Fisheries

Northern Zone Rock Lobster (*Jasus edwardsii*) Fishery Status Report 2020/21

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

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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.

The 2020 season (i.e. 2020/21) was the second consecutive year the NZRLF was impacted by overseas market disruptions. Therefore, to allow for greater fishing flexibility, the 2020 season was extended from 1 November to 30 October (normally 1 November to 31 May). This status report presents data from 1 November 2020 to 31 May 2021, which is the agreed assessment period considered for guiding TACC setting.

In 2020, the total allowable commercial catch (TACC) in the NZRLF was 324 t (263 t Inner sub-region, 61 t Outer sub-region). This reflected a regular TACC of 296 t plus 28 t of carry-over from the 2019 season. The reported logbook catch (1 November 2020 to 31 May 2021) was 219.88 t (68% of the TACC). By sub-region, the logbook catch was 197.68 t from the Inner sub-region and 22.20 t from the Outer sub-region.

Effort required to take the catch was 213,995 potlifts, reflecting the fourth consecutive season that effort has decreased and the lowest estimate on record (but noting that the TACC was under-caught in both 2019 and 2020).

Catch per unit effort (CPUE) of legal-sized lobsters (kg/potlift) is the primary biological performance indicator for the fishery. In 2020, the zonal legal-sized CPUE was 1.05 kg/potlift, reflecting a 36% increase from 2016 (0.77 kg/potlift) and the highest CPUE since 2011. Current estimates are above the Trigger Reference Point (TrRP) (0.60 kg/potlift) for the fishery.

The secondary biological performance indicator is the pre-recruit index (PRI; no. of undersized lobsters/potlift). In 2020, the PRI was 0.22 undersized/potlift reflecting a 10% increase from 2019 (0.20 undersized/potlift) and remaining above the 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. While overall biomass remains low in 2020, levels have increased over the last four seasons, which, combined with reduced TACCs and under-catch in 2020, have reduced the exploitation rate to 19%, the lowest on record. Despite improvements at the zonal level, the performance of the Outer sub-region of the fishery remains uncertain due to the low levels of catch in recent seasons (14 t in 2019 and 22 t in 2020).

The stock status classification for the NZRLF is defined in the Management Plan for the fishery (PIRSA 2021). In 2020, the CPUE of 1.05 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	2020/21	2019/20
TACC	324 t	296 t
Total commercial catch (Nov-May)	219.9	219.6 t
Total effort (Nov-May)	213,995 poltifts	254,563 potlifts
Commercial CPUE (Nov-Apr)	1.05 kg/potlift	0.89 kg/potift
Pre-recruit index (Nov-Mar)	0.22 undersized/potlift	0.20 undersized/potlift
Biomass estimate	1,430 t	1,255 t
Exploitation rate	19%	19%
Status	**Sustainable**	**Sustainable**

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

1 INTRODUCTION

This fishery status report updates the 2019/20 stock assessment report for the Northern Zone Rock Lobster Fishery (NZRLF) (Linnane et al. 2021) 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; Flood et al. 2014; Stewardson et al. 2018) 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 2020/21 stock assessment report that is due in July 2022.

In 2020, the total allowable commercial catch (TACC) in the NZRLF was 324 t (263 t Inner sub-region and 61 t Outer sub-region) which reflected a regular TACC of 296 t plus 28 t carry-over from 2019. 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 2020 to 31 May 2021, 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 2020/21 stock assessment report that is due in July 2022.

2 METHODS

Data sources presented in this report are described in Linnane et al. (2021). Briefly, the catch and effort data presented are obtained from a mandatory daily logbook program administered by SARDI Aquatic Sciences. 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.

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

A detailed description of the qR fishery assessment model is provided in McGarvey and Matthews (2001) and Linnane et al. (2019). 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 2014-2019, 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 NZ 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 will be given in the stock assessment reports for 2020/21 due in 2022.

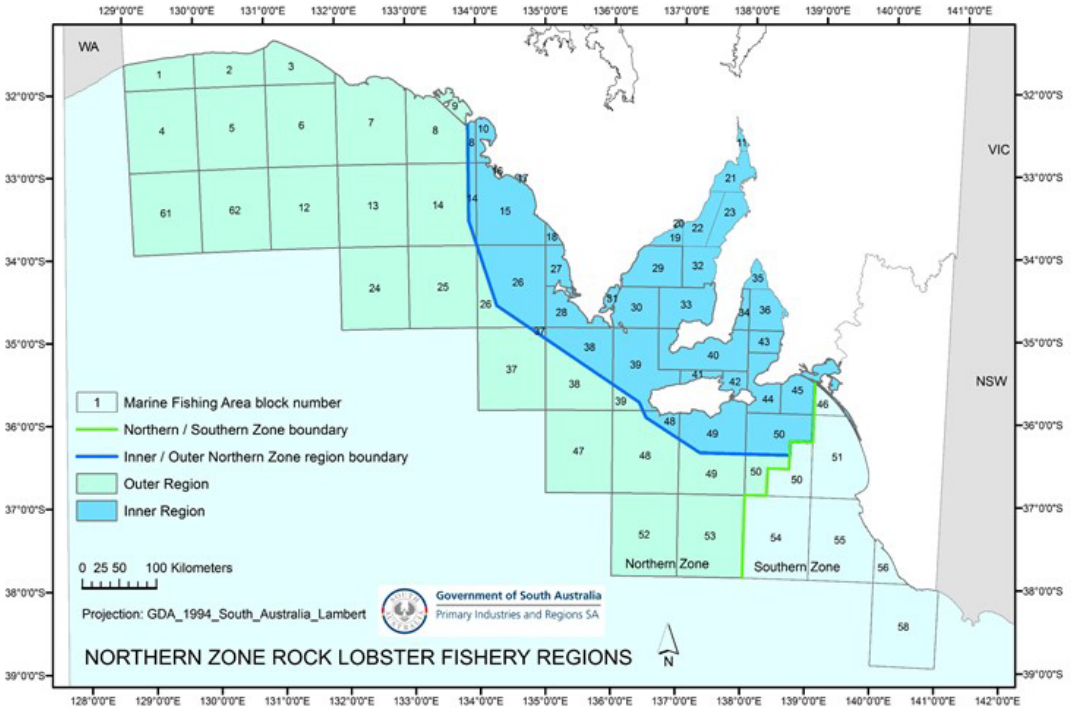

Figure 1 Northern Zone Rock Lobster Fishery Marine Fishing Areas (MFAs) and associated sub-regions.

