UNIVERSITY of TASMANIA | IMAS INSTITUTE FOR MARINE & ANTARCTIC STUDIES

TASMANIAN RECREATIONAL ROCK LOBSTER AND ABALONE FISHERIES: 2017-18 FISHING SEASON

Jeremy M. Lyle

September 2018

fishwise

Institute for Marine and Antarctic Studies, University of Tasmania, Private Bag 49, Hobart TAS 7001

Enquires should be directed to:
Dr Jeremy Lyle
Institute for Marine and Antarctic Studies
University of Tasmania
Private Bag 49, Hobart, Tasmania 7001, Australia
Jeremy.Lyle@utas.edu.au
Ph. (03) 6226 8277
Fax (03) 6227 8035

Executive Summary

This report provides an assessment of the 2017-18 recreational Rock Lobster and Abalone fishing season and continues the time series monitoring trends in these fisheries commenced in the mid-1990s.

During 2017-18 17,200 persons held at least one recreational Rock Lobster licence and 10,800 persons held a recreational Abalone licence. Compared with 2016-17 this represented a 5% decrease and was approximately 80% of the 2007-08 peak in licence sales.

This survey involved a random sample of licence-holders who were contacted by telephone prior to the start of the 2017-18 fishing season and invited to participate in a panel survey to monitor their Rock Lobster and Abalone fishing activity between November 2017 and April 2018. A total of 449 respondents (354 valid licence-holders) completed the survey (75% effective response rate), providing detailed catch and effort information for each fishing trip undertaken. These data were scaled up to represent the activity of all licence-holders.

The 2017-18 Rock Lobster season (Eastern region: 18 Nov 2017 – 30 Apr 2018; Western region: 4 Nov 2017 – 31 Aug 2018) was monitored to the end of April 2018. During this period licensed recreational fishers were estimated to have harvested 72,009 (95% CI: 60,425 – 84,156) lobster, based on 77,209 fisher days of effort. Potting was the dominant method, representing 80% of the effort (days fished) and contributing 63% of the harvest. Dive collection accounted for 19% of the effort and 34% of the harvest, while ring usage contributed 1% of the effort and 3% of the harvest. The overall average catch rate was 0.93 lobster per day fished, with daily harvest rates of 0.73 for pots, 1.59 for dive collection, and 1.38 for rings.

The Rock Lobster fishery was concentrated off the east coast with this area accounting for 70% of the harvest (by number). The remaining harvest was split more or less evenly between the north and west coasts. Conversion of numbers to weights produced a recreational harvest estimate of 73.2 tonnes for the survey period, with catches from the east coast accounting for 62%, the north coast 18%, and the west coast 20% by weight. Overall, the recreational catch represented about 43% of the total allowable recreational catch (TARC) of 170 tonnes and was equivalent to about 6% of the 2017-18 total allowable catch (TAC) of 1221 tonnes, which includes the total allowable commercial catch (TACC) of 1051 tonnes.

A key component of the East Coast Stock Rebuilding Strategy has been the implementation of a notional east coast recreational catch share of 41 tonnes for the amended east coast stock rebuilding zone. The catch for this revised zone was, estimated at 40.4 tonnes indicating that the notional catch limit was not exceeded. However, there is little doubt that the biotoxin closures had a significant impact on the activity of many east coast fishers, implying that without the closures the catch would have exceeded the notional catch limit. This compares with “over-catches” of 13.6 and 8.2 tonnes in 2014-15 and 2016-17, respectively and an “under-catch” of 6.3 tonnes in 2015-16. As for the current year, the low catch in 2015-16 was influenced by biotoxin closures during the peak fishing months.

Respondents were asked a range of questions relevant to the management and state of the Rock Lobster fishery, key findings included:

- Slightly fewer than half of the respondents indicated that the overall quality of the lobster fishery was about the same as in 2016-17; the remainder were more or less evenly divided between the quality being better or worse compared with the 2016-17;
- Just over a third of respondents indicated the east coast biotoxin closures had impacted on where or how often they went fishing for lobster during 2017-18. The main impact being reduced fishing opportunities and reduced effort, only 3% of those affected indicated that they had travelled to other areas to fish for lobster;
- Over 80% of respondents indicated that they considered that the government had done enough to communicate information about the biotoxin closures, an improvement compared with previous seasons that were affected by biotoxin outbreaks;
- prior to the first major biotoxin event in 2012 almost 20% of fishers at least occasionally consumed the hepatopancreas (known colloquially as the mustard), of this group 30% indicated that they no longer consume this part of the lobster due to awareness of the health risks.

The recreational Abalone harvest up until the end of April 2018 was estimated at 45,142 (95% CI: 30,113 – 62,073) individuals, based on 10,079 diver days of effort. Blacklip Abalone accounted for almost 90% and Greenlip Abalone 10% of the total numbers. Over 61% of the catch was taken from the east coast, with a further 27% from the north and 12% from the west coasts. About one in five dives resulted in the daily bag limit of 10 abalone being taken; the overall average daily harvest rate was 4.5 abalone.

By converting numbers to weights, the recreational harvest was estimated at 22.1 tonnes, equivalent to just under 2% of the 2018 TACC (1,333 tonnes). There are currently no performance indicators or a TARC for the Tasmanian recreational Abalone fishery.

.

Table of Contents

1 INTRODUCTION

Rock Lobster and Abalone are highly prized by recreational fishers in Tasmania. Southern Rock Lobster (*Jasus edward*sii) and occasionally the Eastern Rock Lobster (*Sagmariasus verreauxi*) are taken by a variety of methods, including pots, ring nets and dive collection. Two species of Abalone, Blacklip Abalone (*Haliotis rubra*) and Greenlip Abalone (*H. laevigata*), are targeted by recreational divers; the former species harvested around the state and dominating the catch and the latter species generally restricted to the north coast 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 in Tasmania. The licences are method-based and prior to the mid-1990s consisted of a pot and a general dive licence; the latter permitting 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 lobster dive, scallop dive and abalone licences. In 1998, a Rock lobster ring licence was introduced to close a loophole in the legal capture of Rock Lobster by recreational fishers. 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, the latter commonly known as hookah).

Licences are issued annually, with the licensing year extending from November to the following October. In a given year, recreational fishers may hold up to three categories of lobster licence (pot, ring and/or dive) and/or an abalone licence[1]. In addition to licensing, minimum size limits, closed seasons, and a ban on the taking of females carrying eggs, referred to as in 'berry', apply to Rock Lobster. Minimum size limits apply for Abalone. Recreational fishers are also subject to daily bag and possession limits for both Rock Lobster and Abalone and a boat limit for Rock Lobster.

Following the introduction of the current licensing system, the number of persons holding recreational Rock Lobster licences more than doubled from about 8500 in 1995-96 to 21,000 by 2007-08 (Fig. 1). Increases occurred in each of the licence categories, with over 18,000 pot, 9,000 dive and 5,600 ring net licences issued in 2007-08. Rock Lobster licence numbers remained relatively stable up until 2009-10, then declined over the following three seasons before increasing slightly to levels comparable to the mid-2000s. A sharp fall in licence numbers was experienced in 2015-16, largely influenced by closures of parts of the east coast early in the season due to harmful algal blooms (biotoxin events). Similar biotoxin events were experienced during the 2017-18 season, contributing to a 5% decline in licence sales compared with 2016-17. In the current season almost 17,200 persons held at least one Rock Lobster licence category, with 14,400 pot, 7,900 dive and 4,400 ring licences issued. Abalone licence sales have followed a similar trend, almost tripling between 1995-96 and 2007-08, to a peak of 13,500 licences (Fig. 1). Sales have remained relatively stable since 2010-11 but at a lower level, with 10,800 licences issued in 2017-18.

[1] Note, the licensing system also includes gillnet, beach seine, setline and scallop licence categories.

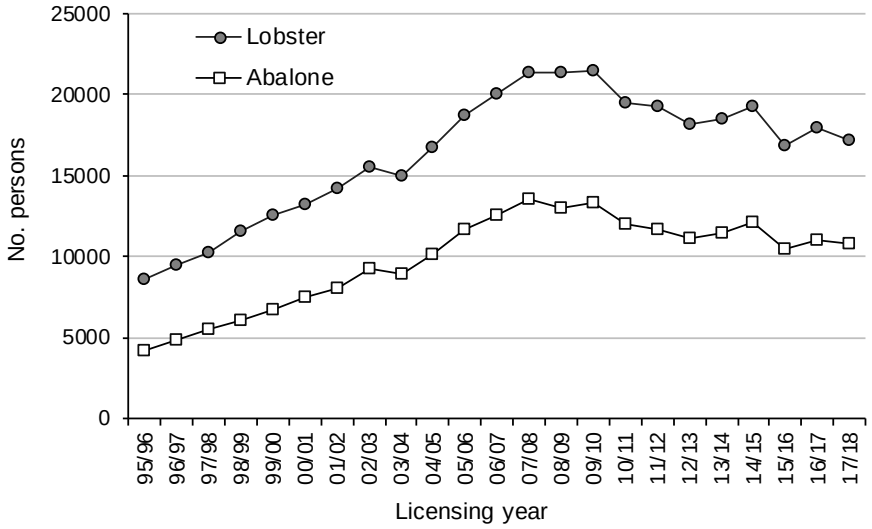

Fig. 1. Number of persons holding recreational Rock Lobster and Abalone licences by licensing year.

Concurrent with the initial increase in recreational licence sales was the introduction of quota management for the commercial Rock Lobster fishery in 1998. This was implemented to address the objective of reducing catches to sustainable levels and allow rebuilding of legal-sized biomass (Ford 2001). The total allowable commercial catch (TACC) was initially set at 1502 tonnes and represented a reduction in landings which had previously 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 this level until 2008-09. In response to concerns about declining stock levels, a situation exacerbated by a protracted period of poor recruitment (Linnane *et al*. 2010), the TACC was then progressively reduced to 1050.7 tonnes by 2014-15 and has been maintained at this level in subsequent seasons.

In the 2005 management review of the Tasmanian Rock Lobster fishery, provision was made for an explicit allocation to the recreational sector. Under these arrangements, a notional total allowable recreational catch (TARC) was 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 2017-18 which, when added to the TACC, resulted in a notional TAC of 1220.7 tonnes. Recreational catch information is required to evaluate performance against the TARC and also as an input into the Rock Lobster assessment developed to model stock status and undertake risk assessments under different management scenarios (Hartmann *et al.* 2013).

More recent concerns over the status of the east coast Rock lobster stocks resulted in the implementation a 10 year plan (2013-2023) to rebuild east coast stocks to greater than 20% of unfished biomass (DPIPWE, 2015). The rebuilding strategy seeks to limit the total Rock Lobster catch from the east coast to 200 tonnes, and is based on a notional resource sharing arrangement of 21% for the recreational sector (42 tonnes) and 79% for the commercial sector (158 tonnes). In 2018, the stock rebuilding zone was amended to exclude waters south of the southern coastline of Bruny Island (DPIPWE 2018) (Fig. 2). As a consequence the total catch target was reduced to 175 tonnes, with catch cap of 134 tonnes for the commercial sector and a revised notional catch limit of 41 tonnes for the recreational sector.

