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Northern Zone Rock Lobster (*Jasus edwardsii*) Fishery Status Report 2019/20

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

SARDI Publication No. F2007/000714-14
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PO Box 120 Henley Beach SA 5022

October 2020

Status Report to PIRSA Fisheries and Aquaculture

SOUTH AUSTRALIA

Government of South Australia
Department of Primary Industries and Regions

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EXECUTIVE SUMMARY

The status of South Australia's Northern Zone Rock Lobster Fishery (NZRLF) stock is determined using a weight-of-evidence analysis under the National Fishery Status Reporting Framework.

In 2019 (i.e. 1 November 2019 to 31 October 2020), the total allowable commercial catch (TACC) in the NZRLF was 296 t (250 t Inner sub-region and 46 t Outer sub-region). This reflected an 18% reduction in TACC from 360 t in 2016. There is evidence the reduction since 2016 has reversed the downward trend in harvestable biomass.

In 2019, the fishery was impacted by the COVID-19 market closure which occurred in late January of 2020. The total reported catch from logbook data (November-May) was 219.56 t (205.40 t Inner sub-region and 14.16 t Outer sub-region) (74% of the TACC). The primary impact of the closure was a considerable reduction in catch in February 2020 (6 t, where normally up to 60 t is landed), as well as subsequent months of the season. Effort required to take the catch was 254,563 potlifts.

Catch per unit effort (CPUE) of legal and undersized (pre-recruit) lobsters are the main indicators of legal and pre-recruit abundance. In 2019, zonal legal-sized CPUE (November-April) was 0.89 kg/potlift, reflecting a 16% increase from 2016 (0.77 kg/potlift) with increases observed across broad spatial scales in all major Marine Fishing Areas (MFAs) of the fishery. Despite COVID-19 impacts, there was no change in CPUE between 2018 and 2019.

In 2019, the logbook derived pre-recruit index (PRI) was 0.20 undersized/potlift reflecting a marginal decrease from 2018 (0.21 undersized/potlift), but remaining above the draft harvest strategy trigger reference point (TrRP) of 0.16 undersized/potlift. Trends in model estimated recruitment and PRI are highly correlated with both indicating recent increases in fishery recruitment. 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 legal-size lobster biomass from 1999 to 2008. While overall biomass remains low in 2019, levels have increased over the last three seasons, which, combined with TACC and under-catch in 2019, have reduced the exploitation rate to 13%. Despite improvements at the zonal level, the performance of the Outer sub-region of the fishery remains uncertain. The low catch level of 14 t makes assessment difficult in 2019, however, catch rates in MFAs 7 and 8, two key catch areas, remain close to historical lows.

There is now evidence to indicate that the status of the NZRLF stock has improved over the last two seasons in response to TACC reductions. Specifically: (i) catch rates have increased by 16% over the last two seasons with improvements in fishery performance observed across broad spatial scales; (ii) biomass estimated by the qR model has increased and exploitation rates are at historical lows; and (iii) the PRI is above the TrRP.

As a result, based on a weight-of-evidence approach, the NZRLF stock is classified as "**sustainable**" at the current TACC of 296 t. This means that the current fishing mortality is being adequately controlled to avoid the stock becoming recruitment impaired.

Table 1 Key statistics for the NZRLF.

Statistic	2019/20	2018/19
TACC	296 t	296 t
Total commercial catch (Nov-May)	219.6 t	289.7 t
Total effort (Nov-May)	254,563 potlifts	326,435 potlifts
Commercial CPUE (Nov-Apr)	0.89 kg/potift	0.89 kg/potlift
Pre-recruit index (Nov-Mar)	0.20 undersized/potlift	0.21 undersized/potlift
Biomass estimate	1,778 t	1,689 t
Exploitation rate	13%	18%
Status	**Sustainable**	**Sustainable**

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

1 INTRODUCTION

This fishery status report updates the 2018/19 stock assessment report for the Northern Zone Rock Lobster Fishery (NZRLF) (Linnane et al. 2020) 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 current status of the resource in relation to the performance indicators specified in the management plan for the fishery (PIRSA 2014).

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 NFSRF was used in this report based on a 'weight-of-evidence' approach.

In 2019, the total allowable commercial catch (TACC) in the NZRLF was 296 t (250 t Inner sub-region and 46 t Outer sub-region). 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 2019 to 31 May 2020, 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 2019/20 stock assessment report that is due in July 2021.

2 METHODS

Data sources presented in this report are described in Linnane et al. (2020). 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).

Logbook data from 1 November to 30 April are used to estimate the primary biological performance indicator of catch per unit effort (CPUE). Data to estimate the secondary performance indicator of pre-recruit index (PRI) were also obtained from logbook data. The November to March period was used as these are the known months where the catchability of undersized lobsters is highest. 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 model is provided in McGarvey and Matthews (2001) and Linnane et al. (2019). A number of updates have been made in the 2017

version of the qR model based on recommendations by Smith (2017) and to accommodate the extended 12-month fishing season within the NZRLF. These include: (i) improved estimates of lobster weights-at-age; (ii) logbook catch data summed over the 12 month fishing season starting on 1 June of each year; and (iii) from 2014-2019, using a rescaled measure of fishing effort that corrects for the consistently lower winter catch rates from June-October.

Trend in CPUE over 1995-2019 was similar for seasonal November to April and November to January. In 2019, to remove the impact of the limited catch rate data after January 2020 due to the COVID-19 market closure (see Section 3.1), a data pre-processing model was developed to infer catch rates had the trend (yearly relative level) up to 22 January continued in the 2019/20 season. Effort used in the qR model input data for 2019 season was subsequently corrected accordingly in both Northern and Southern fishing zones. Details of the model correction method will be given in the full assessment reports for 2019/20 due in 2021.