3 RESULTS

3.1 Commercial catch and effort statistics

It is important to note that a Southern Rock Lobster market closure occurred in 2020/21 which impacted on catch, effort and CPUE outputs. The impact was particularly evident in November of 2020 but should also be taken into consideration when interpreting fishery trends throughout the entire 2020/21 season.

3.1.1 Zone

In 2020, the TACC in the NZRLF was 324 t (263 t Inner sub-region, 61 t Outer sub-region). This reflected a regular TACC of 296 t plus 28 t of carry-over from the 2019 season. The reported logbook catch (1 November 2020 to 31 May 2021) was 219.88 t (68% of the TACC) (Figure 2a). By sub-region, the logbook catch was 197.68 t from the Inner sub-region and 22.20 t from the Outer sub-region (Table 2).

Long-term trends show a consistent decline in catch from 1999 to 2008. 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 2020 was, 213,995 potlifts reflecting a 16% decrease from 2019 (254,563 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 decreased consecutively over the next five seasons. The 2020 estimate is the lowest on record (but noting that the TACC was under-caught by 32% in 2020).

In 2020, the legal-sized CPUE was 1.05 kg/potlift, reflecting a 36% increase from 2016 (0.77 kg/potlift) and the highest CPUE since 2011 (Figure 2b). Following a period of 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, 2020 reflected the first season since spatial management was introduced in 2015 that Inner sub-region catch rates exceeded 1 kg/potlift. For the Outer-region, CPUE increased by 18% from 0.78 kg/potlift in 2019 to 0.92 kg/potlift in 2020 (Table 2).

Pre-recruit Index (PRI) estimates are now based on logbook data (previously catch sampling) from November to March inclusive. In 2020, the PRI was 0.22 undersized/potlift reflecting a 10% increase from 2019 (0.20 undersized/potlift) and

remaining above the trigger reference point (TrRP) of 0.16 undersized/potlift (Figure 2c). 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. 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.

Table 2 Commercial catch and effort statistics for the NZRLF sub-regions based on data from November-May. *Note: 2020 Inner and Outer TACCs included 13 t and 15 t carry-over respectively from 2019.

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
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	24,082	0.92	*61	38.80

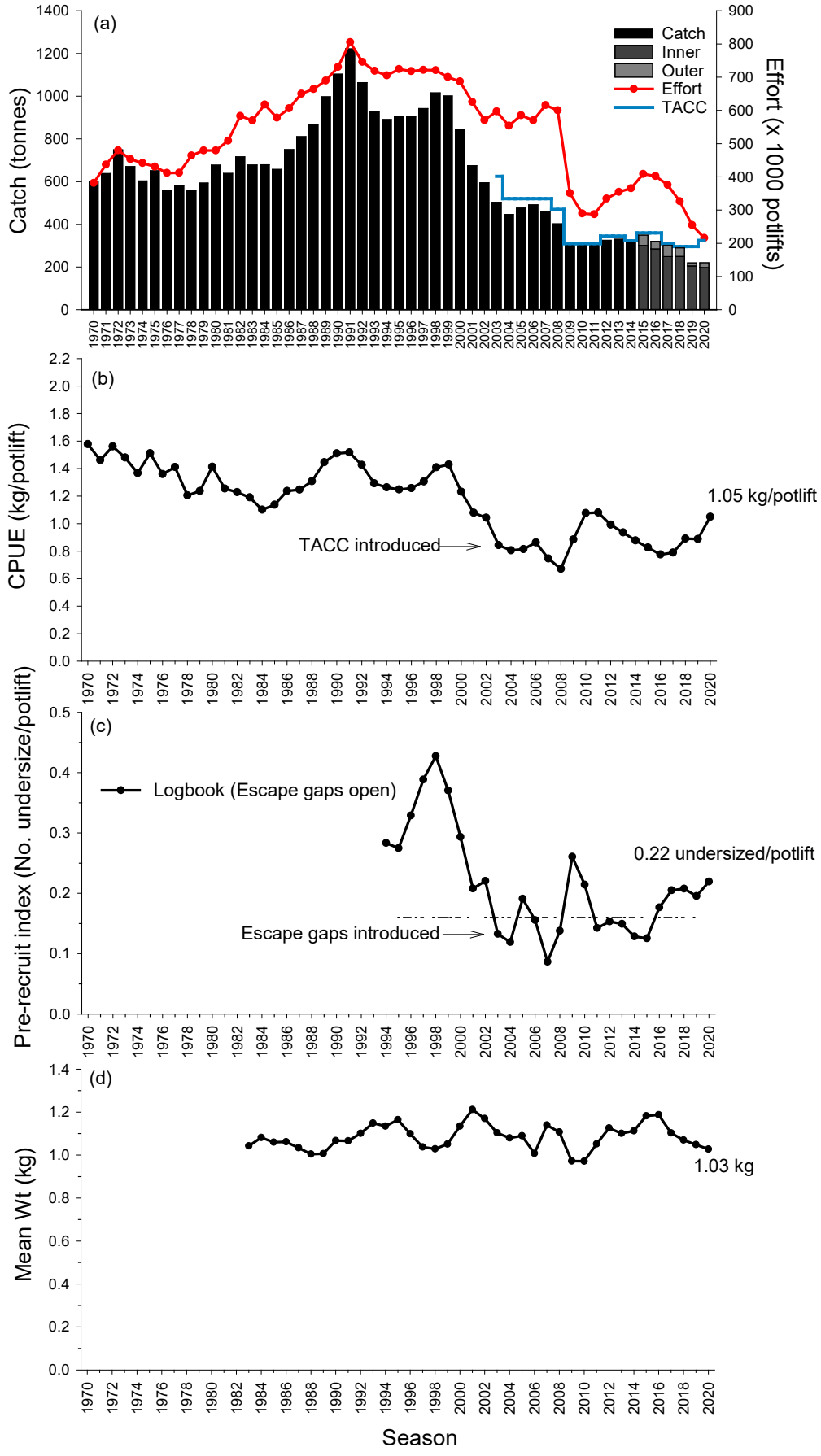

Figure 2 Fishery dependent outputs for the NZRLF. (a) Catch and effort including total allowable commercial catch (TACC) limit; (b) catch per unit effort (CPUE; (c) pre-recruit index (PRI) including trigger reference point (dashed line) based on logbook data with escape gaps; and (d) mean weight.

