- The harvest strategy is based on standardised CPUE from commercial catch and effort logbook information and is derived from the 'fishing year data series' (i.e. November to September). All estimates of standardised CPUE are rounded to two decimal places.
- TACCs are predetermined and have been calculated using agreed rates of exploitation.
- TACCs are set by assessing the fishing zone's performance against stock performance indicators, biological reference points and applying decision rules. These factors include the standardised CPUE from that year's stock assessment, a pre-recruit index (PRI) and predefined TACC tables that determine whether the annual TACC is increased, maintained or decreased in the following season.
- The rate of exploitation is constant unless the annual standardised CPUE falls below 0.40kg/pot lift (the upper limit reference point), when it is incrementally reduced (Figure 9).
- The annual standardised CPUE will be rounded to two decimal points when it is at and above the upper limit reference point and the exploitation rate is constant (refer to the green zone in Figure 9). It will be increased to three decimal points when the annual standardised CPUE falls between the upper and lower limit reference points (refer to the orange zone in Figure 9).
- The fishery will be closed if the catch rate falls to 0.25kg/pot lift (the lower limit reference point) or less (Figure 9).
- To receive an increase in TACC, the annual PRI must be above the PRI threshold set for each zone.
- The TACC can only be increased by one level at any time ('one-jump rule').
- An upper limit, or cap, on TACC levels has been included in this harvest strategy. The cap for the Western Zone is 300 tonnes and 70 tonnes for the Eastern Zone.



**Figure 9.** Theoretical construction of the proposed harvest strategy framework.

## 2.1 Exploitation rates

- The exploitation rates when the catch rate is at and above the upper reference point are:
  - 26.3% in the Western Zone; and
  - 20.5 % in the Eastern Zone.

## 2.2 Stock performance indicators

Performance indicators measure and track the performance of the stock against the operational objectives in this harvest strategy and are integral in determining the level at which the TACC will be set.

Three biological performance indicators are used in setting the TACC:

1. **Egg production** – an estimate of the spawning size of the population. It is a crucial determinant of the health of the stock and is used in this strategy as a primary indicator in the decision rules.
2. **Standardised CPUE** – CPUE data comes from the catch and effort logbooks submitted by commercial fishers. In lobster fisheries, CPUE is accepted as being proxy representing the abundance of rock lobsters in the fishery above the legal minimum length. It is expressed as the effort required to harvest a defined amount of catch. Standardised CPUE has had irregularities in the data removed and it has been standardised for a range of factors that affect catchability, such as month, year, depth, region and fisher (i.e. the ability and practices of fishers)
3. **Pre-recruit index** – is the number of undersize lobsters per pot lift and is derived from the data collected through the fixed-site survey and on-board observer programs. The annual PRI will be rounded to two decimal places.

A further performance indicator, available biomass, will be used in the assessment of the fishery. This indicator however does not result in explicit TACC adjustments in the fishery in the way egg production, standardised CPUE and pre-recruit index do. Available biomass, as well as historic exploitation rates, is used to provide a more comprehensive picture of the status of the fishery and trends over time.

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## 2.3 Reference points for the performance indicators

Reference points are the benchmarks of performance that define acceptable levels of impact on a stock (Sloane et al. 2014). Reference points are usually linked to the performance indicators and three types have been used; these are limit, threshold and target reference points.

### ***Limit reference points***

Limit reference points (LRP) act like a safety measure as they establish the point at which there is significant risk to the sustainability of the stock. The LRPs used in this harvest strategy are:

**1. Egg production LRP**

Model estimated egg production must be above the LRP of 20% of unfished levels with a 90% probability.

**2. Standardised CPUE LRP**

An upper and a lower LRP have been established, both of which are CPUE-based.

a. Upper LRP: 0.40kg/pot lift

b. Lower LRP: 0.25kg/pot lift

If the standardised CPUE starts to fall and then breaches the upper LRP, the harvest rates are decreased sequentially until the lower LRP is reached. If the LRP point is breached, the fishery will be closed to all fishing.

### ***Threshold reference point***

Threshold reference points can represent a threshold value which triggers a certain management action or a pre-determined management response.

#### ***Pre-recruit index threshold***

In this harvest strategy, threshold reference points have been established for the PRI. The PRI threshold is determined using data from the fixed-site surveys and on-board observer program and is averaged, weighted by region based on past commercial catch during a reference period of 2005 to 2014.

To be eligible for an increase in the TACC in an upcoming season, the PRI for that stock assessment period must be above the threshold level for that zone.

The PRI thresholds are:

- 1.81 undersize per pot lift in the Western Zone; and
- 0.32 undersize per pot lift in the Eastern Zone.

### ***Target reference point***

The target reference point defines the level or value of an indicator that is considered ideal or desirable and at which management should aim.

