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Recreational fishing for Western Rock Lobster: estimates of participation, effort and catch from 2018/19–2020/21. Fisheries Research Report 313

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Executive Summary

The Western Rock Lobster (WRL) (*Panulirus cygnus*) is one of the four Rock Lobster (RL) species found in Western Australia. It was the first fishery in the world to obtain Marine Stewardship Council Certification and the first in Western Australia to be managed under a resource allocation process. Catches from the commercial and recreational sectors are required to determine and monitor Total Allowable Catch (TAC), Total Allowable Recreational Catch (TARC) and proportion of Allowable Harvest Level (AHL) achieved. The TARC is set at 5% of the AHL and evaluated in the harvest strategy based on a 5-year average.

Since 2018/19, data for the recreational sector have been collected using phone-recall surveys to provide estimates of participation, fishing effort and retained catch (by numbers) from recreational fishers who hold a RL licence. Average weight, obtained from boat ramp surveys, are used to convert estimates of retained catch from licensed fishers by number to weight. Tour Operator Returns (Charter Logbooks) provide a census of the annual participation, effort and retained catch (by numbers) from charter fishers. Random length samples of WRL are provided by tour operators and converted to weight using a length-weight equation which are then used to covert the retained catch from numbers to weight.

Participation in the RL recreational fishery (all species) by licensed fishers (RL licence holders aged five years and older) in 2020/21 (1 February 2020–31 January 2021) was 66.8% or 37,469 fishers (95% CI 35,350–39,587). These values were steady from 2018/19–2020/21 (*i.e.,* the 95% CI overlapped between years).

The total fishing effort for RL fishing (all species) in 2020/21 was 522,485 days fished (95%CI 491,063–553,907); of which 76.9% or 401,600 (363,338–439,862) was by potting and 23.1% or 120,885 (93,904–147,866) by diving. These values were steady from 2018/19–2020/21. The majority of fishing effort occurred in the Metro-West Coast region (63.5–68.4%).

The retained recreational catch of WRL by licensed fishers in 2020/21, based on an overall (*i.e.,* combined across potting and diving) average weight of 587.4 g, was 526 t (95% CI 460–592); of which 79.8% or 420 t (362–478) was harvested by potting and 20.2% or 106 t (68–145) by diving. Total catch (in tonnes) was steady from 2018/19–2020/21.

Retained recreational catch of WRL from charter fishing in 2020/21 was 16 t (based on an overall average weight of 494.9 g), an increase from 9 t in 2018/19 (based on an overall average weight of 569.0 g). The majority of the charter catch was taken by potting (88.9–93.7%).

The 5-year average recreational catch (for licensed and charter fishing combined) was 427 t in 2018/19, which represents an AHL of 4.6%. The AHL increased to 4.9% in 2019/20 and 2020/21 with a 5-year average recreational catch of 468 t and 498 t, respectively.

1.0 Introduction

1.1 Background

The Western Rock Lobster (WRL) (*Panulirus cygnus*) is one of the four Rock Lobster (RL) species found in Western Australia, and the fishery for this species is the most highly valued in Western Australia. It was the first fishery in the world to obtain Marine Stewardship Council Certification and the first fishery in Western Australia to be managed under a resource allocation process (Gaughan and Santoro, 2021). Catches for the commercial (95% allocation) and recreational (5% allocation) sectors are therefore required to determine and monitor Total Allowable Catches (TAC), Total Allowable Recreational Catches (TARC) and proportion of Allowable Harvest Level (AHL) achieved (Crowe et al., 2013; Ryan et al., 2016).

The West Coast Rock Lobster Managed Fishery (WCRLF) is managed using Total Allowable Commercial Catch (TACC) limits across three zones, which stretch from Exmouth to Augusta (Figure 1). Data on commercial catches are obtained via mandatory logbook reporting and baited pots are the only allowable method of commercial capture (Bellchambers et al., 2017).

Fishing for RL species from Tour Operator vessels can occur using pots and by diving. Reporting via statutory Tour Operator Returns (Charter Logbooks) provides an assumed census of retained recreational catch of WRL from charter fishing (Ryan et al., 2016).

The recreational fishery is managed using a statewide TARC for WRL (first introduced in 2010/11) and a recreational licence (first introduced in the 1970s) is required to target any RL species in Western Australia. When summarised by financial year, there were 51,474 RL recreational licences issued in the 2018/19 (DPIRD, 2019), and 50,210 issued in 2019/20 (DPIRD, 2020). The 56,362 RL licences issued in 2020/21 (DPIRD, 2021) exceeded the previous peak in numbers which occurred in 2016/17 (55,441) (DoF, 2017) and 2017/18 (55,368) (DPIRD, 2018). The majority of fishing activity for RL occurs between Perth and Geraldton.

Catches from recreational fishers are managed primarily using input controls (*i.e.,* pots-per-licence, bag limits, size limits, possession limits and closed seasons). There have been several changes to the temporal restrictions, most recently in July 2018, when the recreational fishery was opened for 12-months each year (Appendix 1). Prior to this, fishing for RL had been restricted to fishing from 15 October–30 June (Ryan et al., 2016).

Historically, estimates of catch (in numbers) for the recreational sector have been collected using mail surveys (1986/87–2017/18) which captured data for the shorter fishing seasons (7.5 or 8.5 months) permitted at the time (Melville-Smith and Anderton, 2000; Ryan et al., 2016; Thomson and Melville-Smith, 2005; Trinnie et al., 2021). These surveys were run after the closure of the fishing season at the end of June each year. Periodic phone-diary surveys were also conducted between 2000/01 and 2008/09 (Baharthah, 2007) and phone-recall surveys in 2001/02 (Baharthah, 2007) and from 2015/16 to 2017/18 (Trinnie et al., 2021).

1.2 Need

The historical mail surveys worked efficiently when the recreational fishery was open for short time periods, as it minimised biases associated with fishers having to recall data over a long time period (Pollock et al., 1994). However, declining response rates (26% in 2017/18) (Trinnie et al., 2021) and an easing of management restrictions to allow for a 12-month recreational fishing season (as of July 2018) necessitated a new approach to data collection. These changes also coincided with a realignment of the commercial fishing season (15 January–14 January). Therefore, a new sampling methodology was needed to address declining response rates, minimise recall bias and better align fishing seasons between the recreational and commercial sectors.

1.3 Objectives

The objective of this report is to provide estimates of participation, fishing effort and catch (by numbers) of RL (all species) from the recreational sector during the 2018/19 (1 February 2018–31 January 2019), 2019/20 (1 February 2019–31 January 2020) and 2020/21 (1 February 2020–31 January 2021) fishing seasons. For WRL only, the average weight and retained catch (by weight) are also calculated. These estimates were calculated from phone-recall surveys of RL licensed fishers, boat ramp surveys of boat-based recreational fishers and data from statutory Tour Operator Returns.

These estimates are used to determine AHL, from which the future TARC is determined (5% of the AHL). These estimates are also used to compare the recreational sector against the TARC and evaluated in the harvest strategy based on a 5-year average.

2.0 Method

2.1 Phone-recall survey

2.1.1 *Survey design and scope*

The phone-recall survey is a single-phase design, with all sampling completed in a single wave over a period of approximately four weeks. The use of prompts and defined fishing regions and months were used to assist fishers with recalling information and minimise recall bias.

The phone-recall survey is a stratified random sampling design, with samples divided into homogeneous units to reduce sampling variance. These strata were related to groupings of Regional Development Commission (RDC) boundaries, similar to other statewide recreational fishing surveys (Ryan et al., 2019). However, some boundaries have been combined to better represent the population of RL licensed fishers. The five residential strata are defined as Metro, Mid-West (including the Mid-West and Wheatbelt RDCs), Peel, South-West and Country (including the Kimberley, Gascoyne, Goldfields-Esperance, Great Southern RDCs and Interstate).

The sampling frame for these phone-recall surveys was a list of fishers who had held or renewed a RL licence during the 12-months prior to the survey period. This licence is required to undertake fishing for any of the four RL species in Western Australia. A minimum age criterion of 5 years was applied to the phone-recall surveys, and parents were required to be a proxy for children aged 5–13 years. Parent permission was required for children aged 14–17 years to participate. A random sample of 2,000 RL licence holders who held a licence issued in the 12-months prior to the survey period were selected for each survey. Subject to their consent to participate in the survey, RL fishers were asked to recall their effort and catch within this fishery over the previous 12-months (Table 1).

Activity from fishers collecting RL from the shore are included in the phone-recall survey. However, RL fishing by licensed fishers from charter-boats were excluded from the phone-recall survey as these catches are reported through mandatory Tour Operator Returns (Charter Logbooks) (Section 2.3).

Commercial management zones for the RL fishery are different to the bioregions and zones used for reporting recreational fishing activity in the recreational statewide surveys (Ryan et al., 2019). However, modification of the geographical boundaries used for recreational fishing surveys broadly aligned to reporting between the sectors. The phone-recall surveys therefore collected data from five marine ‘regions’: North Coast Bioregion, Gascoyne Coast Bioregion, Mid-West Coast (including the Kalbarri and Mid-West zones in the West Coast Bioregion), Metro-West Coast (including the Metropolitan and South zones in the West Coast Bioregion) and South Coast Bioregion (Figure 1). The Gascoyne Coast Bioregion and Mid-West Coast approximates the combination of Zone A and Zone B of the commercial RL fishery. Separate estimates for either of these zones cannot be provided. The Metro-West Coast region approximates Zone C of the commercial RL fishery.

Table 1 Data elements for each data collection method for 2018/19–2020/21.

