INTERNAL REPORT

TASMANIAN RECREATIONAL ROCK LOBSTER AND ABALONE FISHERIES – 2006/07 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 20,000 persons holding at least one rock lobster licence and 12,500 persons licensed to fish for abalone during 2006/07. This represents more than doubling of the number of 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 sixth survey of the lobster fishery and the fifth for the abalone fishery undertaken since 1996. A random sample of licence-holders was contacted by telephone in October 2006 and invited to participate in the survey in which fishing activity was monitored throughout the 2006/07 season. A total of 427 licensed respondents completed the survey, representing about one in 50 licence holders and a response rate of over 90%.

During the 2006/07 rock lobster season (4 November 2006 – 31 August 2007), recreational fishers harvested an estimated 135,000 lobsters, based on 113,400 fisher days of effort. Potting was the dominant method and represented almost 80% of the effort (days fished) but only 63% of the estimated harvest. Dive collection accounted for about 18% of the effort and 32% of the harvest, while ring usage contributed 2% of the effort and 4% of the harvest. The overall average harvest rate for the season was 1.2 lobsters per day, with daily harvest rates of 0.9 for pots, 2.2 for dive collection, and 2.3 for rings. The daily bag limit of five lobsters was rarely attained for pots (< 3% of pot days) whereas the bag limit was attained in about one in five days based on dive and ring methods.

Seasonally the lobster fishery exhibited three distinct phases; intense activity early in the season (November to January) that accounted for about 68% 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 5% of the season's total.

Conversion of numbers to weights produced a total recreational harvest estimate of 135 tonnes, with catches from the south-east and east coasts accounting for 60%, the north coast 26%, and west coast 14% of the total weight. This represented 79% of the total allowable recreational catch (TARC) of 170 tonnes and was equivalent to 8% of the notional total allowable catch (TAC) (inclusive of the commercial catch) of 1,693.5 tonnes.

An estimated 105,500 abalone, based on 20,900 diver days of effort, were harvested by recreational fishers between 1 November 2006 and 31 October 2007. About 59% of the total abalone harvest was taken between November and January, 33% between February and April, and 9% between May and October. In total, 40% of the catch was taken from the south-east coast, with catches from the east and north coasts also significant.

About one-fifth of all dives that were targeted at abalone resulted in no retained catch. By contrast, the daily bag limit of 10 abalone was achieved in over one-quarter of all dives and the overall average daily harvest rate was 5.0 abalone.

By converting numbers to weights, the 2006/07 recreational harvest of abalone was determined to have been 49 tonnes, equivalent to 2% of the combined recreational and commercial catch of 2,459 tonnes. There are currently no explicit performance indicators relating to the recreational fishery for abalone.

Overall, there has been surprisingly little change in harvest estimates for rock lobster and abalone since the early 2000s despite the steady increase in licence numbers. Several factors have contributed to this: firstly 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; secondly there has been a general decline in the average number of days fished per season for both rock lobster and abalone; and thirdly, linked to this latter point, there have been declines in the average seasonal harvest per fisher. Factors contributing to these trends warrant further attention but are consistent with a general perception amongst respondents that most had fished less often than in the previous season.

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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 lobster 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, with both fisheries subject to quota management.

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 abalone licences 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 lobster. Minimum size limits apply for abalone. Recreational fishers are also subject to daily bag limits of five lobster and ten abalone and possession limits of ten lobster and twenty abalone.

Since the introduction of the present licensing system, the number of persons holding at least one recreational lobster licence has increased steadily from about 8,500 to 20,000 in 2006/07, representing a more than doubling of numbers since 1995 (Fig. 1). Increases have occurred in each of the licence categories, with about 16,600 pot, 8,700 dive and 5,200 ring net licences issued in 2006/07. Abalone licence numbers have almost tripled since 1995, with about 12,500 issued in 2006/07 (Fig. 1).

Set against these trends has been the introduction in 1998 of quota management for the commercial rock lobster fishery, 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 1,502 tonnes and effectively represented a reduction in catches which had averaged over 1,700 tonnes per annum for the decade prior to 1998. The TACC was increased to 1,523.5 tonnes in 2002 and has been maintained at this level since.

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

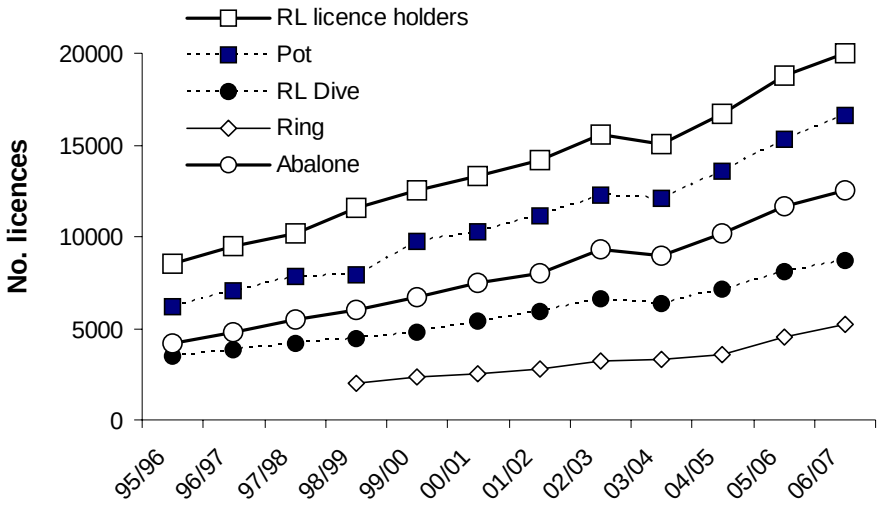

Fig. 1. Numbers of recreational rock lobster (RL) and abalone licences issued annually since 1995/96. RL licence holders refers to the number of persons holding at least one recreational lobster licence.

As part of a recent review of the management of the rock lobster fishery, provision has been made for an explicit allocation to the recreational sector. Under the new arrangements, the total allowable recreational catch (TARC) is set at 170 tonnes or 10% of the total allowable catch (TAC), which ever is the larger quantity. Although a TARC was not explicitly set for the 2006/07 season, the approval of policy in 2006 effectively set a notional TARC of 170 tonnes, which when added to the TACC produced a notional TAC for 2006/07 of 1,693.5 tonnes. This and future reports will therefore report on the recreational catch against the TARC[3]. It should be noted that previous reports have reported the percentage of recreational catch against the TACC since the previous policy document specified that if the recreational catch exceeded 10% of the TACC a review would be triggered. Recreational catch information is also required as an input into the rock lobster assessment model developed to assess stock status and undertake risk assessments under different management scenarios (Haddon & Gardner 2008).

