

MRFC FINAL REPORT

A SURVEY OF THE 2000/01 TASMANIAN RECREATIONAL ROCK LOBSTER FISHERY AND OPTIONS FOR FUTURE ASSESSMENT

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A survey of the 2000/01 Tasmanian recreational rock lobster fishery and options for future assessment

J. Forward and J.M. Lyle

Summary

Rock lobsters form the basis of a significant recreational fishery in Tasmania, with over 13,000 fishers issued recreational rock lobster licences in the 2000/01 licensing year (Nov 2000 to Aug 2001). Licence holders are permitted to use a variety of methods to harvest lobsters including pots, rings and dive collection. Fishery management measures include size limits, bag limits and season closures.

Despite the significance of the fishery there have been few attempts to gather information about levels of catch and effort. The present study provides a detailed assessment of the 2000/01 recreational rock lobster fishery in terms of participation, intensity of fishing effort, harvest levels and catch rates. A further objective was to provide recommendations about the on-going assessment of the recreational fishery.

A methodological approach involving a longitudinal telephone/diary survey was adapted for this study. Random samples of rock lobster licence holders were selected from the recreational licensing database. The survey design involved a three-stage process comprising an initial screening interview (designed to assess respondent eligibility to participate in the follow-up survey), a follow-up fishing diary survey (whereby fishing activity in the 2000/01 season was monitored in detail), and an attitudinal survey conducted at the end of the diary period (designed to assess attitudes in relation to the fishery and the survey). In addition, a telephone survey was conducted with a different sample of licence-holders at the end of the fishing season to collect retrospective information about total catch and effort. This telephone survey enabled a comparison between recall and diary survey estimates as well as an investigation of the efficacy of the recall survey approach as an alternative to the diary option.

Recreational rock lobster licence holders fished an estimated 101,000 days in the 2000/01 season, yielding a harvest of approximately 128,000 rock lobster. Regionally, the recreational fishery was centred off the southeast coast of Tasmania, with fishing effort in this region producing 45% of the total recreational harvest. The east coast accounted for a further 23% of the harvest. Harvests on the west and north coasts were relatively small, contributing 18% and 14% of the total, respectively. Rock lobster pots were the dominant fishing method used, with almost four times as many days spent using pots than diving. Pots accounted for a larger proportion of the total harvest (55%) than dive collection methods (44%), with a small proportion taken by rings (1%). Mean

daily harvest rates were almost three times higher for divers (2.6 lobster) compared to pot fishers (0.9 lobster).

Seasonally, the recreational fishery exhibited three distinct phases of activity: an initial phase of intense activity early in the season (Nov to Jan) that accounted for 70% of the total effort and harvest; a period of intermediate fishing activity (Feb to Apr) that contributed 23%; and then finally, a phase of low activity (May to Aug) that accounted for 7% of the season's total.

Based on the number of lobster caught, the recreational share of the total rock lobster harvest for the State was relatively low (7.4%). The recreational fishery is assumed to operate primarily in inshore shallow waters due to depth limitations on diving and ease of pot and ring hauling. By contrast, commercial fishers operate over a wider area including deeper offshore reefs, with two thirds of the commercial harvest taken from depths of greater than 18 metres. If the commercial harvest from shallow waters (< 18 metres) is compared with the recreational harvest, the recreational share of the 'shallow water' harvest was more significant, 19% of the total number of rock lobster harvested. Regionally, the recreational share remained relatively low on the west and north coasts (8% and 12% respectively), with a higher share (28%) from the east coast. In southeastern Tasmania, the recreational harvest was only slightly lower than the commercial take, accounting for 45% of the total inshore harvest. In order to permit comparisons between sectors based on harvest weights it will be necessary to determine the size structure of the recreational catch, in particular the dive component.

Over two thirds of diary respondents considered the quality of the recreational rock lobster fishery to be about the same or better in 2000/01 compared to the 1999/00 season. The large majority of diarists considered that they had spent less or about the same time fishing for rock lobster in 2000/01 compared to the preceding season. Almost a third of diarists who commented on the rock lobster fishery expressed their satisfaction with the fishery's management and regulations. The overwhelming majority (98.5%) of diarists who commented on the survey expressed their satisfaction with the survey.

In evaluating options for on-going fishery assessment, consideration was given to the relationships between sample size, precision and survey costs. The application of recall based surveys as an alternative to using the telephone/diary survey was also assessed. An investigation of the relationships between final diary sample size and estimates of mean harvest and precision showed that the seasonal harvest (per diarist) estimator began to stabilise at sample sizes greater than 250 diarists. In addition, there were continued improvements in precision with the larger sample sizes. It is concluded that a screening sample size of about 500 to 550 licence holders is adequate to produce statewide harvest estimates with appropriate precision. In addition, it is suggested that significant survey cost savings may be achieved by part season surveys. These could cover the period of most intense fishing activity between November and April without compromising precision. With this period accounting for well over 90% of the total effort and harvest, only limited fishery information would be lost.

Recall survey estimates of effort and harvest for the 2000/01 season were significantly higher than those for the diary survey, with recall effort and harvest estimates exceeding diary totals by factors of 1.5 and 1.6 times, respectively. The application of adjustment factors to correct for recall biases have the potential to produce estimates that better represent actual catch and effort levels. These would, however, require further comparative surveys to determine the consistency, or otherwise, of such adjustment factors.

Recommendations for future assessment

In considering options for on-going assessment the questions of estimate precision and the scale of reporting, e.g. statewide as opposed to regional, need to be considered when making judgements about the trade-offs between sample size and survey costs. Furthermore, the frequency of any such surveys (whether annual, biennial, or less frequent) needs to be addressed. Factors such as requirements for quantitative information for stock assessment and monitoring of fishery performance indicators, as well as the availability of research funds are considerations. In the absence of clear direction in relation to the above, the following observations are made:

- Telephone recall surveys are not recommended for quantitative assessments of the recreational fishery. They are very cheap to administer, however, catch and effort are unreliable and biased (significant overestimates).
- The efficacy of the telephone/diary survey as a cost-effective and reliable methodology to collect detailed statewide information about the recreational rock lobster fishery has been established by this and earlier studies.
 - A screening sample size of about 500-550 licence holders would appear to be adequate to produce statewide harvest estimates with high precision (< 8% relative standard error).
 - Significant cost savings could be achieved by part season surveys, covering the period of most intense fishing activity (i.e. November to April).
 - In order to improve the precision of regional effort and harvest estimates it would be necessary to increase sample sizes, possibly in combination with stratified random sampling of the licence database. Any increases in sample size will impact directly on survey costs.
- There is an urgent need to determine the size selectivity of recreational fishing methods, in particular dive collection methods, to enable valid comparisons between the recreational and commercial sectors based on catch weights, as well as numbers.

In conclusion, it is recommended that a standardised survey methodology be adopted for on-going assessments so that inter-seasonal variability in parameter estimates can be attributed to changes in the fishery rather than confounded by the impact of methodological changes.

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1 Introduction

1.1 Background

Rock lobsters form the basis of a major commercial fishery as well as being a highly prized catch for recreational fishers in Tasmania. Commercially, the species is harvested using rock lobster pots whereas recreational fishers are permitted to use a variety of methods including pots, rock lobster rings and dive collection. Recreational licences (first introduced in the late 1970s) are required to harvest rock lobster, with size limits, bag limits and closed seasons applying.

There have been few assessments of the recreational rock lobster catch, despite the significance of the fishery. A voluntary recall-based survey completed at the time of licensing in 1986/87 produced a recreational harvest estimate of around 250,000 rock lobsters, about 11% of the commercial harvest at that time (A. Schaap, unpubl. data). An Australian Bureau of Statistics survey of home food production estimated 60 tonnes of rock lobster was 'home produced' in Tasmania for the year ending April 1992 (ABS 1994), equivalent to about 76,000 lobsters. A telephone survey of licensed fishers in the 1995/96 licensing year produced an estimated recreational harvest of around 111,000 rock lobster, representing about 5% of the total state harvest by numbers caught (Lyle and Smith 1998). Each of these surveys were subject, however, to recall bias and, in the case of the 1986/87 survey strong response bias, and therefore harvest estimates were likely to have been inflated to differing degrees.

Reliable catch and effort information from the recreational fishery is only available for the 1996/97 and 1997/98 seasons (Lyle 2000). Recreational harvest estimates for the periods December 1996 to August 1997 and November 1997 to April 1998 were 89,900 and 70,300 lobsters respectively, representing about 5% of the combined recreational and commercial harvest. However, in areas such as southeastern Tasmania, the recreational harvest was in excess of 38% of the total harvest taken from shallow waters (less than 18 metres). That study identified the significance of the interactions between recreational and commercial fishing sectors and highlighted the need for ongoing assessment of the recreational rock lobster harvest.

Since those data were gathered, the commercial rock lobster fishery has come under quota management, with a total allowable commercial catch (TACC) set at 1,502 tonnes in March 1998. This was a reduction in catch compared to the 1,800 tonnes harvested in the previous fishing season. The TACC remained at this level until March 2002 when it was increased to 1,523 tonnes. These management changes to the commercial fishery have been set against a steady increase in the number of recreational rock lobster licences issued each year. Since 1995/96 the number of rock lobster licence holders has risen by 55%, from 8,554 to 13,265 persons in 2000/01 (Fig. 1).

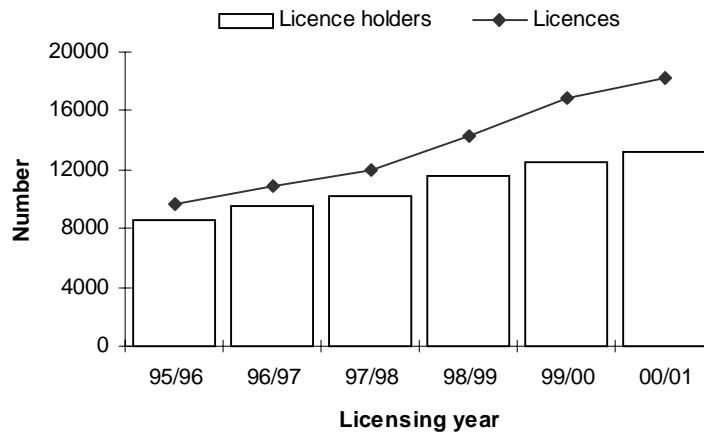


Fig. 1. Numbers of recreational rock lobster licence holders and rock lobster licences issued annually since 1995/96 (licence holders can hold more than one category of rock lobster licence).

The recreational licensing system allows individual fishers to hold up to three categories of rock lobster licence, namely rock lobster pot, rock lobster dive and rock lobster ring. Since 1995/96, the numbers of pot and dive licences issued have increased by 66% and 56% respectively, while ring licences have increased by 25% since their introduction in 1998/99 (Fig. 2). In 2000/01, there were around 10,200 rock lobster pot, 5,300 rock lobster dive and 2,500 rock lobster ring licences issued.

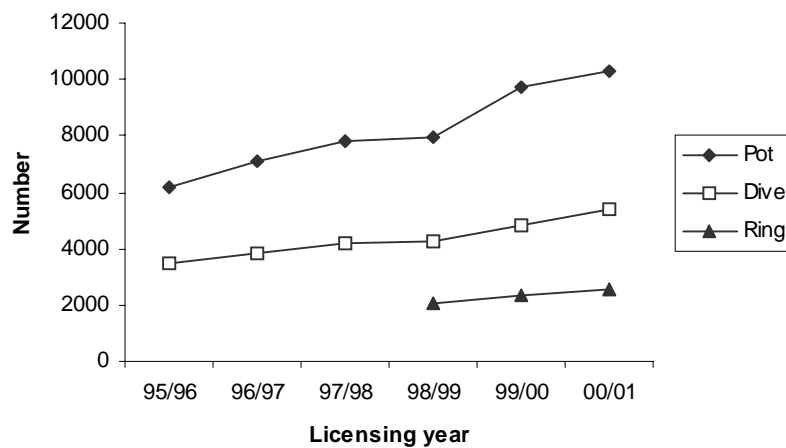


Fig. 2. Numbers of recreational rock lobster pot, dive and ring licences issued annually since 1995/96.