Key elements of the strategy relevant to recreational fishers involved dividing Tasmania into Eastern and Western Rock Lobster Fishing Regions (Fig. 2), reducing Eastern Region bag and possession limits and delaying the opening of the Eastern region fishery

by two weeks. The daily bag and possession limits in the Eastern region were reduced from 5 to 3 and from 10 to 6, respectively in November 2011. Bag and possession limits for the Western region remained unchanged at 5 and 10 lobsters, respectively. Boat limits were also introduced for the first time and were set at 15 lobsters for the Eastern region and 25 for the Western region. In November 2015, the Eastern region daily bag, possession and boat limits were further reduced to 2, 4 and 10 lobsters, respectively. In addition, the Eastern region fishing season was closed on 30 April, some four months earlier than in previous years. These more recent changes were implemented to constrain the recreational catch to within the east coast catch share.

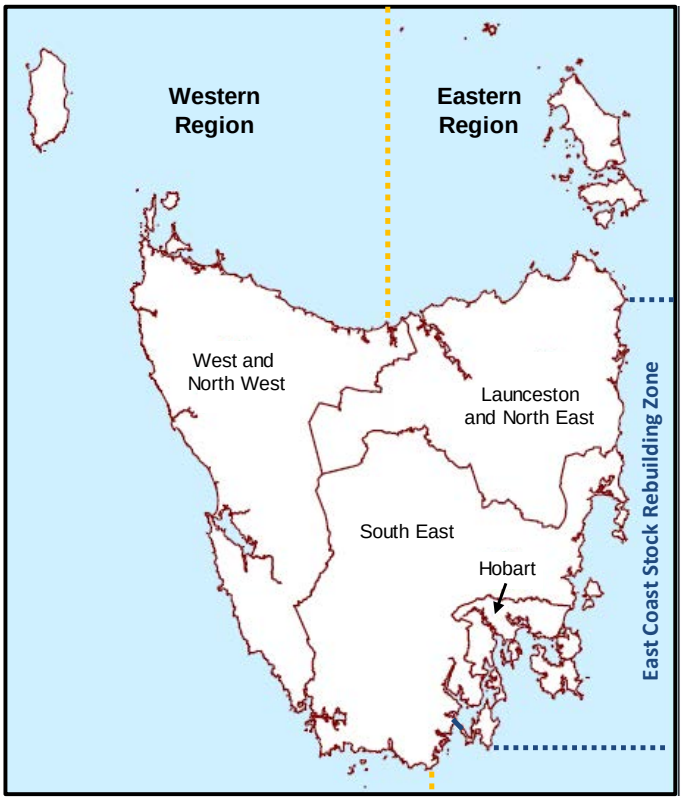

Fig. 2 Map showing Tasmanian ASGS Statistical Areas, Rock Lobster Fishing Regions and the current (2018) east coast stock rebuilding zone.

The TACC for Abalone has been reduced progressively since 2010, from 2660 to 1333.5 tonnes in 2018 (1200.5 tonnes for Blacklip and 133 tonnes for Greenlip Abalone). 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 (Mundy & Jones 2017).

This survey represents the thirteenth in a series for Rock Lobster and the twelfth for Abalone undertaken since 1996. Key objectives include characterisation of the 2017-18 Rock Lobster and Abalone fisheries in terms of participation, fishing effort and catch, with particular focus on the fishery off the east coast.

2 METHODS

2.1 Survey design

The methodology applied is based on that used successfully in previous surveys and independently reviewed by Pollock (2010). The design involves a two-stage process; an initial telephone interview to profile licence-holders and establish eligibility for a telephone-diary survey in which fishing activity is monitored in detail. The diary period included the 2017-18 licensing year up until the closure of the Eastern region Rock Lobster fishery (i.e between 1 November 2017 and 30 April 2018).

2.1.1 Survey sample

The survey sample was selected from the 2016-17 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 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 licence.

The database of all persons holding a 2016-17 recreational rock lobster licence was divided into five regional (i.e. residential) strata. For Tasmanian residents, regions corresponded to the Australian Bureau of Statistics (ABS) ASGS Statistical Areas (Level 4), namely Hobart, South East, Launceston and North East, and West and North West (Fig. 2). Interstate residents were grouped into a fifth 'Interstate' stratum. A stratified random sample was selected from the database, with a constant sampling fraction applied to each of the South East and Launceston and North East strata and a lower sampling fraction (two thirds of that for the South East and Launceston and North East) applied to the three remaining strata. Higher sampling rates for residents of the South East and Launceston and North East strata were intended to improve the precision of estimates of east coast fishing activity.

2.1.2 Screening survey

Respondents were contacted by telephone during October 2017 and asked about their fishing for Rock Lobster and Abalone during the 2016-17 season (number of days fished and estimated retained catch for either species) and whether they expected to renew their fishing licences for the 2017-18 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 were deemed eligible and were invited to participate in the diary survey. Those who accepted were mailed a simple diary and letter of introduction. Diarists were contacted by telephone shortly afterwards to confirm receipt of their survey kit and have reporting requirements explained. Diarists were then contacted regularly by telephone throughout the survey period by experienced 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 for non-diarised data. By maintaining regular contact, mostly at least once a

month, interviewers were also able to clarify any misunderstandings or inconsistencies at the time of the interview, thereby maximising overall data quality and completeness.

Information collected for each fishing activity or 'event' included the date, location, method used, target species for divers, start and finish times (including any significant breaks from fishing), and the numbers of lobster and/or abalone kept (harvested). In addition, the numbers of lobster released and reason(s) for release were recorded. Fishing locations were allocated into the eight areas used for lobster fishery assessment reporting (Fig. 3), though further disaggregation was feasible since more specific location information was routinely collected.

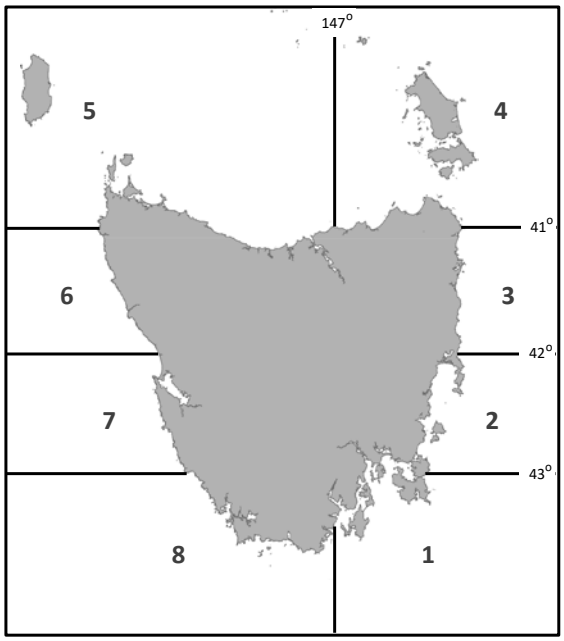

Fig. 3. Map of Tasmania showing fishery assessment areas referred to in the text.

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 lobster on the same day, with catch and effort information linked separately to each method.

Pots were generally fished overnight, although in a small number of instances they were not checked for several days, generally because unfavourable sea conditions prevented retrieval. The start of a 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 that day. For the purposes of calculating effort, overnight sets were considered to represent a single pot-day of effort.

The enumeration period for lobster was from the opening of the season (4 Nov 2017 Western region; 18 Nov 2017 Eastern region) until closure of the Eastern region fishery (30 April 2018). For abalone the survey period was from 1 Nov 2017 to 30 Apr 2018.

2.1.4 Wash-up survey

At the completion of the diary survey all fully responding diarists aged 18 years and older were asked a series of questions relating to their fishing activity, perceptions relating to the quality of the fishery, and opinions regarding recent management changes.

2.2 Data analysis

2.2.1 Catch and effort

Although initial sample selection was based on the 2016-17 licence database, licence details for 2017-18 were used for data expansion. That is, the licence status (licences held and dates of issue) was established for all diarists by reference to the 2017-18 licence database and expansion factors calculated as the size of the licensed population divided by the number of licensed diarists.

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. For instance, 53% of licences were issued by the end of November, 79% by the end of December 2017 and 90% by the end of January 2018. 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 (sensitive to the stratification) 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, rings and dive methods to harvest Rock Lobster and the harvesting 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 'bootstrap' method was used to estimate 95% confidence limits using the percentile method (Haddon 2001). In each instance 1000 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 2016-17 fishing season were asked whether they would also measure their catch as part of the survey. Respondents who expressed an interest 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 events, enabling size composition information to be made sensitive to fishing 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 and the east coast recreational catch share.

3 RESULTS

3.1 Response rates

3.1.1 Screening survey

From a random sample of 825 licence-holders selected from the 2016-17 licence database, 51 (6.1%) either had no telephone listing or the number was disconnected or incorrect. This represented sample loss and reduced the effective sample to 744. Contact was made with 708 licence-holders, of whom 692 fully responded, representing a screening survey response rate of 83.1%. Non-contacts (despite multiple attempts by telephone over a period of several weeks) accounted for 8.7% of the net sample and refusals or other non-response a further 2.1% (Table 1).

Amongst the respondents, 80 indicated that they were not likely to renew their licence(s) in 2017-18 and hence were not eligible for inclusion in the diary survey. The balance (612) indicated they were likely to renew their licence(s) (Table 1). Of this latter group, 77.5% were determined to have renewed their licence(s) based on the 2017-18 licence database, this compared with a renewal rate of 22.5% for those respondents who did not expect to take out a licence in 2017-18.

Table 1 Sample details and response rates for the screening and diary survey components

	Sample	% sample/ % eligible	Licence renewed 2017-18	Licence not renewed	% renewed
Screening survey					
Gross sample	825		581	244	70.4
Sample loss	51	6.1			
Net sample	744		541	233	72.7
Full response	692	83.1	492	200	71.1
Non-response	16	2.1	10	6	62.5
Non-contact	66	8.7	39	27	59.1
Eligible for diary					
Y- Likely to renew	612		474	138	77.5
N - Not likely to renew	*80*		*18*	*62*	22.5
Diary Survey					
Full response	449	73.6	354	95	78.8
Partial response	72	11.8	52	20	72.2
Refuse diary	91	14.6	68	23	74.7

3.1.2 Telephone-diary survey

In total 612 respondents were deemed eligible to participate in the diary survey (i.e. likely to renew), of whom 521 accepted the diary with 449 completing the survey. Of the responding diarists, 95 (21.1%) did not take up a licence during 2017-18 despite rating

themselves as 'quite likely' or 'very likely' to do so. Among the remaining 354 respondents, 349 held at least one category of lobster licence and 235 were licensed for abalone. Considering the number of total number of eligible respondents who renewed their licences (474) this represented an effective survey response rate of 74.6% (Table 1). 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.

The numbers of individual lobster and abalone licences (population) and the sample of responding diarists are presented in Table 2. Overall, about one in 50 of all 2017-18 licence holders were involved in the survey.

Table 2 Total number of 2017-18 lobster and abalone licence holders, numbers sampled (fully responding) and sample fraction by licence type.

Licence type	Licence holders	Diarists	% sampled
Rock Lobster pot	14,407	300	2.08
Rock Lobster dive	7,868	170	2.16
Rock Lobster ring	4,461	93	2.08
Abalone	10,797	235	2.18
Total licences	37,533	798	2.13
Total persons	17,841	354	1.98

Fully responding diarists reported a total of 1835 fishing events during the survey period, 1789 (97%) of which were considered valid events[2]. In total, 84% of all valid fishing events were reported as being diarised, 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

3.2.1 2016-17 seasonal participation

Information provided in the screening survey indicated that 82.7% (SE 1.4%) of 2016-17 Rock Lobster licence holders fished for Rock Lobster during that season, with 71.9% (SE 1.7%) harvesting at least one lobster. That is, out of the 18,159 persons licensed in 2016-17, 15,023 fished for Rock Lobster with 13,050 harvesting one or more lobster during that season. This information is, however, subject to recall bias as it was collected retrospectively and as such is considered indicative only.