Since 1995, the TACC for abalone has varied between 2,100 – 2,800 tonnes and was set at 2,502.5 tonnes (2,380 tonnes for blacklip and 122.5 tonnes for greenlip abalone) in 2007. 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 *et al*. 2007).

The current survey represents the sixth in a series for rock lobster and the fifth for abalone undertaken since 1996. Key objectives include characterisation of the 2006/07 rock lobster and abalone fisheries in terms of participation, fishing effort and catch.

[3] From the 2007/08 licensing year the TAC, TACC and TARC will set by public notice.

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 2005/06 recreational licensing database administered by the Department of Primary Industries and Water. 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 2006 and asked about their intention to renew their lobster and/or abalone licences for the 2006/07 fishing season. Sampling was conducted without replacement, i.e. persons without a telephone listing or those who could not be contacted were not substituted in the sample.

2.1.3 Telephone-diary survey

All respondents who indicated that they were 'quite likely' or 'very likely' to renew their licences 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 2006 and April 2007, 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, target species 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 if more than one method was used 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 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 2006/07 fishing season (4 November 2006 to 31 August 2007) while for abalone the enumeration period was the licensing year (1 November 2006 to 31 October 2007).

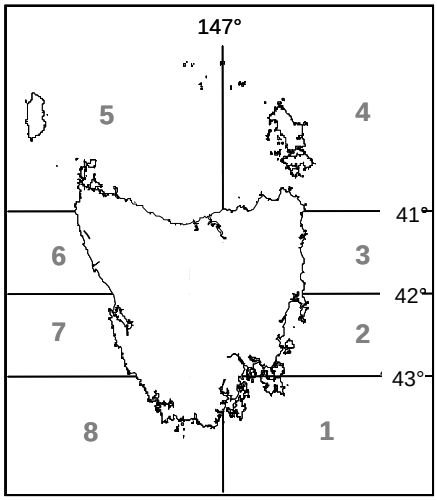

Fig. 2. Map of Tasmania showing fishing areas

2.2 Data analysis

2.2.1 Catch and effort

Although initial sample selection was based on the 2005/06 licence database, licence details for 2006/07 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 2006/07 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 67% of lobster and abalone licences were issued by the end of November 2006, this proportion increased to 83% by the end of December and 90% by the end of January 2007. Very few additional licences were issued after April 2007. 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 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 lobsters was provided by a group of volunteer fishers (not diarists) located around the State. Fishing method, location, sex and carapace length (mm) were recorded.

Average weights were determined by converting lengths 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).

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 2006/07 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 2007 were presented. For regional comparisons between commercial and recreational 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 741 licence-holders selected from the 2005/06 licence database, 47 (6%) either had no telephone listing or the number was disconnected. This represented sample loss and reduced the effective sample to 694. Contact was made with 629 licence-holders, of whom 594 fully responded, representing a screening survey response rate of 86%. Non-contacts (despite at least ten attempts by telephone over a period of several weeks) accounted for 9% of the sample and refusals a further 5% (Fig. 3).

Amongst the respondents, 39 indicated that they were not likely to renew their licence(s) in 2006/07 and hence were not eligible for inclusion in the diary survey[4]. The balance (555) indicated they were likely to renew their licence(s) and 94% (522) agreed to participate in the diary survey (Fig. 3).

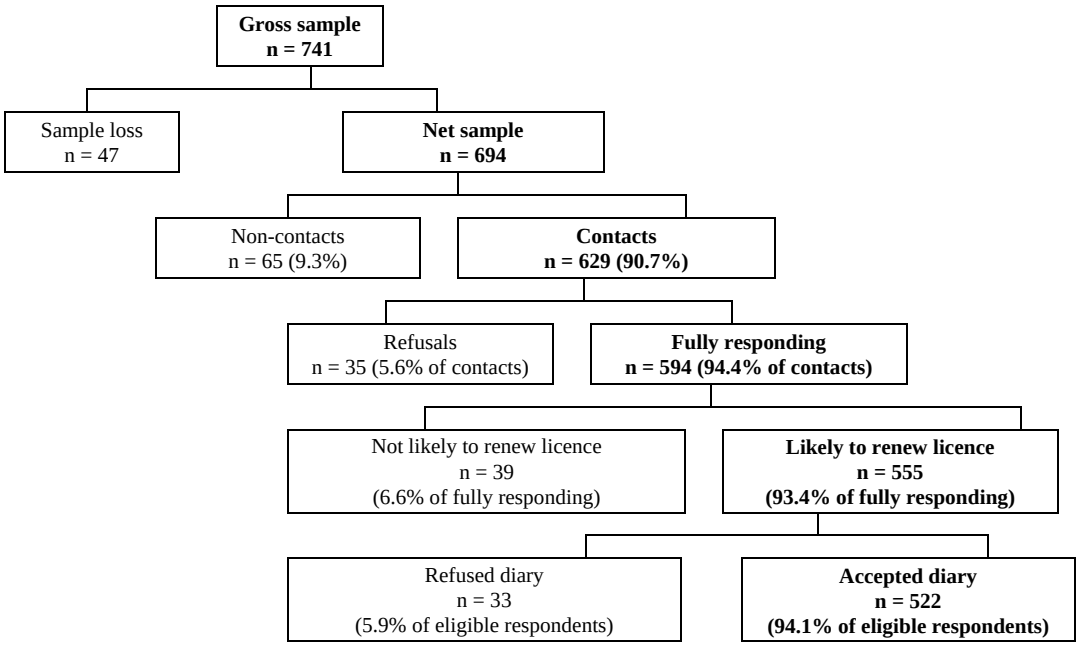

Fig. 3. Diagrammatic representation of the screening survey response profile (n is sample size).

[4] The licence status of these respondents was checked at the end of the 2006/07 season and 12 renewals (31%) were identified.

3.1.2 Telephone-diary survey

Diary response was high, with 484 diarists or 93% of respondents who accepted the diary participating for the entire survey period (Fig. 4). Respondents who went out of scope during the diary period (e.g. moved overseas or interstate with no intention to fish again in Tasmania for the remainder of the season) were treated as fully responding if complete information was collected up until the time they went out of scope. Based on the total number of eligible respondents identified in the screening survey (555), the effective response rate for the diary survey was 87%. 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 adjustments for non-response.

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.

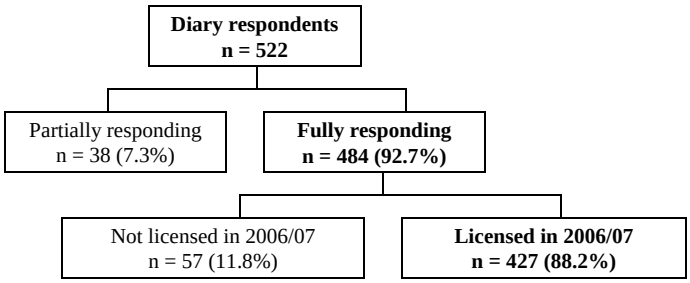

Fig. 4. Diagrammatic representation of the diary survey response profile (n is sample size).

