TASMANIAN RECREATIONAL ROCK LOBSTER AND ABALONE FISHERIES: 2016-17 FISHING SEASON

Jeremy M. Lyle and Sean R. Tracey

July 2017

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 2016-17 recreational Rock Lobster and Abalone fishing season and continues the time series monitoring trends in these fisheries commenced in the mid-1990s.

During 2016-17 18,000 persons held at least one recreational Rock Lobster licence and 11,000 persons held a recreational Abalone licence. Compared with 2015-16 this represented a 7% increase in numbers but was >15% below 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 2016-17 fishing season and invited to participate in a telephone/diary panel survey to monitor their Rock Lobster and Abalone fishing activity between November 2016 and April 2017. A total of 413 respondents (359 valid licence-holders) completed the survey (79% 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 2016-17 Rock Lobster season (Eastern region: 19 Nov 2016 – 30 Apr 2017; Western region: 5 Nov 2016 – 31 Aug 2017) was monitored to the end of April 2017. During this period licensed recreational fishers were estimated to have harvested 87,650 (95% CI: 74,794 – 100,625) lobster, based on 81,690 fisher days of effort. Potting was the dominant method, representing 83% of the effort (days fished) and contributing 68% of the harvest. Dive collection accounted for 16% of the effort and 29% of the harvest, while ring usage contributed 2% of the effort and 3% of the harvest. The overall average catch rate was 1.07 lobster per day fished, with daily harvest rates of 0.87 for pots, 1.90 for dive collection, and 1.88 for rings.

The Rock Lobster fishery was concentrated off the east coast with this area accounting for 63% 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 87.9 tonnes for the survey period, with catches from the east coast accounting for 57%, the north coast 24%, and the west coast 18% by weight. Overall, the recreational catch represented about 52% of the total allowable recreational catch (TARC) of 170 tonnes and was equivalent to about 7% of the 2016-17 total allowable catch (TAC) of 1221 tonnes, which includes the total allowable commercial catch (TACC) of 1051 tonnes. In terms of individual harvest, it was estimated that about 6% of the active fishers reported catches of more than 20 lobsters, this group alone accounting for 26% of the total catch. This highlights the influence that a relatively small group of avid fishers can have on the total catch of Rock Lobster

A key component of the East Coast Stock Rebuilding Strategy has been the implementation of a notional east coast recreational catch share of 42 tonnes. The east coast catch was, however, estimated at 50.2 tonnes, exceeding the catch share by 8.2 tonnes. This compared with an “under-catch” of 6.3 tonnes in 2015-16 and an “over-catch” of 13.6 tonnes in 2014-15. The lower catch in 2015-16 was influenced by a combination of factors, in particular biotoxin closures between November and mid-January and resultant lower licence sales. Based on the past three seasons it is evident that restricting recreational catches to the east coast target will represent a major challenge for management, a situation that will be exacerbated as stocks continue to rebuild.

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

- most active fishers suggested that the quality of the fishery had improved or was at least similar to the 2015-16 season;
- recently lowered daily bag and/or boat limits were attained at least once during the current season by almost 30% of surveyed fishers, a small minority indicated that these lower limits had influenced how often or where they fished for Rock Lobster;
- approximately a third of respondents reported using the plastic DPIPWE gauge to measure Rock Lobster, almost 60% used commercially available metal gauges;
- the Sea Fishing Guide, licence renewal newsletter, DPIPWE website and Tas Fish Guide phone app were most commonly cited as useful sources of information about fishery regulations;
- the vast majority of fishers indicated that, when fishing for lobster, they also do other types of fishing, most commonly inshore line fishing;
- in response to a hypothetical scenario involving a delay to opening of the season until early December, almost three-quarters of respondents indicated that in such a circumstance they would likely pursue other types of fishing during the extended closure period, 18% indicated they would delay doing any fishing until the season opened, the remainder indicated that they did not usually start fishing until later in the year.

The recreational Abalone harvest up until the end of April 2017 was estimated at 47,522 (95% CI: 32,585 – 64,890) individuals, based on 9,136 diver days of effort. Blacklip Abalone accounted for 70% and Greenlip Abalone 30% of the total numbers. Over 60% of the catch was taken from the east coast, with a further 25% from the north and 10% 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 4.9 abalone.

By converting numbers to weights, the recreational harvest was estimated at 21.6 tonnes, equivalent to just over 1% of the 2017 TACC (1,561 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.

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). There was a 7% increase in licence sales in the current season; to just over 18,000 persons holding at least one Rock Lobster licence category, which included 15,200 pot, 8,000 dive and 4,400 ring licences issued. Abalone licence sales have followed a similar trend, almost tripling since 1995-96 to peak of 13,500 in 2007-08 (Fig. 1). Sales remained relatively stable after this but at a slightly lower level since 2010-11, with just over 11,000 licences issued in the current season.

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

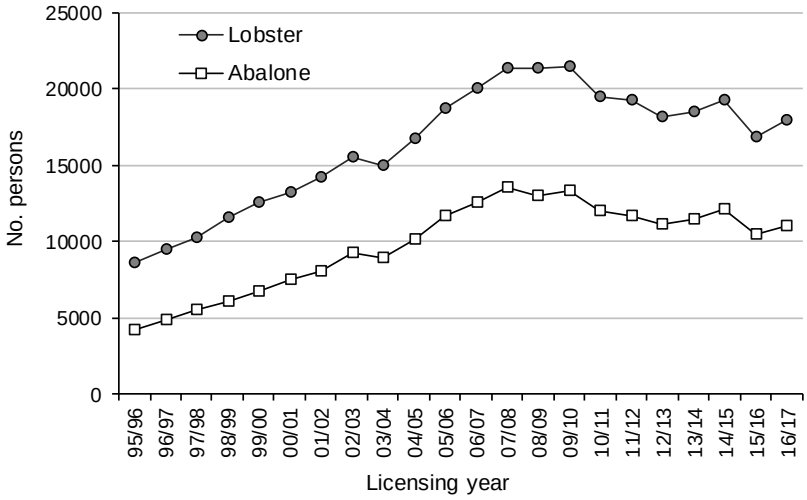

Fig. 1. Number of persons holding recreational Rock Lobster and Abalone licences by licensing year.

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 catches 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 1103 tonnes by 2011-12, remaining at this level until 2013-14, and then further reduced to 1050.7 for the 2014-15 and 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 2016-17 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 (Areas 1-3, refer to Fig. 3) 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). 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.

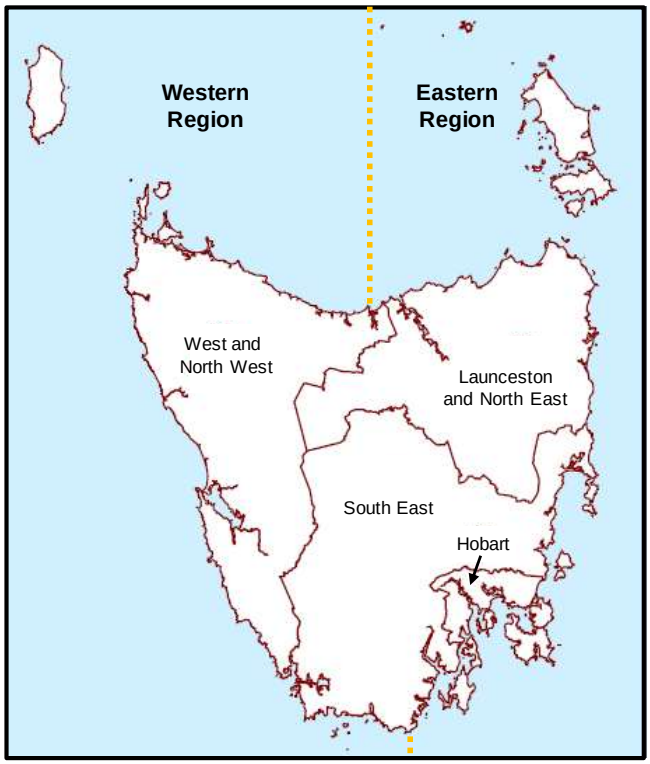

Fig. 2 Map showing Tasmanian ASGS Statistical Areas (adapted from Pink, 2011) and Rock Lobster Fishing Regions.

The TACC for Abalone has been reduced progressively since 2010, from 2660 to 1561 tonnes in 2017 (1421 tonnes for Blacklip and 140 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 (Tarbath & Mundy 2015).

This survey represents the twelfth in a series for Rock Lobster and the eleventh for Abalone undertaken since 1996. Key objectives include characterisation of the 2016-17 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 2016-17 licensing year up until the closure of the Eastern region Rock Lobster fishery (i.e between 1 November 2016 and 30 April 2017).

2.1.1 Survey sample

The survey sample was selected from the 2015-16 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 2015-16 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 2016 and asked about their fishing for Rock Lobster and Abalone during the 2015-16 season (number of days fished and estimated retained catch for either species) and whether they expected to renew their fishing licences for the 2016-17 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.

