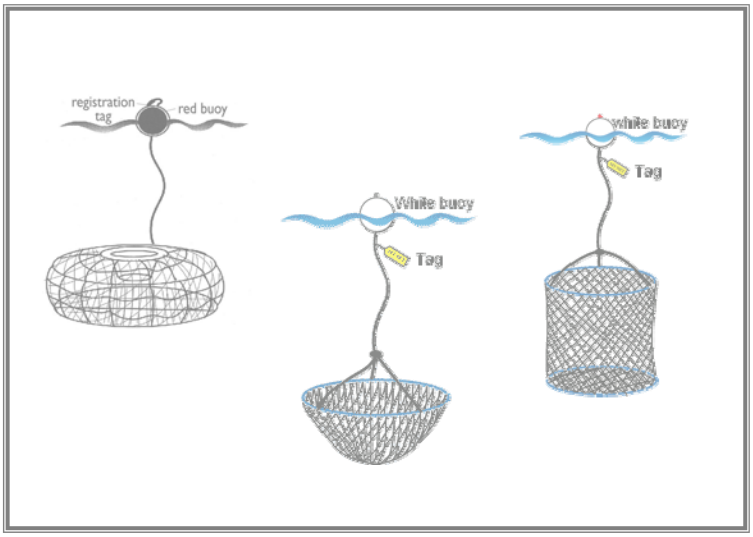
Report for PIRSA Fisheries

Survey of Recreational Rock Lobster Fishing in South Australia during 2004/05



D.R. Currie, Sorokin S.J. and T.M. Ward

January 2006

SARDI Aquatic Sciences Publication No. RD04/0228-2
SARDI Research Report Series No. 123

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SARDI Aquatic Sciences Publication No. RD04/0228-2
SARDI Research Report Series No. 123

Printed in Adelaide January 2006.

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Date: 25th January 2006
Distribution: PIRSA Fisheries, South Australian Rock Lobster Fishery Management Committee, SARDI Aquatic Sciences Library
Circulation: Public Domain

TABLE OF CONTENTS

LIST OF FIGURES ..... **IV**

LIST OF TABLES ..... **IV**

LIST OF APPENDICES ..... **V**

EXECUTIVE SUMMARY ..... **VI**

1 INTRODUCTION **1**

1.1 OVERVIEW 1
1.2 DESCRIPTION OF THE FISHERY 1

2 METHODS **2**

2.1 POTTER SURVEY METHODOLOGY 2
2.2 SAMPLE 2
2.3 DIARY MAIL-OUT 2
2.4 TELEPHONE CONTACT 3
2.5 ANALYSIS 3
2.5.1 Monthly catch and effort estimates *3*
2.5.2 Expansion of monthly estimates *4*
2.5.3 Fishing season estimates *4*

3 RESULTS **5**

3.1 SEASONAL REGISTRATIONS 5
3.2 SURVEY PARTICIPATION 6
3.2.1 Fishing by zone *7*
3.3 POTTERS 7
3.3.1 Total effort *7*
3.3.2 Spatial and temporal patterns in effort *7*
3.3.3 Trips by each fisher *10*
3.3.4 Total harvest *11*
3.3.5 Mean weight *12*
3.3.6 Estimated total harvest (by weight) *12*
3.3.7 Harvest per unit effort (HPUE) *13*
3.3.8 Daily harvest per fisher *14*
3.3.9 Annual harvest per fisher *15*
3.3.10 Sex ratio of harvest *16*
3.3.11 Number of under-size lobster caught. *17*
3.3.12 Numbers of other lobster returned to the water *17*
3.4 DROP-NETTERS 17
3.4.1 Effort *17*
3.4.2 Harvest *18*
3.4.3 Drop-netters versus potters *18*
3.5 DIVERS 19
3.5.1 Effort *19*
3.5.2 Mean weight of lobsters *19*
3.5.3 Estimated harvest *19*

4 DISCUSSION **20**

5 REFERENCES **23**

6 ACKNOWLEDGEMENTS **24**

LIST OF FIGURES

FIGURE 1. NUMBERS AND HOME POSTAL STATE/TERRITORY OF ROCK LOBSTER POTTERS REGISTERED TO FISH RECREATIONALLY FOR ROCK LOBSTER IN SOUTH AUSTRALIA DURING THE 2004/05 SEASON. PROPORTION OF LICENCES RELATIVE TO THE AUSTRALIAN TOTAL (5773) ARE PROVIDED IN BRACKETS IN THE LEGEND. 5
FIGURE 2. DISTRIBUTION OF RECREATIONAL ROCK LOBSTER LICENCES BY REGISTERED POSTCODE IN SOUTH AUSTRALIA AND VICTORIA DURING THE 2004/05 SEASON. REGISTRATION NUMBERS ARE REPRESENTED BY THE DIAMETER OF THE RED-FILLED CIRCLES. 6
FIGURE 3. DIAGRAMMATIC SUMMARY DETAILING PARTICIPATION RATES IN THE 2004/05 RECREATIONAL ROCK LOBSTER SURVEY. 7
FIGURE 4. DISTRIBUTION OF RECREATIONAL LOBSTER CATCH AND FISHING EFFORT DURING THE 2004/05 FISHING SEASON. BAR LENGTHS HERE REPRESENT RELATIVE EFFORT/HARVEST FOR EACH FISHING REGION (NUMBERED) AS A PERCENTAGE OF THE STATEWIDE TOTAL (SEE TABLE 3). 9
FIGURE 5. SEASONAL FISHING EFFORT (POTLIFTS) BY FISHING ZONE DURING 2004/05. ERROR BARS SHOW THE STANDARD ERROR OF THE MONTHLY ESTIMATE. 10
FIGURE 6. DISTRIBUTION OF THE NUMBER OF TRIPS FOR ALL RESPONDENTS DURING THE 2004/05 FISHING SEASON. NOTE SOLID BARS DENOTE NUMBER OF FISHERS WHILE SMALL FILLED CIRCLES REPRESENT THE CUMULATIVE TOTAL. 10
FIGURE 7. DISTRIBUTION OF POTTING TRIPS PER FISHER IN THE A) SOUTHERN ZONE, AND B) NORTHERN ZONE IN THE 2004/05 SEASON. NOTE THAT DATA FOR POTTERS WHO DID NOT FISH HAVE BEEN EXCLUDED. 11
FIGURE 8. SEASONAL HARVEST (NUMBER OF LOBSTER) BY POTTERS IN EACH FISHING ZONE DURING 2004/05. ERROR BARS SHOW THE STANDARD ERROR OF THE MONTHLY ESTIMATE. 12
FIGURE 9. MONTHLY HARVEST RATES (LOBSTERS / POTLIFT) BY POTTERS IN EACH FISHING ZONE DURING 2004/05. 13
FIGURE 10. MONTHLY HARVEST RATES (KG / POTLIFT) BY POTTERS IN EACH FISHING ZONE DURING 2004/05. 13
FIGURE 11. DISTRIBUTION OF DAILY LOBSTER HARVESTS IN THE A) SZ AND B) NZ DURING THE 2004/05 FISHING SEASON. NOTE SOLID BARS DENOTE NUMBER OF FISHING TRIPS WHILE SMALL FILLED CIRCLES REPRESENT THE CUMULATIVE TOTAL. 14
FIGURE 12. DISTRIBUTION OF THE ANNUAL LOBSTER HARVEST PER FISHER IN THE A) SOUTHERN ZONE AND B) NORTHERN ZONE DURING THE 2004/05 FISHING SEASON. NOTE SOLID BARS DENOTE NUMBER OF FISHERS WHILE SMALL FILLED CIRCLES REPRESENT THE CUMULATIVE TOTAL. 15
FIGURE 13. COMPARISON OF THE CUMULATIVE CONTRIBUTION OF FISHERS TO THE OVERALL HARVEST (BOTH ZONES COMBINED). 16
FIGURE 14A. PROPORTION OF MALE AND FEMALE LOBSTERS HARVESTED EACH MONTH BY RECREATIONAL POTTERS IN THE SOUTHERN ZONE DURING THE 2004/05 SEASON. 16
FIGURE 14B. PROPORTION OF MALE AND FEMALE LOBSTERS HARVESTED EACH MONTH BY RECREATIONAL POTTERS IN THE NORTHERN ZONE DURING THE 2004/05 SEASON. 17
FIGURE 15. STATEWIDE HARVEST RATES FOR LOBSTER CAUGHT BY REGISTERED FISHERS USING POTS AND DROP/HOOP NETS DURING 2004/05. 18
FIGURE 16. PLOTS OF INTER-SEASONAL DIFFERENCES IN A) RECREATIONAL ROCK LOBSTER CATCH, B) FISHING EFFORT, AND C) HARVEST PER UNIT EFFORT IN DIFFERENT FISHING ZONES (NORTHERN AND SOUTHERN), AND SOUTH AUSTRALIA AS A WHOLE. 21

LIST OF TABLES

TABLE 1. TOTAL NUMBER OF RECREATIONAL ROCK LOBSTER REGISTRATIONS CURRENT EACH MONTH BETWEEN OCTOBER 2004 AND MAY 2005. 5
TABLE 2. EFFORT AND HARVEST SUMMARY FOR RECREATIONAL ROCK LOBSTER POTTERS IN SOUTH AUSTRALIA BETWEEN OCTOBER 2004 AND MAY 2005. RSE = RELATIVE STANDARD ERROR. 8
TABLE 3. REGIONAL DISTRIBUTION OF EFFORT AND HARVEST. (SEE APPENDIX 4 FOR REGION CODES) 9
TABLE 4. WEIGHT, NUMBER AND MEAN WEIGHT OF LOBSTERS HARVESTED BY RECREATIONAL ROCK LOBSTER POTTERS DURING THE 2004/05 FISHING SEASON. 12
TABLE 5. MONTHLY LOBSTER CATCH AND FISHING EFFORT DURING 2004/05 BY DIARISTS USING DROP/HOOP NETS. 18
TABLE 6. NUMBER OF DIVES UNDERTAKEN BY RECREATIONAL LICENCE HOLDERS TARGETING ROCK LOBSTER DURING THE 2004/05 FISHING SEASON. 19

LIST OF APPENDICES

APPENDIX 1. COPY OF THE MAIL-OUT COVER LETTER DISTRIBUTED TO ALL LICENSED RECREATIONAL ROCK LOBSTER FISHERS AT THE START OF THE 2004/05 SEASON. 25
APPENDIX 2. COVER AND FIRST PAGE OF THE SURVEY DIARY DISTRIBUTED TO ALL LICENSED RECREATIONAL ROCK LOBSTER FISHERS AT THE START OF THE 2004/05 SEASON. 26
APPENDIX 3. INFORMATION BROCHURE DISTRIBUTED TO ALL RECREATIONAL LICENCE HOLDERS AT THE START OF THE 2004/05 FISHING SEASON OUTLINING SIMPLE METHODS FOR DETERMINING LOBSTER SIZE AND SEX. 27
APPENDIX 4. MAP SHOWING THE DISTRIBUTION OF REGIONAL FISHING CODES FOR SOUTH AUSTRALIA USED TO SUMMARISE RECREATIONAL LOBSTER CATCH AND EFFORT DATA. 28

EXECUTIVE SUMMARY

1. Recreational rock lobster fishers licensed to fish in South Australia were surveyed during the 2004/05 fishing season.

2. The sample population was drawn from the PIRSA Fisheries licensing database in September 2004, and included all fishers with registrations current at this time.

3. The number of registrations was 2474 at the start of the fishing season in October 2004. This increased to 5773 by May 2005.

4. Most potters licensed during 2004/05 were registered in South Australia (87%) and Victoria (12%), with registrations in New South Wales, Queensland, Western Australia and the Northern Territory collectively accounting for the residual (1%).

5. A diary kit explaining the survey was distributed by mail to 2077 registered potters.

6. A total of 1484 registered potters agreed to participate in the survey, representing 71% of the total number of registrations at the start of the season.

7. Participants recorded information on their lobster potting activities for the full season in diaries, and were contacted approximately once per month during the season by trained telephone interviewers who recorded details of their fishing activities.

8. Approximately 65% of registered potters fished during the 2004/05 season, while the remaining 35% did not fish during this period.