Of the responding diarists, 12% did not take up a licence during 2006/07, despite rating themselves as 'quite likely' to 'very likely' to do so. Among the remaining 427 respondents, 406 held at least one category of lobster licence while 297 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 50 licence holders participated in the survey.

Table 1 Total number of 2006/07 lobster and abalone licence holders, numbers sampled (fully responding) and sample fraction by licence type.

Licence type	Licence holders	Diarists	% sampled
Rock lobster pot	16,583	333	2.0
Rock lobster dive	8,717	221	2.5
Rock lobster ring	5,210	113	2.2
Abalone	12,514	297	2.4
Total licences	43,024	964	2.2
Total persons	20,697	427	2.1

Diary respondents reported at total of 2858 fishing events for the survey period, 2847 (>99%) of which were within survey scope. In total, 75% 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 2006/07.

3.2.1 State-wide catch and effort

During the 2006/07 fishing season an estimated 78.4% (SE 2.1%) of rock lobster licence holders (equivalent to 15,687 persons) fished for rock lobster. In addition to those who did do not fish, a further 14.5% of licence-holders reported no retained rock lobster catch for the entire season, implying that 64% of licence holders were responsible for taking the entire catch.

Overall, total fishing effort was estimated at 113,403 fisher days[5] for the season, yielding an estimated harvest of 135,275 lobsters (Table 2). This represented an average seasonal harvest rate of 1.2 lobster per day fished. Lobster pots were the most popular fishing method (accounting for 63% of the total harvest) followed by dive collection (32%) and rings (4%) (Table 2). Although over four times as many fisher days of effort were spent using lobster pots (90,500 days) compared with diving (20,400 days), pots yielded less than double the number of lobsters (86,700 v 43,800 for divers). Lobster ring harvest and effort were low by comparison with the other methods. Mean daily harvest rates were over two times higher for dive (2.2 lobster) and ring (2.3 lobster) methods compared with pots (0.9 lobster).

Table 2. Rock lobster effort, harvest and harvest rates for the 2006/07 season
Values in parentheses represent the 95% confidence intervals

Method	Harvest (no.)	Effort (days)	Av. harvest rate (no. day^{-1})
Pot	85,698 (68,162 – 105,029)	90,534 (75,592 – 107,077)	0.9
Dive	43,852 (34,669 – 54,052)	20,418 (16,533 – 24,571)	2.2
Ring	5,724 (2,170 – 10,008)	2,451 (1,184 – 3,926)	2.3
Total	135,275 (115,425 – 157,405)	113,404 (98,276 – 129,586)	1.2

[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 effort and harvest during December (Fig. 5). Overall, fishing activity slowed dramatically in February but there was 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 lobsters 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 72% of the pot catch taken between November and January and just 23% 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 35% in the following three month period.

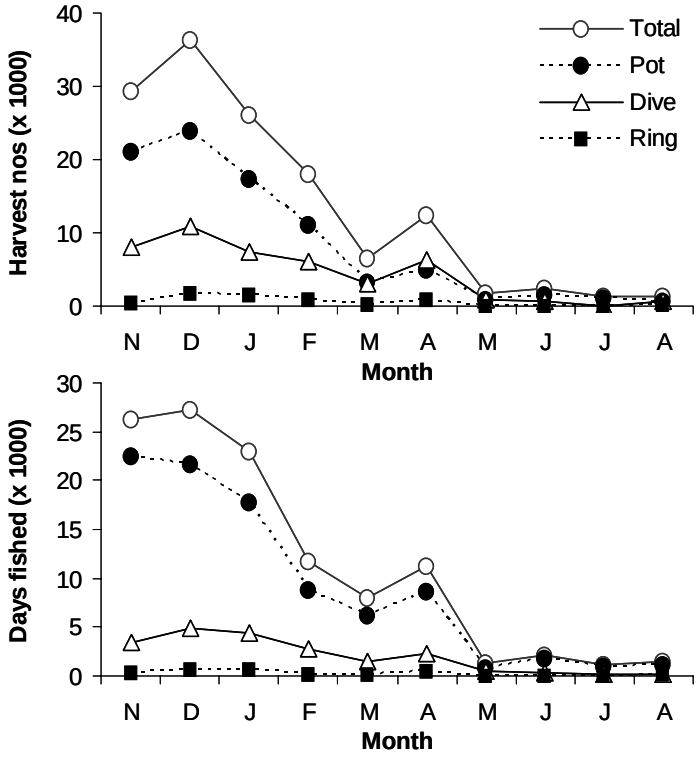

Fig. 5. Recreational rock lobster harvest (numbers) and effort (days fished) by month and method for the 2006/07 fishing season.

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 south-east (Area 1) and east (Areas 2 & 3) coasts. This combined region accounted for 69% of the total estimated lobster harvest (92,793 lobster) and attracted 78% of the total effort (88,188 fisher

days) during 2006/07. Area 1 alone contributed 45% to the total harvest. The north coast (Areas 4 & 5) accounted 16% of the total harvest (22,178 lobster) and 14% of effort (16,318 fisher days) while the west coast (Areas 6-8) contributed 15% of the total harvest (20,302 lobster) and 8% of total effort (8,898 fisher days).

Marked regional differences were evident in the proportion of the rock lobster harvest by the various methods (Fig. 6). Lobster pots accounted for the bulk (53-86%) of the harvest from the south-east, east and north-east coasts (Areas 1-4), whereas dive collection was the primary capture method (95%) off the north-west coast (Area 5) All three methods were of significance in the west coast fishery (Areas 6 & 7); pots accounted for 51-64%, rings 20-33% and dive collection 15-16% of the harvest numbers. Pots were by far the dominant capture method (90%) used in the south-west (Area 8).

Mean daily harvest rates were highly variable around the State, ranging from over two lobster per day off the north-west and west coasts (Areas 5-8) to less than one lobster per day off the east coast (Area 3). Harvest rates for the remaining areas were intermediate, between 1.1-1.2 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 regional variability in harvest rates.

