TASMANIAN RECREATIONAL ROCK LOBSTER AND ABALONE FISHERIES: 2008-09 FISHING SEASON

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Executive Summary

Southern rock lobster and abalone (blacklip and greenlip) are highly prized by recreational fishers in Tasmania. The numbers of rock lobster and abalone licences issued have increased steadily since the introduction of the present recreational licensing system in 1995, with about 21,000 persons holding at least one rock lobster licence and almost 13,000 persons licensed to fish for abalone during 2008-09. This represents more than doubling of the number of rock lobster and tripling of the number of abalone licence-holders since 1995. Rock lobster are taken by a variety of methods, including pots, ring or hoop nets, and dive collection. Abalone are primarily harvested by divers.

The present study represents the seventh survey of the rock lobster fishery and the sixth for the abalone fishery undertaken since 1996. A random sample of licence-holders was contacted by telephone in October 2008 and invited to participate in the survey in which fishing activity was monitored throughout the 2008-09 season. A total of 608 licensed respondents completed the survey, representing about one in 33 licence holders and a effective response rate of almost 90%.

During the 2008-09 rock lobster season (1 November 2008 – 31 August 2009), recreational fishers harvested an estimated 105,500 (95% CI: 91,900 – 119,000) rock lobster, based on 103,200 fisher days of effort. Potting was the dominant method, representing 83% of the effort (days fished) and 61% of the estimated harvest. Dive collection accounted for about 15% of the effort and 33% of the harvest, while ring usage contributed 2% of the effort and 6% of the harvest. The overall average harvest rate for the season was 1.0 rock lobster per day, with daily harvest rates of 0.75 for pots, 2.27 for dive collection, and 2.88 for rings. The daily bag limit of five rock lobster was rarely attained for pots (~1% of pot days) whereas the bag limit was attained in about one in five days based on dive and ring methods.

Seasonally the rock lobster fishery exhibited three distinct phases: intense activity early in the season (November to January) that accounted for about 70% of the total harvest; a period of intermediate fishing activity (February to April) that contributed a further 27%; and finally, a phase of low activity (May to August) that accounted around 3% of the season's total.

Conversion of numbers to weights produced a total recreational harvest estimate of 107 tonnes, with catches from the east coast (Areas 1-3) accounting for 58%, the north coast (Areas 4&5) 24%, and west coast (Areas 6-8) 19% of the total weight. This represented 63% of the total allowable recreational catch (TARC) of 170 tonnes and was equivalent to 6% of the notional total allowable catch (TAC) (inclusive of the commercial catch) of 1,693 tonnes.

An estimated 81,000 (95% CI: 65,700 – 95,600) abalone, based on 14,400 diver days of effort, were harvested by recreational fishers between 1 November 2008 and 31 October 2009. Over half of the abalone harvest was taken between November and January, 40% between February and April, and 8% between May and October. In total, almost 60% of the catch (numbers) was taken from the east coast, with the balance more or less equally taken off the north and west coasts.

Almost one-third of all dives that were targeted at abalone resulted in the daily bag limit of 10 abalone, and the overall average daily harvest rate was 5.6 abalone.

By converting numbers to weights, the 2008-09 recreational harvest of abalone was estimated as 39 tonnes, equivalent to 1.5% of the combined recreational and commercial catch of 2,593 tonnes. There are currently no explicit performance indicators relating to the recreational fishery for abalone.

Overall, there has been no evidence of expansion in recreational harvest for rock lobster and abalone since the mid-2000s despite increases in licence numbers. Several factors have contributed to this: first there has been a decline in the proportion of licence-holders who actually utilise their licences (i.e. fish), resulting in a slower rate of growth in *active* fisher numbers; second there has been a general decline in the average number of days fished per season for both rock lobster and abalone; and third, linked to this latter point, there have been declines in average seasonal harvest per fisher. Furthermore, rock lobster catch rates have declined, with average daily catch rates, and in particular pot catch rates, during 2008-09 at their lowest level since surveys commenced. While factors contributing to these trends warrant further attention, most respondents reported that they had fished less often during 2008-09 than in the previous season, an observation which is consistent with these findings.

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1 INTRODUCTION

Rock lobster and abalone are highly prized by recreational fishers in Tasmania. Southern rock lobster (*Jasus edwardsii*) are taken by a variety of methods, including pots, ring or hoop nets and dive collection[1]. Two species of abalone, blacklip (*Haliotis rubra*) and greenlip (*H. laevigata*), are targeted by recreational divers, the former dominating the catch and the latter generally restricted to the north coast of Tasmania and Bass Strait Islands. In addition to recreational importance, rock lobster and abalone support major commercial fisheries in Tasmania, both of which are subject to catch quotas.

Recreational licences (first introduced in the late 1970s) are required to harvest rock lobster and abalone. The licences are method-based and prior to the mid 1990s comprised rock lobster pot and general dive licences, the latter permitted the capture of rock lobster, abalone, and scallops by diving. The licensing system was revised in 1995 and the general dive licence was split into rock lobster dive, scallop dive and abalone licences. In 1998, a rock lobster ring licence was introduced, effectively closing a loophole in the legal take of rock lobster. Pot fishers are permitted to use one pot, ring fishers up to four rings, and divers can use artificial breathing apparatus (scuba and surface air supply, commonly known as hookah).

Licences are issued annually, with the licensing year extending between November and the following October. Recreational fishers may hold up to three categories of rock lobster licence and/or an abalone licence in a given fishing year[2]. In addition to licensing, minimum size limits, closed seasons, and a ban on the taking of females in berry apply to rock lobster. Minimum size limits apply for abalone. Recreational fishers are also subject to daily bag limits of five rock lobster and ten abalone and possession limits of ten rock lobster and twenty abalone.

Since the introduction of the present licensing system, the number of persons holding at least one recreational rock lobster licence has increased steadily from about 8500 to 21,000 in 2008-09, representing a more than doubling of numbers since 1995 (Fig. 1). Increases have occurred in each of the licence categories, with over 18,000 pot, 9000 dive and 5600 ring net licences issued in 2008-09. Abalone licence numbers have almost tripled since 1995, with almost 13,000 issued in 2008-09 (Fig. 1).

Set against these trends was the introduction of quota management for the commercial rock lobster fishery in 1998, with objectives to reduce catches to sustainable levels and to allow for rebuilding of legal-sized biomass (Ford 2001). The total allowable commercial catch (TACC) was initially set at 1502 tonnes and effectively represented a reduction in catches which had averaged over 1700 tonnes per annum for the decade prior to 1998. The TACC was increased to 1523 tonnes in 2002 and was maintained at

[1] Occasional catches of eastern rock lobster (*Jasus verreauxi*) also occur.
[2] Note, the licensing system also includes net and scallop licence categories.

this level until 2008-09. For 2009-10, the TACC was reduced to 1470 tonnes following concerns about stock levels.

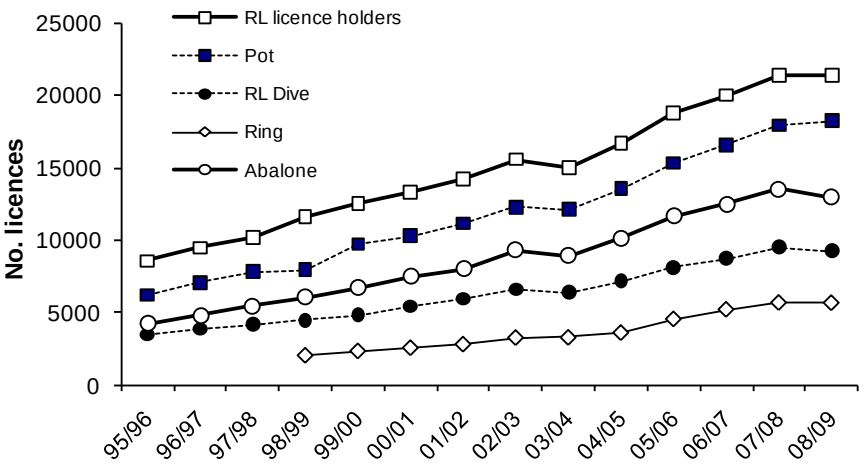

Fig. 1. Numbers of recreational rock lobster (RL) and abalone licences issued annually since 1995/96. RL licence holders refers to the number of persons holding at least one recreational rock lobster licence.

As part of the 2005 management review of the Tasmanian rock lobster fishery, provision was made for an explicit catch allocation to the recreational sector. Under these arrangements, a notional total allowable recreational catch (TARC) is set at 170 tonnes or 10% of the total allowable catch (TAC), whichever is the larger quantity. Based on these criteria, the TARC defaulted to 170 tonnes for 2008-09 which, when added to the TACC, resulted in a notional TAC of 1693 tonnes in 2008-09. Recreational catch information is thus required to evaluate performance against the TARC and also as an input into the rock lobster assessment model developed to assess stock status and undertake risk assessments under different management scenarios (Haddon & Gardner 2009).