9. Approximately 45% of registered potters fished only in the SZ, 18.5% fished only in the NZ, and 1.6% fished in both zones.

10. Most potters (60%) harvested relatively few lobsters (<20) over the season, but a small proportion of potters (8%) caught a large number of lobsters (>100). Overall, 80% of fishers took 35% of the catch, while 20% of fishers took the residual 65% of the catch.

11. It was estimated that there were 96,160 potlifts during the fishing season, with 69,769 (73%) in the SZ and 26,391 (27%) in the NZ.

12. Potting effort was strongly seasonal and was highest in both zones during January, when approximately 30% of the seasonal SZ effort and 38% of the seasonal NZ effort was expended.

13. The total number of lobsters harvested from pots during the 2004/05 season was estimated at 69,368 (SE ± 11,791) lobsters, with 60,379 (87%) taken in the SZ and 8,989 (13%) taken in the NZ.

14. The number of lobsters harvested from pots during 2004/05 was 34% lower than in 2001/02. This result is likely due to declining registration numbers and associated reductions in potting effort.

15. Catch rates (HPUE) by recreational potters have increased in the SZ (0.77 to 0.86 lobster/potlift) and decreased in the NZ (0.57 to 0.34 lobster/potlift) since 1998/99. These trends are consistent with patterns observed in the commercial fishery.

16. The total pot harvest weight during 2004/05 was estimated at 83,175 kg, with 74,615 kg (90%) taken in the SZ and 8,560 kg (10%) taken in the NZ.

17. A total of 47 (3.2%) of the registered potters that participated in the survey also used drop/hoop nets. Recreational potters that used drop/hoop nets caught 1.1 lobsters per net lift, whereas the same fishers caught only 0.9 lobsters per pot lift using registered pots.

18. Registered potters were estimated to have harvested a total of approximately 1,500 lobsters weighing 2,103 kg using drop/hoop nets during 2004/05.

19. A total of 26 (1.8%) registered potters that participated in the survey also harvested lobsters by diving.

20. Registered potters were estimated to have caught approximately 1000 lobsters by diving during 2004/05, weighing approximately 1,421 kg.

21. The combined recreational catch by licensed recreational fishers using pots, drop/hoop nets and diving gear was estimated to be 86,699 kg (= 3.6% of the State TACC).

22. The total estimated harvest by licensed recreational fishers in this survey is an underestimate of the total recreational catch of rock lobsters in South Australia, as it does not include the harvests of recreational divers, drop/hoop netters without registered pots, or fishers using other gear types. Future studies need to include concurrent surveys of all recreational fishing sectors if management triggers for recreational lobster catch (>4.5% of the State TACC) are to be unambiguously assessed.

1 INTRODUCTION

1.1 Overview

The Department of Primary Industries and Resources, South Australia (PIRSA) commissioned SARDI Aquatic Sciences to undertake a survey of recreational rock lobster catch and fishing effort during 2004/05. The survey is telephone and diary based and follows the same study design from previous studies conducted during the 1998/99 and 2001/02 fishing seasons (McGlennon, 1999; Venema, *et al*., 2003). In addition to catch and effort data recorded in previous surveys, this survey includes detailed information on the size and sex of lobsters harvested and released, and thus provides increased levels of precision in the quantity and composition of the resource.

1.2 Description of the Fishery

The Rock Lobster fishery in South Australia targets the Southern Rock Lobster *Jasus edwardsii* (formerly *J. novaehollandiae*). The Southern Rock Lobster has a distribution from Dongara in Western Australia, to Coffs Harbour in New South Wales, around Tasmania and also New Zealand (Edgar, 2000).

The commercial fishery in South Australia is divided into two management zones: the Northern Zone (NZ) with scattered granite reef habitats, extends from longitude 139ºE west to the Western Australia border and includes Kangaroo Island (Lewis, 1981a); the Southern Zone (SZ) with mainly limestone substrate, extends from longitude 139ºE east to the Victorian border (Lewis, 1981b).

Recreational fishing follows the same season as the commercial fishery, and runs from 1 November to 31 May in the NZ, and 1 October to 30 April in the SZ (PIRSA 2001). During this study, the SZ season was extended on a trial basis to 31 May 2005.

Recreational fishers can use a variety of harvesting methods, including pots, drop nets, hoop nets, diving and bait sticks, however regulations for the recreational catch are in place to ensure the long-term health of lobster stocks. Legal sizes for catch are different in each zone (carapace length NZ = 105mm; SZ =98.5mm), and a maximum of 4 lobsters per person or 8 lobsters per boat may be taken each day (PIRSA, 2001). All rock lobster caught by recreational fishers must have the centre tail fan clipped to a recognisable straight line before landing, to allow compliance officers to identify recreational catches. A recreational possession limit of 15 lobsters per person is in place. Other management controls include restrictions on the harvesting of berried females, limits on the size and number of pots used, and the prohibition of fishing in reserve areas.

The total catch of rock lobsters taken by the recreational sector is capped at 4.5% of the total state-wide catch (commercial and recreational). If the total recreational catch is estimated to have reached or exceeded 4.5% of the total catch, PIRSA Fisheries will enter the open market in the following season to lease quota or pots from the commercial sector to offset the estimated recreational over catch (Venema *et al.*, 2003).

2 METHODS

2.1 Potter Survey Methodology

The potter survey was conducted as a combination telephone/diary survey based on the method used by McGlennon (1999). This method of respondent management and information collection has proven superior to mail-back diaries in terms of response rates, reducing respondent burden and enhancing data quality (Venema *et al*., 2003). The same method was also the basis for the first National Recreational and Indigenous Fishing Survey (NRIFS) carried out in 2000/01 (Henry and Lyle, 2003).

The sampling frame used was the database of registered pot holders held by PIRSA Fisheries as of the 25th of September 2004 (i.e. immediately prior to the commencement of the 2004/05 fishing season on the 1st of October). This database contained only those registrations current on this date.

We aimed to obtain data from approximately one-third of the 2004/05 registrations. As PIRSA Fisheries estimated that there could be about 6000 registrations, a target sample-size was initially set at 2000 registrations (a similar number to that targeted during the 2001/02 survey).

2.2 Sample

A database query on the 25th of September 2004 generated a list of 2086 active registrations. Nine of the registrant had no telephone contact details and were subsequently omitted. No other sub-sampling was undertaken and 2077 registrants were included in the survey.

2.3 Diary Mail-Out

A diary kit was distributed to all 2077 potters. This kit included a cover letter explaining the survey (Appendix 1), a diary for recording catch and effort statistics (Appendix 2), a brochure on legal catch methods, a ruler, and a brochure on how to measure and determine the sex of any lobsters caught (Appendix 3).

An attempt was made to contact all 2077 registered potters by telephone within two weeks of the initial mail-out. This was done to ensure that the diary kits had been received and to explain their use to all who agreed to participate in the survey.

All willing participants were asked to record the following information related to their fishing activity:

- Date of fishing.
- Location of fishing (regional block).
- Fishing method (e.g. pots or drop/hoop nets), gear number and platform.
- Number, sex and length of lobster caught and kept (harvested).
- Number, sex and length of lobster caught released.
- Fishing effort (time pots spent in water).

2.4 Telephone Contact

Four interviewers conducted the telephone survey. All had previously participated in either or both of the 2000/01 South Australian Recreational Rock Lobster Survey and the National Recreational and Indigenous Fishing Survey, and had a thorough understanding of the survey methods and the fishing methods used by the registered potters. Each of the four interviewers was randomly allocated a primary telephone contact listing of ~520 registered potters.

Each telephone number on the interviewers list was dialled, however disconnected or wrong number and associated registrants had to be excluded from the survey. If the registered potter did not answer on the first attempt, the number was rung again on three additional occasions at different times of the day. If the potter could not be contacted in this way he/she was classified as non-contact and was not rung subsequently.

Interviewers phoned contactable/willing participants (diarists) at approximately monthly intervals during the season and recorded their diarised information. The frequency of the ongoing calls was adjusted to reflect the level of fishing activity of each respondent.

2.5 Analysis

2.5.1 Monthly catch and effort estimates

The analytical procedure for a systematic random sample follows Pollock *et al*. (1994). The variables analysed were: 1) number of potlifts per diarist per month; 2) number of lobster harvested per diarist per month; and 3) weight of lobsters harvested per diarist per month. Weights were derived from individual length measurement using the conversion factor proposed by Dr. Rick McGarvey (SARDI Aquatic Sciences).

$$Wt(g) = 0.000483 * L^3(mm) \tag{1.1}$$

Diarists who were licensed in 2004/05 but considered themselves unlikely to fish were included in all analyses. These were treated as expending zero effort and therefore producing zero harvest.

For K(=4) independent systematic random samples, the overall (systematic mean) was

$$\overline{y}_i = \left[\sum_{j=1}^{K} \overline{y}_{ji} \right] / K \tag{1.2}$$

where $\overline{y}_{ji}$ = Σ *potlifts* or *harvest* / Σ *respondents* for the *j*th interviewer in the *i*th month, and its variance was

$$\hat{Var}(\overline{y}_i) = s^{*2} / K \tag{1.3}$$

where

$$s^{*2} = \frac{1}{K-1} \sum_{j=1}^{K} (\overline{y}_{ji} - \overline{y}_i)^2 \tag{1.4}$$

$\overline{y}_i$ was calculated each month for a) the State and b) separately for each fishing Zone.

On average each interviewer managed around 370 diarists per month, including diarists who were unlikely to fish during the season. As the season progressed, and diarists were lost from the survey the numbers of diarists for each interviewer in Equation 1.2 was adjusted accordingly.

2.5.2 Expansion of monthly estimates

The estimator of the population monthly total was

$$\hat{Y}_i = N_i \bar{y}_i \tag{1.5}$$

with variance

$$Var(\hat{Y}_i) = N_i^2 Var(\bar{y}_i) \tag{1.6}$$

where N_i is the number of current registrations on the 15th of each month.

The standard error of the estimator is

$$SE(\hat{Y}_i) = \sqrt{Var(\hat{Y}_i)} \tag{1.7}$$

and the relative standard error (%) was

$$RSE = (SE(\hat{Y}_i)/(\hat{Y}_i) * 100 \tag{1.8}$$

2.5.3 Fishing season estimates

The estimate of the total effort (potlifts) or harvest (number of lobsters) for the fishing season was

$$Total(T) = \sum_{i=1}^{n} \hat{Y}_i \tag{1.9}$$

with a variance of

$$Var(T) = \sum N_i^2 Var(\hat{Y}_i) + 2 \sum_{1 \le i < j \le n} N_i N_j Cov(\hat{Y}_i, \hat{Y}_j) \tag{1.10}$$

where $Cov(\hat{Y}_i, \hat{Y}_j)$ is the covariance of $\hat{Y}_i$ and $\hat{Y}_j$

and the standard error of *T* is

$$SE(T) = \sqrt{Var(T)} \tag{1.11}$$

3 RESULTS

3.1 Seasonal registrations

At the end of the season, the current registrations were calculated for the 15th of each month in order to estimate monthly effort and harvest levels. The number of registrations increased steadily over the season from 2474 in October 2004 to 5773 in May 2005 (Table 1). Total number of registrations for the 2004/05 season were 25% lower than in 2001/02, when 7678 potters registered.

Table 1. Total number of recreational rock lobster registrations current each month between October 2004 and May 2005.

Month	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05
Current Registrations	2474	3588	4543	5227	5527	5637	5747	5773

South Australian recreational rock lobster fishing licences were registered by residents of all States and Territories, except the ACT and Tasmania (Figure 1). Most of these potters were resident in either South Australia 5027 (87%) or Victoria 704 (12%), while residents of New South Wales, Queensland, Western Australia and the Northern Territory accounted for the residual 40 (<1%).