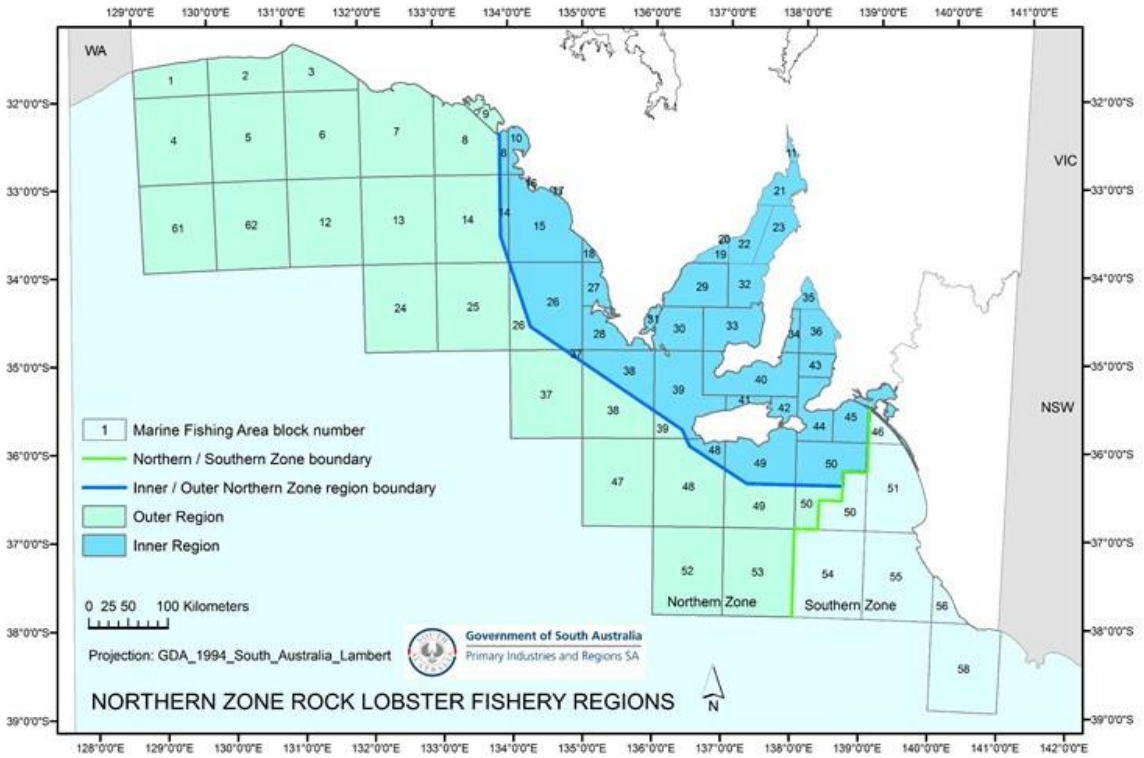

Figure 1 Northern Zone Rock Lobster Fishery Marine Fishing Areas (MFAs) and associated sub-regions.

3 RESULTS

3.1 Commercial catch and effort statistics

A COVID-19 Southern Rock Lobster market closure occurred in late January 2020 which impacted on catch, effort and CPUE outputs. This was particularly evident from February to May 2020 and should be taken into consideration when interpreting fishery trends during the latter part of the 2019/20 season.

3.1.1 Zone

In 2019, the TACC in the NZRLF was 296 t (250 t Inner sub-region, 46 t Outer sub-region). The reported logbook catch (1 November 2019 to 31 May 2020) was 219.56 t (74% of the TACC) (Figure 2a). By sub-region, the logbook catch was 205.40 t from the Inner sub-region and 14.16 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 2019 was 254,563 potlifts, reflecting a 22% decrease from 2018 (326,435 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, the 2019 estimate reflects the fourth consecutive season that effort has decreased and is the lowest estimate on record (but noting that the TACC was under-caught by 26% in 2019).

Catch rate in the NZRLF is based on logbook data from November to April. In 2019, the legal-sized CPUE was 0.89 kg/potlift, the same as 2018 but reflecting a 16% increase from 2016 (0.77 kg/potlift) (Figure 2b). Following a period of consistent decline between 1999 and 2008, when CPUE decreased to a historical low of 0.68 kg/potlift, CPUE briefly increased to 1.1 kg/potlift in 2011, before again declining to 0.77 kg/potlift in 2016.

Pre-recruit Index (PRI) estimates are now based on logbook data (previously catch sampling) from November to March inclusive. In 2019, the PRI was 0.20 undersized/potlift reflecting a marginal decrease from 2018 (0.21 undersized/potlift), but remaining above the draft harvest strategy TrRP of 0.16 undersized/potlift (Figure 2c). In the NZRLF, the time taken for pre-recruits to enter into 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 three seasons to 1.05 kg in 2019. 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.

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
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

