Fisheries

# Northern Zone Rock Lobster (*Jasus edwardsii*) Fishery Status Report 2022/23

A. Linnane, R. McGarvey, J. Feenstra, K. Mark and D. Graske

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PO Box 120 Henley Beach SA 5022

November 2023

Status Report to PIRSA Fisheries and Aquaculture

Government of South Australia
Department of Primary Industries and Regions

SARDI
South Australian Research and Development Institute

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## EXECUTIVE SUMMARY

This report assesses the status of South Australia's Northern Zone Rock Lobster Fishery (NZRLF) stock and provides the latest estimates of the biological performance indicators (PIs), information in context of the reference points (RPs) and stock status classification described in the Management Plan for the fishery. Stock status was determined using the harvest strategy for the fishery that was developed in alignment with the National Fishery Status Reporting Framework (NFSRF) classification system used to determine the status of all South Australian fish stocks.

Overseas market disruptions have been prevalent across the industry in recent seasons. Therefore, to allow for greater fishing flexibility, the 2022 (i.e. 2022/23) season was extended from 1 November to 31 October (normally 1 November to 31 May). This status report presents data from 1 November 2022 to 31 May 2023, which is the agreed assessment period considered for guiding TACC setting.

In 2022, the total allowable commercial catch (TACC) in the NZRLF was 330 t (261 t Inner sub-region and 69 t Outer sub-region). This reflected a regular TACC of 296 t plus 34 t carry-over. The reported logbook catch (1 November 2022 to 31 May 2023) was 234 t (71% of the TACC). By sub-region, the logbook catch was 196 t from the Inner sub-region and 37 t from the Outer sub-region.

Effort required to take the catch in 2022 was 178,529 potlifts reflecting a 15% decrease from 2021 (209,223 potlifts). The 2022 estimate is the lowest on record (but noting that the TACC was under-caught by 29% to the end of May 2023).

Catch per unit effort (CPUE) of legal-sized lobsters is the primary biological performance indicator for the fishery. In 2022, the legal-sized CPUE was 1.33 kg/potlift, reflecting a 73% increase from 2016 (0.77 kg/potlift) and the highest CPUE since 1999 Current estimates are above the Trigger Reference Point (TrRP) (0.60 kg/potlift) for the fishery. At a sub-zonal level, since spatial management was implemented in 2015, Outer sub-region catch rates have marginally decreased. This in contrast to the Inner sub-region where catch rates have increased considerably since 2015.

The secondary biological performance indicator is the pre-recruit index (PRI; no. of undersized lobsters/potlift). In 2022, the PRI was 0.19 undersized/potlift reflecting a 17% decrease from 2021 (0.23 undersized/potlift) but remaining above the trigger reference point (TrRP) of 0.16 undersized/potlift. In the NZRLF, the time taken for pre-recruits to enter the fishable biomass is estimated to be approximately one year.

Model outputs show long-term declines in lobster biomass from 1999 to 2008. Over the last six seasons, biomass has increased, which, combined with reduced TACCs have reduced the exploitation rate to 16%, the lowest on record. Egg production in the fishery remains low with 2022 estimates equating to 15% of unfished levels, but with increases in recent seasons.

The stock status classification for the NZRLF is defined in the Management Plan for the fishery (PIRSA 2021). In 2022, the CPUE of 1.33 kg/potlift was above the TrRP of 0.60 kg/potlift. As a result, the NZRLF stock is classified as "**sustainable**". This means that the current level of fishing mortality is being adequately controlled to avoid the stock becoming recruitment impaired.

**Table 1** Key statistics for the NZRLF.

| Statistic | 2022/23 | 2021/22 |
|---|---|---|
| TACC | 330 t | 383 t |
| Total commercial catch (Nov-May) | 234.7 t | 259.5 t |
| Total effort (Nov-May) | 178,529 poltifts | 209,223 poltifts |
| Commercial CPUE (Nov-Apr) | 1.33 kg/potlift | 1.25 kg/potlift |
| Pre-recruit index (Nov-Mar) | 0.19 undersized/potlift | 0.23 undersized/potlift |
| Biomass estimate | 1,828 t | 1,704 t |
| Exploitation rate | 16% | 18% |
| Egg Production | 15% | 14% |
| **Status** | **Sustainable** | **Sustainable** |

**Keywords:** Rock lobster, Northern Zone, Fishery Status, *Jasus edwardsii*.

# 1 INTRODUCTION

This fishery status report updates the 2021/22 stock assessment report for the Northern Zone Rock Lobster Fishery (NZRLF) (Linnane et al. 2023) and is part of the SARDI Aquatic Sciences ongoing assessment program for the fishery. The aims of the report are to provide a synopsis of information available for the NZRLF and assess the status of the resource in relation to the performance indicators specified in the management plan for the fishery (PIRSA 2021).

The Department of Primary Industries and Regions (PIRSA) has adopted the National Fishery Status Reporting Framework (NFSRF; Piddocke et al. 2021) to determine the status of all South Australian fish stocks. The harvest strategy for the NZRLF (PIRSA 2021) was developed in alignment with the NFSRF classification system to allow determination of stock status. A comprehensive assessment that includes more detailed spatial and temporal analyses will be provided in the 2022/23 stock assessment report that is due in July 2024.

In 2022/23 (hereafter referred to as 2022), the total allowable commercial catch (TACC) in the NZRLF was 330 t (261 t Inner sub-region and 69 t Outer sub-region) which reflected a regular TACC of 296 t plus 34 t carry-over. As of the 2015 season, fishing in the NZRLF can be undertaken over the 12-month period from 1 November to 31 October of the following year (Linnane et al. 2016). This status report presents data from 1 November 2022 to 31 May 2023, which is the agreed assessment period considered for guiding TACC setting. A comprehensive assessment that includes data from all fishing months will be provided in the 2022/23 stock assessment report that is due in July 2024.

# 2 METHODS

Data sources presented in this report are described in Linnane et al. (2023). Briefly, the catch and effort data presented are obtained from a mandatory daily logbook program administered by PIRSA Fisheries and Aquaculture. Catch and effort data are presented by zone, sub-region and Marine Fishing Area (MFA) (Figure 1).

The primary biological performance indicator is commercial logbook CPUE (kg of legal sized lobsters/potlift) based on data from November to April, inclusive. A Trigger Reference Point (TrRP) of 0.60 kg/plotift is specified in the harvest strategy, below which, exploitation rates (and corresponding TACCs) are reduced considerably (PIRSA, 2021). The secondary indicator is commercial logbook PRI (no. of undersized lobsters/potlift) based on data from November to March, inclusive. TACCs can only be increased if the PRI is above a TrRP of 0.16 undersized/potlift.

In 2023, the FRDC report "*Assessing the efficiency of alternative rock lobster pot designs*" (McLeay et al. 2023) was completed. The report identified differences in catch efficiencies for both legal and undersized lobsters in newly adopted Western Australia (WA) batten pots compared to traditional beehive designs. To account for this in legal sized CPUE and undersized PRI reporting, the following adjustments were applied to these indices; (i) For the Inner sub-region, nominal CPUE of beehive only pot users was rescaled downward by 0.9916 (the difference in CPUE from 2015–2019 between the 8 licences that nominated to use WA pots and the remaining fleet using beehive pots); (ii) For the Outer sub-region, due to limited data, nominal CPUE was estimated from beehive pot users only with no rescaling applied and (iii) For the entire zone, PRI from beehive only pot users was rescaled upward by 1.0311 (the difference in PRI from 2015–2019 between the 8 licences that nominated to use WA pots and the remaining fleet using beehive pots). For the key indicators of CPUE and PRI, both adjusted and non-adjusted indices by pot type are presented in this report.