These increases and the restrictions on the commercial harvest, suggest that the recreational share of the total rock lobster catch may have increased in both absolute and relative terms. The size of the recreational harvest has been identified as a management performance indicator for the Tasmanian rock lobster fishery. Specifically, the Rock Lobster Fishery Management Plan states that if the recreational harvest exceeds 10% of the TACC in a year, recreational management arrangements will be reviewed. Further, the recreational catch is an important input parameter into the State’s rock lobster stock assessment model, which was developed to assess the status of the stocks and undertake risk assessments for different management scenarios.

In the absence of a specific monitoring program, the recreational rock lobster data required to fully evaluate management performance indicators and for on-going resource assessment are unavailable.

The current survey aims to provide a detailed assessment of the recreational rock lobster fishery in terms of participation, intensity of fishing effort, harvest levels and catch rates. The study also seeks to inform the development of a strategy for the on-going assessment of the recreational rock lobster fishery.

2 Methods

2.1 Survey design

2.1.1 Overview

A methodological approach involving a longitudinal telephone/diary survey previously used successfully to collect statewide and national information about recreational fishing activity (Coleman 1998, McGlennon 1999, Lyle 2000, Lyle *et al.* 2002) was adapted for this study.

The survey design involved a three-stage process, comprising an initial screening interview, a follow-up fishing diary survey and an attitudinal survey conducted at the end of the diary period. A randomly selected sample of recreational rock lobster licence holders was contacted by telephone and assessed for eligibility to participate in the follow-up diary survey. Diary survey respondents were issued with 'memory jogger' diaries and encouraged to record key information for all rock lobster fishing activity undertaken. Respondents were contacted regularly by telephone throughout the diary period by survey interviewers, who recorded details of fishing activity since last contact. The frequency of the contact was tailored to the needs and behaviour (fishing avidity) of individual respondents and detailed information was routinely collected very soon after each fishing event, minimising recall bias problems for any non-diarised data. By maintaining regular contact, interviewers were also able to immediately clarify any misunderstandings or inconsistencies at the time of the interview, thereby ensuring overall data quality and completeness. This approach to respondent management and data collection, by necessity, required highly trained and proficient interviewers, and this was achieved through careful interviewer recruitment, development and management.

In addition, a telephone recall survey was conducted with a separate sample of licence holders at the end of the 2000/01 rock lobster season and information was collected, retrospectively, about total rock lobster harvest and days fished during the season.

2.1.2 Screening survey

A sample of 1999/00 recreational rock lobster licence holders was contacted by telephone during October 2000, immediately prior to the commencement of the 2000/01 season, and assessed for likelihood to renew rock lobster licences in 2000/01. Respondents indicating their intention to renew were invited to participate in the follow-up diary survey to encompass the 2000/01 rock lobster fishing season.

2.1.3 Diary survey

Diary survey respondents were sent a survey kit prior to the opening of the rock lobster fishing season on 11th November 2000. The kit included a diary in which respondents were encouraged to record basic information about their fishing for rock lobster.

All diary respondents were then contacted by telephone, at least once a month, throughout the diary period and details of fishing for rock lobster, whether any were caught or not, since the last contact was recorded. Data included the date, fishing location; method used; start and finish times (including any significant breaks from fishing); the numbers of rock lobster kept (harvested) and numbers released or discarded; and, where rock lobster were released or discarded, the reason(s) for doing so.

Respondents were also asked whether or not information relating to each fishing activity or 'event' had been recorded in their diaries. By definition, a fishing event was described in terms of fishing region and method, if either changed on a given day a separate event was recorded. That is, for example, two separate events were recorded if a respondent used a pot and dived for rock lobster on the same day.

For rock lobster pots, the start of the fishing day was taken as the time the pot was set and the finish as the last time on a given day that it was checked or hauled. In cases where the pot was checked more than once a day, catch related to the total number of lobster for that day. Where the pot was fished more or less continuously over a period of several days, the last check on a given day (often involving baiting of the pot) effectively represented the start of the next fishing event, which finished the next day.

2.1.4 Attitudinal survey

The attitudinal survey was conducted at the end of the diary period, during the final telephone interview. In addition to providing fishing details, respondents were asked a number of questions aimed at assessing attitudes in relation to the quality of the fishery and their behaviour in terms of time spent fishing, compared with the previous season. Respondents were also invited to make general comments about the rock lobster fishery and the current survey.

2.1.5 Recall survey

The recall survey was conducted by telephone interview at the end of the fishing season (in September 2001) but involved a different sample of rock lobster licence holders drawn from the 2000/01 licence database. Licence holders previously selected for the screening survey were excluded from selection in the recall survey. The recall survey sample included persons who had been licensed in 1999/00, as well as persons who had not held a rock lobster licence in 1999/00 but had taken out rock lobster licence(s) for the 2000/01 season. This latter group, of course, had not been available for selection in screening and hence diary surveys.

The recall survey was designed to collect total effort (number of days fished) and harvest (number of rock lobster retained) information for the 2000/01 fishing season (based on respondent recall) for comparison with diary survey estimates. This in effect enabled an investigation of recall bias issues and the efficacy of using this alternative approach to the diary option. To ensure compatibility between surveys in terms of sample selection, recall estimates for renewing 1999/00 licence holders only have been used in the analyses. Appropriate adjustments were made in terms of determining expansion factors.

2.2 Survey scope

The survey's geographic scope encompassed marine and estuarine waters of Tasmania, including the offshore Bass Strait islands (i.e. King and Flinders Island), extending offshore to the extent of the Exclusive Economic Zone. Although sixteen fishing regions were defined for the purpose of reporting the location of fishing activity it has been necessary to collapse these regions to provide adequate sample sizes for regional reporting. Four major regions have been defined; northern (including King and Flinders Islands), eastern, southeastern and western Tasmania (Fig. 3).

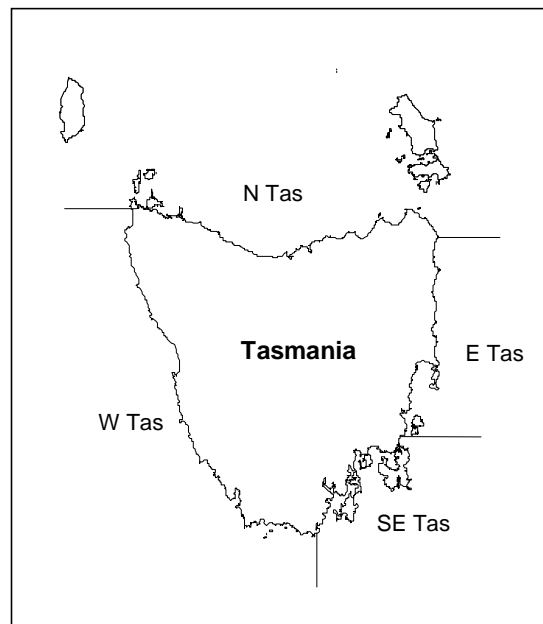


Fig. 3. Map of Tasmania, showing fishing regions.

Persons in-scope were defined as holders of Tasmanian recreational rock lobster pot, dive and/or ring licences. While the majority of rock lobster licence holders in any licensing year are Tasmanian residents, a small number of interstate and overseas residents also take out licences. Commercial fishers are eligible to hold recreational rock lobster licences, although restrictions controlling recreational gear and its use on commercial fishing trips apply. Rock lobster licences are not issued to persons under 10 years of age.

The scope of the survey was also confined to licensed recreational fishing activities, namely, the use of pots, rings and diving methods (surface air, scuba and snorkel) to harvest rock lobster. Commercial fishing activity was excluded from the study, as was any unlicensed fishing for rock lobster by diary survey respondents. That is to say, any illegal fishing activity detected in this survey was excluded from analyses.

The diary survey encompassed the period 11th November 2000 to 31st August 2001, the 2000/01 recreational rock lobster fishing season.

2.3 Sampling

2.3.1 Sampling frame

The Tasmanian recreational sea fishing licence database provided the sampling frame used in the study. Administered by the Department of Primary Industries, Water and Environment, the licensing system is structured around a base licence, to which additional licences may be added at marginal cost. Recreational fishers are able to purchase base licences, as well as add licences to their ‘package’, at any time throughout the licensing year, defined as the period 1st November to 31st October in the following year¹. Typically, rock lobster licence uptake is high early in the licensing year. While many licensees hold rock lobster licences for only part of the licensing year (i.e. they take up licences some time after 1st November), the vast majority of licences are taken up during the first three months of the season.

2.3.2 Sampling procedure

Random samples of rock lobster licence holders in the 1999/00 and 2000/01 licensing years were drawn from the recreational sea fishing licence database for the screening and recall surveys, respectively. Information accessed from the licensing database included name, address, telephone number, licence(s) held and date(s) of issue.

2.4 Data analysis

2.4.1 Catch and effort

In this study the licensed rock lobster fisher represented the sample unit and holders of recreational rock lobster licences constituted the population. Given the progressive increase in the number of recreational rock lobster licence holders during the licensing year, the sample size (i.e. number of diary survey respondents who were licensed) and total number of licensed fishers changed within the diary enumeration period. In order to account for this dynamic, the number of rock lobster licence holders registered on the licence database and the number of diary respondents licensed at the end of each month provided the basis for expansion. The base unit for effort and catch analysis was the monthly effort and catch for each licensed respondent and this was expanded by the relevant monthly sample fraction.

An exception to this ‘monthly’ expansion approach was required for the recall survey data where only whole of season, rather than monthly, catch and effort data were available. In this instance a ‘single’ expansion, based on the overall sample fraction, was applied. For comparability, recall and diary estimates were compared on the basis of this single expansion approach.

The ‘bootstrap’ method was used to estimate effort and harvest, with confidence limits determined using the percentile method (Haddon 2001). In each instance 10,000 simulations were conducted.

¹ The recreational rock lobster licensing year is not consistent with the commercial quota year which is defined as the period 1st March to the end of February in the following year.

2.4.2 Influence of sample size

The influence of sample size (number of diary respondents) on parameter estimation and precision was assessed using Monte Carlo sampling techniques. For this analysis 10,000 simulations were made using a range of predetermined sample sizes to determine the mean seasonal harvest per licence holder. The relative standard error (RSE), calculated as standard error expressed as a percentage of the mean harvest, was determined for each sample size and used as a measure of precision.

2.4.3 Proportional responses

Calculation of standard errors for proportional responses, for example the proportions of licence holders who fished for rock lobster and who responded 'yes' or 'no' to attitudinal questions, was based on Cochran (1977).

3 Results and Discussion

3.1 Response rates

3.1.1 Screening survey

A random sample of 550 licence holders was selected from the database of 1999/00 rock lobster licence holders. The response profile to this initial screening survey is shown diagrammatically in Fig. 4. Contact was made with 88% of the licence holders sampled and, of the remainder, 7% could not be contacted (despite at least ten attempts by telephone over a period of several weeks) and a further 4% either had no telephone listing or the number was disconnected. Respondents without a listing or with a disconnected number effectively represent sample loss. Of the 485 licence holders successfully contacted, over 99% responded, with less than 0.5% refusing to participate in the survey. If sample loss is discounted, the effective response rate was almost 92%.

Amongst the respondents, 50 indicated that they were not likely to renew their licence(s) in 2000/01 and hence were not eligible for inclusion in the diary survey². The balance (433) indicated they were likely to renew their licence(s) in 2000/01 and almost 96% (415) agreed to participate in the diary survey.