Table 3. Recreational rock lobster effort, harvest and harvest rates by fishing area for 2006/07
Values in parentheses represent the 95% confidence intervals

Area	Harvest (no.)	Effort (fisher-days)	Harvest rate (no. per fisher-day)
1	61,185	52,174	1.2
	(47,012 – 78,296)	(40,941 – 65,045)	
2	15,169	12,870	1.2
	(9,923 – 21,031)	(9,000 – 17,148)	
3	16,438	23,143	0.7
	(9,796 – 24,472)	(13,695 – 35,555)	
4	8,484	12,331	1.1
	(7,164 – 21,178)	(6,667 -18,985)	
5	11,199	3,987	2.1
	(3,832 – 14,277)	(1,963 – 6,566)	
6	6,786	5,204	2.2
	(5,108 – 19,188)	(2,673 – 8,242)	
7	2,316	2,565	2.7
	(1,468 – 14,178)	(800 – 4,829)	
8	2,316	1,129	2.1
	(453 – 5,252)	(223 – 2,559)	

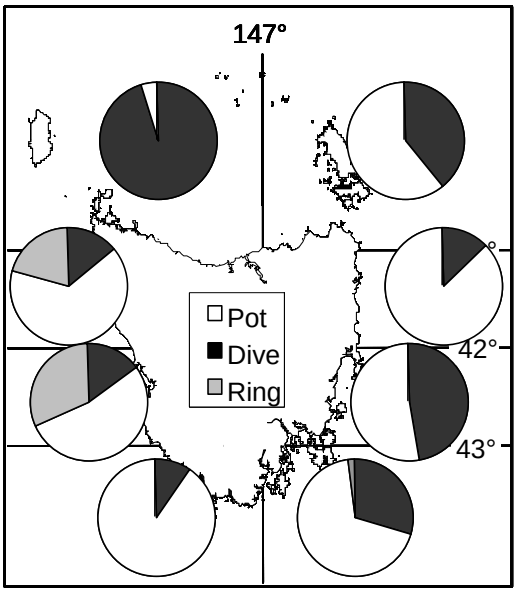

Fig. 6. Proportion of regional harvest by fishing method (pie charts).

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 recreational fishery off the south-east coast (Fig. 7). Almost half of the harvest was derived from waters around the Tasman Peninsula, with the western Storm Bay (including Bruny Island) next in importance, accounting for one fifth of the catch. The D'Entrecasteaux Channel contributed 15%, Norfolk/Frederick Henry Bays a further 12%, and the Derwent just 7%.

Pots accounted for the majority of the Tasman, western Storm Bay and D'Entrecasteaux Channel catches whereas dive collection was the dominant method in the Derwent (Fig. 7). There was roughly an equal split between pot and dive catch in Norfolk/ Frederick Henry Bays. Ring catches were comparatively low throughout the region.

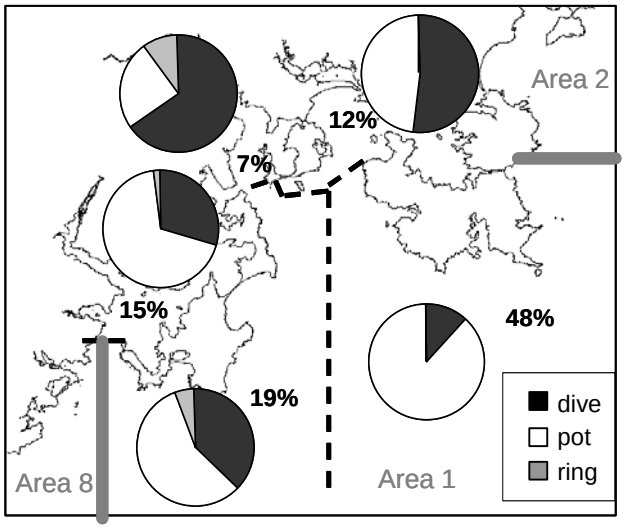

Fig. 7. Regional distribution of Area 1 harvest (%) and proportion of harvest by method (pie charts).

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 lobster rarely achieved (~3% of all fishing days). By contrast, divers and fishers using rings took the bag limit on about one in every five days fished, with nil catches reported for about one in four days fished.

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 (3.0 lobster) followed by scuba (2.0 lobster) and snorkel (1.1 lobster). The bag limit was attained in 37% of the hookah dives, compared with 16% of scuba and 6% of the snorkel effort. Overall, scuba proved the most popular dive method for lobster, accounting for 44% of the total dive effort and 41% of the harvest. Hookah was next in importance, representing 35% of the effort and 48% of the harvest, while snorkel divers contributed 21% of the effort and just 11% of the dive harvest.

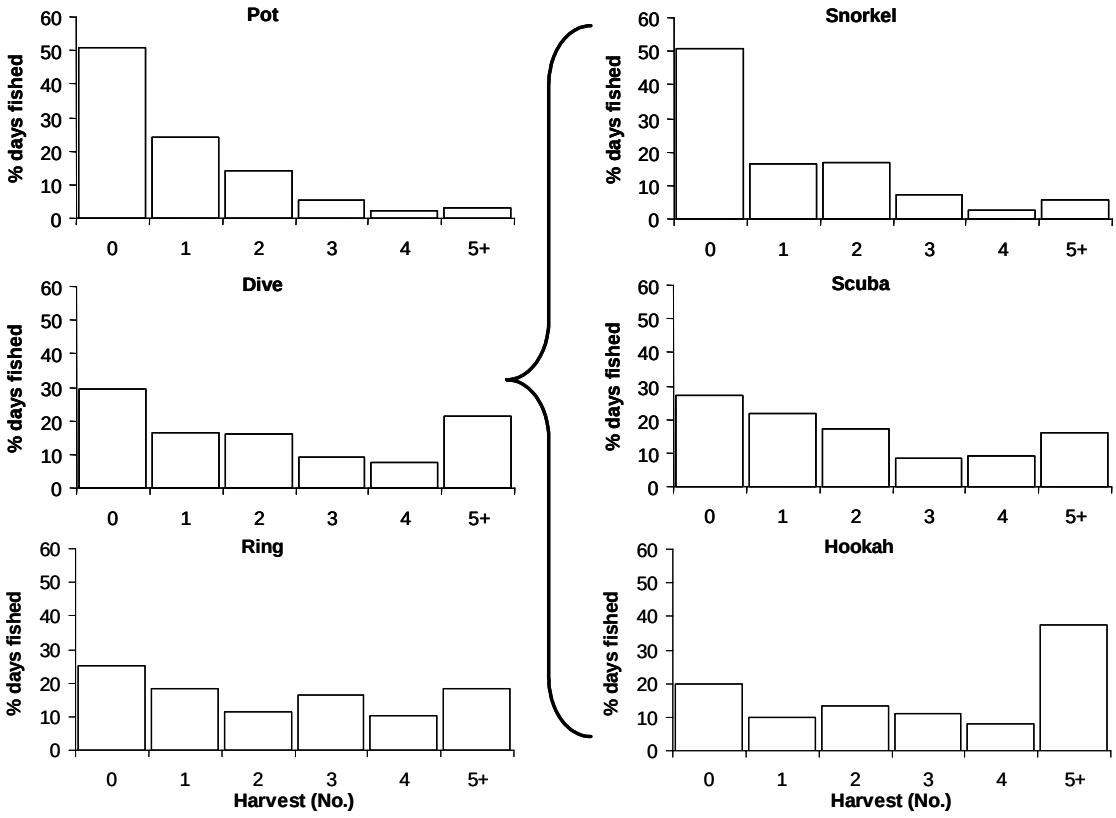

Fig. 8. Distribution of daily lobster harvest by fishing method for 2006/07 licence holders.