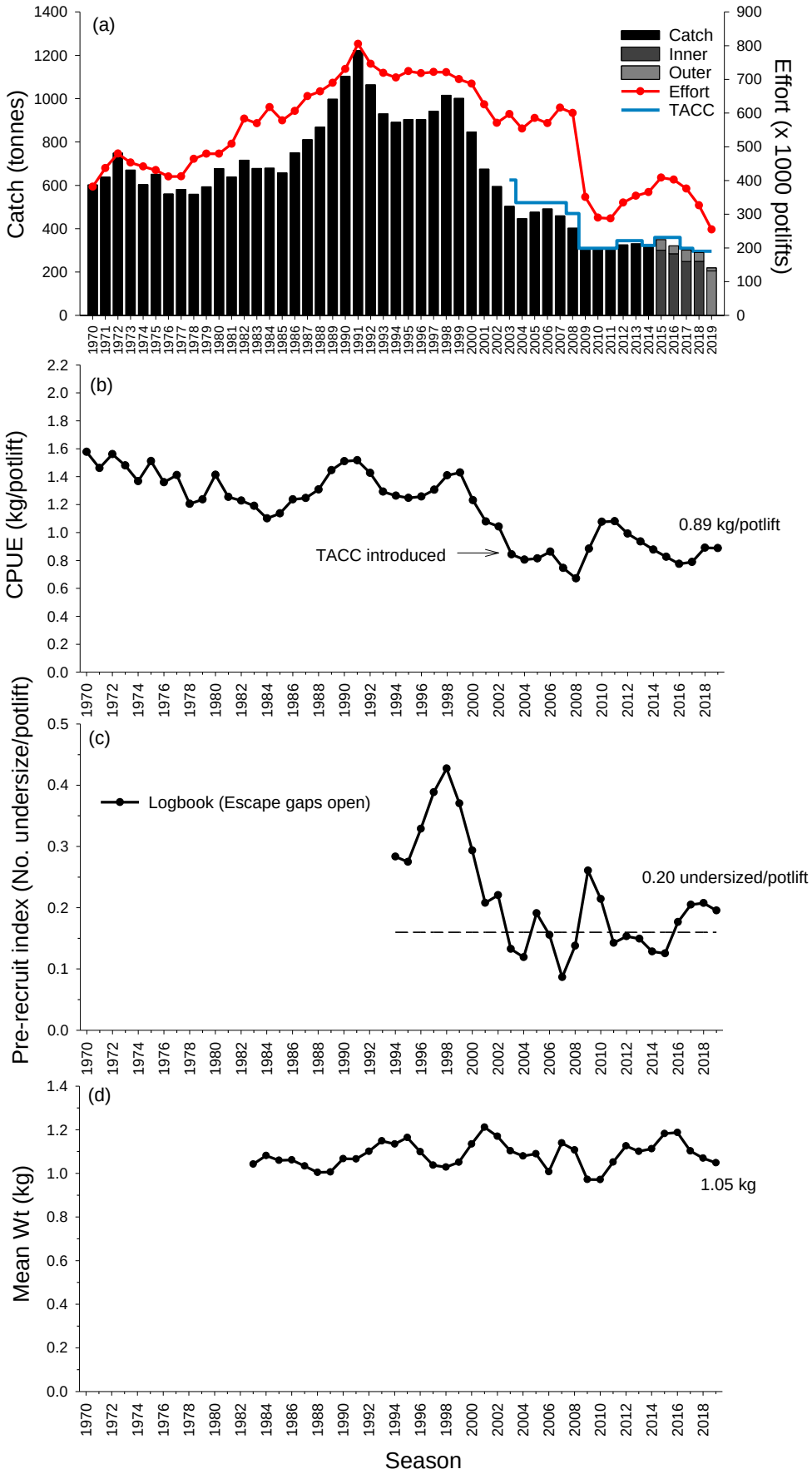

Figure 2 Fishery dependent outputs for the NZRLF. (a) Catch and effort including total allowable commercial catch (TACC) limit; (b) catch per unit effort (CPUE; (c) pre-recruit index (PRI) including trigger reference point (dashed line); and (d) mean weight.

3.1.2 Within-season trends

Within-season commercial catch trends presented here are based on data from 2017 to 2019. 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 3). The highest catches are taken during spring/summer from November to February (Figure 3a) before declining thereafter.

The impact of the COVID-19 market closure was evident in 2019. Specifically, following the closure in late January, the catch in February decreased to 6 t, where normally up to 60 t are landed (Figure 3a). Catches remained constrained through March (15 t) before increasing in April and May as market conditions improved. In 2019, the highest catch was taken in December (62 t), and the lowest catch in February (6 t).

Within-season effort levels are largely consistent with those of catch (Figure 3a). In 2019, effort was highest in December (66,372 potlifts) and lowest in February (7,104 potlifts).

Legal-sized CPUE generally tends to be highest in spring/summer at the start of the season and declines thereafter (Figure 3b). In 2019, monthly catch rates were consistently higher from November to January compared to 2018 but decreased considerably in February and March due to the market closure. Catch rates recovered to levels comparable with 2018 during April and May of 2019. In 2019, CPUE was highest in January (1.00 kg/potlift) and lowest in May (0.66 kg/potlift).

Monthly trends in catch rate of pre-recruits (i.e. PRI) tend to follow those of legal-sized CPUE, being highest at the start of the season before decreasing thereafter (Figure 3c). Compared to 2018, monthly PRI in 2019 was similar from November to January before a considerable decrease in February and March due to the market closure. In 2019, the PRI was highest in November (0.22 undersized/potlift) and lowest in May (0.11 undersized/potlift).

Monthly legal-sized mean weight generally increases as the season progresses (Figure 3d). In 2019, with the exception of February, monthly mean weight was consistently lower across most months compared to 2018 being highest in May (1.23 kg) and lowest in November (90 kg).