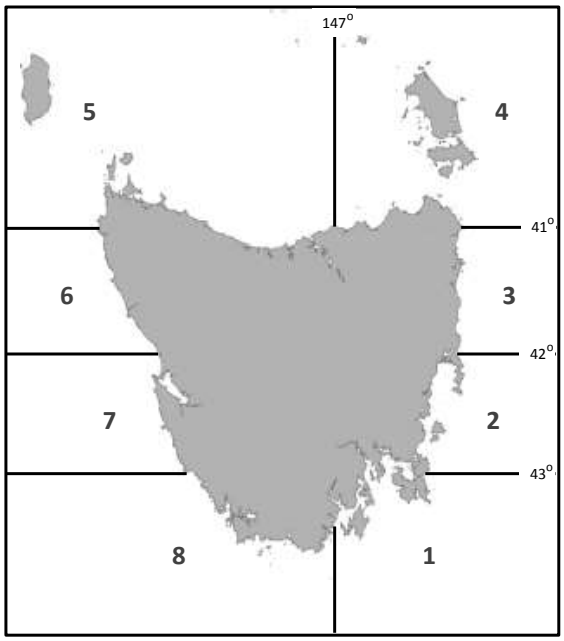

Fig. 3. Map of Tasmania showing fishery assessment areas referred to in the text.

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 (5 Nov 2016 Western region; 19 Nov 2016 Eastern region) until closure of the Eastern region fishery (30 April 2017). For abalone the survey period was from 1 Nov 2016 to 30 Apr 2017.

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 2015-16 licence database, licence details for 2016-17 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 2016-17 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 2016, 82% by the end of December 2016 and 92% by the end of January 2017. 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 2015-16 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 800 licence-holders selected from the 2015-16 licence database, 54 (6.8%) either had no telephone listing or the number was disconnected or incorrect. This represented sample loss and reduced the effective sample to 746. Contact was made with 682 licence-holders, of whom 620 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 8.6% of the net sample and refusals or other non-response a further 8.3% (Table 1).

Amongst the respondents, 79 indicated that they were not likely to renew their licence(s) in 2016-17 and hence were not eligible for inclusion in the diary survey. The balance (541) indicated they were likely to renew their licence(s) (Table 1). Of this latter group, 88.4% were determined to have done so, compared with 45.5% of those respondents who did not expect to renew their licences.

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

	Sample	% sample/ eligible	Licence renewed 2016-17	Licence not renewed 2016-17	% renewed
Screening survey					
Gross sample	800		615	185	76.9
Sample loss	54	6.8			
Net sample	746		580	166	77.7
Full response	620	83.1	493	127	79.5
Non-response	62	8.3	43	19	69.3
Non-contact	64	8.6	44	20	68.8
Eligible for diary					
Y- Likely to renew	541		457	84	88.4
N - Not likely to renew	*79*		*36*	*43*	45.5
Diary Survey					
Full response	413	76.3	359	54	86.9
Partial response	39	7.2	36	3	92.3
Refuse diary	89	16.5	62	27	69.7

3.1.2 Telephone-diary survey

In total 541 respondents were deemed eligible to participate in the diary survey (i.e. likely to renew), of whom 452 accepted the diary with 413 completing the survey. Of the responding diarists, 54 (13.1%) did not take up a licence during 2016-17 despite rating themselves as ‘quite likely’ or ‘very likely’ to do so. Among the remaining 359 respondents, 355 held at least one category of lobster licence and 221 were licensed

for abalone. Considering the number of total number of eligible respondents who renewed their licences (457) this represented an effective survey response rate of 78.6% (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 the 2016-17 licence holders involved in the survey.

Table 2 Total number of 2016-17 lobster and abalone licence holders, numbers sampled (fully responding) and sample fraction by licence type.

Licence type	Licence holders	Diarists	% sampled
Rock Lobster pot	15,201	307	2.02
Rock Lobster dive	7,980	160	2.01
Rock Lobster ring	4,456	85	1.91
Abalone	11,035	221	2.00
Total licences	38,672	773	2.00
Total persons	18,681	359	1.92

Fully responding diarists reported a total of 1997 fishing events during the survey period, 1950 (98%) of which were considered valid events[2]. In total, 94% 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 2015-16 seasonal participation

Information provided in the screening survey indicated that 80.3% (SE 1.6%) of 2015-16 Rock Lobster licence holders fished for Rock Lobster during that season, with 65.2% (SE 1.8%) harvesting at least one lobster. That is, out of the 17,049 persons licensed in 2015-16, 13,697 fished for Rock Lobster but only 11,123 harvested 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 2016-17 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 2016 and April 2017, inclusive.

An estimated 76.0% (SE 2.3%) of licence holders fished for Rock Lobster at least once during the fishing season with 65.5% (SE 2.5%) harvesting at least one lobster during the diary period. That is, out of the 18,009 licence-holders, 13,686 actually fished for lobster with 11,796 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 81,690 fisher days[3] for the period November to April, yielding a total harvest of 87,650 lobster[4] (Table 3). This represented an average harvest rate of 1.07 lobster per day fished. Pots were the most popular fishing method (accounting for 68% of the total harvest) followed by dive collection (29%) and rings (3%) (Table 3). Although five times as many fisher days of effort were spent using pots compared with diving, the catch taken by pots was only 2.4 times greater than that taken by divers. Average catch rates for divers (1.90 lobster per day) were more than double those for pot fishers (0.87 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 (1.88 lobster).

Table 3. Rock Lobster effort, harvest and harvest rates for the 2016-17 season
Values in parentheses represent the 95% confidence intervals

Method	Harvest (no.)	Effort (days)	Mean harvest rate (no. day^{-1})
Pot	59,347 (48,970 – 70,182)	68,188 (56,148 – 79,775)	0.87
Dive	25,025 (18,159 – 33,283)	13,186 (10,181 – 16,604)	1.90
Ring	3,278 (1,741 – 5,263)	1,742 (1,018 – 2,569)	1.88
Total	87,650 (74,794 – 100,625)	81,690 (69,613 – 93,421)	1.07

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 63% of the total estimated harvest (55,363 lobster) and attracted over three-quarters of the total effort (64,471 fisher days) during the survey period. Area 1 alone accounted for 34% of the state-wide harvest and 38% the total effort. The north coast (Areas 4 & 5) accounted for 16% of the harvest (13,976 lobster) and 10% of effort (7,880 fisher days) while the west coast (Areas 6 - 8) contributed 20% of the total harvest (17,958 lobster) and 11% of total effort (9,339 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 1-3 (62-98%) and Areas 6-8 (64-91%), while dive collection was the primary capture method in Areas 4-5 (82-89%). Rings were most commonly used off the west coast, accounting for up to 28% the harvest in Area 7.

Mean daily harvest rates were highly variable around the state, ranging from over two lobster per day in Areas 5-7 to 0.7 in Area 3 (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.

[4] While the vast majority of the lobster were Southern Rock Lobster, diarists did report two instances involving catches involving Eastern Rock Lobster, one off St Helens and the second in Recherche Bay (southern Tasmania).

Table 4. Recreational Rock Lobster effort, harvest and harvest rates by fishing area for 2016-17

Values in parentheses represent the 95% confidence intervals

Area	Harvest (no.)	Effort (fisher-days)	Harvest rate (no. per fisher-day)
1	29,796	31,438	
	(23,877 - 36,563)	(25,346 - 38,126)	0.95
2	11,216	11,469	
	(7,827 - 14,451)	(7,999 - 14,820)	0.98
3	14,704	21,564	
	(8,630 - 21,782)	(12,620 - 30,898)	0.68
4	4,882	3,996	
	(2,550 - 7,346)	(2,157 -5,793)	1.22
5	9,094	3,883	
	(3,408 - 16,499)	(1,886 - 6,127)	2.34
6	4,350	1,638	
	(1,635 - 7,665)	(761 - 2,684)	2.66
7	9,689	3,353	
	(5,421 - 15,147)	(1,931 - 5,137)	2.89
8	3,919	4,348	
	(2,219 - 5,802)	(2,365 - 6,545)	0.90

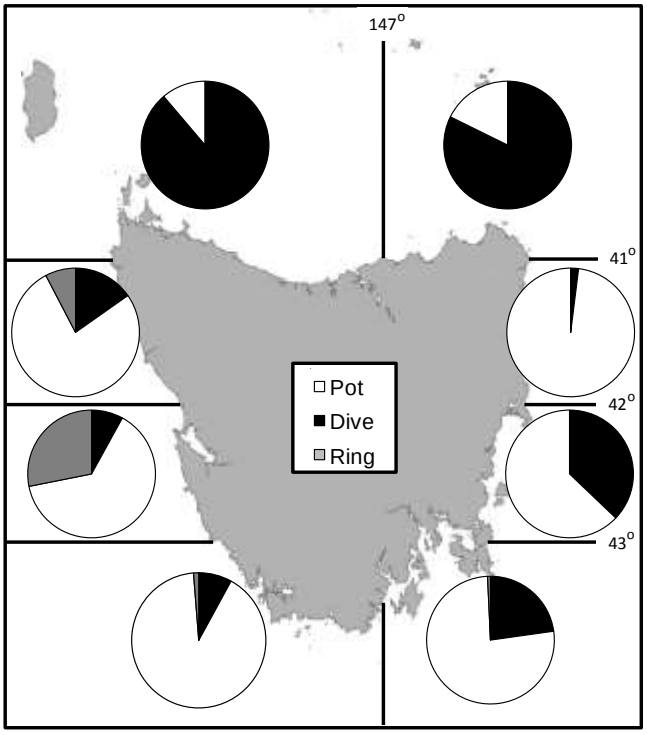

Fig. 4. Proportion of regional harvest by fishing method (pie charts).