Specification	Item	Phone-recall survey	Boat ramp survey	Tour Operator Returns (Charter Logbook)
Persons in scope	Residency status	All, including Western Australian residents and interstate visitors*	All, including Western Australian residents, interstate and international visitors	All, including Western Australian residents, interstate and international visitors
	Age	<5 years excluded	All	All
	Sampling frame	RL licence holders valid for 12-months prior to survey	Spatio-temporal	Census
Activities	Sectors	Recreational fishing only (traditional/indigenous fishing excluded)		
	Platform	Shore- and boat-based	Boat-based only	
	Boat type	Private-boat and for-hire fishing (charter-boat excluded)		Charter-boat
	Methods	All methods including diving and potting		
Species	Species	All rock lobster species (n=4)	All rock lobster species (n=4)	All species (including rock lobster species)
	Catch	Retained	Retained	Retained and released
	Biological	NA	Carapace length and weight	Carapace length
Geographic scope	Fishing activity	Regions (n=5)	Key public boat ramps in the Metropolitan Zone of the West Coast bioregion – reported to 10 x 10 nautical mile blocks	Statewide, Bioregions (n=4) – reported to 5 x 5 nautical mile blocks
	Fishing access	All shore access and boat launching locations	Key public boat launching locations	All charter boat departure locations
Temporal scope	Coverage	Feb - Jan	Dec - Jan	Feb - Jan
	Day hours	All	6 am–10 am; 12 noon–4 pm	All

* International visitors out-of-scope

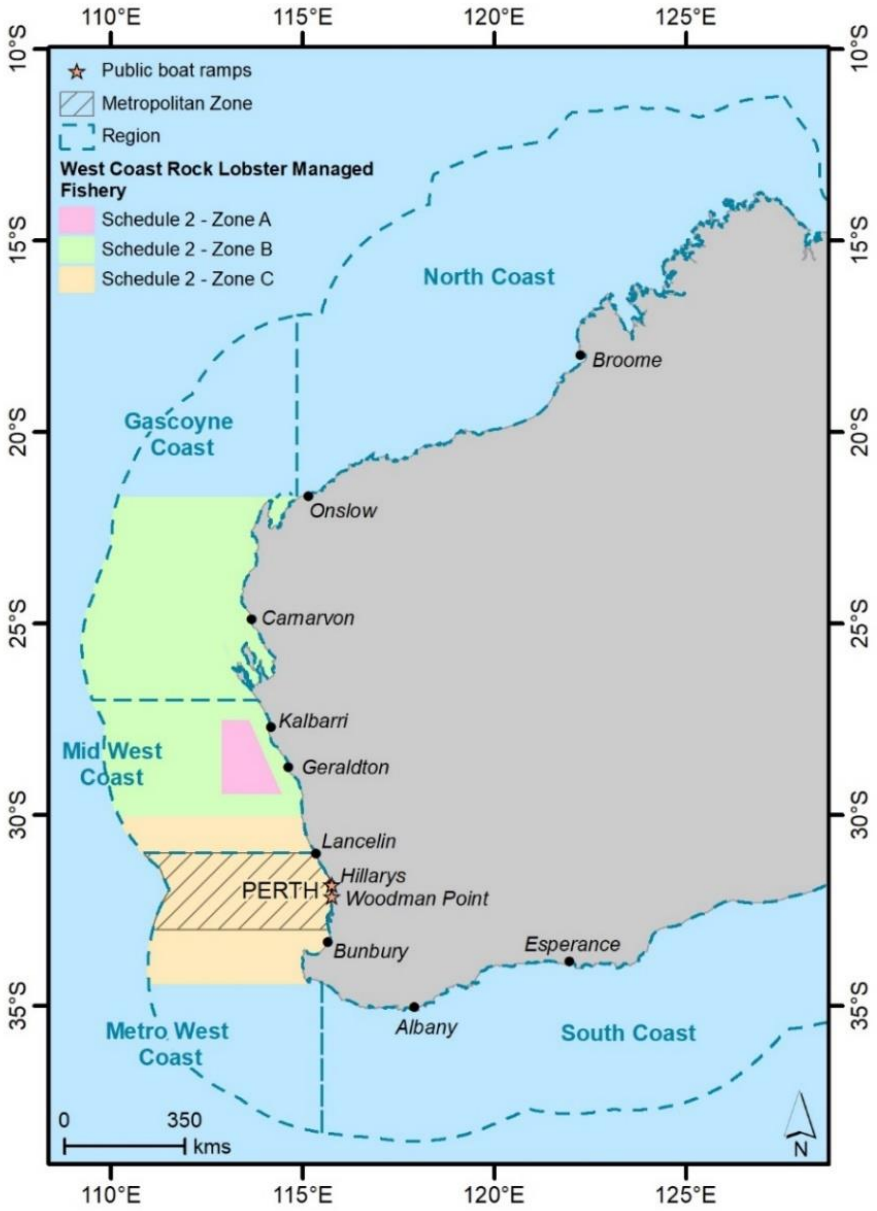

Figure 1 Management zone boundaries for the WRL commercial fishery, reporting regions fished by RL recreational fishers during phone-recall surveys and location of boat ramp surveys.

2.1.2 *Analysis*

Raw data on participation, fishing effort and retained catch was expanded to the population of RL licence holders within the recall period using the *survey* package in R, following established protocols for analysis of recreational fishing surveys (Lumley, 2010; Lyle et al., 2010; Ryan et al., 2019). Each estimate has an associated measure of variability, including Standard Error, Confidence Intervals and Relative Standard Error (RSE). For example, the range around estimated catch is represented as 95% confidence intervals (95% CI).

The sample weight (or expansion factor) for each stratum (RDC) was calculated as

$$\alpha_{hi} = \frac{N_h}{n_h}$$

where α_{hi} is the weight for the RL licence holder *i* in stratum *h*, N_h= total number of RL licence holders in stratum *h* and n_h= number of RL licence holders sampled in stratum *h.*

In 2018/19, the population totals for RL licence holders used to draw the survey sample and expand up to population were the same as the RL recreational fishing season (*i.e.,* 1 February 2018–31 January 2019). In 2019/20 and 2020/21, the population total for RL licence holders used to draw the survey sample was taken earlier (23 January–22 January) than the recall period and RL recreational fishing season (1 February–31 January). This resulted in a difference of 353 RL licences in 2019/20 and 71 in 2020/21 but enabled the survey to commence as swiftly as possible after the recall period had ended. The number of RL licence holders from the recall period was used to expand raw survey data to population estimates.

Estimates of participation (by number of RL holders) are summarised statewide and by region for all rock lobster fishing (*i.e.,* all four RL species) as well as by fishing method for each season (February 2018–January 2019, February 2019–January 2020 and February 2020–January 2021). Estimates of effort are calculated as number of days fished for RL (all species) and are summarised statewide, and by each region and fishing method.

Recreational catch estimates were converted from numbers to weight for comparison against the TARC. The average weight of WRL obtained from the boat ramp survey (see Section 2.2) was multiplied with the raw catch data and then expanded to population estimates for all RL licence holders within the recall period.

Statewide and regional annual estimates of retained catch (weight ± 95% CI) of WRL are provided for each method (potting and diving). Consistent with other published studies, estimates were deemed to be robust when a sample size of ≥30 fishers was achieved and the Relative Standard Error (RSE) was ≤0.4 (calculated as the standard error of the sample divided by the estimate) (Henry and Lyle, 2003; Ryan et al., 2019). Non-robust estimates are indicated in tables and figures when they occur.

An adjustment of recreational catch estimates (by numbers and weight) from phone-recall surveys are required to account for recall and non-response biases in these survey methods. A constant correction factor was applied to estimated recreational catches from mail surveys conducted from 1986/87–2017/18 (0.39) (Thomson, 2013). A different adjustment value is required for the phone-recall surveys due to the higher response rates as well as lower recall bias (due to the use of prompts and defined fishing locations and months) when compared to the mail surveys. A correction factor for the 2018/19, 2019/20 and 2020/21 phone surveys was therefore based on comparisons of estimated recreational catches (potting and diving combined) from three adjusted-mail and phone–recall surveys conducted from 2015/16–2017/18 (0.62) (Trinnie et al., 2021).

2.1.3 *Response rate*

In all surveys, a random sample of 2,000 people were selected from those who were licensed to fish for RL in the previous 12-months (from 1 February–31 January) (Table 2). The number of licences in any survey year (or fishing season) varied between 50,200–56,064 and the sample represented ~4% of licence holders in each year. The overall response rate was similar for all surveys (95.9–98.4%). Less than 30 RL licence holders were out of scope in each survey, (*i.e.,* international visitors).

Table 2 Sample size and response profile by stratum for the phone-recall survey conducted in February 2019, February 2020 and February 2021. Note: RL licence holder total population valid for period 1 February–31 January in each survey year.

	Total RL Holders	Initial sample	Sample loss	Net sample	Non-response		Full response	Response rate^
					Non Contacts	Refusals		
Phone-recall survey – February 2019								
Metro	30,706	500	91	409	4	3	401	98.0%
Mid-West	7,958	375	76	299	4	1	294	98.3%
Peel	5,201	375	54	321	5	5	311	96.9%
South-West[#]	5,216	375	54	321	6	1	314	97.8%
Country *	4,064	375	65	310	7	2	301	97.1%
Out of scope	12							
TOTAL	53,157	2,000	340	1,660	27	12	1,621	97.7%
Phone-recall survey – February 2020								
Metro	28,490	500	55	445	1	5	439	98.6%
Mid-West	7,808	375	50	325	0	8	317	97.5%
Peel	4,917	375	56	319	3	3	313	98.1%
South-West[#]	5,076	375	45	330	1	3	326	98.8%
Country*	3,902	375	62	313	2	1	310	99.0%
Out of scope	27							
TOTAL	50,220	2,000	268	1,732	7	20	1,705	98.4%
Phone-recall survey – February 2021								
Metro	32,603	500	73	427	0	15	409	95.8%
Mid-West	8,096	375	61	314	1	10	298	94.9%
Peel	5,566	375	47	328	2	13	312	95.1%
South-West[#]	5,526	375	49	326	5	7	313	96.0%
Country*	4,270	375	54	321	0	7	313	97.5%
Out of scope	3							
TOTAL	56,064	2,000	284	1,716	8	52	1,645	95.9%

* Country combines Kimberley, Gascoyne, Goldfields-Esperance, Great Southern RDC and Interstate
[#] Mid-West combined Mid-West and Wheatbelt
^ Full response / (Eligible + Non-Contacts)

2.2 Boat ramp survey

2.2.1 *Survey design*

The boat ramp survey is a probability-based survey based on a restricted spatio-temporal sampling frame (Smallwood and Ryan, 2020). The survey aimed to measure the length and weight of WRL during peak periods of fishing effort in the recreational fishery to obtain a representative sample of WRL retained by recreational fishers across public boat ramps in the Metropolitan zone of the West Coast bioregion (Figure 1). From this, an index of the average weight retained by recreational fishers was developed to convert estimates of catch by numbers to catch by weight.

The design of the 2018/19, 2019/20 and 2020/21 surveys were consistent (Table 1). The design of these surveys has been refined from boat ramp surveys completed over the preceding three years (2015/16–2017/18) across broader spatial (10 public boat ramps distributed throughout the West Coast bioregion) and temporal (December–April) periods (Desfosses *et al.,* in prep). This has enabled a pragmatic and cost-effective sampling frame to provide a consistent and robust time series of comparable survey data that is representative of the WRL fishery.