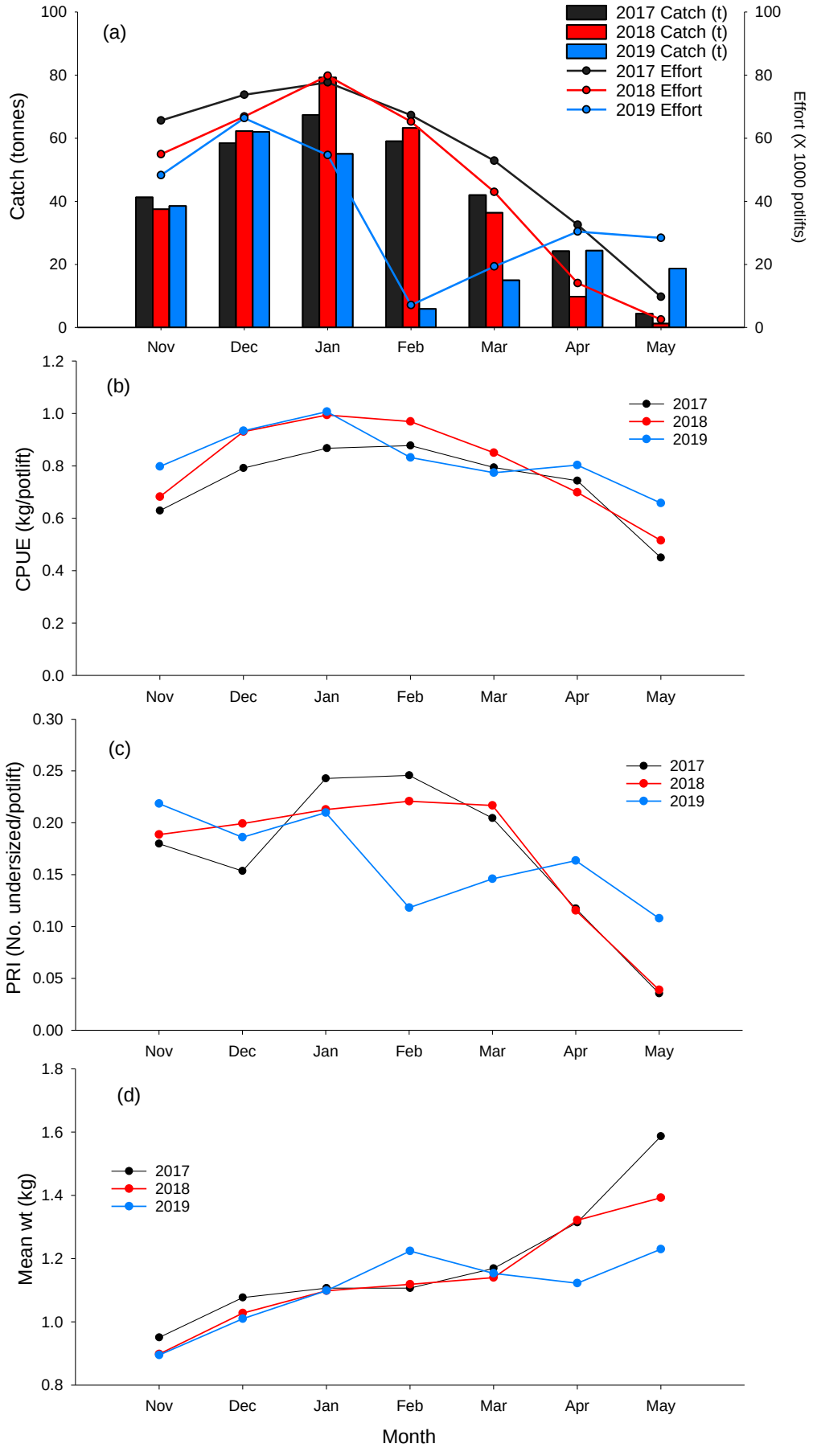

Figure 3 Within-season fishery dependent trends in the NZRLF. (a) Catch and effort; (b) catch per unit effort (CPUE); (c) pre-recruit index (PRI); and (d) mean weight.

3.1.3 Spatial trends

In 2019, 89% of the catch (195 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 eight seasons. The exception was MFA 28 where catch decreased from 74 t in 2014 to 36 t in 2019 (Figure 4e). In 2019, within the primary MFAs, the highest catch was taken in MFA 39 (43 t) (Figure 5a) and the lowest in MFA 7 (<1 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 52,000-91,000 potlifts annually over the last five seasons) (Figure 5a). In 2019, effort decreased in all primary MFAs with the exception of MFA 40.

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 2-3 seasons. The exceptions are MFAs 7 and 8 (Figure 4f and g) where, despite increases in 2019, estimates remain historically low.

Spatial estimates of the catch sampling 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 4k-o) and higher in the south-eastern MFAs of 39, 40, 48, 49 and 50 (Figure 5k-o).The zonal decrease in PRI in 2019 was largely driven by MFAs, 15, 27, 39 and 48.

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 2019, the zonal decrease in mean weight was observed in all of the primary MFAs with the exception of MFAs 39 (Figure 5p), 40 (Figure 5q), and 50 (Figure 5t).