Since 1995, the TACC for abalone has varied between 2,100 – 2,800 tonnes and was set at 2,593.5 tonnes (2,471 tonnes for blacklip and 122.5 tonnes for greenlip abalone) in 2008. While there are no specific management performance indicators relating to the recreational fishery for abalone, recreational catch data are taken into account in the annual assessment process (Tarbath & Gardner 2009).

The current survey represents the seventh in a series for rock lobster and the sixth for abalone undertaken since 1996. Key objectives include characterisation of the 2008-09 rock lobster and abalone fisheries in terms of participation, fishing effort and catch.

2 METHODS

2.1 Survey design

The methodology adopted was based on that used successfully in previous surveys and involved a two-stage process; an initial telephone interview to establish eligibility and collect profiling information; and follow-up telephone-diary survey in which fishing activity was monitored in detail.

2.1.1 Survey sample

The survey sample was selected from the 2007-08 recreational licensing database administered by the Department of Primary Industries, Parks, Water and Environment. While the majority of licence holders are Tasmanian residents, a small number of interstate and overseas residents also take out licences. Commercial fishers are eligible to hold recreational licences, although restrictions controlling recreational gear and its use on commercial fishing trips apply. Persons under 10 years of age are not eligible to hold a rock lobster licence.

All fishers with rock lobster and/or abalone licences were included in the 'population' of licence-holders. The database was then split into three strata based on licence(s) held; Stratum 1 - holders of at least a rock lobster dive licence (may or may not also possess pot, ring and/or abalone licences); Stratum 2 - all remaining rock lobster licence-holders (may or may not also possess an abalone licence); and Stratum 3 – abalone-only licence holders. A sample was randomly selected from each stratum, with higher sampling rates for stratum 1, intended to improve precision in dive harvest estimates.

2.1.2 Screening survey

Respondents were contacted by telephone during October 2008 and asked about their intention to renew their rock lobster and/or abalone licences for the 2008-09 fishing season. Sampling was conducted without replacement, i.e. persons without a telephone listing or those who did not respond were not substituted in the sample.

2.1.3 Telephone-diary survey

Respondents who indicated an intention to renew their licences for the 2008-09 season were deemed eligible and were invited to participate in the diary survey. Those who accepted were mailed a diary and letter of introduction. Diarists were contacted by telephone shortly afterwards to confirm receipt of the diary and to have reporting requirements explained. Diarists were then contacted regularly by telephone throughout the diary period by survey interviewers who recorded details of any rock lobster and/or abalone fishing activity since last contact. The frequency of the contact was tailored to

the needs and behaviour (level of fishing activity) of individual respondents and thus detailed information was routinely collected soon after each fishing event, minimising recall bias problems for any non-diarised data. By maintaining regular contact, interviewers were also able to immediately clarify any misunderstandings or inconsistencies at the time of the interview, thereby ensuring overall data quality and completeness.

In practice, diarists were contacted at least once a month between November 2008 and April 2009, even if no fishing activity was planned. In May, all diarists were contacted as usual and asked whether they anticipated any more fishing trips during the remainder of the season. Regular contact was maintained with those who expected to fish, whereas those not planning to fish again were not contacted again until September (after the closure of the rock lobster season), when details of any unexpected fishing activity was collected. Diarists who held abalone licences were contacted again in November to ensure that any late season abalone fishing activity was also recorded.

Information recorded for each fishing activity or 'event' included the date, fishing location, method used, species targeted for divers, start and finish times (including any significant breaks from fishing), and the numbers of rock lobster and/or abalone kept (harvested). In addition, the number of rock lobster released (or discarded) and reason(s) for release were recorded. Fishing locations were then allocated into the eight areas used for rock lobster assessment reporting (Fig. 2), though further spatial disaggregation was feasible since quite specific location information was routinely collected.

By definition, a fishing event was described in terms of method and fishing region. If more than one method was used or different regions were fished on a given day, separate events were recorded. For example, two separate events were recorded if a respondent used a pot and dived for rock lobster on the same day, with catch and effort information linked separately to each method.

Pots were generally fished overnight. In a small number of instances pots were not checked for several days, usually because of unfavourable weather conditions. The start of the fishing day was taken as the time the pot was set and the finish as the last time on a given day that it was checked or hauled. In cases where the pot was checked more than once in a day, the reported catch related to the total number of rock lobster taken for the day. For the purposes of calculating effort, overnight sets were considered to represent a single pot-day of effort.

For rock lobster, the enumeration period encompassed the 2008-09 fishing season (1 November 2008 to 31 August 2009) while the enumeration period for abalone was the licensing year (1 November 2008 to 31 October 2009).

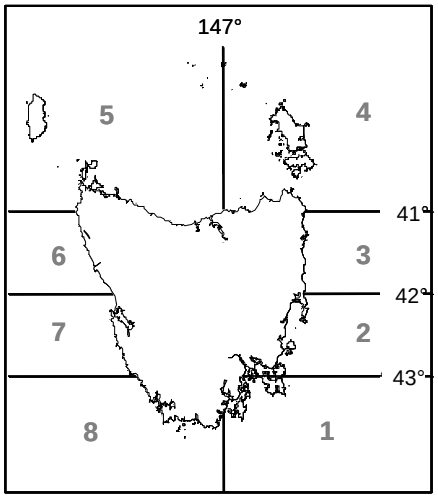

Fig. 2. Map of Tasmania showing assessment areas

2.2 Data analysis

2.2.1 Catch and effort

Although initial sample selection was based on the 2007-08 licence database, licence details for 2008-09 were used for data expansion. That is, the licensing status (licences held and dates of issue) was established for all diarists by reference to the 2008-09 licence database and expansion factors calculated as the size of the licensed population divided by the number of licensed diarists within each stratum. A small number of diarists, by virtue of licences actually held in the diary survey period, changed strata for the purposes of data analysis. As initial sample selection was random these effects are not assumed to have introduced systematic biases.

Since the number of licensed fishers increased progressively during the season, the sample size (i.e. number of *licensed* diarists) and total number of licensed fishers changed within the diary enumeration period. About 69% of rock lobster and abalone licences were issued by the end of November 2008, this proportion increased to 86% by the end of December and 93% by the end of January 2009. Very few additional licences were issued after April 2009. In order to account for this dynamic, the number of licence holders registered on the licence database and the number of licensed diarists at the end of each month provided the basis for calculating expansion factors that were applied to fishing activity for the given month.

The survey scope was confined to licensed recreational fishing activities; namely, the use of pots and rings and dive methods to harvest rock lobster and the harvest of abalone. Any fishing activity reported by diarists whilst unlicensed (either prior to renewing a licence or by diarists who did not renew licences) was considered out of scope and thus excluded from all analyses. The base unit for catch and effort analysis was the total monthly effort and catch for each licensed respondent and this was expanded by the relevant monthly expansion factor.

The 'bootstrap' method was used to estimate harvest and effort confidence limits, determined using the percentile method (Haddon 2001). In each instance 5000 simulations were conducted.

2.3 Size composition

Size composition information for recreationally caught rock lobster was provided by volunteer diarists. At screening, potential diarists who had reported substantial fishing activity during the 2007-08 fishing season were asked whether they would be prepared to measure their catch as part of the survey. Respondents who expressed an interest in measuring their catch were provided with a set of callipers and an instruction sheet showing how to measure and sex rock lobster. Sex and carapace length (mm) information reported by respondents was linked to capture event, enabling size composition information to be made sensitive to method and region.

Lengths were converted into weights using the following relationships:

$$W = 0.000285L^{3.114} \qquad \text{males}$$

$$W = 0.000271L^{3.135} \qquad \text{females}$$

where W is body weight (g), L is carapace length (mm) (Punt & Kennedy 1997). Average weights by method and region were then applied to convert harvest numbers to weight for the purpose of comparison with the TARC.

2.4 Commercial catch data

Commercial catch data was obtained from compulsory catch returns provided by rock lobster and abalone fishers. Rock lobster data are reported on a daily basis by depth and by ½ degree fishing blocks and applied to the 2008-09 quota year (March to February). Catches are reported in terms of numbers and weights.

Abalone divers report daily catch weights taken by fishing block or sub-block and catch data for the calendar year 2008 were presented. For regional comparisons between commercial and recreational abalone catches, if commercial fishing blocks were bisected by recreational area boundaries (defined in Fig. 2), commercial catches within such blocks were apportioned equally between the two adjacent recreational areas.

3 RESULTS

3.1 Response rates

3.1.1 Screening survey

From a random sample of 1030 licence-holders selected from the 2007-08 licence database, 45 (4.4%) either had no telephone listing or the number was disconnected. This represented sample loss and reduced the effective sample to 985. Contact was made with 888 licence-holders, of whom 868 fully responded, representing an effective screening survey response rate of 88%. Non-contacts (despite at least ten attempts by telephone over a period of several weeks) accounted for 10% of the sample and refusals a further 2% (Fig. 3).

Amongst the respondents, 75 indicated that they were not likely to renew their licence(s) in 2008-09 and hence were not eligible for inclusion in the diary survey[3]. The balance (793) indicated they were likely to renew their licence(s) and 93% (741) agreed to participate in the diary survey (Fig. 3).

