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Amateur harvest estimates for scallop and rock lobster fisheries from the eastern Coromandel, New Zealand 2007–08

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This report provides the results of a pilot study to assess the feasibility of estimating the amateur harvest in the main part of the Coromandel scallop fishery (SCA CS) and the rock lobster fishery from Cape Colville to Hot Water Beach.

The survey was conducted during the peak of the scallop season, 1 December 2007 to 28 February 2008, a period of 90 days. The survey was stratified by day type (weekdays versus weekend/holidays) with a higher proportion of weekend and holiday days being sampled. Harvest and effort information were collected by interviewing returning fishers at 15 boat access points between Port Charles and Hahei Beach on 16 survey days. We determined the observed harvest for each survey day at each ramp and scaled this up to the total number of harvesters at that ramp, which includes boat parties not interviewed and those that refused to be interviewed. The mean catch per day within each stratum was scaled up by the number of days in each stratum for the survey period.

The survey covered 6017 boat trips and 12 646 people returning to access points. Overall 12.3% of boat trips were not intercepted. These consisted of boat trailers remaining in the car park at the end of the session (7%), boats that were missed by interviewers while they were busy with other work (4.7%), and boat parties that refused to be interviewed (0.6%).

Most (78.7%) boat trips involved some fishing activity for finfish or shellfish. Only 21.3% of interviewees stated they were not fishing on that trip. Of the boats fishing, 17% targeted or caught scallops and 14.4% targeted or caught rock lobster. Within these proportions 5% targeted both rock lobster and scallops. For trips targeting scallops or rock lobster the mean harvest per boat was 54 scallops or three rock lobster. Just over 25% of trips that targeted rock lobster caught or kept no rock lobster.

The total estimated harvest during the survey period was 203 100 scallops (CV 19.4%) with an estimated green weight harvested by amateur fishers of 23.6 t. This equates to 2.8 t meat weight. The total estimated harvest during the survey period was 10 653 rock lobster (CV 21.4%) with an estimated green weight harvested by amateur fishers of 7.3 t

We discuss potential improvements to the survey method for these species in this area and how it could be scaled up for these or other species. A balance is required between collecting all the information that could be useful and keeping the interview on busy ramps short and relevant. This survey was specifically targeted at scallops or rock lobster. If fishers had not targeted or caught these species the interview was terminated having taken less than a minute.

The use of a roving interviewer to collect data from secondary access points and help supervise stationary interviewers worked well. This hybrid technique could be used in scaling up the survey in a cost efficient way. The key elements of any future surveys of CRA 2 and SCA CS amateur harvest include design, planning and delivery issues.

The key design issues are to identify the main and secondary access points for fishers targeting these species and what information is required for harvest and HPUE estimates. It is better to focus on a few key questions, aligned to the survey objectives. Where possible, existing data should be used to optimise the number of survey days and the temporal stratification. A review of offsite survey data will identify the contribution of fishing methods that the survey will miss and how these may be adjusted for in the final harvest estimates.

The key planning issues include keeping travel times for roving interviewers down and how to get coverage of access points in remote areas. Knowledge of boat movement patterns and any local boating or fishing restrictions is important.

The key delivery issues are finding reliable interviewers and providing good training and supervision. Minimising respondent burden helps interviewers collect quality data and keeps interviewees engaged. Providing timely feedback to all involved is important.

1. INTRODUCTION

The Coromandel scallop fishery is highly valued by commercial, amateur and customary fishers. The north eastern Coromandel is a popular holiday designation within a few hours' drive of major cities such as Auckland, Hamilton and Tauranga. The SCA CS quota management area occupies the area from Cape Rodney in the Hauraki Gulf to Town Point in the Bay of Plenty (Figure 1). SCA CS management provides for an in-season TAC increase, based on the result of a pre-season survey. The 2007 pre-season survey estimated a Current Annual Yield (CAY) of 348 t (Williams 2008). Following consultation, the Minister set the TAC at 165 t, consisting of an ACE increase from 22 t to 108 t meatweight, an increase in the allowance for other sources of fishing-related mortality from 11 t to 37 t meatweight, and increases in the allowances for amateur and customary Maori fishing from 7.5 t to 10 t meatweight each (SCA CS Final Advice Paper, Ministry of Fisheries 2007). The actual commercial landing for 2007–08 was 59.3 t meatweight for the SCA CS area (Ministry of Fisheries 2010).

The recreational fishery is managed by minimum size limit (100 mm), daily bag limits (20 scallops per person) and a restricted season (September to March inclusive) (Ministry of Fisheries 2010). Diving (SCUBA and free diving) is the primary harvest method but there is also an amateur dredge fishery. Hand gathering of scallops can occur in some harbours (e.g. Tauranga) and on open beaches following severe storm events (e.g. Kuaotunu Beach).

Most existing information on amateur scallop harvest comes from off-site surveys (Table 1). However a review by the Marine Recreational Fisheries Technical Working Group of the methodologies used for these surveys concluded that the total harvest estimates may be inaccurate and the estimates should be treated as unreliable (Ministry of Fisheries 2010). The surveys do however reveal that historically most amateur fishing occurred in December and January (Table 2).

The rock lobster quota management area CRA 2 includes the area between Bream Tail and East Cape. The amateur fishery is managed by minimum legal size (tail width male 54 mm, female 60 mm), daily bag limits (6 rock lobster per person) and a prohibition on taking soft shell rock lobsters or rock lobsters with eggs (Ministry of Fisheries Science Group 2009). Diving (SCUBA and free diving) and potting are the primary harvest methods.

Off-site survey estimates of CRA 2 catch have ranged from 82 t to 241 t in 2001 (Table 1). A high of proportion trips targeting scallop and rock lobster are made using boats. An estimate of the CRA 2 amateur harvest based on the ratio of snapper to rock lobster seen during boat ramp interviews and the total snapper harvest from aerial overflight was attempted in 2005. The result was a 30 t estimate for CRA 2 (Hartill 2007). As with the scallop estimates the accuracy of these survey harvest estimates is uncertain.

The overall objective for this research was to conduct a pilot study to assess the feasibility of estimating the amateur harvest in the main part of the scallop and rock lobster fishery from Cape Colville to Hot Water Beach during the peak season. The research sought to:

- estimate the amateur scallop harvest from the main bed (Whitianga) in the Coromandel scallop fishery for the 2007/08 scallop fishing season,
- obtain detailed capture location information to determine the amount of the amateur scallop harvest taken inside and outside the areas closed to commercial scallop fishing,
- estimate the amateur harvest of rock lobster taken over the same period for the area from Cape Colville to Hot Water Beach.

2. METHODS

2.1 Sampling approach

The sampling methodology is based on an access point survey with a spatio-temporal sampling frame (Pollock et al. 1994). Harvest and effort information was collected by interviewing returning fishers at 15 boat access points between Port Charles and Hahei Beach (Figure 2). Harvest estimates were only for boat based fishers.

The survey was conducted during the peak of the summer season, 1 December 2007 to 28 February 2008 (90 days). Fishing effort is usually higher on weekends and holidays than week days. Survey days were stratified by type (weekdays versus weekend/holidays) to improve estimate precision. Because many fishers were likely to be on holiday over the Christmas to New Year period the four midweek survey days from the 22nd of December to the 31st of December 2007 were categorised as holidays. Therefore there were 54 weekdays and 36 weekend/holidays available to be surveyed in the three month period.

Survey days were selected at random from the available days in each stratum. The survey effort has approximately double the weight for the weekend/holiday days as the midweek days. This weighting was not based on data but rather our experience that there is greater effort and harvest on weekends and holidays and greater variability between these days. The number of days in the three month survey period per strata and the sampling fractions are given in Table 3.

Five of the ramps in the southern section of the survey area (Hot Water Beach to Whangapoua) had dawn to dusk interviewer coverage provided by two interviewers each working a seven hour shift to provide a total survey of 14 hours per day. At Kuaotunu, during the peak holiday period, a third interviewer was employed to ensure coverage of all returning boats. Because most boats returned to the marina after midday, interviewers at the Whitianga marina worked from 14:00 to 21:00 hrs. Three access points were deemed to be tidal and had one interviewer, so session times (7 hours total) were adjusted to maximise the intercept of returning boats around the time period either side of local high tide. Harvest estimates were scaled up for vessels not interviewed during the survey sessions and at ramps for empty boat trailers at the end of the day (see below). No other adjustment was made to harvest estimates for the hours not included during the survey day at the marina and tidal ramps.

Six access points were covered by a roving interviewer in the remote north eastern Coromandel Peninsular from Port Charles to Kennedy Bay using a bus route survey (Pollock et al. 1994). Wait times at each launch site were pre-set by the principal investigator and provided to the interviewer. Longer wait times were set where more effort was likely. The start time and direction of travel on the route were selected at random for a single seven hour survey session each day. Total effort for the day was estimated using the direct expansion method to expand effort from fisher interviews (Pollock et al. 1994), see below.

2.2 Interview information collected

Each vessel on returning to the ramp was allocated a number. Interviewers recorded whether people had been fishing that trip, and if so recorded the target species and how many people had been on board. Interviewers then asked the fishers whether they had caught scallops or rock lobster. The following information was recorded on hard copy paper record (see Appendix 2).

For all vessels:

- Intercept code (interviewed, not interviewed, refused)
- Did they fish this trip
- Target species
- Type of boat
- Number of fishers
- Time of return to ramp or marina.

For scallop vessels:

- Fishing method (SCUBA, snorkel, dredge)
- Number of SCUBA tanks used
- Time started fishing for scallops
- Time finished fishing for scallops
- Total time fishing for scallops
- Area fished
- Was it in an area closed to commercial scallop fishing (interviewers provided maps of the closed areas to assist fishers' responses)?
- Number of scallops kept
- Estimate of the number of undersized scallops returned
- Length frequency of scallops harvested (a 20 to 30 sub-sample per vessel).

For Rock lobster vessels:

- Fishing method (SCUBA, snorkel, potting)
- Number of SCUBA tanks used
- Number of pots hauled
- Time started fishing for rock lobster
- Time finished fishing for rock lobster
- Total time fishing for rock lobster
- Area fished
- Number of rock lobster kept
- Estimate of the number of undersize rock lobster returned
- Tail width and sex of each rock lobster.