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 the western area of Storm Bay (including Bruny Island) collectively accounted for almost three-quarters of the catch, with Norfolk-Frederick

Henry Bay and the D'Entrecasteaux Channel[5] contributing the bulk of the remainder. Comparatively low catches were taken from the Derwent Estuary.

Pots accounted for the majority of the catch taken from the Tasman Peninsula and Norfolk-Frederick Henry Bay areas and western Storm Bay region (Fig. 5). Dive collection was the dominant capture method in the D'Entrecasteaux Channel and Derwent Estuary. Rings accounted for a very minor proportion of the catch.

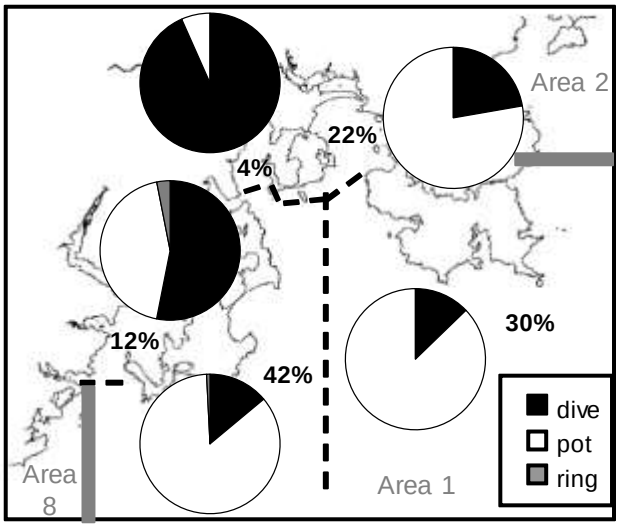

Fig. 5. Regional distribution of Area 1 harvest (%) and proportion of harvest by method (pie charts).

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 (19 November) coupled with closures in two biotoxin zones (Fig. 6) meant that the typical peak in fishing activity during November was less pronounced during 2016-17. Effort and catches peaked in December and January, fell dramatically in February and then remained relatively stable for the remainder of the study period (Fig. 7).

The underlying seasonal pattern of catch and effort in the fishery was influenced most strongly by variation in pot fishing activity, with 80% of the pot catch taken between November and January (Fig. 7). Dive catch and effort followed a similar pattern although the magnitude of the variability in catches was less pronounced, with 56% of the catch taken between November and January.

[5] It should be noted that the region defined as the D'Entrecasteaux Channel for the purposes of this report does not correspond with that defined in the fisheries regulations, rather it includes waters south of the Scott Point to Partridge Island (including Southport) boundary which are open to the use of pots.

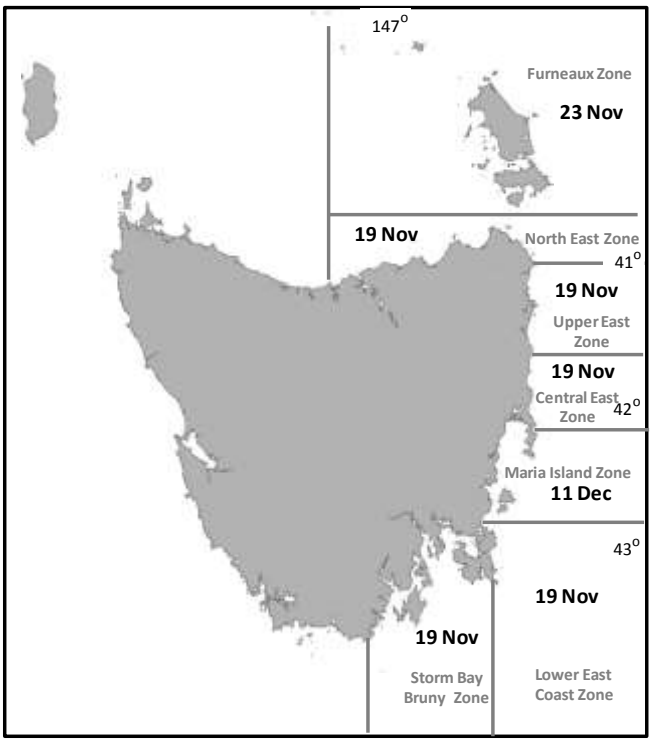

Fig. 6. Map showing the biotoxin management zones and dates on which the zones were opened for fishing during 2016-17.

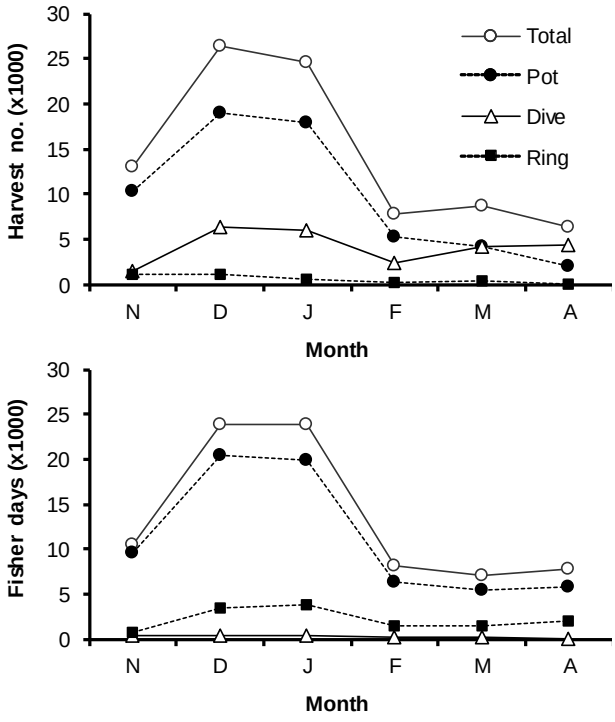

Fig. 7. Recreational Rock Lobster harvest (numbers) and effort (days fished) by month and method for the 2016-17 fishing season.

3.2.6 Daily harvest

Daily catch distributions differed markedly by fishing method and between management regions (Fig. 8). For instance, just under half of the total pot effort in the Eastern region (Areas 1-4) resulted in no retained catch, this compared with 38% for the Western region (Areas 5-8) (Fig. 8). The Eastern region daily bag limit of two lobster was achieved on 22% of the days fished whereas in the Western region 40% of the effort resulted in catches of at least two lobster, with 10% resulting in the Western region bag limit of five being taken. Divers had higher success rates, with almost two-thirds of dives in the Eastern region attaining the bag limit of two lobster compared with 76% in the Western region (39% of the Western region the dive effort in the resulted in catches of five lobster). There was very limited ring effort reported in the Eastern region, only 25% of which resulted in a retained catch of at least one lobster. The method was more effective in the Western region, with 85% of the days fished resulting in catch of at least one lobster and the bag limit of five lobsters was taken on about 20% 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 3.5 lobster for Eastern and Western regions, respectively), followed by scuba (1.4 and 3.0 lobster) and snorkel (0.8 and 2.8 lobster). Catches taken using hookah accounted for 48% of the total dive harvest, scuba 40% and snorkel 12%.