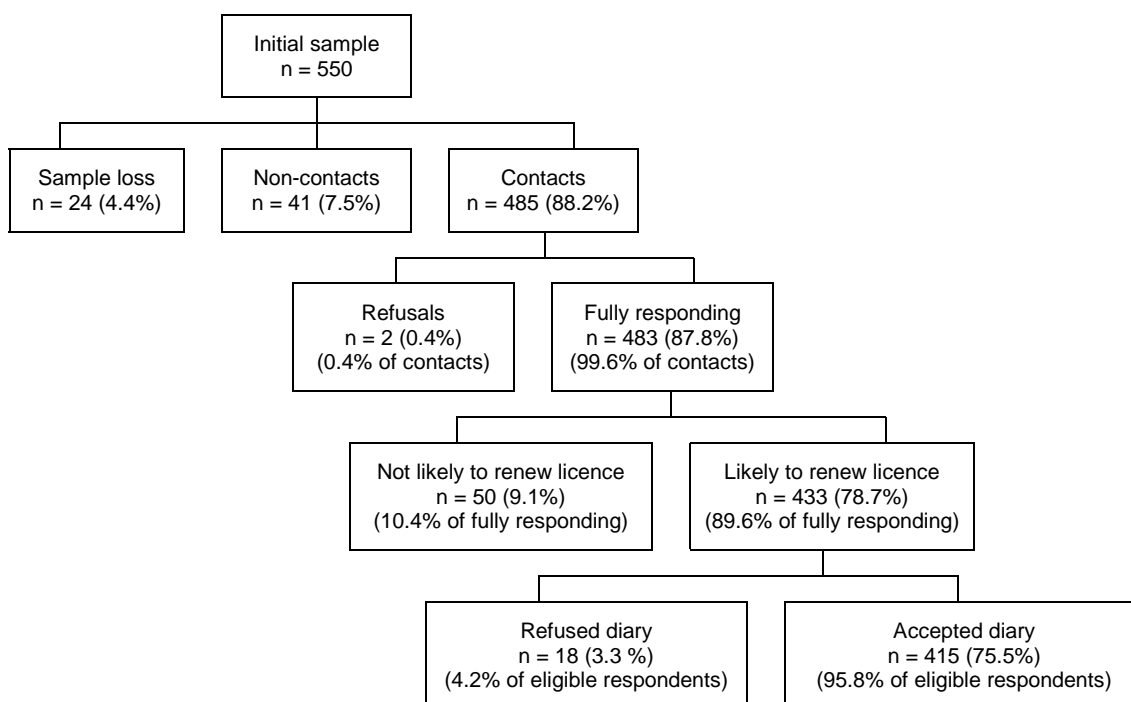


Fig. 4. Diagrammatic representation of the screening survey responses.

² The rock lobster licence status of these respondents was checked at the end of the 2000/01 season and only 14 licence renewals were identified.

3.1.2 Diary survey

Diary survey response was high, with 98% of respondents who accepted a diary fully participating for the entire survey period (Fig. 5). Respondents who went out of scope during the diary period (i.e. moved overseas or interstate with no intention to fish in Tasmania for the remainder of the 2000/01 season) were treated as fully responding if complete information was collected up until the time they went out of scope. Data for the few diarists who partially responded (i.e. who declined to participate for the full period or with whom contact was lost through telephone disconnection) were excluded from all analyses. Given the very high response rates, possible biases arising from non-response were not considered to be a significant problem in this study.

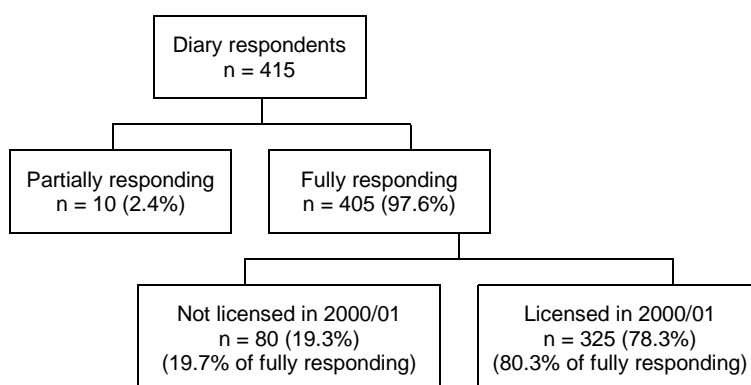


Fig. 5. Diagrammatic representation of the diary survey responses.

Of the fully responding diarists, however, almost 20% did not take up a licence during the 2000/01 licensing year. The remaining 325 respondents, representing 2.5% of all rock lobster licence holders in 2000/01, therefore comprised the sample component for expansion and analysis. In Table 1 the number of 2000/01 rock lobster licence holders and fully responding licence holders sampled are presented by licence type, indicating the strong alignment between the proportion of licence categories for the diary survey sample and the total population of licence holders.

Table 1. Total number of 2000/01 rock lobster licence holders and number of fully responding licence holders sampled, by licence type.

(values in parentheses represent percentage of total licences issued and total number sampled)

Licence type	Licence holders	Diarists	% sampled
Rock lobster pot	10285 (56.4)	265 (56.9)	2.6
Rock lobster dive	5394 (29.6)	135 (29.0)	2.5
Rock lobster ring	2553 (14.0)	66 (14.2)	2.6
Total licences	18232	466	2.6
Persons	13265	325	2.5

While all recreational rock lobster fishing activities by diary survey respondents were recorded, only those activities undertaken whilst in possession of a recreational rock lobster fishing licence were used in subsequent analyses. That is, if a respondent reported fishing for rock lobster prior to obtaining a rock lobster licence (determined by reference to date of issue on the licensing database), such data were excluded from subsequent analysis as it in effect represented unlicensed fishing. Overall, diary survey respondents reported a total of 2,865 fishing events for the survey period, 2,747 (96%) of which were within the scope of the survey.

Non-diarised fishing proved to be a minor issue, with 88% of all reported fishing events documented in respondent diaries.

3.1.3 Recall survey

A random sample of 550 rock lobster licence holders was interviewed by telephone following the closure of the 2000/01 season. 64% of the sample (355 persons) had been licensed in 1999/00, while the balance (195 persons) had not held a rock lobster licence in 1999/00 but had taken out rock lobster licence(s) for the 2000/01 season. To ensure compatibility between recall and diary surveys in terms of sample selection, the recall survey response of renewing 1999/00 licence holders only were used in analyses.

From the sample of renewing 1999/00 licence holders, 86% fully responded to the survey (Fig. 6). Of the remainder, 3% could not be contacted and 9% either had no telephone listing or the number was disconnected (i.e. sample loss), while refusals accounted for less than 1% of the sample. If sample loss is discounted, the effective response rate was about 95%, which is comparable to the screening survey.

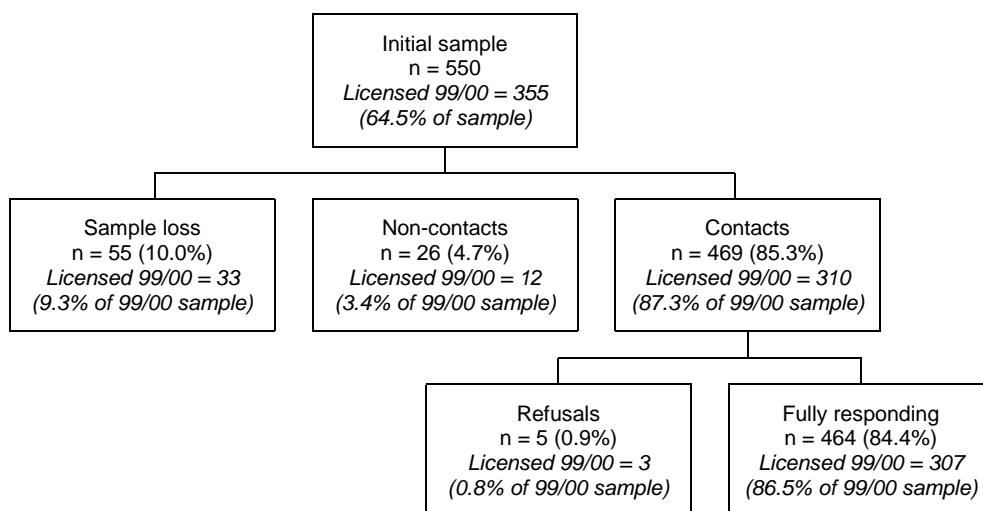


Fig. 6. Diagrammatic representation of the recall survey response.

3.2 2000/01 recreational rock lobster licences

During 2000/01 a total of 13,265 recreational fishers held one or more recreational rock lobster licences. In 2000/01, about 68% of licence holders held a single licence type (i.e. rock lobster pot, dive or ring), with rock lobster pot the dominant category (Table 2). Of the remaining licence holders, 27% combined two licences (i.e. pot and dive, or pot and ring, or dive and ring), with 5% taking out all three rock lobster licences. Overall, 78% of licensees held a rock lobster pot licence, 41% a rock lobster dive licence and 19% a rock lobster ring licence.

Table 2. Types and combination of Tasmanian recreational rock lobster licences held by licensees in 2000/01.

Licence type/combination	No. licence holders	% total
Pot only	6188	46.6
Dive only	2505	18.9
Ring only	316	2.4
Pot and dive	2019	15.2
Pot and ring	1367	10.3
Pot, dive and ring	711	5.4
Dive and ring	159	1.2
Total licence holders	13265	100

Licence uptake was high early in the 2000/01 licensing year (Fig. 7), with 60% of all rock lobster licence holders registered by the end of November, 82% by the end of December and over 91% by the end of January 2001.

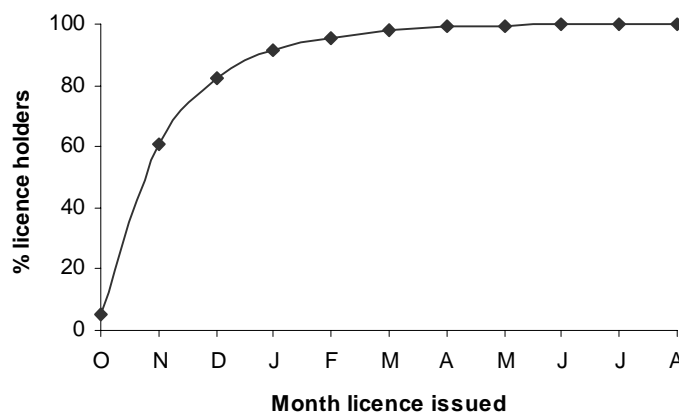


Fig. 7. Cumulative proportion (%) of the total number of 2000/01 rock lobster licence holders registered by month of licence issue.

3.3 Total effort and harvest

Information reported in this section relates to analyses of diary survey data provided by fully responding licence holders, and is presented as expanded estimates for the total population of recreational rock lobster licence holders in 2000/01.

3.3.1 Effort, harvest and harvest rates

An estimated 86.5% (SE 1.9%) of all rock lobster licence holders (equivalent to 11,408 licensees) did some fishing for rock lobster during the 2000/01 rock lobster season, but usage rates varied by licence type. For instance, fishers with only a dive licence were slightly more likely to fish (88%) than those with a pot only licence (84%) and those with a combination of pot and dive licences (87%).

Estimates of total recreational effort (expressed in terms of fisher days) and harvest for the 2000/01 season are presented in Table 3. Overall, total fishing effort was estimated at almost 101,000 fisher days for the season, yielding an estimated harvest of approximately 128,000 lobsters. The mean harvest rate for the season was 1.3 rock lobster per fisher day.

Table 3. Total recreational rock lobster effort, harvest and harvest rate for 2000/01.
(values in parentheses represent the 95% confidence limit)

	Effort (fisher days)	Harvest (no.)	Harvest rate (no. per fisher day)
Total	100866 (88507 – 113923)	128219 (109519 – 148266)	1.3

Estimates of effort, harvest and harvest rates for pot, ring and dive methods are presented in Table 4. Total fishing effort estimates by method indicate that almost four times as many days were spent using rock lobster pots (80,600 days) than diving (21,500 days). Harvest estimates by method indicate that just over 70,000 rock lobster were taken by pot (55% of the total harvest), 56,000 by diving methods (44% of the harvest) and about 1,500 (1% of the harvest) by rings. Mean daily harvest rates were almost three times higher for divers (2.6 lobster) compared to pot fishers (0.9 lobster).

Table 4. Recreational rock lobster effort, harvest and harvest rate by fishing method for 2000/01.
(values in parentheses represent the 95% confidence limit)

	Effort (fisher days)	Harvest (no.)	Harvest rate (no. per fisher day)
Pot	80638 (68111 – 94012)	70344 (58489 – 83116)	0.9
Dive	21579 (16474 – 27094)	56415 (40697 – 73889)	2.6
Ring	1361 (688 – 2157)	1525 (274 – 3454)	1.1

Over the full season the majority of diary survey respondents fished relatively few days and harvested few lobsters, whereas a small proportion fished often and harvested many lobsters. For instance, over 60% of diarists fished between one and ten days, whereas just 3% fished for 40 or more days (Fig. 8). Almost a quarter of the diarists caught no rock lobster during the season (this included the 14% who did not fish for lobster at all), while a further 26% harvested less than 5 lobster (Fig. 9). Only 6% of diarists harvested 40 or more rock lobster for the season.