3.2.2 2017-18 catch and effort

Information reported in this and following sections relates to diary survey data provided by fully responding licence holders and is presented as expanded estimates representative of the activities of all recreational Rock Lobster licence holders between November 2017 and April 2018, inclusive.

An estimated 69.9% (SE 2.5%) of licence holders fished for Rock Lobster at least once during the fishing season with 57.5% (SE 2.7%) harvesting at least one lobster during the diary period. That is, out of the 17,162 licence-holders, 12,004 actually fished for lobster with 9,940 retaining at least one for the period.

[2] Events reported by diarists whilst unlicensed were considered out of scope and not valid.

Overall, total fishing effort was estimated to be 77,209 fisher days[3] for the period November to April, yielding a total harvest of 72,009 lobster (Table 3). This represented an average harvest rate of 0.93 lobster per day fished. Pots were the most popular fishing method (accounting for 63% of the total harvest) followed by dive collection (34%) and rings (3%) (Table 3). Although four times as many fisher days of effort were spent using pots compared with diving, the catch taken by pots was only 1.8 times greater than that taken by divers. Average catch rates for divers (1.59 lobster per day) were more than twice that for pot fishers (0.73 lobster per day), accounting for the discrepancy between method-based contributions to total catch and effort. The average daily harvest for rings was similar to that for divers (1.38 lobster).

Table 3. Rock Lobster effort, harvest and harvest rates for the 2017-18 season up until 30 April

Values in parentheses represent the 95% confidence intervals

Method	Harvest (no.)	Effort (days)	Mean harvest rate (no. day^{-1})
Pot	45,388 (37,133 – 54,589)	62,396 (50,254 – 76,230)	0.73
Dive	24,455 (16,662 – 33,285)	15,422 (10,485 – 17,350)	1.59
Ring	2,165 (950 – 3,630)	1,565 (407 – 2,148)	1.38
Total	72,009 (60,425 – 84,156)	77,209 (64,983 – 91,699)	0.93

3.2.3 Regional catch and effort

Catch, effort and catch rates by fishing areas (refer Fig. 3) are summarised in Table 4 and indicate that the fishery was primarily concentrated on the east coast (Areas 1-3). This combined region accounted for 70% of the total estimated harvest (50,343 lobster) and attracted 82% of the total effort (63,513 fisher days) during the survey period. Area 1 alone accounted for 45% of the state-wide harvest and 58% the total effort. The north coast (Areas 4 & 5) accounted for 12% of the harvest (8,632 lobster) and 10% of effort (7,636 fisher days) while the west coast (Areas 6 - 8) contributed 18% of the total harvest (13,032 lobster) and 8% of total effort (6,059 fisher days).

Marked regional differences were evident in the proportion of the Rock Lobster harvest taken by different fishing methods (Fig. 4). Pots accounted for the bulk of the harvest in Areas 1 and 3 (70 and 98%, respectively) and Area 7 (55%), while dive collection was the primary capture method in Area 2 (68%) and Areas 4-5 (52-93%). Rings were most commonly used off the west coast, accounting for up to 28% of the harvest in Area 7.

Mean daily harvest rates were highly variable around the state, ranging from over 1.5 lobster per day in Areas 6-8 to 0.7 in Area 1 (Table 4). Stock abundance and fishing pressure (including commercial activity), along with differing regional bag limits and the relative mix of fishing methods used (Fig. 4), represent key factors contributing to this regional variability.

[3] A fisher day is defined as a day in which lobster was a nominated target species and/or lobsters were caught.

Table 4. Recreational Rock Lobster effort, harvest and harvest rates by fishing area for 2017-18

Values in parentheses represent the 95% confidence intervals

Area	Harvest (no.)	Effort (fisher-days)	Harvest rate (no. per fisher-day)
1	32,991	44,648	
	(26,214 – 41,472)	(33,654 – 56,936)	0.74
2	5,136	4,674	
	(2,506 – 8,296)	(2,633 – 7,270)	1.10
3	12,218	14,190	
	(8,142 – 16,926)	(10,015 – 19,230)	0.86
4	5,053	4,749	
	(2,543 - 7,754)	(2,362 -7,366)	1.06
5	3,579	2,887	
	(921 – 7,276)	(1,243 – 4,889)	1.24
6	7,748	4,215	
	(2,678 – 14,089)	(1,811 – 7,130)	1.84
7	4,678	1,662	
	(1,614 – 8,252)	(609 – 3,117)	2.81
8	606	182	
	(0 – 1,817)	(0 - 545)	3.33

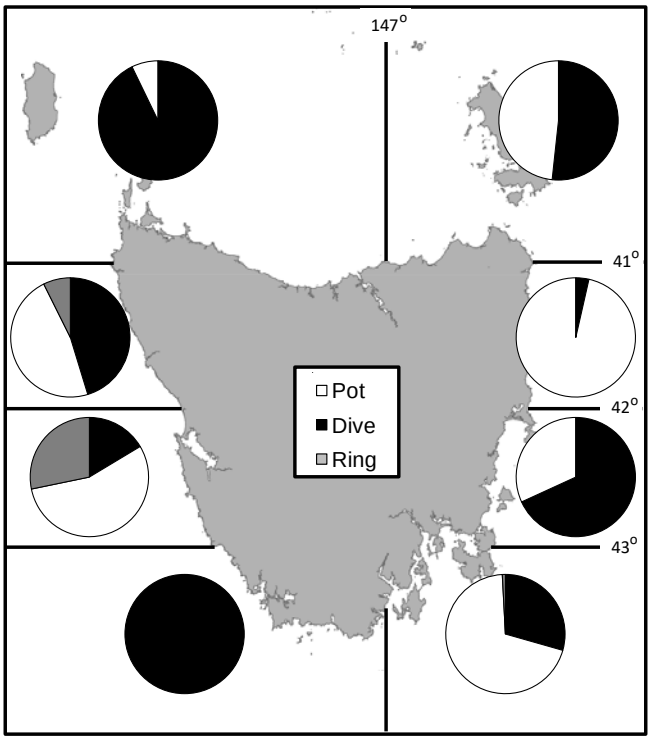

Fig. 4. Proportion of regional harvest by fishing method (pie charts).

3.2.4 Southeast coast

Catch data for Area 1 have been disaggregated into five sub-areas to better describe the spatial characteristics of the fishery in the southeast (Fig. 5). Waters surrounding the Tasman Peninsula and Storm Bay (including eastern Bruny Island) accounted for half of the catch, with the area to the south of Bruny Island and the D'Entrecasteaux Channel collectively accounting for a further third of the harvest. Norfolk-Frederick Henry Bay contributed 11% while comparatively low catches were reported from the Derwent Estuary.

Pots accounted for the majority of the catch taken from all areas apart from the Derwent Estuary where dive collection accounted for virtually all of the catch (Fig. 5).

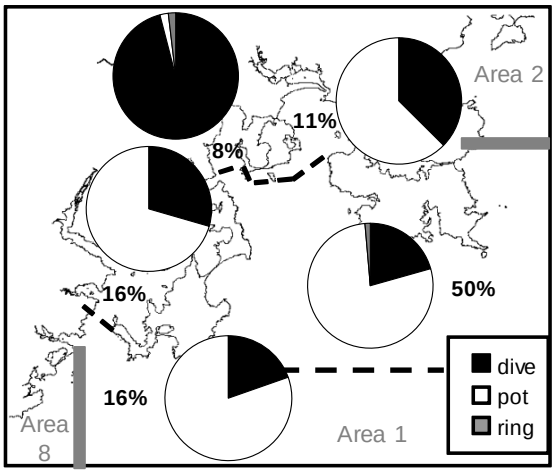

Fig. 5. Regional distribution of Area 1 harvest (%) and proportion of harvest by method (pie charts).

3.2.5 Seasonal catch and effort

Although the Western region was opened during the first weekend in November, the delay in opening the Eastern region (18 November) coupled with extended closures in three east coast biotoxin zones (Fig. 6) meant that the typical peak in fishing activity during November was not evident. Overall catches peaked in December whereas effort peaked in January, largely due to seasonal variation in potting activity (Fig. 7). Catch and effort both fell dramatically in February followed by a minor increase in activity in March, associated with the Easter holiday period.

The underlying seasonal pattern of catch and effort in the fishery was influenced most strongly by variation in pot fishing activity, with 78% of the pot catch taken between November and January (Fig. 7). By contrast, variability in monthly dive catch estimates was less pronounced, with just over half the dive catch taken between February and April.

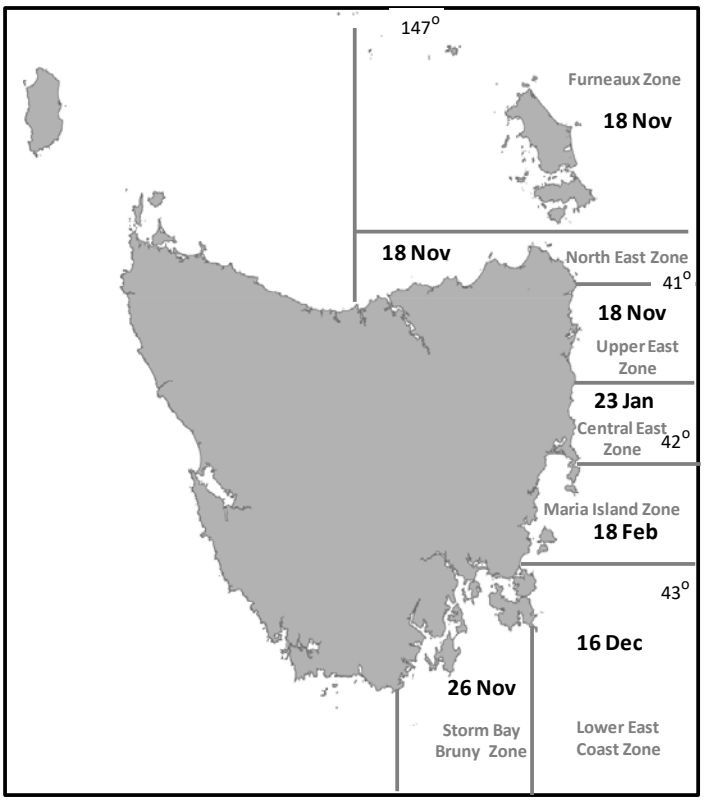

Fig. 6. Map showing the biotoxin management zones and dates on which the zones were opened for fishing during 2017-18.