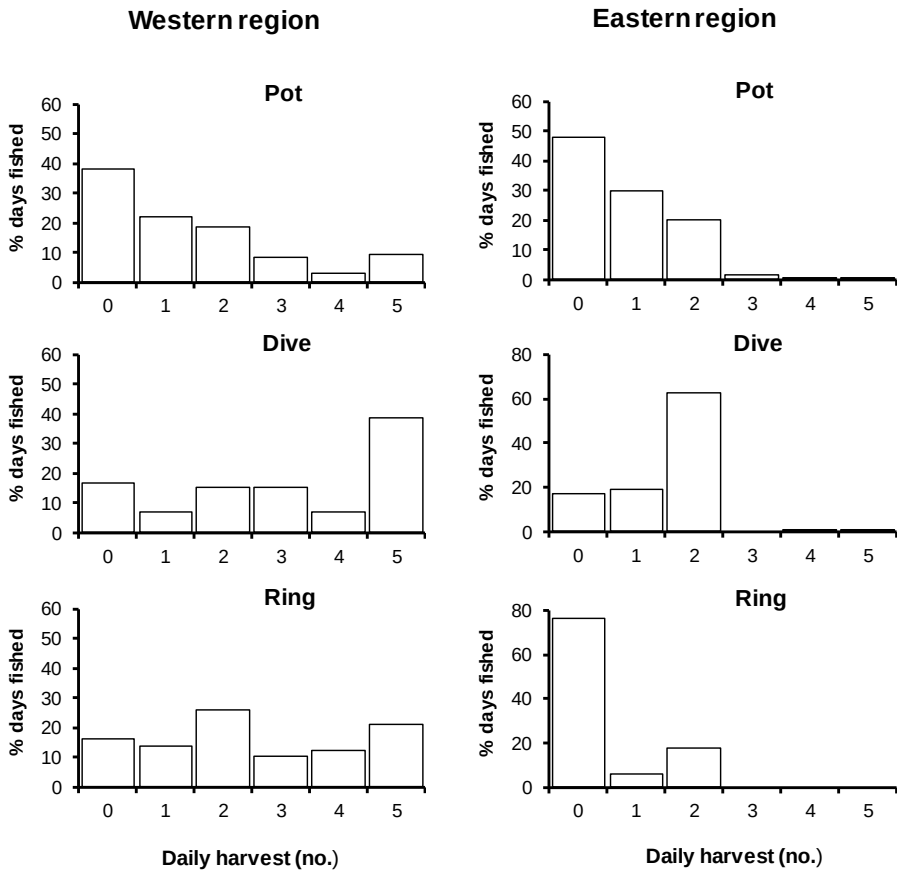

Fig. 8. Distribution of daily Rock Lobster harvest by fishing method and management region.

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 2016-17 fishing season up to the end of April (Fig. 9). Overall 14% of the active fishers harvested no lobsters while a further 43% harvested between one and five lobsters for the survey period, with proportionally fewer active fishers harvesting six or more lobsters from the east coast compared with the west coast (37% compared with 43%). About 6% of the active fishers reported catches of more than 20 lobsters, this group alone accounting for 26% of the total catch. This analysis highlights the influence that a relatively small group of avid fishers can have on determining the total catch of Rock Lobster.

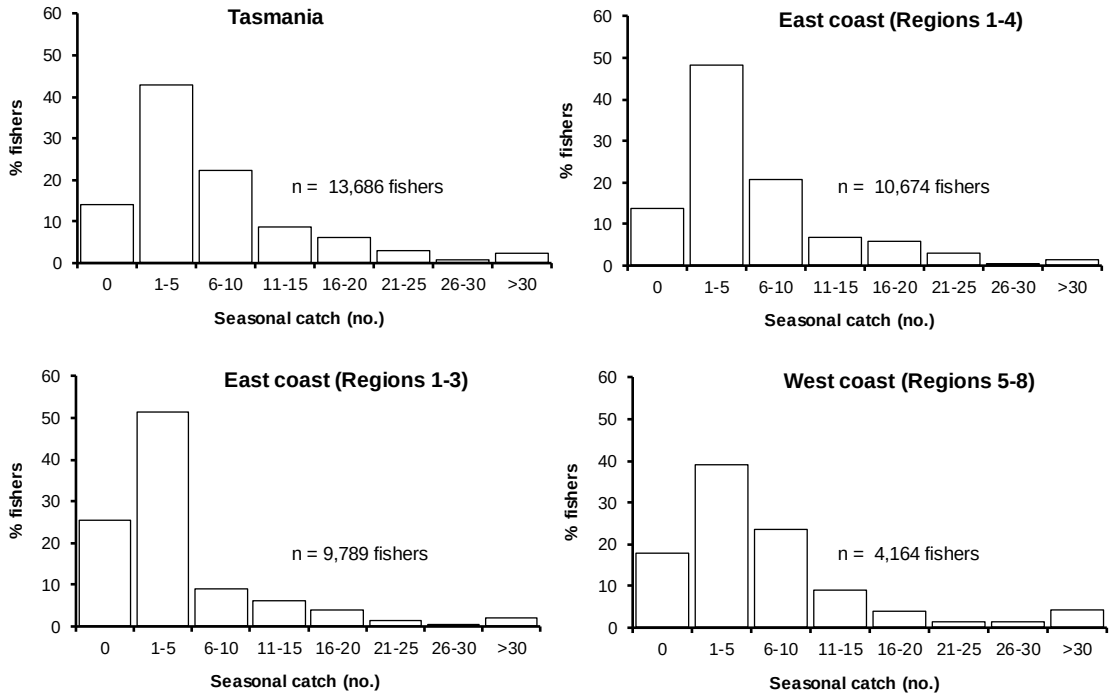

Fig. 9. Seasonal harvest of Rock Lobster for fishers who were active within specific fishing areas and for the whole fishery. n is estimated number of active licence-holders.

3.2.8 Released catch

A total of 67,825 Rock Lobster (95%CL 49,572 – 92,923) were estimated to have been released or discarded from pot catches, equivalent to 1.14 for every retained lobster. About 93% of pot releases were due the capture of undersized Rock Lobster, 5% of releases were due to over bag limit catches, <1% were berried females, and 1% were discarded dead or damaged.

Although divers may release Rock Lobster some 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 691 pot caught, 174 dive caught and 38 ring caught Rock Lobster from around Tasmania. Overall, retained pot caught Rock Lobster ranged between 105-244 mm carapace length (CL), with an average estimated weight of 889 g. Dive caught Rock Lobster had a similar size range,105–248 mm CL, but were larger on average, with an estimated average weight of 1168 g. Ring caught Rock Lobster ranged between 108–162 mm CL, with an average weight of 914 g. However, as relatively few ring caught Rock Lobster were measured[6], data for pots and rings have been combined in subsequent analyses. Male to female sex ratios for pot (1.0:0.80) and for dive (1.0:0.50) catches indicated that significantly more males than females were retained for both methods.

Length frequency distributions by region are presented in Fig. 10. Moving south to north along the east coast there was a general trend for the average size of Rock Lobster to increase, with the largest lobsters taken off the north coast (refer Table 5). There was insufficient data available from the west coast (Areas 6-8) catches to determine whether the latitudinal trend in average size observed off eastern Tasmania persisted in that region and areas have been combined for analysis.