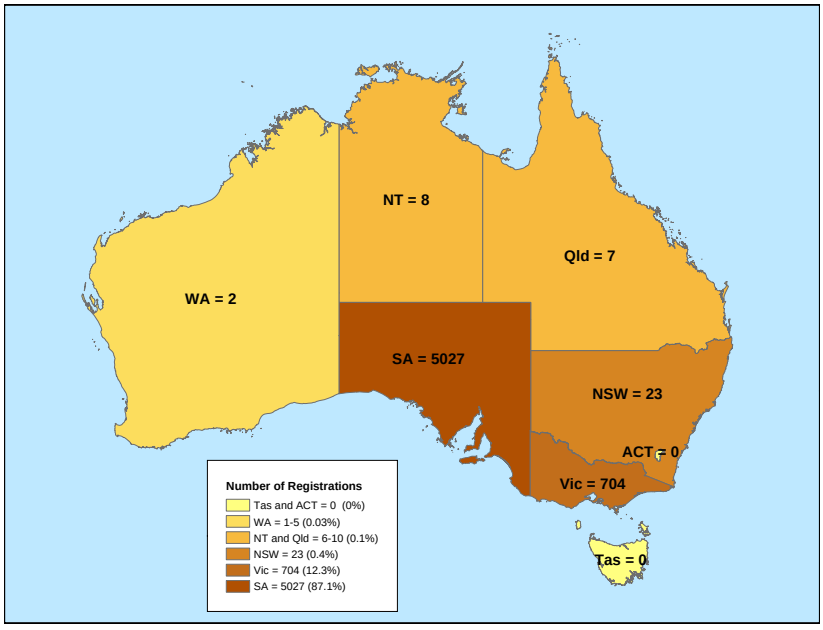


Figure 1. Numbers and home postal State/Territory of rock lobster potters registered to fish recreationally for rock lobster in South Australia during the 2004/05 season. Proportion of licences relative to the Australian total (5773) are provided in brackets in the legend.

A large proportion 2210 (38%) of potters registered during 2004/05 resided in six local government districts in the southeast corner of South Australia (Lacepede, Wattle Range, Grant, Robe, Naracoorte and Lucindale; Figure 2). A large number of potters were also registered in the suburbs of metropolitan Adelaide 1109 (19%). Most registrations, by postcode, were lodged in regional areas surrounding the towns of Beachport (PC 5280; 561

(10%)), Mount Gambier (PC 5290; 545 (9%)), Port MacDonnell (PC 5291; 330 (6%)), Kingston (PC 5275; 223 (4%)), Naracoorte (PC 5271; 179 (3%)), Robe (PC 5275; 166 (3%)), Victor Harbor (PC 5211; 153 (3%)) and Port Lincoln (PC 5606; 111 (2%)). In contrast, <90 potters (<2%) were registered at any other postcode elsewhere in Australia.

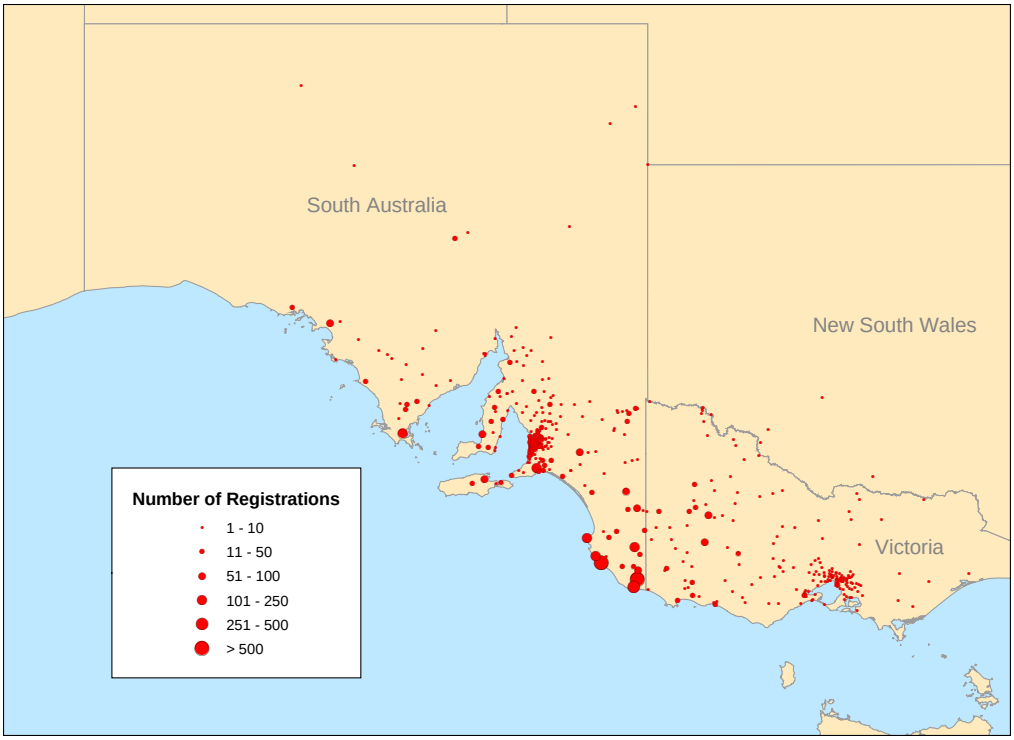


Figure 2. Distribution of recreational rock lobster licences by registered postcode in South Australia and Victoria during the 2004/05 season. Registration numbers are represented by the diameter of the red-filled circles.

3.2 Survey participation

Information taken from the database of commercial potters on the 25th of September 2004 (immediately prior to the start of the fishing season) showed that there were 2086 current registrations. Of these, 2077 had home and phone contact details, and constituted the initial sample population for the survey. Each of these registered potters was mailed a diary kit and was contacted by telephone at the start of the season. Some of the registered potters on the mail-out could not be contacted, others refused to participate, but a majority provided detailed catch and effort information throughout the fishing season.

A flow diagram charting the progress of the telephone diary survey is presented in Figure 3. From the initial sample of 2077 contact was made with 1828 (88.0%). Of these, 1484 (81.2%) expressed a wish to participate and agreed to follow-up calls. This group of 1484 diarists (representing 71.1% of registered potters at the start of the 2004/05 season) constituted the post-screening sample population for the survey. The remaining licence holders 344 (18.8%) refused to participate.

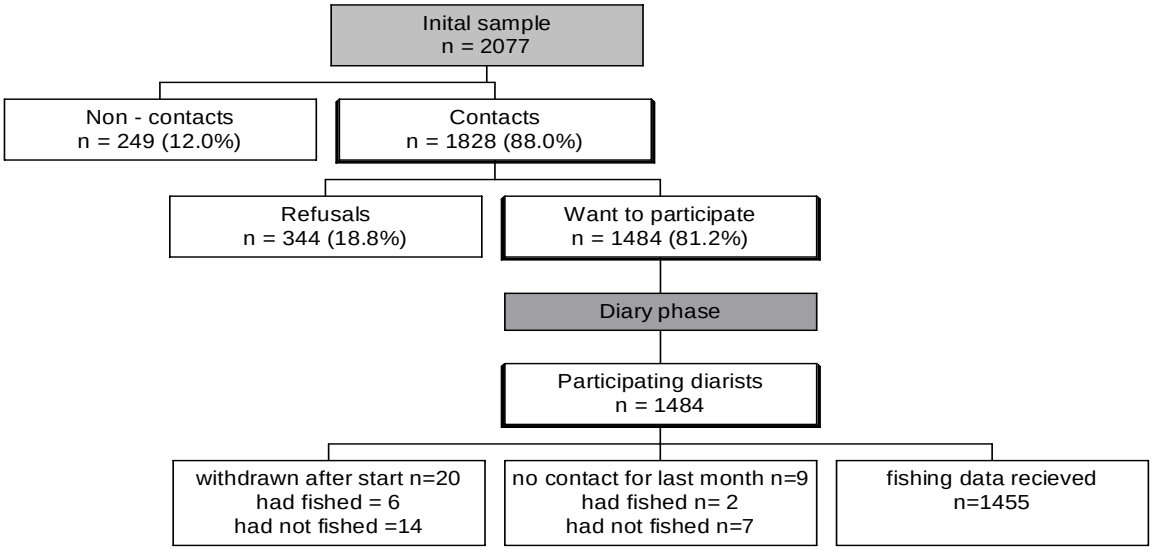


Figure 3. Diagrammatic summary detailing participation rates in the 2004/05 recreational rock lobster survey.

Over the course of the survey 20 participants withdrew, and a further 9 could not be contacted during the last month of the survey. These incomplete data were still incorporated in our analyses after appropriate alterations to monthly sample sizes. The residual 1455 (98.0%) of the post-screen sample population went on to complete the survey and report their catches over the entire season.

3.2.1 Fishing by zone

Of the 1455 potters to report their catches over the entire season, 655 (45.0%) fished only in the SZ, 269 (18.5%) fished only in the NZ, 24 (1.6%) fished in both zones and 507 (34.9%) did not fish at all.

3.3 Potters

3.3.1 Total effort

Fishing effort was collected on a per trip basis, where each trip involved the retrieving of pots previously baited and set. Hence effort was taken to be the number of pots lifted on each trip.

The survey recorded 12,623 fishing trips. Registered potters accounted for 12,393 trips, 127 used hoop or drop nets, 99 used snorkel or dive gear and 4 used bait and line. Of the 12,393 potting trips, 8,838 took place in the SZ and 3,555 in the NZ.

Diarists recorded a total of 28,370 potlifts during the season. These data were used to estimate that 96,160 (SE ± 15,224) potlifts were made during the season by recreational potters, including 69,769 (73%) in the SZ and 26,391 (27%) in the NZ.

3.3.2 Spatial and temporal patterns in effort

Tables 2 and 3 and Figure 4 show the total effort (%) and harvest in each region and zone and for the State. Over 13% of the total effort and over 16% of the total catch was taken from each of three regions in the SZ (23, 24 and 24), whereas 13.1% of the total effort and 6.5% of the total catch was taken in one region in the NZ (19).

Table 2. Effort and harvest summary for recreational rock lobster potters in South Australia between October 2004 and May 2005. RSE = relative standard error.

Region	Month								
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Total[1]**
Southern Zone									
Effort (potlifts)	992	2,364	11,298	20,862	12,557	16,387	4,027	1,282	69,769
RSE (%)	31.5	31.7	35.2	33.2	46.2	35.6	23.3	36.2	16.5
Harvest (numbers)	741	1,863	9,736	17,028	11,727	15,134	3,090	1,060	60,379
RSE (%)	31.4	34.6	38.1	36.7	38.8	42.4	22.9	38.7	17.3
Mean weight (kg)	0.870	0.853	1.121	1.171	1.323	1.315	1.356	1.813	
Harvest weight (kg)	644.7	1,589.1	10,914.1	19,939.8	15,514.8	19,901.2	4,190.0	1,921.8	74,615.5
Northern Zone									
Effort (potlifts)	14	2,938	7,177	10,705	2,314	2,536	452	255	26,391
RSE (%)	55.1	30.5	26.0	37.4	20.6	16.1	49.8	30.9	17.2
Harvest (numbers)	11	985	2,988	3,549	741	538	136	41	8,989
RSE (%)	70.7	32.4	25.1	37.7	31.3	28.6	56.3	66.3	17.7
Mean weight (kg)	0.505	0.863	0.915	0.918	1.000	1.188	1.940	1.668	
Harvest weight (kg)	5.6	850.1	2,734.0	3,258.0	741.0	639.1	263.8	68.4	8,560.0
State[1]									
Effort (potlifts)	1,005	5,303	18,475	31,567	14,871	18,923	4,479	1,537	96,160
RSE (%)	30.8	32.4	32.0	34.3	41.4	32.4	16.0	28.7	15.8
Harvest (numbers)	752	2,848	12,724	20,577	12,468	15,672	3,226	1,101	69,368
RSE (%)	30.9	34.1	35.1	36.9	36.5	40.0	19.6	37.2	17.0
Harvest weight (kg)[1]	650.2	2,439.2	13,648.1	23,197.8	16,255.8	20,540.4	4,453.9	1,990.2	83,175.5

[1] *The sum of cell values may not equal column or row totals due to rounding.*

Table 3. Regional distribution of effort and harvest. (see Appendix 4 for region codes).