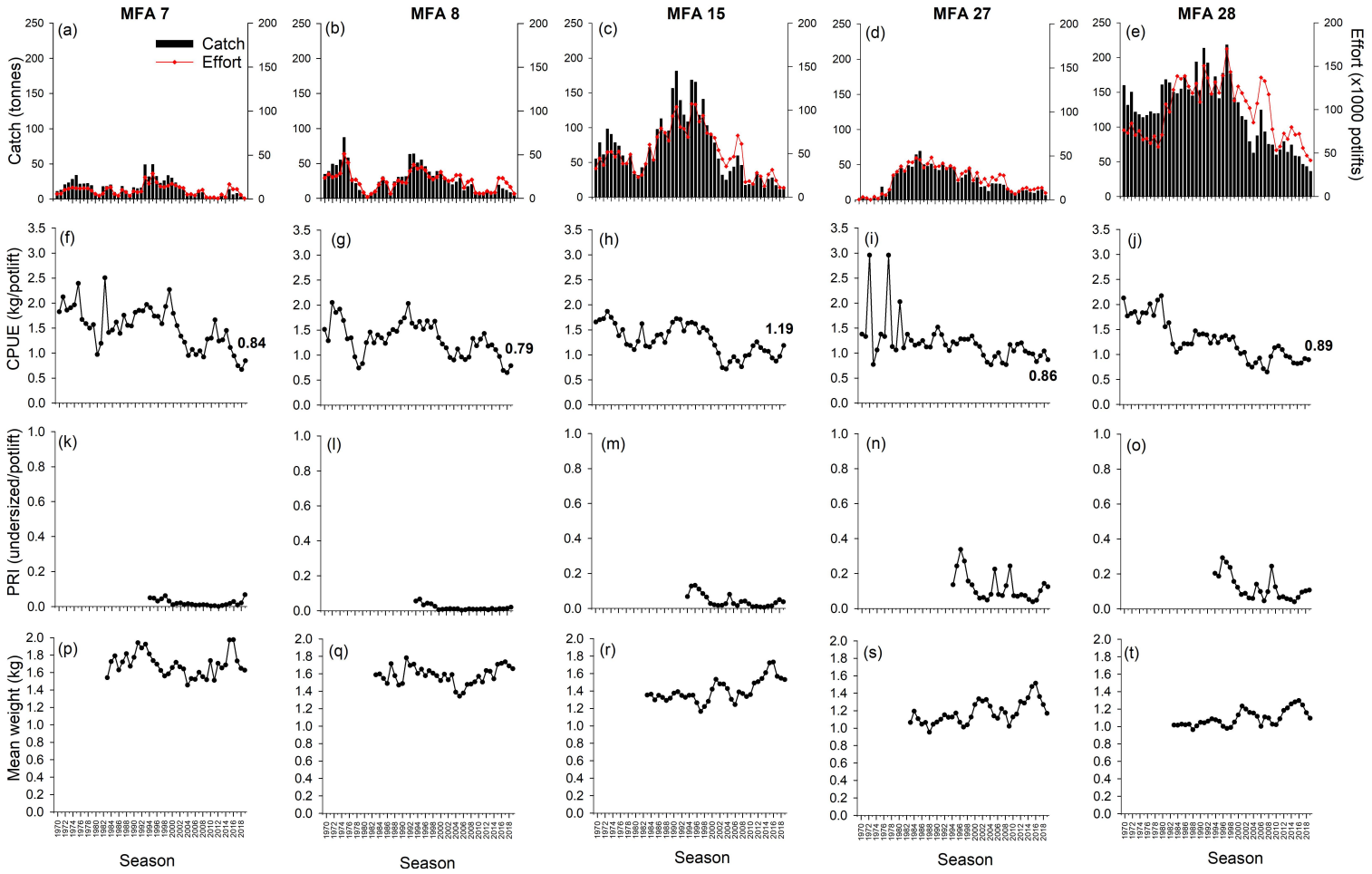

Figure 4 Spatial fishery dependent trends in the NZRLF for MFAs 7-28. (a-e) Catch and effort; (f-j) catch per unit effort (CPUE); (k-o) pre-recruit index (PRI); and (p-t) mean weight.

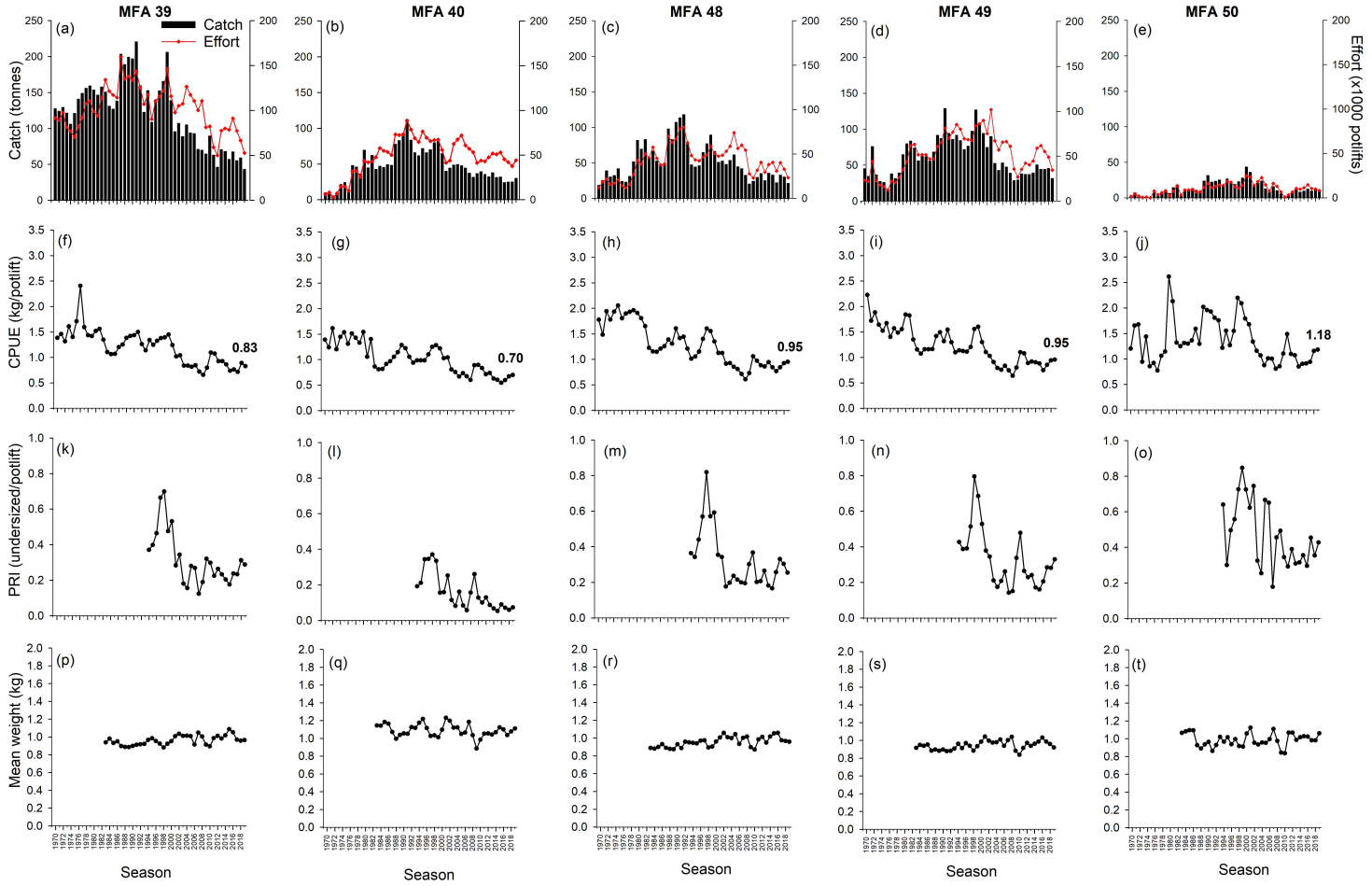

Figure 5 Spatial fishery dependent trends in the NZRLF for MFAs 39-50. (a-e) Catch and effort; (f-j) catch per unit effort (CPUE); (k-o) pre-recruit index (PRI); and (p-t) mean weight.

3.1.4 Additional indices

3.1.4.1 Ovigerous (spawning) females

In 2019, the catch rate of ovigerous (spawning) female lobsters was 0.03 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 but with some recent increases over the last three seasons.

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; $R^2 = 0.83$).

The number of dead lobsters/potlift decreased from 1998 (0.08 dead/potlift) to 2002 (0.04 dead/potlift) and with the exception of 2010 (0.06 dead/potlift), has remained below 0.05 dead/potlift since (Figure 6b). In 2019, the catch rate was 0.05 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 (with the exception of 2015), the annual estimate has remained below 0.005 octopus/potlift and in 2019 was 0.002 octopus/potlift.