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

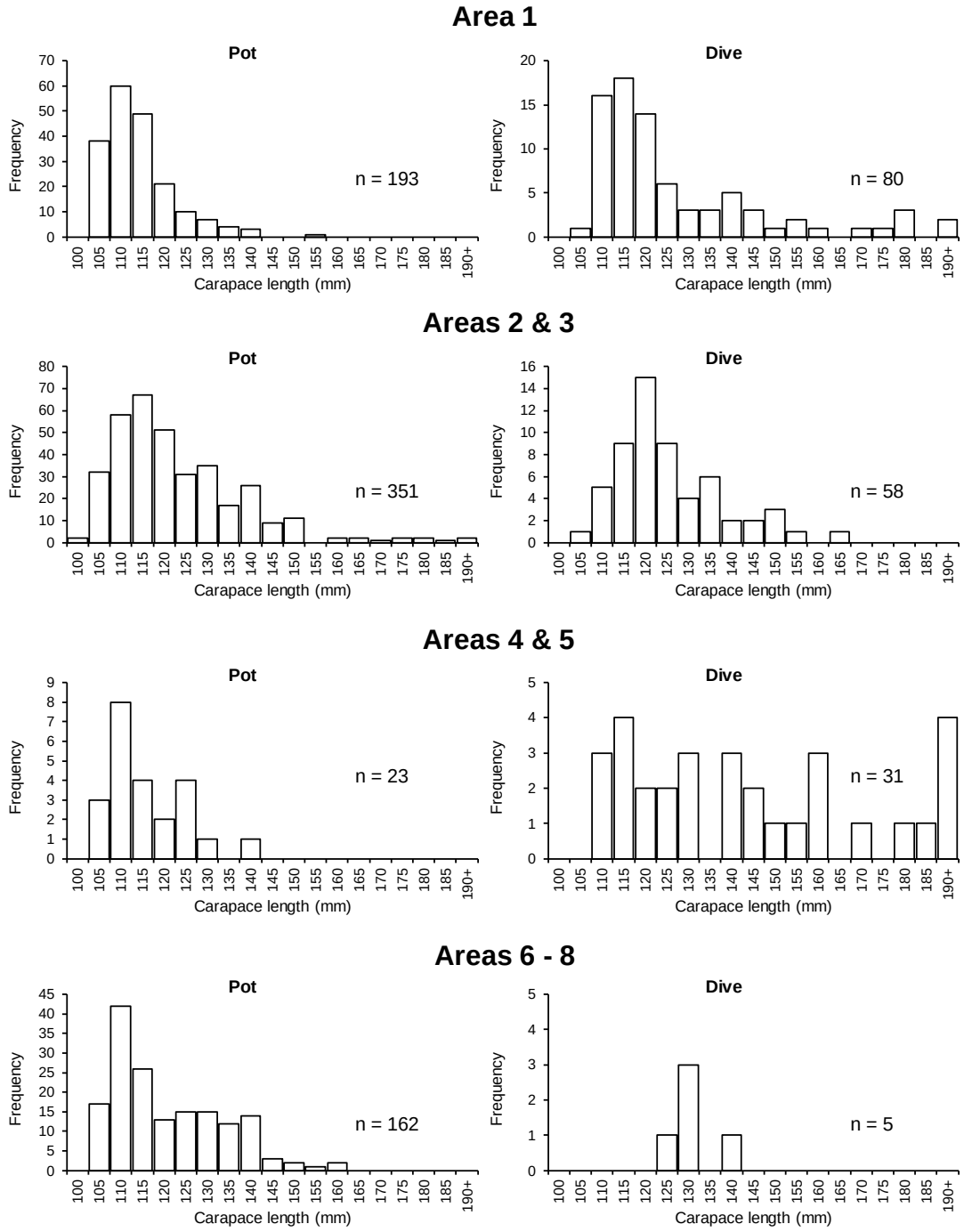

Fig. 10. Length frequency distributions by 5 mm size class for recreationally caught Rock Lobster taken by dive, pot and ring fishing methods by assessment area(s). n is sample size.

3.2.10 Harvest weights

The weight of the 2016-17 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 87.9 tonnes[7], equivalent to 51% of the TARC. Regional harvest estimates ranged between 28.4 tonnes (Area 1) and 3.5 tonnes (Area 8) (Table 5). As a proportion of the recreational harvest, the east coast (Areas 1-3) accounted for 57%, north coast (Areas 4&5) 24%, and west coast (Areas 6-8) 18% 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 (16% 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	744	1134	24,820	28.4
2	983	980	11,012	12.6
3	983	980	14,453	16.5
4	773	1621	7,180	8.2
5	773	1621	13,877	15.9
6	879	1085	3,960	4.5
7	879	1085	8,676	9.9
8	879	1085	3,511	4.0
Total			87,941	

3.3 Abalone

3.3.1 2015-16 participation

Information provided in the screening survey suggested that 59.9% (SE 2.6%) of 2015-16 licence holders fished for Abalone during that season and that 57.1% (SE 2.6%) kept at least one Abalone. That is, out of 10,692 persons licensed in 2015-16, an estimated 6,402 fished for Abalone with 6,019 harvesting at least one Abalone. However, as this information was collected retrospectively at the end of the 2015-16 season it is subject to recall bias and as such is considered indicative only.

3.3.2 2016-17 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 recreational abalone licence holders between November 2016 and April 2017, inclusive.

During 2016-17 an estimated 33.5% (SE 3.2%) of Abalone licence holders (i.e. 3,695 out of the 11,035 licence-holders) fished for Abalone with 29.7% (SE 3.1%) (3,282 persons) harvesting at least one Abalone.

[7] 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.

The total estimated harvest was estimated to be 47,522 Abalone (95% CI: 32,585 – 64,890), the result of 9,136 fisher days[8] of effort. This represented an average harvest rate of 5.2 Abalone for each day fished. Blacklip Abalone dominated the catch, accounting for 70% of the total catch numbers (33,333) while Greenlip Abalone represented 30% of the state-wide total (14,189) (Table 6).

Table 6. Abalone harvest, effort and harvest rates by fishing area for 2016-17
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	14,680 (7,563 – 22,606)	-	2,732 (1,613 - 3,877)	5.37	522	7,663
2	3,004 (1,264 – 5,205)	-	1,236 (561 - 1,928)	2.43	517	1,553
3	3,475 (613– 9,922)	-	721 (264 - 1,622)	4.82	528	1,835
4	1,722 (527 – 3,341)	4,765 (1,510 – 8,353)	1,365 (612 - 2,228)	4.75	356**	2,309
5	3,402 (787 – 6,239)	9,425 (530 – 21,994)	2,016 (561 - 3,863)	6.36	356**	4,561
6	2,093 (283 – 4,574)	-	342 (82 - 677)	6.11	501	1,048
7	398 (10 – 1,901)	-	40 (0 - 190)	10.0	501	199
8	4,560 (1088 – 8,875)	-	683 (148 - 1,378)	6.67	531	2,421
Total	33,333 (23,480 – 44,352)	14,189 (3,992 – 26,416)	9,136 (6,788 – 11,658)	5.20		21,590

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 on the east coast (Areas 1-3, 45% total harvest) and north coast (Areas 4-5, 41% total harvest), with Areas 1 and 5 each accounting for > 25% of the state-wide total. Blacklip Abalone were taken from all areas whereas Greenlip Abalone were restricted to the north coast. Regional harvest rates varied between 2.4 and >6.Abalone per day, the highest catch rates occurring in the northwest (Area 5) and west (Areas 6-8) coasts.

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). The D'Entrecasteaux Channel, and outside of Bruny Island were the most important sub-areas, collectively accounting for two-thirds of the total harvest. The Tasman Peninsula and Norfolk-Frederick Henry Bay areas were of secondary importance, with roughly similar catches taken from each of these sub-areas.

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

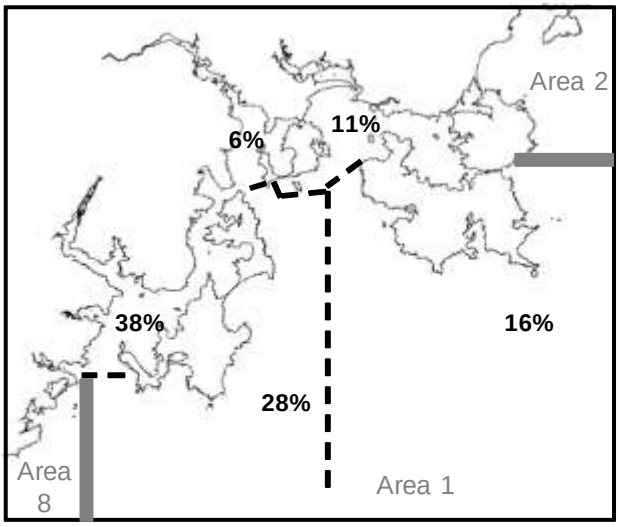

Fig. 11. Regional distribution of Area 1 Abalone harvest.

3.3.5 Seasonal catch and effort

The fishery for Abalone exhibited a strong seasonal pattern, with a marked increase in catch and effort between December and January (Fig. 12). The typical peak in catch and effort in November was not evident in 2016, highlighting the links between the Rock Lobster and Abalone fisheries (the majority of Abalone licence-holders also hold Rock Lobster dive licences).

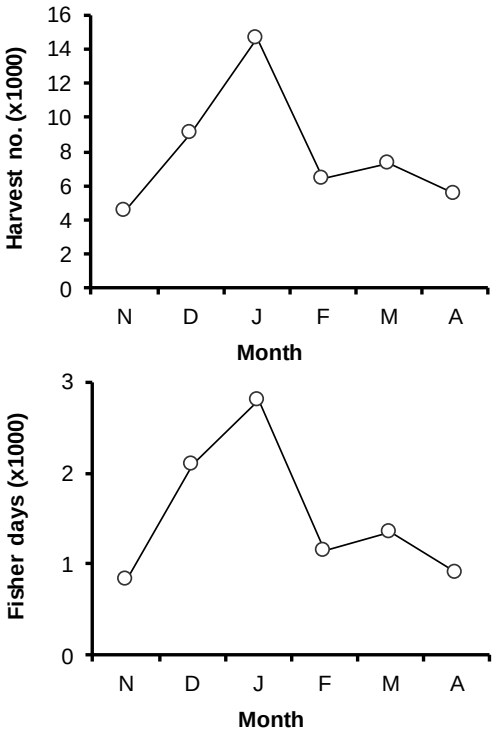

Fig. 12. Recreational Abalone harvest (numbers) and effort (days fished) by month during the 2016-17 fishing season.

3.3.6 Daily harvest

Over one in four targeted dives (27%) resulted in the daily bag limit of ten Abalone being achieved, while only one in six dives (17%) resulted in no catch (Fig. 13). Scuba divers reported the highest average catch rate (6.0 Abalone per day), with the bag limit achieved on almost 40% dives. Average daily catch rates for snorkel (5.3) and hookah (4.1) were considerably lower, as was the proportion of effort that resulted in ten Abalone being taken (23% for snorkel and 16% for hookah). However, of the three dive methods snorkel dominated, accounting for 40% of the harvest and 39% of effort (diver days). Scuba dive effort was next in importance, representing 39% of the harvest and 33% of the effort, while hookah divers contributed 22% of retained catch and 27% of the effort.