Length-frequency data were obtained from a fishery-dependent catch sampling program. Puerulus sampling was undertaken at four sites in the NZRLF and based on data collected from July to October.

A detailed description of the qR fishery assessment model is provided in McGarvey and Matthews (2001) and Linnane et al. (2022). The primary output from the model were: (i) legal-sized biomass; (ii) egg production; (iii) % unfished egg production; (iv) exploitation rate (fraction of legal-sized biomass harvested); and (v) recruitment. Updates made since 2017 include: (i) logbook catch totals summed over the NZRLF 12-month fishing season starting from 1 June of each year; (ii) from 2014 onward using a rescaled measure of fishing effort that removes the effect of lower winter (June-October) catch rates; and (iii) additionally adjusting the model measure of effort, (2019/20 season only), to account for COVID market disruption after 22 January 2020.

Two further modifications were made in 2021 to the NZRLF qR model: (iv) new weights-at-age were used that assume first-year recruits have a mean length obtained by one-half-year's growth above the LML of 105 mm CL; (v) a separate catchability parameter for years since the implementation of quota (2003+) is now estimated. Both modifications have improved the agreement of model data compared with data mean weight (as Cw/Cn). The resulting qR model biomass and egg production time series now agree closely with those estimated by LenMod, most notably in recent years. Details of the full model correction are provided in Linnane et al. (2022).

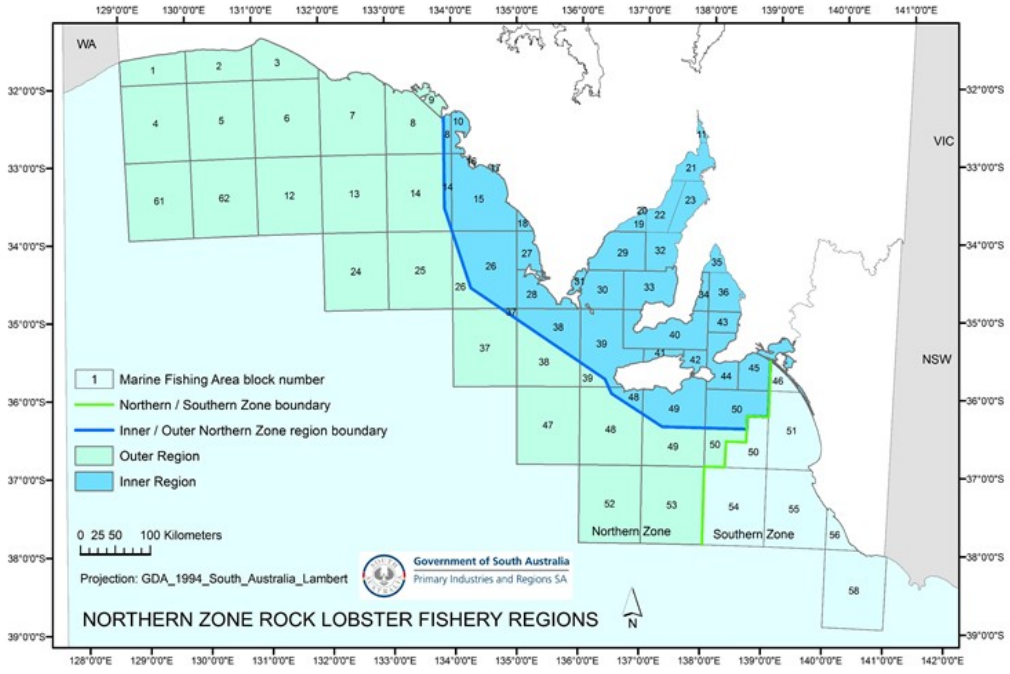



**Figure 1** Northern and Southern Zones and Marine Fishing Areas (MFAs) and associated sub-regions in the South Australian Rock Lobster Fishery.

# 3 RESULTS

## 3.1 Commercial catch and effort statistics

It is important to highlight that overseas market disruptions have been prevalent across the Southern Rock Lobster industry in South Australia in recent seasons. Such disruptions can impact catch, effort and CPUE outputs and therefore should be considered when interpreting fishery trends across recent seasons.

### 3.1.1 Zone and Sub-region

In 2022, the total allowable commercial catch (TACC) in the NZRLF was 330 t (261 t Inner sub-region and 69 t Outer sub-region) which reflected a regular TACC of 296 t plus 34 t carry-over. The reported logbook catch (1 November 2022 to 31 May 2023) was 234 t (71% of the TACC) (Figure 2a). By sub-region, the logbook catch was 197 t

(75% of TACC) from the Inner sub-region and 37 t from the Outer sub-region (54% of TACC) (Table 2).

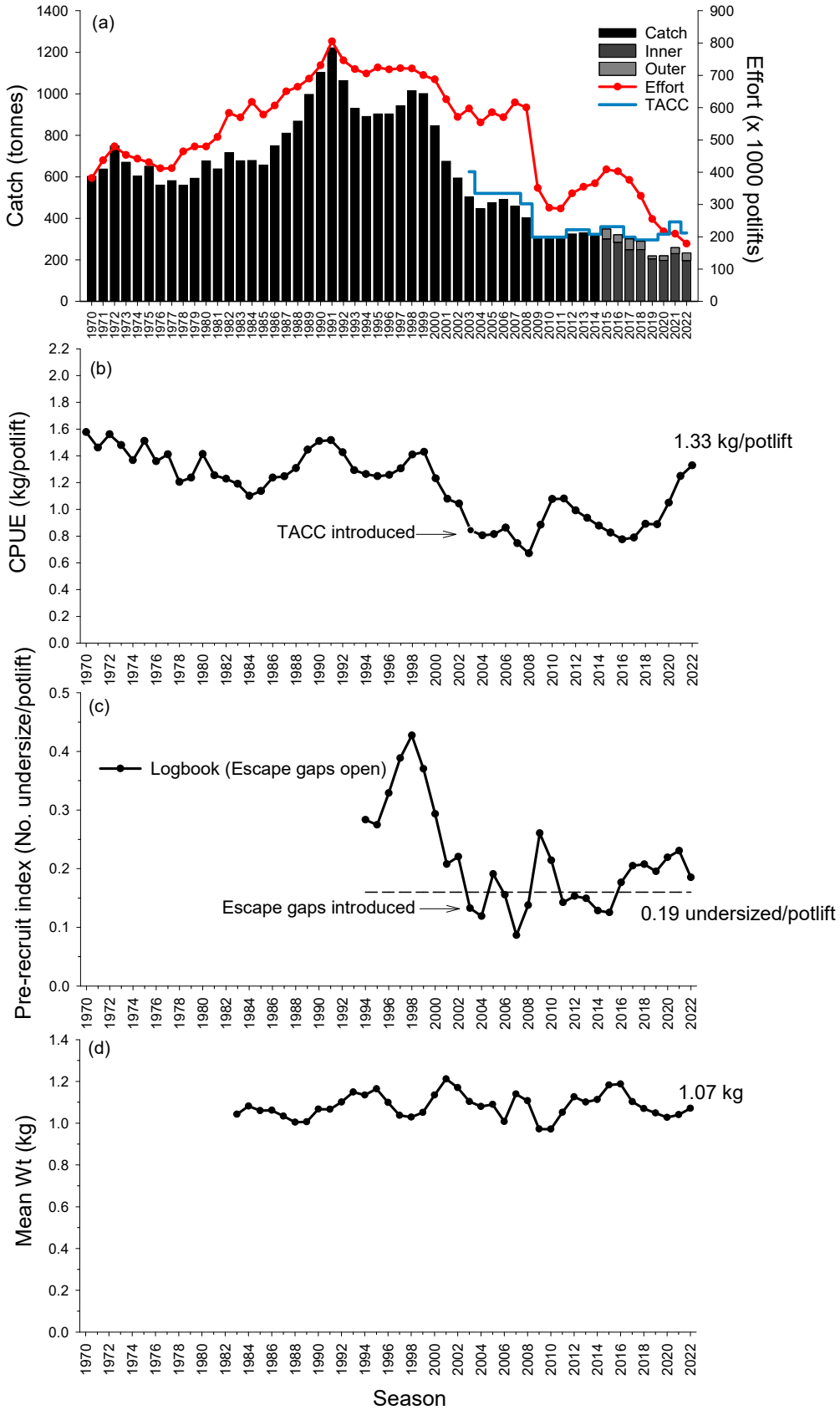
The long-term trend shows a consistent decline in catch from 1999 to 2009. Importantly, despite introduction of a TACC in 2003, the TACC was considerably under-caught until catch levels were further constrained in 2009 when the TACC was reduced from 470 t to 310 t (Figure 2a). Current catch levels are low in a historical context and have remained relatively stable over recent seasons.