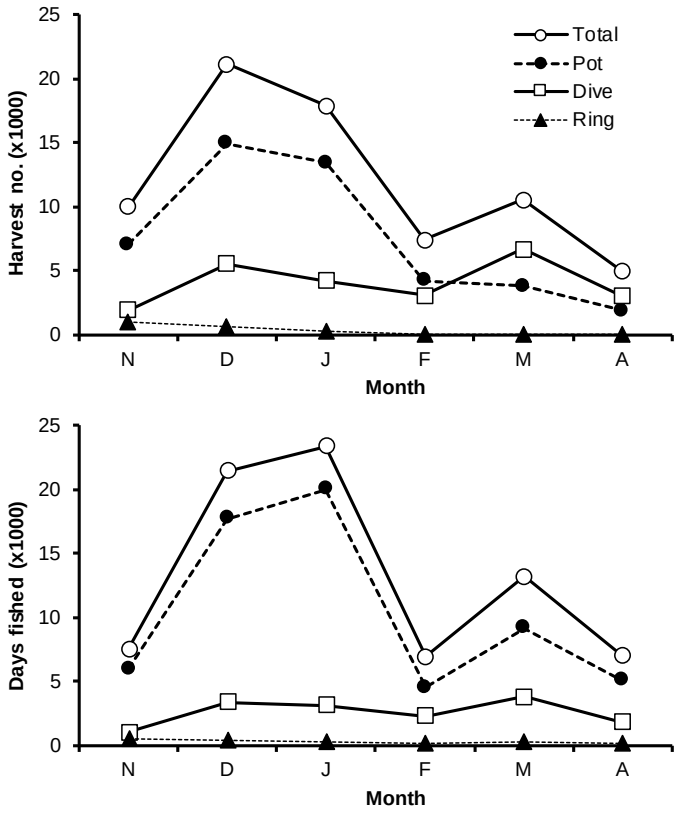

Fig. 7. Recreational Rock Lobster harvest (numbers) and effort (days fished) by month and method for the 2017-18 fishing season.

3.2.6 Daily harvest

Daily catch distributions differed markedly by fishing method and between management regions (Fig. 8). For instance, over half of the total pot effort in the Eastern region (Areas 1-4) resulted in no retained catch, this compared with 45% for the Western region (Areas 5-8) (Fig. 8). The Eastern region daily bag limit of two lobster was achieved on less than 20% of the days fished whereas in the Western region 36% of pot-days resulted in catches of at least two lobster, with 5% resulting in the Western region bag limit of five being taken. Divers had higher success rates, with over half of all dives in the Eastern region catching at least two lobster compared with 60% for the Western region. In fact a third of dives in the Western region resulted in the bag limit of five lobster being attained. There was limited ring effort reported in the Eastern region, over half of which resulted in a retained catch of at least one lobster. The method was more effective in the Western region, with 70% of the days fished resulting in catch of at least one lobster and the bag limit of five lobsters was taken on about 10% of occasions.

The actual dive method used had a strong effect on catch rates. Average daily harvest rates were highest for hookah (1.7 and 3.8 lobster for Eastern and Western regions, respectively), followed by scuba (1.3 and 1.7 lobster) and snorkel (1.0 and 0.8 lobster). Catches taken using hookah accounted for 52% of the total dive harvest, scuba 29% and snorkel 19%.

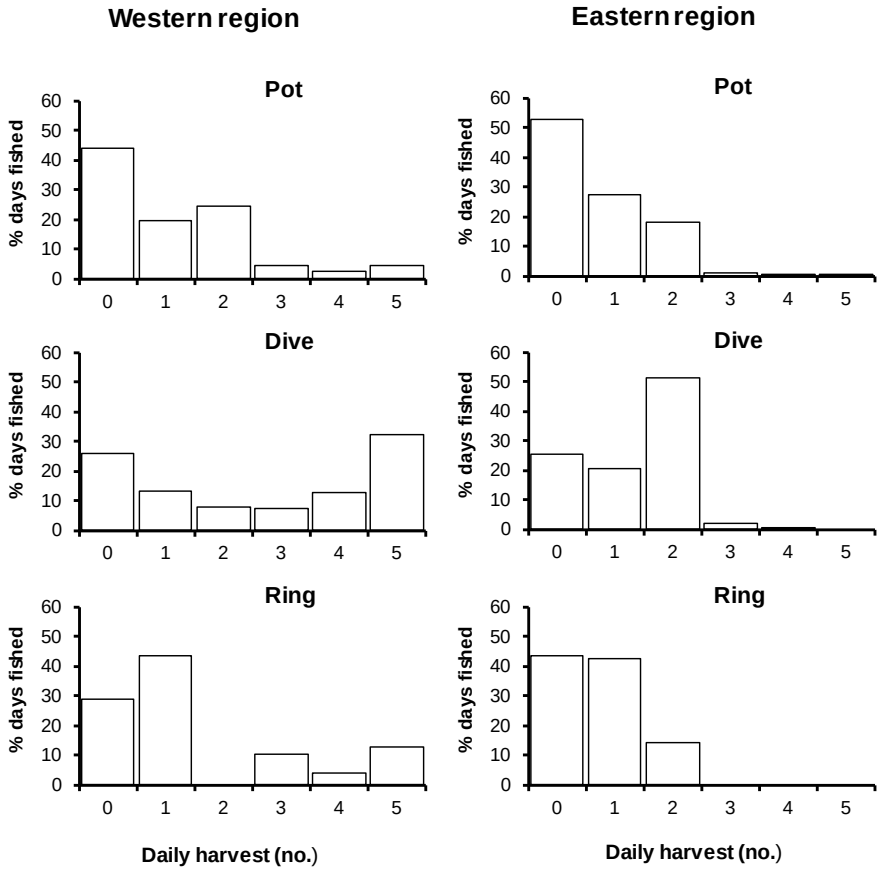

Fig. 8. Distribution of daily Rock Lobster harvest by fishing method and management region.

3.2.7 Individual season harvest estimates

Individual season limits for recreational fishers have been flagged as a potential management option to constrain the overall recreational harvest and share the catches more equitably between fishers. It was, therefore, worthwhile to report on the numbers of Rock Lobster retained by individual fishers during the 2017-18 fishing season up to the end of April (Fig. 9). Overall 17% of the active fishers harvested no legal sized lobsters, 42% harvested 5 or fewer lobsters during the survey period and 11% took 16 or more lobsters, this latter group accounting for 38% of the total harvest. Almost half of the licence holders who fished the east coast had seasonal catches of between 1 and 5 lobsters while only 9% of fishers took more than 16 lobsters but contributed 35% of the total east coast harvest. This analysis highlights the influence that relatively small numbers of avid fishers can have in determining the total harvest.

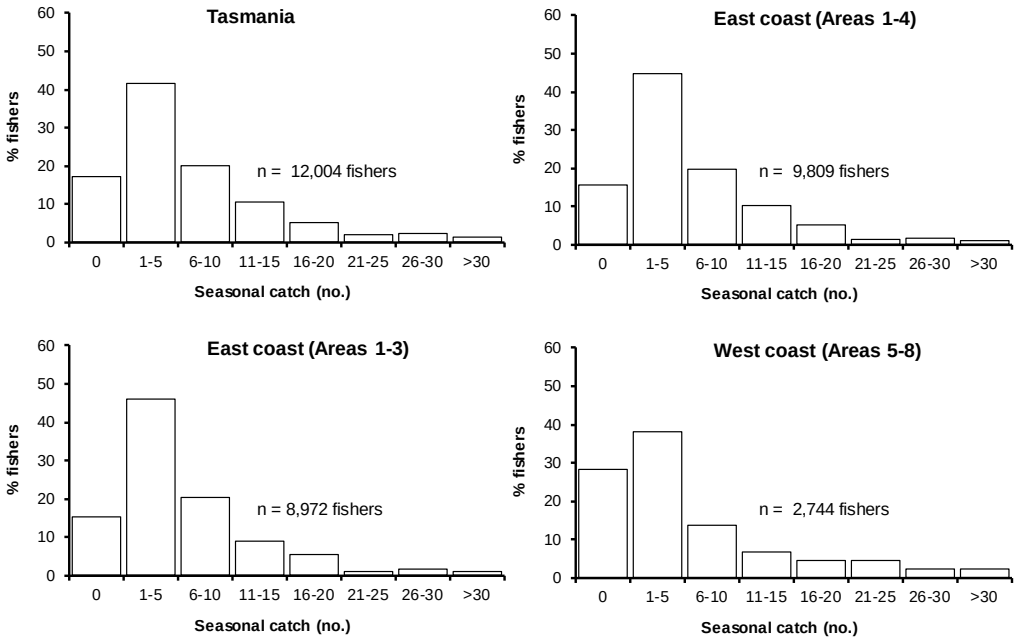

Fig. 9. Seasonal harvest of Rock Lobster for fishers who were active within specific fishing areas and for the whole fishery. n is estimated number of active licence-holders.

3.2.8 Released catch

A total of 48,259 Rock Lobster (95%CL 34,881 – 64,131) were estimated to have been released from pot catches, equivalent to 1.06 for every retained lobster. About 92% of pot releases were due the capture of undersized Rock Lobster, 4% of releases were due to over bag limit catches, <1% were berried females, and 3% were discarded dead or damaged.

Although divers release some Rock Lobster much of this 'sorting' probably occurs underwater and therefore a similar analysis of reasons for release by divers was not attempted.

3.2.9 Size composition

Diarists reported lengths for 673 pot caught, 175 dive caught and five ring caught Rock Lobster from around Tasmania. Pot caught Rock Lobster ranged between 105-194 mm carapace length (CL), with an overall average weight of 912 g. Dive caught Rock Lobster had a broader size range,105–287 mm CL, and were larger, with an average weight of 1474 g. Since very few ring caught Rock Lobster were measured[4], data for pots and rings have been combined in subsequent analyses. Male to female sex ratios for pot (1.0:0.80) and for dive (1.0:0.63) catches indicated that significantly more males than females were retained for both methods.

Length frequency distributions by region are presented in Fig. 10. Apart from the east coast (Areas 1-3) data were limited and may not be representative. For instance, dive catches sampled from the north coast (Areas 4 & 5) included a disproportionate representation of large individuals (> 200 mm) suggesting that diarists may have selectively measured the largest individuals.