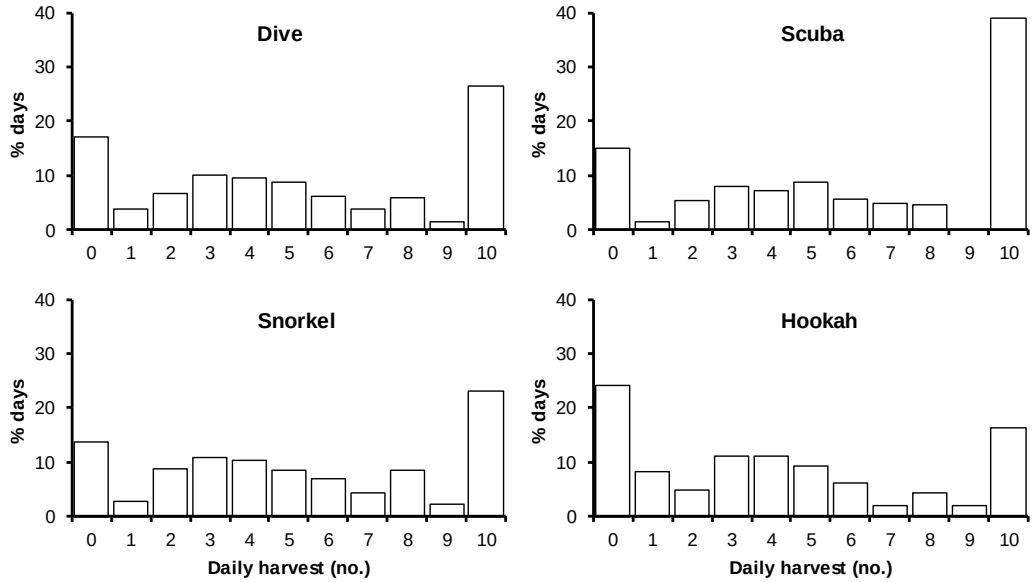

Fig. 13. Distribution of daily Abalone harvest by dive methods for 2016-17 licence holders

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 southwest coast (Area 8) and 356 g off the north coast (Areas 4&5) (Table 6). Using these values, the recreational harvest between November and April was estimated to be about 21.6 tonnes. Regionally, harvest estimates ranged from 7.7 tonnes in Area 1 to just less than one tonne in Area 7 (Table 6). The catch for the combined east coast (Areas 1-3) was 11.0 tonnes, the north coast (Areas 4&5) 6.9 tonnes, and the west coast (Areas 6-8) 3.7 tonnes.

3.4 Wash-up survey

3.4.1 General

The overall response rate to the wash-up survey was 95.0% (360 out of a net eligible sample of 379)[9].

3.4.2 Constraints to fishing

Diarists who did not fish for Rock Lobster during 2016-17 were asked, as an open ended question, about their main reasons for not fishing during the season. The most commonly cited reason for licensed respondents was lack of time due to work and/or family commitments, unfavourable weather conditions was next in importance (Table 7). Lack of time followed by a lack of a boat or equipment were the most common reasons cited by diarists who did not renew licences.

Table 7. Main reasons for not fishing for Rock Lobster during 2016-17

Reasons	Not licensed	%	Licensed	%	Combined	%
Lack of time/work and/or family commitments	16	41.0	34	47.9	50	45.5
Lack of boat or equipment	7	17.9	6	8.5	13	11.8
Weather	1	2.6	11	15.5	12	10.9
Lack of interest/ alternative interests	3	7.7	5	7.0	8	7.3
Other fishing activities	-		8	11.3	8	7.3
Health/age	4	10.3	3	4.2	7	6.4
Lack of opportunity/ fishing partner	4	10.3	1	1.4	5	4.5
Moved interstate/travelling/did not visit Tasmania	2	5.1	1	1.4	3	2.7
Poor catch rates	-		1	1.4	1	0.9
Other	2	5.1	1	1.4	3	2.7
No. respondents	39		71		110	

3.4.3 Fishery quality

Amongst those respondents who had fished for Rock Lobster, more than twice as many suggested that the quality of the fishery in 2016-17 was better (34%) rather than worse (15%) compared with the previous season (Table 8). Almost half of the active fishers, however, suggested that the overall quality was about the same as in the previous year. Respondents were then asked whether, based on their own experience, they had noticed that legal-size Rock Lobster were less abundant or more difficult to catch in 2016-17. Only 28% of respondents (n = 250) agreed with the proposition, the majority (62%) disagreed and 10% were unsure.

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

Table 8. Response to the question relating to the perceived quality of the 2016-17 Rock Lobster season relative to 2015-16

Response	No.	%
Better	84	33.6
Worse	37	14.8
(About the) Same	110	44.0
Unsure	19	7.6
Total respondents	250	

3.4.4 Impacts of Eastern Region management changes

Respondents were reminded of recent management changes applying to the Eastern region, specifically the reductions in the daily bag limit to 2 and maximum boat limit to 10 lobsters. Respondents were then asked whether they had exceeded these reduced limits and had to release legal sized lobsters or cease fishing during the survey period. Of those respondents (n = 225) who fished in the Eastern region, 28% indicated that they had exceeded one or both of these limits at least once during the season (up from 23% in 2015-16). The bag limit was the more commonly achieved limit by the east coast fishers (23%); relatively few fishers reached the new boat limit (8%). For those individuals who reported reaching the boat limit, the average number of trips on which their fishing party reached the boat limit was 2.6 times (range 1-9 occasions).

Respondents were also asked whether the Eastern region management changes had had a direct influence on how often or where they went fishing for lobsters, focusing on whether they fished more or less because of the lower limits or fished more than usual in the Western region where the limits were higher. The vast majority (78%) of respondents (n = 242) indicated that the management changes had not really influenced their fishing activities, only 3% indicated they fished more, 12% fished less and 5% fished more in the Western region.

3.4.5 Policing and enforcement

Out of 248 active fishers who responded to questions about policing, 23% indicated that they had been checked by Marine Police whereas 76% were not checked whilst fishing for lobster during 2016-17 (one unsure response). Inspections occurred mostly on water (71%) and to a lesser extent off water (36%), noting that four respondents reported being checked on as well as off water. Of those individuals checked whilst in possession of Rock Lobster (n = 51), 84% indicated that their catch was inspected by the Marine Police.

3.4.6 Measuring Rock Lobster

Respondents were asked whether they mainly used the plastic measuring gauge provided by the DPIPWE or another type of measure to determine whether Rock Lobster were legal sized or not. One third of respondents indicated that they used the DPIPWE gauge, the remainder used another type of measure (Table 9). Overall, metal gauges (mainly brass, bronze or aluminium) were the most commonly used measuring device (59%), callipers were less commonly used. Several respondents using the metal gauges indicated that they were produced commercially. Of those respondents using the DPIPWE plastic gauge, the vast majority (89%) were generally happy with how they performed. Several respondents did, however, express concern about the accuracy of the gauges, recognising that they are provided for use as a guide only. Other respondents suggested that they should be manufactured out of metal to increase robustness and ensure measurement accuracy.

Table 9. Response to the question of what respondents use to determine whether Rock Lobster are legal sized.

Measure		No.	%
DPIPWE plastic gauge		89	32.6
Other		183	67.0
	Metal gauge	*161*	*59.0*
	Metal callipers	*14*	*5.1*
	Plastic gauge	*3*	*1.1*
	Plastic callipers	*3*	*1.1*
	Other	*2*	*0.7*
None		1	0.4
Total respondents		273	

3.4.7 Information sources

Respondents were asked about how they found out about regulations relevant to the lobster fishery, such as season opening dates, bag and size limits, etc. The Sea Fishing Guide, licence renewal newsletter and DPIPWE website were the most commonly cited sources of information (> 40% respondents) (Table 10). The Tas Fish Guide phone app, friends and family and DPIPWE Fishing News email alerts were also identified key sources of information (>20% respondents). In terms of what was considered the most useful sources of information, the Sea Fishing Guide, licence renewal newsletter, DPIPWE website and Tas Fish Guide phone app were rated most highly. Overall, the DPIPWE sponsored Fisheries Tasmania facebook page, along with the newspapers and TV, were not identified as important as sources of information about the fishery.

Table 10. Information sources used by respondents to find out about Rock Lobster fishing regulations, including those considered to be most useful.