3.1.2 Within-season trends

Within-season commercial catch trends presented here are based on data from 2018 to 2020. 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 although market disruptions were evident in within-season catch, effort and CPUE trends in both 2019/20 and 2020/21 seasons (Figure 3). The highest catches are taken during spring/summer from November to February (Figure 3a) before declining thereafter.

The market closures occurred in late January and November of the 2019/20 and 2020/21 seasons, respectively. Consequently, the catch in February of the 2019/20 seasons decreased to 6 t, where normally up to 60 t are landed (Figure 3a). In the 2020/21 season, the overall impact was lower catches, particularly from November to January, compared to previous seasons. In 2020/21, the highest catch was taken in December (53 t), and the lowest catch in May (13 t).

Within-season effort levels are largely consistent with those of catch (Figure 3a). In 2020/21, effort was highest in December (49,713 potlifts) and lowest in May (18,324 potlifts).

Legal-sized CPUE generally tends to be highest in summer at the start of the season and declines thereafter (Figure 3b). In 2020/21, monthly catch rates were consistently higher across all months of the season compared to 2019/20. In 2020/21, CPUE was highest in January (1.17 kg/potlift) and lowest in May (0.69 kg/potlift).

Monthly trends in catch rate of pre-recruits (i.e. PRI) are highest at the start of the season before decreasing thereafter (Figure 3c). Compared to 2019/20, the monthly PRI in 2020/21 was higher across most months. In 2020/21, the PRI was highest in February (0.25 undersized/potlift) and lowest in May (0.10 undersized/potlift).

Monthly legal-sized mean weight generally increases as the season progresses (Figure 3d). In 2020/21, with the exception of November and April, monthly mean weight was consistently lower across most months compared to 2019/20, being highest in April (1.18 kg) and lowest in November (0.90 kg).

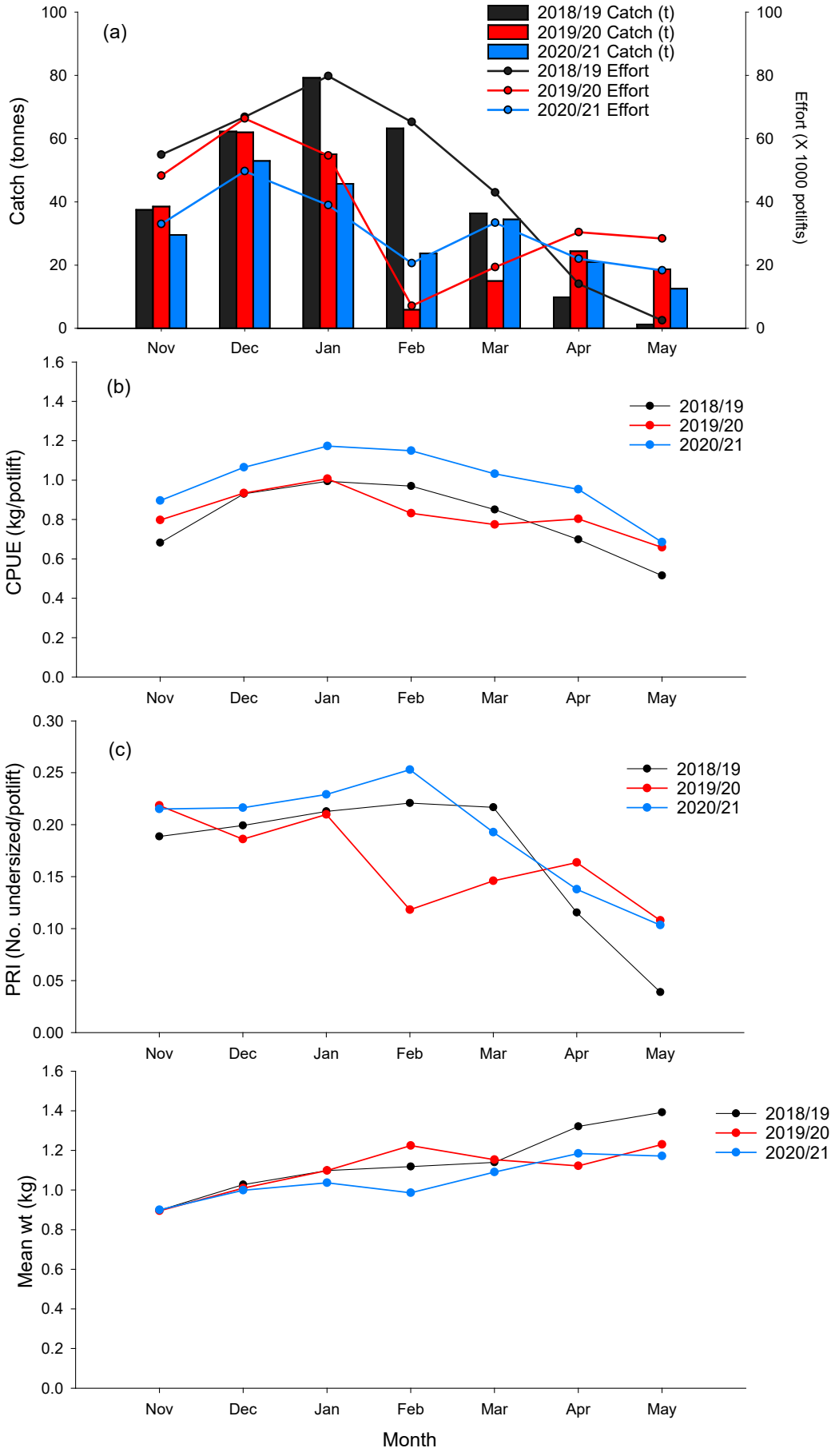

Figure 3 Within-season fishery dependent trends in the NZRLF. (a) Catch and effort; (b) catch per unit effort (CPUE); (c) pre-recruit index (PRI); and (d) mean weight.