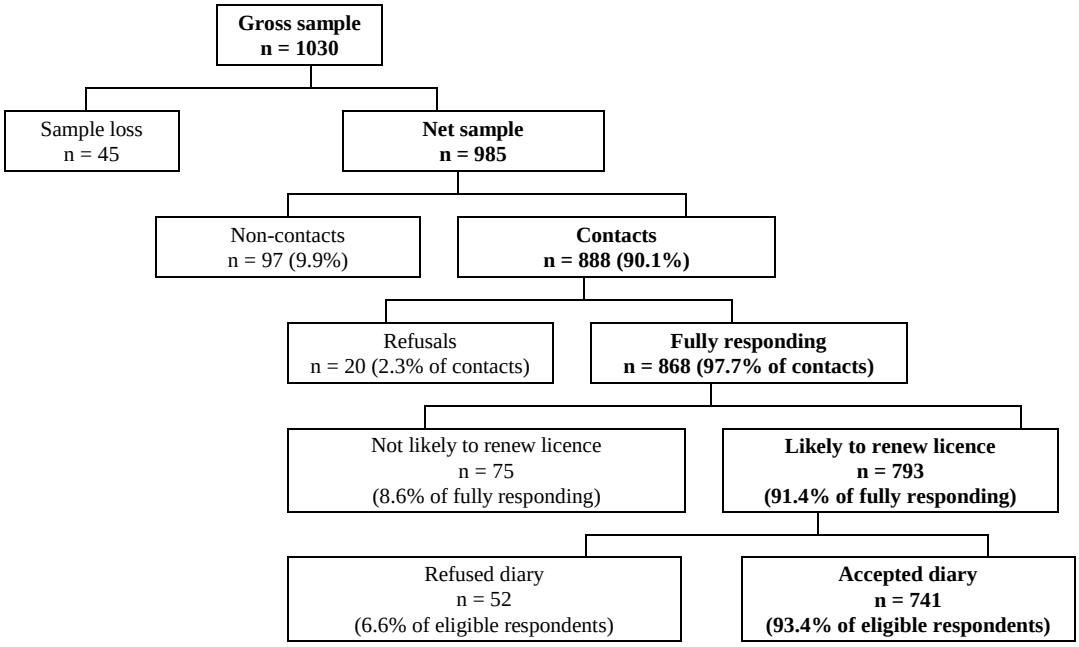

Fig. 3. Diagrammatic representation of the screening survey response profile (n is sample size).

[3] The licence status of these respondents was checked at the end of the 2008-09 season and 22 renewals (29%) were identified.

3.1.2 Telephone-diary survey

Diary response was high, with 697 diarists or 94% of respondents who accepted the diary participating for the entire survey period (Fig. 4). Based on the total number of eligible respondents identified in the screening survey (793), the effective response rate for the diary survey was 88%. Given the high response rates, possible biases arising from non-response were not considered to be a significant problem in this study and thus analyses do not incorporate non-response adjustments.

Data for the diarists who partially responded (i.e. declined to participate for the full period or with whom contact was lost) have been excluded from all analyses.

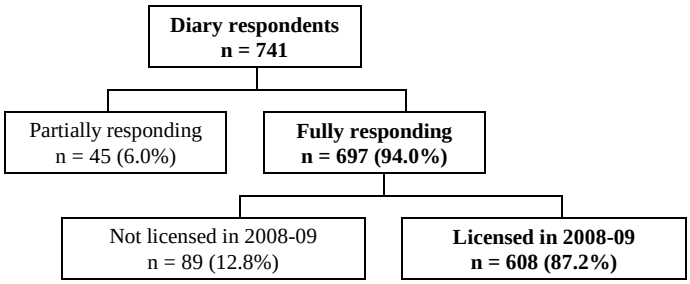

Fig. 4. Diagrammatic representation of the diary survey response profile (n is sample size).

Of the responding diarists, 13% (89) did not take up a licence during 2008-09, despite rating themselves as 'quite likely' to 'very likely' to do so. Among the remaining 608 respondents, 588 held at least one category of rock lobster licence while 412 had an abalone licence. The numbers of rock lobster and abalone licences in the licensed population and the sample of responding diarists are presented in Table 1 and indicate, as mentioned in Section 2.1.1, that dive licence holders were over sampled through the stratification process. Overall, about one in 33 licence holders participated in the survey.

Table 1 Total number of 2008-09 rock lobster and abalone licence holders, numbers sampled (fully responding) and sample fraction by licence type.

Licence type	Licence holders	Diarists	% sampled
Rock lobster pot	18,256	508	2.8
Rock lobster dive	9,255	306	3.3
Rock lobster ring	5,668	168	3.0
Abalone	12,976	412	3.2
Total licences	46,155	1394	3.0
Total persons	21,977	608	2.8

Fully responding diarists reported a total of 3234 fishing events during the survey period, 3176 (>98%) of which were valid events[4]. In total, 84% of all valid fishing events were reported as being recorded in the diaries, the balance was based on recalled fishing activity (typically collected by survey interviewers within a few weeks of the activity taking place).

3.2 Rock lobster

Information reported in this section relates to analyses of diary survey data provided by fully responding licence holders, and is presented as expanded estimates for the total population of recreational rock lobster licence holders in 2008-09.

3.2.1 State-wide catch and effort

During the 2008-09 fishing season an estimated 75.2% (SE 1.8%) of rock lobster licence holders (equivalent to 16,050 persons) fished for rock lobster. In addition to those who did do not fish, a further 18.9% reported no retained rock lobster catch for the entire season, implying that the catch of rock lobster was taken by just 56.2% of licence holders (12,005 persons).

Overall, total fishing effort was estimated at 103,200 fisher days[5] for the season, yielding an estimated harvest of 105,538 rock lobster (Table 2). This represented an average seasonal harvest rate of 1.0 rock lobster per day fished. Pots were the most popular fishing method (accounting for 61% of the total harvest) followed by dive collection (33%) and rings (6%) (Table 2). Although over five times as many fisher days of effort were spent using pots compared with diving, pots yielded less than twice the number of rock lobster. Ring harvest and effort was low by comparison with the other methods. Mean daily harvest rates were over three times higher for dive (2.27 rock lobster) and ring (2.88 rock lobster) methods compared with pots (0.75 rock lobster).

Table 2. Rock lobster effort, harvest and harvest rates for the 2008-09 season
Values in parentheses represent the 95% confidence intervals

Method	Harvest (no.)	Effort (days)	Mean harvest rate (no. day^{-1})
Pot	64,594 (56,459 – 76,805)	86,585 (76,941 – 99,886)	0.75
Dive	34,671 (26,497 – 44,200)	15,235 (12,565 – 18,335)	2.27
Ring	6,230 (3,117 – 10,115)	2,165 (1,296 – 3,220)	2.88
Total	105,538 (91,855 – 119,045)	103,200 (91,624 – 115,050)	1.02

[4] Events reported by diarists whilst unlicensed were considered out of scope and invalid.
[5] A fisher day is defined as a day in which lobster was a nominated target species and/or lobsters were caught.

3.2.2 Seasonal catch and effort

Intense fishing activity corresponded with the opening of the season and the summer holiday period, with greatest levels of effort and harvest during January (Fig. 5). Overall, fishing activity slowed dramatically in February/March followed by a slight increase in activity in April corresponding with the Easter holiday period. There was relatively limited fishing during the final four months of the season, related to the closure of the fishery for female rock lobster and the onset of cooler and unsettled weather.

The underlying pattern of catch and effort in the fishery was influenced strongly by monthly variation in pot fishing activity, with 77% of the pot catch taken between November and January and 21% between February and April (Fig. 5). Dive catch and effort was more evenly distributed between November and April, with 59% of the catch taken in the first three months and a further 36% in the following three month period.

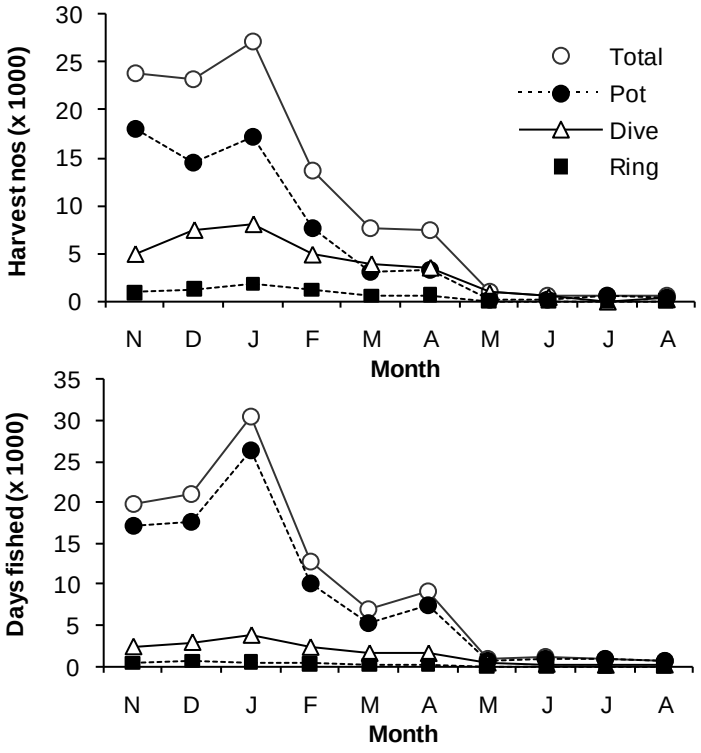

Fig. 5. Recreational rock lobster harvest (numbers) and effort (days fished) by month and method for the 2008-09 fishing season.