Effort required to take the catch in 2022 was 178,529 potlifts reflecting a 15% decrease from 2021 (209,223 potlifts) (Figure 2a). In 2009, effort decreased considerably from 600,000 to 350,000 potlifts, before decreasing further to 287,000 potlifts in 2011. After increases to 408,000 potlifts in 2015, effort has decreased consecutively over the next seven seasons. The 2022 estimate is the lowest on record (but noting that the TACC was under-caught by 29% to the end of May 2022).

In 2022, the legal-sized CPUE was 1.33 kg/potlift, reflecting a 73% increase from 2016 (0.77 kg/potlift) and the highest CPUE since 1999 (Figure 2b). Following a decline between 1999 and 2008, when CPUE decreased to a historical low of 0.68 kg/potlift, CPUE increased to 1.1 kg/potlift in 2011, before again declining to 0.77 kg/potlift in 2016. By sub-region, the Inner sub-region catch rate was 1.46 kg/potlift reflecting an 80% increase from 2015 (0.81 kg/potlift). The Outer sub-region catch rate was 0.88 kg/potlift in 2022 reflecting a 15% decrease over the same period (1.04 kg/potlift in 2015) (Figure 3; Table 2). Pot type adjusted CPUEs (beehive pots only) in 2022 were 1.42 and 0.97 kg/potlift in the Inner and Outer sub-regions respectively (Figure 3).

Pre-recruit Index (PRI) estimates are based on logbook data from November to March inclusive. In 2022, the PRI was 0.19 undersized/potlift reflecting a 17% decrease from 2021 (0.23 undersized/potlift), but remaining above the trigger reference point (TrRP) of 0.16 undersized/potlift (Figure 2c). The pot type adjusted PRI (beehive pots only) in 2022 was 0.18 undersized/potlift. In the NZRLF, the time taken for pre-recruits to enter the fishable biomass is estimated to be approximately one year.

The legal-sized mean weight of lobsters has remained relatively stable since 1983 (Figure 2d). Between 2010 (0.97 kg) and 2016 (1.19 kg) mean weight increased before decreasing over the next four seasons to 1.03 kg in 2020. Over the last two seasons mean weight has increased and in 2022 was 1.07 kg. Variations in mean weight generally reflect long-term patterns of recruitment, with lower mean weights resulting




from influxes of small lobsters into the fishable biomass and higher mean weights resulting from several consecutive years of low recruitment.

**Figure 2** Fishery dependent outputs for the NZRLF. (a) Catch and effort including total allowable commercial catch (TACC) limit; (b) catch per unit effort (CPUE; (c) pre-recruit index

(PRI) including trigger reference point (dashed line) based on logbook data with escape gaps; and (d) mean weight.

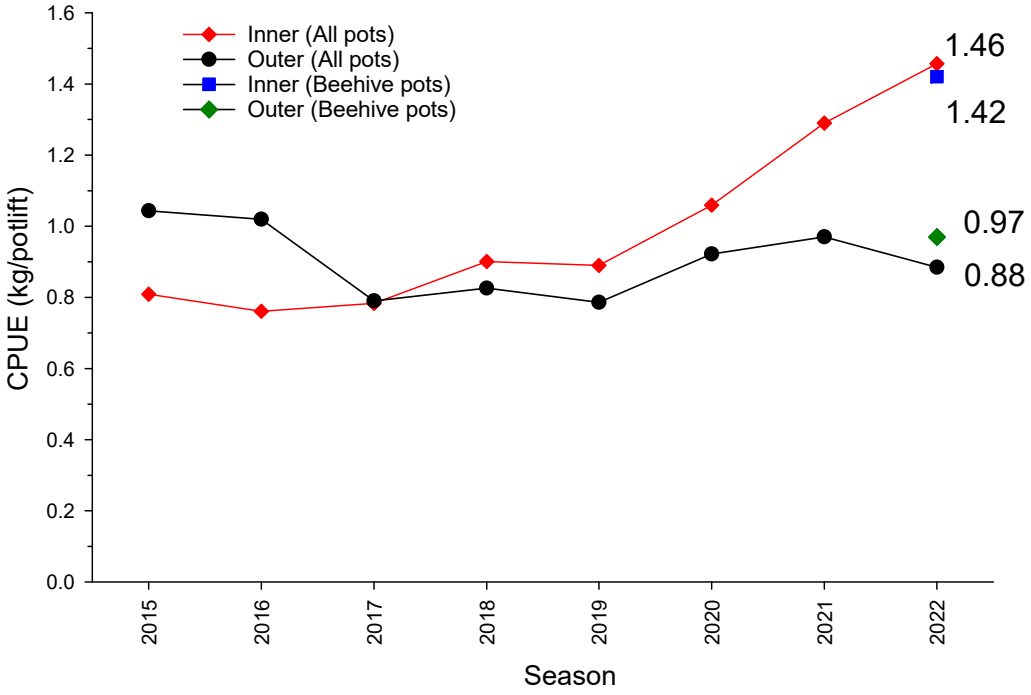



**Figure 3** Catch rates by sub-region and adjusted pot type for the NZRLF.

**Table 2** Commercial catch and effort statistics for the NZRLF sub-regions based on data from November-May. *Note: 2020, 2021 and 2022 Inner and Outer TACCs include carry-over.

| **Inner sub-region** | | | | | |
|---|---|---|---|---|---|
| Season | Catch (t) | Effort (potlifts) | CPUE (kg/potlift) | TACC (t) | TACC Uncaught (t) |
| 2015 | 301.18 | 378,667 | 0.80 | 300 | 0 |
| 2016 | 284.58 | 382,007 | 0.74 | 300 | 15.47 |
| 2017 | 249.17 | 319,290 | 0.78 | 250 | 0.83 |
| 2018 | 249.65 | 277,843 | 0.90 | 250 | 0.35 |
| 2019 | 205.40 | 236,457 | 0.87 | 250 | 44.60 |
| 2020 | 197.68 | 191,876 | 1.03 | *263 | 65.32 |
| 2021 | 230.34 | 179,199 | 1.29 | *286 | 55.66 |
| 2022 | 197.10 | 136,131 | 1.46 | *261 | 75.18 |
| **Outer sub-region** | | | | | |
| Season | Catch (t) | Effort (potlifts) | CPUE (kg/potlift) | TACC (t) | TACC Uncaught (t) |
| 2015 | 32.74 | 34,705 | 0.94 | 60 | 27.26 |
| 2016 | 20.94 | 20,576 | 1.01 | 60 | 39.06 |
| 2017 | 46.83 | 58,889 | 0.80 | 60 | 13.17 |
| 2018 | 40.13 | 48,592 | 0.83 | 46 | 5.87 |
| 2019 | 14.16 | 18,106 | 0.78 | 46 | 31.84 |
| 2020 | 22.20 | 24,402 | 0.92 | *61 | 38.80 |
| 2021 | 29.13 | 30,024 | 0.97 | *97 | 67.87 |
| 2022 | 37.30 | 42,157 | 0.88 | *69 | 54.05 |

### 3.1.2 Within-season trends

Within-season commercial catch trends presented here are based on data from 2020 to 2022. Results from earlier seasons are provided in previously published stock assessment reports (http://pir.sa.gov.au/research/publications/research_reports). In general, within-season trends in catch, effort, CPUE, PRI and mean weight within the NZRLF are consistent through time (Figure 4). The highest catches are taken during spring/summer from November to January (Figure 4a) before declining thereafter.