The two busiest public boat ramps (Hillarys and Woodman Point) (Figure 1) and peak months (December and January) for RL fishing effort and catch, were sampled using face-to-face interviews with fishers as they returned from their fishing trip. Based on fixed cameras that monitor launches and retrievals of vessels at these two boat ramps, the optimal time for sampling was identified to be during the morning (6:00 to 10:00) which was expected to primarily sample fishers using rock lobster pots, and during the afternoon (12:00 to 16:00) which was expected to sample more divers, or potting occurring in deeper waters. Survey days were classified as either weekday (Monday to Friday) or weekend/public holiday (Saturday, Sunday, weekday public holidays). Survey staff were instructed to cancel a shift if thresholds were not met for a number of trailers at the ramp, or if wind speeds exceeded 25 knots at the start of the shift. Cancelled shifts were rescheduled for the same time of day and day type within the month. Biological data such as sex, carapace length (mm), body weight (grams), and appendage (legs, antennae) loss were collected.

2.2.2 *Analysis*

The estimated catches from the phone-recall survey were converted from numbers to weight for comparison against the TARC. This was calculated as the (arithmetic) average weight combined across potting and diving (herein referred to as overall) for WRL in each survey year. The lower and upper 95% CI for average weight were also calculated.

2.2.3 *Response rate*

Interviews were conducted with 920 (2018/19), 748 (2019/20) and 798 (2020/21) vessels at Hillarys and Woodman Point public boat ramps in December and January of each survey period. The response rate for all surveys was >99.0%.

2.3 Tour Operator Returns

2.3.1 *Data collection*

Daily trip sheets are a mandatory reporting requirement for all tour (charter) operators as part of their license requirement and therefore provide an assumed census of fishing activity (Table 1). The numbers of individual RL retained and released by clients on each fishing trip are recorded by the tour operators, and a random sample of lobster carapace lengths are taken from the retained catch.

2.3.2 *Analysis*

Recreational catch from tour operators were provided for time periods which match that for the phone-recall surveys from 2018/19–2020/21 (*i.e.,* February–January). Analysis of tour operator data prior to this time was based on financial year.

Data from tour operators could only be reported if more than three operators had provided returns for a particular species, or the temporal or spatial period of interest. Non-reporting of data due to confidentiality has been indicated in the report where it occurs.

Fishing for RL species from tour operators can also be assigned to a specific fishing method (*i.e.,* potting and diving). Separate fishing 'sessions' are recorded for each method used on a fishing trip and allowed fishing effort for RL and catches to be assigned to diving (including snorkelling) and potting. However, if the gear type or fishing method used in each session has not clearly been reported or separated on returns then any fishing for RL species will be assigned to potting. Validation of Tour Operator Returns aims to correct for these situations where inaccurate reporting is occurring, especially in more recent years when there is an increased emphasis on fishing for RL species. The use of both potting and diving of the same trip occurred on only eight occasions from 2018/19–2020/21.

The total number of clients on board each trip in which potting occurred was used as the measure of participation for this method; noting this may be an overestimate as not all clients may have been involved in this activity. For diving, the exact number of participants was recorded and used as a measure of participation. To calculate the total number of participants the values from both methods were combined. On the few occasions (8) where multiple activities occurred, clients (152) were assumed to have participated in both activities.

Fishing effort for tour operators was measured as the number of days fished and included any trips where any RL species were caught (retained or released). The number of pots used by an operator is not considered in this analysis as the focus is on overall effort, and not considering the various drivers that may affect effort. It is not possible to assign fishing effort if a tour operator was targeting RL species but caught nothing; and these trips will not be included in any results for participation and fishing effort.

Catches from tour operators were also converted from numbers to weight for comparison against the TARC. This was calculated by multiplying the catch (by

numbers) obtained from Tour Operator Returns with an average weight for WRL, which is obtained by utilising random carapace lengths (CL) collected by tour operators. These random length samples are converted to a single average weight for each year using the following length-weight equation $0.002831*CL^{2.744}$ (unpublished DPIRD data). Only random length samples which were obtained within each survey year (from February–January) were included in the calculation of average weight and was combined across potting and diving (*i.e.,* overall). This differs to previous analyses from which an average weight was calculated using random length samples obtained across all years.

2.3.3 *Response rate*

While it is a mandatory requirement for tour operators to submit returns, there can be some delay in their processing and the data being available for analysis. Data extraction occurred on the 24 August 2021 and at this time >98% of Tour Operator Returns had been entered up until the end of January 2021. Based on prior knowledge of tour operators, the few outstanding returns are unlikely to have catches of RL.

2.4 Recreational harvest

The calculation of the TARC and AHL requires elements from all data collection methods (phone-recall surveys, boat ramp survey and tour operator returns) to generate an estimated catch for the recreational sector by weight. Moreover, as the calculation of the proportion of AHL is based upon 5-year historic moving average of both the estimated recreational catch (from licensed fishers and charter) and TARC, data is also required from historical mail-recall surveys completed prior to 2018/19 (Trinnie et al., 2021). A constant average weight value of 500g was also applied to convert estimates of recreational catch by numbers for licensed fishers to weight prior to 2015/16 (Trinnie et al., 2021). Therefore, as an example, the 5-year moving average of recreational catch in 2018/19 requires data from the phone-recall survey from that year, as well as data from historic mail-recall surveys in 2014/15–2017/18. The estimated recreational catch for licensed fishers in 2014/15 was also converted to weight using a constant value (500g).

3.0 Results

3.1 Participation

3.1.1 *Phone-recall survey*

The total number of RL licences issued statewide increased from 53,157 in 2018/19 to 56,064 in 2020/21. The Metropolitan area had the greatest number of licences in all survey years (Appendix 2–Appendix 4).

Participation in the RL recreational fishery (all species) by licensed fishers (RL licence holders aged five years and older) in 2020/21 (1 February 2020–31 January 2021) was steady at 37,469 fishers (95% CI 35,350–39,587) when compared to previous survey years (*i.e.,* the 95% CI overlapped between survey years) (Figure 2a). The participation rate in 2020/21 was 66.8%, which was also similar across years (66.6–67.7%).

The Metro-West Coast had the highest numbers of fishers participating in RL fishing in all survey years (48.4% in 2018/19 to 51.9% in 2020/21), followed by the Mid-West Coast (14.0% in 2018/19 to 12.3% in 2020/21) (Figure 2b).

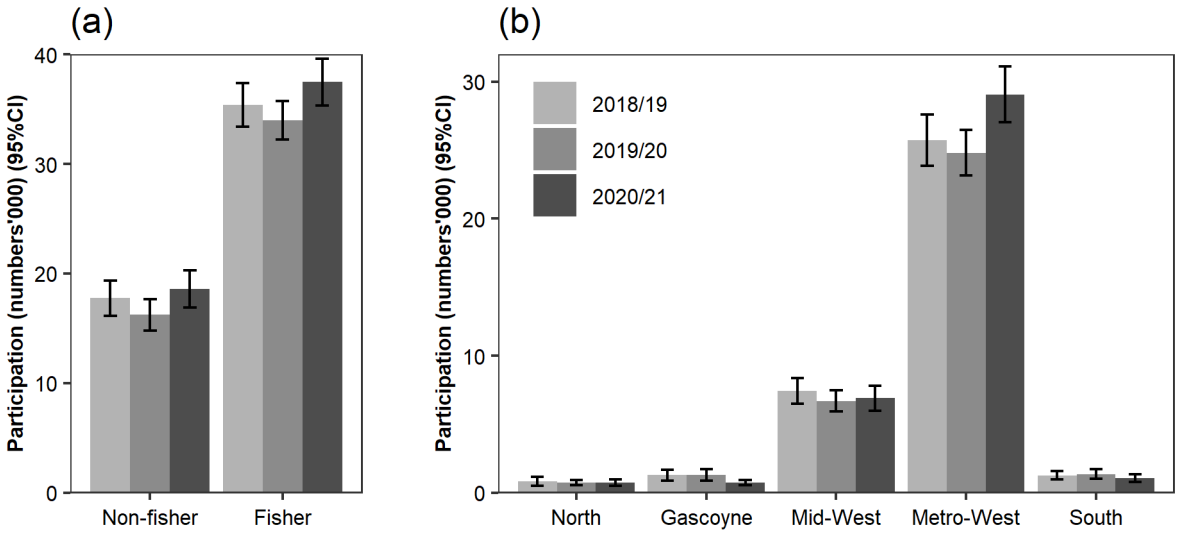

Figure 2 Estimated number of RL licence holders (±95% CI) aged five years and older who fished recreationally for rock lobster (a) statewide (non-fishers versus fishers) and (b) by region (fishers only) from 2018/19–2020/21.

Participants who fished for RL using pots in 2020/21 comprised 50.7% or 28,402 of RL licence holders (95% CI 26,371–30,433). This was steady when compared to previous survey years with 50.7% or 26,942 fishers (25,042–28,842) in 2018/19 and 51.5% or 25,870 fishers (24,187–27,553) in 2019/20.

Participants who targeted RL by diving in 2020/21 comprised 20.7% or 11,607 of RL licence holders (95% CI 10,220–12,993). This was also steady when compared to previous survey years with 20.0% or 10,613 fishers (9,330–11,896) diving in 2018/19 and 22.0% or 11,024 fishers (9,830–12,219) in 2019/20. The proportion of fishers

using both potting and diving was small, but consistent across survey years; 5.5% in 2018/19, 8.4% in 2019/20 and 7.9% in 2020/21.

In all survey years, the Metro-West Coast had the highest numbers of fishers participating in potting from 73.4% in 2018/19 to 78.2% in 2020/21, followed by the Mid-West Coast with 23.4% in 2018/19 to 20.4% in 2020/21 (Figure 3a). For diving, the Metro-West Coast also had the highest numbers of fishers participating in this activity from 68.2% in 2018/19 to 71.5% in 2020/21 (Figure 3b). Diving was more widely spread across regions than potting.