In addition to interview data the following information were collected on each ramp sampling day:

- Weather conditions
- Number of trailers parked at the start of the survey day and number of trailers at ramp at end of the survey day
- In addition to the interviewers allocated to each ramp, a roving interviewer covered all the trailer boat access points starting at a random boat ramp then moving in a random direction on a morning or afternoon circuit. The number of trailers at each ramp was counted and any fishers on the ramp interviewed. This included all the ramps with interviewers assigned. The roving interviewer also assisted with communication and quality control of boat ramp surveyors.

2.3 Estimating total harvest

Main ramps and Marinas

We interview most groups of fishers returning via these access points and count the groups that are not interviewed (M) or refuse (R). We also count the number of trailers left at the end of the survey session (B). Combined, this gives an estimate of total effort for each site. For sample day *j* in a stratum let:

B_{ij}	Boat trailers in the car park at the end of day *j* at the *i*th site
C_{ij}	Total harvest of all interviewed boat trip groups at the *i*th site on day *j*
D_j	Total harvest for all sites on day *j*
D_m	Mean daily harvest in the stratum
H	Total harvest
I_{ij}	Boat trip groups interviewed at the *i*th site on day *j*
M_{ij}	Boat trip groups not interviewed (missed) at the *i*th site on day *j*
n	Number of sampled days
N	Total number of days in the stratum
R_{ij}	Boat trip groups who refused to be interviewed at the *i*th site on day *j*

The total harvest for within each ramp type stratum on day *j* is the mean harvest per trip for each site (C_{ij}/I_{ij}) from interviewed boats scaled up by multiplying by the sum of all interviewed and non-interviewed trips at that site ($I_{ij}+ M_{ij}+ R_{ij}+ B_{ij}$) and then summed over sites

$$D_j = \sum_i (C_{ij}/I_{ij})(I_{ij}+ M_{ij}+ R_{ij}+ B_{ij}) \quad (1)$$

Within each stratum the estimated mean daily harvest D_m is

$$D_m = \sum D_j/n \quad (2)$$

and the estimated daily variance is $\mathrm{Var}(D) = \sum_j (D_j - D_m)^2/(n - 1)$, where n is the number of sampled days. Then the estimated variance of the mean harvest within each stratum is

$$\mathrm{Var}(D_m) = (\mathrm{Var}(D)/\sqrt{n})\sqrt{(1 - n/N)} \quad (3)$$

where N is the total number of fishing days in the stratum, and 1 – n/N is the finite population correction that takes into account the fraction of the fishing days that are sampled (Manly 2009, section 2.3). It follows that the estimated total harvest in the whole stratum is $H = N.D_m$, with estimated variance

$$\mathrm{Var}(H) = N^2\, \mathrm{Var}(D_m) \quad (4)$$

and standard error $\mathrm{SE}(H) = \sqrt{\mathrm{Var}(H)}$.

For all strata combined the estimated total harvest will be the sum of the estimated harvest for the individual strata. The variance of this sum will be the sum of the individual strata variances, and the standard error of the estimated total harvest will be the square root of the variance. Similarly, the estimated harvest for all main ramps and marinas combined is the sum of the results for all of the strata, with the variance of a total being the sum of the variances for the components of the total.

Estimating Total Harvest - bus route direct expansion

Rather than use the sum of the trip duration in the effort term (e_i) we use the sum of the number of trips at each ramp because the number of scallops or rock lobster kept is often determined by the bag limit rather than time on the water. The following definitions are used for the bus route with m ramps:

E_j	Total estimated effort (trips) for the bus route on day *j*
D_j	Total estimated harvest for the bus route on day *j*
D_m	Mean estimated harvest per day
T_j	Length of the fishing day in minutes on day *j*
e_{ij}	Observed fishing effort (trips) for the *i*th ramp on day *j*
C_{ij}	Total observed harvest for the *i*th ramp on day *j*
w_{ij}	is the observation (wait) time in minutes for the *i*th site on day *j*

At ramp *i* on day *j* in a stratum the total number of boat trips observed per minute is e_{ij}/w_{ij}. The estimated total number of trips for the whole of fishing day *j* at that ramp is therefore the length of the fishing day (in minutes) times the trips per minute $T_j\ e_{ij}/w_{ij}$ and the estimated total number of trips for all ramps for each bus route on that day is

$$E_j = T_j \sum_i (e_{ij}/w_{ij}), \qquad (5)$$

To estimate the total harvest on day *j* it can be noted that for all ramps combined the mean harvest per trip is $\sum C_{ij}/\sum e_{ij}$ on that day, where the summations are over the *m* ramps. This then provides an estimate of the total harvest for the bus route on day *j* by multiplying by the expanded total number of trips on day *j*, i.e.

$$D_j = E_j \sum C_{ij}/\sum e_{ij} \qquad (6)$$

The mean harvest per day, D_m, is the sum of harvest for the bus route on day *j* divided by the days sampled $\sum D_j/n$ within each stratum, with estimated variance of

$$\mathrm{Var}(D_m) = (\mathrm{Var}(D)/\sqrt{n})\sqrt{(1 - n/N)} \qquad (7)$$

where there are n observed days in the stratum, N is the total number of days in the stratum, and 1-n/N is the finite population correction. The standard error of the mean daily harvest is then $SE(D_m) = \sqrt{\mathrm{Var}(D_m)}$ while the estimated total harvest for the bus route for the N fishing days in the stratum is therefore $H = N.D_m$ with a variance given by

$$\mathrm{Var}(H) = N\ \mathrm{Var}(D_m) \qquad (8)$$

The total harvest for the bus route in all strata can also be estimated as the sum of the harvest H in the individual strata, with the variance of this sum estimated by the sum of the variances for the individual strata. Also the estimated total harvest for all bus routes either within a stratum or for the entire fishing season can be estimated by summing the totals from the different strata (as with the main ramps above), with the estimated variance of the total being the sum of the variances for the components of the total.

Mean weight calculation

Harvest estimates in number of fish are converted to total harvest weight by multiplying by mean weight estimates. The scallop length weight regression for the commercial Coromandel scallop fishery (Ministry of Fisheries 2010) was used to calculate the weight for each 1 mm size class and then multiplied by the number of measured scallops at each length. These were summed and divided by the number of measured scallops to get the mean weight.

Almost all rock lobster encountered were measured and sexed. Nine records of packhorse rock lobster were removed from the dataset. Separate length weight regressions for male and female fish for CRA 2 (Ministry of Fisheries 2010) were used to estimate the weights for each measured rock lobster by sex and the combined mean weight was calculated from all weights. It is assumed that the 6% of rock lobster that were not measured have the same mean weight as those that were.

3. RESULTS

3.1 Interviews

Access point surveys were conducted on 7 mid-week days and 9 days during weekends and holidays. A total of 5595 boat trips were observed at the access points covered and a further 422 unattended trailers were observed at the end of interview sessions (Table 4). Overall 12.3% of observed trips from ramps were not interviewed. These consisted of the trailer counts (7%), boats that were missed by interviewers while they were busy (4.7%), and boat parties that refused to be interviewed (0.6%) (Table 5). Possibly some of the boats missed were "soft refusals" by people who avoided the interviewer. Many of the ramps had over 130 vessel returns in a day with the busiest ramp being Cooks Beach estuary ramp with 177 boat returns in 14 hours ending at 2100 hours on 30 Dec 2007.

There was a slight difference between weekdays and weekend/holidays in the return times of boats from all access points. A larger proportion of boats returned in the early afternoon on weekends and holidays while a larger proportion of trips during week days returned after 1630 hours (Figure 3).

Most (78.7%) boat trips involved some fishing activity for finfish or shellfish. Only 21.3% of interviewed parties said they were not fishing on that trip. Of the vessels fishing, 17% targeted or caught scallops and 14.4% targeted or caught rock lobster. Within these proportions 5% targeted both surveyed species (Table 6). The majority (73.7%) of fishing trips were targeting other species such as snapper, gurnard or gamefish.

The survey includes 12 646 intercepts of people fishing from boats. Particularly busy access points were the Cooks Beach estuary ramp, the main Kuaotunu ramp and the main Whitianga ramp near the wharf. The numbers of people intercepted by date and access point are detailed in Table 7. By far the busiest weekend/holiday survey day was 30 January 2007 (2282 people) and the busiest mid-week survey day was 9 January 2008 (1064 people). These were also the days with the largest harvest of scallops and rock lobster.

3.2 Scallop numbers and size

Three times more scallops came over the Kuaotunu ramp than the access point with the next highest total, Opito Bay (Table 8). No scallops were intercepted in the bus route survey on the northern ramps.

The area around the Mercury Islands, and Home Bay on Great Mercury in particular, provided most of the scallops recorded. Seventy five percent of scallops recorded in the survey came from this area (coded MEI in Figure 2). The mean length of scallops from MEI (110.4 mm) is very similar to the mean length of scallops caught in all other areas (109.6 mm) and the length distributions were also visually very similar (Figure 4). A slightly higher proportion of lengths 98–104 mm came from all other areas while a higher proportion of scallops 113–120 mm came from the MEI area. A small proportion of scallops were under the minimum legal size (MLS) of 100 mm (2.3%). This could be due, at least in part, to measurement error by fishers or interviewers.

For boats interviewed that were targeting scallops, an average of 53.6 scallops per trip were kept. The number kept per boat tended to be in multiples of the bag limit, especially at 40, 60, and 80 per trip (Figure 5). Just over 6% of trips that targeted scallops kept none.

3.3 Rock lobster numbers and size

A total of 1900 rock lobster were measured during the survey. The access point with the most rock lobster landed was Hahei Beach, followed by Whitianga main ramp and Kuaotunu (Table 9). The Mercury Bay (MEB) and Mercury Islands (MEI, Figure 2) were the main areas from which captures were reported.

For the completed interviews almost all (96%) of rock lobster were measured and sexed. Slightly more males (56.7%) were encountered than females (43.3%). There is a different size limit for male and female rock lobster. The distribution of tail widths by sex is shown in Figure 6. Most of the largest (over 80 mm) rock lobster seen were males. A greater proportion of rock lobster 60–66 mm were female, while most rock lobster less than 60 mm were male. There were a number of rock lobster one or two millimeters less than the respective MLS (Figure 6). The total proportion undersize was 4.6%. These could be due, at least in part, to measurement error by fishers or interviewers.