3.2.3 Regional catch and effort

Effort, catch and catch rates by fishing areas (refer Fig. 2) are summarised in Table 3 and indicate that the fishery was primarily focussed off the east coast (Areas 1-3). This combined region accounted for two-thirds of the total estimated harvest (70,419 rock lobster) and attracted 73% of the total effort (76,186 fisher days) during 2008-09. Area 1 alone contributed 28% to the total harvest. The north coast (Areas 4&5) accounted 14% of the total harvest (15,070 rock lobster) and 13% of effort (13,826 fisher days) while the west coast (Areas 6-8) contributed 19% of the total harvest (20,006 rock lobster) and 13% of total effort (13,974 fisher days).

Table 3. Recreational rock lobster effort, harvest and harvest rates by fishing area for 2008-09
Values in parentheses represent the 95% confidence intervals

Area	Harvest (no.)	Effort (fisher-days)	Harvest rate (no. per fisher-day)
1	29,697	30,692	0.98
	(23,483 – 36,635)	(25,333– 36,686)	
2	21,371	20,783	1.03
	(15,402 – 28,431)	(15,506 – 26,951)	
3	19,351	24,710	0.78
	(12,420 – 27,547)	(16,629 – 33,661)	
4	10,271	8,849	1.16
	(5,947 – 15,866)	(5,313 – 13,522)	
5	4,799	4,977	0.96
	(1,760 – 8,845)	(2,248 – 8,725)	
6	8,330	6,185	1.35
	(4,784 – 12,650)	(3,738 – 8,602)	
7	7,404	3,141	2.36
	(3,839 – 11,712)	(1,758 – 4,450)	
8	4,273	4,648	0.91
	(1,973 – 7,072)	(2,125 – 7,669)	

Marked regional differences were evident in the proportion of the rock lobster harvest taken by the different fishing methods (Fig. 6). Pots accounted for the bulk (64-78%) of the harvest from the east coast (Areas 1-3), whereas off the north coast (Areas 4&5) dive collection was the primary capture method (59-74%). All three methods were of significance in the west coast fishery (Areas 6-8); pots accounted for 36-69%, rings 10-56% and dive collection 7-24% of the harvest by number.

Mean daily harvest rates were highly variable around the state, ranging from over two rock lobster per day in Area 7 to less than 0.8 in Area 3. Harvest rates for the remaining areas were intermediate, between 0.9-1.35 rock lobster per day (Table 3). Stock abundance and total fishing pressure (including commercial activity), along with the relative mix of fishing methods used, noting significantly higher harvest rates for dive collection and rings compared with pots (Table 2), represent key factors contributing to this regional variability.

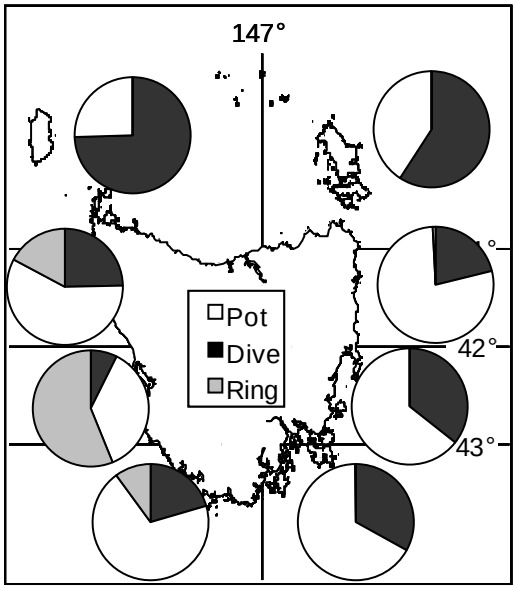

Fig. 6. Proportion of regional harvest by fishing method (pie charts).

3.2.4 South-east coast fishery

Catch data for Area 1 have been disaggregated into five sub-areas to better define the spatial characteristics of the fishery off the south-east coast (Fig. 7). Over 40% of the harvest was derived from the waters around the Tasman Peninsula, with western Storm Bay (including Bruny Island) next in importance and accounting for one fifth of the catch. The D'Entrecasteaux Channel contributed 19%, Norfolk/Frederick Henry Bays a further 9%, and Derwent 4% to the total.

Pots accounted for the majority of the Tasman, western Storm Bay and D'Entrecasteaux Channel catches whereas dive collection was the dominant method in Norfolk/ Frederick Henry Bays and the Derwent (Fig. 7).

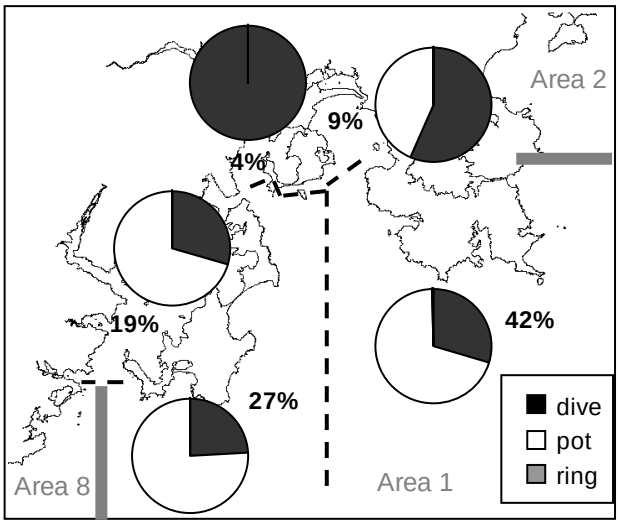

Fig. 7. Regional distribution of Area 1 harvest (%) and proportion of harvest by method (pie charts).

3.2.5 Daily harvest

Daily catch distributions differed markedly by fishing method (Fig. 8). Overall about half of all pot-days yielded no retained catch, with the daily bag limit of five rock lobster rarely achieved (~1% of all fishing days). By contrast, divers took the bag limit on about one in every five days fished, with nil catches reported for about one in four days fished. Rings were also very effective with the bag limit reached in about one-third of all fishing days.

Dive effort, which can be split into snorkel, scuba and hookah methods, revealed a strong method effect on catch rates (Fig. 8). Overall, average daily harvest rates were highest for hookah (2.9 rock lobster), followed by scuba (2.1 rock lobster) and snorkel (0.8 rock lobster). The bag limit was attained in one third of all hookah dives, compared with 15% of scuba and 5% of the snorkel effort. Overall, hookah proved the most popular dive method for rock lobster, accounting for 45% of the total dive effort and 59% of the harvest. Scuba was next in importance, representing 40% of the effort and 36% of the harvest, while snorkel divers contributed 15% of the effort and 5% of the dive harvest.

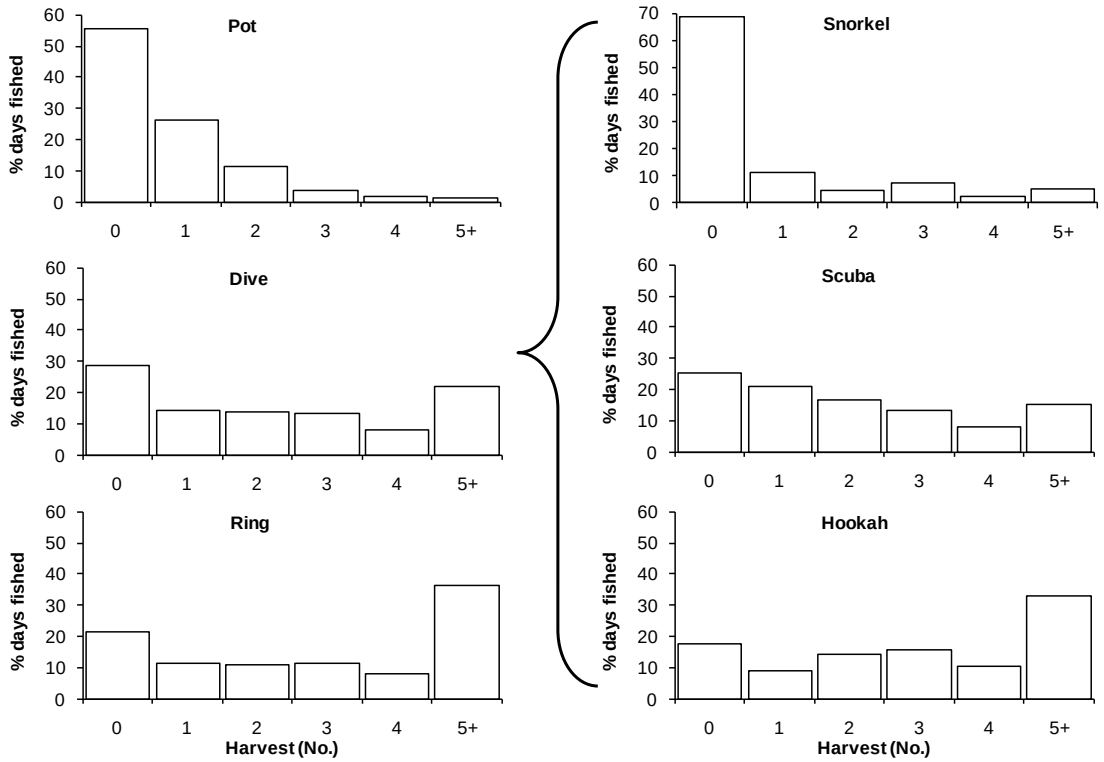

Fig. 8. Distribution of daily rock lobster harvest by fishing method for 2008-09 licence holders.