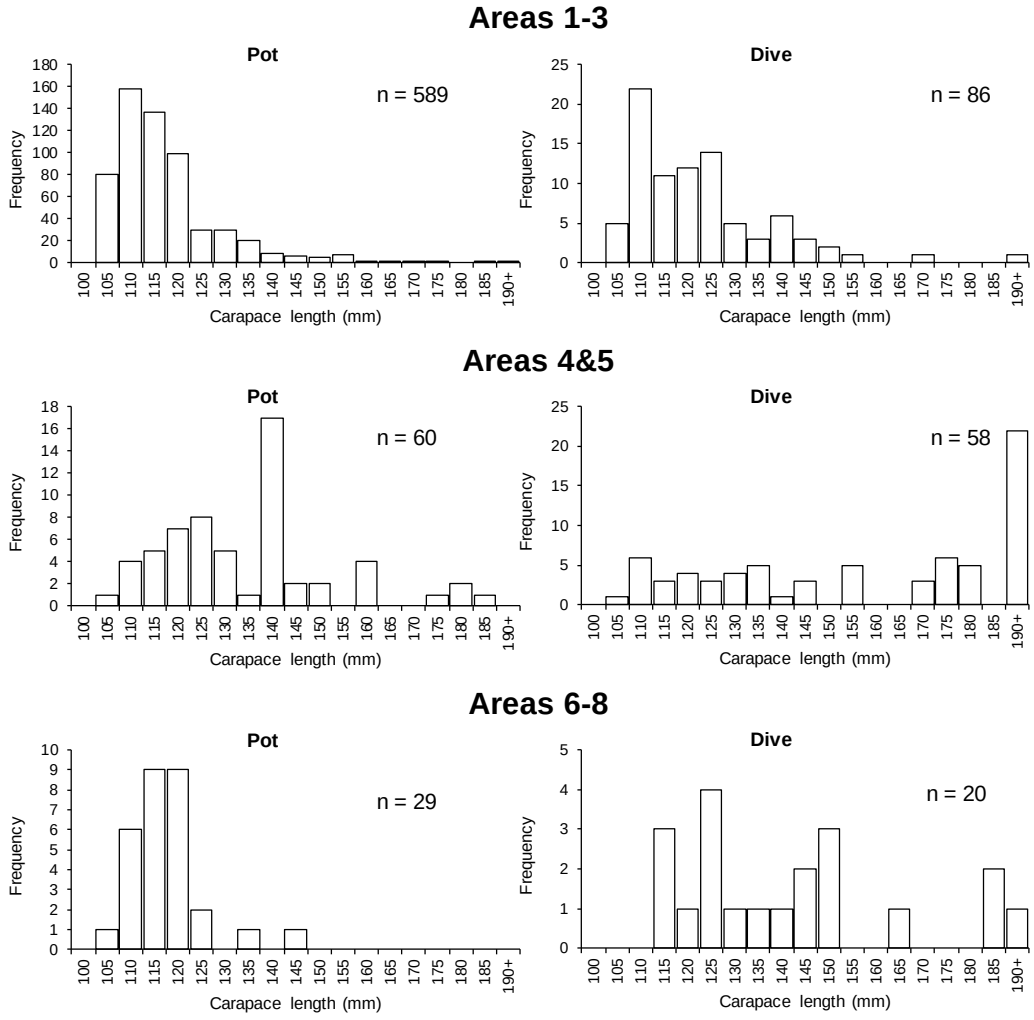

Fig. 10. Length frequency distributions by 5 mm size class for recreationally caught Rock Lobster taken by dive, pot and ring fishing methods by assessment area(s). n is sample size.

[4] Measurements of ring caught lobster were mainly derived from Areas 6 & 7.

3.2.10 Harvest weights

The weight of the 2017-18 recreational harvest was estimated by multiplying the average Rock Lobster weights by the numbers harvested by method and area. Average weights by area and method used to determine harvest weights are presented in Table 5.

The state-wide harvest was estimated to be 73.2 tonnes[5], equivalent to 43% of the TARC. Regional harvest estimates ranged from 29.8 tonnes (Area 1) to less than one tonne (Area 8) (Table 5). As a proportion of the recreational harvest, the east coast (Areas 1-3) accounted for 62%, north coast (Areas 4&5) 18%, and west coast (Areas 6-8) 20% of the total weight. In the case of the north coast, the combined effects of larger Rock Lobster on average and the dominance of dive collection meant that the region contributed disproportionately more to the overall catch weight compared with numbers (12% of the retained numbers, refer Table 4).

Table 5. Average Rock Lobster weight (g) by method and estimated harvest (kg) by area

	Av. weight (g)			%
Area	Pot/Ring	Dive	Harvest (kg)	total
1	868	992	29,840	40.8
2	868	992	4,892	6.7
3	868	992	10,659	14.6
4	1353	1648	7,607	10.4
5	1353	1648	5,822	8.0
6	855	1609	9,270	12.7
7	855	1609	4,579	6.3
8	855	1609	518	0.7
Total			73,187	

3.3 Abalone

3.3.1 2016-17 participation

Information provided in the screening survey suggested that 61.0% (SE 2.4%) of 2016-17 licence holders fished for Abalone during that season and that 56.7% (SE 2.4%) kept at least one Abalone. That is, out of 11,190 persons licensed in 2016-17, an estimated 6,821 fished for Abalone with 6,339 harvesting at least one Abalone. However, as this information was collected retrospectively at the end of the 2016-17 season it is subject to recall bias and as such is considered indicative only.

3.3.2 2017-18 catch and effort

Information reported in this and following sections relates to diary survey data provided by fully responding licence holders and is presented as expanded estimates

[5] Any illegal harvest taken by recreational fishers, whether due to fishing whilst unlicensed or catches in excess of legal limits, is not included in the harvest estimates.

representative of the activities of recreational abalone licence holders between November 2017 and April 2018, inclusive.

During 2017-18 an estimated 30.7% (SE 3.0%) of Abalone licence holders (i.e. 3,313 out of the 10,797 licence-holders) fished for Abalone with 28.4% (SE 3.0%) (3,066 persons) harvesting at least one Abalone.

The total estimated harvest was estimated to be 45,142 Abalone (95% CI: 30,113 – 62,073), the result of 10,079 fisher days[6] of effort. This represented an average harvest rate of 4.5 Abalone for each day fished. Blacklip Abalone dominated the catch, accounting for almost 90% of the total catch numbers (40,456) while Greenlip Abalone represented just over 10% of the state-wide total (4,686) (Table 6).

Table 6. Abalone harvest, effort and harvest rates by fishing area for 2017-18
Values in parentheses represent the 95% confidence intervals, * average weight based on commercial catch sampling data; ** weighted in accordance to the proportion of Blacklip and Greenlip Abalone in the catch and average species weight.

	Harvest (no.)					
Area	Blacklip Abalone	Greenlip Abalone	Effort (fisher days)	Harvest rate (no. per fisher day)	Av. weight (g)*	Harvest (kg)
1	24,728 (13,641 – 38,352)	-	4,900 (3,073 – 6,951)	5.05	522	12,907
2	1,882 (292 – 4,124)	-	687 (303 – 1,151)	2.74	517	972
3	865 (74– 1,994)	-	368 (69 - 766)	2.35	528	456
4	5,369 (1,457 – 8,846)	2,108 (317 – 4,142)	1,897 (521 – 3,591)	3.94	412**	3,228
5	2,271 (883 – 3,928)	2,578 (113 – 6,630)	1,006 (432 – 1,681)	4.82	386**	1,870
6	4,372 (625 – 11,426)	-	912 (136 – 2,326)	4.79	501	2,191
7	558 (0 – 1,481)	-	156 (0 - 415)	3.58	501	280
8	410 (0 – 1,182)	-	154 (0 - 432)	2,67	531	218
Total	40,456 (27,927 – 55,815)	4,686 (1,290 – 8,700)	10,079 (7,211 – 13,446)	4.48		22,124

3.3.3 Regional catch and effort

Regional catch, effort and harvest rates for Abalone are presented in Table 6. The recreational fishery was concentrated in the southeast (Area 1, 54% total harvest) and, to a lesser extent, on the north coast (Areas 4-5, 27% total harvest). Blacklip Abalone were taken from all areas whereas Greenlip Abalone were restricted to the north coast. Regional harvest rates varied between 2.4 and ~ 5 Abalone per day, the highest catch rates were in the southeast (Area 1) and northwest (Areas 5 & 6) of the state.

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

3.3.4 Southeast coast

Data for Area 1 were disaggregated into five sub-areas to better define the spatial characteristics of the fishery in the southeast of the state (Fig. 11). Norfolk-Frederick Henry Bay, Storm Bay and the D'Entrecasteaux Channel combined to account for over three-quarters of the regional harvest. Catches from the Derwent and south of Bruny were roughly similar but small in magnitude.

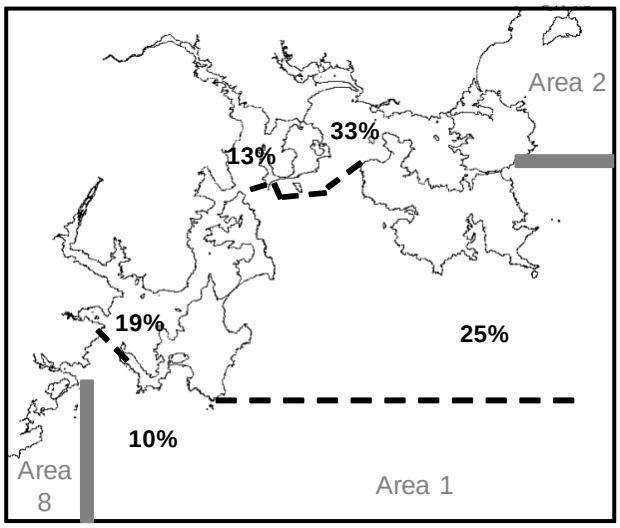

Fig. 11. Regional distribution of Area 1 Abalone harvest.

3.3.5 Seasonal catch and effort

The fishery for Abalone exhibited a strong seasonal pattern, with catch and effort peaking in December (Fig. 12). The typical peak in catch and effort in November was not evident in 2017, highlighting the links between the Rock Lobster and Abalone fisheries (the majority of Abalone licence-holders also hold Rock Lobster dive licences).

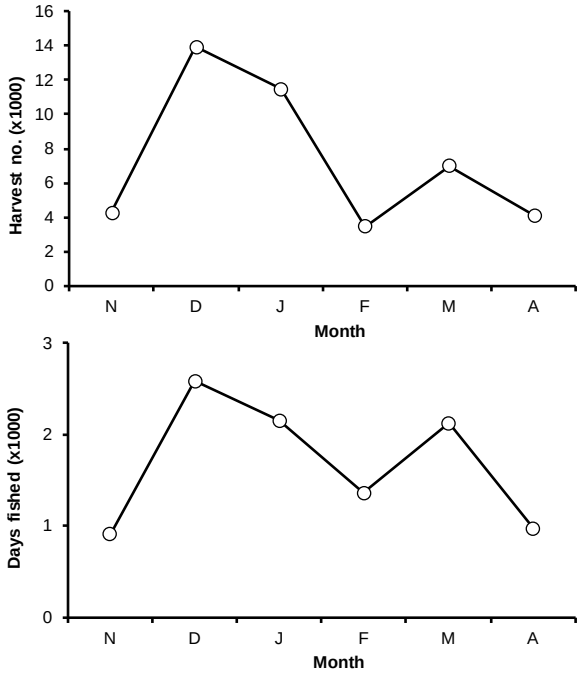

Fig. 12. Recreational Abalone harvest (numbers) and effort (days fished) by month during the 2017-18 fishing season.

3.3.6 Daily harvest

About one in five targeted dives resulted in the daily bag limit of ten Abalone being achieved, with a similar proportion resulting in no catch (Fig. 13). While hookah divers reported the highest average catch rate (5.1 Abalone per day), snorkel divers took the bag limit of 10 abalone more frequently (31%) that either of the other two dive methods. Average daily catch rates for snorkel (4.6) were slightly lower than for hookah but were higher than for scuba divers (3.5). Overall, snorkel diving accounted for 43% of the harvest and 41% of effort (diver-days), hookah was next in importance (39% of the harvest and 28% of the effort) followed by scuba (25% of the retained catch and 31% of the effort).