For boats interviewed that were targeting rock lobster most had more than one diver aboard and an average of three rock lobster kept per boat per trip. The number kept per trip declines from 18% that kept one to 2.3% that kept 10 per boat per trip (Figure 7). Just over 25% of trips that targeted rock lobster kept none, or caught no rock lobster.

3.4 Scallop harvest estimate

The numbers of scallops harvested within the sampled area for the survey period of 90 days was estimated following the method in Section 2.3. It was estimated that a total of 203 100 scallops (CV 19.4%) were landed at the access points surveyed between 1 December 2007 and 28 February 2008 (Table 10). The average weight of scallops derived from the published length weight regression (Ministry of Fisheries 2010) and survey measurements was 116.4 g. Therefore, the estimated green weight of scallops harvested during the 90 day survey is 23.6 t (CV 19.4%) which converts to a meat weight of 2.8 t (Table 10).

3.5 Rock lobster harvest estimate

The numbers of rock lobster harvested by boat based methods within the survey area was estimated following the method in Section 2.3. It was estimated that a total of 10 653 rock lobster (CV 21.4%) were landed at the access points surveyed (Table 10). The average weight of rock lobster derived from the published tail width weight regression (Ministry of Fisheries 2010) and survey measurements was 513.5 g for females and 821.2 g for males. The estimated green weight of rock lobster harvested during the 90 day survey is therefore 7.3 t (21.4%).

3.6 Scallop HPUE

A subset of the SCUBA and dredge interviews (those with all data fields completed) were used to calculate HPUE for scallops. There was insufficient data (less than 5%) from free dive trips for a similar analysis. For some fishers a scallop dive was just part of the day's fishing which could be several hours long. Trips with scallop dives of longer than 90 minutes were excluded as these probably include other fishing methods. Data from 448 SCUBA trips and 78 dredge trips were used (Table 11). Mean harvest rates per SCUBA trip were about twice the scallop harvest per dredge trip both inside and outside the amateur only areas. Overall scallop harvest per SCUBA diver was 32.2 (s.e. 1.0) per hour while harvest per tank used was 40.7 (1.2). The mean scallop harvest per person dredge hour was 9.4 (0.9) (Table 12).

3.7 Rock Lobster HPUE

A subset of the interviews (those with all data fields completed) were used to calculate HPUE for rock lobster. Data from 389 trips targeting rock lobster and 206 trips fishing both scallops and rock lobster were used (Table 6). Overall harvest per trip was 3.2 (s.e. 0.04), and harvest per person dive hour was 1.4 (0.07) while harvest per tank was 1.5 (0.07) (Table 13). Scuba diver harvest of rock lobster was highest in the MEB and MEI areas (Figure2) which include the Mercury Islands, Mercury Bay and the coast to the south. Harvest rates per tank were highest on the northern coast between Port Charles and Whangapoua, followed by the MEB area.

4. DISCUSSION

The survey location on the east coast of the Coromandel Peninsula is a fairly discrete area, known to be popular with amateur fishers especially during the summer holiday period. The main scallop beds fished by amateur fishers in this area are relatively well defined, extending from the outer Mercury Bay to the Mercury Islands. In recent years the beds in Home Bay, on the sheltered south western side of Great Mercury Island (an area partially closed to commercial scallop dredging) have provided the best size and abundance of scallops. Boats crossing to Mercury Island have to be large enough to cross about 6 miles of relatively open water so tend to use the main launching ramps.

This pilot survey used a near complete census approach to recording harvest on sample days, covering all the main access points in the survey area. The 15 survey days were randomly selected from the two strata in the survey period, weekdays and weekend/public holidays.

In general we were able to interview most of the trailer vessels involved in the scallop and rock lobster fisheries on the north east coast of the Coromandel Peninsula. However, during the peak holiday period boat ramps and trailer parks reached saturation point, and some boats launched from secondary access points were not interviewed. A roving interviewer visited all main and secondary access sites using a random start point, random direction method and counted boat trailers. Trailer counts at secondary ramps were not used in these harvest estimates. The roving interviewer helped supervise staff on primary ramps.

A balance is required between collecting all the information that could be useful and keeping the interview on busy ramps short and relevant. Each group of people in a boat returning to access points was interviewed and asked if they had been fishing and what they had been targeting. They were also asked specifically if they had caught scallops or rock lobster during that trip. If they had not then the interview was terminated having taken less than a minute in total.

About 79% of boat trips surveyed involved some fishing. Of these about 26% targeted or caught scallops or rock lobster. It would not have been possible to get good coverage of all vessels with scallop or rock lobster if a full survey of all finfish was included in the interview.

There was a strong level of fisher support for the survey (based on the experiences of surveyors and the small number of fishers refusing to be surveyed). The direct interview approach has the additional benefit that fisheries management is seen to be operating and valuing harvester's advice.

The weather was generally fine and relatively calm over the peak holiday period in 2007–08. We estimate over 203 000 scallops and 10 650 rock lobster were harvested by boat based methods from this area. The scallop green weight harvest estimate of 23.6 t (CV 19.4%) during the survey period equates to 2.8 tonnes meat weight for the main three months of the six month season for amateur fishers. The rock lobster green weight harvest estimate is 7.3 t (CV 21.4%) during the survey period.

Harvest estimates for this survey were initially made by Matt Pawley (University of Auckland) but a hard drive failure made it difficult to replicate and document the method.

These initial estimates and bootstrapped variance were 205 425 scallops with a green weight of 23.9 t (CV 8.7%) and 10 615 rock lobster with a green weight of 7.3 t (CV 8.5%). These are very similar to the estimates above using the method in Section 2.3. The main difference is the CV which is much lower using the bootstrap of daily harvest totals from all ramps.

The survey is not a complete census of all boat effort and will underestimate total boat based harvest because:

- some secondary launch access points were not covered,
- vessels using private access points in the 'Whitianga Waterways' were not covered,
- some vessels may not have returned to the ramp at all (e.g. anchor off the beach) during periods of good weather,
- larger vessels from outside the area (e.g. Tairua, Whangamata, Tauranga) may have fished the area and left without coming through a surveyed access point.

In addition, no attempt was made to estimate scallop and rock lobster harvest from shore based fishers. Information from off-site surveys can provide information on the proportion of harvest from other methods. However, caution is required when using data from off-site surveys, such as the national telephone diary survey, for specialist fisheries in relatively small areas. The national diary survey in 1999–2000 had a reasonably large number of rock lobster (752) reported by diarists in CRA 2 (Boyd & Reilly 2002). Of these 6% were reported by shore based methods. In 2007–08 fishers reported that the scallop beds close to shore had few legal sized fish (Wally Leighton, Opito Bay. Pers. comm.).

The proportion of boat based scallop and rock lobster harvest missed in the survey area is likely to be higher than the 6% rock lobster land based estimate from 2000. We would estimate 10%. Therefore, there is the potential for the harvest estimate to be biased low by 15% to 20%. We also note that the survey period and days selected had an uncommonly good spell of fine, calm weather, particularly over the December and January holiday period. These estimates could well be higher than those from a typical summer.

We consider that the method as described in this report adequately describes a minimum estimate of the harvest of rock lobster and scallops within the survey area during the survey period.

4.1 Optimising the design for future Coromandel scallop and rock lobster surveys

The access point method using a near complete census of boat based harvest was a reasonable method for estimating the harvest of these two species. Based on the experience gained from this pilot survey, future surveys within this geographical area, should consider the following modifications to the survey design:

- Sampling should be extended to the whole harvest season for each fishery.
- In 2007–08 Whangapoua and Matarangi ramps in Whangapoua Harbour were only surveyed during the upper half (6–7 hours) of the tidal range. However experience showed that fishers were crossing the bar for greater than a 7 hour window – there should be full day coverage of the Whangapoua and Matarangi boat ramps for days when the harbour bar is open (deemed safe to cross).
- During the peak holiday period (Christmas to early January) interviewer coverage should occur on the third ramp (Robinson Road) in Whitianga as the other two ramps reach "saturation point".
- On weekends and peak holiday period two people should be assigned to cover the Whitianga marina. One person could be positioned at the marina entrance counting the entering vessels and directing the interviewer to the next vessel to be surveyed (as specified in the survey protocol). Two way communication (such as by handheld radio or SMS messaging) would be required.

- The use of some on-the-water interviews at the main dive sites could be used to determine the proportion of vessels with scallops or rock lobster fishers not returning to survey access points.
- It appears that actual dive or dredge effort was not well recorded. There may be opportunities to improve reliability and accuracy of this information. For example technology is now available for divers to provide exact SCUBA dive time where a dive computer is used. This could be requested if accurate HPUE is required.
- A repeat survey should provide a harvest estimate using comparable duration and coverage to this pilot survey as well as a full season estimate with expanded coverage.

4.2 Scaling up to a larger area

Our pilot survey covered part of the wider quota management area for scallops or rock lobster (SCA CS or CRA 2) for three months over summer. The method used in the pilot survey could be scaled up to cover the whole, or a much larger proportion, of the management area for scallops and rock lobster and the entire fishing year. Some relevant considerations on scaling up this type of survey are:

- The number of sites that can be fully covered by an access point survey will be limited by the cost considerations (particularly related to employing and managing interviewers).
- A combination of dawn to dusk coverage of the main access points for the species concerned and roving interviewers covering secondary access points would seem to be the most cost efficient methodology. There are also benefits (training, re-equipping, supervision) in having the roving interviewer talk to the stationary interviewers as they pass the main ramps and if visits coincide, to help out during peak activity periods.
- The survey approach and sampling frame may be most efficiently managed using a QMA wide sampling frame divided into a series of sub-regional units, clustering groups of ramps and interviewers. The size of these areas would depend on the number of access points and the level of precision required for the harvest estimates
- The survey should be extended to the whole fishing year for each species, but separate strata for winter and summer activity should be used.