Market issues were particularly prevalent during the 2020 season with lower catches from November to February, compared to previous seasons (Figure 4a). In 2022, the highest catch was taken in November (63 t), and the lowest catch in April (7 t).

Within-season effort levels are largely consistent with those of catch (Figure 4a) In 2022, effort was highest in November (44,451 potlifts) and lowest in April (9,299 potlifts).

Legal-sized CPUE generally tended to increase from November to January/February before decreasing thereafter (Figure 4b). However, in 2022 CPUE was highest in November/December before decreasing monthly to April. In 2022, CPUE was highest in December (1.57 kg/potlift) and lowest in April (0.75 kg/potlift).

Monthly trends in catch rate of pre-recruits (i.e. PRI) were highest at the start of the season before decreasing thereafter (Figure 4c). In 2022, except for December and May, PRI was consistently lower across all months compared to previous seasons. In 2022, the PRI was highest in December (0.20 undersized/potlift) and lowest in April (0.11 undersized/potlift).

Monthly legal-sized mean weight generally increased as the season progresses (Figure 4d). In 2/22, the mean weight was lowest in November (0.96 kg) and highest in April (1.25 kg).

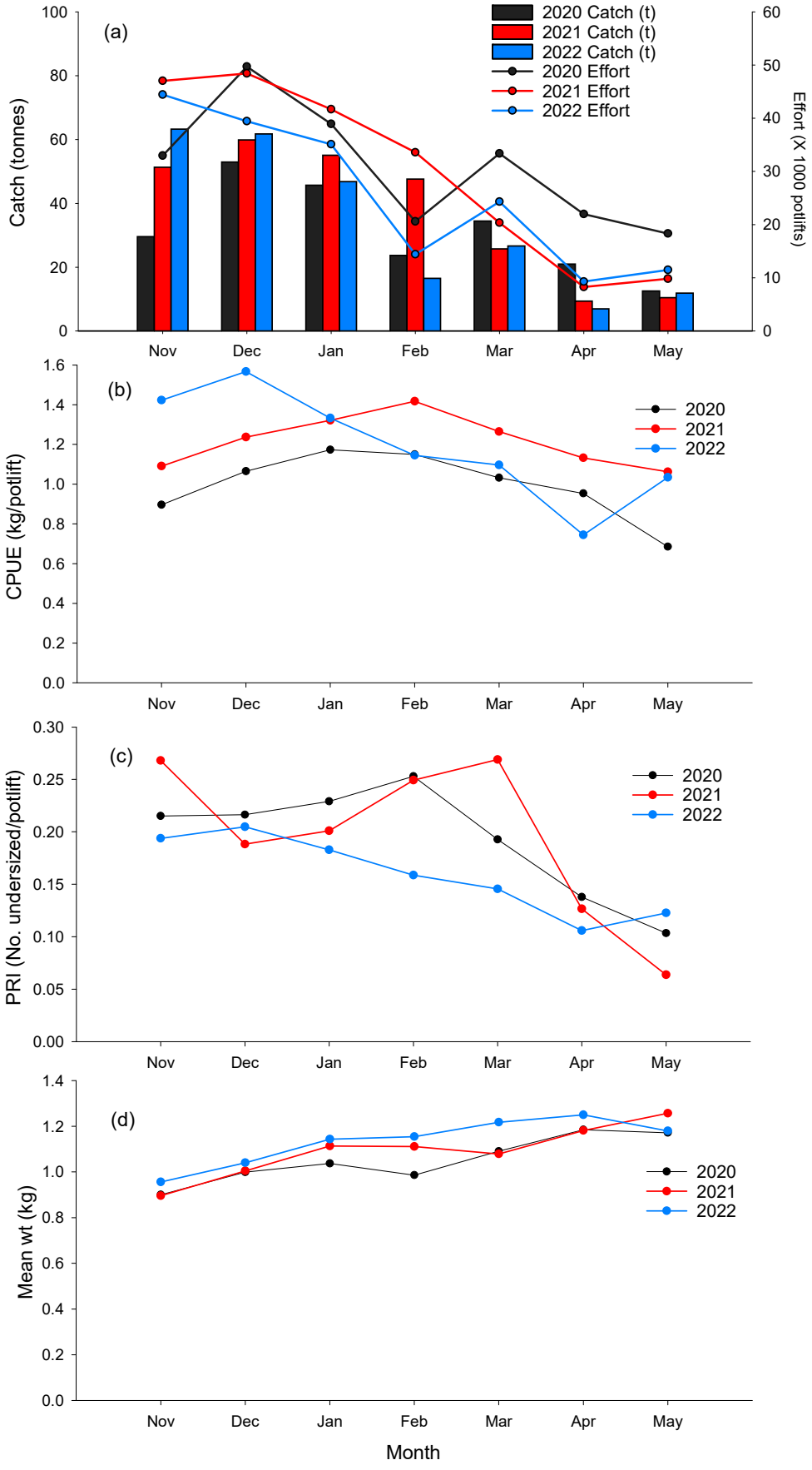



**Figure 4** Within-season fishery dependent trends in the NZRLF. (a) Catch and effort; (b) catch per unit effort (CPUE); (c) pre-recruit index (PRI); and (d) mean weight.

### 3.1.3 Spatial trends (MFAs)

In 2022, 92% of the catch (215 t) originated from ten MFAs (MFAs 7, 8, 15, 27, 28, 39, 40, 48, 49 and 50) (Figure 5 and Figure 6; see Figure 1 for location of MFAs). Current catch levels are now low in a historical context but have remained relatively stable across most MFAs over the last decade. In 2022, within the primary MFAs, the highest catch was taken in MFA 39 (44 t) (Figure 6a) and the lowest in MFA 15 (4 t) (Figure 5a).

Effort levels largely reflected trends in catch (Figure 5 and Figure 6). In recent seasons, the highest effort has been in MFA 39 (approximately 30,000–90,000 potlifts annually over the last seven seasons) (Figure 6a). In 2022 compared to 2021, effort decreased in all major MFAs with the exception of MFAs 7, 15, 27 and 50.

Trends in legal-sized annual CPUE were temporally consistent among the MFAs, with higher values occurring in the 1970s through to the late 1990s, and lows in the 2000s (Figure 5 and Figure 6). From 1999 to 2008, CPUE generally declined in most regions. More recently, following six seasons of successive decline from 2010 to 2016 and with the exceptions of MFAs 7, 8 and 15, catch rates have increased in almost all MFAs over the last 5–6 seasons.

Spatial estimates of the logbook based PRI indicate that the number of undersized/potlift is consistently lower in the north-western MFAs of 7, 8, 15, 27 and 28 (Figure 5) and higher in the south-eastern MFAs of 39, 40, 48, 49 and 50 (Figure 6). Compared to 2021, the zonal decrease in PRI in 2022 was driven by declines across all major MFAs.