3.2.6 Released catch

In total, 152,929 lobsters were estimated to have been released or discarded from pot catches, equivalent to 1.8 for every lobster retained. About 93% of pot releases were reported to be due to undersized lobsters, 6% were berried females and 1% because lobsters were dead or damaged. Just 0.1% of all released lobster were as a result of over bag limit catches.

Although divers may release lobsters, i.e. the catch is landed and then sorted, most of this 'sorting' occurs underwater and therefore a similar analysis of reasons for release by divers was not attempted.

3.2.7 Size composition

Lengths were available for 608 dive caught lobster from the south-east and east coasts (Areas 1-3) of Tasmania (Fig. 9). Dive caught lobster ranged between 102–239 mm carapace length (CL), with an average weight of 921 g. The male to female sex ratio of the dive catch (1:0.93) did not differ significantly from 1:1.

Pot caught lobsters tended to be smaller, ranging between 105-146 mm CL, however the sample size was too low (30 individuals) to justify using these data to estimate the average size of pot caught lobsters.

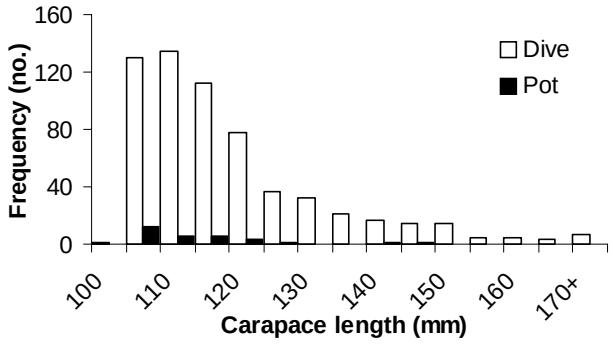

Fig. 9. Length frequency distributions by 5 mm size class for recreationally caught lobster taken by dive and pot fishing methods.

3.2.8 Estimated harvest weight

The weight of the 2006/07 recreational harvest was estimated by multiplying the average weight of a lobster, specified by method and area caught, by the numbers harvested. The average weight by area of commercially caught lobsters taken in shallow waters (< 20 m) during the 2006/07 quota year was used as a proxy for recreationally pot caught lobster. Average weights for dive caught lobster from the east and south west coasts (Areas 1-3, & 8) were based on the sample of dive caught lobster (refer above). For the remaining areas (Areas 4-7), average dive caught lobster weights

were adjusted by the average dive to pot weight ratio (1.33) established by Lyle *et al*. (2005). In the absence of information about the size composition of ring catches it was assumed that ring caught lobsters averaged the same weight as pot caught individuals. Average weights by area and method used to determine harvest weight are presented in Table 4.

The state-wide harvest was estimated to be 135 tonnes or 79% of the TARC, with regional harvests ranging between 51 tonnes (Area 1) and 2 tonnes (Area 8) (Table 4). As a proportion of the recreational harvest by weight, the south-east and east coast (Areas 1-3) accounted for 60%, the north coast (Areas 4 & 5) 26%, and the west coast (Areas 6-8) 14%. The combined effects of dive collection and presence of large lobsters off the north coast was particularly evident, with that region accounting for just 16% of the numbers retained (refer Table 3).

Table 4. Average lobster weight (g) by method and total estimated harvest (kg) by area
* av. weight based on commercial catch weights from shallow water;[1] av. weight calculated by multiplying av. pot weight by 1.33 (conversion ratio between pot and dive weights, based on Lyle *et al.* 2005).

	Av. weight (g)		Total
Area	Pot/Ring*	Dive	harvest (kg)
1	803	921	51,271
2	865	921	13,520
3	999	921	16,246
4	1353	1799[1]	20,896
5	1239	1648[1]	13,824
6	974	1295[1]	11,435
7	832	1107[1]	5,943
8	824	921	1,932
Total			135,067

3.2.9 Comparison with commercial catches

The recreational harvest represented 8.0% of the notional 2006/07 TAC and 8.1% of the actual combined harvest (recreational plus 2006/07 quota year catch). Regionally, there was marked variability in the recreational share of the total catch, ranging from 21% in the south-east (Area 1) to less than 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 fishing sectors overlap and therefore interact. On this basis, the recreational harvest represented almost one fifth of the total shallow water

catch of 727 tonnes[6] (Fig. 10B). The recreational harvest accounted for almost half of the total catch from the south-east (Area 1), and represented between one-quarter and one-third of the total catch from the east (Areas 2 & 3), north east (Area 4) and north-west (Area 6) coasts. In the remaining areas the recreational fishery was a comparatively minor component of the catch, especially in the west and south-west (Areas 7 & 8).

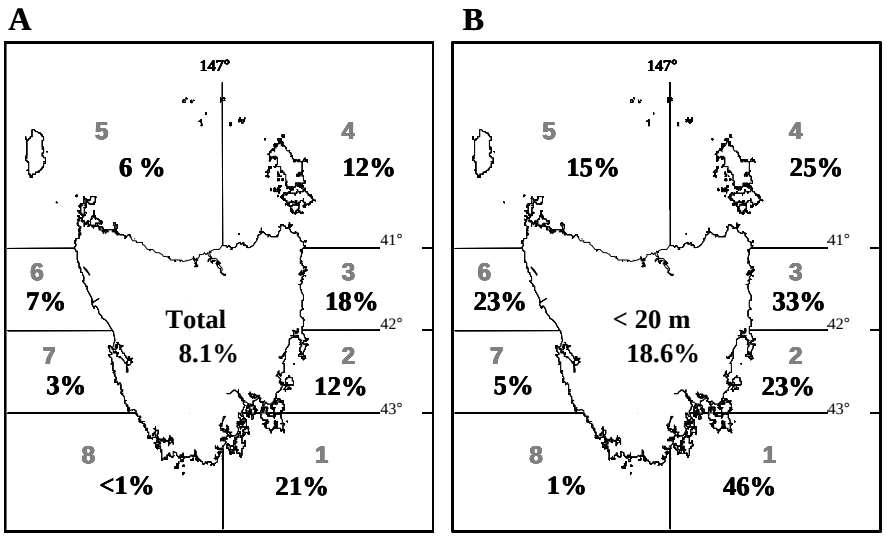

Fig. 10. 2006/07 recreational lobster harvest (weight) expressed as a percentage of the total rock lobster catch by area: (A) based on total catch; and (B) based on catches from shallow water (< 20m) (refer text).