4.3 Surveys for other species or other areas

The methodology used in this survey appears feasible for assessing the harvest of a range of species. Some advantages of the approach include the direct collection of data that does not rely on harvester recall days after the fishing event, that accurate information on the size of fish taken can be obtained, all fishing activity (e.g. rod and reel fishing, diving, dredging, etc.) from trailer boats and potentially in future locally berthing launches can be recorded, and the apparent willingness of fishers to participate (provided the interview does not fatigue the interviewee). A final advantage is that this type of access point survey may be used with other survey methods (such as large scale offsite surveys) to compare estimates from concurrent surveys.

Before applying the methodology to other species and/or areas we would suggest that a pilot survey be undertaken (particularly over the peak harvest season) before the main survey to determine the feasibility of the approach. In particular the pilot should assess the sampling design to be used in light of what is practical (from a resource management perspective) and the likely precision of the estimates required. The pilot should be designed, where possible, using a characterisation of the fishery by method, area, and access points.

For many species a dawn to dusk survey on the main access points would seem to be the most appropriate approach – with the coverage of secondary access points using roving interviewers and the bus route method (Pollock et al. 1994). This would allow harvest estimates from larger areas and would be most appropriate where catch is mostly taken from boats and access points are well defined.

Although the current pilot had the advantage of being relatively easy to administer by the interviewers, the level of training required may change according to the species or information to be collected. For example if HPUE collection is part of the objective, then additional interviewer training and follow-up may be needed to ensure that fishers give accurate effort estimates. Special care needs to be made during the pilot to assess the level of response burden and to minimise the potential for response fatigue.

4.4 Summary

The identified key elements of any future surveys of CRA 2 and SCA CS amateur harvest include design, planning and delivery issues.

The key design issues are to identify the main and secondary access points for fishers targeting these species and what information is required for harvest and HPUE estimates. It is better to focus on a few key questions, aligned to the survey objectives. Where possible, existing data should be used to optimise the number of survey days and the temporal stratification. A review of offsite survey data will identify the contribution of fishing methods that the survey will miss and how these may be adjusted for in the final harvest estimates.

The key planning issues include keeping travel times for roving interviewers down and finding a way to get coverage of access points in remote areas. Knowledge of boat movement patterns and any local boating or fishing restrictions is important.

The key delivery issues are finding reliable interviewers and providing good training and supervision. Minimising respondent burden helps interviewers collect quality data and keeps interviewees engaged. Providing timely feedback to all involved is important.

5. ACKNOWLEDGMENTS

This research was funded by Ministry for Primary Industries through project REC2007/11. We acknowledge with thanks the assistance of Matt Pawley and Brian Manly who assisted with calculating harvest estimates and CVs. Thanks to Tony Fox and Warren Harris for their local advice and support. The contribution of the boating public, charter vessel operators, and the many amateur fishers who agreed to have their harvest measured must be acknowledged as the project could not have been completed without their assistance. Interviewers at all the boat ramps, beaches and Whitianga marina made a particularly worthy contribution and their diligence and effort is appreciated. Many thanks to Neville Smith and the Marine Amateur Fisheries Working Group for providing their review and comments that helped to improve this paper.

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Table 1: Estimates of amateur scallop and rock lobster harvest from fisheries management areas that include Coromandel from national telephone diary surveys in 1993–94 1996, 1999–2000 and 2000–01.

	SCA CS scallops			CRA 2 rock lobster			
Survey Year	Number of scallops	CV (%)	Estimated green weight (t)	Number of rock lobster	CV (%)	Estimated green weight (t)	Reference
1993/94	626 000	14	60.0–70.0	133 000	29	82	Bradford (1997)
1996	614 000	12	62	233 000	10	138	Bradford (1998)
2000	257 000	101	30.1	324 000	26	236	Boyd and Reilly (2002)
2001	472 000	47	55.3	331 000	27	241	Boyd and Reilly (2004)

Table 2: Percentage of scallops caught by diarists in regional and national surveys by month from the Coromandel scallop fishery.

Month	Percentage
July	4.9%
August	4.1%
September	4.9%
October	9.9%
November	6.4%
December	22.3%
January	34.7%
February	11.1%
Unknown	1.7%

Data are summarised from the five large-scale fishing diary surveys: 1993–94, 1996, 1997, 1999–00, 2000–01. (Boyd and Reilly 2002, 2004, Bradford 1997, 1998)

Table 3: Sampling design survey days per strata.

Stratum	Total days	% of survey period	Surveyed days	Sampling fraction
Weekday	54	60%	7	0.13
Weekend/ Public Holiday	36	40%	9	0.25
Total	90	100%	16	0.18

Table 4: The number of boats intercepted by location type. Trailer only is the count of trailers at the end of the day.

	Ramp	Beach	Marina	Roving	Trailer only	Total
Number of Boats	3001	2248	265	81	422	6017
Proportion	0.499	0.374	0.044	0.013	0.070	

Table 5: The number of boats intercepted by interview outcome. Trailer only is the count of trailers at the end of the day.

	Interviewed		Not interviewed			
	Fishing	Not Fishing	Missed	Refused	Trailer only	Total
Number of Boats	4151	1124	281	39	422	6017
Proportion of total	0.690	0.187	0.047	0.006	0.070	
Proportion of interviewed	0.787	0.213				

Table 6: The number of boats interviewed with fishers who targeted or caught scallops or rock lobster.

	Scallop	Rock lobster	Scallop and rock lobster	Other species	Total
Number of boats fishing for	498	389	206	3058	4151
Proportion	0.120	0.094	0.050	0.737	1.000

Table 7: The number of people interviewed by ramp, day stratum (weekend/holiday or week day) and date.

Day type	Date	Cooks Beach estuary	Hahei main beach	Kuaotunu east	Matarangi estuary	Opito beach	Whangapoua ramp	Whitianga ramp & pontoon	Whitianga wharf ramp	Whitianga marina berths	Northern roving ramps	Total fishers
WE/Holiday	02-Dec-07		23	79					14	63	2	179
	15-Dec-07	39	9	72	18	54	6	32	5	16	3	251
	27-Dec-07	292	142	195	153	119	200	74	237	37	23	1 449
	30-Dec-07	402	240	387	283	130	221	106	434	79	27	2 282
	02-Jan-08	345	159	374	280	191	211	61	82	62	14	1 765
	06-Jan-08	247	146	202	95	124	66	97	361	118	12	1 456
	13-Jan-08	198	100	232	101	61	116	55	267	67	21	1 197
	27-Jan-08	260	6	331	89	103	84	55	148	64	29	1 140
	10-Feb-08	28	2	6	1	13		0	43	29		122
WE total		1 811	827	1 878	1 020	795	904	494	1 577	535	131	9 841
Week day	04-Dec-07		13	42	1		0	12	26	12	4	106
	21-Dec-07	12		26	10				13	0	2	61
	09-Jan-08	251	133	195	81	37	59	56	200	52	17	1 064
	18-Jan-08	109	43	87	11	31	27	7	96	16	9	427
	30-Jan-08	135	21	132		15	27	4	101	39	22	474
	07-Feb-08	36	2	67	2	16	9	3	38	7	6	180
	20-Feb-08	58		36	2	12	4	33	76	79	2	300
Week total		601	212	585	107	111	126	115	550	205	62	2 612
Total fishers		2 412	1 039	2 463	1 127	906	1 030	609	2 127	740	193	12 646

Table 8: The number of scallops landed by ramp, day stratum (weekend/holiday or week day) and date.

Day type	Date	Cooks Beach estuary	Hahei main beach	Kuaotunu east	Matarangi estuary	Opito beach	Whangapoua ramp	Whitianga ramp & pontoon	Whitianga wharf ramp	Whitianga marina berths	Northern roving ramps	Total SCA
WE/Holiday	02-Dec-07		100	621					80	520		1 321
	15-Dec-07	0	0	605	80	252	0	2	40	0		979
	27-Dec-07	404	221	1 380	258	551	398	294	482	60		4 048
	30-Dec-07	798	220	3 134	1 175	780	1 104	690	1 333	170		9 404
	02-Jan-08	501	60	1 967	1 139	336	626	530	47	200		5 406
	06-Jan-08	441	19	747	363	974	120	200	562	160		3 586
	13-Jan-08	499	260	1 023	256	407	360	160	638	189		3 792
	27-Jan-08	490	0	2 009	300	394	387	160	120	0		3 860
	10-Feb-08	0	0	0	40	0	0	0	40	120		200
WE total		3 133	880	11 486	3 611	3 694	2 995	2 036	3 342	1 419		32 596
Week day	04-Dec-07		0	167	0		0	60	60	140		427
	21-Dec-07	0		80	57				0	0		137
	09-Jan-08	241	160	1 238	204	310	120	120	194	500		3 087
	18-Jan-08	100	58	232	0	313	140	0	120	0		963
	30-Jan-08	22	0	560		100	74	0	104	55		915
	07-Feb-08	0	0	400	0	0	40	3	0	0		443
	20-Feb-08	205		27	0	0	0	0	0	0		232
Week total		568	218	2 704	261	723	374	183	478	695		6 204
Total SCA		3 701	1 098	14 190	3 872	4 417	3 369	2 219	3 820	2 114	0	38 800

Table 9: The number of rock lobster landed by ramp, day stratum (weekend/holiday or week day) and date

Day type	Date	Cooks Beach estuary	Hahei main beach	Kuaotunu east	Matarangi estuary	Opito beach	Whangapoua ramp	Whitianga ramp & pontoon	Whitianga wharf ramp	Whitianga marina berths	Northern roving ramps	Total CRA
WE/Holiday	02-Dec-07		25	32					11	2		70
	15-Dec-07	0	10	12	0	7	0	1	0	0		30
	27-Dec-07	37	62	24	42	44	34	6	77	4	5	330
	30-Dec-07	41	90	68	39	69	23	30	82	35	5	477
	02-Jan-08	46	38	43	32	57	10	15	8	7	1	256
	06-Jan-08	20	20	13	25	16	1	14	20	1	3	130
	13-Jan-08	14	16	40	3	10	8	15	36	13	0	155
	27-Jan-08	14	1	33	8	5	1	8	5	0		75
	10-Feb-08	0	5	0	0	0	0	0	0	1		6
WE total		172	267	265	149	208	77	89	239	63	14	1 529
Week day	04-Dec-07		17	2	0		0	5	10	10	6	44
	21-Dec-07	0		0	0				2	0		2
	09-Jan-08	44	38	19	3	5	0	4	23	19	2	155
	18-Jan-08	16	14	5	0	5	8	0	22	0		70
	30-Jan-08	2	7	16		14	0	0	10	11		60
	07-Feb-08	0	1	2	0	0	0	0	2	0		5
	20-Feb-08	9		0	0	0	0	3	2	1		15
Week total		71	77	44	3	24	8	12	71	41	8	351
Total CRA		243	344	309	152	232	85	101	310	104	22	1 902

Table 10: The harvest estimates for the 90 day survey period in 2007–08 by numbers harvested, green weight and meat weight for scallops.