3.2.6 Released catch

In total 68,919 rock lobster were estimated to have been released or discarded from pot catches, equivalent to 1.1 for every rock lobster retained. About 89% of pot releases were reported to be due to undersized rock lobster, 5% were berried females and 1% each because rock lobster were dead or damaged or as a result of over bag limit catches.

Although divers may release rock lobster, i.e. the catch is landed and then sorted with the possibility of high-grading, most of this 'sorting' probably occurs underwater and therefore a similar analysis of reasons for release by divers was not attempted.

3.2.7 Size composition

Diarists reported lengths for 1233 pot caught, 716 dive caught and 64 ring caught rock lobster from around Tasmania. Overall, pot caught rock lobster ranged between 105-220 mm carapace length (CL), with an average weight of 897 g. Dive caught rock lobster ranged between 105–240 mm CL but tended to be larger on average, with a mean weight of 1104 g. As relatively few ring caught rock lobster were measured[6], data for pots and rings have been combined in subsequent analyses. Male to female sex

[6] Measurements of ring caught lobster were derived almost exclusively from Areas 6&7.

ratios for pot/ring (1:1.07) and dive (1:0.99) catches did not differ significantly from 1:1.

Length frequency distributions by region are presented in Fig. 9. Moving south to north along the east coast there was a general trend for the average size of rock lobster to increase, with the largest lobster taken off the north coast (refer Table 4). Data for Areas 4-8 have been combined owing to relatively small sample sizes, although in determining average weights for the purpose of converting catch numbers to mass, the north coast (Areas 4&5) and west coast (Areas 6-8) have been treated separately (refer Table 4). There was insufficient data available from the west coast (Areas 6-8) catches to determine whether the latitudinal trend in average size observed off eastern Tasmania persisted in that region.

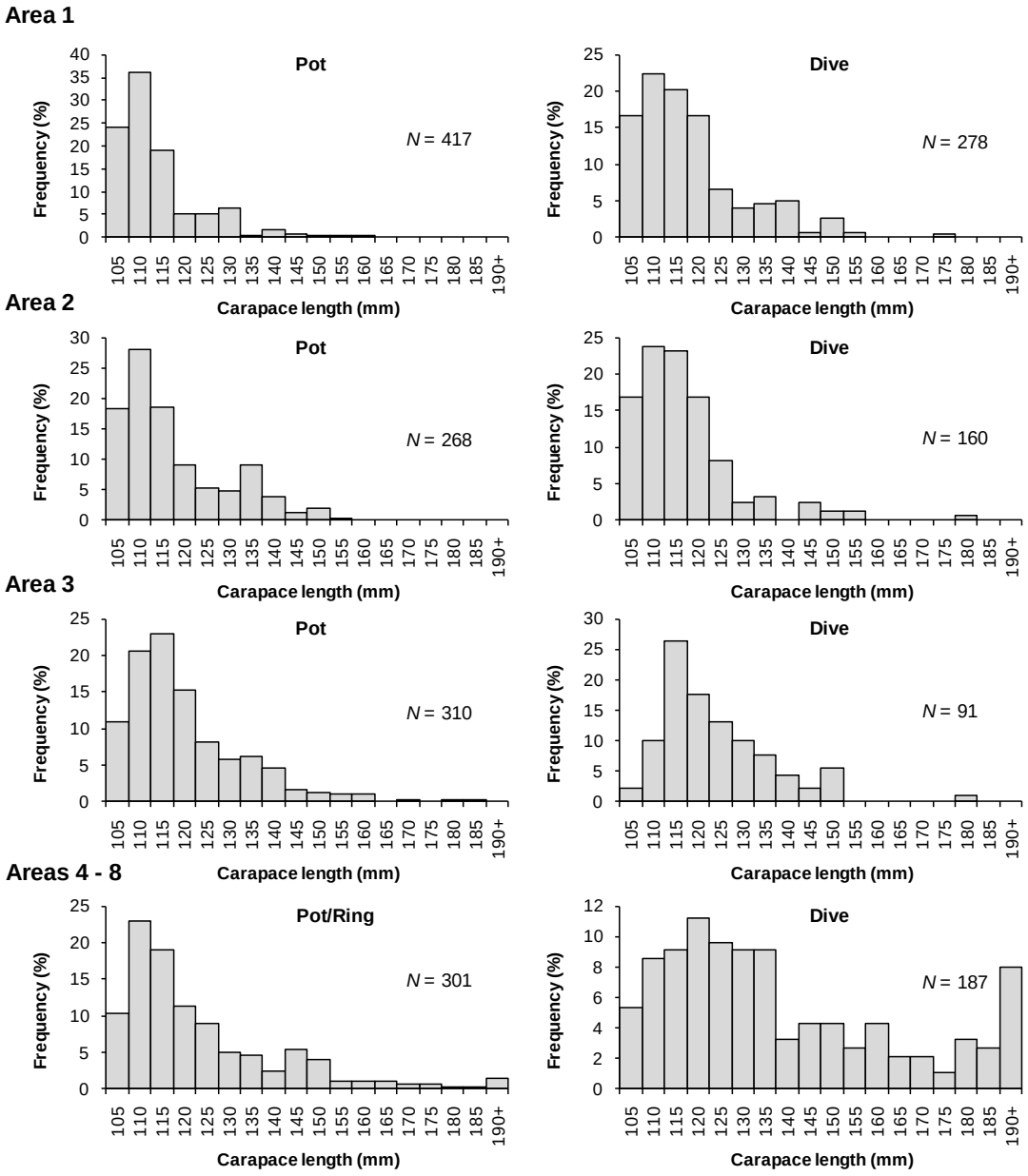

Fig. 9. Length frequency distributions by 5 mm size class for recreationally caught rock lobster taken by dive, pot and pot/ring fishing methods by assessment area. *N* is sample size.

3.2.8 Estimated harvest weight

The weight of the 2008-09 recreational harvest was estimated by multiplying the average weight of a rock lobster, specified by method and region of capture, by the numbers harvested. Average weights by area and method used to determine harvest weight are presented in Table 4.

The state-wide harvest was estimated to be 107 tonnes, equivalent to 63% of the TARC. Regional harvest estimates ranged between 24.5 (Area 1) and 4 tonnes (Area 8) (Table 4). As a proportion of the recreational harvest, the east coast (Areas 1-3) accounted for 58%, north coast (Areas 4&5) 24%, and west coast (Areas 6-8) 18% of the total weight. The combined effects of the dominance of dive collection along with the presence of large rock lobster was particularly evident off northern Tasmania, with that region accounting for 14% of the retained numbers (refer Table 3).

Table 4. Average rock lobster weight (g) by method and total estimated harvest (kg) by area

	Av. weight (g)		Total
Area	Pot/Ring	Dive	harvest (kg)
1	792	889	24,506
2	878	870	18,702
3	944	1037	18,648
4	1417	1828	17,060
5	1417	1828	8,270
6	942	1228	8,434
7	942	1228	7,130
8	942	1228	4,276
Total			107,027

3.2.9 Comparison with commercial catches

The recreational harvest represented 6.3% of the notional 2008-09 TAC and 7.5% of the actual combined recreational and commercial catch. Regionally, there was marked variability in the recreational share of the total harvest, ranging from 16-20% in the east (Areas 1-3) to 1% in the south-west (Area 8) (Fig. 10A).

Since the majority (here assumed to be all) of the recreational catch is taken from shallow coastal waters (< 20 m), it is also appropriate to compare catches at the spatial scale (depths) at which the two sectors overlap and therefore interact. On this basis, the recreational harvest represented almost a quarter of the combined shallow water catch

of 438 tonnes[7] (Fig. 10B). The recreational harvest was roughly equivalent in magnitude (~ 50% of the total) to the shallow water commercial catch in each of the east coast fishing areas. Recreational catches also represented a relatively significant component of the inshore harvest from Area 6 (46%) and Area 4 (23%). The significance of the recreational catch in Area 6, however, was more a function of the low shallow water commercial catch than indicative of a large recreational take. The recreational share of the inshore catch was relatively minor in the remaining west and north coast fishing areas.