Region	Effort (No. of potlifts)			Harvest (No. of lobster kept)		
	SZ %	NZ %	State %	SZ %	NZ %	State %
1		0.0	0.0		0.0	0.0
2		2.8	0.8		2.2	0.3
3		15.6	4.6		8.8	1.2
4		2.4	0.7		1.6	0.2
5		1.7	0.5		1.7	0.2
6		0.9	0.3		1.0	0.1
7		1.0	0.3		2.3	0.3
8		0.0	0.0		0.0	0.0
11		0.0	0.0		0.0	0.0
12		9.4	2.7		13.0	1.8
13		5.2	1.5		7.8	1.1
14		2.8	0.8		1.7	0.2
15		2.9	0.8		3.2	0.4
19		45.0	13.1		47.0	6.5
20		10.0	2.9		9.8	1.4
21		0.3	0.1		0.0	0.0
22	0.3		0.2	0.4		0.3
23	44.7		31.7	41.3		35.6
24	35.8		25.3	39.4		33.9
25	19.2		13.6	19.0		16.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

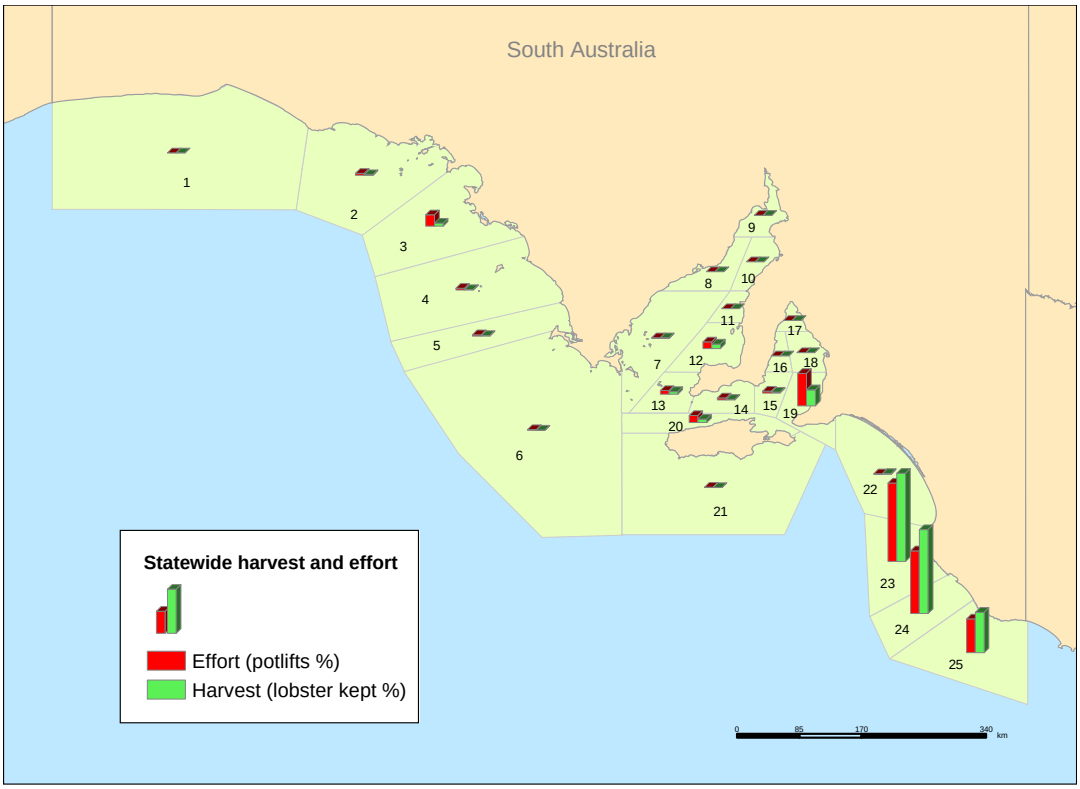


Figure 4. Distribution of recreational lobster catch and fishing effort during the 2004/05 fishing season. Bar lengths here represent relative effort/harvest for each fishing region (numbered) as a percentage of the statewide total (see Table 3).

Fishing effort was strongly seasonal in both zones and peaked in January at approximately 20,000 potlifts in the SZ, and 10,000 potlifts in the NZ (Figure 5).

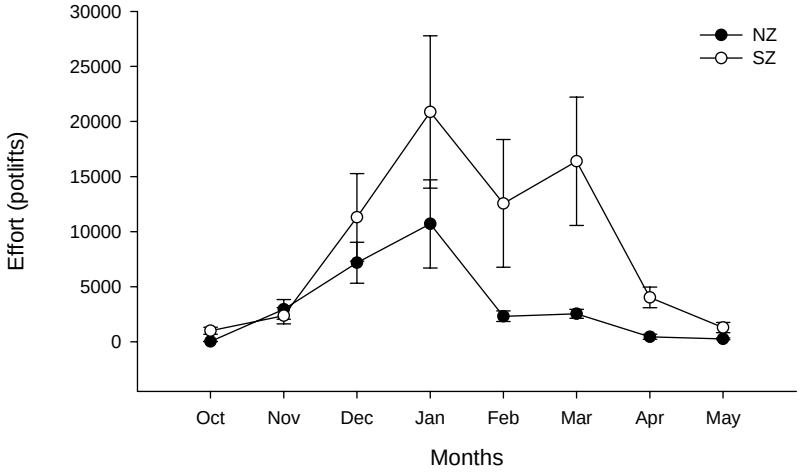


Figure 5. Seasonal fishing effort (potlifts) by fishing zone during 2004/05. Error bars show the standard error of the monthly estimate.

3.3.3 Trips by each fisher

The distribution of effort by individual respondents was typical of recreational fisheries, with a large proportion fishing relatively few times and a small number fishing frequently (Figure 6). About 35% did not fish at all and approximately 36% conducted less than 10 trips for the season. Just over 1% fished for 80 or more trips. The average number of trips was 9.3 across all respondents (including those who did not fish).

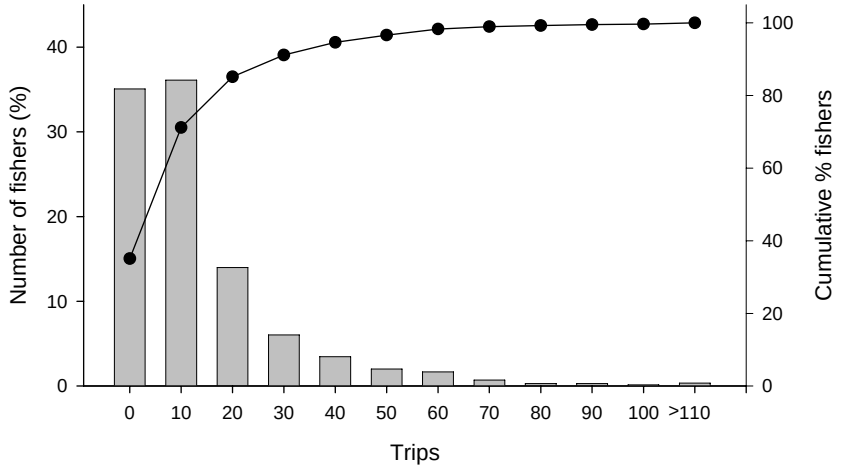
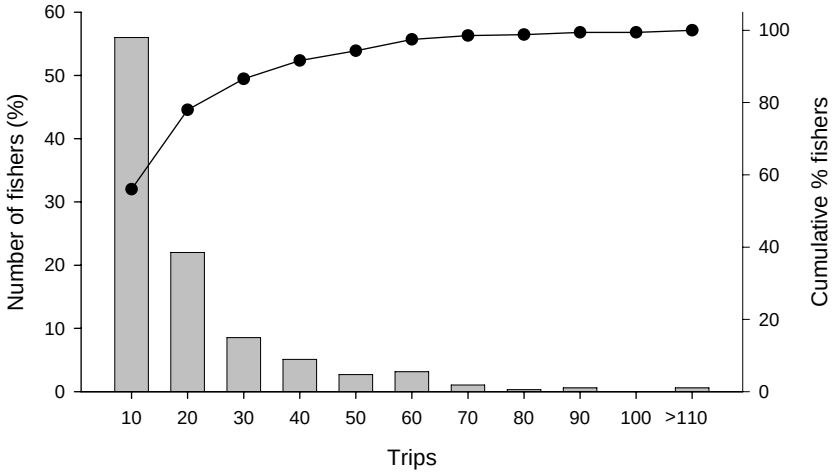


Figure 6. Distribution of the number of trips for all respondents during the 2004/05 fishing season. Note solid bars denote number of fishers while small filled circles represent the cumulative total.

The statewide average number of trips for those who fished at least once was 14.6. This was similar in each zone, with 14.7 trips in the SZ and 13.6 trips in the NZ. Most potters (>55%) in both zones fished less than 10 trips for the season (Figure 7), and fewer than 10% of potters in each zone fished more than 40 times during the season.

a)



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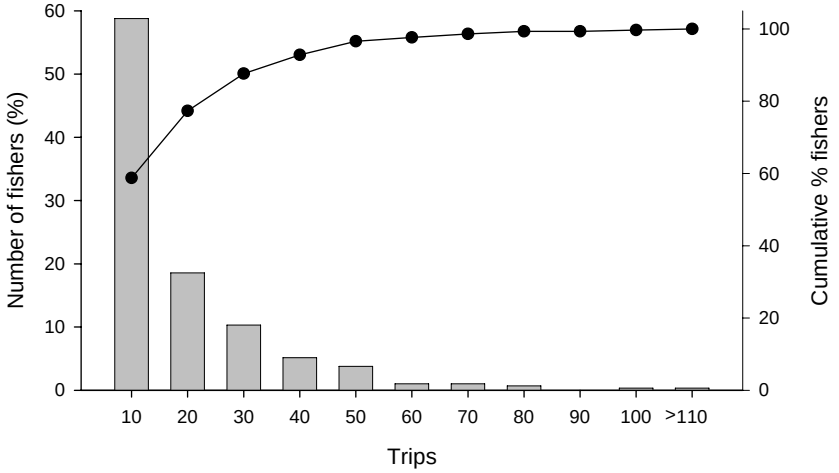


Figure 7. Distribution of potting trips per fisher in the a) Southern Zone, and b) Northern Zone in the 2004/05 season. Note that data for potters who did not fish have been excluded.

3.3.4 Total harvest

A total of 20,308 lobsters were harvested by diarists during the 2004/05 season. This suggests, from expanded monthly registrations, that the total recreational harvest by registered potters in South Australia during 2004/05 was 69,368 (SE ± 11,791) lobsters (Table 2), representing 60,379 lobsters (87%) from the SZ and 8,989 lobsters (13%) from the NZ.

The seasonal pattern of harvest closely followed fishing effort, with a peak of approximately 17,000 lobsters in January in the SZ and 3,500 lobsters in January in the NZ (Table 2, Figure 8).

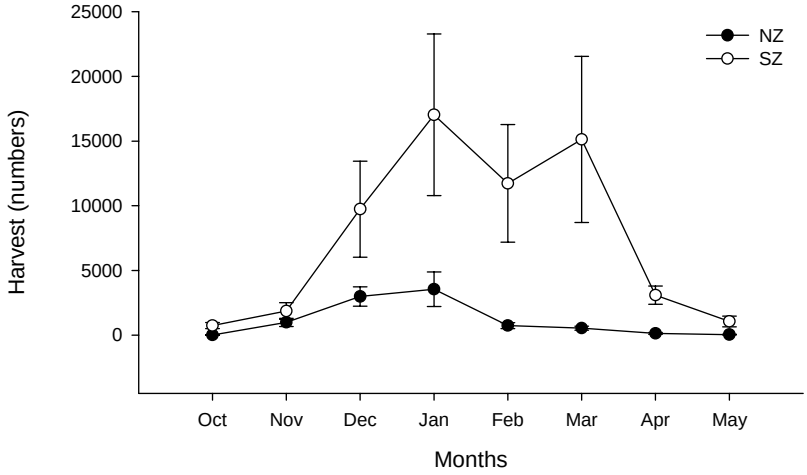


Figure 8. Seasonal harvest (number of lobster) by potters in each fishing zone during 2004/05. Error bars show the standard error of the monthly estimate.