Rock lobster mean weights were highest in MFAs located in the north of the NZRLF (e.g. MFA 7, 8, 15, 27) (Figure 5) and lowest in MFAs located further south (e.g. MFA 48, 49, 50) (Figure 6). In 2022 compared to 2021, the zonal increase in mean weight was largely driven by MFAs 7, 8, 28 (Figure 5) and 39, 40, 49 and 50 (Figure 6).

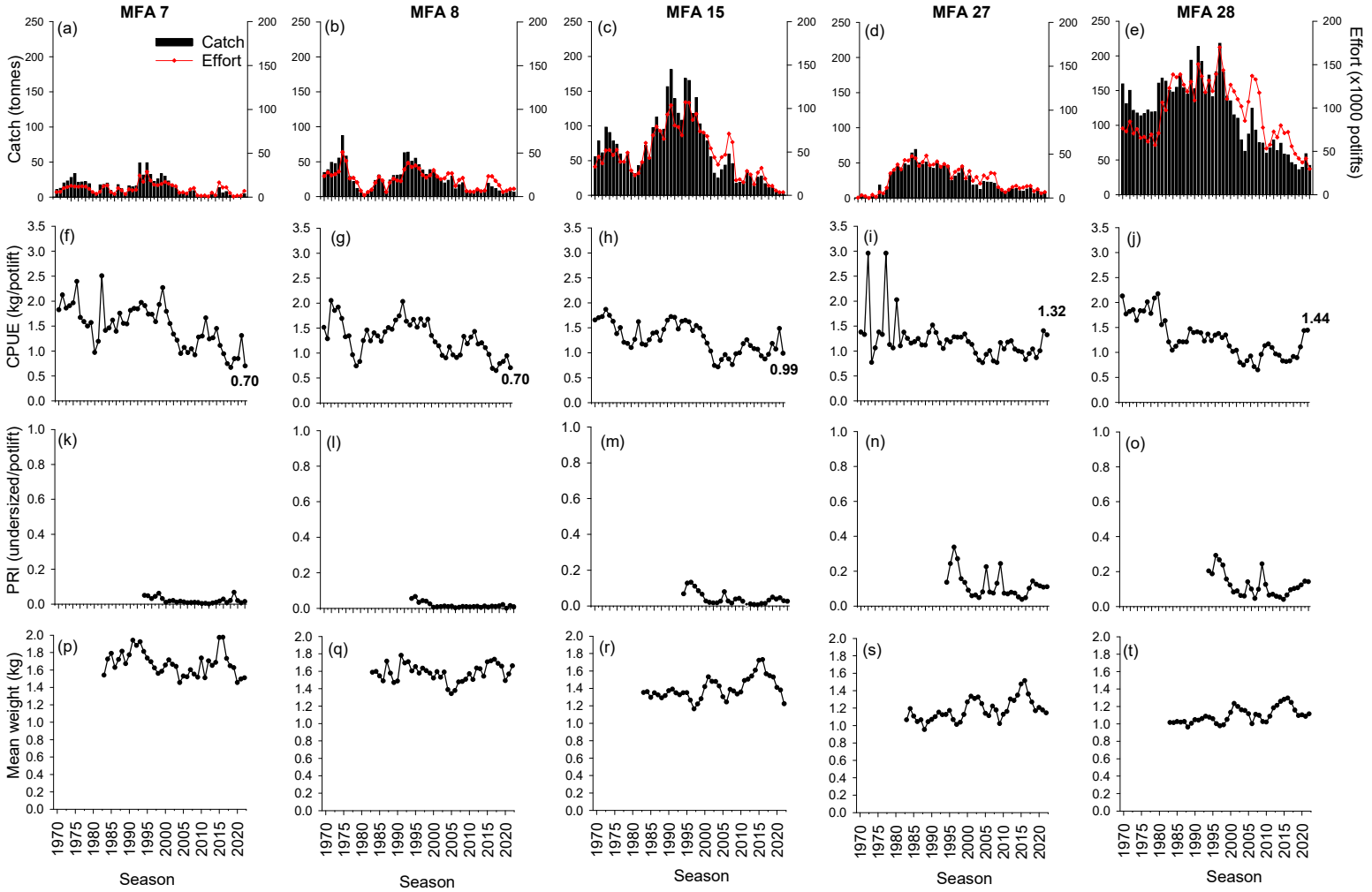



**Figure 5** Spatial fishery dependent trends in the NZRLF for MFAs 7-28. (a-e) Catch and effort; (f-j) catch per unit effort (CPUE); (k-o) pre-recruit index (PRI); and (p-t) mean weight.

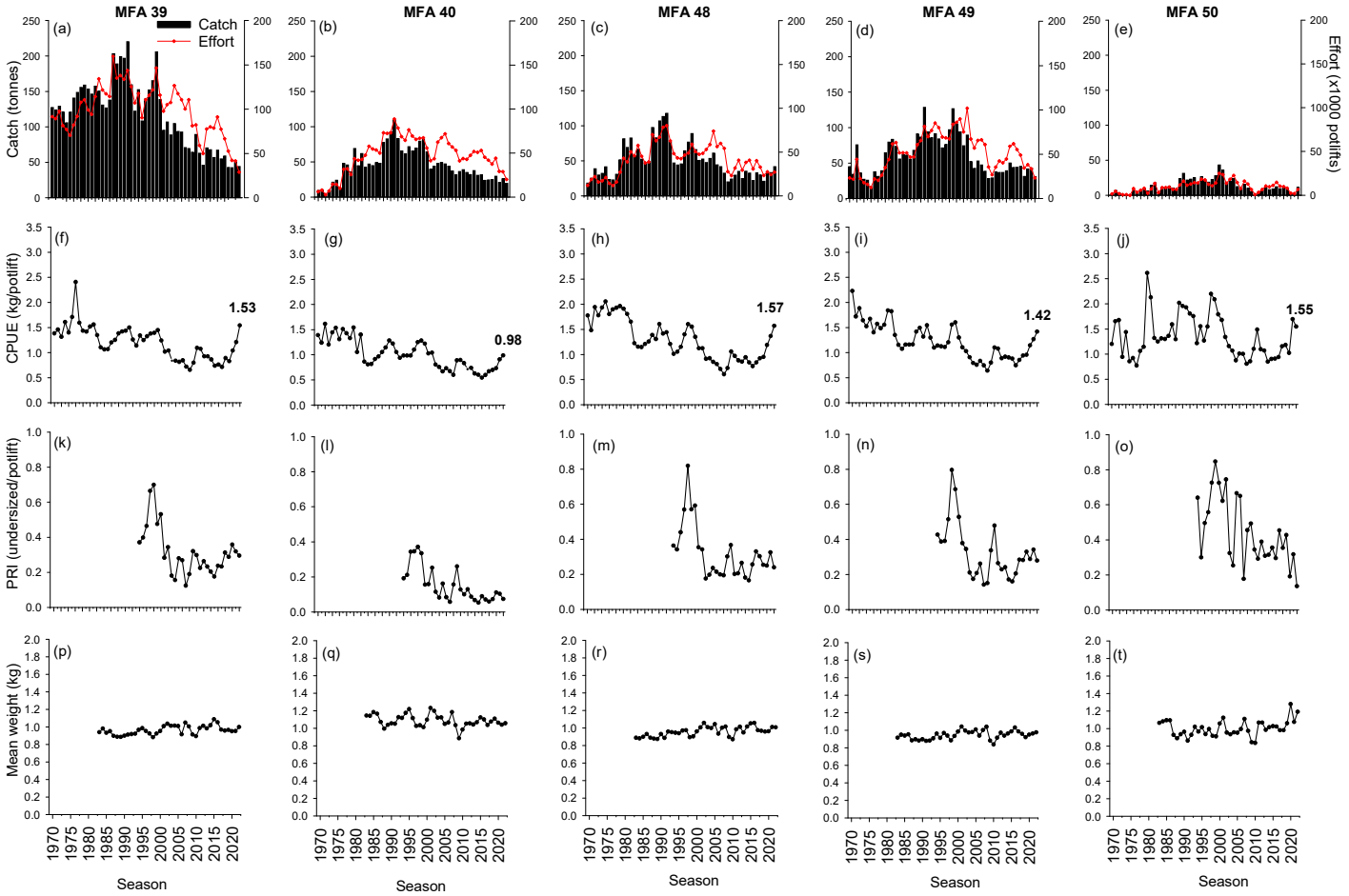



**Figure 6** Spatial fishery dependent trends in the NZRLF for MFAs 39-50. (a-e) Catch and effort; (f-j) catch per unit effort (CPUE); (k-o) pre-recruit index (PRI); and (p-t) mean weight.