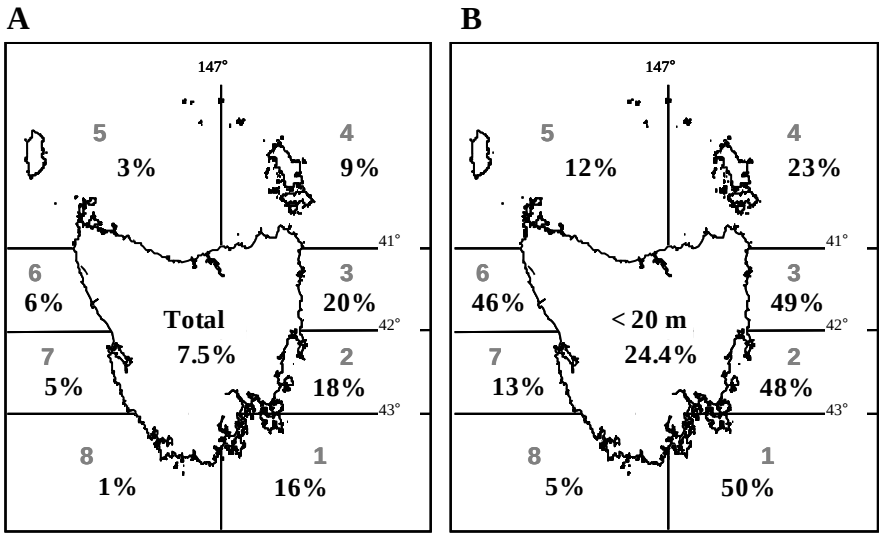

Fig. 10. 2008-09 recreational rock lobster harvest (weight) expressed as a percentage of the total rock lobster catch (commercial plus recreational) by area: (A) based on total catch (all depths); and (B) shallow water (< 20m) catches (refer text).

3.3 Abalone

Information reported in this section relates to analyses of diary survey data provided by fully responding licence holders, and is presented as expanded estimates for the total population of recreational abalone licence holders during 2008-09.

3.3.1 State-wide catch and effort

An estimated 38.8% (SE 2.1%) of abalone licence holders (equivalent to 5033 persons) actually fished for abalone during 2008-09, harvesting 81,021 abalone (95% CI: 65,676 – 95,628) for 14,444 fisher days[8] (95% CI: 12,024 – 16,610) of effort. This represented

[7] Shallow water commercial catch was reported as 331 tonnes for the 2008-09 quota year.

[8] A fishing day was defined as one in which abalone was a nominated target species and/or abalone were caught.

an average harvest rate of 5.6 abalone for each day fished. The catch was taken almost exclusively by dive collection methods, though a small proportion (<0.5%) was also taken by hand collection (wading).

3.3.2 Seasonal catch and effort

The fishery for abalone exhibited a strong seasonal pattern, with a marked increase in effort between November and January, and peak catches in January (Fig. 11). The first three months of the licensing year accounted for 52% of the annual harvest and 56% of the effort. There was a sharp decline in effort and harvest in February/March and a minor increase in the level of fishing activity during April, mainly due to Easter fishing. The February to April period contributed around 40% of the annual harvest and effort. There was very limited fishing for abalone during the final six months of the licensing year.

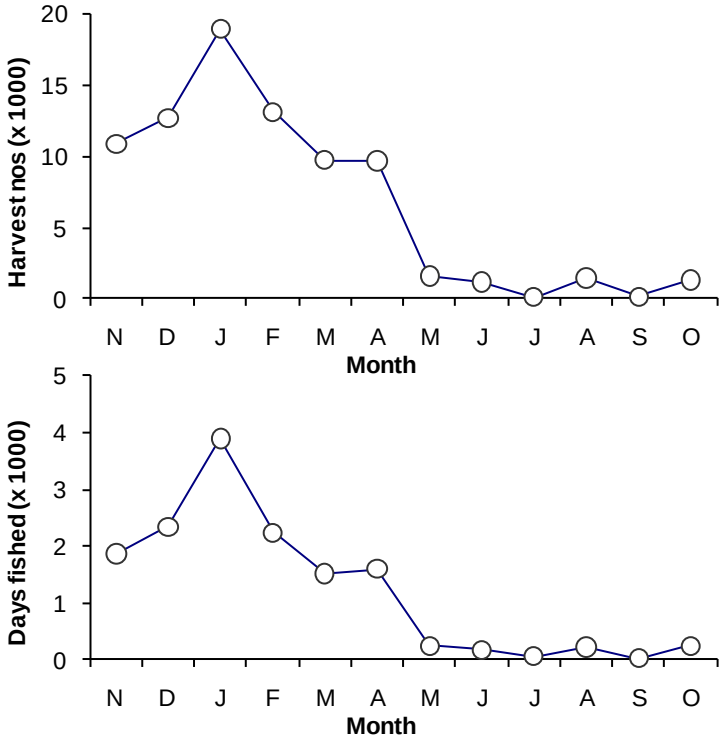

Fig. 11. Recreational abalone harvest (numbers) and effort (days fished) by month for the 2008-09 fishing season.

3.3.3 Regional catch and effort

Regional catch, effort and harvest rates for abalone are presented in Table 5. Recreational effort and harvest was concentrated in the south-east, with one third of the harvest and 37% of the effort reported from Area 1. The remaining east coast fishing areas (Areas 2&3) collectively accounted for a further 25 and 30%, the north coast (Areas 4&5) 25 and 19%, and the west coast (Areas 6-8) about 20 and 14% of the catch and effort, respectively. Regional harvest rates varied between 4-5 abalone per day off the east coast (Areas 1-3), around 6 per day off the north coast (Areas 4-5) and 8-9 per day off west coasts (Areas 6 -8).

Table 5. Recreational abalone effort, harvest and harvest rates by fishing area for 2008-09
Values in parentheses represent the 95% confidence intervals, * average weight based on commercial catch sampling data (D Tarbath, TAFI)

Area	Harvest (no.)	Effort (fisher days)	Harvest rate (no. per fisher day)	Av. weight (g)*	Harvest (kg)
1	27,414 (20,155 – 36,964)	5,387 (4,077 – 6,865)	5.1	512	14,036
2	10,861 (6,532 – 16,233)	2,584 (1,730 – 3,668)	4.2	463	5,029
3	9,698 (4,427 – 16,817)	1,761 (914 – 2,847)	5.5	463	4,490
4	7,821 (3,339 – 13,502)	1,348 (584 – 2,331)	5.8	393	3,074
5	9,324 (4,341 – 15,893)	1,452 (799 – 2,276)	6.4	393	3,664
6	10,675 (5,904 – 16,407)	1,349 (719 – 2,132)	7.9	549	5,861
7	1,923 (288 – 4,322)	237 (29 - 507)	8.1	549	1,056
8	3,305 (1,166 – 5,904)	372 (143 - 665)	8.9	549	1,814

3.3.4 South-east coast fishery

Data for Area 1 were disaggregated into five sub-areas to better define the spatial characteristics of the fishery in the south east (Fig. 12). The Tasman Peninsula was the most important sub-area, accounting for just under half of the total harvest, followed by the Norfolk-Frederick Henry Bay, D'Entrecasteaux Channel and Bruny Island in decreasing importance. Catches from the Derwent Estuary were relatively insignificant.

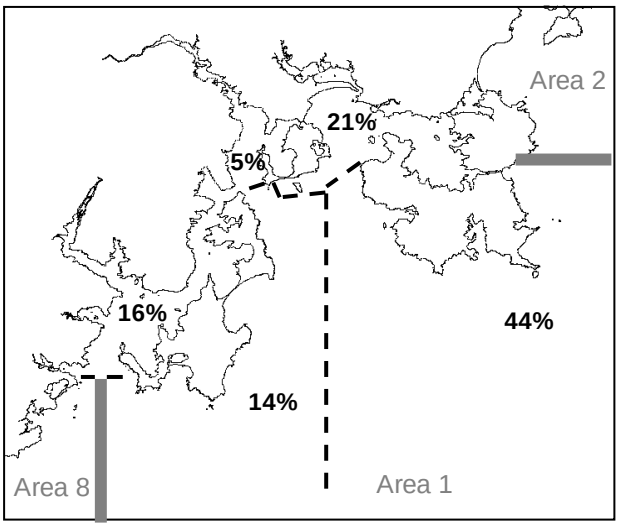

Fig. 12. Regional distribution of Area 1 abalone harvest.

3.3.5 Daily harvest

Approximately 32% of the dive effort targeted at abalone resulted in the bag limit being achieved (or exceeded) whereas less than 15% of dives resulted in no harvest (Fig. 13). Divers using hookah achieved the highest catch rates (6.1 abalone per day), with 43% of diver-days of effort achieving the bag limit of ten abalone. Average daily catch rates for snorkel (5.6) and scuba (5.1) were slightly lower, as was the proportion of effort that resulted in at least ten abalone being taken (29% for snorkel and 25% for scuba).

Of the three dive methods snorkel accounted for 42% of the harvest and 41% of effort (diver days), hookah 33% of the harvest and 30% of the effort, and scuba contributed 25% of retained catch and 28% of the effort.