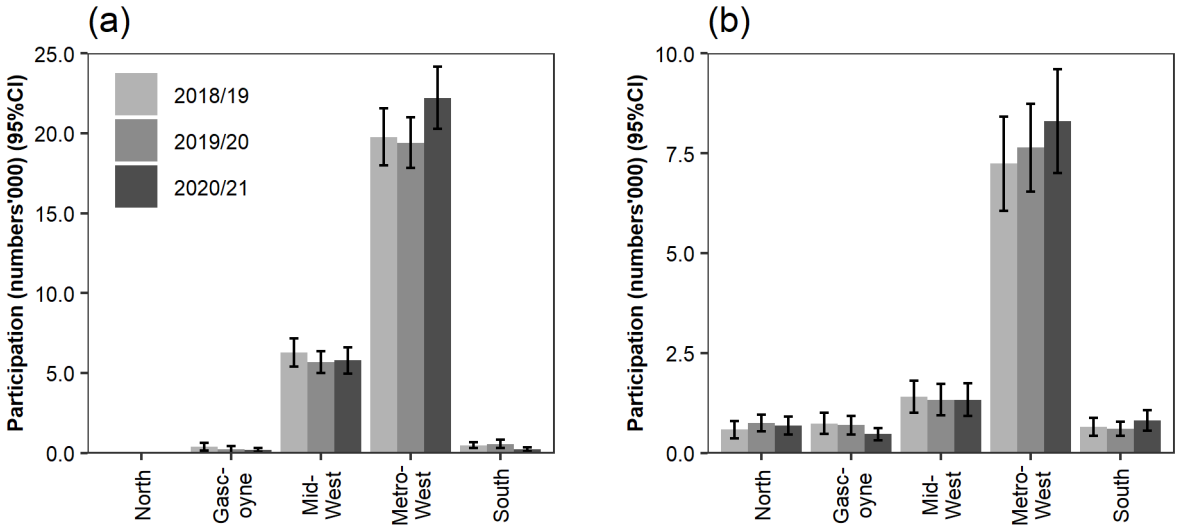

Figure 3 Estimated number of RL licence holders (±95%CI) aged five years and older who fished recreationally for rock lobster by region by (a) potting and (b) diving from 2018/19–2020/21.

3.1.2 *Tour operators*

The number of tour operators undertaking trips which involved catching RL species throughout Western Australia was 55 in 2018/19, 64 in 2019/20 and 57 in 2020/21. Over 90% of tour operators were in the West Coast bioregion.

Participation increased from 2018/19 (15,045 people) to 2019/20 (17,955) and then decreased in 2020/21 (13,999) (Table 3). The majority of participants used pots; increasing from 79.3% in 2018/19 to 86.9% in 2020/21. Participation in diving for RL species decreased from 20.7% in 2018/19 and 13.1% in 2020/21.

Table 3 Fishing participation (number of clients) for all rock lobster species obtained from tour operators from 2018/19–2020/21 for trips with potting, diving and total. Data extracted: 24 August 2021.

Season	Number of people		
	Potting	Diving	Total
2018/19	11,929	3,116	15,045
2019/20	15,158	2,797	17,955
2020/21	12,167	1,832	13,999

Due to confidentiality (*i.e.,* the small number of tour operators undertaking trips which involved catching RL species outside of the West Coast Bioregion) tour operator participation in RL fishing cannot be reported by bioregion.

3.2 Effort

3.2.1 *Phone-recall surveys*

Total fishing effort for RL fishing (all species) in 2020/21 was 522,485 days fished (95%CI 491,063–553,907); of which 76.9% or 401,600 (363,338–439,862) was by potting and 23.1% or 120,885 (93,904–147,866) by diving (Table 4). Estimated fishing effort (total and by method) was steady between all survey years (*i.e.,* the 95% CI overlapped between years). The proportion of effort for potting and diving was also similar.

Table 4 Estimated fishing effort (days) for all rock lobster species by licensed fishers by potting, diving and total from 2018/19–2020/21, with lower (LCI) and upper (UCI) 95% confidence intervals.

Season	Fishing effort (days)								
	Potting			Diving			Total		
	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI
2018/19	395,823	360,803	430,844	89,973	73,032	106,914	485,796	456,064	515,528
2019/20	391,345	355,859	426,830	124,819	100,284	149,354	516,164	487,638	544,690
2020/21	401,600	363,338	439,862	120,885	93,904	147,866	522,485	491,063	553,907

The majority (68.4–73.5%) of the fishing effort occurring in the Metro-West Coast in all survey years (Table 5). In 2020/21 the Metro-West Coast had 384,010 days fished (95%CI 343,636–424,384); of which 77.3% or 296,961 (260,897–333,026) was by potting and 22.7% or 87,049 (61,700–112,397) by diving. Estimated fishing effort (total and by method) in the Metro-West Coast was steady between all survey years.

Table 5 Estimated fishing effort (days) for all rock lobster species obtained using phone-recall surveys for 2018/19–2020/21 for each region by potting, diving and total with lower (LCI) and upper (UCI) 95% confidence intervals.

Note: (1) values in bold indicate RSE>0.4; values in italics indicate n<30; (2) due to the number of decimal places in the input parameters and rounding, the values across regions with a year may not sum to the totals at a statewide level.

Region	Fishing effort (days)								
	Potting			Diving			Total		
	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI
2018/19									
North	0	0	0	6,742	3,650	9,834	6,742	3,651	9,833
Gascoyne	*5,346*	*1,659*	*9,034*	**9,541**	**1,620**	**17,463**	14,888	6,161	23,614
Mid-West	112,711	92,458	132,964	8,664	5,443	11,886	121,375	101,280	141,471
Metro-West	272,631	241,301	303,961	59,431	46,168	72,694	332,062	300,636	363,488
South	*5,135*	*2,293*	*7,977*	5,594	3,068	8,120	10,729	6,981	14,477
2019/20									
North	0	0	0	6,579	4,233	8,924	6,579	4,237	8,921
Gascoyne	***1,666***	***0***	***3,506***	7,762	4,004	11,520	9,428	5,258	13,598
Mid-West	104,330	87,068	121,592	18,101	9,822	26,381	122,431	103,924	140,939
Metro-West	279,874	247,555	312,193	87,090	65,730	108,451	366,964	331,227	402,702
South	*5,475*	*1,213*	*9,737*	5,287	3,082	7,492	10,762	5,981	15,542
2020/21									
North	0	0	0	7,088	3,799	10,377	7,088	3,801	10,375
Gascoyne	***2,090***	***21***	***4,158***	4,482	2,411	6,553	6,572	3,622	9,521
Mid-West	100,079	83,443	116,716	13,269	6,512	20,026	113,348	95,388	131,309
Metro-West	296,961	260,897	333,026	87,049	61,700	112,397	384,010	343,636	424,384
South	*2,470*	*852*	*4,087*	8,997	3,576	14,419	11,467	5,802	17,133

3.2.2 *Tour operators*

Fishing effort (in days fished) based on trips where any RL species were caught by tour operators increased from 1,466 days fished in 2018/19 to 1,873 in 2019/20 and decreased to 1,699 in 2020/21 (Table 6). The majority of this effort was obtained by tour operators using potting (83.4–89.7%). Effort by diving was also relatively consistent over these same time periods (10.3–16.6%). Only eight logbook returns indicated that both potting and diving occurred on the same trip and therefore contribute to a day fished for each method (but are only contribute one day to the total).

Due to confidentiality (*i.e.,* the small number of tour operators undertaking trips which involved catching RL species outside of the West Coast Bioregion) tour operator effort cannot be reported by bioregion.

Table 6 Fishing effort (days fished) for all rock lobster species obtained from tour operators from 2018/19–2020/21 for potting, diving and total. Data extracted: 24 August 2021.

Season	Fishing effort (days fished)		
	Potting	Diving	Total
2018/19	1,223	243	1,466
2019/20	1,618	258	1,873
2020/21	1,529	175	1,699

3.3 Average weight

3.3.1 *Boat ramp survey*

The overall average weight (in grams) of WRL for boat-based recreational fishers obtained from boat ramp surveys increased from 604.0 g (95% CI 589.2–620.4) in 2018/19 to 651.7 g (624.7–682.0) in 2019/20 (Table 7). In 2020/21, the average weight returned to a similar level to 2018/19 with 587.4 g (570.0–608.0).

Table 7 Overall average weight (in grams) obtained from boat ramp surveys from 2018/19–2020/21 with lower (LCI) and upper (UCI) 95% confidence intervals.

Season	Average weight (grams)		
	Estimate	LCI	UCI
2018/19	604.0	589.2	620.4
2019/20	651.7	624.7	682.0
2020/21	587.4	570.0	608.0

3.3.2 *Tour operators*

The number of length samples recorded in Tour Operator Returns has increased from 3,429 or 20.6% of the retained catch by number in 2018/19 to 10,452 or 32.3% in 2020/21 (Table 8). The overall average weight (in grams) of WRL obtained from tour operators decreased from 569.0 g (95% CI 558.9–579.1) in 2018/19 to 494.9 g (492.2–497.5) in 2020/21.

Table 8 Overall average weight (in grams) of WRL (combined across methods; potting and diving) obtained from tour operators statewide from 2018/19–2020/21. Data extracted: 24 August 2021.

Season	Number of length samples	Average weight (grams)		
		Estimate	LCI	UCI
2018/19	3,429	569.0	558.9	579.1
2019/20	7,716	546.3	541.5	551.2
2020/21	10,452	494.9	492.2	497.5

3.4 Retained catch

3.4.1 *Phone-recall survey*

The overall average weight of WRL obtained from boat ramp surveys (Section 3.3.1) and a correction factor (0.62) were used to convert statewide (Appendix 5) and bioregional (Appendix 6) estimates of the retained catch of WRL by number to weight.

The retained catch of WRL by licensed fishers in 2020/21 was 526 t (95%CI 460–592); of which 79.8% or 420 t (362–478) was harvested by potting and 20.2% or 106 t (68–145) by diving (Table 9). The total catch (potting and diving combined) was steady between all survey years. However, the proportion of catch harvested by potting varied with 81.8% in 2018/19 and 73.3% in 2019/20.

Table 9 Estimated recreational catch (in tonnes) of WRL from licensed fishers by potting, diving and total from 2018/19–2020/21, with harvest ranges (lower and upper 95% confidence intervals).

Season	Retained catch (tonnes)								
	Potting			Diving			Total		
	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI
2018/19	372	328	417	83	64	102	455	409	502
2019/20	382	337	427	139	96	181	521	461	581
2020/21	420	362	478	106	68	145	526	460	592

The majority (77.5%) of the retained catch in 2020/21 was from the Metro-West Coast with 408 t (95%CI 344–472); of which 78.1% or 318 t (264–373) was by potting and 21.9% or 90 t (51–128) by diving (Table 10). Retained catch (total and by method) in the Metro-West Coast was steady between all survey years.