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 2006/07.

3.3.1 State-wide catch and effort

An estimated 52.3% (SE 2.6%) of abalone licence holders (equivalent to 6,542 persons) actually fished for abalone during 2006/07, harvesting 105,465 abalone (95% CI: 87,101 – 126,090) for 20,900 fisher days[7] (95% CI: 17,427 – 24,945) of effort. This represented an average harvest rate of 5.0 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).

[6] Shallow water commercial catch was reported as 592 tonnes for the 2006/07 quota year.
[7] A fishing day was defined as one in which abalone was a nominated target species and/or abalone were caught.

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 December and January (Fig. 11). The first three months of the licensing year accounted for 59% of the harvest and 61% of the effort. There was a sharp decline in effort and harvest in February and a minor increase in the level of fishing activity during April, mainly due to Easter fishing. The February to April period contributed around 30% of the annual harvest and effort. There was very limited fishing for abalone during the final six months of the licensing year.

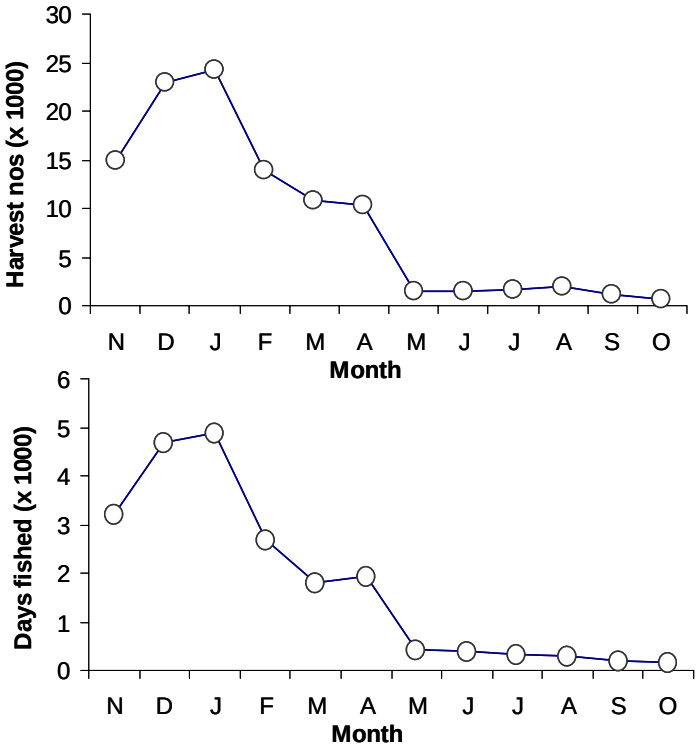

Fig. 11. Recreational abalone harvest (numbers) and effort (days fished) by month for the 2006/07 fishing season.

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 of the State, with 40% of the harvest and 43% of the effort reported from Area 1. The east coast (Areas 2 & 3) accounted for a further 20 and 26%, the north coast (Areas 4 & 5) 33 and 25%, and the west coast (Areas 6-8) about 7 and 5% of the catch and effort, respectively. Regional harvest rates varied between 3 and 7 abalone per day, being highest off the north and north-west coasts (Areas 5 & 6).

Table 5. Recreational abalone effort, harvest and harvest rates by fishing area for 2006/07
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	42,455 (32,034 – 54,043)	9,108 (7,003 – 11,500)	4.7	512	21,737
2	14,606 (7,967 – 22,697)	3,650 (2,079 – 5,641)	4.0	463	6,763
3	6,102 (2,549 – 10,722)	1,729 (852 – 2,977)	3.4	463	2,825
4	15,972 (6,909 – 27,010)	2,678 (1,203 – 4,697)	6.0	393	6,277
5	19,450 (10,480 – 30,115)	2,631 (1,538 – 3,867)	7.4	393	7,644
6	4,927 (2,324 – 8,037)	725 (358 – 1,158)	6.8	549	2,705
7	841 (24 – 1,988)	201 (5 - 469)	4.2	549	462
8	1,110 (199 – 2,321)	184 (34 - 368)	6.0	549	609

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 D"Entrecasteaux Channel was the most important sub-area, accounting for 38% of the harvest, followed by the Tasman Peninsula (24%), and western Storm Bay and Frederick Henry / Norfolk Bays (18-19%). Insignificant catches of abalone were taken from the Derwent Estuary.

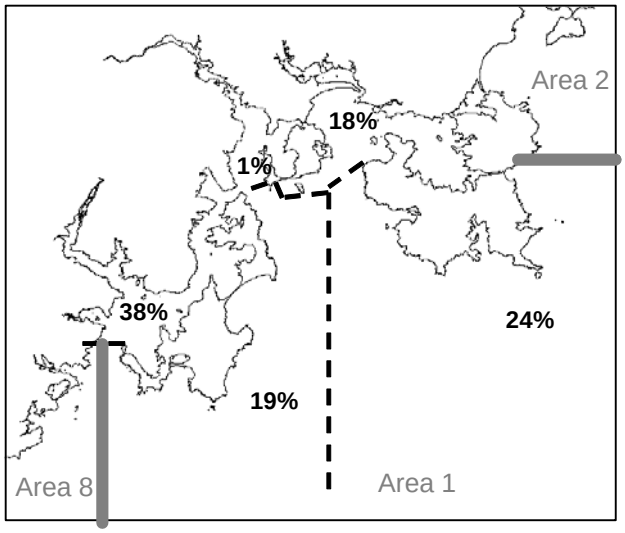

Fig. 12. Regional distribution of Area 1 abalone harvest.

3.3.5 Daily harvest

Approximately 27% of the dive effort targeted at abalone resulted in the bag limit being achieved (or exceeded) whereas less than 20% of dives resulted in no harvest (Fig. 13). Divers using hookah achieved the highest catch rates (6.1 abalone per day), with 40% of dives achieving the bag limit of ten abalone. Daily catch rates for snorkel were slightly lower (5.3 abalone), with about 28% of dives resulting in a catch of ten or more abalone. The average daily catch rate for scuba was substantially lower (3.9 abalone), with at least ten abalone taken on just 15% of the days dived.

Of the three dive methods snorkel accounted for 40% of the harvest and 38% of effort (diver days), hookah 33% of the harvest and 27% of the effort, and scuba contributed 27% of retained catch and 34% of the effort.