On average, diarists fished for 8.5 days during the 2000/01 season, harvesting a total of 10.5 rock lobster for the season. If only those diarists who fished are considered, then the average effort expended was 9.8 days and the average harvest was 12.1 rock lobster per fisher. These estimates should be considered in the context of the progressive increase in the number of licence holders throughout the season (refer to section 3.2) and thus relationships between the timing of licence uptake and effort expended. Diarists who took out licences either prior to the commencement of the licensing year (i.e. in October 2000) or by the end of November 2000 fished, on average, two to three times more days than those who took up licenses later in the season (Fig. 10).

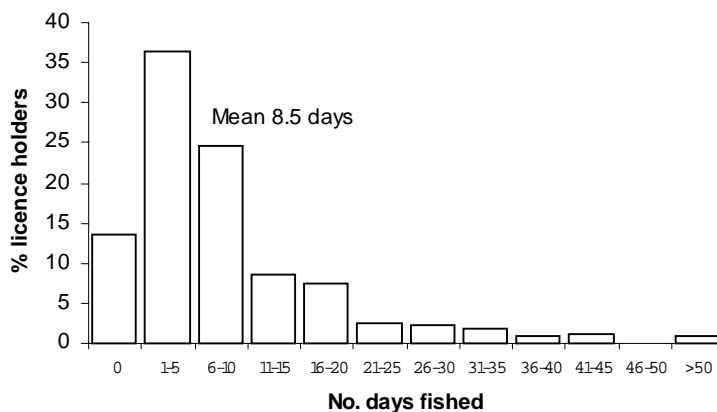


Fig. 8. Distribution of seasonal rock lobster effort by 2000/01 recreational rock lobster licence holders.

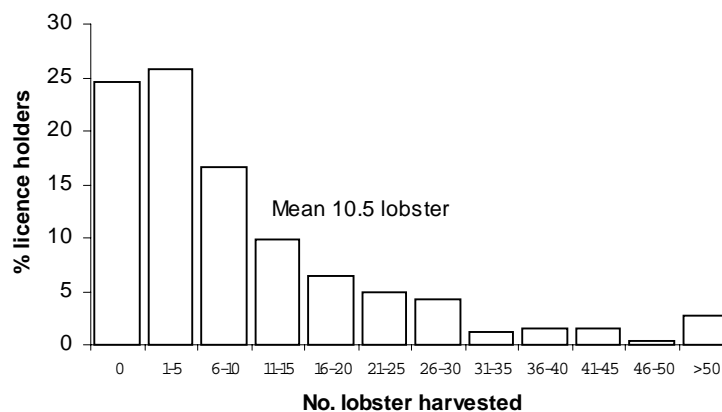


Fig. 9. Distribution of seasonal rock lobster harvest by 2000/01 recreational rock lobster licence holders.

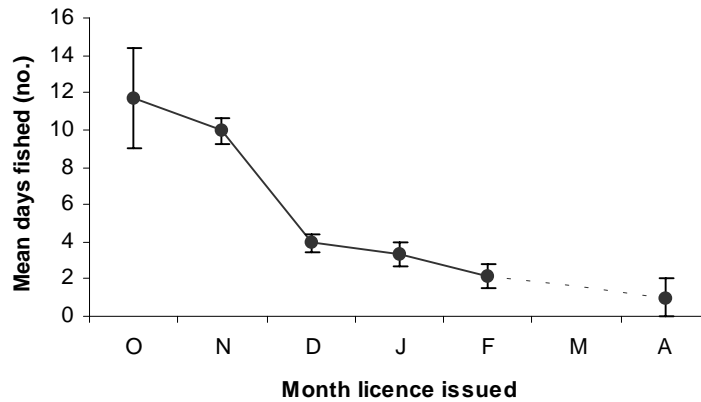


Fig. 10. Mean days fished (with standard error) by diary survey respondents, by month of licence issue.

In order to assess the relative contribution of individual licence holders to the total effort and harvest, the cumulative effect of adding one more licensee's effort and harvest (after sorting by the sum of the seasonal effort and harvest) to the total has been calculated. The strong impact of a relatively small proportion of licence holders is evident, with 80% of the effort and harvest accounted for by 40% and 33% of licence holders, respectively (Fig. 11). Conversely, 60% and 67% of licence holders contributed just 20% of the total effort and harvest, respectively.

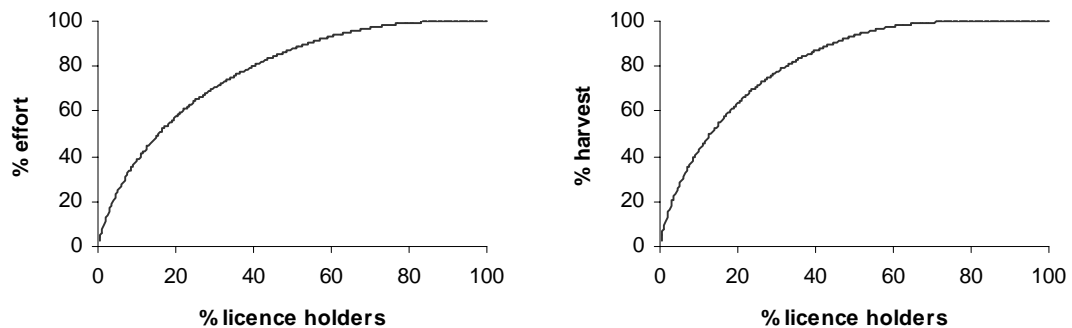


Fig. 11. Cumulative contribution to the overall 2000/01 recreational rock lobster effort (left) and harvest (right) by rock lobster licence holders.

3.3.2 Seasonal effort and harvest

Monthly estimates of recreational effort and harvest indicate strong seasonality in the fishery, with three distinct phases of activity (Fig. 12): a phase of high effort and harvest early in the season (November to January), followed by a phase of intermediate effort and harvest (February to April) and then a phase of low effort and harvest (May to August). The initial period of intense fishing activity accounted for 70% of both effort and harvest, the following period of intermediate activity about 23% and the final phase less than 7%. Intense fishing activity corresponded with the opening of the season and the summer holiday period, with greatest effort and harvest during January. By contrast, fishing activity was relatively limited during the final four months of the

season, corresponding to closure of the fishery for female lobsters and the onset of cooler and unsettled weather.

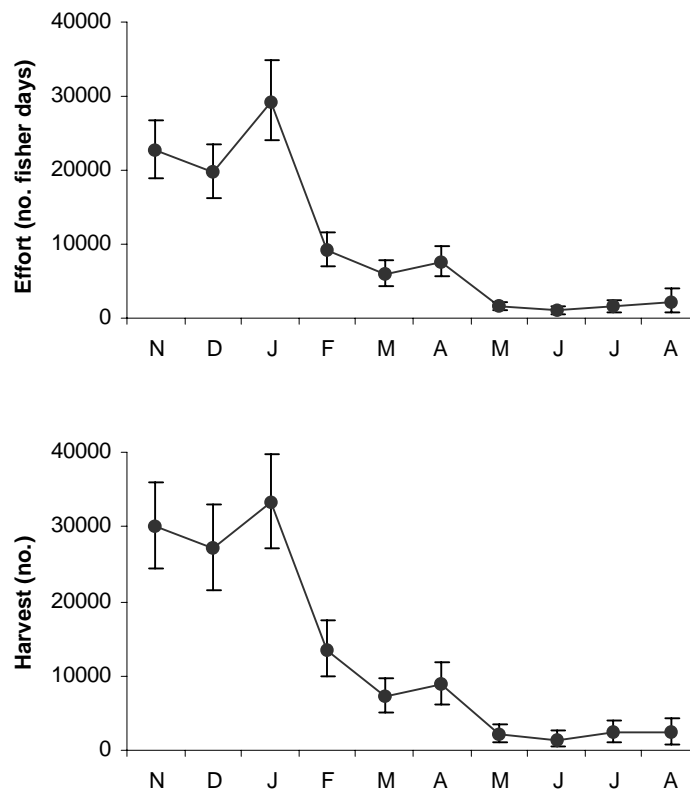


Fig. 12. Monthly estimates (with 95% confidence limits) of rock lobster effort (days fished) and harvest (numbers) by recreational rock lobster fishers in the 2000/01 rock lobster season.

3.3.3 Regional effort and harvest

Effort, harvest and harvest rates by fishing region (refer Fig. 3) are summarised in Table 5 and indicate that the recreational fishery was centred primarily off the southeast coast. This region alone contributed 47% of the total effort (48,870 fisher days) and 45% of the total harvest (57,224 lobster) in the 2000/01 season. Almost a third of the effort was expended on the east coast but resulted in only 23% of the harvest. The balance of effort was distributed relatively equally between the west and north coasts (around 10% in each region), with these regions contributing 18% and 14% of the harvest, respectively.

Table 5. Recreational rock lobster effort, harvest and harvest rates by fishing region for 2000/01.
(values in parentheses represent the 95% confidence limit)

Region	Effort (fisher days)	Harvest (no.)	Harvest rate (no. per fisher day)
N Tas	11054 (6822 – 16246)	18523 (9768 – 28945)	1.7
E Tas	33460 (23664 – 44558)	29316 (21299 – 37866)	0.9
SE Tas	48870 (39423 – 58906)	57224 (44583 – 71828)	1.2
W Tas	10343 (6746 – 14443)	23265 (13738 – 34247)	2.2

Regional differences were evident in the proportion of rock lobster harvested by method (Fig. 13). The harvest of rock lobster on the north coast was principally by dive collection methods (70% of the harvest), whereas rock lobster pots accounted for the majority of the harvest on the east and southeast coasts (67% and 60% respectively). On the west coast, there was a greater balance between pot and dive methods (48% and 46% of the harvest respectively), with a small proportion of the harvest (6%) taken by rings.

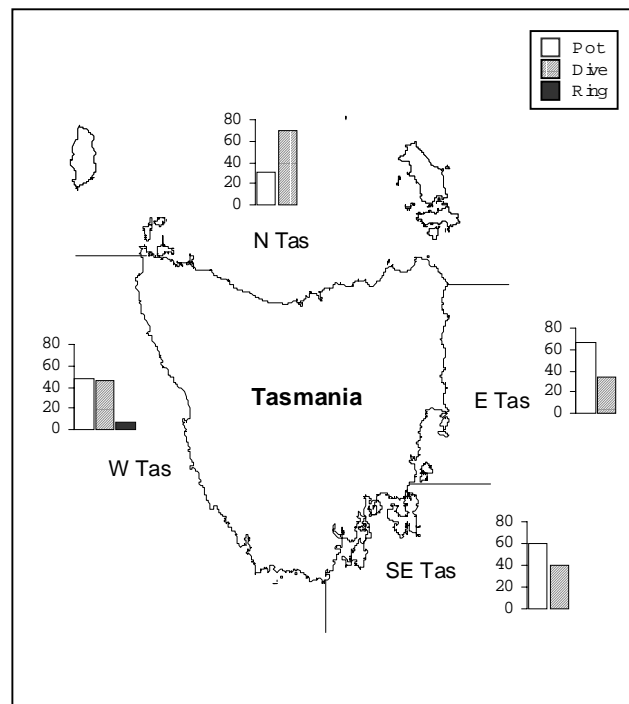


Fig. 13. Recreational rock lobster harvest by fishing region and method expressed as a percentage of the regional total for 2000/01.

Regional harvest rates were, on average, highest on the west coast (2.2 lobster per day), slightly lower on the north coast (1.7 lobster), intermediate for the south east coast (1.2 lobster) and lowest on the east coast (only 0.9 lobster). Stock abundance and total fishing pressure (including commercial activity), along with the relative mix of fishing

methods used, noting significantly higher harvest rates for dive collection compared to pots (refer section 3.4), are factors that contribute to regional variability in harvest rates.