3.1.3 Spatial trends

In 2020, 95% of the catch (208 t) came from ten MFAs (MFAs 7, 8, 15, 27, 28, 39, 40, 48, 49 and 50) (Figure 4 and Figure 5; 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 nine seasons. The exception was MFA 28 where catch decreased from 74 t in 2014 to 39 t in 2020 (Figure 4e). In 2020, within the primary MFAs, the highest catch was taken in MFA 39 (43 t) (Figure 5a) and the lowest in MFA 7 (1.5 t) (Figure 4a).

Effort levels largely reflect trends in catch (Figure 4 and Figure 5). In recent seasons, the highest effort has been in MFA 39 (approximately 42,000-91,000 potlifts annually over the last five seasons) (Figure 5a). In 2020, effort decreased in MFAs 15, 28, 39, 40 and 50 and increased in MFAs 7, 8, 27, 48 and 49.

Trends in legal-sized annual CPUE are temporally consistent among the MFAs, with higher values occurring in the 1970s through to the late 1990s, and lows in the 2000s (Figure 4 and Figure 5). From 1999 to 2008 CPUE generally declined in most regions with the estimates in MFAs 7, 28, 39, 40, 48 and 49 the lowest on record in 2008. More recently, following six seasons of successive decline from 2010 to 2016, catch rates have increased in almost all MFAs over the last 3-4 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 4) and higher in the south-eastern MFAs of 39, 40, 48, 49 and 50 (Figure 5).The zonal increase in PRI in 2020 was largely driven by MFAs, 28, 39, and 40.

Rock lobster mean weights are highest in MFAs located in the north of the NZRLF (e.g. MFA 7, 8, 15, 27) (Figure 4) and lowest in MFAs located further south (e.g. MFA 48, 49, 50) (Figure 5). In 2020, the zonal decrease in mean weight was observed in all of the primary MFAs with the exception of MFAs 27 (Figure 4), 49 (Figure 5), and 50 (Figure 5t).

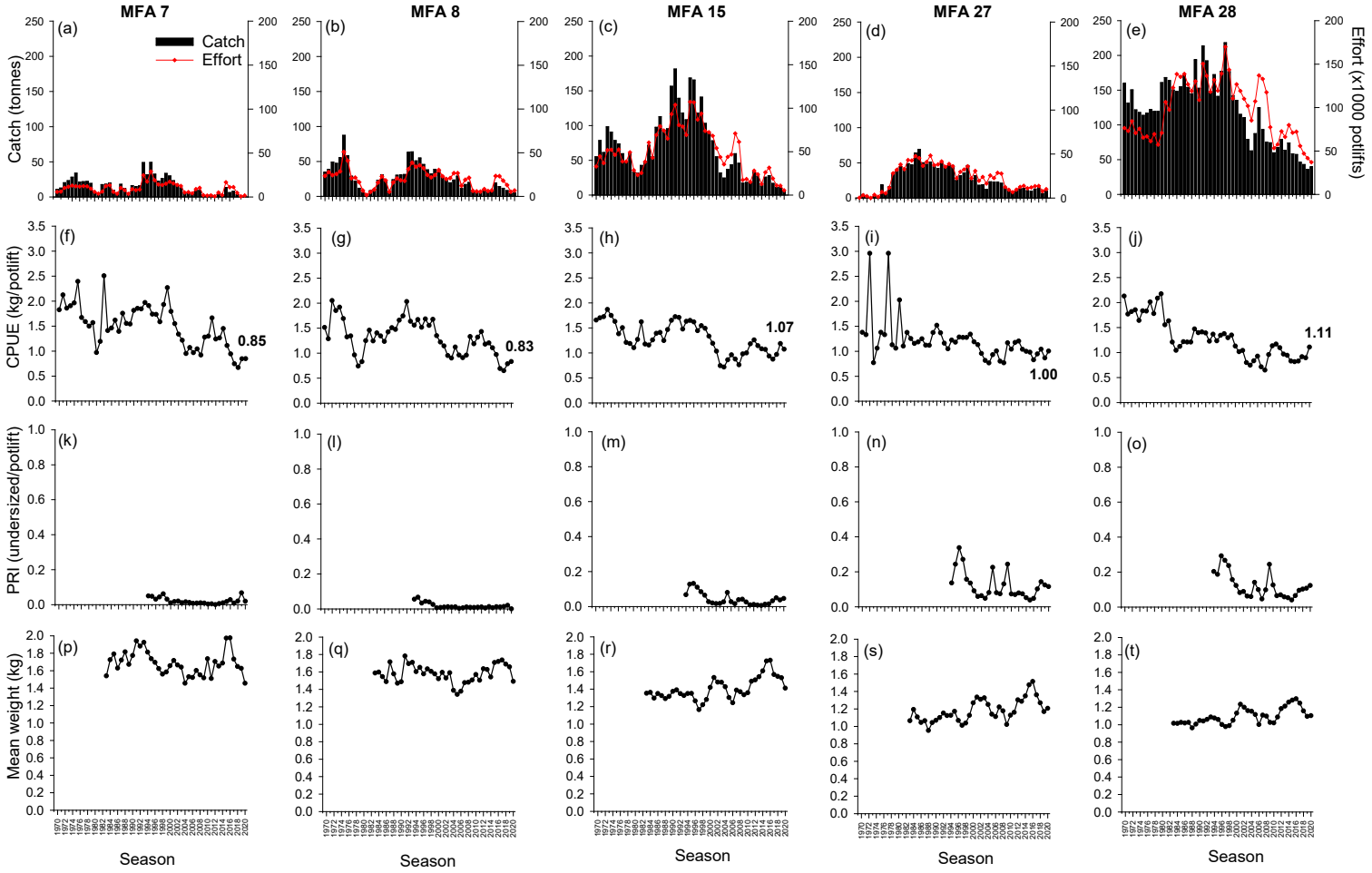

Figure 4 Spatial fishery dependent trends in the NZRLF for MFAs 7-28. (a-e) Catch and effort; (f-j) catch per unit effort (CPUE); (k-o) pre-recruit index (PRI); and (p-t) mean weight.