3.1.4.3 Average days fished

In 2019, the average number of days fished per licence holder in the NZRLF was 92 days, reflecting the fourth consecutive season that this index has decreased (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 fact that the fishery 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. Since then, the TACC has been reduced to 296 t for the 2018 season.

3.1.4.4 High-grading

Current estimates of high-grading (legal-sized lobsters returned to the water due to low market value) in the NZRLF are low and in 2019 was 1.1 t (Figure 6d). Since the introduction of a TACC in 2003, estimates have not exceeded 3 t in any year. 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.

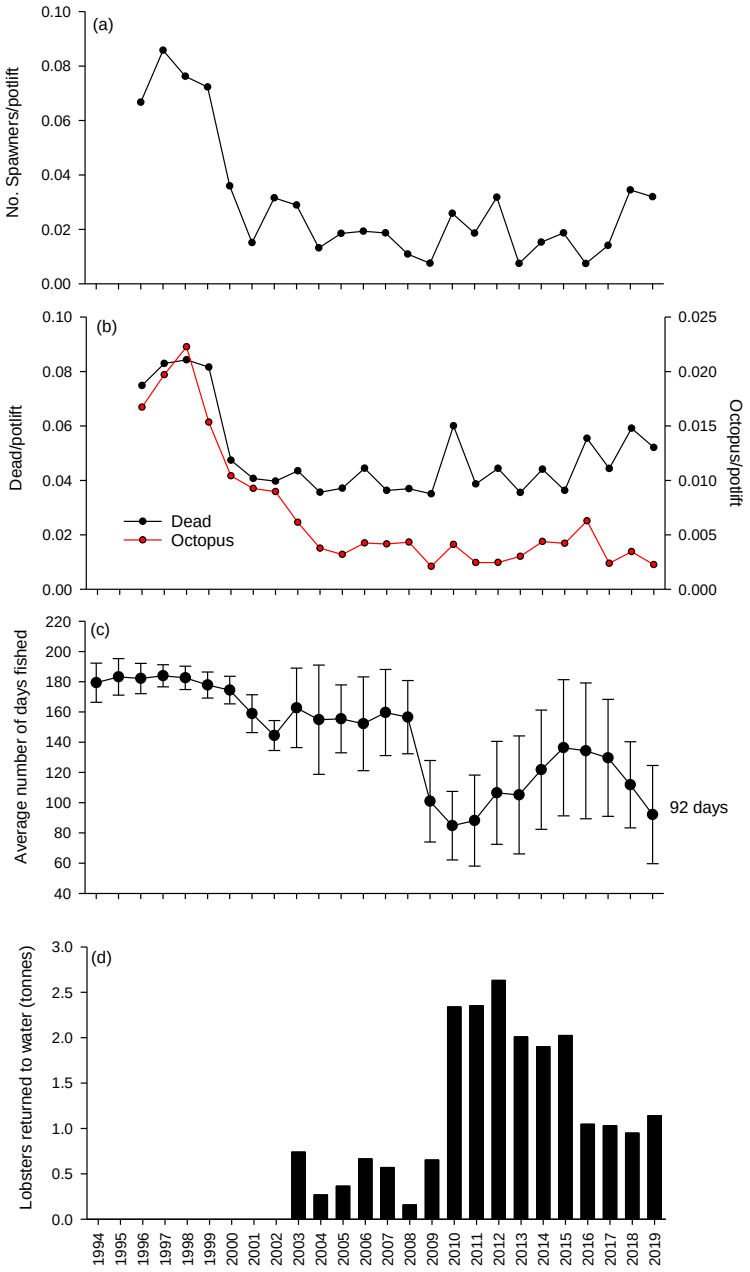

Figure 6 Additional fishery-dependent indices in the NZRLF. (a) Catch rate of spawning lobsters; (b) predation mortality and predatory octopuses; (c) average number of days fished; and (d) levels of high-grading.

3.2 Puerulus settlement index (PSI)

In 2019, the puerulus settlement index (PSI) in the NZRLF was 0.23 puerulus/collector which was below the long-term average (0.40 puerulus/collector) (Figure 7). Over the previous three seasons (2016-2018), PSIs have been above both the long-term average and median for the time series, 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 2020 to 2022 based on recent PSIs from 2016 to 2018.

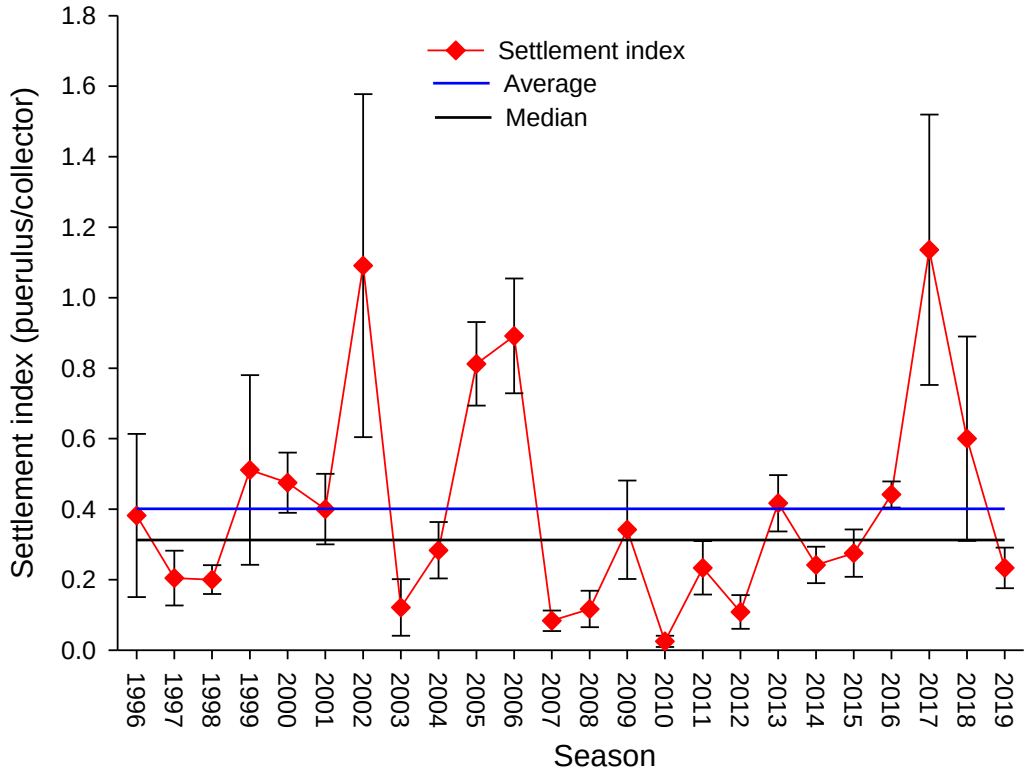

Figure 7 Puerulus settlement index (PSI) (mean ±SE) in the NZRLF from 1996 to 2019.