3.3.4 Released catch

In total, 140,161 rock lobster (95% confidence limit range 112,844 – 170,671) were estimated to have been released by licence holders during 2000/01, equivalent to 1.1 rock lobster for every one retained. The seasonal pattern of lobster releases (Fig. 14) closely followed that for effort (Fig. 12), with highest quantities of released lobsters occurring early in the season when effort was greatest.

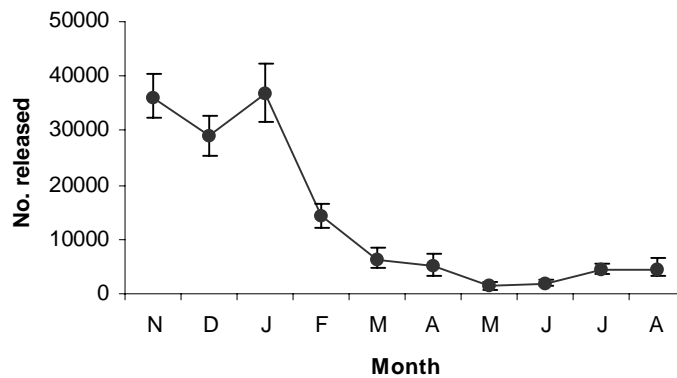


Fig. 14. Monthly estimates (with 95% confidence limits) of numbers of released rock lobster for by recreational rock lobster fishers in the 2000/01 rock lobster season.

Pot fishers reported an average of 1.6 lobster released for every one retained over the entire fishing season. On a monthly basis, the ratio of released to retained lobsters fluctuated between 1.1 to 2 lobsters from the start of the season up until May, after which the released ratio increased to 3 to 3.5 (Fig. 15). This sharp increase in the proportion of the catch that was released reflects the impact of the closure of the recreational fishery with respect to the harvesting of female rock lobster from May onwards.

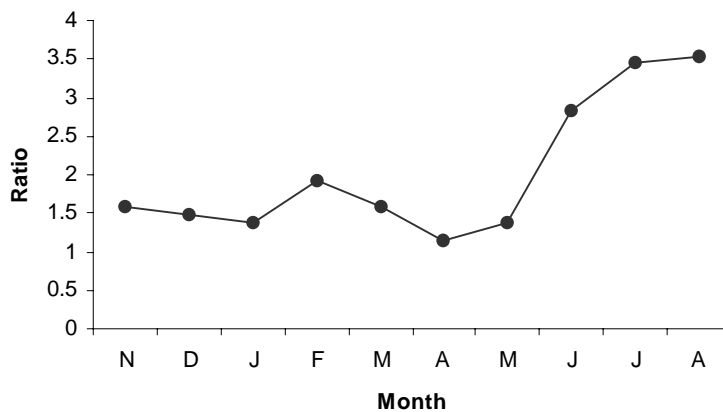


Fig. 15. Monthly ratio of the number of rock lobster released to the number retained by recreational rock lobster pot fishing in the 2000/01 rock lobster season.

Between November and April, 96% of the pot catch that was released was reported as being under the legal minimum size, 2% were discarded because they were dead or damaged, 1% were berried females and less than 0.5% of releases were due to over bag limit catches. In the latter part of the season, May to August, berried females and the closure of the fishery to females (effectively the same thing) were significant reasons for release, comprising 45% of the released lobsters, with the balance (55%) being undersized.

By contrast, divers are able to target and individually select lobster underwater, and therefore in the strictest sense, releases of 'landed catch' were low, in fact just 20% of all releases in 2000/01. During the first part of the season undersize lobsters accounted for 90% of diver releases, compared with 51% for the latter half of the season. Releases of female lobster represented the balance of releases in post April catches. Over bag limit catches represented just over 3% of releases up until May. This suggests that high grading of the catch (i.e. where the bag limit is exceeded and then the catch is sorted and, presumably, only the largest rock lobster are retained) only occurs to a limited extent.

3.4 Pot and dive methods

3.4.1 Effort, harvest and harvest rates

Monthly estimates of recreational pot and dive effort (number of days fished), harvest and harvest rates for the 2000/01 season are presented in Fig. 16. Pot effort was concentrated between November and January, with greatest activity during January, and then fell sharply in February. Dive effort was also highest in January, though showed only a moderate decline in February. Effort for both methods remained relatively stable between February and April, declined in May and was maintained at relatively low levels through to the end of the season.

Almost 80% of the total rock lobster pot harvest (about 55,900 rock lobster) and 60% of the dive harvest (about 33,600 lobster) was accounted for during the first three months of the season. By the end of April, 95% of the pot and 91% of the dive harvest was taken.

Harvest rates for pots were relatively stable between November and January, at around 0.9 rock lobster per pot day whereas dive harvest rates declined from about 3.1 to 2.3 lobster per day. Between February and April pot harvest rates then declined to just 0.5 but rose slightly in subsequent months, though this apparent 'recovery' was based on very limited data. Dive harvest rates generally declined as the season progressed but remained consistently 2 to 3 times higher than harvest rates for pots.

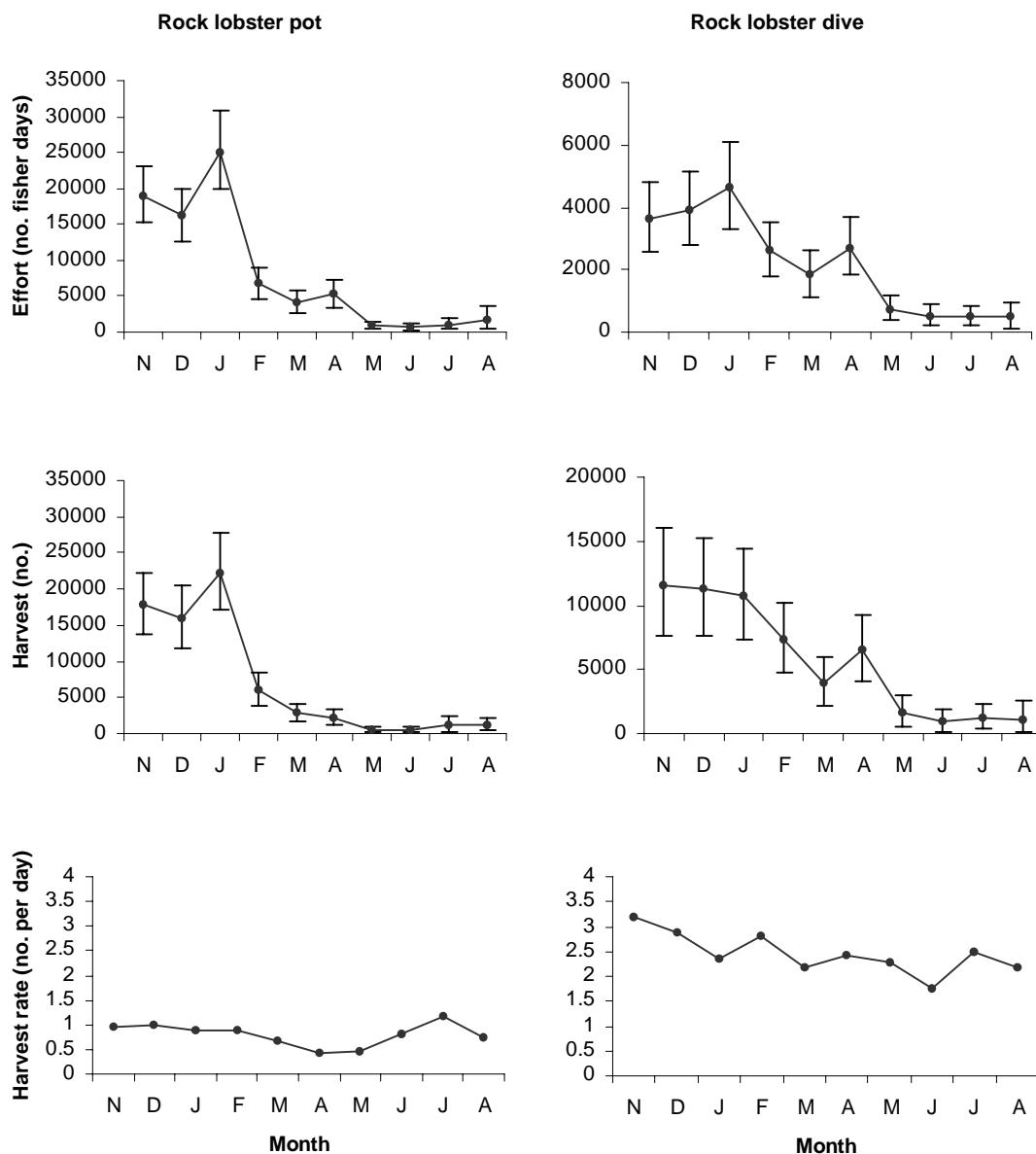


Fig. 16. Monthly estimates (with 95% confidence limits) of rock lobster effort (days fished) and harvest (numbers), and mean harvest rates (lobsters per day) for pot and dive methods for the 2000/01 recreational rock lobster season. (Note, the Y-axis differs between the two fishing methods for effort and harvest).

3.4.2 Effort and harvest per fisher

On average, diary respondents targeted rock lobster using pots for 10.2 days during 2000/01 and harvested a total of 8.9 lobster for the season (Table 6). The average daily harvest rate for pots was 0.9 rock lobster. By contrast, respondents using dive methods averaged fewer fishing days (5.8 days), but harvested nearly twice as many rock lobster for the season (15.3 lobster). The average daily harvest rate for dive methods was 2.6 lobster.

A number of dive collection methods were reported by diary respondents, namely, snorkel, scuba and surface air supply (hookah). Scuba diving was the most frequently used method (45% of reported dive events), followed by surface air (41%) and snorkel

(14%). About 30% of respondents who reported dive activity used more than one dive method during the season.

Table 6. Mean effort, harvest and harvest rates for rock lobster pot and diving methods by diarists during the 2000/01 season.

	Rock lobster pot	Rock lobster dive
No. reported events	2145	565
No. fishers	211	97
Mean days fished	10.2	5.8
Mean harvest	8.9	15.3
Mean harvest per day	0.9	2.6

3.4.3 Daily harvest

The distribution of daily harvests during the 2000/01 season differed substantially between rock lobster pot and dive methods (Fig. 17). Just 50% of pot days fished resulted in a retained catch of at least one rock lobster, compared to 80% for dive. The daily bag limit of five rock lobster was attained or exceeded in only a very small proportion (1.6%) of days fished with pots and contrasted the situation for dive capture, where at least five lobster were retained in over one quarter (27%) of the days dived for rock lobster.

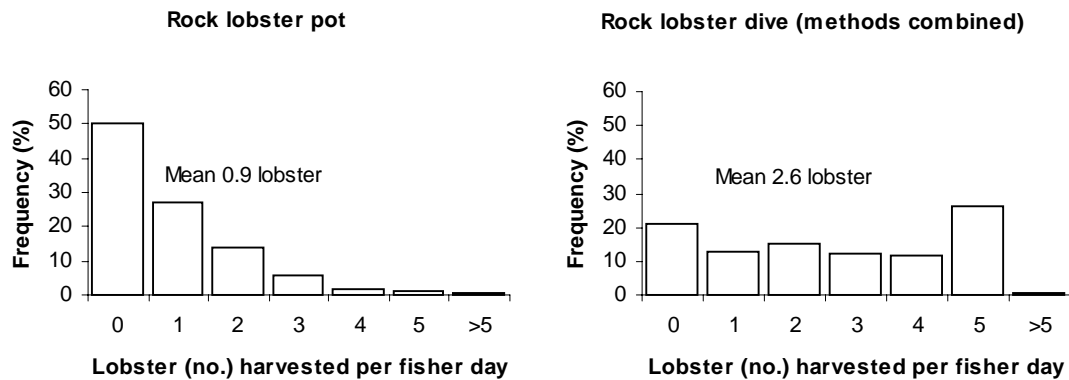


Fig. 17. Distribution of rock lobster pot and dive harvest per fisher day by 2000/01 recreational rock lobster licence holders.