	Used		Most useful	
Source	No.	%	No.	%
Sea Fishing Guide	171	47.8	106	29.6
Licence renewal newsletter	162	45.3	81	22.6
DPIPWE website	150	41.9	85	23.7
Tas Fish Guide phone app	82	22.9	57	15.9
Friends/family	81	22.6	26	7.3
DPIPWE Fishing News email alerts	74	20.7	39	10.9
Newspaper	36	10.1	7	2.0
Fisheries Tasmania Facebook	28	7.8	9	2.5
Other	15	4.2	4	1.1
TV	14	3.9	2	0.6
Total respondents	358		358	

3.4.8 Other fishing activities

In order to better understand how Rock Lobster fishing/diving fits within the range of fishing activities carried out by individuals, respondents were asked to nominate, from a list of common fishing activities, those that they usually combined when on a lobster fishing trip. Respondents were also asked which activities they included as part of their

most recent lobster fishing/diving trip. It is evident from Table 11 that for the vast majority of respondents lobster fishing is just one component of a wider range of fishing activities; less than 10% of respondents indicated that when lobster fishing it was usually their sole fishing activity for that trip. Inshore line fishing for species such as Flathead was the most common activity conducted when also fishing for lobster, this was followed in descending importance by squid fishing, abalone diving, offshore line fishing (for species such as Striped Trumpeter), gillnetting and fishing for gamefish. However, when considering the most recent lobster fishing trip a greater proportion (24%) were exclusively for Rock Lobster. Inshore line fishing was included on almost 60%, followed by gillnetting (9%), Abalone diving and offshore line fishing (8% each) of trips. The relatively high occurrence of gillnet usage when lobster fishing can be linked to bait capture.

Table 11: Activities associated with fishing for Rock Lobster.

	Usual activities		Most recent trip	
Activity	No.	%	No.	%
Inshore line fishing	282	79.2	160	56.9
Squid fishing	111	31.2	10	3.6
Abalone diving	89	25.0	23	8.2
Offshore line fishing	86	24.2	23	8.2
Gillnetting	76	21.3	26	9.3
Gamefish fishing	61	17.1	9	3.2
Other fishing	43	12.1	15	5.3
Exclusively lobster	33	9.3	68	24.2
Total respondents	356		281	

3.4.9 Delayed season openings

Respondents were asked to consider how they might respond if the Rock Lobster season opening was delayed until early December, noting that as part of the east coast stock rebuilding strategy the opening of the Eastern region had already been delayed by two weeks. Options presented included a switch to other types of fishing during November and early December, wait until the season opened before starting to fish or no effect since the respondent normally did not start fishing until later in the year.[10] Almost three-quarters of respondents indicated they expected they would pursue other types of fishing during the extended closure (Table 12), a finding that is consistent with the observation that most fishers combined other types of fishing when targeting lobster (Table 11). Interestingly, 18% of respondents indicated that they would delay going fishing until the lobster season opened suggesting a relationship between the timing of opening and the resumption of fishing activities. A comparatively small proportion of respondents indicated that they generally did not go fishing during November and early December as thus would be largely unaffected by a delayed season opening.

[10] This presupposes that many Tasmanian fishers effectively cease sea fishing during the winter months and resume as the weather starts to warm up.

Table 12 Responses to delayed season opening scenarios.

Response	No.	%
Other types of fishing	262	73.6
Wait until season opened	64	18.0
Don't normally start fishing until later in the season	15	4.2
Unsure	15	4.2
Total	356	

3.4.10 Likelihood to renew licences

Respondents were asked about their likelihood to take out a Rock Lobster licence for the 2017-18 season. Overall the vast majority (94%) indicated that they were likely to re-licence (Table 13). Not unexpectedly, proportionally fewer (86%) of those respondents who did not renew their licence in 2016-17 considered they would take a licence in 2017-18. The main reasons given for being unlikely to take out a licence included not expecting to be resident or visit Tasmania, age/health, lack of access (boat), and lack of time.

Table 13 Likelihood to renew Rock Lobster licences in 2017-18 based on licence status in 2016-17.

	Combined		Licensed		Not licensed	
	No.	%	No.	%	No.	%
Likely	336	93.9	298	94.9	38	86.4
Not likely	19	5.3	14	4.5	5	11.4
Unsure	3	0.8	2	0.6	1	2.3
Total respondents	358		314		44	358

4 DISCUSSION

4.1 Catch and effort

4.1.1 General trends

To date, twelve 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 this declined before stabilising at levels comparable to the late 1990s (Fig. 14). The catch in the current season represented an increase of almost 50% over 2015-16, a season that was particularly impacted by biotoxin closures, and was comparable to levels taken in the first half of the 2010s (Table 14).

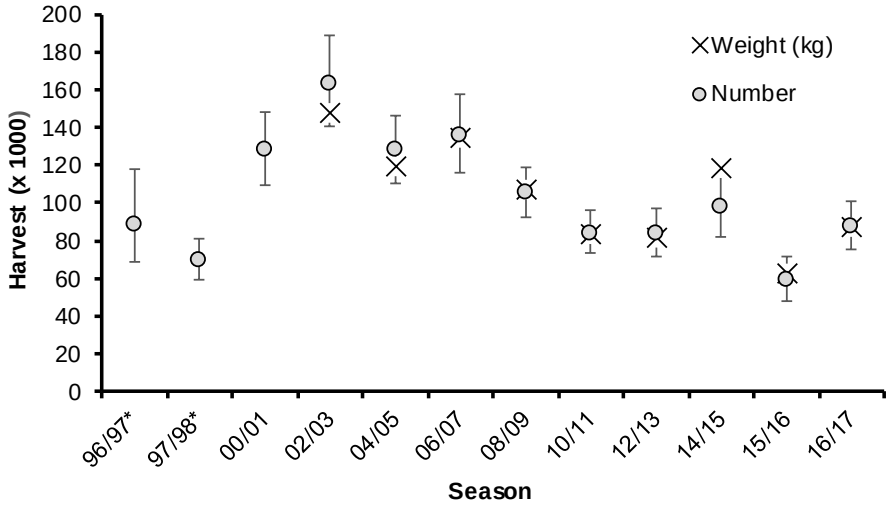

Fig. 14. Estimated Rock Lobster harvest (number and weight) plotted against fishing season. Error bars represent 95% confidence limits for numbers. * indicates partial season surveys.

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 a major impact on the state-wide catch (Fig.15). There was a slight recovery in catches in all areas during 2016-17, the combined result of increased effort and higher catch rates when compared with the previous season.

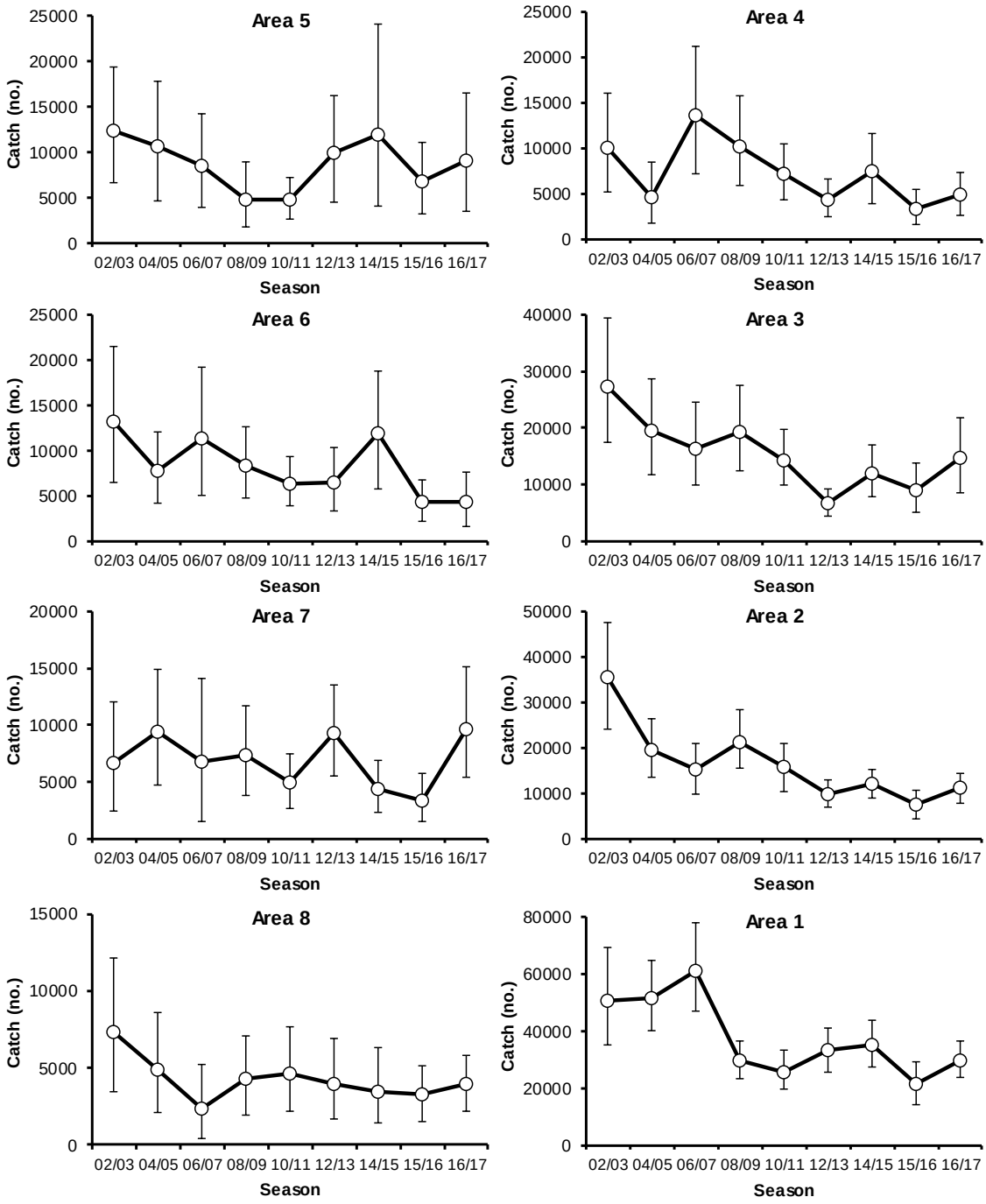

Fig. 15. Regional Rock Lobster harvest estimates (numbers) by recreational fishing season. Error bars represent 95% confidence limits.