The statewide retained recreational catch (in numbers) of Southern Rock Lobster (*Jasus edwardsii)* and Tropical Rock Lobster species (*Panulirus ornatus* and *P. versicolor*) represent 2.5–5.6% of the total RL catch in each survey year (Appendix 5). These species are taken mainly in the South Coast and North Coast, respectively.

Table 10 Estimated retained recreational catch (in tonnes) of WRL obtained using phone-recall surveys from 2018/19–2020/21 for each region by potting, diving and total, with harvest ranges (lower and upper 95% confidence intervals).

Note: (1) values in bold indicate RSE>0.4; values in italics indicate n<30; (2) due to the number of decimal places in the input parameters and rounding, the values across regions with a year may not sum to the totals at a statewide level.

Region	Retained catch (tonnes)								
	Potting			Diving			Total		
	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI
2018/19									
North	0	0	0	***0***	***0***	***0***	***0***	***0***	***0***
Gascoyne	***5***	***1***	***10***	*3*	*1*	*5*	8	3	13
Mid-West	119	94	143	8	4	11	126	102	151
Metro-West	246	206	285	66	48	83	311	270	353
South	***3***	***0***	***6***	*7*	*2*	*12*	10	4	15
2019/20									
North	0	0	0	***0***	***0***	***0***	***0***	***0***	***0***
Gascoyne	***1***	***0***	***2***	**5**	**0**	**11**	**6**	**1**	**12**
Mid-West	118	94	142	16	8	24	134	109	159
Metro-West	261	222	301	113	75	151	374	320	428
South	*2*	*1*	*3*	4	2	7	6	3	9
2020/21									
North	0	0	0	***0***	***0***	***1***	***0***	***0***	***1***
Gascoyne	***1***	***0***	***3***	*1*	*1*	*2*	3	1	4
Mid-West	98	75	121	8	5	12	107	84	129
Metro-West	318	264	373	90	51	128	408	344	472
South	*2*	*1*	*3*	7	3	11	9	5	13

3.4.2 *Tour operators*

The overall average weight for WRL calculated using tour operator data (Section 3.3.2) was used to convert the statewide retained catch by numbers to weight. The total catch of WRL (by numbers) for Tour Operators is provided in Appendix 7. Where confidentiality permits (*i.e.,* more than three tour operators reported catch), the statewide retained recreational catch of Southern Rock Lobster (*Jasus edwardsii)* and Tropical Rock Lobster species (*Panulirus ornatus* and *P. versicolor*) are also reported.

The retained catch (in tonnes) of WRL from charter fishers increased from 9 t in 2018/19 to 16 t in 2020/21 (Table 11). The majority of the catch was taken by potting

(88.9–93.7%). Catches of WRL by potting increased from 8 t in 2018/19 to 15 t in 2020/21. Catches obtained by diving have remained relatively consistent (1 t).

Due to confidentiality (*i.e.,* the small number of tour operators undertaking trips which involved catching RL species outside of the West Coast Bioregion) tour operator catches cannot be reported by bioregion.

Table 11 Recreational catch (in tonnes) of WRL by potting, diving and total obtained from tour operators from 2018/19–2020/21. Data extracted: 24 August 2021.

Season	Retained catch (tonnes)		
	Potting	Diving	Total
2018/19	8	1	9
2019/20	14	1	15
2020/21	15	1	16

3.5 Recreational Harvest

3.5.1 *Total Allowable Recreational Catch (TARC)*

The TARC for 2018/19 was 506 t (Table 12). The recreational allocation of WRL catch is based on 5–year historic moving averages of the retained catch and the TARC (see Section 2.4). Thus, in 2018/19, the 5–year moving average of retained catch was 427 t and the 5–year moving average of the TARC was 464 t.

The TARC for 2019/20 was 490 t. The 5–year moving average of retained catch for 2019/20 was 468 t and the 5–year moving average of the TARC was 481 t.

The TARC for 2020/21 increased from the previous year up to 533 t. The 5–year moving average of retained catch for 2020/21 was 498 t and the 5–year moving average of the TARC was 503 t.

3.5.2 *Allowable Harvest Level (AHL)*

In 2018/19, 4.6% of the AHL was achieved, which increased to 4.9% in 2019/20 and 2020/21; all of which are below the 5% AHL (Table 12).

Table 12 Total Allowable Recreational Catch (TARC), estimated retained catch (licensed fishers + charter) and proportion of Allowable Harvest Level (AHL) attained since 2012/13.

Note:

1. Percentage of 5-year TARC formula: 100*(Catch 5-year average/TARC 5-year average);
2. Proportion of AHL formula: 5*(5–year moving average retained catch/5–year moving average TARC);
3. n.a. = data not available prior to implementation of quota management.

Season	AHL (t)	TARC (t)	Estimated Retained Catch (t)	TARC 5-year average (t)	Catch 5-year average (t)	Percentage of 5-year TARC (%)	Proportion of AHL (%)
2012/13	6,440	322	125	-	142	-	n.a.
2013/14	7,760	388	243	-	159	-	n.a.
2014/15	8,080	404	330	339	190	55%	2.8%
2015/16	8,440	422	393	365	241	66%	3.3%
2016/17	9,600	480	461^	403	310	77%	3.8%
2017/18*	10,120	507	489^	440	383	87%	4.4%
2018/19*	10,120	506	464^	464	427	92%	4.6%
2019/20*	9,800	490	535^	481	468	97%	4.9%
2020/21	10,650	533	542^	503	498	99%	4.9%

^ includes charter catches from logbooks (prior to 2016/17 charter catch was captured within the recreational catch)

***** The 2017/18 season covers the period 15 October 2017 - 30 June 2018, prior to the recreational fishery being open year-round from 1 July 2018.

****** The 2018/19 season covers the period February 2018 to January 2019. Therefore, 5 months of catch
(February–June 2018) is reported in both the 2017/18 season and the 2018/19 season.

******* The first recreational season that almost complete aligns with the commercial season, being February 2019 to January 2020.

4.0 Discussion

4.1 Participation, fishing effort and retained catch

Recreational fishing for RL has been a licensed activity since the 1970s, with mail-recall surveys used for annual monitoring of this fishery since 1986 (Trinnie et al., 2021). This licence has provided revenue to support recreational fishing and a sampling frame to assist dedicated surveys of this specialised fishery. A transition away from a mail-recall survey was required for a number of reasons, including addressing a declining response rate (26% in 2017/18). The phone-recall surveys achieved this goal by attaining response rates >96%.

Participation in the RL recreational fishery (all species) by licensed fishers (RL licence holders aged five years and older) in 2020/21 (1 February 2020–31 January 2021) was steady at 37,469 fishers (95% CI 35,350–39,587) when compared to previous survey years (*i.e.,* the 95% CI overlapped between survey years). The participation rate in the RL fishery (all species), estimated from the phone-recall survey, was similar between 2018/19–2020/21 (66.6–67.7%). This was consistent with participation estimated for the 2017/18 mail survey (64%) (Trinnie et al., 2021).

Fishing effort (total and by method) was steady from 2018/19–2020/21. In 2020/21, the total estimated fishing effort for RL fishing (all species) was 522,485 days fished (95%CI 491,063–553,907); of which 76.9% or 401,600 (363,338–439,862) was by potting and 23.1% or 120,885 (93,904–147,866) by diving. The greatest effort occurred in the Metro-West Coast, followed by the Mid-West Coast.

The retained catch (by weight) of WRL by licensed fishers was obtained from integrating phone-recall surveys and boat ramp surveys, and was steady from 2018/19–2020/21. In 2020/21 the retained catch was 526 t (95%CI 460–592); of which 79.8% or 420 t (362–478) was harvested by potting and 20.2% or 106 (68–145) by diving. In the context of the time series of retained catches from licensed fishers, which commenced in 1986/87, those in the last 5 years (since 2015/16) have been the highest since data collection commenced (Figure 4). This followed a period of lower catches from 2005/06–2012/13. The increase in catches since 2012/13 have largely been due to higher catches obtained by potting. Although the catches of RL taken by diving have also increased, this has not been to the same extent as potting and therefore the proportion of catch taken by diving has been generally lower from 2013/14 – 2020/21 (16.9–26.7%) when compared to the 25.1–36.8% recorded between 2005/06–2012/13 (Figure 5).

There was a significant increase in participation, fishing effort and retained catch from 2012/13–2016/17 (Trinnie et al., 2021) and these levels have been maintained since 2018/19. There are a number of reasons for these increases including changes to management regulations that have increased opportunities for the recreational sector to access this resource. Several management changes have occurred since 2012/13, including increased pot limits, increased bag limits and extended fishing seasons (Appendix 1). The most recent management changes occurred in July 2018 and included opening the RL fishery for 12-months each year. WRL catches are also

dependent upon a number of biological and environmental factors such as successful puerulus settlement and expected conditions for fishing (Crowe et al., 2013). However, the main reasons for the increase in recreational catch are not only an easing of management regulations, but also increased abundance and size of WRL as a result of the move to a more conservative level of fishing for the commercial sector in the late 2000s which is now targeting maximum economic yield rather than maximum sustainable yield (Caputi et al., 2015; Reid et al., 2013). The increase in size of WRL has been demonstrated by the change in mean weight of WRL caught by licensed fishers since the introduction of boat ramp surveys in 2015/16 (583.8–651.7g) which, although variable between survey years, has been consistently higher than the previously applied constant (500g) (Appendix 8) (Trinnie et al., 2021).

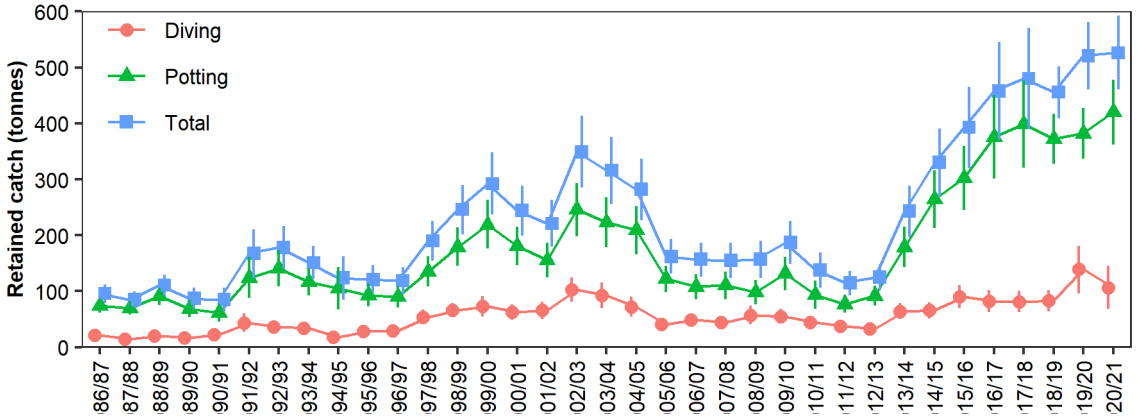

Figure 4 Time series of retained catch (95% Confidence Intervals) of Western Rock Lobster by licensed fishers by potting (green), diving (red) and total (blue) from 1986/87–2020/21. Estimates for 1986/87–2017/18 from Trinnie et al. (2021). Note: A RL licence was required to fish from a charter boat prior to 2016/17 and these catches are included in the retained catch from 1986/87–2016/17.