3.3.5 Mean weight

Individual carapace lengths or weights of 9,840 (48%) of the 20,308 lobsters harvested by diarists were recorded. Carapace lengths were subsequently converted to weights (using the conversion formula $Wt(g) = 0.000483 * L^3(mm)$) and the combined data used to estimate the monthly mean weights of lobster in each zone.

The mean weight of lobsters in the SZ ranged from 0.87 kg in October to 1.8 kg in May, with a seasonal mean of 1.2 kg, whereas in the NZ mean weight ranged from 0.5 kg in October to 1.9 kg in April, with a seasonal mean of 0.9 kg (Table 4). Mean weight generally increased throughout the season in both zones.

Table 4. Weight, number and mean weight of lobsters harvested by recreational rock lobster potters during the 2004/05 fishing season.

Region	**Month**								**Season**
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Southern Zone									
Weight (kg)	186	385	1923	2529	2016	1967	500	363	9869
Number	214	452	1715	2161	1524	1496	369	200	8131
Mean weight (kg)	0.870	0.853	1.121	1.171	1.323	1.315	1.356	1.813	1.214
Northern Zone									
Weight (kg)	1	268	574	559	100	52	14	13	1582
Number	2	311	628	609	100	44	7	8	1709
Mean weight (kg)	0.505	0.863	0.915	0.918	1.000	1.188	1.940	1.668	0.926

3.3.6 Estimated total harvest (by weight)

The mean weight of lobsters in each month in each zone (from recreational mean weight data) was used to convert harvest numbers to weight. The total harvest was estimated at 83,175kg (Table 2). Of this total, 74,615 kg (90%) were caught in the SZ and 8,560 kg (10%) in the NZ.

3.3.7 Harvest per unit effort (HPUE)

Harvest rates (number/potlift) were calculated directly from monthly effort and harvest estimates, with mean weights used to calculate kg/potlift.

Harvest rates by number were higher in the SZ than the NZ (Figure 9). In the SZ, harvest rates by numbers were relatively stable throughout the season, and ranged from 0.75 lobsters per potlift in October to 0.93 lobsters per potlift in February. In the NZ, harvest rate by numbers declined over the course of the season from 0.44 lobsters per potlift in October to 0.16 lobsters per potlift in May.

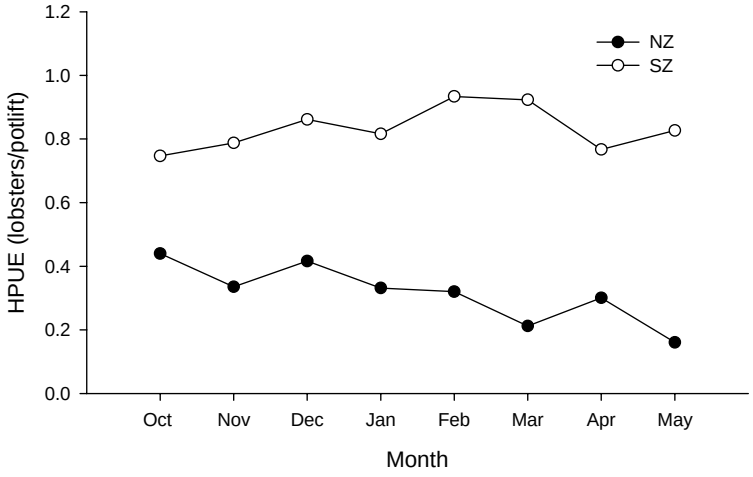


Figure 9. Monthly harvest rates (lobsters / potlift) by potters in each fishing zone during 2004/05.

Harvest rates by weight did not parallel those of numbers due to seasonal increases in the mean weights of lobster in both zones during the fishing season (Figure 10). In the SZ, harvest rate by weight progressively increased from a low of 0.65 kg per potlift in October to a high of 1.49 kg per potlift in May. In the NZ, harvest rates by weight were lowest in October (0.22 kg per potlift) and highest in April (0.58 kg per potlift)

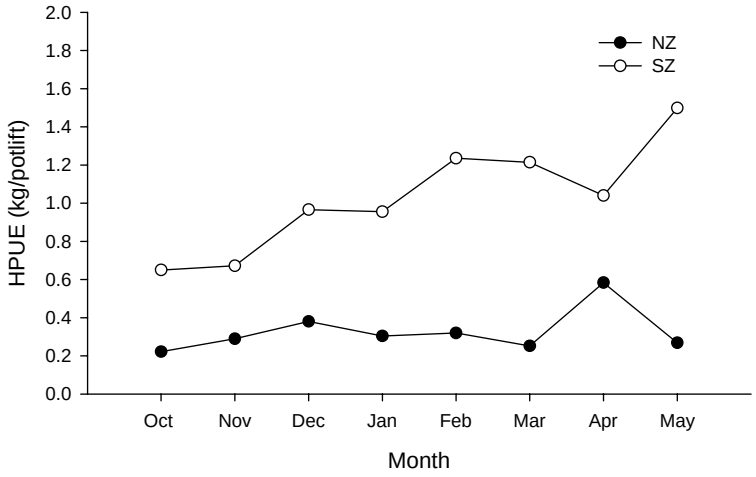
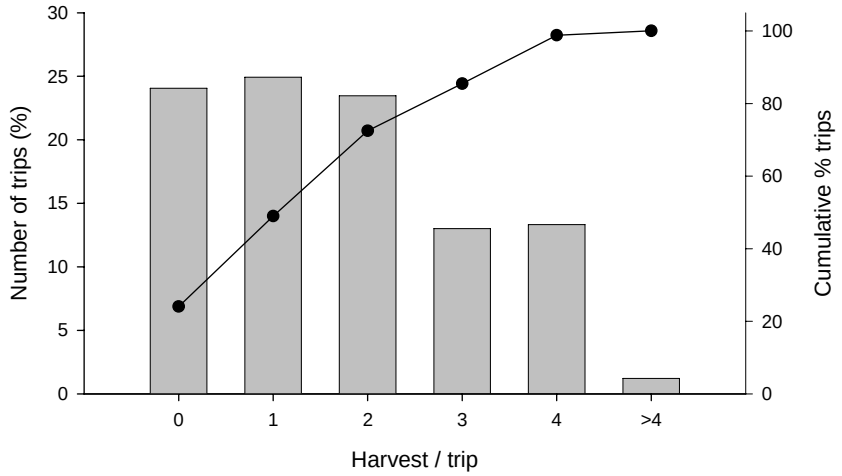


Figure 10. Monthly harvest rates (kg / potlift) by potters in each fishing zone during 2004/05.

3.3.8 Daily harvest per fisher

The daily harvests differed between the two fishing zones (Figure 11). In the NZ, just over half of all fishing trips (53%) resulted in a zero harvest. By comparison, less than a quarter of trips in the SZ (24%) failed to yield any lobster. In the SZ, the bag limit of four lobsters was taken on 13% of trips whereas in the NZ the bag limit was taken on only 2% of trips. A total of 188 (1.5%) trips yielded more than the daily bag limit of four lobsters, with 150 in the SZ and 38 in the NZ. Of these, 138 reported the extra lobsters as berried females that were subsequently returned to the sea.

a)



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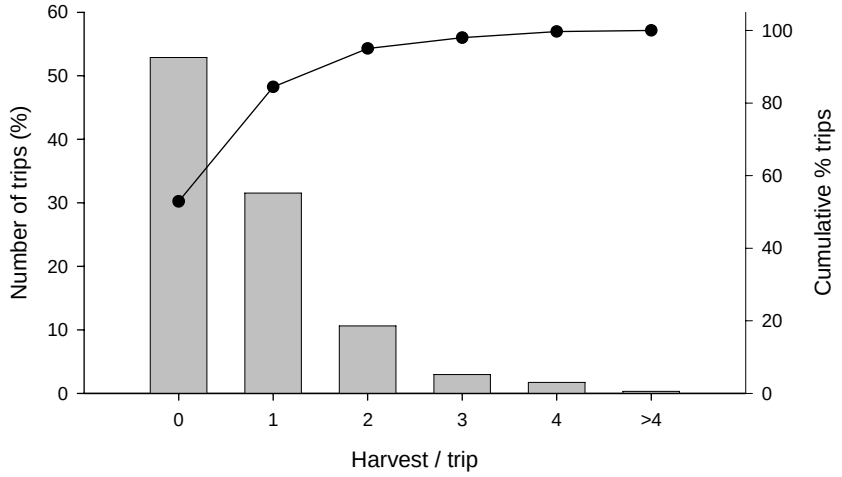


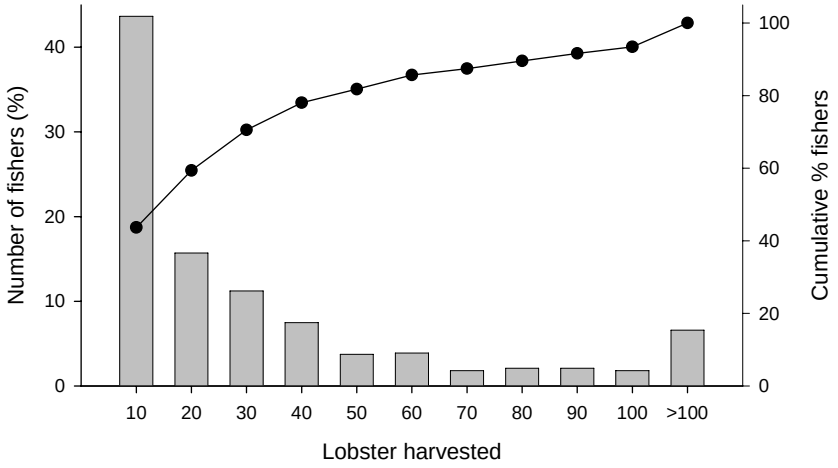
Figure 11. Distribution of daily lobster harvests in the a) SZ and b) NZ during the 2004/05 fishing season. Note solid bars denote number of fishing trips while small filled circles represent the cumulative total.

3.3.9 Annual harvest per fisher

The average seasonal harvest of all respondents (including those who did not fish) was 13.7 lobster / year. Of those who fished, the average was 21.7 lobsters. However this average differed between zones, with 11.5 lobsters harvested per fisher per year in the NZ and 30.6 in the SZ.

Most potters caught relatively few lobsters, but a small proportion of potters caught a large number of lobsters. In the SZ, approximately 60% of potters harvested 20 lobsters or less, whilst 8% of potters harvested 100 or more lobsters (Figure 12a). In the NZ, 86% of potters harvested 20 lobsters or less, whilst 2% of potters harvested 100 or more lobsters (Figure 12b).

a)



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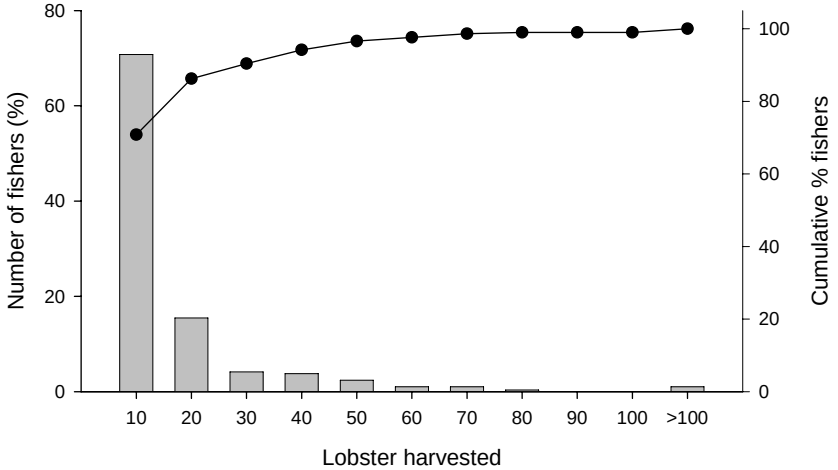


Figure 12. Distribution of the annual lobster harvest per fisher in the a) Southern Zone and b) Northern Zone during the 2004/05 fishing season. Note solid bars denote number of fishers while small filled circles represent the cumulative total.

The strong impact of a relatively small proportion of fishers on the overall harvest is seen in Figure 13, where 80% of fishers take only 35% of the catch and the remaining 20% take 65%.