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 catch estimate for the current season was similar to that for 2015-16, making catches for the past two seasons amongst the lowest since surveys commenced the mid-1990s (Table 14).

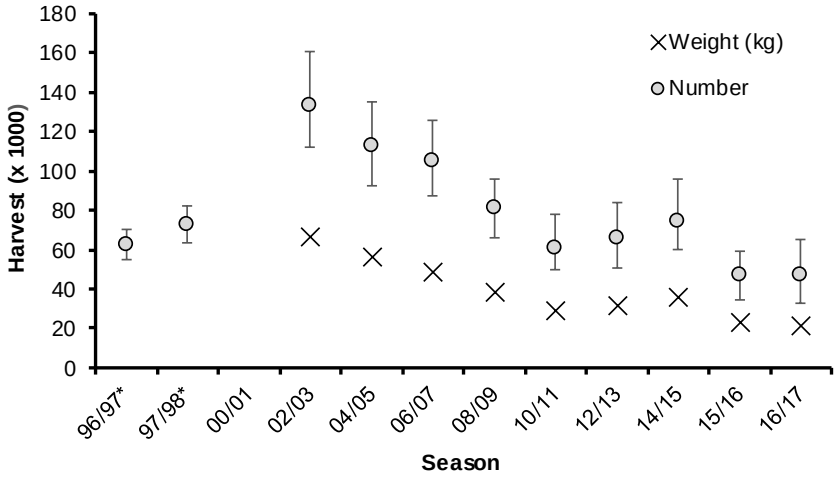

Fig. 16. Estimated Abalone harvest (number and weight) plotted against fishing season. Error bars represent 95% confidence limits for numbers. * indicates partial season surveys.

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 declined from over 86 to 68% for lobster, and from 63 to 33% for abalone (Table 14). Lack of time (due work and/or family commitments), weather and lack of access to a boat were the most commonly cited reasons for not fishing for lobster during 2016-17.

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 about 5-6 for lobster, and from 23 to 12-13 for abalone) (Table 14). Furthermore, daily harvest rates for lobster have declined since the early 2000s (1.3 down to 0.84 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 (Table 14). Each of the catch rate metrics were, however, higher in 2016-17, suggesting an improvement in the quality of the fishery. This observation was supported by at least a third of fishers who agreed that the quality of the fishery was better in the current season than during 2015-16.

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 14. 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*
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
% fished	86.5	88.4	81.9	78.4	75.2	71.7	76.0	75.4	68.4	76.0
No. active fishers	11,408	14,308	13,679	15,687	16,050	13,997	13,814	14,552	11,500	13,686
Harvest (no.)	128,219	163,454	127,987	135,592	105,538	83,472	83,772	98,442	58,805	87,650
Harvest (kg)	nd	148,526	119,354	135,067	107,027	84,261	81,849	118,996	63,022	87,941
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
Fisher days	100,866	125,898	109,788	124,305	103,985	87,617	85,849	101,699	69,920	81,690
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
Av. daily harvest (no.)	1.27	1.30	1.17	1.09	1.01	0.95	0.98	0.97	0.84	1.07
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
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
Abalone										
No. licence holders		9,272	10,133	12,514	12,976	11,972	11,157	12,084	10,509	11,035
% fished		63.5	55.8	52.3	38.8	36.3	42.0	42.4	37.9	33.5
No. active fishers		5,853	5,653	6,542	5,033	4,349	4,682	5,126	3,896	3,695
Harvest (no.)		133,711	112,571	105,515	81,021	60,943	66,438	74,769	47,113	47,522
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
Fisher days		25,342	18,185	23,201	14,445	12,117	11,428	15,110	9,548	9,136
Av. days per active fisher		4.3	3.2	3.5	2.9	2.8	2.4	2.9	2.5	2.5
Av. daily harvest (no.)		5.28	6.19	4.55	5.61	5.03	5.81	4.95	4.93	5.20

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 2000-01 was unclear and has not been evident in subsequent seasons. Rings represent a minor component of the fishery.

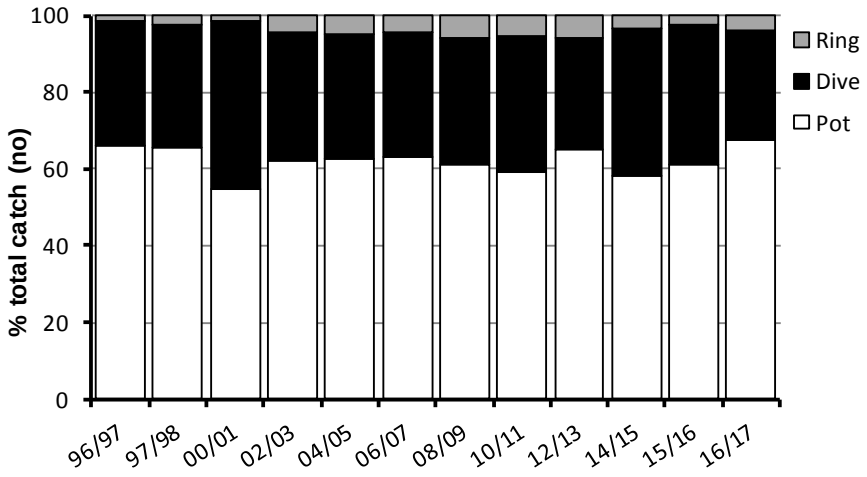

Fig. 17. Proportion of the Rock Lobster harvest by method and fishing season

4.1.3 Catch rates

The average daily harvest rate for pots (0.87 lobster) during 2016-17 represented an increase compared with the previous season as was comparable to levels experienced during the early 2000s when the daily bag limit was five and not two, as currently applies to the main segment of the fishery (Table 14). This suggests that pot catch rates have remained largely insensitive to these bag limit changes, confirmed by two decades of survey data which confirms 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). The increased catch rate in the current year may, therefore, be indicative of stock rebuilding that is occurring on the east coast. 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 corresponds 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 (5.2) in 2016-17 was within the range of that reported in 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 22% of the pot effort in the Eastern region and 10% of the pot effort in the Western region resulting in the respective bag limits being achieved during 2016-17. By contrast, bag limits had a more obvious impact on dive catches, with 64% of the dive effort in the Eastern region and 38% 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. Artificial breathing apparatus were less of an advantage when diving for Abalone, with free-diving proving particularly successful.

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 63 and 45% 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 40% and the latter about 15% 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, Tarbath & Gardner 2013).

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).

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 2016-17 Rock Lobster harvest estimate of 87.9 tonnes represented 52% the TARC (170 tonnes) and was equivalent to 7.2% of the 2016-17 TAC[11] (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 2016-17 recreational catch did not, therefore, breach this management reference point.

The east coast (Areas 1-3) catch of 50.2 tonnes did, however, exceed the notional recreational east coast catch share allocation of 42 tonnes by 8.2 tonnes or 19.5%. This compares with an "under-catch" of 6.3 tonnes in 2015-16 (influenced by widespread biotoxin closures early in that season) and an "over-catch" of 13.6 tonnes in 2014-15. 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 14). 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 21.6 tonnes was equivalent to 1.4% of the 2017 TACC (1561 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.

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 – Anita, Carol, Cathy, Josephine, Sandra, - 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.

[11] TACC plus TARC

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.

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

Pink, B. (2011). Australian Statistical Geography Standard (ASGS) Volume 1 – Tasmania maps. Australian Bureau of Statistics. ABS Catalogue No. 1270.0.55.001

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.

Tarbath, D., and Mundy, C. (2015). Tasmanian Abalone fishery assessment - 2014. Institute for Marine and Antarctic Studies Fishery Assessment Report, 148p.