### 3.1.4 Additional indices

#### *3.1.4.1 Ovigerous (spawning) females*

In 2022, the catch rate of ovigerous (spawning) female lobsters was 0.04 spawners/potlift, the highest since 1999 (Figure 7a). Consistent with overall declines in legal-sized lobster catch rates (Figure 2b), the CPUE of spawners decreased from 1997 (0.09 spawners/potlift) to 2001 (0.02 spawners/potlift). Since then, the index has remained below 0.05 spawners/potlift.

#### *3.1.4.2 Predation mortality*

The Maori octopus (*Pinnoctopus cordiformis*) is the primary predator of lobsters within commercial fishing pots (Brock and Ward 2004). As a result, both the catch rate of octopus and dead lobsters are highly correlated (Figure 7b; $R^2$ = 0.72).

The number of dead lobsters/potlift decreased from 1998 (0.08 dead/potlift) to 2002 (0.04 dead/potlift). Thereafter, estimates have ranged between 0.3 and 0.07 dead/potlift (Figure 7b). In 2022, the catch rate was 0.07 dead lobsters/potlift.

Similarly, octopus catch rates decreased from 0.02 octopus/potlift in 1998 to 0.003 octopus/potlift in 2005 (Figure 7b). Since then (except for 2016), the annual estimate has remained below 0.005 octopus/potlift and in 2022 was 0.004 octopus/potlift.

#### *3.1.4.3 Average days fished*

In 2022, the average number of days fished per licence holder in the NZRLF was 83 days (S.E. 33 days), reflecting the seventh consecutive season that this index has decreased and the lowest recorded (Figure 7c). Overall, the index is a proxy for fishing effort and largely reflects trends in annual potlifts within the fishery (Figure 2a). From 2003 to 2008, the estimate ranged from 152 to 163 days, despite the fishery having changed to output controls in the form of a TACC quota system in 2003. These data indicate that during this period, the TACC (introduced in 2003 at 625 t and subsequently reduced to 470 t in 2008) had minimal impact in constraining effort in the fishery, highlighted by the fact that the 2008 estimate of 156 days fished was only 15% less than that recorded in 1997 (184 days), when the fishery was managed under input controls. In 2009, the TACC was reduced to 310 t which resulted in the average numbers of days fished decreasing to 100 days. In 2010, it decreased further to 84 days, the lowest estimate on record. Over the next five seasons, the estimate increased to 134 days, which in part, reflects the increase in TACC to 345 t in 2012 and 360 t in 2015.

### *3.1.4.4 High-grading*

Current estimates of high-grading (legal-sized lobsters returned to the water due to lower market value) in the NZRLF are low and in 2022 was 1.2 t (Figure 7d). Since the introduction of a TACC in 2003, estimates have not exceeded 3 t in any fishing season. While the overall reported values in logbooks are likely to be conservative (since high-grading is recorded on a voluntary basis), the estimates are still considered to be indicative of an overall trend.

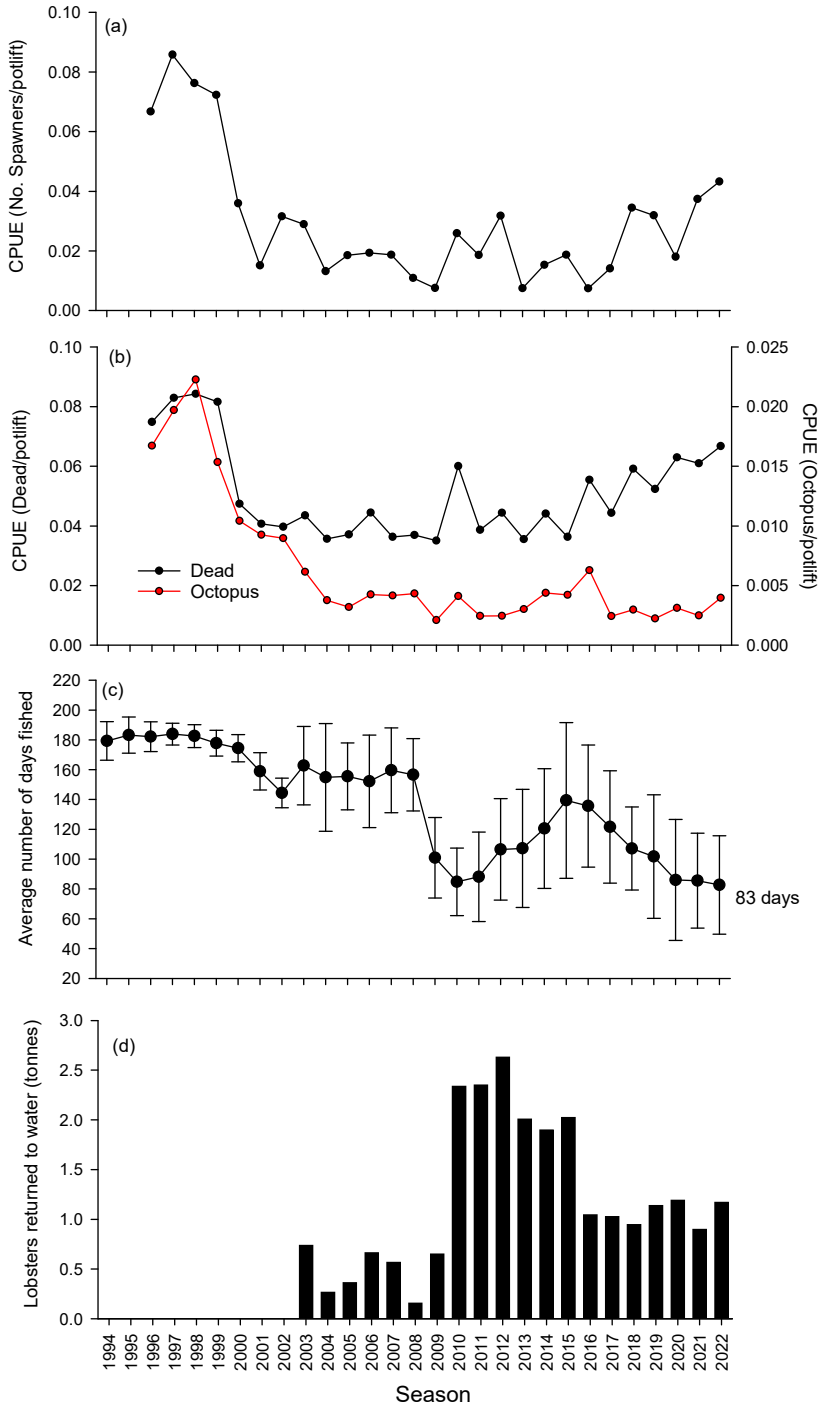



**Figure 7** Additional fishery-dependent indices in the NZRLF. (a) Catch rate of spawning lobsters; (b) predation mortality and predatory octopuses; (c) average number of days fished; and (d) levels of high-grading.