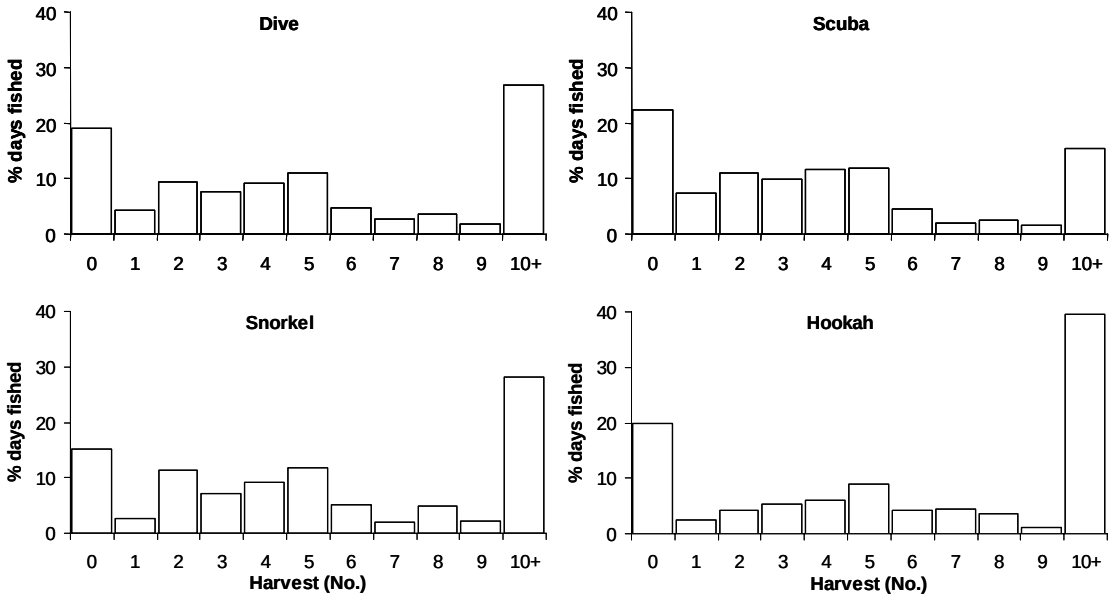

Fig. 13. Distribution of daily abalone harvest by dive methods for 2006/07 licence holders

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.). Based on these values, the estimated recreational harvest during 2006/07 was about 49.0 tonnes. Regionally, harvest estimates ranged from 26.8 tonnes in Area 1 to < 1 tonne in Areas 7 & 8 (Table 5). The catch for the combined south-east and east coasts (Areas 1-3) was 31.3 tonnes, the north coast (Areas 4 & 5) 13.9 tonnes, and the west coast (Areas 6-8) 3.8 tonnes.

3.3.7 Comparison with commercial catches

The 2007 commercial abalone catch was 2410 tonnes[8], indicating that the recreational harvest was equivalent to 2.0% of the total statewide catch. Regionally, the recreational fishery accounted for 5-6% of the catch off the south-east and east coast (Areas 1-3), around 3-4% off the north coast (Areas 4 & 5), and just 0.1% for the west coast (Areas 7 & 8) (Fig. 14).

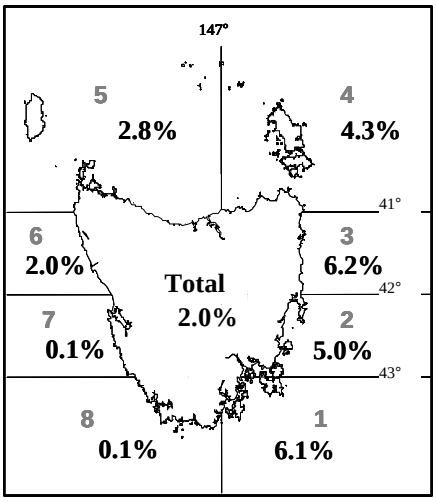

Fig. 14. 2006/07 recreational harvest (weight) of abalone expressed as a percentage of the total catch by area (inclusive of 2007 commercial catches).

[8] Based on estimated weights - blacklip abalone accounted for 2286 tonnes and greenlip 124 tonnes.

4 DISCUSSION

To date, six estimates of recreational rock lobster harvest are available based on the methodology applied in this survey. The surveys have indicated an underlying significant positive correlation between catch and licence numbers, with 59% of variability in harvest being explained by number of licences issued (Fig. 15). While catches do exhibit some inter-seasonal variability not directly linked to licence numbers (e.g. 1996/97 v 1997/98, 2002/03 v 2004/05), there has, however, been a general levelling of catches since 2000/01, despite a 50% increase in licence numbers over that period. A similar analysis for abalone indicated that catches increased with licence numbers since the mid-1990s, with 60% of variability in harvest being explained by number of licences issued (Fig. 16). However, since the early 2000s, catches have tended to fall slightly even though licence numbers have continued to grow.

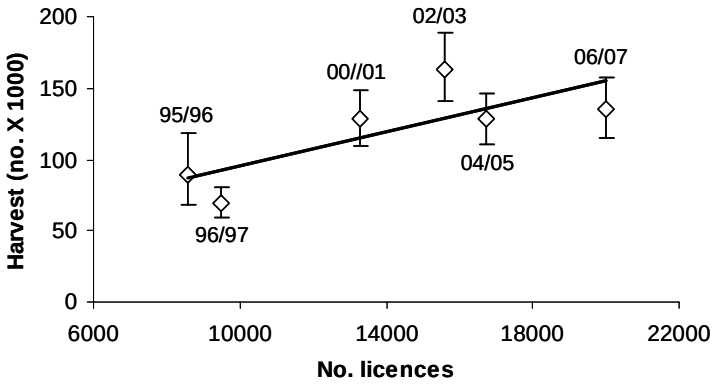

Fig. 15. Estimated rock lobster harvest (season indicated) plotted against number of licence holders. Error bars represent 95% confidence limits and linear regression line has been plotted.

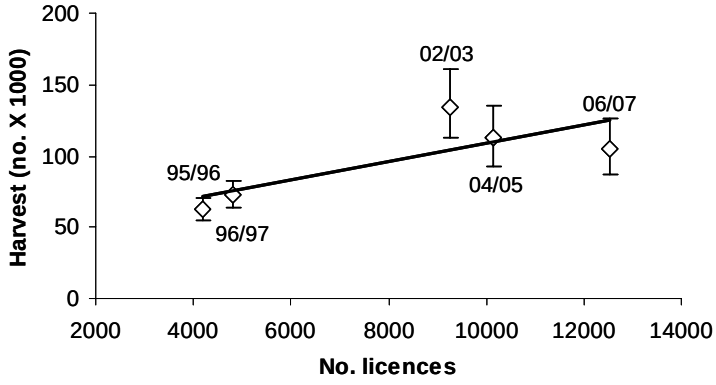

Fig. 16. Estimated abalone harvest (season indicated) plotted against number of licence holders. Error bars represent 95% confidence limits and linear regression line has been plotted.