Amongst the dive methods, surface air was the most effective method, with one or more rock lobster harvested on 87% of dive days, compared with 77% for snorkel and 72% for scuba (Fig. 18). The proportion of days on which the daily bag limit was achieved (or exceeded) was also higher for surface air (38% of days fished), than for either scuba (20%) or snorkel (18%) methods. Overall, mean harvest rates for divers using surface air were 3.3 lobster per day and compared to 2.2 for scuba and snorkel methods.

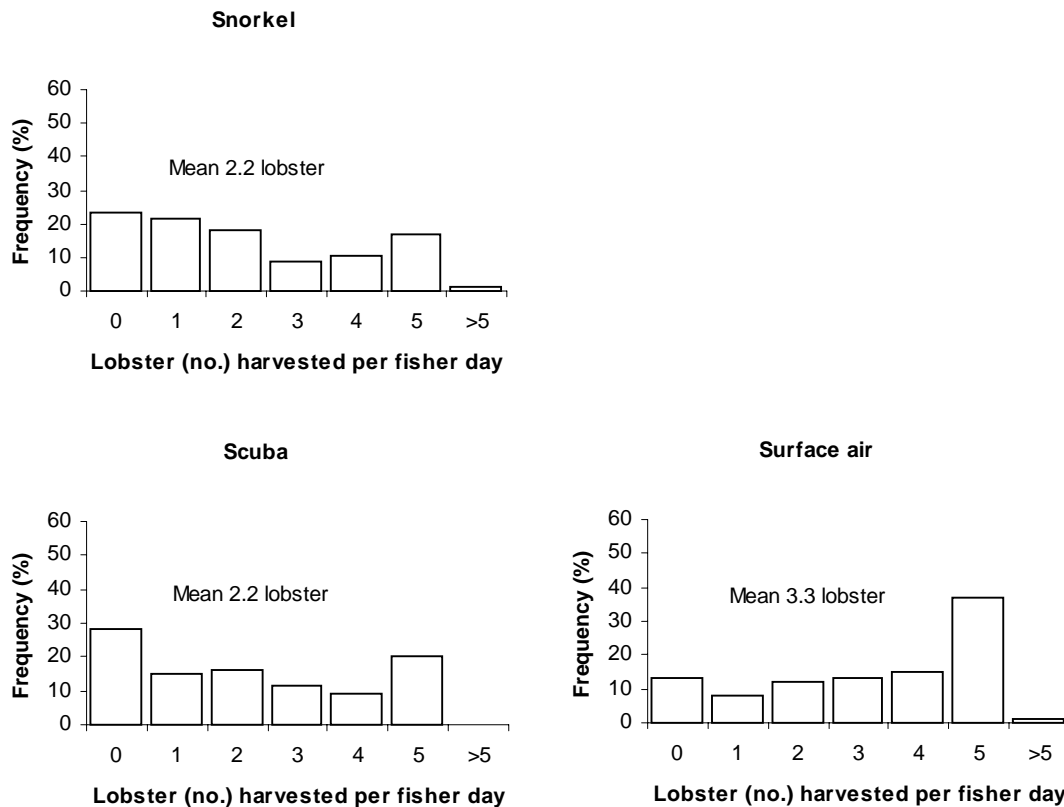


Fig. 18. Distribution by method of rock lobster dive harvest per fisher day by 2000/01 recreational rock lobster licence holders.

3.5 Comparison with previous assessments

The survey methodology applied in this survey is fundamentally similar to that applied by Lyle (2000) in assessments of the 1996/97 and 1997/98 recreational rock lobster seasons. As these previous surveys were only part season assessments, valid inter-seasonal comparisons have been restricted to the December to April period. The main developments distinguished relate to harvest size, proportion of the harvest taken by fishing method and harvest rates.

The recreational harvest taken between December 2000 and April 2001 was about 89,800 lobster and was comparable to that for the same period in 1996/97 (86,600 lobster) but was substantially higher than in 1997/98 (57,700 lobster). The relative proportions of the harvest taken by method appear to have changed over time. In the 1996/97 and 1997/98 seasons pots accounted for around 64% of the harvest, with divers taking between 32-34%. By contrast, in 2000/01 pots represented just 55% of the harvest while the dive component had increased to 44% (Fig. 19).

Variability in the proportion of pot and dive licences issued could be expected to explain some this difference, however, there has been no evidence of such a shift across the three licensing years. The proportion of licensees issued with a dive licence has in fact remained constant at 40% in each of the licensing years assessed. Similarly, the proportion of licensees issued with a pot licence has remained relatively stable, ranging from 75% to 78% of licence holders.

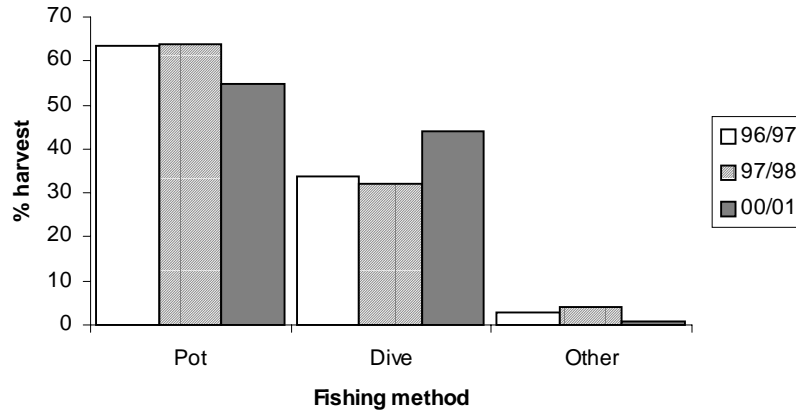


Fig. 19. Relative proportion of recreational rock lobster harvest by fishing method in the 1996/97, 1997/98 and 2000/01 licensing years (for the period December to April). Other methods include rings and incidental catch in gillnets.

This shift in the proportion of the harvest taken by method has been the result of relative changes in effort, coupled with harvest rate variability between seasons. An increase in the relative contribution of dive effort has been the primary contributing factor. In 2000/01 dive effort accounted for 21.5% of the combined total number of pot and dive days fished, compared with 19.2% in 1996/97 and 17.7 % in 1997/98. Method based harvest rates have also been variable between seasons. For instance, the mean dive harvest rates in 2000/01 and 1996/97 (2.5 lobster per day) were higher than in 1997/98 (2.1 lobster). Conversely, pot harvest rates were higher in 1996/97 (1.13 lobster per day) than in 1997/98 (0.86 lobster) and 2000/01 (0.88 lobster).

3.6 Comparison with commercial fishery

In Tasmania, commercial rock lobster harvests are reported in terms of numbers and weight, enabling direct comparison between the sectors on the basis of numbers caught. Comparisons on the basis of weight are complicated by the absence of size composition information for the recreational catch. However, as commercial and recreational pots conform to identical standards in relation to pot entrance and escape gap sizes, it is probable that average sizes of pot caught lobsters would be comparable between the two sectors (when depth of capture and region are taken into account). By contrast, anecdotal accounts indicate that dive caught lobsters are, on average, larger than pot caught specimens. This would suggest that the recreational share of the total harvest would be slightly higher if based on weight rather than numbers, as considered in this analysis. This issue has been explored in some detail as part of the 2000/01 rock lobster fishery assessment (Gardner *et al.* 2002).

Details of the commercial harvest were accessed from commercial rock lobster catch returns. Where commercial fishing block boundaries did not directly coincide with recreational fishing regions employed in the diary survey, the commercial harvest within these overlapping blocks was allocated on a pro-rata basis to the appropriate fishing region.

Between November 2000 and September 2001, around 1,350 tonnes or nearly 1.6 million rock lobster were harvested by the commercial sector³. When combined with the recreational harvest of 128,000 lobster, the recreational share amounted to 7.4% of the total harvest (numbers) for the State (or 8.0% of the commercial catch). Regionally, the recreational share of the west coast harvest was low (3%), due mainly to the importance of this region to the commercial fishery (accounting for over half of the total commercial catch numbers) (Table 7). Off the north coast the recreational component represented about 4% of the total harvest, whereas off the east and southeast coasts the harvest share was almost 16% and 23%, respectively.

Table 7. Recreational and commercial rock lobster harvest estimates (numbers) by fishing region, indicating the recreational proportion of the combined harvest (Nov 2000 to Sept 2001).

(values in parentheses represent the 95% confidence limit ranges)

Sector	Region				
	N Tas	E Tas	SE Tas	W Tas	Total
Recreational	18523 (9768 – 28945)	29316 (21299 – 37866)	57224 (44583 – 71828)	23265 (13738 – 34247)	128219 (109519 – 148266)
Commercial	420329	158834	196084	822410	1597657
Combined	438852	188150	253308	845675	1725876
% recreational	4.2 (2.2 – 6.6)	15.6 (11.3 – 20.1)	22.6 (17.6 – 28.4)	2.8 (1.6 – 4.0)	7.4 (6.3 – 8.6)

Depth limitations on diving and ease of pot and ring hauling suggest that the recreational rock lobster fishery operates primarily in inshore shallow waters⁴. Commercial fishers operate over a wider area, including deeper offshore reefs, with two thirds of the total commercial harvest taken from depths of greater than 18 metres. If the commercial harvest from shallow waters (< 18 metres) is compared with the recreational harvest, then the recreational share of the 'shallow water' harvest is more significant, representing 19% of the total (or 23.9% of the commercial catch) (Table 8). Regionally, the recreational share remained relatively low on the west and north coasts (8% and 12% respectively), with a higher share (28%) from the east coast. In southeastern Tasmania however, the recreational harvest was only slightly lower than the commercial take, accounting for 45% of the total harvest.

Pot harvest rate comparisons are possible between commercial and recreational sectors based on December to April data for 1996/97 and 1997/98 (Lyle 2000) and for 2000/01. Commercial harvest rates in shallow water were consistently higher than recreational harvest rates, by a factor of 1.1 in 1996/97, 1.2 in 1997/98 and 1.3 in 2000/01 (Fig. 20). The commercial sector's collective fishing experience, together with the use of technology (i.e. colour echo sounders, radar and global positioning systems), would suggest that it is more effective at locating suitable and productive areas in which to set pots than the recreational sector.

³ The commercial fishing season varied slightly from the recreational season and extended into September 2001

⁴ All of the rock lobster fishing activity reported by diary survey respondents was undertaken within five kilometres of the coast.

Table 8. Shallow water (< 18m) harvest estimates (numbers) for recreational and commercial rock lobster fisheries by fishing region, indicating recreational proportion of the combined harvest (Nov 2000 to Sept 2001).

(values in parentheses represent the 95% confidence limit)

Sector	Region				Total
	N Tas	E Tas	SE Tas	W Tas	
Recreational	18523 (9768 – 28945)	29316 (21299 – 37866)	57224 (44583 – 71828)	23265 (13738 – 34247)	128219 (109519 – 148266)
Commercial	140032	76341	70251	249178	535801
Combined	158555	105656	127475	272443	664020
% recreational	11.7 (6.2 – 18.3)	27.7 (20.2 – 35.8)	44.9 (35.0 – 56.3)	8.5 (5.0 – 12.6)	19.3 (16.5 – 22.3)

Although there was a good correlation between trends in recreational and commercial harvest rates for 1996/97 and 1997/98, the 2000/01 harvest rates, relative to 1997/98, varied for the two sectors. Specifically, commercial harvest rates were higher whereas recreational rates had declined slightly in 2000/01. The reasons for this divergence are not clear but the data do indicate that trends in harvest rate for the recreational fishery do not necessarily mirror those for the commercial sector. This suggests that the use of commercial fishery data as a proxy for recreational harvest rates and thus as an indicator, possibly linked to the number of recreational licence holders, of potential recreational harvest levels would be unreliable.

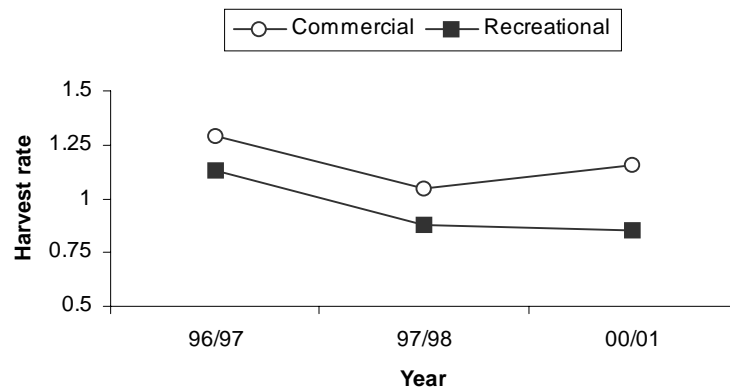


Fig. 20. Comparison between shallow water pot harvest rates (number of lobster per pot day) for commercial and recreational fisheries in 1996/97, 1997/98 and 2000/01 (based on December to April data in each year).