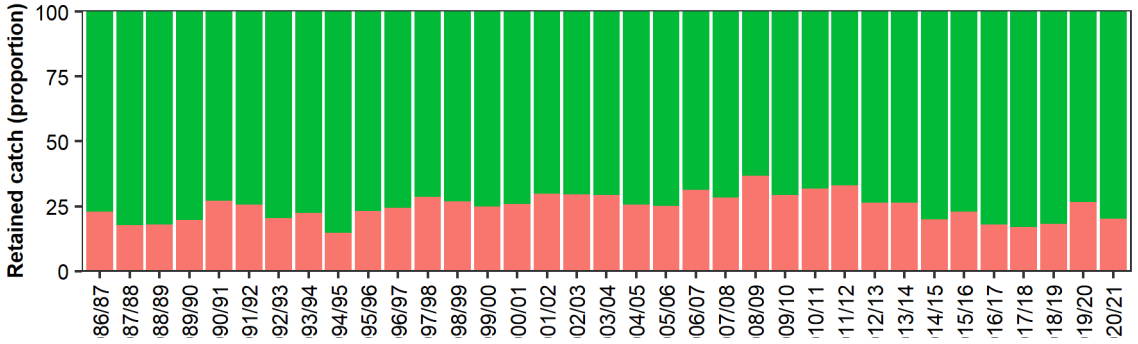

Figure 5 Time series of proportion of estimated recreational catch of Western Rock Lobster by licensed fishers by potting (green) and diving (red) from 1986/87–2020/21. Estimates for 1986/17 to 2017/18 from Trinnie et al. (2021). Note: A RL licence was required to fish from a charter boat prior to 2016/17 and these catches are included in the retained catch from 1986/87–2016/17.

While the number of tour operators participating in RL fishing was similar in 2018/19–2020/21, there was a decline in fishing effort and participation (number of people) in 2020/21, which is likely due to travel restrictions implemented as a result of the COVID-19 pandemic. Interestingly, this trend was not reflected in the retained catch which increased from 9 t in 2018/19 to 16 t in 2020/21. This was another substantial increase from the 3 t in 2016/17 when policy changes were introduced to accommodate catches from charter fishing within the Total Allowable Recreational Catch (Appendix 9). This included removing the requirement for a RL licence to be held when fishing from a tour operator vessel, with this data subsequently being collected via Tour Operator Returns (logbooks). This disconnect between participation, fishing effort and retained catch may be due to a number of reasons such as the diverse and changing behaviour of charter fishers in response to changing policy and other social factors, including travel restrictions due to COVID-19.

A 3-year trial of the most recent changes to RL fishing on tour operator vessels began in November 2019 and includes increases to the number of pots allowed per vessel (from six to 12) as well as increased boat limits (from 24 up to 40 for vessels licensed for six to 10 passengers). New catch reporting requirements are currently being implemented to evaluate the success of this trial and will provide an understanding of the effect of these new regulations on catches from tour operator vessels.

Although every effort is made to ensure that data collected from licensed fishers via phone-recall and boat ramps surveys, as well as returns provided by Tour Operators, are accurate and provided in a timely manner, there may be circumstances where additional QA/QC of data may identify data errors which may only be corrected for outside of the reporting period. Tour Operator returns received after a reporting period will also only be included in subsequent fishing seasons. These factors may lead to some estimates being revised in future reporting.

4.2 Management Implications

The recreational fishery has been managed using a statewide TARC since 2010/11. The TARC in 2020/21 was 533 t, the highest of all previous years. The 5-year average recreational catch (from licensed and charter fishing) in 2020/21 represents an AHL of 4.9%. This proportion has been steadily increasing from 2.8% in 2014/15 towards the 5% allocated to the recreational sector (DoF, 2014; IFAAC, 2010). This increase in AHL was to be expected due to the easing of management regulations, and the conservative level of fishing by the commercial sector which has resulted in increased abundance and size of WRL.

4.3 Future research

This report summarises the results of phone-recall surveys used to capture data on fishing activity from RL licence holders over a 12-month period which closely matches the commercial fishing season. This transition away from the mail surveys, which have been run annually since 1986/87, due to changing management arrangements for the fishery as well as the declining response rate, necessitated a

change to a more robust survey method. This change has provided an opportunity to review the existing methodologies and to develop a revised best-practice approach for estimating the recreational catch of WRL. Additional research underway includes,

- *Comparison of survey modes:* The phone-recall surveys in this report has been conducted concurrently with an online-recall survey to explore the potential for an alternative survey mode to provide estimated recreational catches of WRL, including the development of multi-modal (*i.e.,* multiple method) sampling designs.
- *Comparison of recall period:* The phone-recall surveys in this report used a 12-month recall period to match the RL fishing season (*i.e.,* in February, for recall period from January–previous February). Additional surveys were completed at 3-month intervals between these annual surveys (*i.e.,* in May, August and November) to explore the potential benefits of generating annual estimates based on this shorter recall period.
- *Correction factors (adjustments):* A consistent correction factor is currently applied to catch estimates and further investigation needs to be undertaken to determine appropriate adjustments by method, and also for fishing effort. Recent phone-diary surveys (in 2015/16, 2017/18 & 2020/21) will provide additional survey data from which a relationship between different survey modes can be derived.
- *Average weight:* Boat ramp surveys have been used to provide an average weight for WRL, which is calculated as an arithmetic mean across both fishing methods. These surveys were designed to improve upon the value of 0.5 kg that was applied across all previous years that is not appropriate now as a result of easing recreational management regulations and the conservative level of commercial fishing has resulted in an increase in the mean weight. Analyses include the estimation of separate average weights for each fishing method; potential proxies from other available datasets (*i.e.,* Tour Operator Logbooks, commercial monitoring); design-based estimation of average weight which accounts for the spatial and temporal nature of the current sampling regime; and model-based estimation of average weight which uses linear models to standardise average weight.

The application of this research will subsequently impact on estimates of participation, fishing effort and retained catch (and their uncertainty). Any revisions will be considered as part of the broader review process. It is anticipated that these changes would be implemented only after consultation with managers, scientists and stakeholders with due consideration given to the effects of any changes on the harvest ranges.