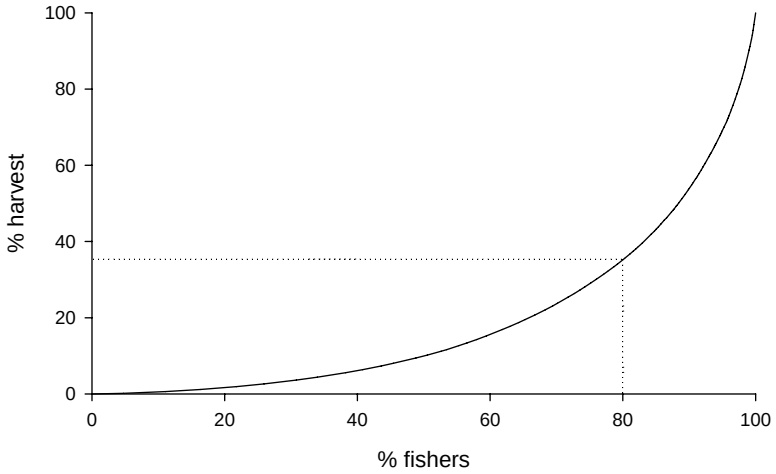


Figure 13. Comparison of the cumulative contribution of fishers to the overall harvest (both zones combined).

3.3.10 Sex ratio of harvest

The proportion of females in the catch varied considerably over the course of the season and also differed markedly between the two between management zones (Figures 14a & 14b). On average, females accounted for approximately 24% of the seasonal catch in the SZ, with the highest proportion being harvested close to the start of the season (November, 30%) and the lowest being taken at the end of the season (May, 9%). In contrast, females comprised a much larger proportion of the seasonal catch (37%) in the NZ. As observed in the SZ, females were more commonly harvested in the NZ at the start of the season (October, 50%) than at the end of the season (May, 25%).

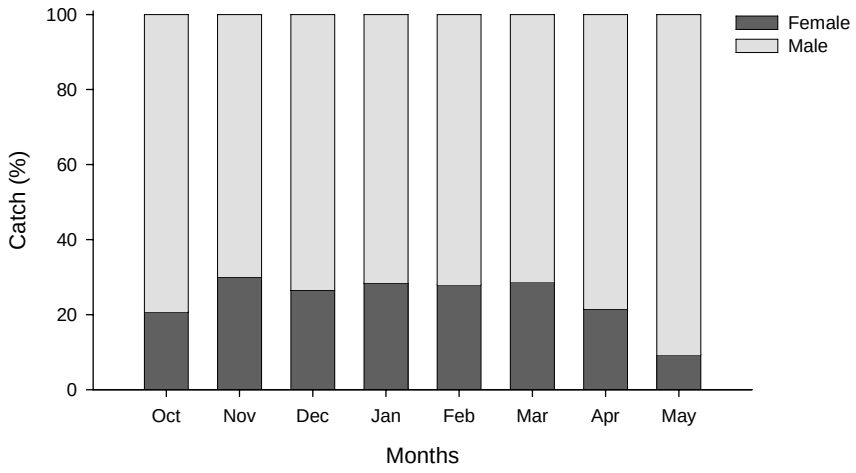


Figure 14a. Proportion of male and female lobsters harvested each month by recreational potters in the Southern Zone during the 2004/05 season.

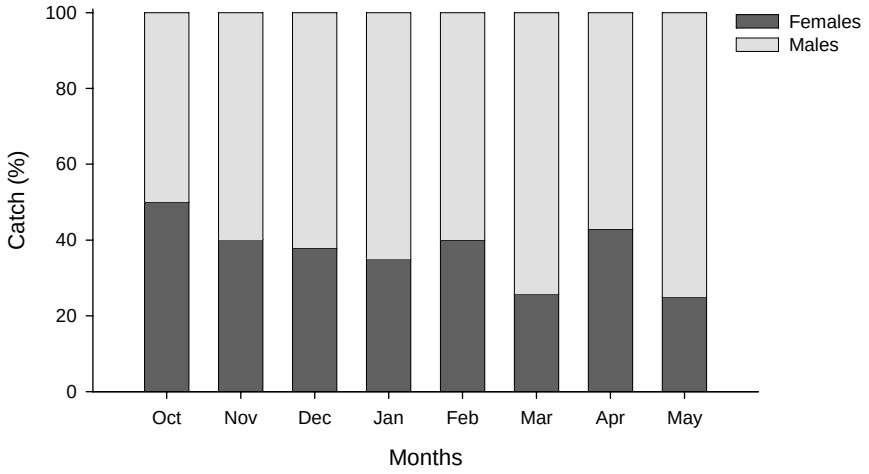


Figure 14b. Proportion of male and female lobsters harvested each month by recreational potters in the Northern Zone during the 2004/05 season.

3.3.11 Number of under-size lobster caught.

Diarists returned a total of 17,343 lobsters to the water during the fishing season, including 15,064 in the SZ and 2,279 in the NZ. Of these, 16,967 (97.8%) were returned as they failed to exceed the minimum legal length. From the proportion of undersized to legal harvest within the diarist data, it can be inferred that approximately 57,950 undersized lobsters were returned to the water by all registered potters during the 2004/05 season.

The ratio of undersized to legal lobsters did not differ markedly between the two fishing zones. In the SZ, 0.86 undersized lobster were caught for every lobster harvested, compared to 0.81 in the NZ.

3.3.12 Numbers of other lobster returned to the water

Of the remaining 376 lobsters returned to the water, 33 (8.8%) were females carrying eggs, 66 (17.5%) were dead or damaged, and 277 (73.7%) were in excess of the bag limit.

3.4 Drop-netters

3.4.1 Effort

A total of 127 fishing trips by registered potters involved the use of drop/hoop nets. A total of 47 diarists used drop/hoop nets and 392 net-lifts were made by participants in the survey. Most of the drop/hoop net fishing was conducted in the SZ (Table 5).

Table 5. Monthly lobster catch and fishing effort during 2004/05 by diarists using drop/hoop nets.

Region	Month								Season
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	(total)
Southern Zone									
Lobster kept	21	40	112	29	76	60	49	37	424
Lobster released	16	10	109	38	97	56	38	46	410
Net lifts	26	38	97	26	50	58	55	38	388
Northern Zone									
Lobster kept	0	0	0	0	0	0	0	0	0
Lobster released	0	0	1	0	0	0	0	0	1
Net lifts	0	0	4	0	0	0	0	0	4
State									
Lobster kept	21	40	112	29	76	60	49	37	424
Lobster released	16	10	110	38	97	56	38	46	411
Net lifts	26	38	103	26	50	58	55	38	392

3.4.2 Harvest

An average of 3.33 lobsters per fishing trip were harvested by drop/hoop netting. Diarists caught a total of 835 lobsters using drop/hoop nets during 2004/05. Almost half (49.2%) of these lobsters were released, including 380 (92%) that were under-sized, 27 (7%) that were in excess of the bag limit and 4 (1%) that were berried females.

These data suggest that registered potters harvested approximately 1,500 lobsters using drop/hoop nets during the 2004/05 season. From mean monthly weights of lobsters harvested by drop/hoop netters it is estimated that the total statewide harvest was 2,103 kg.

3.4.3 Drop-netters versus potters

Catch rates using drop/hoop nets were consistently higher than those using pots over the course of the season (Figure 15). Potters that also used drop/hoop nets caught an average of 0.9 lobsters per potlift and 1.1 lobsters per net lift over the course of the 2004/05 season.

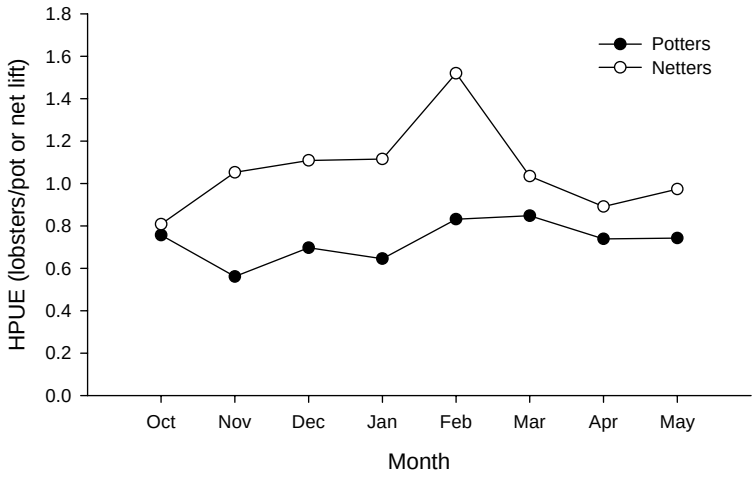


Figure 15. Statewide harvest rates for lobster caught by registered fishers using pots and drop/hoop nets during 2004/05.

3.5 Divers

A total of 26 registered potters kept detailed records of their diving or snorkelling activities for rock lobster during the 2004/05 fishing season.

3.5.1 Effort

Participants in the diary survey recorded a total of 99 dives during the 2004/05 rock lobster season. Overall 4% of the dives were made in the NZ and 96% in the SZ (Table 6). Approximately 71% of the dives were made using scuba; 5% were made using hookah (surface air supply) and 24% using snorkelling equipment. Of these dives, 81% were conducted from a boat and 19% from the shore.

Approximately 69% of rock lobster (by numbers) were taken using scuba, 6% were taken using hookah and 25% using snorkelling gear. Lobsters taken from a boat comprised 83% of the catch, whilst 17% were taken from the shore.

Table 6. Number of dives undertaken by recreational licence holders targeting rock lobster during the 2004/05 fishing season.

Region	Area code	Dives for lobster	Lobster harvested (n)
Northern Zone	4	1	1
	19	3	2
Southern Zone	23	47	127
	24	35	122
	25	13	32
Total		99	284

3.5.2 Mean weight of lobsters

The mean weight of lobsters taken by recreational divers was 1.415kg (SE ± 0.065) in the SZ and 1.742kg (SE ± 0.125) in the NZ.

3.5.3 Estimated harvest

Diarists that actively targeted lobster by diving during 2004/05 caught a total of 310 lobsters. Of these, 284 (92%) were harvested and 26 (8%) were returned to the water as undersize. Over the course of the season, registered licence holders that dived harvested an average of 2.9 lobsters by diving on each fishing trip. Using the monthly catch rates for divers as estimators, it may be inferred that divers holding recreational rock lobster licences took approximately 1,000 lobsters during 2004/05 weighing a total of 1,421 kg.

4 DISCUSSION

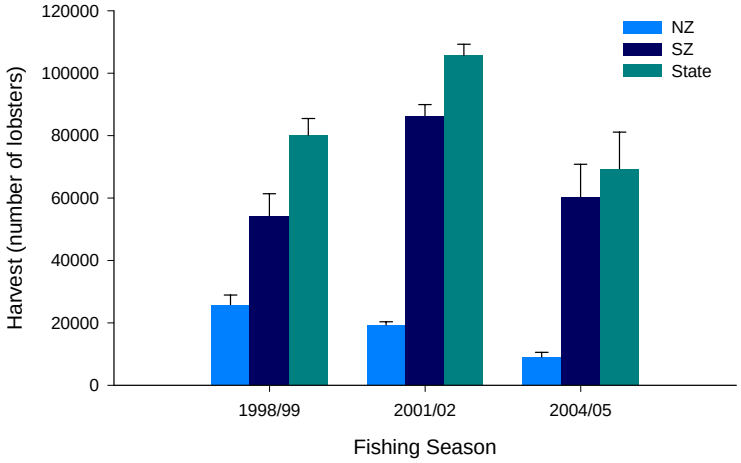
The response rate in the 2004/05 recreational survey was high and this level of co-operation from registered potters continued throughout the season. The total population of registered potters was also clearly defined, and a high proportion of the initial sample participated fully in the study (70.1%). These factors combined with the high sampling fraction (>25%), suggest that the estimate of the total number of lobsters taken by registered potters during the 2004/05 season of 69,368 (SE ± 11,791) lobsters is highly robust.