Gardner *et al.* (2002) have reported on the examination of fishery performance indicators based on comparisons between recreational and commercial harvest levels and concluded that the recreational harvest trigger point was not exceeded in 2000/01. Recreational data obtained in the study have also been input into the rock lobster stock assessment model to evaluate future harvest strategies and stock biomass and egg production predictions (Gardner *et al.* 2002).

3.7 Attitudes of licence holders

Information contained in this section was collected at the end of the diary survey period, during the final telephone interview with diary respondents.

3.7.1 Quality of the fishery

Diary survey respondents were surveyed in relation to the quality of rock lobster fishing, and their behaviour in terms of time spent fishing in the 2000/01 season.

Respondents were asked whether the quality of the rock lobster fishing they had done in the 2000/01 season was better, worse or about the same as that for the previous season. Over two thirds of respondents considered the quality of rock lobster fishing to be about the same, or better, in 2000/01 compared to 1999/00 (Table 10). Only 17% of diarists believed the quality of fishing to be worse in 2000/01. These results are comparable to those reported for the 1996/97 season where only 16% of licence holders believed the quality of fishing to be worse compared to the season prior. By contrast, 33% of licence holders in 1997/98 considered the quality of fishing to be worse than in 1996/97 (a response that was no doubt linked to the marked drop in pot catch rates between 1996/97 and 1997/98 – refer section 3.6).

Of the respondents who considered the quality of fishing to be better in 2000/01, the majority stated they had caught more lobster (54%), including a proportion who considered that catch rates had improved. A further 13% of diarists stated that they had caught larger lobster than in the preceding season. Diarists also reasoned that fishing in different areas (16%) and that the impacts of management controls (10%) had contributed to a better quality of fishing in 2000/01.

Of the respondents who considered the quality of fishing to be worse in 2000/01, the majority stated they had caught fewer lobster (52%), including a proportion who considered catch rates to have declined. A further 10% of diarists stated they had caught smaller lobster than in the preceding season. Diarists also reasoned that the impacts of commercial fishing on the availability of lobsters (27%) and unsettled weather (10%) had contributed to poorer fishing in 2000/01, compared with the 1999/00 season.

Over 80% of respondents considered that they had spent less or about the same amount of time fishing for rock lobster in 2000/01 compared to the preceding season. Only 16% considered that they had fished more in the 2000/01 season.

Table 9. Diarists' opinions on the quality and time spent rock lobster fishing in the 2000/01 season compared to 1999/2000.

SE standard error		
Response	%	SE
<i>Quality of rock lobster fishing in 2000/01 compared to the previous season</i>		
Better	22.0	2.5
Worse	17.3	2.3
About the same	49.8	3.0
Unsure	10.8	1.8
<i>Amount of time rock lobster fishing during 2000/01 compared to the previous season</i>		
More	15.7	2.1
Less	56.2	2.9
About the same	27.4	2.6
Unsure	0.7	0.5

3.7.2 General comments

Respondents were also invited to make general comments about the recreational rock lobster fishery in Tasmania and the current survey. Of the 37% of diarists who commented on the recreational rock lobster fishery, almost a third expressed general satisfaction with the fishery's management and regulations (Table 11), as opposed to 6% who expressed dissatisfaction with these arrangements. A further 20% suggested changes to existing regulations, with the majority of proposals relating to restrictions to be placed on the use of dive collection methods. Other general suggestions related to the full closure of the fishery at the end of April and increases to the daily bag limit. Diarists were also concerned about insufficient policing and enforcement (9.3%), the impact of commercial fishing on the availability of rock lobster in inshore waters (8%) and the costs associated with rock lobster fishing, including licence fees (5%). A small proportion (6%) of respondents called for an increase in the number of designated recreational fishing only areas, specifically in sheltered inshore waters.

Table 10. Diarists' comments on recreational rock lobster fishing, 2000/01.

SE standard error		
Response	%	SE
<i>General comments about recreational rock lobster fishing</i>		
Satisfaction with management/regulation	31.4	4.3
Dissatisfaction with management/regulation	5.9	2.2
Suggested changes to regulations - general	10.2	2.8
Suggested changes to regulations - dive	9.3	2.7
Insufficient policing and enforcement	9.3	2.7
Commercial fishing impacts	7.6	2.4
Recreational fishing only areas	5.9	2.2
Costs of rock lobster fishing	5.1	2.0
Other	15.3	3.3

Of the 21% of diarists who commented on the current survey, the overwhelming majority (98.5%) indicated their satisfaction with the survey (Table 12). Positive comments included "the survey is a good idea", "happy to participate in the survey" and "the survey should be done on a regular basis". The only dissatisfaction (1.5%) expressed related to the length of the survey.

3.8 Future survey options

An objective of this study was to evaluate options for the on-going assessment of the recreational fishery. Underpinning this evaluation is the basic premise that the telephone/diary survey methodology as applied in this survey provides an accurate description of the fishery in terms of effort and harvest, regionally and seasonally. In evaluating survey options, consideration has been given to the relationships between sample size, precision and survey costs, and to the application of an alternative approach of using a telephone survey to collect retrospective information about fishing at the end of the season.

3.8.1 Sample size

The relationships between diary sample size (i.e. fully responding and licensed diary survey respondents) and estimates of mean harvest and precision (expressed as relative standard error or RSE) are presented in Fig. 21. The seasonal harvest (per diarist) estimator started to stabilise at sample sizes of greater than 250 diarists, though there were continued improvements in RSE with the sample sizes of over 250 diarists. Based on the actual sample of 325 diarists, the mean harvest per diarist was 10.47 lobster, with an RSE of 7.6%.

By considering the actual response profile and survey costs, including both fixed (i.e. questionnaire development, interviewer training) and field costs (i.e. interviewer fees, diary printing, telephone and postage expenses), a reduction in the number of diarists to 300 would have provided a cost saving of just 7%. This would, however, have resulted in an increase in the RSE to 7.9%. Similarly, while a sample of 250 diarists would have saved 20% of the survey costs RSE would have increased to 8.64%. From a cost benefit perspective (considering the relative cost savings of smaller sample sizes and associated impacts on estimate precision), a reduction in the diary survey sample size below about 300 respondents (equivalent to a screening sample of 510 licence holders) would be difficult to justify.

Alternatively, significant cost savings could be achieved, with minimal impact on data precision, by maintaining sample size but limiting data collection to the period of the most intense fishing activity. For rock lobster, this is clearly the period from the opening of the season in November to the end of April (refer Fig. 12). This six month period alone accounted for well over 90% of the total effort and harvest. Had the current survey been terminated at the end of April, there would have been an overall cost saving of over 25% of the fixed and field costs. By this approach only limited fishery information would be lost, however, uncertainty would remain when making comparisons between fishing seasons, should there be significant shifts in fishing patterns between years.

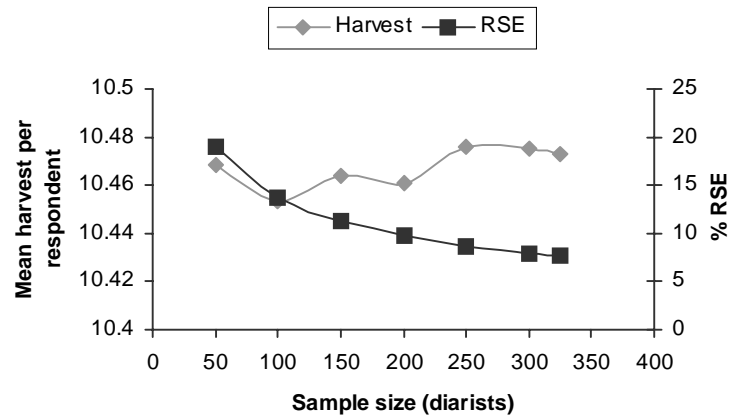


Fig. 21. Relationship between sample size and estimates of mean seasonal harvest and relative standard error.

The above analysis of the relationship between sample size and precision relates to statewide estimates. As for any sampling based survey, disaggregation of the data, for instance spatially, temporally or by method, will result in reduced precision in parameter estimation at the disaggregated level. In the context of the rock lobster fishery this is evident in terms of the size of the 95% confidence limit ranges relative to regional estimates of effort and harvest (refer Table 5). Improvements in precision can be achieved through increased sample sizes, possibly in conjunction with stratified sampling to increase the relative sample take in regions of greatest interest. While beyond the scope of this project, this is an issue for future consideration in developing a strategy for on-going assessments.

3.8.2 Recall survey option

Rock lobster effort, harvest and harvest rates derived from diary and recall surveys are presented in Table 9. The effect of applying a single rather than monthly expansion approach to the analysis of the diary data (refer to section 2.4) resulted in an 8% increase in effort and harvest estimates. This is a consequence of fact that the single expansion effectively gives too much ‘weight’ to those fishers licensed early in the season (noting the progressive uptake of licences through the season).

Recall estimates of effort and harvest were significantly higher than those for the diary survey, with recall effort and harvest estimates exceeding diary (single expansion) totals by factors of 1.5 and 1.6 times, respectively. Recall based effort in 2000/01 was almost 170,000 fisher days compared with around 109,000 days for the diary survey. Similarly, recall based harvest was around 225,000 rock lobster, contrasting with 138,000 lobster for the diary survey. By contrast, derived harvest rate estimates for diary and recall surveys were very consistent, at around 1.3 lobster per day.

Lyle (2000) also demonstrated that recall surveys produced significantly higher estimates, by factors similar to those determined in the present analysis.

Table 11. Recreational rock lobster effort, harvest and harvest rates based on diary (monthly and single expansion factors applied) and recall surveys, 2000/01.
(values in parentheses represent the 95% confidence limit)

	Diary1 (monthly expansion)	Diary2 (single expansion)	Recall (single expansion)	Ratio Recall/Diary2
Effort (no. fisher days)	100866 (88507 - 113923)	108689 (95284 - 122776)	167564 (146291 - 189775)	1.54
Harvest (no.)	128219 (109519 - 148266)	138366 (118255 - 159905)	224894 (188827 - 263351)	1.62
Harvest rate (no. per fisher day)	1.27	1.27	1.34	1.05

Considering effort and harvest estimates for individual fishers, it is evident that overall, recall survey respondents overestimated both the number of days fished and the number of rock lobster harvested for the season (Figs. 22 and 23). On average, recall respondents reported fishing 12.7 days during the 2000/01 season, compared with 8.5 days for diary respondents. While recall and diary survey estimates of effort differed, the proportion of survey respondents who did not fish at all during 2000/01 was consistent at 13% for the two survey methods. Proportionally more diarists fished for fewer than 5 days than indicated by recall respondents. Conversely, more recall respondents reported fishing between 11 and 30 days than did diarists.

Recall respondents reported harvesting an average of 17.0 rock lobster for the season, compared to just 10.5 lobster caught and kept by diary respondents, though there was general similarity between surveys in the proportion of respondents who reported no harvest (around 24%). Proportionally, over double the number of recall respondents reported very large catches (> 40 lobster) compared to diarists, with this group exerting a large influence on the overall mean harvest estimates.

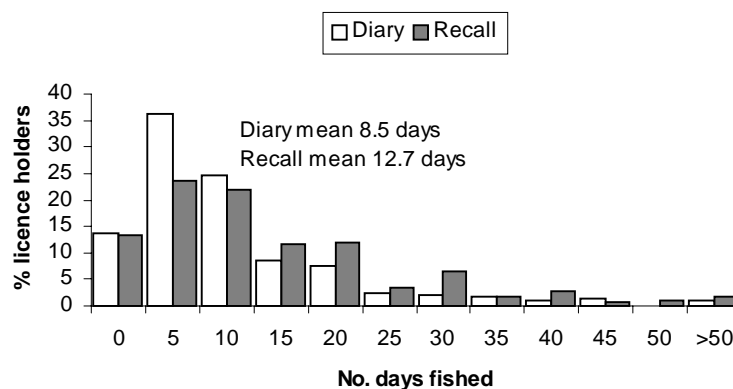


Fig. 22. Relative distribution of seasonal recreational rock lobster effort (by class interval) for diary and recall surveys, 2000/01.