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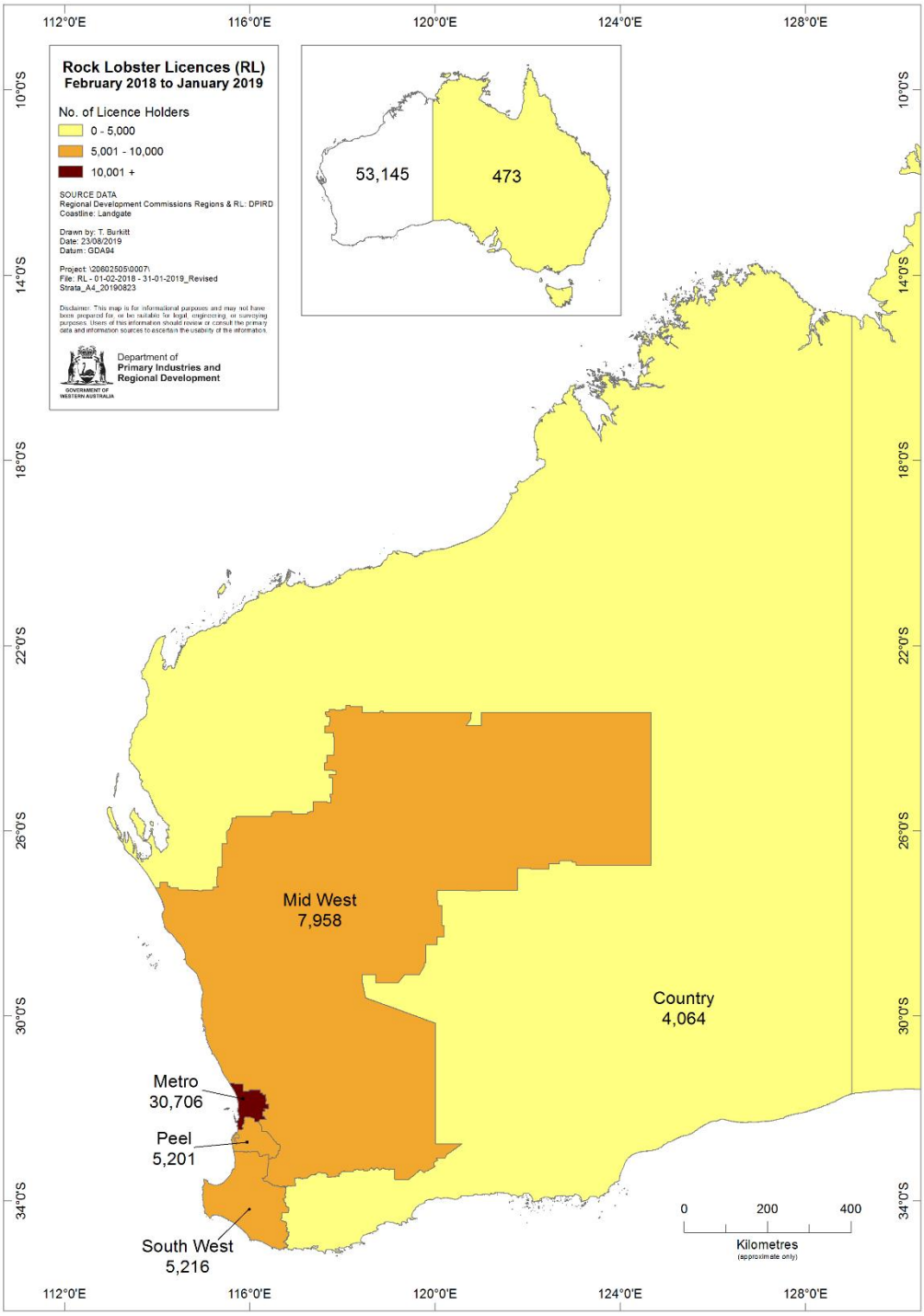
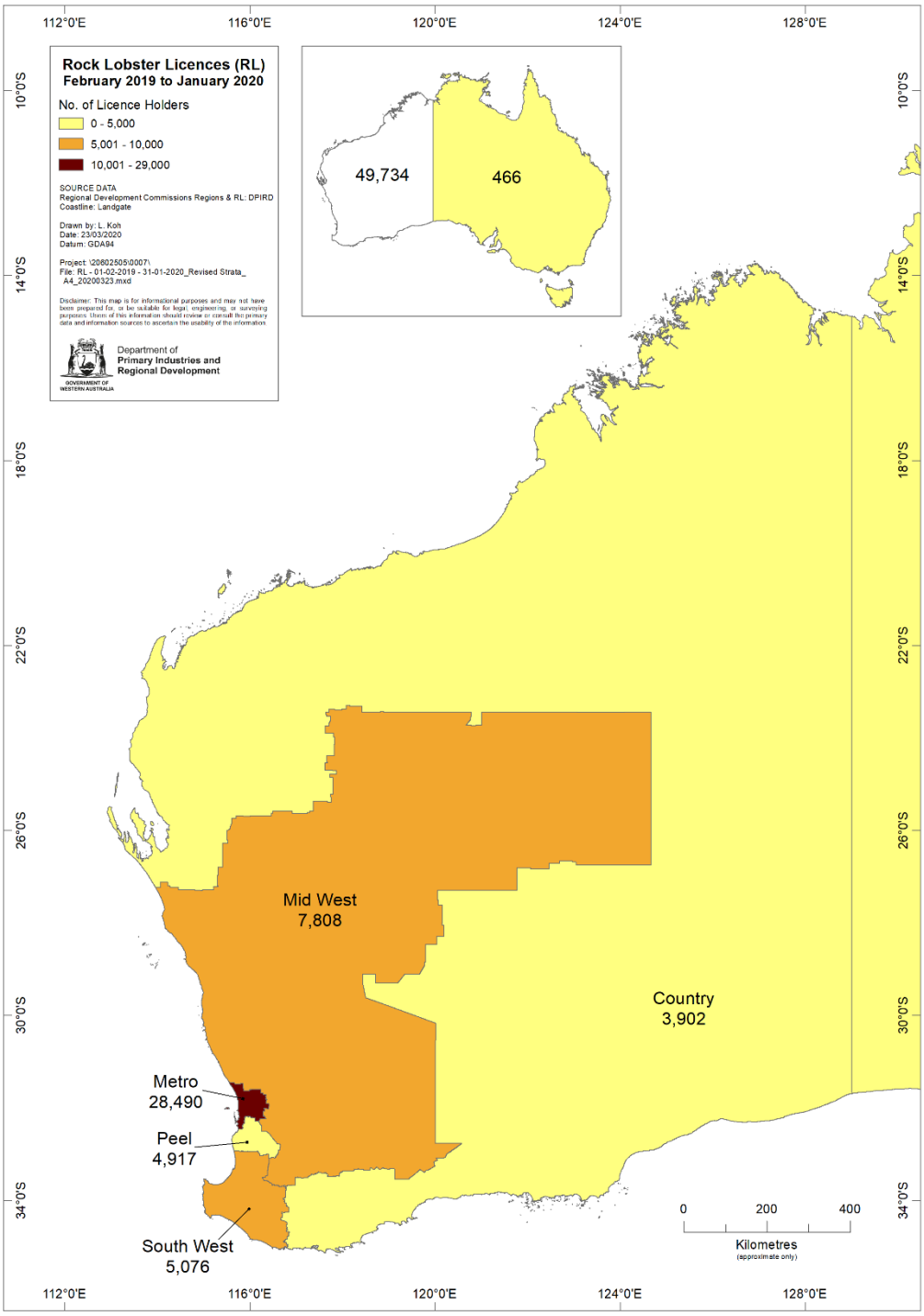
7.0 Appendices

Appendix 1 Management history of the Western Rock Lobster recreational fishery [adapted from Ryan et al. (2016) and Trinnie et al. (2021)].

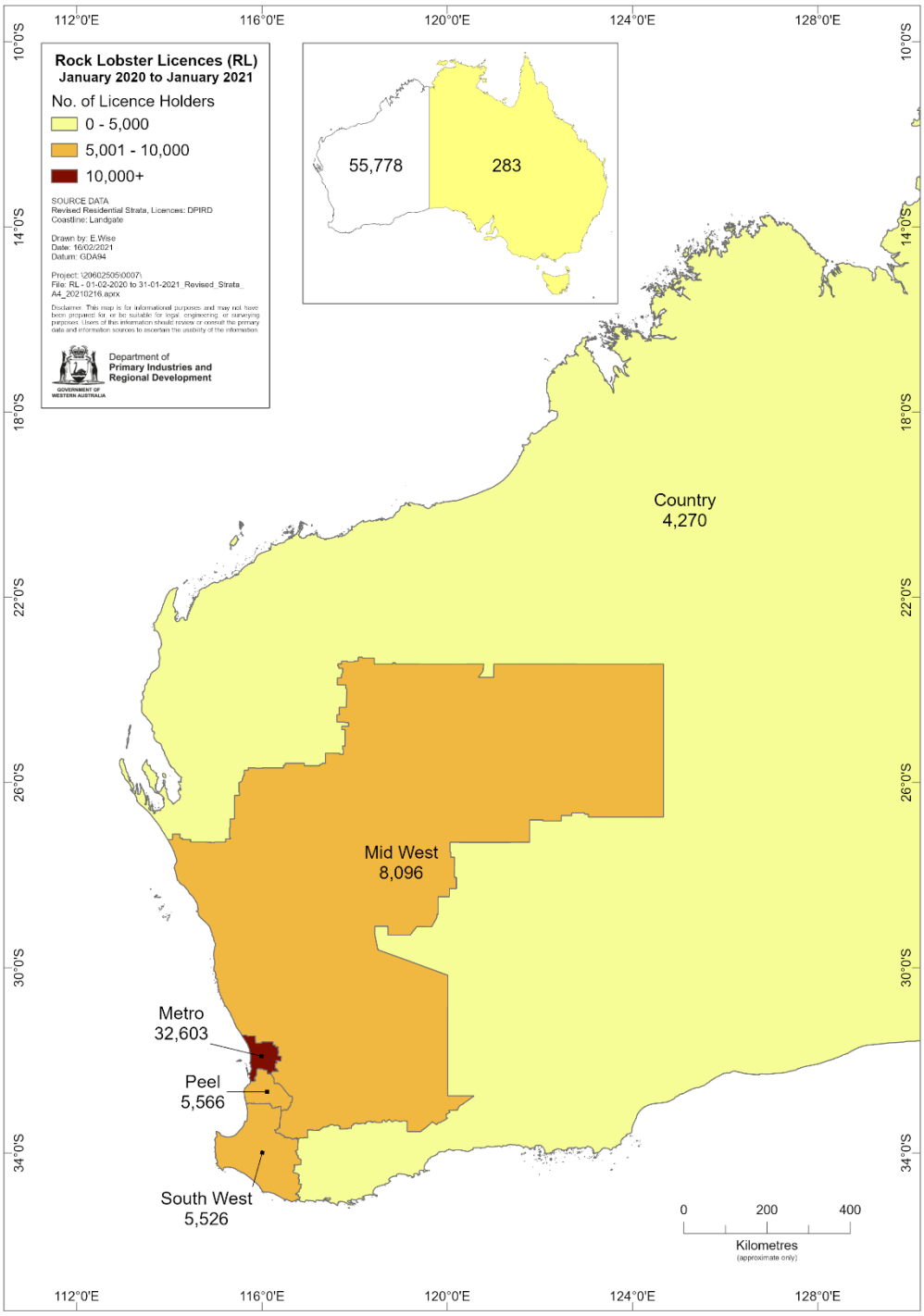
Year	Management
1970s	Lobster recreational fishing licence (for four rock lobster species)
2000/01	Number of licensed fishers per boat unrestricted; open season from 15 November–30 June; WRL to be tail-clipped; night-time fishing prohibited; gear restricted to 2 pots per fisher; escape gaps in pots to allow undersize WRL to escape; diving restricted to hand collection, snare or blunt crook; protection of reproductive females; minimum carapace length of 77 mm (15 November–31 January) and 76 mm (1 February–30 June); daily bag limit of 8 per fisher and boat limit of 16, where 2 or more licensed fishers; exceptions for Abrolhos Islands season from 15 March–30 June and diving not permitted, and Ningaloo Marine Park daily bag limit of 4 and boat limit of 8
2002/03	Maximum carapace length for female WRL larger than 105 mm (above 30S) and 115 mm (below 30°S)
2005/06	Minimum and maximum carapace lengths reflect the WRL commercial fishery
2008/09	Possession limit of 24 per person; daily bag limit decreased to 6 per fisher and boat limit to 12
2009/10	Maximum carapace length for female WRL decreased to 95 mm (above 30S) and 105 mm (below 30S)
2010/11	Escape gaps defined as a minimum height 55 mm and minimum width 305 mm
2011/12	Minimum carapace length decreased from 77 to 76 mm for entire season
2012/13	Number of licensed fishers per boat increased to 3; increase in pots to 6 per boat, where 3 or more licensed fishers; escape gap height in pots decreased to 54 mm; daily bag limit increased to 8 per fisher and boat limit to 24 where 3 or more licensed fishers; removal of prohibition on diving at Abrolhos Islands
2013/14	Season from 15 October–30 June, except Abrolhos Islands
2016/17	Tour operators permitted to use rock lobster pots as part of the activities undertaken on a fishing tour. Other changes to licensed fishing tours include RL licence not required by a person fishing for rock lobster on a fishing charter boat; maximum of 8 per person, with a boat limit of 24 lobster per trip when there are 3 or more persons on board; up to 6 pots permitted; fishing for RL permitted year around; RL may only be consumed on a fishing tour (Restricted Fishing Tour Operators only).
2017/18	Season open for 12-months (commencing July 2018), noting a transition (or overlap) with the new fishing season occurred from February–June 2018. Pots are permitted to be shared between 2 licensed fishers.
2018/19	New fishing season from February–January in each year, commencing in February 2018.
2019/20	3-year trial commences in November 2019 for selected Tour Operator vessels. Changes include; increase in number of pots allowed per vessel (from 6 to 12 per trip), increased boat limits (from 24 up to 40 for vessels licensed for six to 10 passengers and from 24 up to 80 for vessels licenced for more than 10 passengers); permission for rock lobster to be stored on board within their associated boat limit and permission for Tour Operators to pull, move, set and boat rock lobster pots outside a fishing tour in order to provide a better experience for patrons.