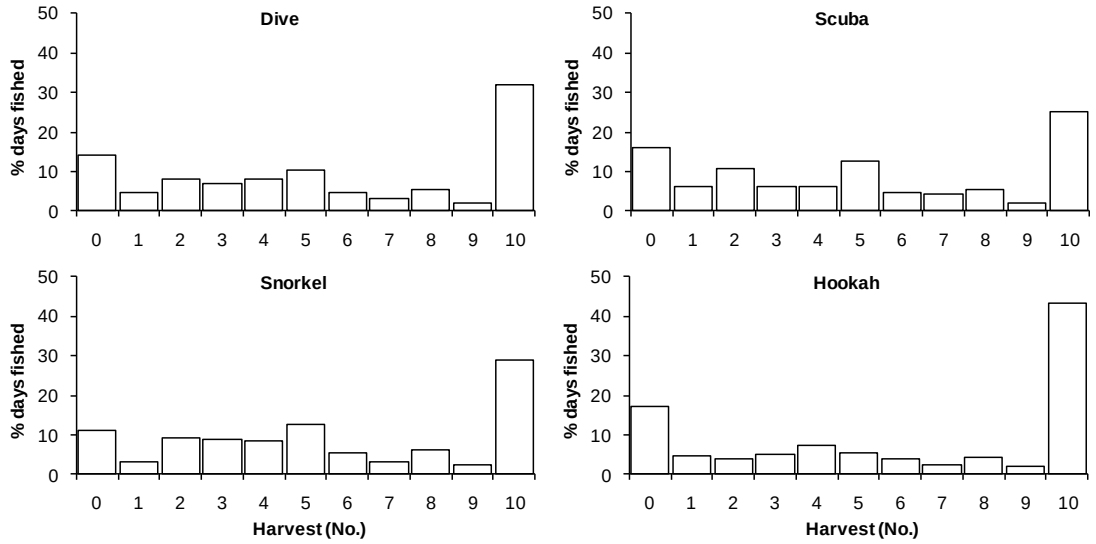

Fig. 13. Distribution of daily abalone harvest by dive methods for 2008-09 licence holders

3.3.6 Estimated harvest weight

Size composition information was not available for recreationally caught abalone. However, based on commercial catch sampling, the average legal-sized abalone by the major fishing regions was estimated to vary between 549 g off the west coast (Areas 6-8) and 393 g off the north coast (Areas 4&5) (Table 5; D. Tarbath, pers. comm.). Using these values, the recreational harvest during 2008-09 was estimated to be about 39.0 tonnes. Regionally, harvest estimates ranged from 14 tonnes in Area 1 to about 1 tonne in Area 7 (Table 5). The catch for the combined east coast (Areas 1-3) was 23.5 tonnes, the north coast (Areas 4&5) 6.7 tonnes, and the west coast (Areas 6-8) 8.7 tonnes.

3.3.7 Comparison with commercial catches

The 2008 commercial abalone catch was 2554 tonnes[9], indicating that the recreational harvest was equivalent to 1.5% of the combined state-wide catch. Regionally, the recreational component of the fishery accounted for almost 12% of the combined commercial and recreational harvest in the north east (Area 3), whilst in all other regions the recreational contribution was relatively low (<5%) (Fig. 14).

[9] Based on estimated weights - blacklip abalone accounted for 2433 tonnes and greenlip 121 tonnes.

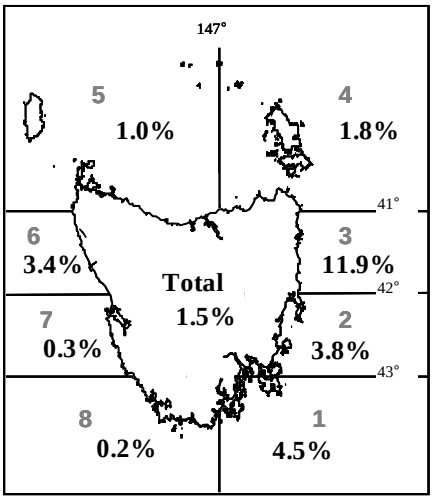

Fig. 14. 2008-09 recreational harvest (weight) of abalone expressed as a percentage of the total catch by area (inclusive of 2008 commercial catches).

4 DISCUSSION

To date, seven estimates of recreational rock lobster harvest are available based on the methodology applied in this survey. Prior to the mid-2000s, the rock lobster harvest generally increased as licence numbers grew but since then harvest levels have stabilised and even declined slightly in spite of continued growth in licence sales (Fig. 15). However, since 2000-01 95% confidence intervals have overlapped in each of the years apart from 2002-03, indicating that statistically estimates have not differed significantly. The decline in rock lobster catches between the two most recent surveys was almost exclusively due to a halving of the catch taken from Area 1 (refer Lyle 2008). While the reason for this change is not clear, lower catch rates may have been a factor. In addition, anecdotal reports suggest that some fishers may have directed effort into alternative fishing activities, including gamefishing; noting that 2009 was one of the most productive tuna seasons off south-eastern Tasmania in recent years.

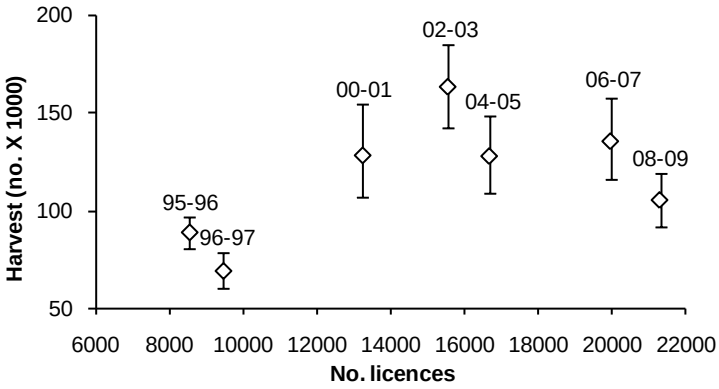

Fig. 15. Estimated rock lobster harvest (season indicated) plotted against number of licence holders. Error bars represent 95% confidence limits.

A similar analysis for abalone indicated a comparable pattern of harvest in relation to licence numbers (Fig. 16). That is, harvest levels have declined (but not significantly) since the mid-2000s, even though licence numbers have continued to grow.

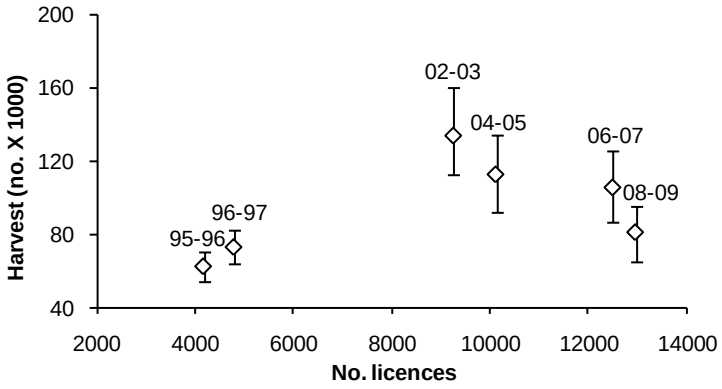

Fig. 16. Estimated abalone harvest (season indicated) plotted against number of licence holders. Error bars represent 95% confidence limits.

Since 2000-01 there has been an underlying decline in the proportion of licence-holders who actually utilised their licences (i.e. fish); from over 85 to 75% for rock lobster, and 63 to 39% for abalone, resulting in slower growth or even decline in active fisher numbers despite increases in licence numbers (Table 6). Coupled with this has been a general decline in the average number of days fished per season (based on active fishers) for both rock lobster (8.8 down to 6.5 days) and abalone (4.3 down to 2.9 days), which is linked to declines in average seasonal harvest per fisher (11.4 down to 6.6 rock lobster, and 22.8 down to 16.1 abalone) (Table 6). There has also been a decline in overall harvest rates for rock lobster (1.3 down to 1.0 per day), which has further contributed to the reduction in average seasonal harvest. By contrast, harvest rates for abalone have tended to fluctuate without obvious trend.

Thus despite the general growth in licence numbers over the past decade this has not translated into comparable increases in effort or harvest levels. On the contrary, declines in participation rates, general reduction in avidity (days fished) and falling (or stable) catch rates have tended to dampen the influence of increased licence numbers. Social (e.g. motivations, availability of time, access), biological (e.g. stock size, catch rates) and environmental (weather) factors all appear to play a role in influencing fisher behaviour and highlight the need to better understand the dynamics and drivers of recreational fishers.

Table 6. Number of rock lobster and abalone licence holders, estimated number and proportion who fished, total and average harvest and effort per fisher by licence year and average daily harvest rates.