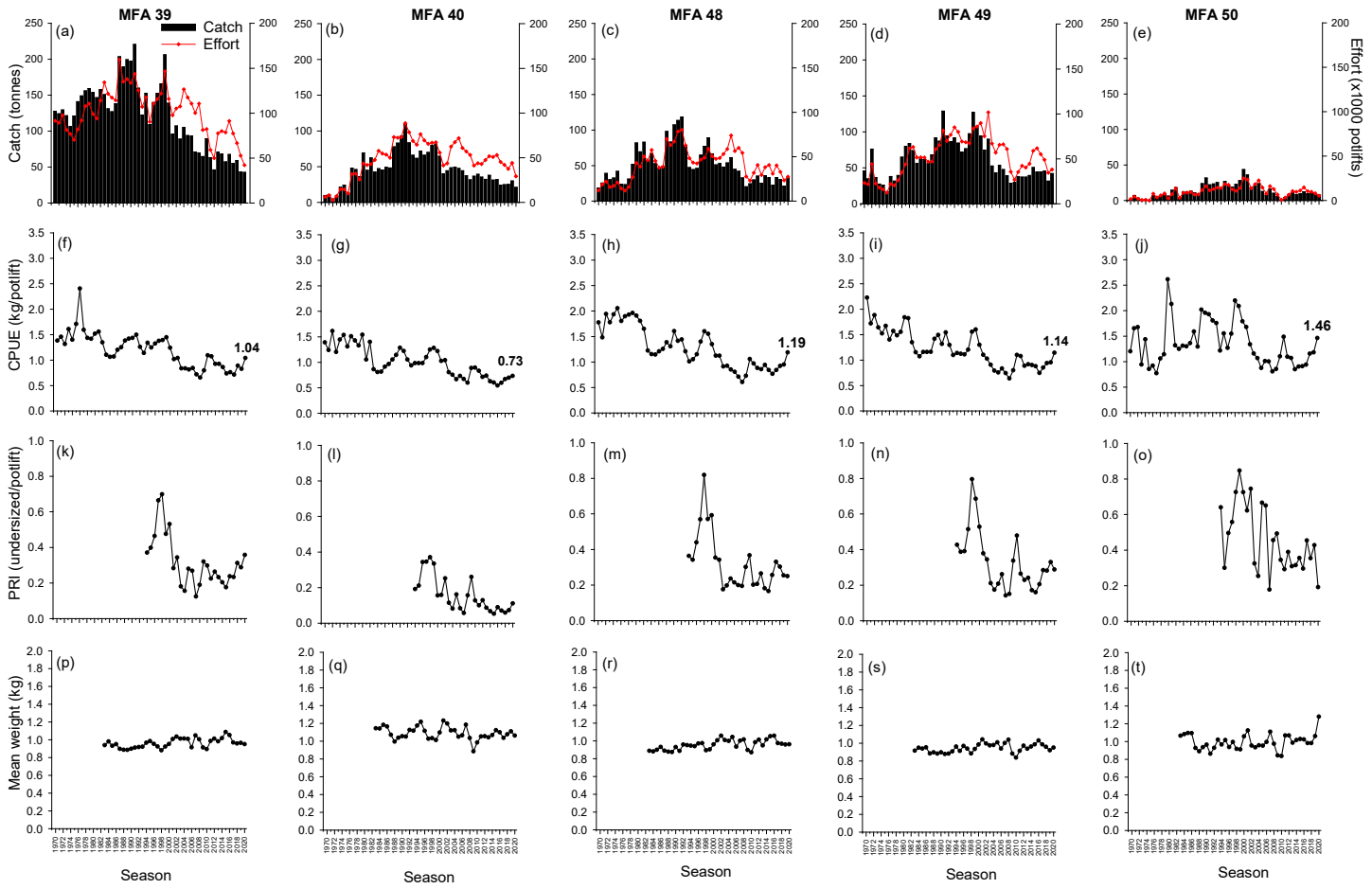

Figure 5 Spatial fishery dependent trends in the NZRLF for MFAs 39-50. (a-e) Catch and effort; (f-j) catch per unit effort (CPUE); (k-o) pre-recruit index (PRI); and (p-t) mean weight.

3.1.4 Additional indices

3.1.4.1 Ovigerous (spawning) females

In 2020, the catch rate of ovigerous (spawning) female lobsters was 0.02 spawners/potlift (Figure 6a). 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 0.04 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 6b; R^2 = 0.79).

The number of dead lobsters/potlift decreased from 1998 (0.08 dead/potlift) to 2002 (0.04 dead/potlift) and except for 2010 (0.06 dead/potlift), has remained below 0.05 dead/potlift thereafter (Figure 6b). In 2020, the catch rate was 0.06 dead lobsters/potlift.

Similarly, octopus catch rates decreased from 0.02 octopus/potlift in 1998 to 0.003 octopus/potlift in 2005 (Figure 6b). Since then (except for 2015), the annual estimate has remained below 0.005 octopus/potlift and in 2020 was 0.003 octopus/potlift.

3.1.4.3 Average days fished

In 2020, the average number of days fished per licence holder in the NZRLF was 76 days, reflecting the fifth consecutive season that this index has decreased and the lowest recorded (Figure 6c). 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 2020 was 1.2 t (Figure 6d). 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.