		CRA Harvest	CRA % CV		SCA Harvest	SCA % CV
Ramps and Marina	WkDay	3 051	37.2		55 970	40.0
	WE/Hol	7 043	27.9		147 129	22.0
Bus-route	WkDay	215	68.7		0	
	WE/Hol	344	42.0		0	
Total harvest		10 653	21.4		203 100	19.4
Mean weight (g)	688.255			116.4		
Total weight (t)		7.3			23.6	
Meat weight (t)					2.8	

Table 11: The SCUBA and dredge fishing effort and harvest for scallops taken inside and outside the amateur only scallop areas.

	Amateur only scallop areas (n = 363)	Outside amateur only scallop areas (n = 85)
SCUBA people (sum of SCA SCUBA gatherers)	1 139	260
SCUBA vessels (sum of SCA SCUBA vessels)	363	85
SCUBA effort (sum of SCUBA effort minutes (excl: > 90 mins)	38 080	10 326
SCUBA tank (sum of tanks used by SCA SCUBA (excl > 90 mins)	516	122
SCUBA harvest (sum of SCA harvested)	21 653	4 331
Dredge people (sum of SCA dredge gatherers)	189	60
Dredge vessels (sum of SCA dredge vessels)	57	21
Dredge harvest (sum of SCA dredge harvested)	1 504	539

Table 12: Scallop harvest per unit effort for harvest inside and outside the amateur only scallop areas by SCUBA vessel, hour, tank or by dredge vessel or hour.

	Amateur only scallop areas	Outside amateur only scallop areas	All areas
Per SCUBA vessel:	59.65 (0.96)	50.95 (1.06)	58.00 (0.86)
Per SCUBA effort (per person dive hour):	34.12 (1.24)	25.17 (1.83)	32.21 (1.02)
Per SCUBA tank:	41.95 (1.40)	35.36 (2.65)	40.68 (1.17)
Per dredge vessel	26.39 (2.83)	25.67 (5.08)	26.19 (2.42)
Per dredge effort (per person.dredge hour)	9.12 (0.92)	10.52 (2.23)	9.45 (0.88)

Table 13: Rock Lobster harvest per unit effort by SCUBA per trip, person hour, or tank.

	Number of rock lobster harvested
Per SCUBA trip:	3.20 (0.14)
Per SCUBA effort (per person dive hour):	1.40 (0.07)
Per SCUBA tank:	1.54 (0.07)

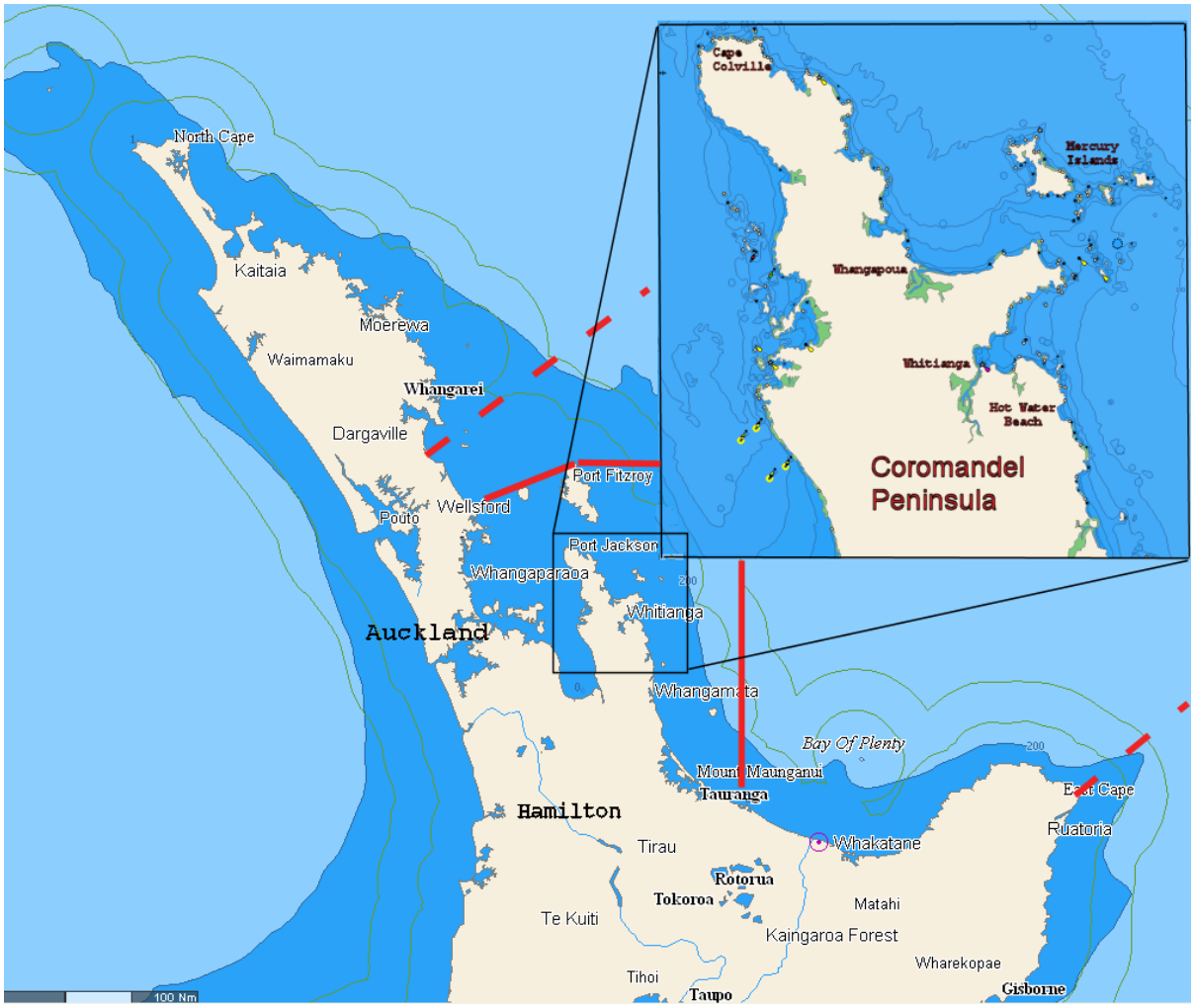


Figure 1: Location of the Coromandel Peninsula on the east coast of the North Island. Boundaries of the quota management areas CRA 2 for rock lobster (dashed lines) and SCA CS for scallops (solid lines).

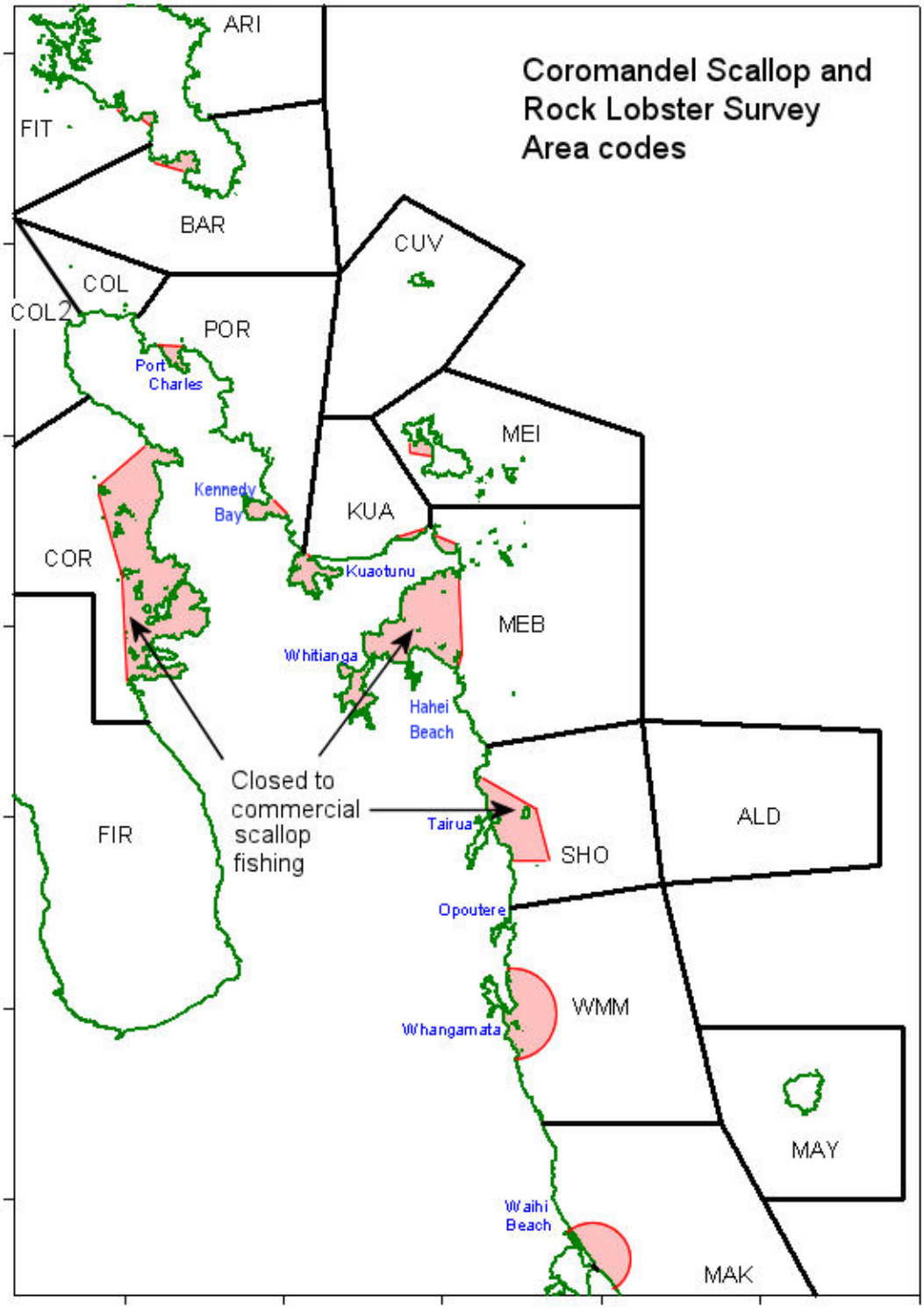
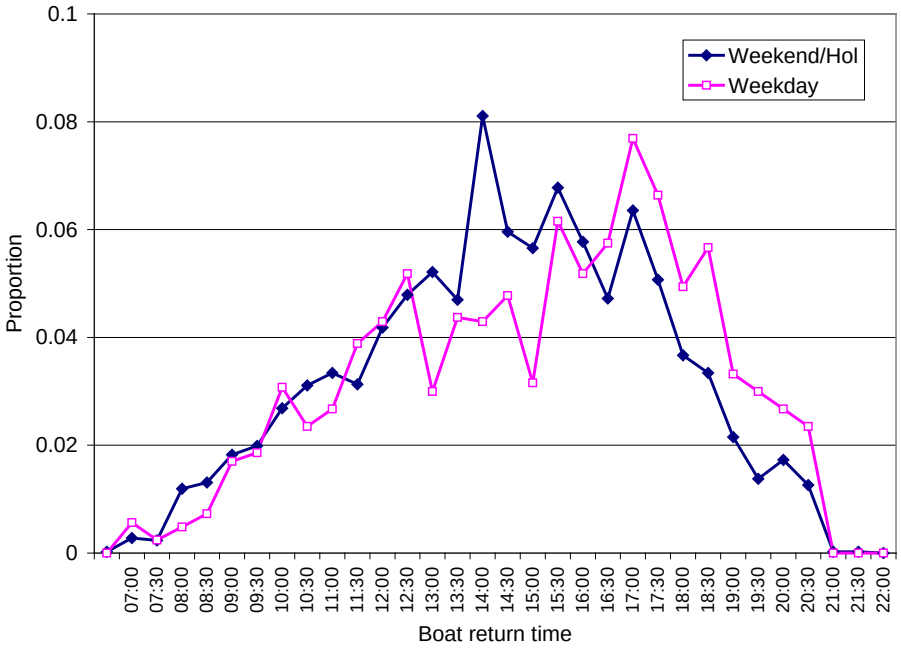