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 2011-2019. 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 2019, a total of 5,863 lobsters were sampled with a 46:54 male:female sex ratio. Of these, 67% were within the 105 to 140 mm CL size range with 19% of lobsters in 2019 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 decreased from 23% to 19% between 2018 and 2019, reflecting the minor reduction in undersized catch rate over the same period (Figure 2c).

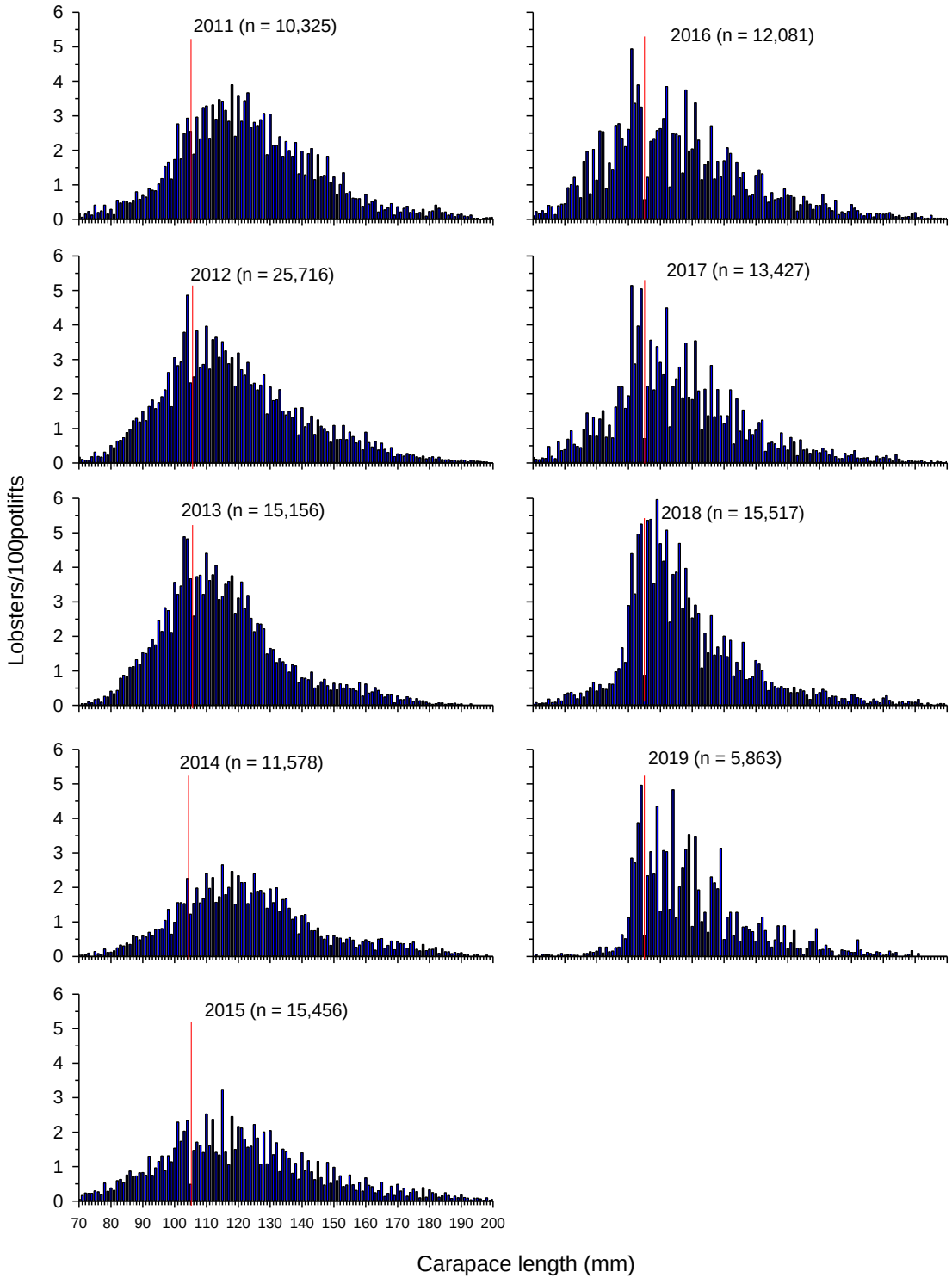

Figure 8 Length-frequency distributions of male and female lobsters combined in the NZRLF from 2016 to 2019 (red line indicates MLS at 105 mm CL).

3.4 qR Model outputs

Model outputs show long-term declines in legal-size lobster biomass from 1999 to 2008 (Figure 9a). Estimates increased in 2009 and 2010 and have remained at approximately 1,700 t over the last decade. In 2019, the estimate was 1,778 t.

In line with declines in lobster biomass, egg production estimates decreased by 65% from approximately 419 billion in 1990 to 148 billion in 2008 (Figure 9b). Over the last decade, egg production has averaged approximately 188 billion with the 2019 estimate at 186 billion. Egg production estimates are low in a historical context, equating to 15% of unfished levels in 2019 (Figure 9c).

Exploitation rate averaged approximately 34% from 1990 to 2008 before decreasing to 16% in 2011 (Figure 9d). Estimates increased to 24% in 2016 before declining over the next three seasons to 13% in 2019.

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 seven seasons, with the 2019 estimate of 0.46 million individuals being the third highest since 2010. Trends in recruitment from the qR model are highly correlated with PRI estimates from logbook data (1994-2019) (R^2 = 0.90).