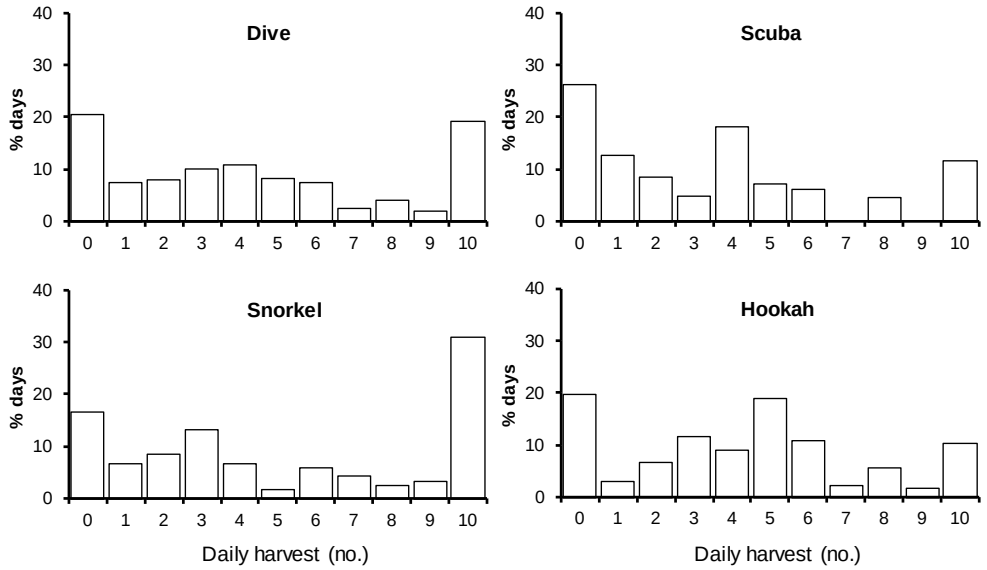

Fig. 13. Distribution of daily Abalone harvest by dive methods for 2017-18 licence holders

3.3.7 Harvest weights

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 531 g off the south coast (Area 8) and 386 g off the north coast (Areas 5) (Table 6). Using these values, the recreational harvest between November and April was estimated to be about 22.1 tonnes. Regionally, harvest estimates ranged from 12.9 tonnes in Area 1 to just less than one tonne in Areas 2-3 and 7-8 (Table 6). The catch for the combined east coast (Areas 1-3) was 14.3 tonnes, the north coast (Areas 4&5) 5.1 tonnes, and the west coast (Areas 6-8) 2.7 tonnes.

3.4 Wash-up survey

3.4.1 General

The overall response rate to the wash-up survey was 79.2% (328 out of a net eligible sample of 424)[7].

3.4.2 Constraints to fishing

Diarists who did not fish for Rock Lobster during 2017-18 were asked, as an open ended question, about their main reasons for not fishing during the season. The most commonly cited reason by licensed respondents was lack of time due to work and/or family commitments, this was followed by the impact of the biotoxin closures during the peak season (Table 7). Lack of time and biotoxin closures were also the most common reasons cited for not renewing licences.

Table 7. Main reasons for not fishing for Rock Lobster during 2017-18

Reasons	Not licensed	%	Licensed	%	Combined	%
Lack of time/work and/or family commitments	38	48.7	38	46.3	76	47.5
Biotoxin closures	14	17.9	11	13.4	25	15.6
Weather	3	3.8	8	9.8	11	6.9
Health/age	4	10.3	3	4.2	7	6.4
Lack of opportunity/ fishing partner	3	3.8	3	3.7	6	3.8
Lack of boat or equipment	2	2.6	4	4.9	6	3.8
Other fishing activities	3	3.8	3	3.7	6	3.8
Moved interstate/travelling/did not visit Tasmania	2	2.6	3	3.7	5	3.1
Lack of interest/ alternative interests	2	2.6	1	1.2	3	1.9
Other	3	3.8		0.0	3	1.9
No. respondents	78		82		160	

[7] Eligible respondents were those who completed the diary survey and were over 18 years of age.

3.4.3 Fishery quality

Slightly fewer than half of the respondents who fished for Rock Lobster in 2017-18 indicated that the overall quality of the fishery was about the same as in 2016-17; the remainder were more or less evenly divided between the quality being better rather worse compared with the previous year (Table 8). This contrasts the situation in 2016-17, when more than twice as many respondents suggested that the quality of the fishery in 2016-17 was better (34%) rather than worse (15%) when compared with the 2015-16 season (Lyle and Tracey 2017).

Table 8. Response to the question relating to the perceived quality of the 2017-18 Rock Lobster season relative to 2016-17

Response	No.	%
Better	49	25.7
Worse	51	26.7
(About the) Same	84	44.0
Unsure	7	3.7
Total respondents	191	

3.4.4 Policing and enforcement

Out of 187 active fishers who responded to questions about policing, 25% indicated that they had been checked by Marine Police whereas 73% were not checked whilst fishing for lobster during 2017-18 (2% were unsure). Comparable figures were 23% and 76% in 2016-17, 20% and 79% in 2015-16 and 34% and 66% in 2014-15.

3.4.5 Importance of fishing

To better understand the significance that respondents attribute to fishing in general, and lobster fishing in particular, they were asked to rate the importance of fishing compared with other outdoor activities that they participate in and the importance of lobster fishing compared with other types of fishing. Overall, fishing was ranked as the most important outdoor activity for 42% of respondents, with 45% indicating that fishing was just one of many outdoor activities they participated in (Table 9). When asked about the importance of lobster fishing 21% indicated that it was their most important activity whereas almost 60% indicated that it was just one of many types of fishing they pursued.

Respondents were also asked about the range of fishing activities that they had also participated in during the past year. Inshore line fishing for species such as flathead was by far the most common activity, followed by diving for abalone and/or scallops (a higher proportion amongst lobster fishers who were active in 2017-18), game fishing and deepwater fishing (Table 10). About 30% of active lobster fishers also reported net fishing, about double to rate for those respondents who did not fish for lobster during 2017-18. The relatively high occurrence of gillnet usage amongst lobster fishers may be linked to bait capture.

Table 9: Importance of fishing compared with other types of outdoor activities and lobster fishing compared with other types of fishing

	Fishing		Lobster fishing	
Response	No.	%	No.	%
Most important activity	134	41.6	66	20.6
Second most important activity	42	13.0	66	20.6
One of many activities	146	45.3	189	58.9
Respondents	322		321	

Table 10: Other fishing activities undertaken during the past 12 months.

	All respondents		Fished Rock Lobster	
Activity	No.	%	No.	%
Inshore line fishing	282	87.3	173	91.5
Diving for abalone/scallops	117	36.2	85	45.0
Gamefish fishing	113	35.0	71	37.6
Deepwater bottom fishing	110	34.1	65	34.4
Net fishing	77	23.8	57	30.2
Flounder spearing	74	22.9	50	26.5
Freshwater fishing	73	22.6	50	26.5
Other fishing	14	4.3	12	6.3
Total respondents	323		189	

3.4.1 Impacts of biotoxin closures

Out of 328 respondents, 36% indicated the east coast biotoxin closures (refer Fig. 6) had impacted on where or how often they went fishing for lobster during 2017-18, 61% indicated that the closures had not directly impacted their fishing for lobster (3% were unsure). The main impact of the closures was that fishers had reduced opportunities and either fished less, had trips cancelled or did not fish at all (93%), only 3% of those affected indicated that they had travelled to other areas to fish for lobster and, coincidently, 3% noted greater competition in open areas that they attributed the impacts of the closures on other areas. Very similar responses were obtained following biotoxin closures in 2015-16 (Lyle and Tracey 2016).

3.4.2 Communication of biotoxin closures

Overall, the majority of respondents (81%) considered that the government had done enough to communicate information about the biotoxin closures, this compares with 71% in 2012-13 (Lyle and Tracey 2014) and 73% in 2015-16 (Lyle and Tracey 2016). Only 15% of respondents indicated that they did not consider the government had done enough and 4% were unsure. Amongst respondents who considered more could have been done, 31% suggested greater use of conventional media (TV, radio and print media), 15% wanted more information on the health risks, 13% suggested text messages be sent to licence-holders and 13% requested notifications be made earlier than Friday of weekend openings (to allow planning of trips). Interestingly, 15% suggested that licence holders should be updated by email, a service that already exists

for those who have provided email contact details. The use of signage at access points in affected areas was also suggested. Several respondents also questioned the need to use closures rather than health advisory.

3.4.3 Biotoxins and human health risks

In order to better understand the potential risks to human health from eating Rock Lobsters that could have accumulated the biotoxin (paralytic shellfish toxin, PST), respondents were asked whether, prior to the first major biotoxin outbreak in 2012, they consumed the hepatopancreas (commonly known as "mustard") (Table 11). Overall 20% of respondents indicated that they at least occasionally consumed the hepatopancreas, with highest proportion (~24%) amongst residents in the South East and Launceston and North East regions and lowest incidence amongst Hobart residents (~14%). Interestingly, of those respondent who indicated that prior to 2012 they ate the hepatopancreas (even occasionally/sometimes), 30.3% indicated that as a consequence of the biotoxin closures they no longer consumed this part of the lobsters. In a similar survey conducted at the end of the 2015-16 fishing season, a season also impacted by biotoxin closures, just 14.9% of respondents indicated that had changed the parts of the lobster that they consumed (Lyle and Tracey 2016). At face level it would appear that there is an increase in awareness of the potential health risks amongst fishers.

Table 11: Responses to the question of whether the respondent consumed the hepatopancreas prior to the first major biotoxin outbreak in 2012, based on region of residence

	Residential Region				
Response	Hobart	South East / Launceston and North East	West and North West	Interstate	Total
Yes	12.4	17.4	14.6	20.0	14.9
Occasionally/sometimes	1.9	6.4	4.2	0.0	5.1
No	83.8	76.2	81.3	80.0	79.4
Unsure	1.9			0.0	0.6
No. respondents	105	172	48	10	335

4 DISCUSSION

4.1 Catch and effort

4.1.1 General trends

To date, thirteen estimates of recreational Rock Lobster harvest are available based on the methodology applied in this survey. Rock Lobster catches generally increased between the mid-1990s and 2002-03, reflecting growth in licence sales and improved stock biomass. Despite further growth in licence sales up until 2009-10, catches after 2006-07 generally declined before stabilising at levels more comparable to the late 1990s (Fig. 14). The catch in the current season represented decline of about 18% compared with 2016-17, but was higher than in 2015-16, a season also particularly impacted by biotoxin closures (Table 12).

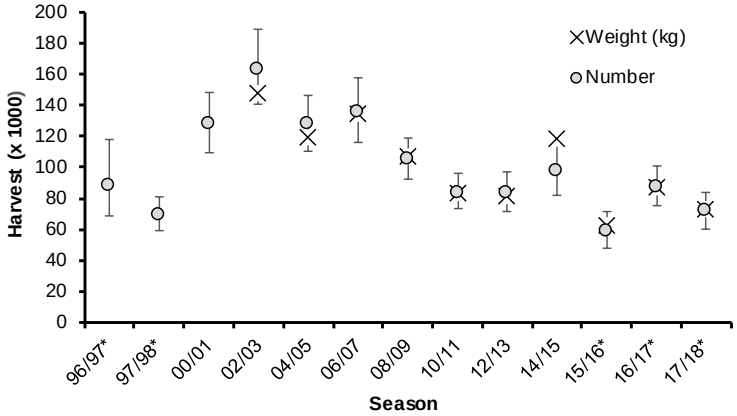

Fig. 14. Estimated Rock Lobster harvest (number and weight) plotted against fishing season. Error bars represent 95% confidence limits for numbers. * indicates partial season surveys.

Although declines in recreational Rock Lobster catches have been experienced in most areas since the early 2000s, the sharp fall in Area 1 during 2008-09 had the major impact on the overall state-wide catch (Fig.15). There has been a slight recovery in Area 1 catches whereas as catches in Area 2 in particular, declined in 2017-18, no doubt linked to the protracted closure of the Maria Island biotoxin zone (Fig. 6). The low estimated catch from Area 8 is mainly due to the low number of reports of fishing from that region (effectively a very small accessible area of coastline) rather than indicative of a major collapse in the fishery.