Figure 2: Amateur fishing area codes around the Coromandel Peninsula with areas closed to commercial scallop dredging (shaded).

a.



b.

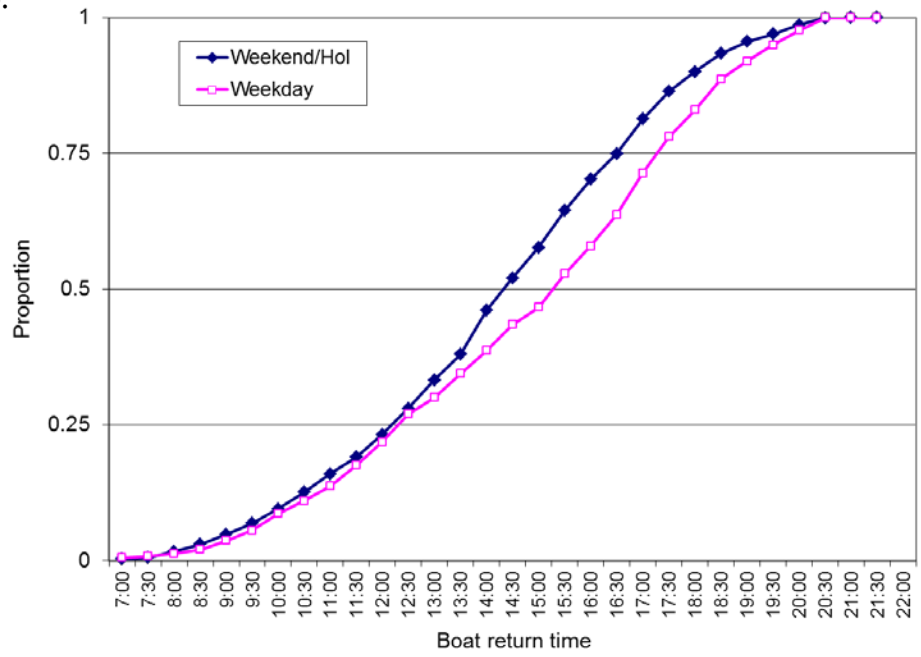
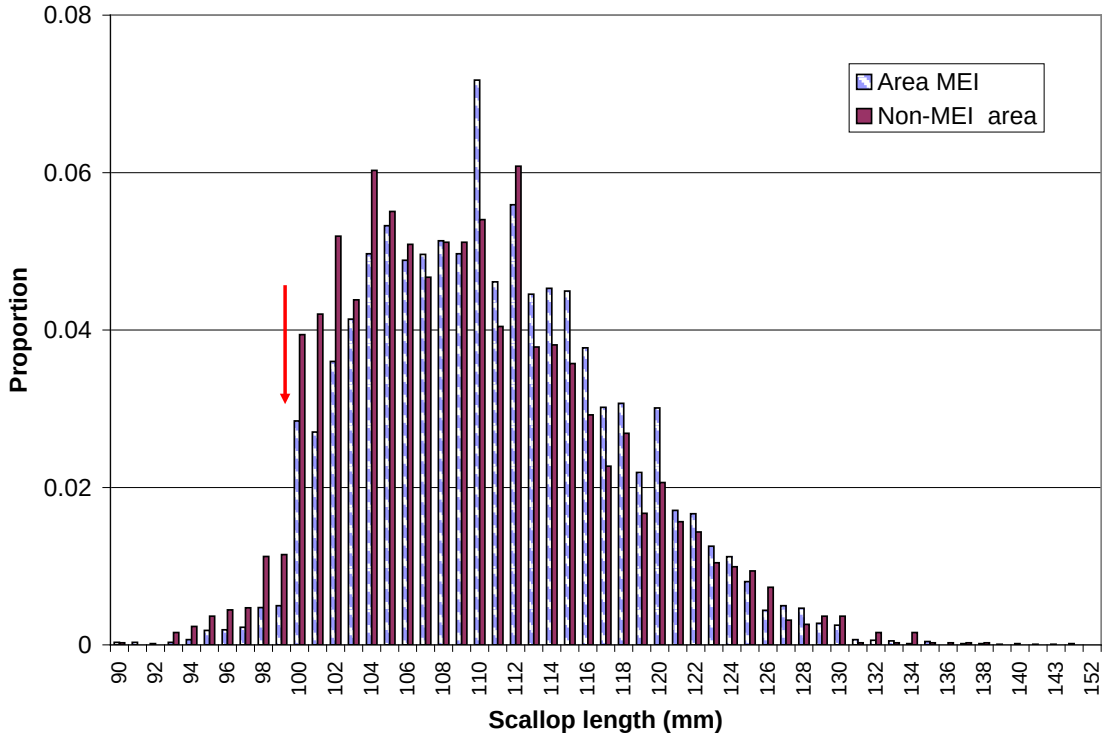


Figure 3: The proportion of boats returning to the ramp or marina by 30 minute time bin and day type (a) as a proportion of all trips and (b) as a cumulative proportion.

a.



b.