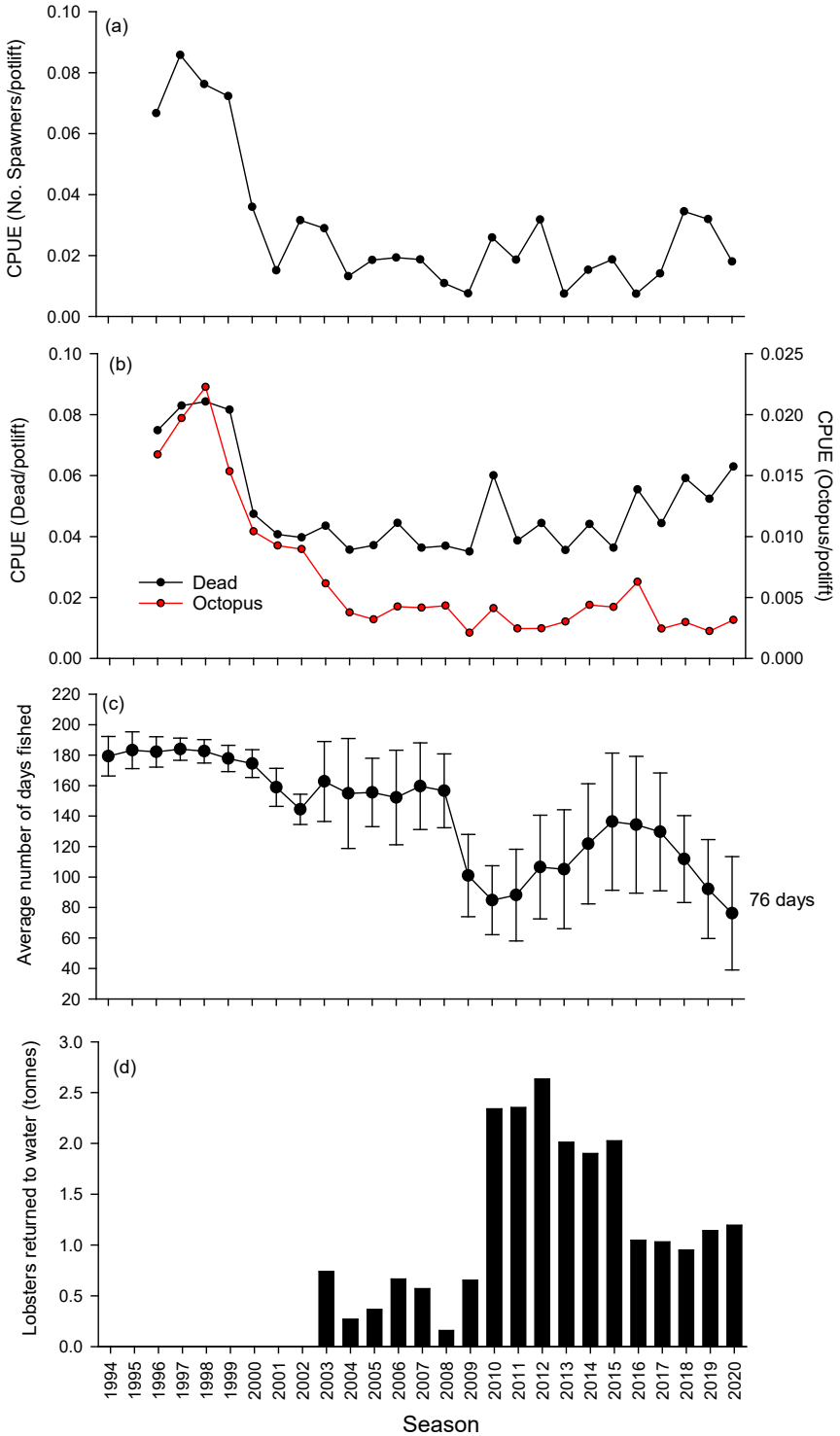

Figure 6 Additional fishery-dependent indices in the NZRLF. (a) Catch rate of spawning lobsters; (b) predation mortality and predatory octopuses; (c) average number of days fished; and (d) levels of high-grading.

3.2 Puerulus settlement index (PSI)

In 2020, the puerulus settlement index (PSI) in the NZRLF was 0.50 puerulus/collector which was above the long-term average (0.41 puerulus/collector) (Figure 7). Recently, PSIs have also been above both the long-term average and median for the time series in 2017 and 2018, with the 2017 PSI (1.14 puerulus/collector) being the highest on record. In the NZRLF, the estimated period between settlement and recruitment to the fishery is four years. As a result, higher than average recruitment could be expected from 2021 to 2024 based on recent PSIs from 2017 to 2020.