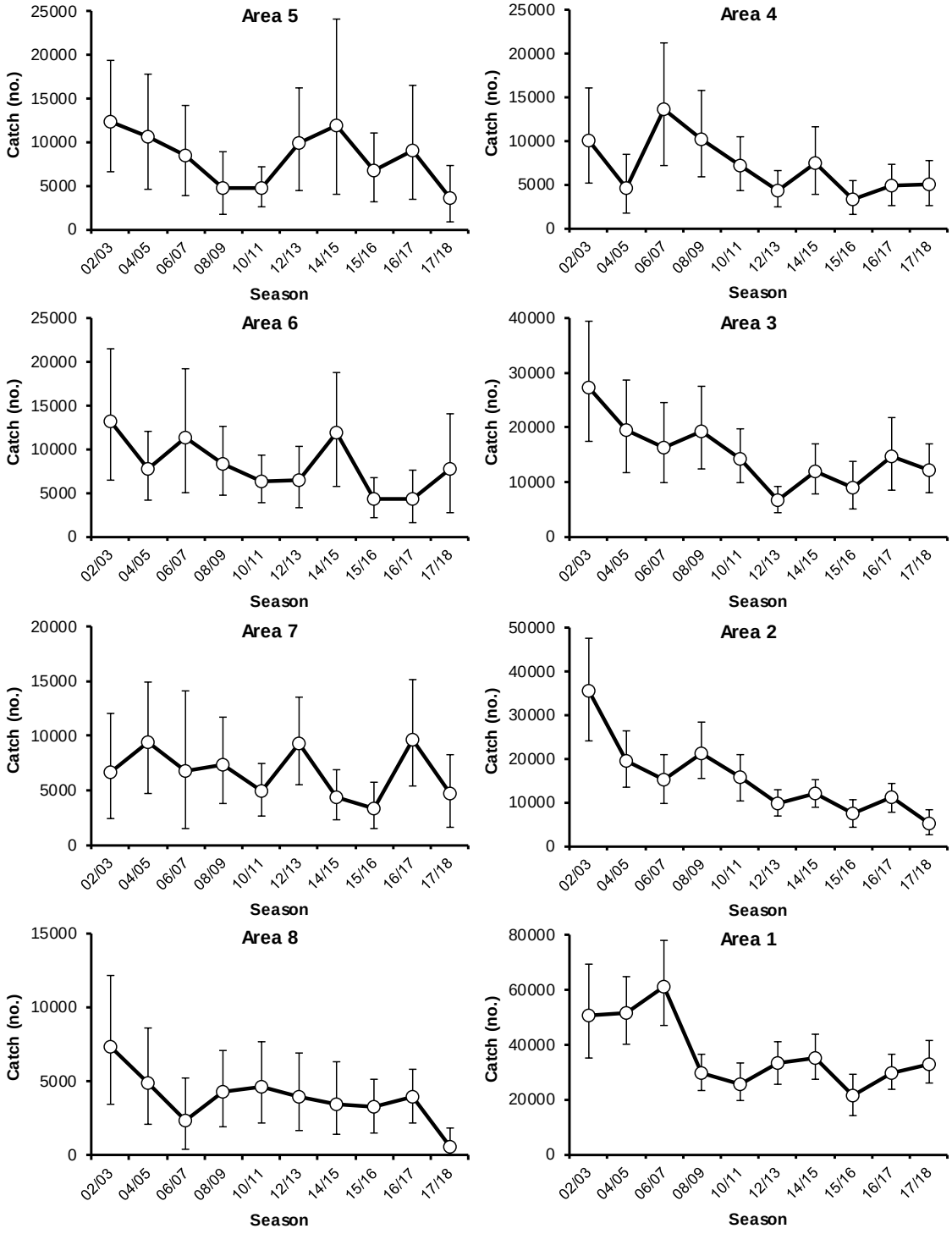

Fig. 15. Regional Rock Lobster harvest estimates (numbers) by recreational fishing season. Error bars represent 95% confidence limits.

Abalone harvest levels have also declined since the early 2000s (Fig. 16) even though licence numbers continued to grow up until 2008-09 (Fig. 1). The current harvest estimate was very similar to those for the previous two seasons, making catches since 2015-16 amongst the lowest since surveys commenced the mid-1990s (Table 12).

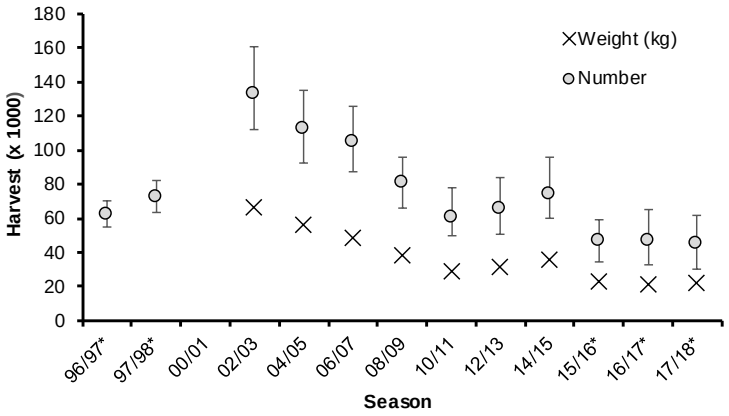

Fig. 16. Estimated Abalone harvest (number and weight) plotted against fishing season. Error bars represent 95% confidence limits for numbers. * indicates partial season surveys.

Social (e.g. motivations, availability of time, access), biological (e.g. stock size, catch rates) and environmental (weather) factors all play a role in influencing fisher behaviour and highlight the need to understand the dynamics and drivers of this behaviour. For instance, since the early 2000s the proportion of licence-holders who actually utilised their licences (i.e. fished) has varied between 86-68% for lobster, and from 63- 31% for abalone (Table 12). In the two seasons especially impacted by biotoxin closures (2015-16 and 2017-18) more than 30% of licence-holders did not fish for lobster. Lack of time (due work and/or family commitments) and the biotoxin closures were the most commonly cited reasons for not fishing for lobster (and not renewing licences) during 2017-18.

Coupled with this trend has been a general decline in the average number of days fished per season by active fishers for both lobster (8.8 down to 6.0 days) and abalone (4.3 down to 2.4 days), contributing to declines in average seasonal harvest per fisher (from greater than 11 to 5-6 for lobster, and from 23 to 12-13 for abalone) (Table 12). Furthermore, daily harvest rates for lobster have declined since the early 2000s (1.3 to less than 1.0 per day); this decline being most influenced by pot catch rates which fell from 1.0 in 2002-03 to 0.65 lobster per day in 2015-16 before recovering to above 0.7 per day (Table 12). Each of the catch rate metrics were lower in 2017-18 compared to the previous season, and in line with this only a quarter of active fishers considered that the quality of the fishery to be better than in the previous year.

Given the above, the general growth in licence numbers up until 2008-09 has not translated into comparable increases of effort or harvest. On the contrary, declines in participation rates, a general reduction in avidity (days fished) and falling (or stable) catch rates have tended to dampen any influence that increased licence sales has had on catches.

Table 12. Number of Rock Lobster and Abalone licence holders, estimated number and proportion who fished, total and average harvest and effort per fisher by year and average daily harvest rates. * part year (Nov-Apr); nd not determined

	Licence year										
	2000-01	2002-03	2004-05	2006-07	2008-09	2010-11	2012-13	2014-15	2015-16*	2016-17*	2017-18*
Rock lobster											
No. licence holders	13,265	15,580	16,710	20,008	21,351	19,519	18,185	19,306	16,810	18,009	17,162
% fished	86.5	88.4	81.9	78.4	75.2	71.7	76.0	75.4	68.4	76.0	69.9
No. active fishers	11,408	14,308	13,679	15,687	16,050	13,997	13,814	14,552	11,500	13,686	12,004
Harvest (no.)	128,219	163,454	127,987	135,592	105,538	83,472	83,772	98,442	58,805	87,650	72,009
Harvest (kg)	nd	148,526	119,354	135,067	107,027	84,261	81,849	118,996	63,022	87,941	73,187
Av. no. per active fisher	11.2	11.4	9.4	8.6	6.6	6.0	6.1	6.8	5.1	6.4	6.0
Fisher days	100,866	125,898	109,788	124,305	103,985	87,617	85,849	101,699	69,920	81,690	77,209
Av. days per active fisher	8.8	8.8	8.0	7.9	6.5	6.3	6.2	7.0	6.1	6.0	6.4
Av. daily harvest (no.)	1.27	1.30	1.17	1.09	1.01	0.95	0.98	0.97	0.84	1.07	0.93
Av. daily pot-harvest (no.)	0.87	1.00	0.90	0.94	0.75	0.68	0.78	0.71	0.65	0.87	0.74
Av. daily dive-harvest (no.)	2.61	2.30	2.31	2.15	2.27	2.36	1.83	1.92	1.61	1.90	1.59
Abalone											
No. licence holders		9,272	10,133	12,514	12,976	11,972	11,157	12,084	10,509	11,035	10,797
% fished		63.5	55.8	52.3	38.8	36.3	42.0	42.4	37.9	33.5	30.7
No. active fishers		5,853	5,653	6,542	5,033	4,349	4,682	5,126	3,896	3,695	3,313
Harvest (no.)		133,711	112,571	105,515	81,021	60,943	66,438	74,769	47,113	47,522	45,142
Harvest (kg)		66,857	56,283	49,022	39,024	29,438	32,138	36,047	23,081	21,590	
Av. no. per active fisher		22.8	19.9	16.1	16.1	14.0	14.2	14.6	12.1	12.9	13.6
Fisher days		25,342	18,185	23,201	14,445	12,117	11,428	15,110	9,548	9,136	10,079
Av. days per active fisher		4.3	3.2	3.5	2.9	2.8	2.4	2.9	2.5	2.5	3.0
Av. daily harvest (no.)		5.28	6.19	4.55	5.61	5.03	5.81	4.95	4.93	5.20	4.48

4.1.2 Fishing methods

Pots have consistently represented the main method used to catch Rock Lobster and apart from 2000-01, have accounted for 58-67% of the total harvest numbers in each of the years surveyed (Fig. 17). Dive methods have typically accounted for about a 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 that year was unclear and has not been evident in subsequent seasons. Rings represent a minor component of the fishery.