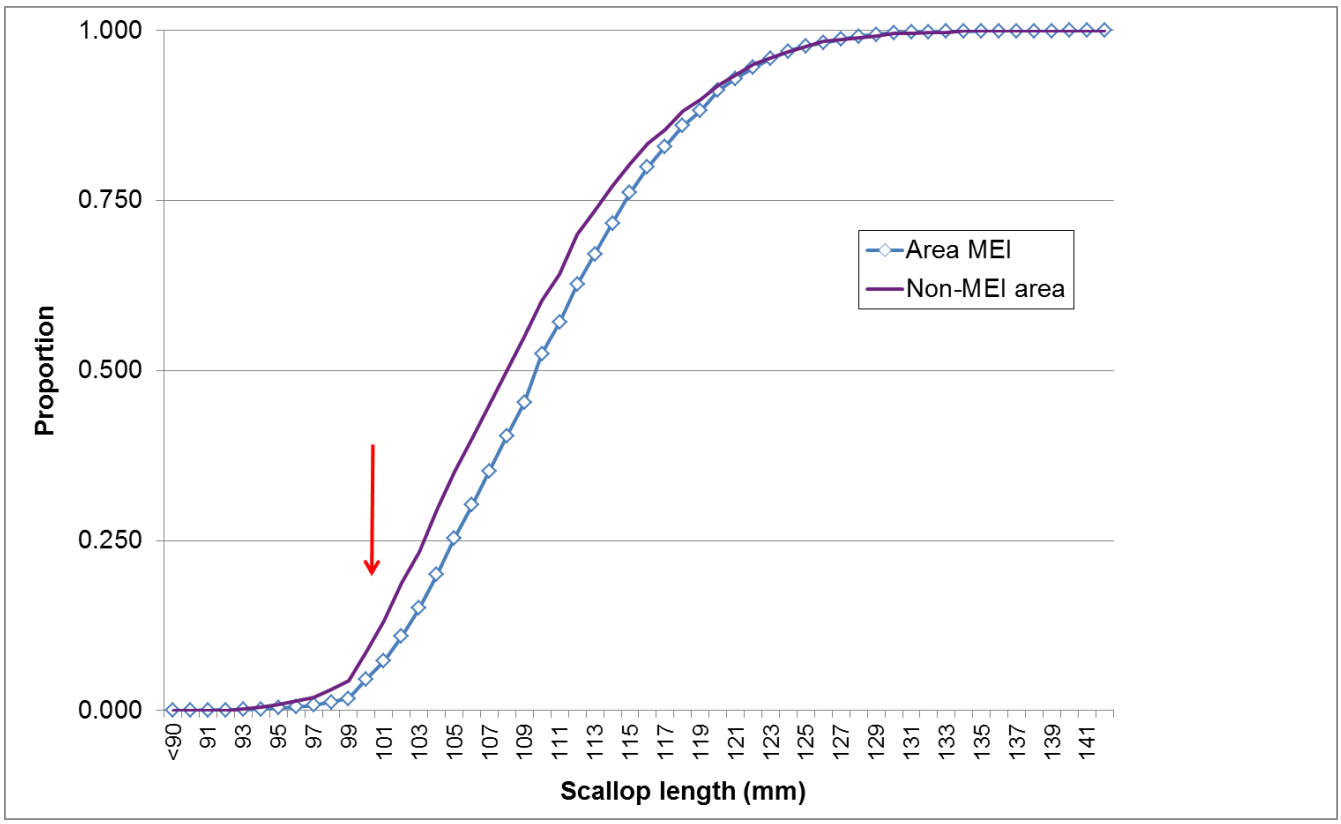
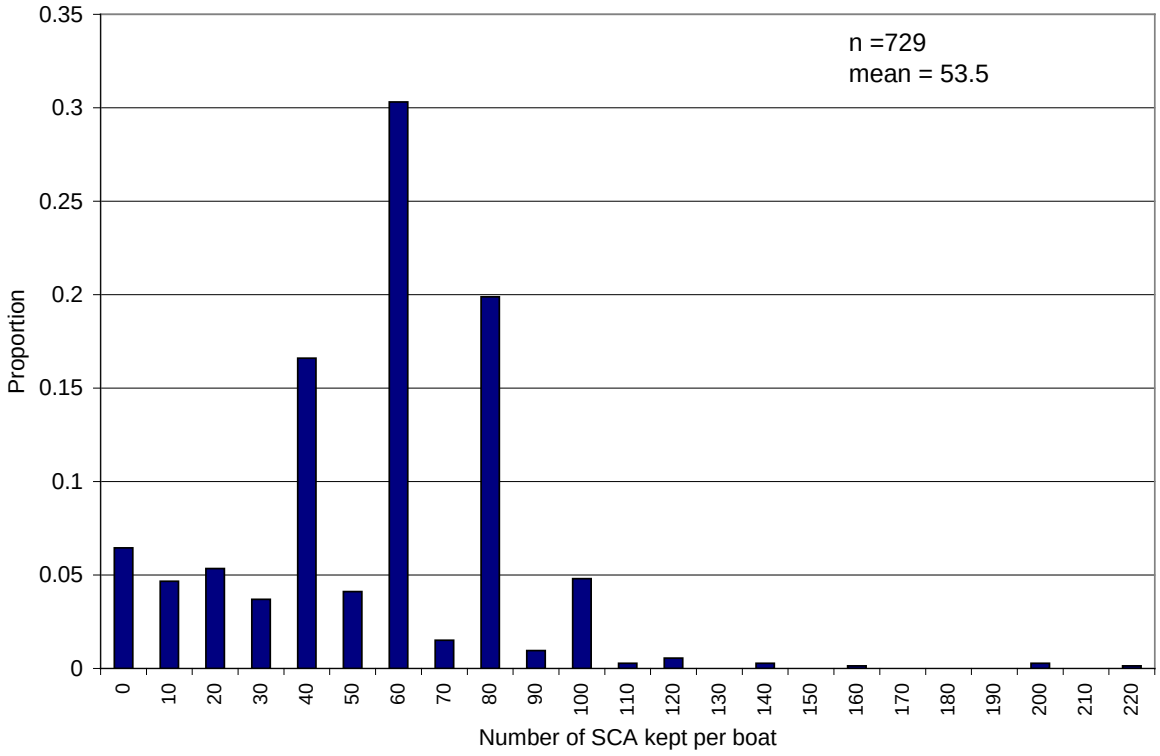


Figure 4: Scallop proportion at length from the main amateur fishing area the Mercury Islands (MEI) and all other areas. MLS for amateur fishers is 100 mm (arrows), (a) as a proportion of all trips and (b) as a cumulative proportion.

a.



b.

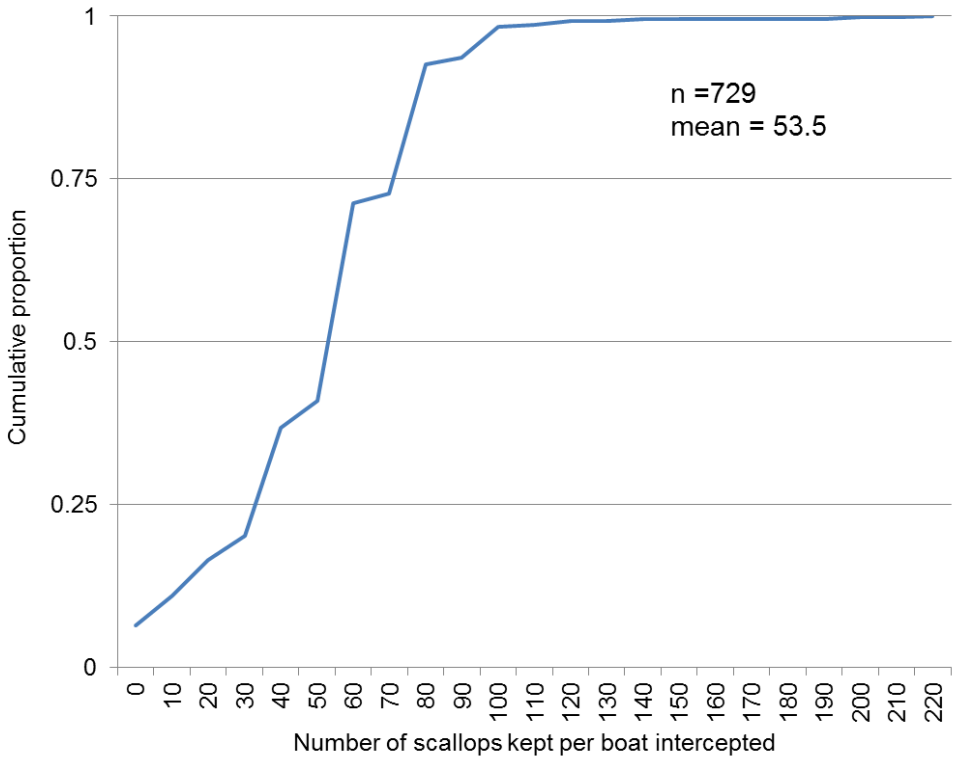
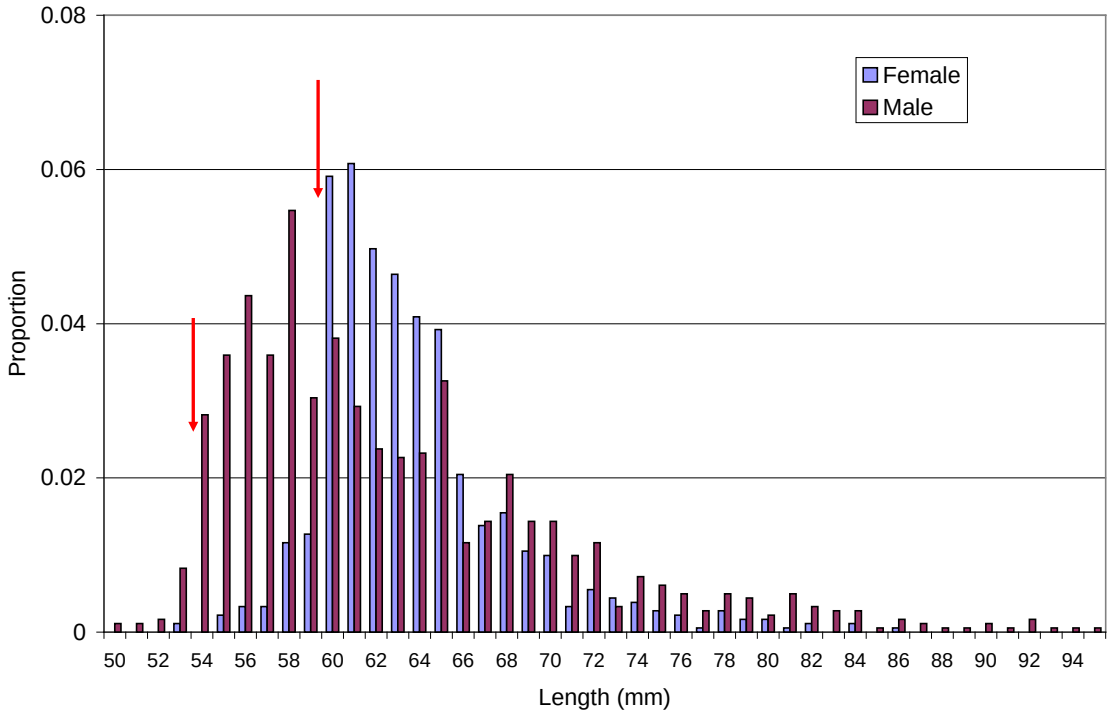


Figure 5: The number of scallops kept per boat per trip (a) as a proportion of all trips catching scallops and (b) as a cumulative proportion.

a.



b.