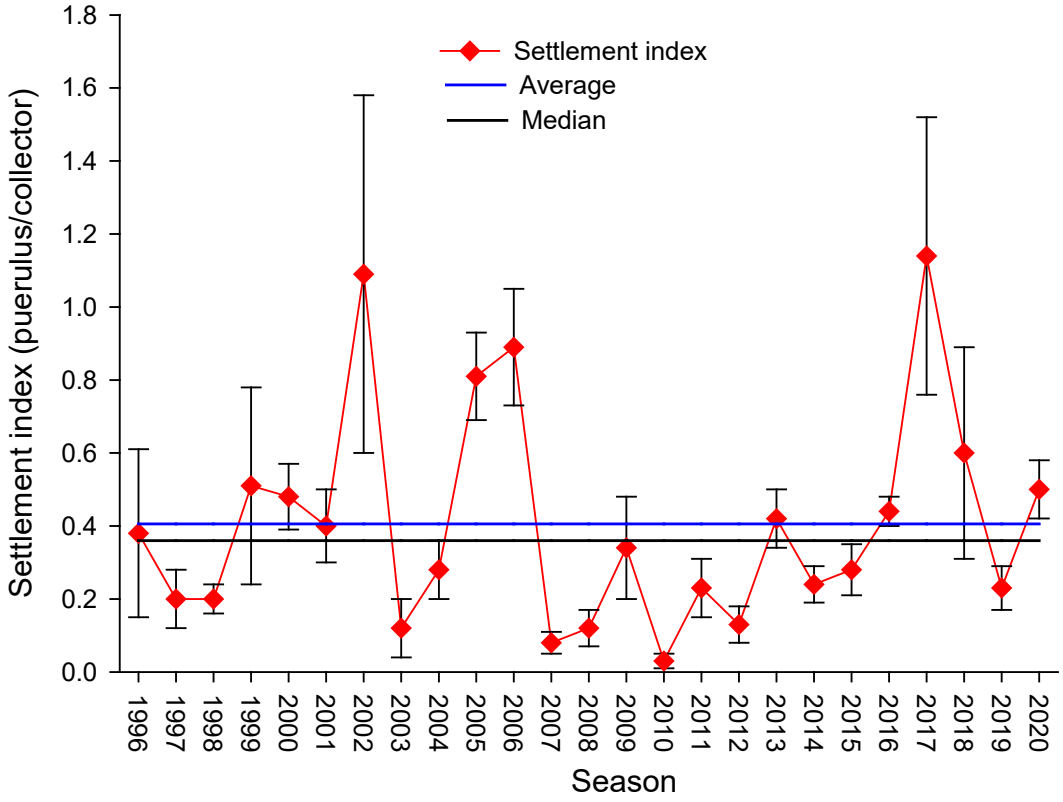

Figure 7 Puerulus settlement index (PSI) (mean ±SE) in the NZRLF from 1996 to 2020.

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 2011-2020. 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 2020, a total of 2,048 lobsters were sampled. Of these, 50% were within the 105 to 130 mm CL size range with 22% of lobsters in 2020 below the minimum legal size (MLS; 105 mm CL) (Figure 8).

Length-frequency data obtained through the voluntary catch sampling program over the last two seasons support recent trends in pre-recruit indices from commercial logbook samples. Notably, the percentage of lobsters measured below the MLS increased from 19% to 22% between 2019 and 2020, reflecting the increase in undersized catch rate over the same period (Figure 2c).

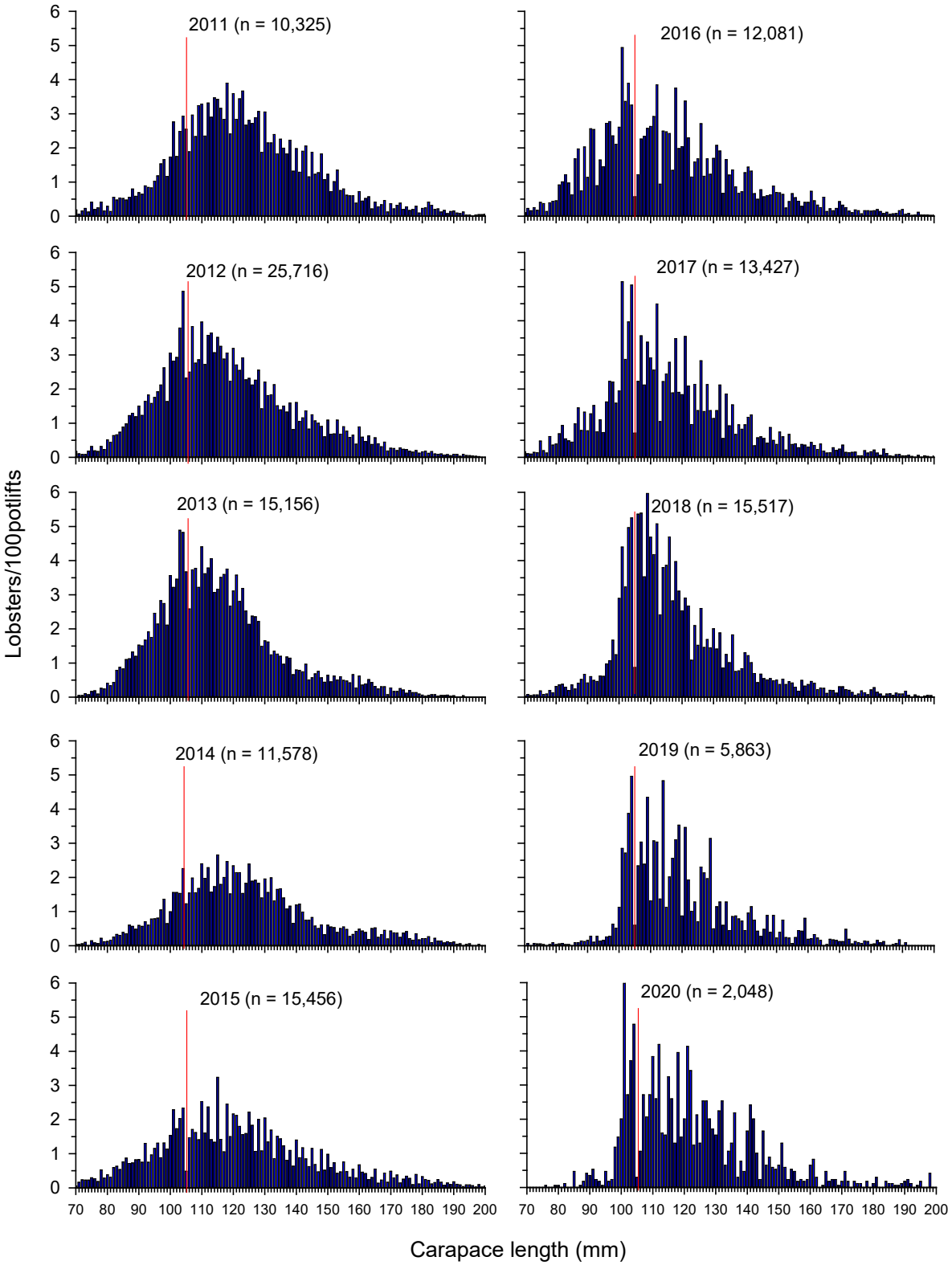

Figure 8 Length-frequency distributions of male and female lobsters combined in the NZRLF from 2011 to 2020 (red line indicates MLS at 105 mm CL).

3.4 qR Model outputs

Model outputs show long-term declines in legal-size lobster biomass from 1999 to 2008 (Figure 9a). Estimates then increased in 2009 and 2010 and have averaged approximately 1,250 t over the last decade. In 2020, the estimate was 1,430 t reflecting increases over the last four seasons.