The number of lobsters harvested by recreational potters has risen and fallen significantly over recent fishing seasons, and in 2004/05 was ~34% lower than the estimated catch in the 2001/02 season (105,620 ± 3,696 lobsters; Venema *et al*., 2003), but similar to the estimated catch for the 1998/99 season (80,093 ± 5,366 lobsters; McGlennon, 1999) (Figure 16a). This apparent rise and fall in recreational potter catch is mirrored by similar trends in effort (Fig 16b), and is almost certainly due to seasonal fluctuations in the number of registered potters (particularly given that changes in catch and registration are of similar magnitude and direction). In 1998/99, 5202 registrations were current each month over the course of the season, but registrations increased by 34% to 6984 in 2001/02, and subsequently declined by 31% to 4815 in 2004/05.

While recreational potting catches and fishing effort have fluctuated considerably over recent fishing seasons, lobster catch rates for the State as a whole have remained relatively stable (0.68-0.72 / lobster per potlift)(Figure 16c). This apparent stability in yield across the State appears to be the product of two contradictory zonal trends. Notably, a marked decline in HPUE in the NZ (from 0.57 lobster per potlift in 1998/99 to 0.34 lobster per potlift in 2004/05), contrasting a small increase in HPUE in the SZ (from 0.77 lobster per potlift in 1998/99 to 0.86 lobster per potlift in 2004/05). Both these trends in catch rate correspond closely with patterns observed in the commercial fishery. Since 1999, HPUE (based on weight) in the NZRLF has progressively declined and 2004/05 was the lowest on record (0.8 kg/potlift; Linnane *et al*., 2005a). Over the same period, catch rates in the SZRLF have generally increased and in 2004/05 were close to record high levels (1.8 kg/potlift; Linnane *et al*., 2005b).

Previous studies to estimate the total weight of the catch by registered potters have relied on measures of the mean weight of lobsters taken by the commercial sector. These estimates have been based on the assumption that the mean weight of lobster harvested by commercial fishers in shallow nearshore waters (less than 15m) would be representative of the mean wights of lobster typically harvested by recreational potters. It has, nonetheless, been recognised that such estimators may result in spuriously low predictions of harvest weight. This is because commercial potters in the quota-managed fishery preferentially retain smaller (higher value) lobsters. It has also been recognised that recreational fishers who are restricted by bag and boat limits may preferentially retain larger lobsters. To provide a more accurate assessment of the total catch weight, the present survey specifically gathered information on the individual sizes/weights of lobsters harvested by recreational potters, and used this to estimating the total statewide harvest weight. The average seasonal mean weight for the SZ in this study (1.21 kg) was 63% greater than the commercial mean used in the 1998/99 survey (0.74 kg) and 60% higher than the commercial mean employed to estimate total catch weight in the 2001/02 survey (0.76 kg). In contrast, the mean seasonal weight for the NZ in this study (0.93 kg) was 17% lower than the commercial mean used in the 1998/99 survey (1.12 kg) and 26% lower than the commercial mean used in the 2001/02 survey. Because the majority of the recreational catch has been consistently harvested from the SZ it is clear that, on balance, past studies have underestimated the total recreational harvest weight.

a)



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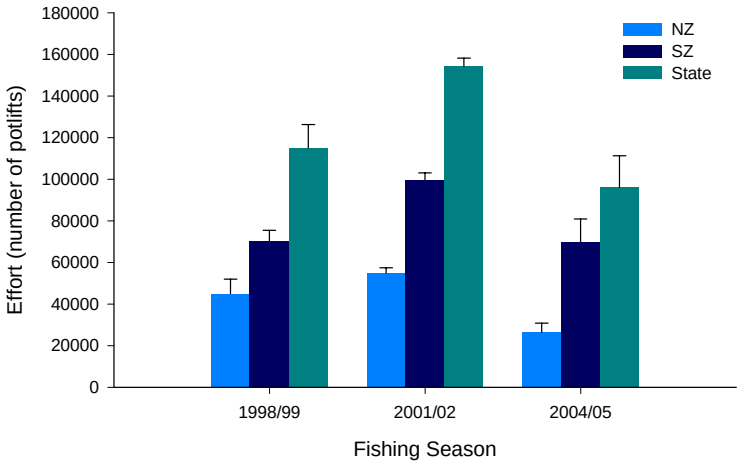

c)

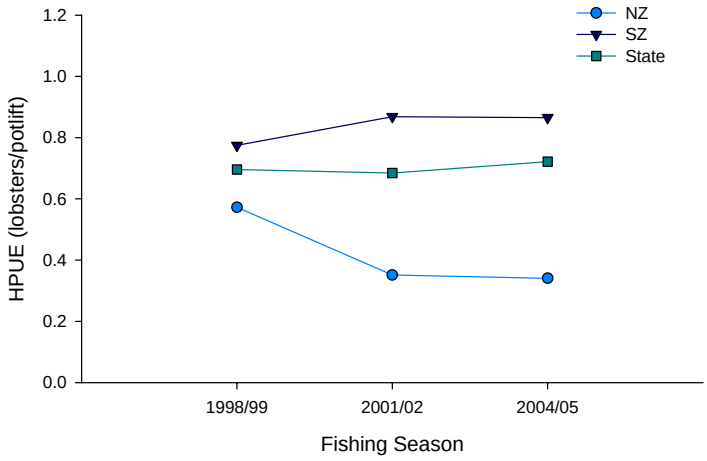

Figure 16. Plots of inter-seasonal differences in a) recreational rock lobster catch, b) fishing effort, and c) harvest per unit effort in different fishing zones (northern and southern), and South Australia as a whole.

The total weight of the recreational potter catch for the 2004/05 season was estimated at approximately 83 tonnes, with 75 tonnes (~90%) coming from the SZ and 8.5 tonnes (~10%) coming from the NZ. These estimates indicate that approximately 3.4% of the state TACC (2420 tonnes) was harvested by licensed recreational potters during 2004/05, and comprised 3.9% of the SZ TACC (1900 tonnes) and 1.6% of the NZ TACC (520 tonnes). Unfortunately these estimates provide minimum guidance, with regards to the total recreational harvest, as they do not incorporate landings by recreational fishers using gear without license requirements.

The catch taken by drop/hoop netters without registered pots is unknown, but may be significant as drop/hoop netters are commonly used in some areas and are highly effective for catching rock lobster. In the present survey, registered potters who also used drop/hoop nets caught, on average, more lobster per netlift than potlift (1.1 *vs.* 0.9 respectively). Because fishers that use drop/hoop nets are not required to either register these types of gear or to be licensed, the seasonal harvest by this method is difficult to quantify. Roving creel surveys (Pollock et al., 1994) probably offer one of the best approaches for accurately assessing the total recreational drop/hoop net catch. However, such creel surveys are often expensive to implement and may be cost prohibitive for the purposes of management (Venema *et al*., 2003).

Recreational divers represent another source of uncertainty in defining the total seasonal harvest. Like drop/hoop netters, individual divers are not required to register and may harvest up to four lobsters per person per day. Moreover, divers typically harvest larger lobster than those taken by pots and more frequently attain the daily bag limit (Lyle *et al*., 2005). Few data are available on the numbers of lobsters taken by divers in South Australian waters. Results from the present study cannot be reliability expanded to estimate the total recreational dive catch, as the sample size was small (26) and was not selected randomly from the recreational dive population. The best available predictor of the recreational dive catch in 2004/05 comes from a 2000/01 survey conducted by Boxall *et al* (2002). This survey estimated that 19 tonnes of lobster (0.8% of the TACC) were harvested by recreational divers during the 2001/02 season. Assuming similar catches by divers during 2004/05, it may be estimated that the total catch by recreational fishers in South Australia (excluding unlicensed drop/hoop netters) is approximately 105 tonnes (4.3% of the TACC).

In South Australia, the relative proportions of lobster harvested by recreational and commercial fishing sectors constitute a key performance indicator for the fishery, with the trigger point for recreational catches set at 4.5% of the total catch (recreational and commercial). Uncertainty in determining the total recreational catch (see above) precludes unambiguous evaluation of fishery performance against this indicator.

More accurate assessments of the recreational catch in future studies may be achieved by undertaking concurrent surveys of all recreational fishing sectors (including registered potters and unregistered drop/hoop netters and recreational divers). This will permit a more comprehensive assessment of the total recreational catch. In Tasmania, such surveys are readily conducted using telephone-diary techniques, as method based licences are required by all recreational fishers targeting lobster using pots, hoop/drop nets or diving (Lyle *et al*., 2005).

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6 ACKNOWLEDGEMENTS

A large number of people have made significant contributions to this project. In particular, we would like to thank the many recreational fishers who participated in this survey and who volunteered their time to record details of their catch. Without their enthusiastic assistance this survey would not have been possible. We are also indebted to the skilled team of telephone interviewers (Marie Rampe, Paul Memmler, Jane Common and Lynette Buttfield) for their commitment to detail and their professionalism in communicating and documenting the survey results. Mark Ayliffe and Gerard Ferrao from PIRSA Fisheries Licensing, provided invaluable information on the numbers and distribution of registered potters, and we are most grateful to them for this. We would also like to thank the large band of SARDI staff at West Beach who generously assisted in preparing the lobster mail-out kits. Finally, we are extremely grateful to Kylie Howard (SARDI, Mount Gambier) for the time and effort spent in collating, entering and validating the large volume of data generated by this survey. This project was commissioned and funded by PIRSA Fisheries with significant in-kind support from SARDI Aquatic Sciences.

Appendix 1. Copy of the mail-out cover letter distributed to all licensed recreational rock lobster fishers at the start of the 2004/05 season.

Our reference: Recrock/04
Please refer to: N/A
Telephone No: 8207 5336

27 September 2004

Dear Sir/Madam

RE: SURVEY OF RECREATIONAL ROCK LOBSTER FISHING IN SOUTH AUSTRALIA – 2004/05

As part of our ongoing commitment to research and management of South Australia's fisheries resources, the Department of Primary Industries and Resources (PIRSA), has commissioned the South Australian Research and Development Institute (SARDI) to conduct a survey of recreational rock lobster fishing in South Australia during the 2004/05 fishing season. The survey will provide a range of important scientific information for stock assessment and management of the recreational rock lobster fishery, including:

- How often people fish for lobsters with pots, and also with drop nets and by diving
- Where and when they fish (regional and seasonal variations)
- Population size-structure and sex ratios
- Catch rates and total harvest

HOW CAN YOU HELP?
Recreational fishers that regularly catch southern rock lobster by diving or by using drop nets, hoop nets or pots are needed to assist in the collection of catch and effort data for the survey. If you would like to participate in the Statewide survey, all you need to do is record a few simple details of your lobster catches over the season in the attached diary. Specifically we need you to record:

- Where you fished and what technique (eg pots, diving) you used
- How many hours you spent fishing each trip
- The size and sex of each lobster caught (including where possible those released)

In order to assist you in recording this information, a research officer from SARDI will contact you by telephone soon. They will also arrange with you a suitable contact time to update your catch records over the season. If you don't wish to participate in the survey simply notify the research officer at this juncture.