#### ***Maximum economic yield***

A target reference point is not explicit in this harvest strategy; however, it is an objective of the management plan to develop a long-term maximum economic yield (MEY) target reference point for the stock. MEY is the theoretical catch or effort level that maximises the profit of the commercial fishery. MEY occurs when the total fishing revenue minus total fishing costs is maximised. Economic efficiency in a fishery suggests that the stock is protected and the net returns (i.e. the profits) for fishers are maximised (Australian Government 2007).

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### 3. DECISION RULES TO SET THE TACC

The annual TACC will be set using the following decision rules:

#### ***Decision Rule 1: Egg production***

Model estimated egg production must be above the limit reference point of 20% of the unfished level with a 90% probability. This decision rule must be satisfied before the CPUE-based harvest strategy can be used to set the TACC.

If this decision rule is not met, the TACC will be determined using the rock lobster fishery model to ensure that the TACC returns the egg production to above the limit reference point within two years with a 90% probability.

#### ***Decision Rule 2: TACC Determination***

When Decision Rule #1 has been met, the TACC is set using the standardised CPUE tables. Refer to Tables 7 and 8, for the Western and Eastern Zones, respectively.

Step 1: Use the standardised CPUE from the preceding season to identify the CPUE band.

Step 2: Determine the TACC level according to the following conditions:

1. The TACC will be **increased** to the next level when:
  - i. the standardised CPUE is in a band higher than in the previous season;

**AND**

  - ii. the PRI (rounded to two decimal places) is at or above the threshold level of 1.80 undersize per pot lift for the Western Zone or 0.32 undersize per pot lift for the Eastern Zone.

One-jump rule: the TACC can only be increased one level per year.

2. The TACC will **remain at the same level** when:
  - i. the standardised CPUE remains in the current band;

**OR**

  - ii. the standardised CPUE has increased to a higher band but the PRI is below the trigger point.
3. The TACC will be **decreased** when:
  - i. the standardised CPUE has decreased into any lower band.

The TACC will be set at the level that corresponds to the standardised CPUE.

#### ***Decision Rule 3: TACC Cap***

A TACC cap of 300 tonnes in the Western Zone and 70 tonnes in the Eastern Zone will be used over the life of the harvest strategy.

## 4. TACC TABLES

The levels of TACC are pre-set and based on the chosen harvest rate. The values of the TACCs and the corresponding CPUE are in the Tables 8 and 9. These tables, in association with the decision rules will be used to set the TACCs for the fishery over the life of the Management Plan.

- The TACC tables consist of CPUE bands and corresponding TACC levels. The tables comprise three levels, which correspond to the upper and lower limit reference points:
  - The CPUE are set at bands of 0.05kg/pot lift when the standardised CPUE is above the upper limit reference point of 0.40kg/pot lift.
  - The band-widths of the TACC levels reduce to 0.025kg/pot lift when the standardised CPUE is between 0.25kg/pot lift and 0.40kg/pot lift.
- If the standardised CPUE drops below 0.25kg/pot lift, the fishery in that zone will be closed to all fishing (commercial and recreational). To determine the status of the fishery in that zone after the closure:
  - Fishing is to be undertaken through the fixed-site survey program, using the survey protocols used in previous seasons;
  - A fixed-site survey measure of CPUE will be computed; and,
  - A re-scaling method will be applied to convert the fixed-site survey CPUE to standardised CPUE.

**Table 8. CPUE thresholds and corresponding TACC levels for the Western Zone.**

CPUE Band	TACC
<0.25	0
0.250 - <0.275	11
0.275 - <0.300	25
0.300 - <0.325	43
0.325 - <0.350	64
0.350 - <0.375	88
0.375 - <0.40	115
0.40 - <0.45	152
0.45 - <0.50	176
0.50 - <0.55	199
0.55 - <0.60	223
0.60 - <0.65	246
0.65 - <0.70	270
0.70 - <0.75	293
0.75 - <0.80	300

**Table 9. CPUE thresholds and corresponding TACC levels for the Eastern Zone.**

CPUE Band	TACC
<0.25	0
0.250 - <0.275	5
0.275 - <0.300	10
0.300 - <0.325	17
0.325 - <0.350	24
0.350 - <0.375	32
0.375 - <0.40	40
0.40 - <0.45	51
0.45 - <0.50	56
0.50 - <0.55	61
0.55 - <0.60	66
0.60 - <0.65	70
0.65 - <0.70	70
0.70 - <0.75	70
0.75 - <0.80	70

- Blue TACC values refer to the TACC cap
- Green TACC values refer to standardised CPUE values that are above the upper LRP and have a constant exploitation rate (26.3% in the Western Zone and 20.5% in the Eastern Zone).
- Orange TACC values refer to standardised CPUE values below the upper LRP and have incrementally decreasing exploitation