## 3.2 Puerulus settlement index (PSI)

In 2022, the puerulus settlement index (PSI) in the NZRLF was 0.53 puerulus/collector (SE 0.15) which was above both the long-term average (0.42 puerulus/collector) and the median (0.38 puerulus/collector) (Figure 8). The estimated period between settlement and recruitment to the fishery in the NZRLF is four years. As a result, higher than average recruitment could be expected from 2024 to 2026 based on recent PSIs from 2020 to 2022.

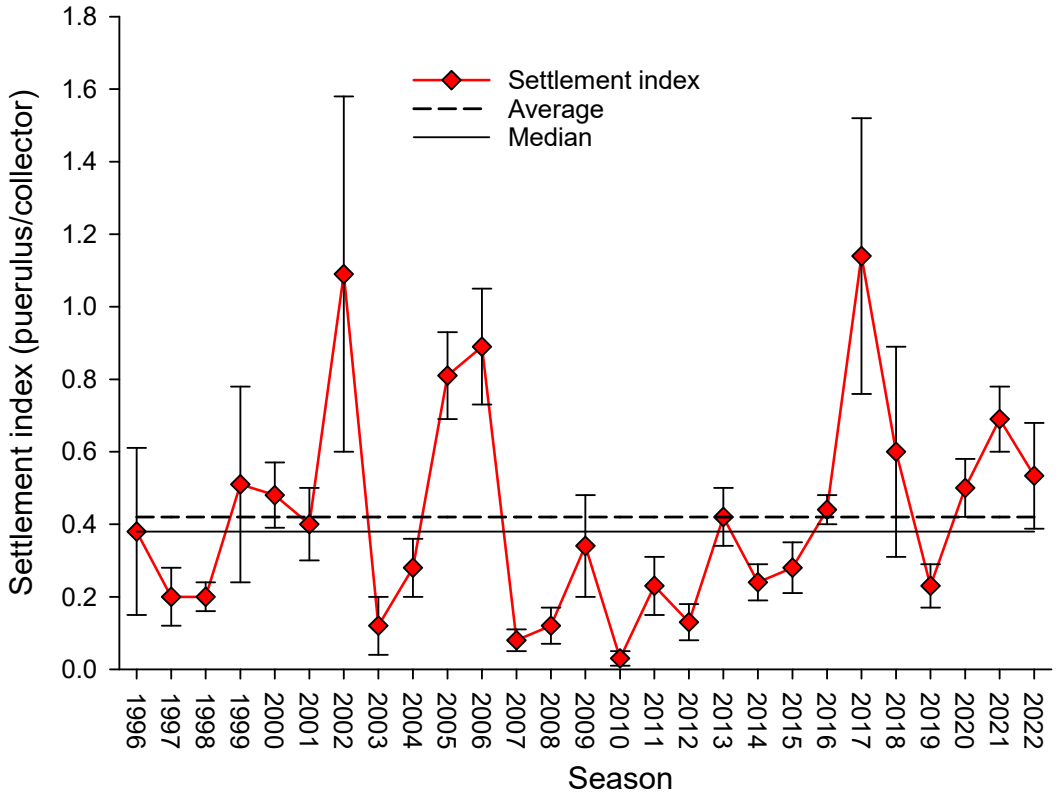



**Figure 8** Puerulus settlement index (PSI) (mean ±SE) in the NZRLF from 1996 to 2022.

## 3.3 Length frequency

Since 1991, up to 32,000 lobsters have been measured annually in the NZRLF as part of the voluntary catch sampling program. The number measured is proportional to the level of participation in the program with data presented as number of lobsters/100 potlifts. In this report, length frequency data are presented from 2013–2022. Earlier length frequency distributions are presented in published stock assessment reports (http://pir.sa.gov.au/research/publications/research_reports).

Male lobsters, which generally grow faster and reach larger sizes than females, range between 70 and 200 mm carapace length (CL). In contrast, few females are larger than 150 mm CL. In 2022, a total of 2,350 lobsters were sampled. Of these, 71% were within the 105 to 150 mm CL range with 13% of lobsters in 2022 below the minimum legal size (MLS; 105 mm CL) (Figure 9).

Length-frequency data obtained through the voluntary catch sampling program over the last two seasons support recent trends in legal size catch rates from commercial logbook data. Notably, the percentage of lobsters measured above the MLS increased from 78% to 87-90% between 2020 and 2022, reflecting the increase in legal size catch rate over the same period Figure 2b).

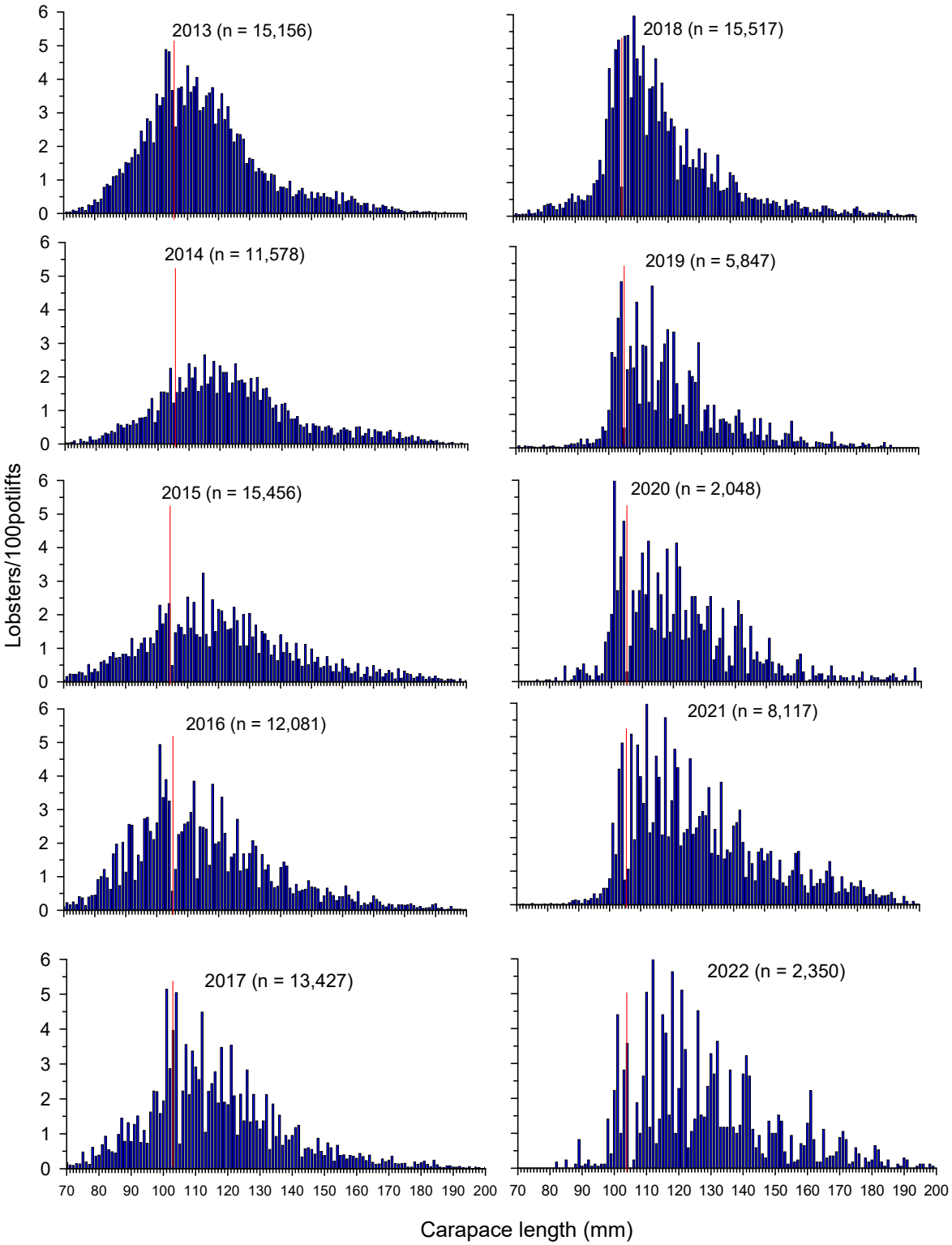



**Figure 9** Length-frequency distributions of male and female lobsters combined in the NZRLF from 2013 to 2022 (red line indicates MLS at 105 mm CL).