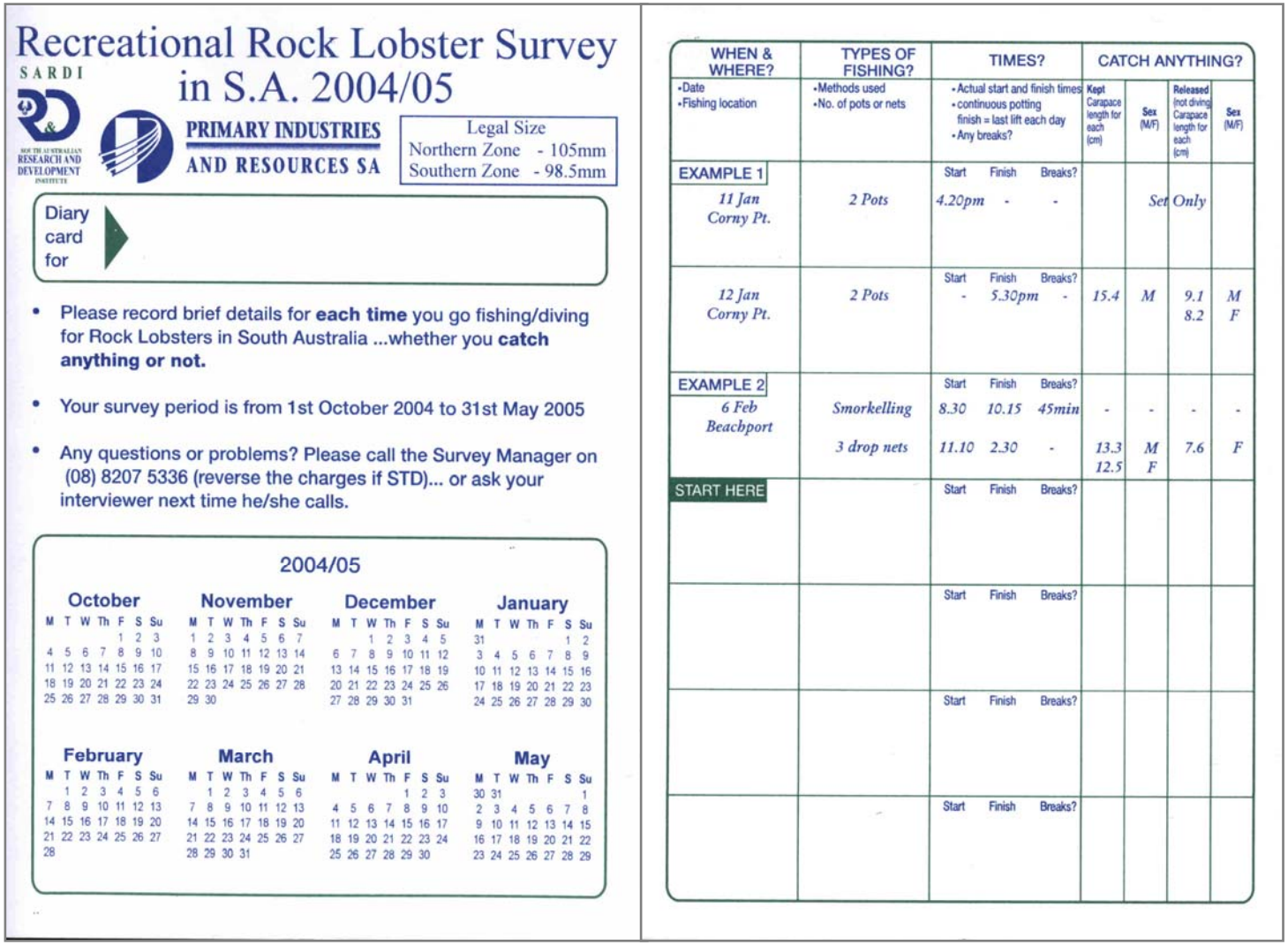
For those fishermen/women who choose to participate, please be assured that all information collected will be treated in the strictest confidence. The data that you provide will be combined with the responses of many hundreds of others randomly selected to participate in the survey. To further ensure confidentiality, all questionaries will be destroyed at the end of this survey.

If you have any questions or concerns about the survey, please feel free to contact me on 8207 5336.

Yours sincerely,

Shirley Sorokin
ROCK LOBSTER SURVEY MANAGER, SARDI

Appendix 2. Cover and first page of the survey diary distributed to all licensed recreational rock lobster fishers at the start of the 2004/05 season.



Recreational Rock Lobster Survey in S.A. 2004/05

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

PRIMARY INDUSTRIES AND RESOURCES SA

Legal Size
Northern Zone - 105mm
Southern Zone - 98.5mm

Diary card for

- Please record brief details for **each time** you go fishing/diving for Rock Lobsters in South Australia ...whether you **catch anything or not.**
- Your survey period is from 1st October 2004 to 31st May 2005
- Any questions or problems? Please call the Survey Manager on (08) 8207 5336 (reverse the charges if STD)... or ask your interviewer next time he/she calls.

2004/05

October

M	T	W	Th	F	S	Su
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

November

M	T	W	Th	F	S	Su
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

December

M	T	W	Th	F	S	Su
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

January

M	T	W	Th	F	S	Su
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

February

M	T	W	Th	F	S	Su
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28						

March

M	T	W	Th	F	S	Su
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

April

M	T	W	Th	F	S	Su
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

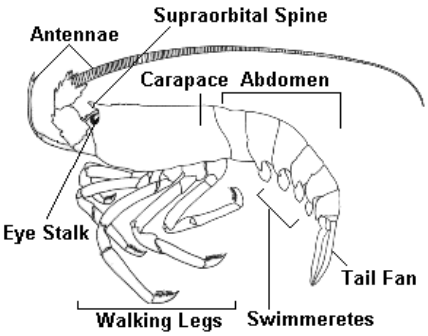
May

M	T	W	Th	F	S	Su
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

WHEN & WHERE?	TYPES OF FISHING?	TIMES?			CATCH ANYTHING?			
• Date • Fishing location	• Methods used • No. of pots or nets	• Actual start and finish times • continuous potting finish = last lift each day • Any breaks?			Kept Carapace length for each (cm)	Sex (M/F)	Released (not diving) Carapace length for each (cm)	Sex (M/F)
EXAMPLE 1		Start	Finish	Breaks?				
11 Jan *Corny Pt.*	*2 Pots*	*4.20pm*	*-*	*-*		*Set Only*		
12 Jan *Corny Pt.*	*2 Pots*	Start *-*	Finish *5.30pm*	Breaks? *-*	*15.4*	*M*	*9.1* *8.2*	*M* *F*
EXAMPLE 2		Start	Finish	Breaks?				
6 Feb *Beachport*	*Smorkelling*	*8.30*	*10.15*	*45min*	*-*	*-*	*-*	*-*
	3 drop nets	*11.10*	*2.30*	*-*	*13.3* *12.5*	*M* *F*	*7.6*	*F*
START HERE		Start	Finish	Breaks?				
		Start	Finish	Breaks?				
		Start	Finish	Breaks?				
		Start	Finish	Breaks?				

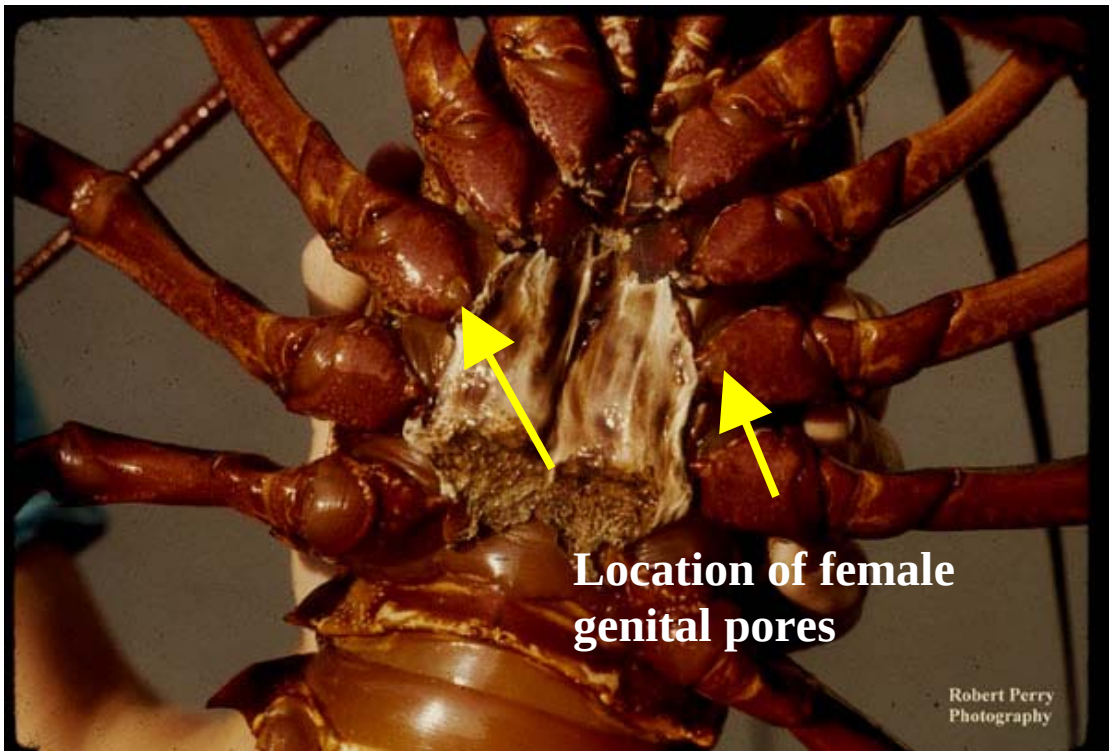
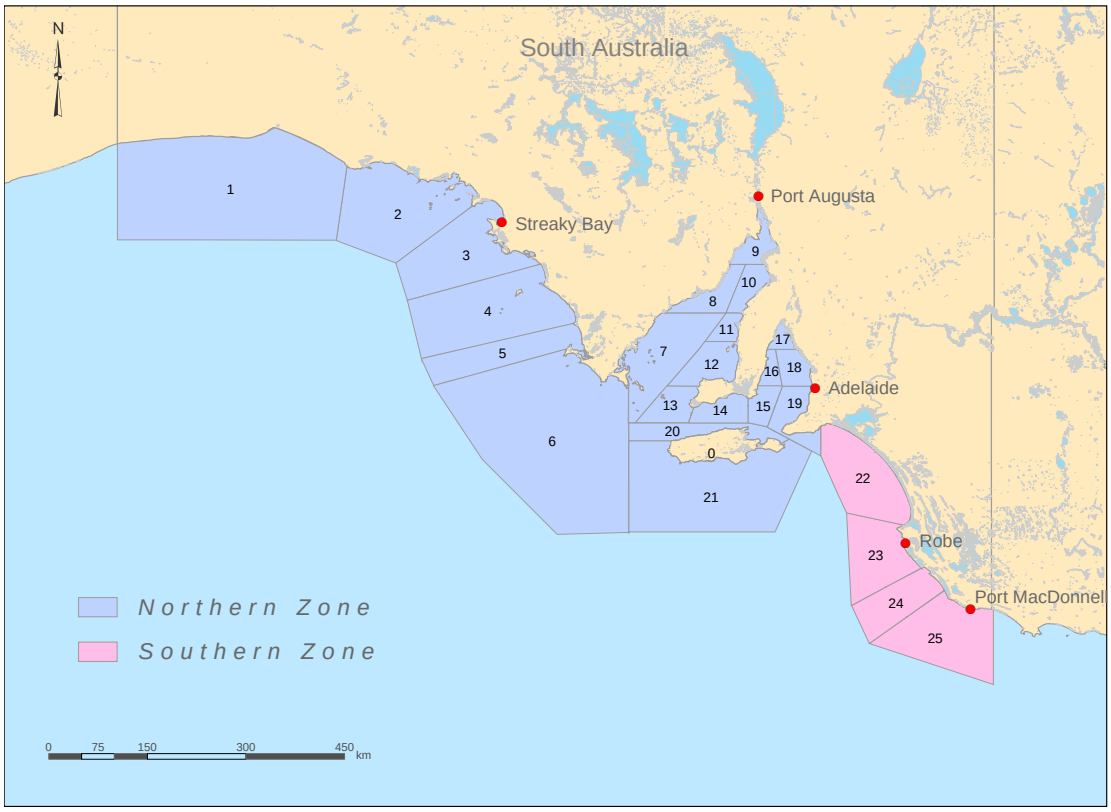
Appendix 3. Information brochure distributed to all recreational licence holders at the start of the 2004/05 fishing season outlining simple methods for determining lobster size and sex.

HOW TO MEASURE AND SEX YOUR ROCK LOBSTER



Rock lobster should be **measured** along the middle and on top of the carapace from the front edge of the groove between the antennae, to the rear edge of the carapace. This measurement does not include any hairs attached to the carapace. When using the ruler provided, try to hold it square across the middle and top of the carapace, and try to estimate the straight-line distance to the nearest millimetre.

One of the best methods of quickly determining the difference between **male** and **female** rock lobster is the location of the genital pore. In males, the genital pore is located at the base of the fifth walking leg. In the female rock lobster, the genital pore is found at the base of the third pair of walking legs, where the eggs are released.



Appendix 4. Map showing the distribution of regional fishing codes for South Australia used to summarise recreational lobster catch and effort data.