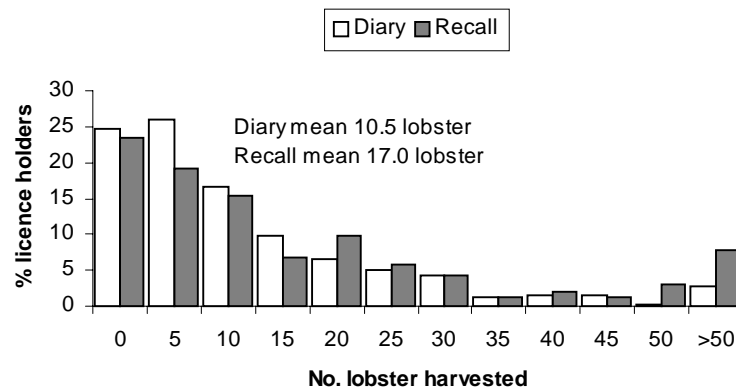


Fig. 23. Relative distribution of seasonal recreational rock lobster harvest (by class interval) for diary and recall surveys, 2000/01.

Recall surveys, whilst relatively cheap to administer (in this instance approximately 15% of the cost of the diary survey fixed and field costs), provide unreliable and biased catch and effort information, and therefore are not recommended to provide quantitative assessments of recreational effort or harvest. However, there may be value in the application of recall bias adjustment factors to estimates of effort and harvest to better reflect actual levels within the fishery. Such an approach would require further comparative assessments to determine the stability, or otherwise, of adjustment factors. Without such validation, adjustments could result in misleading conclusions being made about the status of the fishery.

4 Conclusions and Recommendations

4.1 Key findings

The following points comprise a summary of the survey's key results, presented and discussed in previous sections of the report.

4.1.1 Recreational licensing

- Since 1995/96 the number of recreational rock lobster licence holders has risen by 55%, from 8,554 to 13,265 persons in the 2000/01 licensing year.

4.1.2 Recreational effort and harvest

- An estimated 86.5% of all rock lobster licence holders (equivalent to 11,408 licensees) did some fishing for rock lobster during the 2000/01 season.
- Total recreational fishing effort in 2000/01 was estimated at almost 101,000 fisher days, yielding an estimated harvest of around 128,000 lobsters.
- Almost four times as many days were spent using rock lobster pots (80,600 days) than diving (21,500 days).
- 55% of the total harvest (70,000 rock lobster) was taken by pot, 44% by diving methods (56,000 lobster) and 1% by rings (1,500 lobster).
- Mean daily harvest rates were almost three times higher for divers (2.6 lobster) compared to pot fishers (0.9 lobster).
- On average, diarists fished for 8.5 days during 2000/01, harvesting a total of 10.5 rock lobster for the season.
- The strong impact of a relatively small proportion of licence holders was evident, with 80% of the effort and harvest accounted for by 40% and 33% of licence holders, respectively.
- Seasonally, the recreational fishery exhibited three distinct phases of activity: an initial phase of intense activity early in the season (Nov to Jan) that accounted for 70% of the total effort and harvest; a period of intermediate fishing activity (Feb to Apr) that contributed 23%; and then finally, a phase of low activity (May to Aug) that accounted for 7% of the season's total.
- The recreational fishery was centred primarily off the east coast and in particular the southeast. The southeast coast alone contributed 47% of the total effort and 45% of the recreational harvest.
- Regional differences were evident in the proportion of rock lobster harvested by method. The harvest of rock lobster on the north coast was principally by dive collection methods (70% of the harvest), whereas rock lobster pots accounted for the majority of the harvest on the east and southeast coasts (67% and 60% respectively). On the west coast, there was a greater balance between pot and dive methods (48% and 46% of the harvest respectively), with a small proportion of the harvest (6%) taken by rings.
- In total, over 140,000 rock lobster were estimated to have been released during 2000/01, equivalent to 1.1 rock lobster for every one retained.

- Between November and April, 96% of the pot releases were under the legal minimum size. In the latter part of the season (May to August) berried females and the closure of the fishery to females were also significant reasons for release, comprising 45% of the released lobsters.
- Almost 80% of the total rock lobster pot harvest (about 55,900 rock lobster) and 60% of the dive harvest (about 33,600 lobster) was accounted for during the first three months of the season. By the end of April, 95% of the pot and 91% of the dive harvest was taken.
- The distribution of daily harvests differed between rock lobster pot and dive methods, with just 50% of pot days resulting in a retained catch of at least one rock lobster, compared to 80% for dive.
- Of the dive methods, surface air was the most effective, with one or more rock lobster harvested on 87% of dive days, compared with 77% for snorkel and 72% for scuba.

4.1.3 Comparison with previous assessments

- Recreational harvests for December to April were compared for the 1996/97, 1997/98 and 2000/01 seasons, with the 2000/01 estimate of about 89,800 lobster comparable to that in 1996/97 (86,600 lobster) but substantially higher than in 1997/98 (57,700 lobster).
- In the 1996/97 and 1997/98 seasons pots accounted for around 64% of the recreational harvest, with divers taking between 32-34%. In 2000/01, pots represented 55% of the harvest and dive harvest had increased to 44%. The primary factor contributing to this shift has been a proportional increase in dive effort, though variation in dive and pot catch rates between seasons have also been factors.

4.1.4 Comparison with commercial fishery

- Around 1,350 tonnes or nearly 1.6 million rock lobster were harvested by the commercial sector between November 2000 and August 2001. When combined with the recreational harvest, The recreational share of the combined State harvest was 7.4% based on numbers.
- Regionally, the recreational share of the harvest was highest on the southeast coast, accounting for 23% of the region's total.
- If commercial catches from waters less than 18 metres were considered, then the recreational share of the 'shallow water' harvest was more significant, representing 19% of the total for the State.
- Regionally, the recreational share of the shallow water harvest was highest on the southeast coast where it was only slightly lower than that taken by the commercial sector.
- Comparisons between recreational and commercial fishing activity in shallow water (for the period December to April) indicate that commercial harvest rates were consistently higher, by a factor of 1.1 in 1996/97, 1.2 in 1997/98 and 1.3 in 2000/01.

4.1.5 Attitudes of licence holders

- Over two thirds of diary respondents considered the quality of the recreational rock lobster fishery to be about the same or better in 2000/01 compared to the 1999/00 season.
- The large majority of diarists considered that they had spent about the same time or less fishing for rock lobster in 2000/01 compared to the preceding season.
- Almost a third of diarists who commented on the rock lobster fishery expressed their satisfaction with the fishery's management and regulation.
- The overwhelming majority of diarists who commented on the survey expressed their satisfaction with the survey.

4.1.6 Future survey options

- An investigation of the relationships between final diary sample size and estimates of mean harvest and precision (expressed as relative standard error) showed that the seasonal harvest (per diarist) estimator began to stabilise at sample sizes of greater than 250 diarists. In addition, there were continued improvements in RSE with the larger sample sizes. For the actual sample of 325 diarists, the mean harvest per diarist was 10.47 lobster, with an RSE of 7.6%.
- Based on the current response profile and survey costs, a reduction in the number of diarists to 300 would have provided a cost saving of just 7% but would have resulted in an increase in RSE to 7.9%. Similarly, a sample of 250 diarists would have saved 20% of the survey costs but would have increased RSE to 8.6%.
- Substantial cost savings may be achieved by part season surveys, covering the period of most intense fishing activity between November and April, without necessarily compromising precision. This period accounted for over 90% of the total effort and harvest in 2000/01 and, had the current survey been terminated at the end of April, there would have been an overall cost saving of over 25%.
- Recall estimates of effort and harvest were significantly higher than those for the diary survey, with recall effort and harvest estimates exceeding diary (single expansion) totals by factors of 1.5 and 1.6 times, respectively.
- Recall survey costs were less than 15%, based on similar sample sizes to the diary survey, but survey estimates were considered unreliable.

4.2 Recommendations for future assessment

An objective of this study was to evaluate options for the on-going assessment of the recreational rock lobster fishery. In considering such options, the questions of estimate precision and scale of reporting, e.g. statewide as opposed to regional, need to be addressed so that judgements about the trade-offs between sample size and survey costs can be made. Furthermore, the frequency of any such surveys (whether annual, biennial, or less frequent) needs to be considered in the light of requirements for quantitative information for stock assessment and monitoring of fishery performance indicators, as well as the availability of research funds.

In the absence of clear direction in relation to the above, the following points comprise the conclusions and recommendations made with regard to future assessment options.

- There is not a consistent relationship between recreational and commercial (shallow water) pot harvest rates and therefore the use of commercial data in conjunction with recreational licensing information would be unreliable as a proxy for trends in recreational harvest or effort.
- Telephone recall surveys are not recommended for quantitative assessments of the recreational fishery. They are relatively cheap to administer, however, catch and effort information are unreliable and biased (significant overestimates).
 - There may be value in developing recall bias adjustment factors to apply to estimates of recreational effort and harvest. Such an option would require further comparative assessments to be undertaken to determine the stability, or otherwise, of adjustment factors.
- The efficacy of the telephone/diary survey as a cost-effective and reliable methodology to collect detailed state-wide information about the recreational rock lobster fishery has been established by this and earlier studies.
 - A screening sample size of about 500-550 licence holders would appear to be adequate to produce statewide mean harvest estimates with precision levels of less than 8%.
 - Significant cost savings could be achieved by part season surveys, covering the period of most intense fishing activity (i.e. November to April). Only limited fishery information would be lost by this approach but there would be a cost in the form of increased uncertainty when making comparisons between years through the use of part, rather than whole, season estimates.
 - In order to improve the precision of regional effort and harvest estimates, it would be necessary to increase sample sizes possibly in combination with stratified random sampling of the licence database. Any increases in sample size will impact directly on survey costs.
- Comparisons between the commercial and recreational sectors are complicated by the absence of size composition information for the recreational catch. There is an urgent need to determine the size selectivity of recreational fishing methods, in particular dive collection methods, to enable valid comparisons between the sectors based on catch weight, as well as numbers.

It is highly desirable that the methodology adopted for future surveys is standardised to ensure that any inter-seasonal variability in estimates can be attributed to changes in the fishery rather than confounded by the effects of methodological change.

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References

- ABS (1984) Household fish consumption and non-commercial fishing activities, Tasmania. Australian Bureau of Statistics, Hobart
- Cochran, W.G. (1977) *Sampling Techniques* (Third Edition). John Wiley & Sons, New York, 428p.
- Coleman, A.P.M. (1998) Fishcount: A survey of recreational fishing in the Northern Territory. NT Department of Primary Industry and Fisheries. Fishery Report No. 43.
- Gardner, C., Frusher, S., Eaton, L., Haddon, M. and Mackinnon, C. (2002) Tasmanian rock lobster fishery 2000/2001. Tasmanian Aquaculture and Fisheries Institute Fishery Assessment Report. Tasmania, Australia.
- Haddon, M. (2001) *Modelling and Quantitative Methods in Fisheries*. Chapman and Hall/CRC, Florida, 406p.
- Lyle, J.M. (2000) Assessment of the licensed recreational fishery of Tasmania (Phase 2). TAFI Final Report to FRDC, Project 1996/161.
- Lyle, J.M., Coleman, A.P.M., West, L., Campbell, D. and G.W. Henry (2002) New large-scale survey methods for evaluating sport fisheries. pp207-226. In *Recreational Fisheries: Ecological, Economic and Social Evaluation*. Ed T.J. Pitcher & C.E. Hollingsworth, Blackwell Science.
- Lyle, J.M. and Smith, J.T. (1998) Pilot survey of licensed recreational sea fishing in Tasmania - 1995/96. Marine Research Laboratories Technical Report 51.
- McGlennon, D. (1999) Survey of the licensed recreational rock lobster fishery in South Australia 1998/99. South Australian Research and Development Institute. Final Report.