	Licence year				
	2000-01	2002-03	2004-05	2006-07	2008-09
Rock lobster					
No. licence holders	13,265	15,580	16,710	20,008	21,351
% fished	86.5	88.4	81.9	78.4	75.2
No. active fishers	11,408	14,308	13,679	15,687	16,050
Harvest (nos.)	128,219	163,454	127,987	135,592	105,538
Av. harvest per active fisher	11.2	11.4	9.4	8.6	6.6
Fisher days	100,866	125,898	109,788	124,305	103,200
Av. days per active fisher	8.8	8.8	8.0	7.9	6.5
Av. daily harvest	1.27	1.30	1.17	1.09	1.02
Av. daily pot-harvest	0.87	1.00	0.90	0.94	0.75
Av. daily dive-harvest	2.61	2.30	2.31	2.15	2.27
Abalone					
No. licence holders		9,272	10,133	12,514	12,976
% fished		63.5	55.8	52.3	38.8
No. active fishers		5,853	5,653	6,542	5,033
Harvest (nos.)		133,711	112,571	105,515	81,021
Av. catch per active fisher		22.8	19.9	16.1	16.1
Fisher days		25,342	18,185	23,201	14,444
Av. days per active fisher		4.3	3.2	3.5	2.9
Av. daily harvest		5.28	6.19	4.55	5.61

At the end of the 2008-09 rock lobster season, diarists who had fished were asked whether they had spent more, less or about the same amount of time fishing or diving for rock lobster compared with the previous season (2007-08). Considering those diarists who actually fished for rock lobster, 64% indicated that they had fished less, 27% about the same, and 8% reported that they had fished more than in the previous season[10]. When asked whether the quality of the rock lobster fishery in 2008-09 was better, worse or about the same as the previous season, 15% indicated that it was better, 31% worse, 44% about the same, and 10% were unsure[11]. Of those respondents who indicated that the quality of the fishery was worse, 70% identified declining stock status (reduced availability and/or catch rates), while 16% highlighted issues of size (few legal sized and/or catches mainly of undersized rock lobster). Other reasons offered included competition with other recreational or commercial fishers and factors associated with weather conditions.

To understand why not all licence-holders fished or dived for rock lobster during 2008-09, non-fishing respondents were asked for the main reason(s) for not fishing. While some respondents reported more than one reason, lack of time, mainly related to work or family commitments, was identified by more than half (53%) of the respondents as

[10] Based on 416 respondents.
[11] Based on 412 respondents.

an important reason for not utilising their rock lobster licence(s)[12]. Unfavourable weather conditions (20%), lack of access, mainly to a boat or fishing partners (15%), health issues (13%) and substitution with other activities, including other types of fishing (7%) were also identified as reasons for not fishing during 2008-09.

Pots represent the main method for catching rock lobster by the recreational sector, accounting for 61-64% of the total harvest numbers in each of the years surveyed apart from 2000-01, when pots represented 55% of the total catch (Fig. 17). Dive methods have typically accounted for about one third of the harvest in all seasons apart from 2000-01, when divers took 44% of the total. The reason for the apparent increase in the dive harvest proportion in 2000-01 was unclear and has not been evident in subsequent seasons. Rings continue to represent a minor component of the fishery.

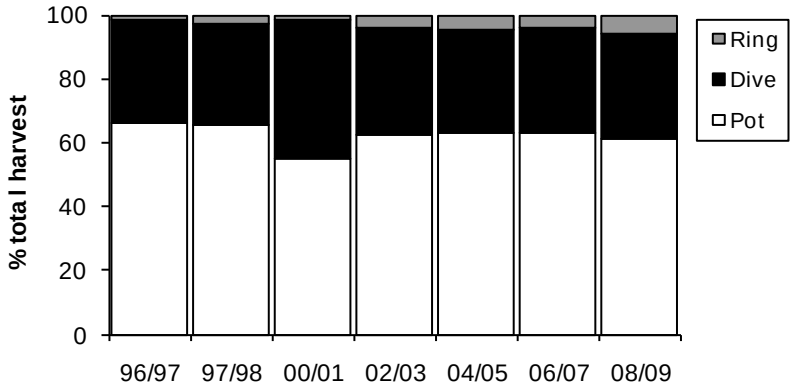

Fig. 17. Proportion of the rock lobster harvest by method and fishing season

Consistent with previous years (Lyle *et al.* 2005, Lyle & Morton 2006, Lyle 2008), fishing activity for rock lobster and abalone is highly seasonal, being most intense immediately following the opening of the season (or licensing year) and over the summer holiday period, with peaks in effort and catches during December and January .This was followed by sharp falls in catch and effort in February and then a slight increase in activity over the Easter holiday period. Activity levels from May to the end of the season (or licensing year) typically remain low and contribute very little in terms of harvest.

The recreational rock lobster and abalone fisheries are concentrated off the south-east and east coasts of Tasmania (Lyle *et al*. 2005, Lyle & Morton 2006, Lyle 2008, present study). In 2008-09, about 28% of the rock lobster and 33% of the abalone harvest (by numbers) was taken off the south-east coast (Area 1), with a further 39% and 25%, respectively, derived from the remaining east coast areas (Areas 2&3). Rock lobster catches from the north coast (Areas 4&5) were comparatively low (14%), whereas this region was more significant for the abalone fishery (25%). The west coast (Areas 6-8) produced about 19% of the rock lobster and 20% of the abalone harvest. The intensity

[12] Based on 104 respondents.

of the fishing activity off the south-east and east coasts reflects a combination of factors, including sheltered and accessible waters and proximity to major population and holiday centres. Factors such as limited availability of suitable reef habitat off the north coast (apart from around the Bass Strait islands), and exposure to unfavourable sea conditions and limited access points off the west coast, contribute to the lower levels of recreational fishing pressure observed in these regions. However, catch rates for rock lobster and abalone tended to be higher off the west coast than elsewhere, the region representing a very significant area for both the commercial rock lobster and abalone fisheries (Haddon & Gardner 2009, Tarbath & Gardner 2009).

There was considerable regional variability in the relative importance of the three rock lobster fishing methods. Pot catches clearly dominated the harvest off the south-east and east coasts, whereas dive collection was the dominant method off the north coast. Pots, dive collection, and rings were each locally important in the west coast areas. Such method-based regional differences are consistent with patterns observed in previous surveys (Lyle 2000, 2008, Forward & Lyle 2002, Lyle & Morton 2004, 2006).

The average daily harvest rate for pots (0.75 rock lobster) during 2008-09 was the lowest recorded since surveys commenced (Table 6) and was consistent with the observation that commercial catch rates were also poor during 2008-09 (C. Gardner, pers. comm.). By contrast, the dive harvest rate (2.3 rock lobster) was within the range determined for previous seasons (i.e. 2.1-2.6). The average daily harvest rate for abalone (5.6 abalone) was also within the range of that reported in previous years (4.5-6.2 abalone).

Artificial breathing apparatus (hookah and scuba) conferred a clear advantage when targeting rock lobster (reflected in catch rates and incidence of the bag limit being achieved), but was less of a factor for abalone, where catch rates for snorkel divers were comparable to those for scuba. This is not unexpected given that abalone are sessile and often common in shallow waters. Of the dive methods, harvest rates were consistently higher for hookah, an observation that has been noted in previous years (Lyle 2000, 2008, Forward & Lyle 2002, Lyle & Morton 2004, 2006).

In Tasmania divers often target both rock lobster and abalone on a dive and, in 2008-09, just under half (46%) of all dives involved targeting both species, with this combined effort accounting for 55 and 61% of the dive harvest of rock lobster and abalone, respectively. Recognition of this fishing behaviour has implications for the management of the fishery, especially in terms of the possible impacts of management change for one or other species.

Bag limits represent the primary management strategy to constrain recreational rock lobster and abalone catches in Tasmania. Pot fishers rarely (~1% days fished) attained the bag limit of five rock lobster. By contrast, bag limits had a more obvious impact on rock lobster and abalone dive catches, with over 20% of the dive effort for either species resulting in the bag limits being achieved.

The estimated recreational rock lobster harvest of 107 tonnes was clearly below (63%) the TARC of 170 tonnes and represented about 6% of the notional 2008-09 TAC. Comparisons based on state-wide catches can, however, underestimate regional impacts and interactions between sectors. This was particularly evident off eastern Tasmania where the recreational fishery accounted for 16-20% of the total rock lobster catch. Furthermore, depth limitations on diving and practicalities of hauling pots and ring nets imply that the recreational rock lobster fishery operates primarily in shallow waters, presumably at depths of less than about 20 m. By contrast, commercial fishers operate over wider areas, including deeper offshore reefs with about 25% of the commercial harvest taken from depths of less than 20 m during 2008-09. Thus, where the sectors overlap (based on depth), the recreational proportion of the shallow water catch was higher than implied by comparison of overall catch levels. If only shallow-water catches are considered, then the recreational fishery represented almost a quarter of the total rock lobster take, and almost half of the rock lobster taken off the east coast of Tasmania.

The estimated recreational abalone harvest of 39 tonnes in 2008-09 was equivalent to 1.5% of the total abalone catch for the state. Regionally, as a proportion of the total harvest, the recreational catch was most significant (12%) off the north-east coast (Area 3), reflecting the comparatively low commercial catch from that area, rather than a high recreational catch in absolute terms. There are no management performance indicators relating to the recreational fishery in the Abalone Management Plan but there is a need to explicitly consider recreational catches into on-going stock assessment and future management strategies for the fishery. This is particularly important since recreational fishers may continue to fish areas even when abalone densities are reduced to below levels that are typically classed as commercially viable.

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Finally, thanks are extended to the recreational fishers who participated in the survey.

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