Appendix 2 Number of RL holders within the modified Regional Development Commission Boundaries from 1 February 2018 to 31 January 2019. Note: country total includes interstate RL holders.



Appendix 3 Number of RL holders within the modified Regional Development Commission Boundaries from 1 February 2019 to 31 January 2020. Note: country total includes interstate RL holders.



Appendix 4 Number of RL holders within the modified Regional Development Commission Boundaries from 1 February 2020 to 31 January 2021. Note: country total includes interstate RL holders.

Appendix 5 Statewide *unadjusted* estimated retained recreational catch (in numbers) of Western Rock Lobster (*Panulirus cygnus*), (Southern Rock Lobster (*Jasus edwardsii)* and Tropical Rock Lobster species (*Panulirus ornatus* and *P. versicolor*) obtained during phone-recall surveys from 2018/19 – 2019/20 for potting, diving and total (combined methods).

Note:

1. these estimates have not been adjusted to account for biases in survey methods
2. values in bold indicate RSE>0.4; values in italics indicate n<30.

Season	Retained catch (numbers)								
	Potting			Diving			Total		
	Estimate	LCI	UCI	Estimat	LCI	UCI	Estimate	LCI	UCI
Western Rock Lobster (*Panulirus cygnus*)									
2018/19	994,540	875,070	1,114,009	221,801	171,455	272,147	1,216,341	1,092,901	1,339,780
2019/20	946,113	834,728	1,057,499	343,103	237,393	448,812	1,289,216	1,140,229	1,438,203
2020/21	1,152,621	993,683	1,311,559	292,408	186,425	398,391	1,445,029	1,263,542	1,626,517
Tropical Rock Lobster (*Panulirus ornatus* and *P. versicolor*)*									
2018/19	0	0	0	13,587	6,667	20,506	13,587	6,668	20,505
2019/20	0	0	0	14,978	10,176	19,780	14,978	10,187	19,769
2020/21	0	0	0	13,890	8,583	19,198	13,890	8,594	19,187
Southern Rock Lobster (*Jasus edwardsii*)									
2018/19	***12,616***	***0***	***27,768***	***3,023***	***0***	***6,700***	**15,639**	**57**	**31,220**
2019/20	***15,381***	***1,835***	***28,926***	3,170	1,214	5,126	18,551	4,660	32,442
2020/21	***36,131***	***4,900***	***67,362***	8,823	1,972	15,673	44,954	13,019	76,889

Appendix 6 Regional *unadjusted* estimated retained recreational catch (in numbers) of Western Rock Lobster (*Panulirus cygnus*) obtained during phone-recall surveys in from 2018/19 - 2019/20 for potting, diving and total (combined methods).

Note:

1. these estimates have not been adjusted to account for biases in survey methods
2. values in bold indicate RSE>0.4; values in italics indicate n<30.
3. due to the number of decimal places in the input parameters and rounding, the values across regions with a year may not sum to the totals at a statewide level.

Region	Retained catch (numbers)								
	Potting			Diving			Total		
	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI
2018/19									
North	0	0	0	***108***	***0***	***317***	***108***	***0***	***317***
Gascoyne	***14,473***	***1,699***	***27,248***	*7,532*	*2,786*	*12,278*	22,005	8,383	35,628
Mid-West	316,765	251,074	382,456	20,051	10,767	29,334	336,816	271,071	402,560
Metro-West	656,359	550,824	761,893	175,405	127,931	222,878	831,763	720,702	942,824
South	***6,943***	***0***	***14,845***	*18,705*	*6,013*	*31,397*	25,648	10,829	40,467
2019/20									
North	0	0	0	***389***	***0***	***817***	***389***	***0***	***818***
Gascoyne	***1,934***	***0***	***4,340***	**13,402**	**450**	**26,355**	**15,336**	**2,169**	**28,503**
Mid-West	292,535	232,795	352,275	39,082	18,611	59,553	331,617	269,145	394,089
Metro-West	647,026	549,177	744,874	279,390	184,453	374,328	926,416	792,727	1,060,106
South	*4,619*	*1,298*	*7,940*	10,839	4,746	16,932	15,458	8,542	22,374
2020/21									
North	0	0	0	***700***	***0***	***1,537***	***700***	***0***	***1,538***
Gascoyne	***3,342***	***0***	***6,955***	*3,658*	*1,603*	*5,714*	7,000	2,841	11,159
Mid-West	269,404	207,005	331,802	23,142	12,383	33,901	292,546	229,854	355,238
Metro-West	874,397	724,492	1,024,301	245,865	140,745	350,986	1,120,262	945,229	1,295,295
South	*5,479*	*1,740*	*9,218*	19,042	8,260	29,824	24,521	13,197	35,845

Appendix 7 Statewide retained recreational catch (in numbers) of Western Rock Lobster (*Panulirus cygnus*), Southern Rock Lobster (*Jasus edwardsii)* and Tropical Rock Lobster species (*Panulirus ornatus* and *P. versicolor*) from 2018/19–2020/21 for potting, diving and total from Tour Operator Returns.

Season	Retained catch (numbers)		
	Potting	Diving	Total
Western Rock Lobster (*Panulirus cygnus*)			
2018/19	14,742	1,862	16,604
2019/20	24,860	1,677	26,537
2020/21	31,043	1,304	32,347
Tropical Rock Lobster (*Panulirus ornatus* and *P. versicolor*)			
2018/19	<3 operators		45
2019/20	<3 operators		65
2020/21	<3 operators		30
Southern Rock Lobster (*Jasus edwardsii*)			
2018/19	<3 operators		
2019/20	<3 operators		
2020/21	<3 operators		

Appendix 8 Timeline of estimated recreational catch (in tonnes) from licensed fishers by potting, diving and total from 1986/87–2020/21, with harvest ranges (lower and upper 95% confidence intervals).

Note:

1. Data for 1986/87–2017/18 were collected using mail surveys (Trinnie et al., 2021);
2. Average weight for 1986/87–2014/15 was a constant value of 500g (Trinnie et al., 2021);
3. A RL licence was required to fish from a charter boat prior to 2016/17 and these catches are included in the retained catch from 1986/87–2016/17.

Season	Avg wt	Retained catch (tonnes)								
		Potting			Diving			Total		
		Estimate	LCI	UCI	Estimate	LCI	UCI	Estimat	LCI	UCI
1986/87	500	74	61	87	22	18	26	96	79	112
1987/88	500	70	58	82	15	12	17	85	71	99
1988/89	500	91	75	106	20	16	24	111	92	129
1989/90	500	69	53	85	17	12	23	87	68	106
1990/91	500	62	45	78	23	15	32	85	64	106
1991/92	500	124	88	161	43	27	60	168	124	211
1992/93	500	141	109	173	36	26	47	178	140	216
1993/94	500	117	92	141	34	26	43	151	121	181
1994/95	500	105	67	143	18	12	24	124	84	163
1995/96	500	93	73	113	28	20	36	121	97	146
1996/97	500	90	71	109	29	22	36	119	95	143
1997/98	500	135	109	162	54	42	67	190	154	225
1998/99	500	179	145	214	66	53	79	246	201	290
1999/00	500	219	176	263	73	55	91	292	237	348
2000/01	500	181	146	215	63	49	77	244	199	289
2001/02	500	156	125	186	66	50	81	221	180	263
2002/03	500	246	198	293	103	81	125	349	285	413
2003/04	500	223	179	268	93	70	115	316	255	376
2004/05	500	209	166	252	72	55	90	282	227	337
2005/06	500	122	98	145	41	32	50	162	132	193
2006/07	500	108	86	130	49	37	60	157	126	187
2007/08	500	111	86	135	44	34	54	155	124	187
2008/09	500	98	76	120	57	41	74	157	124	190
2009/10	500	132	102	161	55	43	68	187	149	225
2010/11	500	94	68	119	44	32	56	138	106	169
2011/12	500	77	61	92	38	29	46	115	93	136
2012/13	500	92	74	110	33	26	40	125	102	148
2013/14	500	179	143	215	64	50	79	243	197	289

Season	Avg wt	Retained catch (tonnes)								
		Potting			Diving			Total		
		Estimate	LCI	UCI	Estimate	LCI	UCI	Estimat	LCI	UCI
2014/15	500	264	213	316	66	51	80	330	269	391
2015/16	583.8	302	245	360	90	70	111	393	320	465
2016/17	578.8	376	301	450	82	63	102	458	371	545
2017/18	573.8	399	321	476	81	63	100	480	390	570
2018/19	604.0	372	328	417	83	64	102	455	409	502
2019/20	651.7	382	337	427	139	96	181	521	461	581
2020/21	587.4	420	362	478	106	68	145	526	460	592

^ The 2018/19 season covers the period February 2018 to January 2019. Therefore, 5 months of catch (February–June 2018) is reported in both the 2017/18 season and the 2018/19 season. This overlap accounted for 33% (152 t) of the retained catch estimated from the phone survey in the 2018/19 season.

Appendix 9 Timeline of retained catch (in tonnes) from charter fishers by potting, diving and total from 2016/17–2020/21, with harvest ranges (lower and upper 95% confidence intervals).

Note:

1. Data extracted from tour operator database on 24 August 2021;
2. Charter catch prior to 2016/17 was captured within the recreational catch;
3. Average weight calculated using random length samples reported on Tour Operator Returns within each season and converted to weight using a length-weight equation.

Season	Avg wt	Retained catch (tonnes)		
		Potting	Diving	Total
2016/17	593.9	2	1	3
2017/18	593.9	8	1	9
2018/19^	569.0	8	1	9
2019/20	546.3	14	1	15
2020/21	494.9	15	1	16

^ The 2018/19 season covers the period February 2018 to January 2019. Therefore, 5 months of catch (February–June 2018) is reported in both the 2017/18 season and the 2018/19 season. This overlap in reporting periods accounted for 48% (4.5 t) of the retained catch from tour operator returns in the 2018/19 season.