## 3.4 qR Model outputs

Model outputs show long-term declines in legal-size lobster biomass from 1999 to 2008 (Figure 10a). Estimates then increased in 2009 and 2010 and have averaged approximately 1,300 t over the last decade. In 2022, the estimate was 1,826 t reflecting increases over the last six seasons and the highest estimate since1999.

In line with declines in lobster biomass, egg production estimates decreased by 68% from approximately 325 billion in 1990 to 105 billion in 2008 (Figure 10b). Over the last decade, egg production has averaged approximately 137 billion with the 2022 estimate at 189 billion. Egg production estimates are low, equating to 15% of unfished levels in 2022, but with increases in recent seasons (Figure 10c).

Exploitation rate averaged approximately 46% from 1990 to 2008 before decreasing to 22% in 2011 (Figure 10d). Estimates then increased to 34% in 2016 before declining over the next six seasons to 16% in 2022, the lowest on record.

Estimates from the qR model suggest that recruitment in the NZRLF is highly variable (Figure 10e). There has been a general increase in recruitment over the last seven seasons, with the 2022 estimate being 0.46 million individuals. Trends in recruitment from the qR model are highly correlated with PRI estimates from logbook data (1994-2022) ($R^2$ = 0.92).

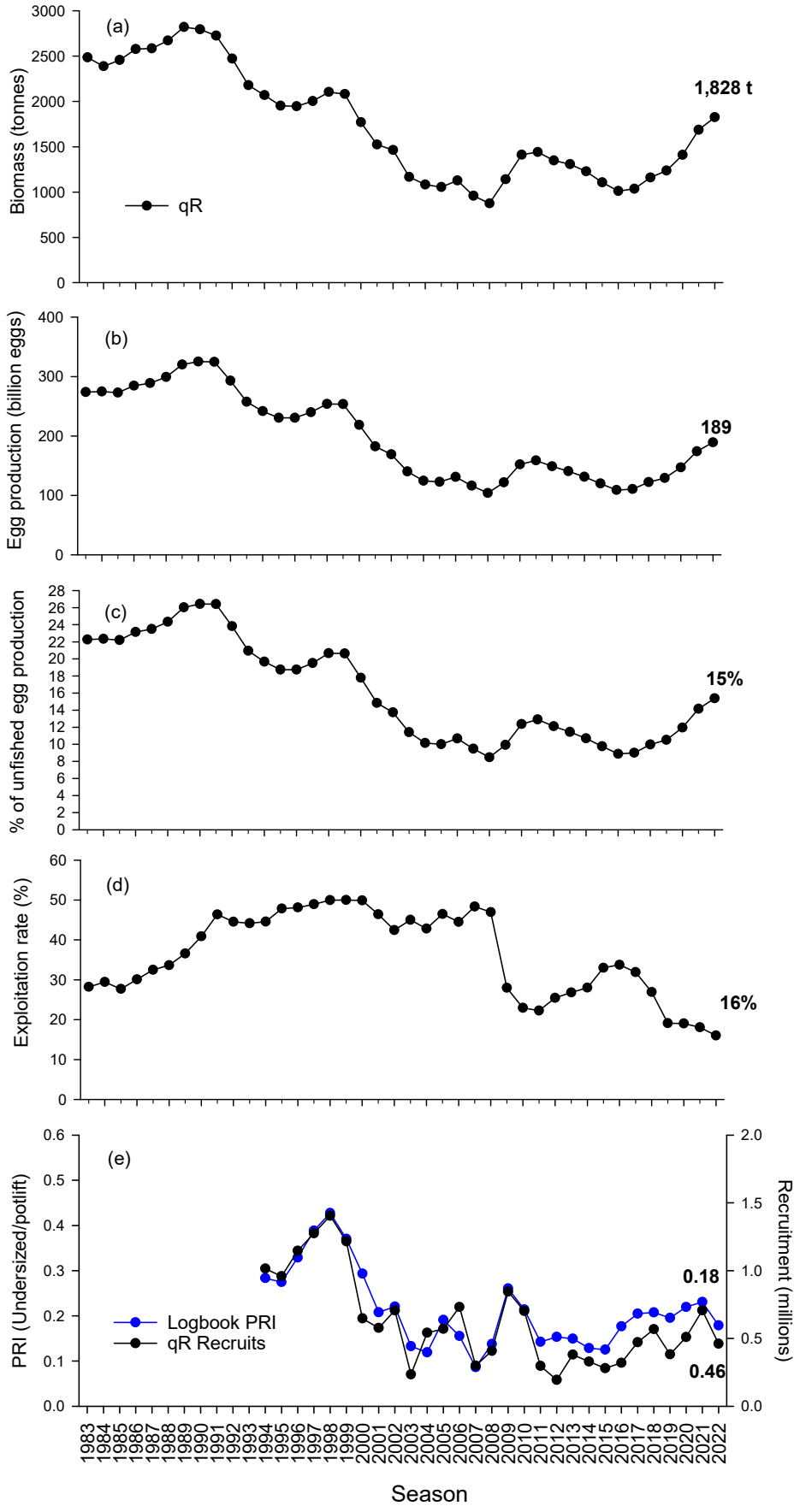



**Figure 10** Fishery model outputs for the NZRLF. (a) Legal-size biomass; (b) Egg production; (c) % of unfished egg production; (d) Exploitation rate; and (e) Recruitment.

# 4 SUMMARY AND STOCK STATUS

Despite recent market disruptions impacting fishery dependent indicators, there remains clear evidence to suggest that the status of the NZRLF has improved in recent seasons. Specifically; (i) biomass levels have increased and exploitation rate is the lowest on record; (ii) CPUE is the highest since 1999 and above the TrRP; and (iii) the PRI is above the TrRP.

At a sub-zonal level, the low catches in 2019 (14 t) and 2020 (22 t) make any assessment of the Outer sub-region difficult. However, since spatial management was implemented in 2015, Outer sub-region catch rates have marginally decreased. This contrasts with the Inner sub-region where catch rates have increased considerably since 2015.

The stock status classification for the NZRLF is defined in the Management Plan for the fishery (PIRSA 2021) using the primary performance indicator (Table 3). In 2022, the CPUE was 1.33 kg/potlift, which is above the TrRP of 0.60 kg/potlift. As a result, the NZRLF stock is classified as "**sustainable**". This means that the current fishing mortality is being adequately controlled to avoid the stock becoming recruitment impaired.

**Table 3** Stock status classification for the NZRLF.

| CPUE (kg/potlift) | Status |
|---|---|
| ≥ 0.60 | Sustainable |
| < 0.60 | Depleting or Recovering |
| ≤ 0.40 | Depleted |

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