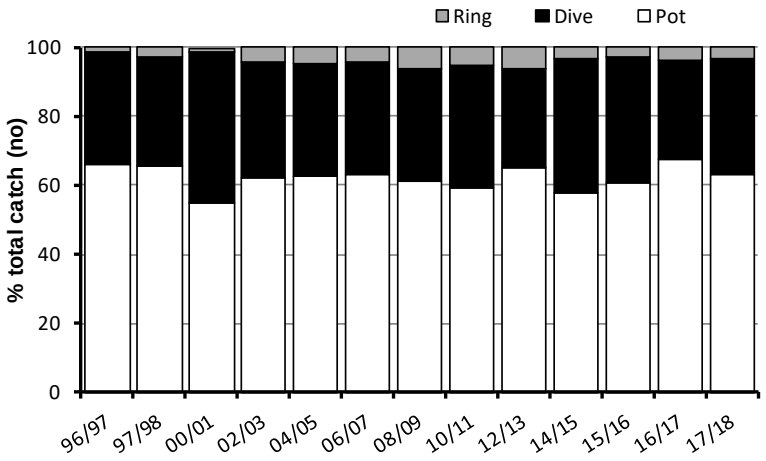

Fig. 17. Proportion of the Rock Lobster harvest by method and fishing season

4.1.3 Catch rates

The average daily harvest rate for pots (0.74 lobster) during 2017-18 represented a 15% decline compared with the previous season but was comparable to levels experienced between 2008-09 and 2014-15 when the daily bag limit was up to five and not two, as currently applies to the main segment of the fishery (Table 12). This suggests that pot catch rates have remained largely insensitive to these bag limit changes, confirmed by two decades of survey data indicating that catches of two or more lobster per pot day are rare. Pot catch rates are, however, more likely to be responsive to trends in Rock Lobster abundance and the trend in pot catch rates over the past decade has been consistent with changes in Rock Lobster population biomass (Hartmann *et al*. 2013). Dive catch rates, by contrast, have tended to fluctuate without obvious trend, apart from the obvious step down to below 2.0 lobsters per day since 2012-13 that corresponded with the reduction in the Eastern region bag limit. Unlike pots which are dependent upon lobster availability and catchability (behaviour), divers actively search for lobster and are able to maintain catch rates by increasing search times such that a relatively high proportion of trips achieve the bag limits.

Abalone catch rates have also fluctuated without obvious trend through time, reflecting the fact that many divers regularly attain the bag limit. The average daily harvest rate for Abalone (4.5) in 2017-18 was, however, at the lower end of the range reported for previous years (4.5-6.2 per day).

Bag limits represent the primary management strategy to constrain recreational Rock Lobster and Abalone catches in Tasmania. As discussed above, bag limits have a less obvious impact on pot catches, with 19% of the pot effort in the Eastern region and 4% of the pot effort in the Western region resulting in the respective bag limits being achieved during 2017-18. By contrast, bag limits had a more obvious impact on dive catches, with 54% of the dive effort in the Eastern region and 33% of the dive effort in the Western region resulting in the bag limits being achieved. For divers, artificial breathing apparatus (hookah and scuba) conferred a clear advantage when targeting Rock Lobster, as reflected in catch rates and incidence of the bag limit being attained. Hookah and scuba were less of an advantage when diving for Abalone, with free-diving proving particularly successful for this species.

4.1.4 Regional patterns

The recreational Rock Lobster and Abalone fisheries are concentrated off the southeast and east coasts of Tasmania, with Areas 1-3 accounting for 70 and 61% of the harvest (by number), respectively. The remainder of the Rock Lobster harvest was split more or less evenly between the north (Areas 4 & 5) and west coasts (Areas 6-8). For Abalone the north coast was more important than the west coast, the former accounting for about 27% and the latter about 12% of the state-wide recreational harvest.

The intensity of the fishing activity off the southeast 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 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 those regions. Despite this, catch rates for Rock Lobster and Abalone tend to be higher off the west coast than elsewhere, this region representing a very significant area for both commercial Rock Lobster and Abalone fisheries (Hartmann *et al*. 2013, Mundy & Jones 2017).

There is considerable regional variability in the relative importance of the various Rock Lobster fishing methods. Pot catches clearly dominate the harvest off the southeast and east coasts, whereas dive collection is the dominant method off the north coast. Pots, dive collection, and rings are each locally important in the west coast areas. Such method-based regional differences are consistent with patterns observed in previous seasons (Lyle 2000, 2008, Forward & Lyle 2002, Lyle & Morton 2004, 2006, Lyle & Tracey 2010, 2012, 2014, 2016a, b, 2017).

4.1.5 Seasonality

Fishing for Rock Lobster and Abalone are highly seasonal activities, being most intense immediately following the opening of the season (or licensing year) and over the summer holiday (December/January) period. Prior to 2015, lobster catch and effort tended to peak strongly in November and December but the delayed opening of the Eastern region combined with biotoxin closures, has meant that activity peaks now occur in December and January. Nonetheless, the pulse of fishing activity associated with the Rock Lobster season opening dates, especially amongst pot fishers, remains important feature of the fishery.

4.2 Management Implications

The 2017-18 Rock Lobster harvest estimate of 73.2 tonnes represented 43% the TARC (170 tonnes) and was equivalent to 6.0% of the 2017-18 TAC[8] (1220.7 tonnes). Although this survey did not cover fishing activity that may have occurred between May and August (noting that the Eastern region was closed during that period), previous surveys have consistently indicated that recreational effort during the winter months is low and catches generally account for less than 5% of the seasonal totals. It can be concluded that the 2017-18 recreational catch did not, therefore, breach this management reference point.

The east coast (Areas 1-3) catch of 45.3 tonnes compares with 50.2 tonnes in 2016-17 and 36.7 tonnes in 2015-16, the lower catch in 2015-16 being influenced by widespread biotoxin closures. In 2018 the east coast stock rebuilding zone was amended to exclude waters south of Bruny Island, thereby focusing the rebuilding strategy in the area where stocks are in poorest condition (DPIPWE 2018). A consequence of this reduced area has been that the target catch level for the recreational sector was reduced from 42 to 41 tonnes and the commercial catch share from 158 to 134 tonnes. When east coast recreational catches are limited to the amended rebuilding zone the total estimated catch was 40.4 tonnes in 2017-18 indicating that the notional catch limit was not exceeded. There is little doubt, however, that the biotoxin closures have had a significant impact on both the number of licences issued and activity of many east coast fishers. In the affected zones, between 8 (Storm Bay Bruny Zone) and 92 (Maria Island zone) days, equivalent to between 5 and 56% of the available fishing days were lost due to biotoxin closures in 2017-18. This would imply that without the closures during the peak fishing period, the east coast catches would have exceeded the notional catch limit.

Monitoring this fishery through time has revealed that the recreational sector is highly responsive in terms of the number of active fishers (more so than the number of licence-holders) and individual fishing activity levels in relation to changing lobster abundance (refer Table 12). As catch rates are expected to further improve under the stock rebuilding strategy it is likely that more individuals will go fishing and fish more often for lobster, representing a major challenge for management in constraining the recreational catch to within the east coast catch share.

The recreational Abalone harvest estimate of 22.1 tonnes was equivalent to 1.7% of the 2018 TACC (1333 tonnes), indicating that the recreational fishery represents a minor component of the Tasmanian Abalone fishery based on catches. While there are no management performance indicators relating to the recreational Abalone fishery, there is a need to explicitly include recreational catches into on-going stock assessment and future management of 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.

[8] TACC plus TARC

Acknowledgments

Funding for this study was provided by the Fishwise Resource Management Fund administered by the Department of Primary Industries, Parks, Water and Environment.

Fiona Ewing provided invaluable assistance with the management of the survey and our team of proficient and committed interviewers – Filipa, Michelle, Shirley, Josephine, Sandra, Jennie and Frances - contributed to the success of the survey, encouraging the co-operation of fishers and maximising response rates, as well as ensuring data quality and completeness. Thanks are also due Graeme Ewing for developing the R-code routines to undertake the bootstrap analyses and assistance with database maintenance.

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

References

DPIPWE (2015) Tasmanian Rock lobster fishery east coast stock rebuilding strategy 2013-2023. Updated August 2015. Wild Fisheries Management Branch, Department of Primary Industries, Parks, Water and Environment.

DPIPWE (2018) Tasmanian Rock Lobster Fishery: East coast stock rebuilding strategy 2013-2023. Updated September 2018. Wild Fisheries Management Branch, Department of Primary Industries, Parks, Water and Environment.

Ford, W. (2001). Restructuring the Tasmanian rock-lobster fishery – the effect of two years of management under individual transferable quotas. *Marine and Freshwater Research* **52**: 1641-1648.

Forward, J., and Lyle, J.M. (2002). A survey of the 2000-01 Tasmanian recreational Rock Lobster fishery and options for future assessment. Tasmanian Aquaculture and Fisheries Institute Final Report to the Marine Recreational Fishery Council, 36p.

Haddon, M. (2001*). Modelling and Quantitative Methods in Fisheries*. Chapman and Hall/CRC, Florida, 406p.

Hartmann, K, Gardner, C., and Hobday, D. (2013). Tasmanian Rock Lobster fishery 2011/12. Institute for Marine and Antarctic Studies, Fishery Assessment Report, 61p.

Linnane, A., Gardner, C., Hobday, D., Punt, A., McGarvey, R., Feenstra, J., Matthews, J. and Green, B. (2010). Evidence of large-scale spatial declines in recruitment patterns of southern Rock Lobster *Jasus edwardsii*, across south-eastern Australia. *Fisheries Research* **105**: 163-171.

Lyle, J.M. (2000). Assessment of the licensed recreational fishery of Tasmania (Phase 2). Tasmanian Aquaculture and Fisheries Institute Final Report to FRDC, Project 1996/161.

Lyle, J.M. (2008). Tasmanian recreational Rock Lobster and Abalone fisheries - 2006/07 fishing season. Tasmanian Aquaculture and Fisheries Institute Report, 22p.

Lyle, J.M. and Morton, A.J. (2004). Survey of the 2002/03 Tasmanian recreational Rock Lobster and Abalone fisheries. Tasmanian Aquaculture and Fisheries Institute, Technical Report 22.

Lyle, J.M. and Morton, A.J. (2006). Survey of the 2004/05 Tasmanian recreational Rock Lobster and Abalone fisheries. Tasmanian Aquaculture and Fisheries Institute Internal Report.

Lyle, J.M., Morton, A.J, and Forward, J. (2005). Characterisation of the recreational fishery for Southern Rock Lobster, *Jasus edwardsii*, in Tasmania, Australia. *New Zealand Journal of Marine and Freshwater Research* **39**: 703-714.

Lyle, J.M. and Tracey, S.R. (2010). Tasmanian recreational Rock Lobster and Abalone fisheries: 2008-09 fishing season. Tasmanian Aquaculture and Fisheries Institute Report, 29p.

Lyle, J.M. and Tracey, S.R. (2012). Tasmanian recreational Rock Lobster and Abalone fisheries: 2010-11 fishing season. Institute for Marine and Antarctic Studies Report, 39p.

Lyle, J.M. and Tracey, S.R. (2014). Tasmanian recreational Rock Lobster and Abalone fisheries: 2012-13 fishing season. Institute for Marine and Antarctic Studies Report, 42p.

Lyle, J.M. and Tracey, S.R. (2016a). Tasmanian recreational Rock Lobster and Abalone fisheries: 2014-15 fishing season. Institute for Marine and Antarctic Studies Report, 42p.

Lyle, J.M. and Tracey, S.R. (2016b). Tasmanian recreational Rock Lobster and Abalone fisheries: 2015-16 fishing season. Institute for Marine and Antarctic Studies Report, 37p

Lyle, J.M. and Tracey, S.R. (2017). Tasmanian recreational Rock Lobster and Abalone fisheries: 2016-17 fishing season. Institute for Marine and Antarctic Studies Report, 34p

Mundy, C. and Jones H. (2017). Tasmanian Abalone fishery assessment - 2016. Institute for Marine and Antarctic Studies Fishery Assessment Report, 147p.

Pollock, K.H. (2010). Review of the telephone diary survey of the Tasmanian recreational Rock Lobster fishery. Report to Tasmanian Association for Recreational Fishing Inc. Murdoch University

Punt, A.E. and Kennedy, R.B. (1997): Population modelling of Tasmanian Rock Lobster, *Jasus edwardsii*, resources. *Marine and Freshwater Research* **48**: 967-980.