Several factors appear to have contributed to this recent 'stability' in catches. Firstly, there has been an underlying trend for a decline in the proportion of licence-holders who actually utilise their licences (i.e. fish), from around 88 to 78% for rock lobster, and 63 to 52% for abalone, resulting in a slower growth rate in active fisher numbers by comparison with licence numbers (Table 6). Coupled with this phenomenon, there 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 7.2 days) and abalone (4.3 down to 3.2 days), which is linked to declines in average seasonal harvest per fisher (11.4 down to 8.6 lobster, and 22.8 down to 16.1 abalone) (Table 6). There have also been slight declines in harvest rates for lobster (1.3 down to 1.2 lobster per day) and abalone (6 down to 5 abalone per day) which have contributed to the reduction in average seasonal harvest.

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

	Rock lobster				Abalone		
	2000/01	2002/03	2004/05	2006/07	2002/03	2004/05	2006/07
No. licence holders	13,265	15,580	16,710	20,008	9,272	10,133	12,514
% fished	86.5	88.4	81.9	78.4	63.5	55.8	52.3
No. fishers	11,408	14,308	13,679	15,687	5,853	5,653	6,542
Fisher days	100,866	125,898	109,788	113,403	25,342	18,185	20,900
Av. days per fisher	8.8	8.8	8.0	7.2	4.3	3.2	3.2
Harvest (nos.)	128,219	163,454	127,987	135,275	133,711	112,571	105,465
Av. catch per fisher	11.2	11.4	9.4	8.6	22.8	19.9	16.1
Av. daily harvest (nos)	1.3	1.3	1.2	1.2	5.3	6.2	5.0

At the end of the 2006/07 rock lobster season, diarists 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. Considering those diarists who actually fished for rock lobster, 56% indicated that they had fished less, 34% about the same, and just 9% reported that they had fished more than in the previous season. While factors influencing changes in individual fishing activity levels were not determined, these trends are set against the growth in licence numbers which has evidently not necessarily translated into comparable increases in the magnitude effort or harvest levels in recent years.

Pots represent the main method for catching rock lobster by the recreational sector, accounting for 62-64% of the total 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 but has not been evident in subsequent seasons. Rings represent a minor component of the fishery.

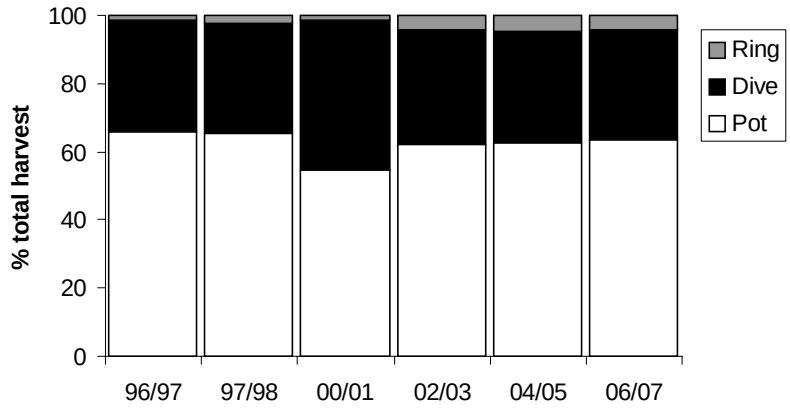

Fig. 17. Proportion of the lobster harvest by method and fishing season

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 (Lyle *et al.* 2005, Lyle & Morton 2006, present study). 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 lobster and abalone fisheries are concentrated off the south-east and east coasts of Tasmania (Lyle *et al*. 2005, Lyle & Morton 2006, present study). In 2006/07, about 45% of the lobster and 40% of the abalone harvest (by numbers) was taken off the south-east coast (Area 1), with a further 23% and 20%, respectively, derived from the east coast (Areas 2 & 3). Lobster catches from the north coast (Areas 4 & 5) were comparatively low (16%), whereas this region was more significant for the abalone fishery (33%). The west coast (Areas 6-8) produced about 15% of the lobster and 7% of the abalone harvest. The intensity 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 off the west coast tend to be higher than elsewhere, the region representing a very significant area for both the commercial rock lobster and abalone fisheries (Tarbath *et al.* 2007, Haddon & Gardner 2008).

There was considerable regional variability in the relative importance of the three 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-west coast. Pots, dive collection, and rings were each locally important in the west coast areas. Such method-based regional differences are generally consistent with patterns observed in previous surveys (Lyle 2000, Forward & Lyle 2002, Lyle & Morton 2004, 2006).

Average daily lobster harvest rates in 2006/07 for pots (0.9 lobster) and diving (2.2 lobster) were within the range, but at the lower end, determined for previous seasons (i.e., 0.9-1.2 for pots, and 2.1-2.6 for dive). The average harvest rate for abalone (5.0 abalone) was slightly lower than reported in previous years (5.3-6.6 abalone).

Artificial breathing apparatus (hookah and scuba) conferred a clear advantage when targeting 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 higher than 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 compared with the other methods, an observation that has been noted in previous surveys (Lyle 2000, Forward & Lyle 2002, Lyle & Morton 2004, 2006).

In Tasmania divers often target both rock lobster and abalone on a dive and, in 2006/07, over half (61%) of all dives involved targeting both species, with this combined effort accounting for 72% and 70% of the dive harvest of 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 lobster and abalone catches in Tasmania. In practice, being restricted to a single pot, pot fishers rarely (<3% days fished) attained the bag limit of five lobster. By contrast, bag limits had a more obvious impact on 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 135 tonnes was clearly below (79%) the notional TARC of 170 tonnes and represented 8% of the notional 2006/07 TAC. Comparisons based on state-wide catches can, however, underestimate regional impacts. This was particularly evident off south-eastern and north-eastern Tasmania where, in 2006/07, the recreational fishery accounted for around one fifth of the total take from these areas. 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 39% of their harvest taken from depths of less than 20 m. Thus, where the sectors overlap (based on depth) the recreational proportion of the shallow water catch was higher than implied by a comparison of total catches. If only shallow-water catches were considered, then the recreational fishery represented almost one fifth of the total rock lobster take, and almost half of the lobster taken off the south-east coast (the majority of which was taken from the Tasman Peninsula).

The estimated recreational abalone harvest of 49 tonnes in 2006/07 was equivalent to 2% of the total abalone catch for the state. Regionally, as a proportion of the total harvest, the recreational catch was most significant (around 5% or greater) off the east coast. 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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