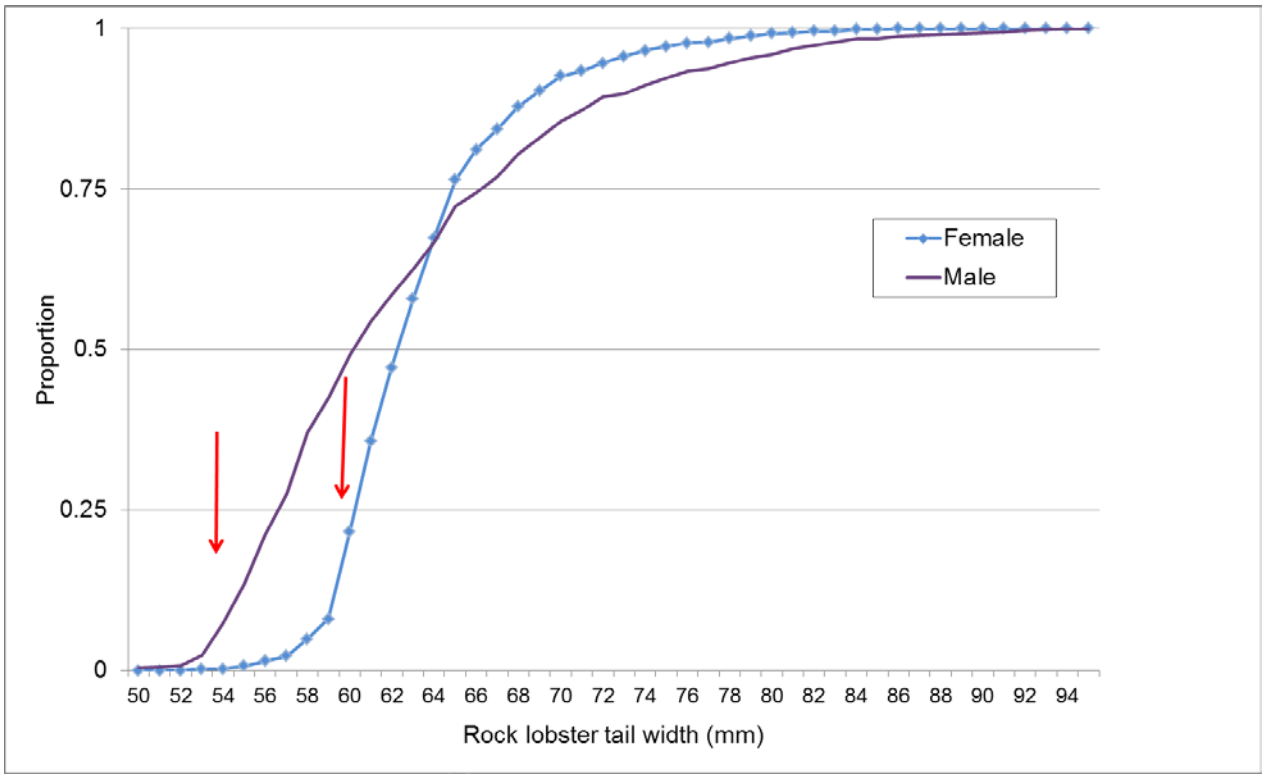
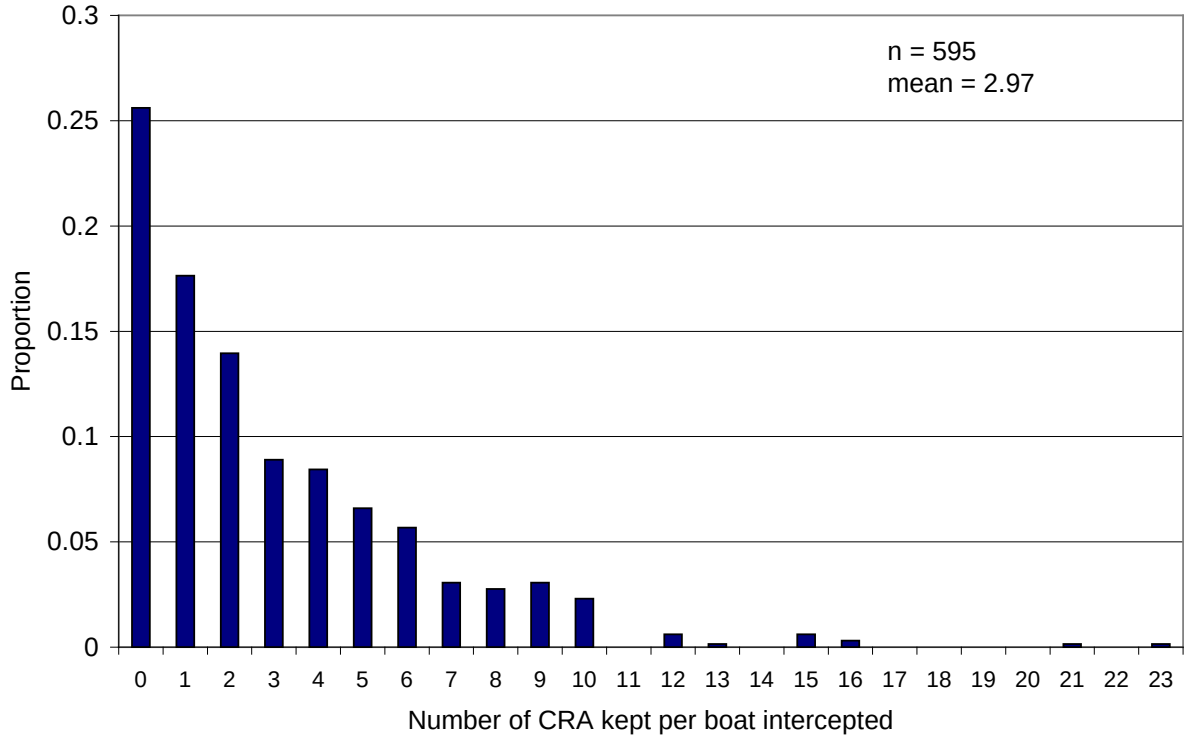


Figure 6: Size distribution of all measured rock lobster with the minimum tail width for males (54 mm) and females (60 mm)(arrows), (a) as a proportion of all trips and (b) as a cumulative proportion.

a.



b.

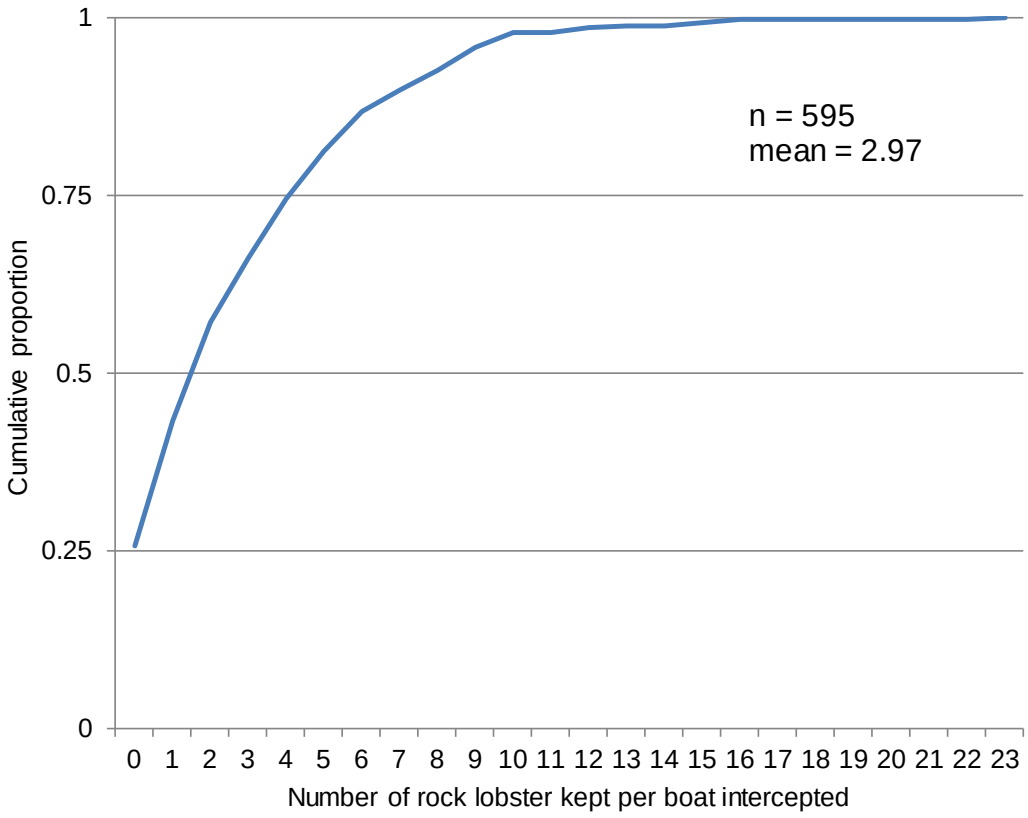


Figure7: The number of rock lobster kept per boat per trip (a) as a proportion of all trips catching rock lobster and (b) as a cumulative proportion.

APPENDIX 1. Daily totals, number of scallops and rock lobster

Date	Day Type	SCA harvest all ramps	CRA harvest all ramps
4/12/2007	Weekday	553	52.7
21/12/2007	Weekday	137	2.0
9/01/2008	Weekday	3 559	173.5
18/01/2008	Weekday	1 056	75.1
30/01/2008	Weekday	1 173	69.6
7/02/2008	Weekday	543	6.0
20/02/2008	Weekday	236	16.6
2/12/2007	WE/Hol	1 440	58.0
15/12/2007	WE/Hol	1 058	32.0
27/12/2007	WE/Hol	4 736	403.1
30/12/2007	WE/Hol	10 627	569.2
2/01/2008	WE/Hol	6 005	278.1
6/01/2008	WE/Hol	4 252	161.6
13/01/2008	WE/Hol	4 159	168.5
27/01/2008	WE/Hol	4 253	83.6
10/02/2008	WE/Hol	253	6.4

APPENDIX 2. Session form for boat ramp and marina interviews

Recreational Harvest Survey Scallops and Rock Lobster **Session Form Catch per Trip** Page of

Interview Ramp Code | Date | Start Time | Finish Time | Count of Boat Trailers Start | Count of Trailers End | Session Number | Interviewer Initials

Cloud Cover %

Wind Strength Knots | Wind Direction

Sea state tick: Calm | Choppy | Rough

Intercept codes: **I** Fishing & interviewed; **O** Other not fishing; **N** Not interviewed unknown; **R** Refused

Fishing for: **SCA** Scallop **CRA** Rock lobster **SNA** Snapper **TAR** Tarakihi **HPB** Hapuku **KIN** kingfish **GEN** General **GUR** Gurnard

Boat codes: **T** Trailer; **L** Launch; **C** Charter; **Y** Yacht; **R** Landbased

SCA & CRA fishing methods: **SC** Scuba; **SK** Snorkel; **DD** Dredge; **PT** Pot

Boat #	Intercept Code	Fishing Y/N	Fishing For	Also Fishing For	Boat Code	Return Time	# of People Fishing	Fishing Method Code	# of Scuba Tanks	# of Pots	Time Start Dive Dredge	Time Finish Dive Dredge	Days SCA and CRA per Year	# SCA Kept	# SCA caught & released	# CRA Kept	# CRA caught & released	Fishing Loc	Rec Only Area Y/N both