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 9b). Over the last decade, egg production has averaged approximately 133 billion with the 2020 estimate at 149 billion. Egg production estimates are low in a historical context, equating to 12% of unfished levels in 2020 (Figure 9c).

Exploitation rate averaged approximately 46% from 1990 to 2008 before decreasing to 22% in 2011 (Figure 9d). Estimates then increased to 33% in 2016 before declining over the next four seasons to 19% in 2020, the lowest on record.

Estimates from the qR model suggest that recruitment in the NZRLF is highly variable (Figure 9e). There has been a general increase in recruitment over the last five seasons, with the 2020 estimate of 0.51 million individuals being the second highest since 2010. Trends in recruitment from the qR model are highly correlated with PRI estimates from logbook data (1994-2020) (R^2 = 0.92).

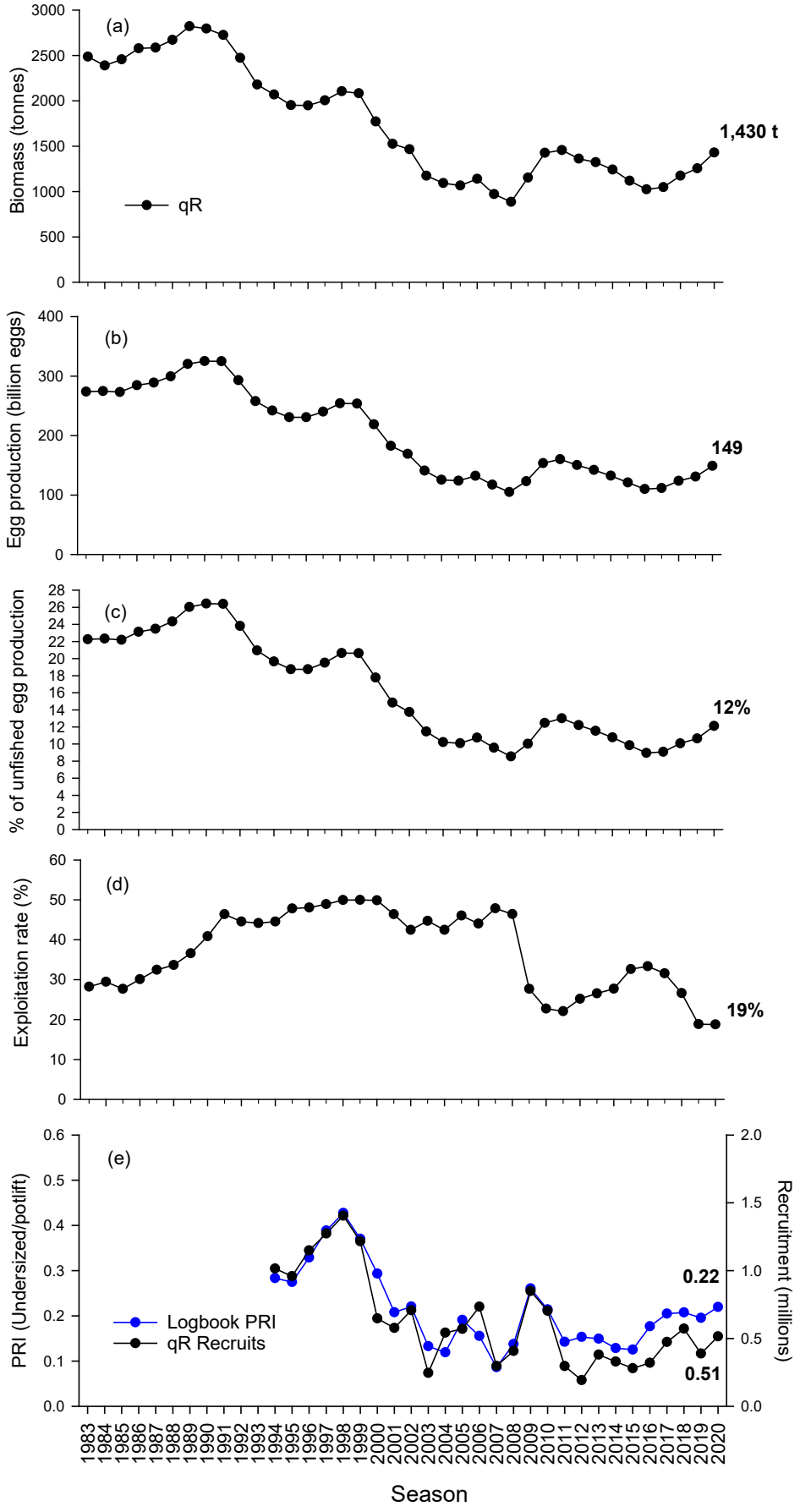

Figure 9 Fishery model outputs for the NZRLF. (a) Legal-size biomass; (b) Egg production; (c) % of unfished egg production; (d) Exploitation rate; and (e) Recruitment.

4 SUMMARY AND STOCK STATUS

Current catch levels in the NZRLF are at historical lows reflecting reductions in the TACC from 360 t to 310 t in 2017 and to 296 t in 2018. The COVID-19 market disruption closure began in late January of 2020 and had a considerable impact on catch, effort and CPUE trends during the 2019 season. For example, catch in February of 2020 was reduced to 6 t where normally up to 60 t of lobster are landed. In 2020, the disruption began in November with the overall impact of reducing catch levels throughout the season.

Despite these disruptions, there is 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 2011 and above the TrRP; and (iii) the PRI has increased and is above the TrRP.

Despite improvements at the zonal level, the performance of the Outer sub-region remains uncertain. Specifically, the low catch of 14 t and 22 t in 2019 and 2020 respectively, makes any assessment of this fishery difficult. However, the increase in catch rate between 2019 and 2020 is positive and reflects the broader large-scale increases in CPUE observed across the fishery in 2020.

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 2020, the CPUE was 1.05 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.

Commercial Catch Rate (kg/potlift)	Status
≥ 0.6	Sustainable
< 0.6	Depleting or Recovering
≤ 0.4	Depleted

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