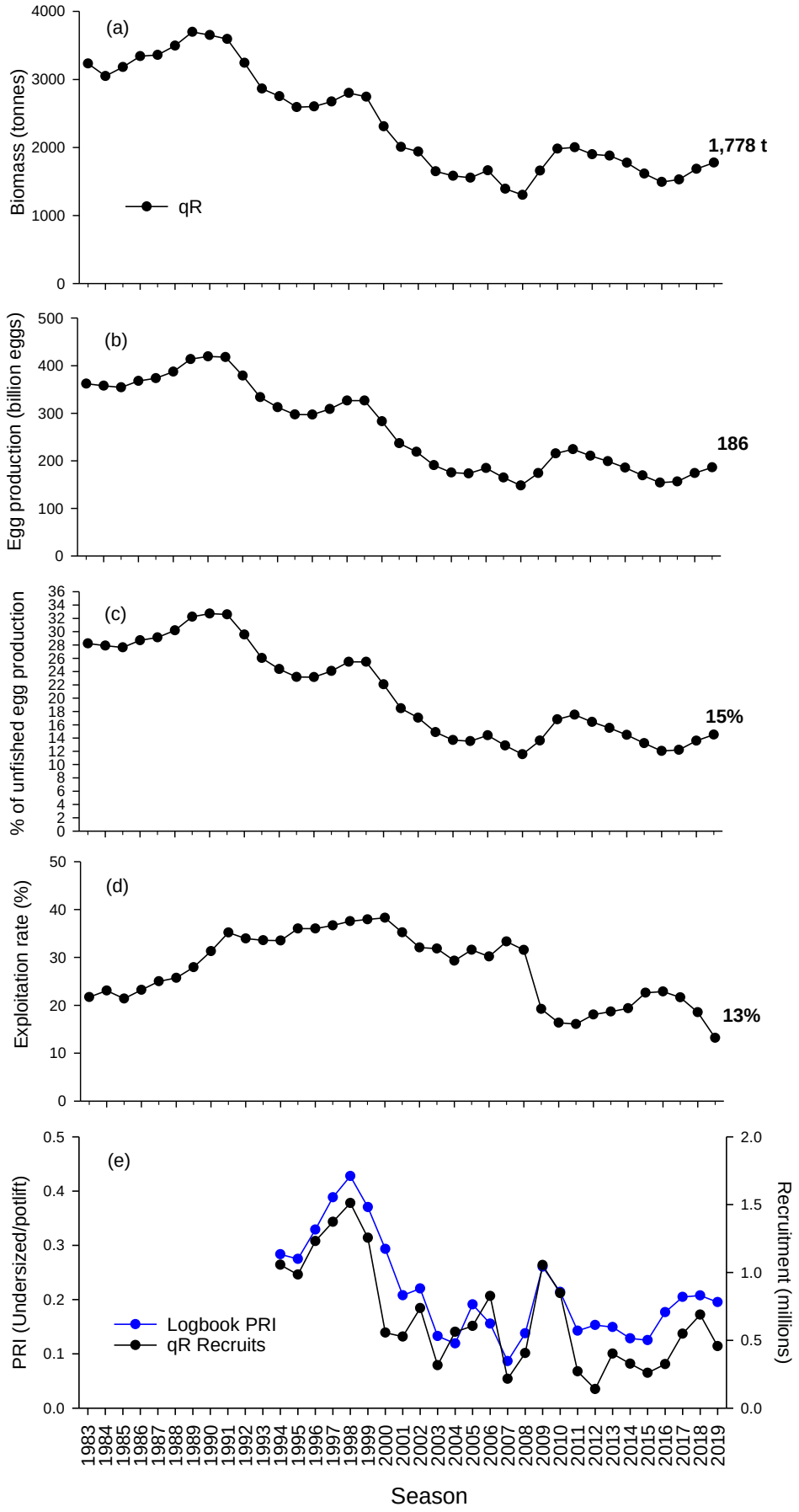

Figure 9 Fishery model outputs for the NZRLF. (a) Legal-size biomass; (b) Egg production; (c) % of unfished egg production; (d) Exploitation rate; and (e) Recruitment.

3.5 Biological performance indicators

The primary biological performance indicator is commercial logbook CPUE (kg of legal sized lobsters/potlift) based on data from November to April, inclusive. The secondary indicator is commercial logbook PRI (no. of undersized lobsters/potlift) based on data from November to March, inclusive.

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. Similar trends in catch levels occurred during March. A partial reopening of the markets after February resulted in increased catch from March to May (58 t), where catch levels are normally lower due to the TACC being fully taken. Consequently, the low CPUE estimate in February (and to some extent, in the following months), is considered to be the consequence of market influences, rather than a reduction in lobster abundance.

After an extended period of decline in performance, there are now some indications of stability within the NZRLF as observed in some key fishery indicators. While overall biomass remains low, model-estimated levels have increased over the last three seasons, which, combined with TACC reductions, has considerably reduced exploitation rates. Biomass increases also reflect positive signals of recent recruitment to the fishery as observed in both PRI and model-estimated recruitment data. As a result, catch rates are generally increasing across most major MFAs.

Despite improvements at the zonal level, the performance of the Outer sub-region of the fishery remains uncertain. The low catch of 14 t makes assessment difficult in 2019. However, catch rates in MFAs 7 and 8, two key Outer sub-region catch areas, remain low in an historical context.

The performance indicators in the current harvest strategy are not linked to a definition of stock status. Consequently, this report uses a ‘weight of evidence’ approach. There is now evidence to indicate that the status of the NZRLF stock has improved over the last two seasons in response to TACC reductions. Specifically: (i) catch rates have increased by 16% over the last two seasons with improvements in fishery performance observed across broad spatial scales; (ii) biomass estimated by the qR model has increased and exploitation rate has been reduced; and (iii) the PRI is above the TrRP.

As a result, based on a weight-of-evidence approach, the current status of the NZRLF stock is classified as "**sustainable"** at the current TACC of 296 t. This means that the current fishing mortality is being adequately controlled to avoid the stock becoming recruitment impaired.

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