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Amateur harvest estimates from an access point survey of marine fishers in the western Bay of Plenty, New Zealand in 2010–11 and 2011–12.

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J.C. Holdsworth

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This survey was an on-site survey of recreational fishers using boats and access points between Port Charles and Maketu in the Western Bay of Plenty. The main purpose was to estimate boat based amateur harvest and fishing effort for scallops and rock lobster using a robust sampling design. The spatial scale of the survey area (290 km by road) and the limited number of boat launch sites made an access point survey feasible. A random stratified design is used to sample 45 days during each fishing year, with strata for summer and winter and week day and weekend/holiday. Mean daily catch within each strata and each location type (main ramp, bus stop ramp, and marina) is used to estimate total harvest from recreational vessels in the area by fishing year. Harvest estimates are also calculated for kahawai and red gurnard to aid comparison with larger scale concurrent amateur harvest surveys.

Expansion of harvest recorded by interviewers at the main ramps and marinas is straightforward, with most boats intercepted and adjustments made for vessels that were missed (9% to 14%) or for those that refused to be interviewed (less than 1%). The direct expansion method used in the bus route component of the survey is described. Effectively it takes the completed fishing trips observed per minute wait time at a ramp and expands it by the number of minutes in the fishing day to get total effort (trips per day) for the route which is multiplied by the mean catch per trip that day to estimate harvest for the route.

A total of 16 803 boat trips were observed in 2010–11 across 45 survey days, including vessels not intercepted and trailers remaining at the end of the day at main ramps. The 13 876 completed interviews showed that 85% of trips involved some fishing activity with estimated harvest on survey days of over 31 000 scallops and 1600 rock lobster.

A total of 12 514 boat trips were observed in 2011–12 across 45 survey days, including vessels not intercepted and trailers remaining at the end of the day at main ramps. The 11 346 completed interviews show that 81% of trips involved some fishing activity with estimated harvest on survey days of over 22 000 scallops and 1200 rock lobster.

Greenweight harvest estimates for amateur fishers during 2010–11 in the survey area are: rock lobster 13.7 t; scallops 36 t; kahawai 205 t; and red gurnard 23 t. CVs for the number of fish harvested range from 6.5% for kahawai to 13.6 % for scallops. The harvest estimates by species in 2011–12 are 26% to 44% lower: rock lobster 7.4 t; scallops 24 t; kahawai 155 t; and red gurnard 13 t with CVs from 9% to 18%. Poor weather over summer, biotoxin warnings and the *Rena* grounding with subsequent oil spill all had a negative effect on fishing effort in 2011–12, especially in the Tauranga area.

The results from the National Panel Survey (NPS) survey were used to expand the access point harvest estimates to the entire Quota Management Areas (QMA). These estimates therefore rely heavily on NPS harvest estimates by area and method in 2011–12. In fisheries with lower participation rates such as scallop and rock lobster, the catch of a few diarists may be unduly influential and these estimates should be treated with caution.

A high proportion of the amateur scallop harvest came from areas closed to commercial fishing, 55% and 88% in 2010–11 and 2011–12 respectively. Overall the estimated greenweight of scallops harvested from boats by amateur fishers in areas closed to commercial fishing was 19.2 t (13.8) in 2010–11 and 21.2 t (18.4) in 2011–12.

1. INTRODUCTION

The Bay of Plenty scallop (*Pecten novaezelandiae*) fishery is highly valued by commercial, recreational and customary fishers. The Eastern Coromandel is a popular holiday designation within a few hours' drive from major cities such as Auckland, Hamilton and Tauranga. The Coromandel scallop quota management area (SCA CS) includes the area from Cape Rodney in the Hauraki Gulf to Town Point in the Bay of Plenty. The total allowable commercial catch (TACC) is 22 tonnes meat weight but the annual catch entitlement (ACE) can be increased with an in-season adjustment based on estimates of recruited biomass (Ministry of Fisheries 2011). The minimum legal size for the Coromandel commercial fishery is 90 mm and the fishing season runs from 15 July to 21 December each year.

The amateur scallop fishery is managed by a minimum legal size (100 mm), daily bag limits (20 per person) and a restricted season (currently 1 September to 31 March inclusive). Diving (SCUBA and snorkelling) is the primary harvest method but there may also be 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).

The rock lobster fishery is also highly valued by all sectors. The CRA 2 quota management area covers the area between Bream Tail and East Cape and has a TACC of 220 t for red rock lobster (*Jasus edwardsii*). There is a national TACC of 40 t for the packhorse rock lobster (*Sagmariasus verreauxi*).

The amateur rock lobster fishery is managed by minimum size limits (Male 54 mm, Female 60 mm), daily bag limits (6 lobsters per person per day) and taking soft shell or rock lobster with eggs is prohibited. Diving (SCUBA and snorkelling) and potting are the primary harvest methods.

The specific objectives established for the MAF-2010/02 project are:

1. To estimate the amateur scallop harvest from the Eastern Bay of Plenty beds in the Coromandel scallop fishery (SCA CS) for the 2010/2011 scallop fishing season (Port Charles to Town Point).

2. To estimate the amateur scallop harvest from the Eastern Bay of Plenty beds in the Coromandel scallop fishery (SCA CS) for the 2011/2012 scallop fishing season (Port Charles to Town Point).

3. To obtain spatially explicit catch location information to determine the amount of the amateur scallop catch taken inside and outside areas closed to commercial scallop fishing.

4. To estimate the amateur harvest of rock lobster from CRA 2 for the 2010/2011 fishing season.

5. To estimate the amateur harvest of rock lobster from CRA 2 for the 2011/2012 fishing season.

In addition the Marine Amateur Fisheries Working Group and contractor agreed that data on kahawai (*Arripis trutta* and *Arripis xylabion*) and red gurnard (*Chelidonichthys kumu*) should be collected and harvest estimated from boats in the survey area. This was to assist in comparing recreational harvest estimates from this survey method with overlapping survey estimates using different methods in 2011–12 including the National Panel Survey by NRB (Wynne-Jones et al. 2014) and the aerial access survey by NIWA (Hartill et al. 2013).

2. METHODS

The survey area has well-defined boundaries in the north (Cape Colville) and south (Ocean Beach, Bay of Plenty) and attracts a large number of recreational fishers, particularly over the summer months. The main survey objective was to estimate boat based amateur harvest for scallop and rock lobster in the 2010–11 and 2011–12 fishing years. The spatial scale of the survey area (290 km by road) and the limited number of boat of launch sites made an access point survey feasible. The design selected, following discussion with MPI and the Marine Amateur Fisheries Working Group, included all day coverage of main boat ramps, afternoon and evening coverage at marinas, plus six routes for all day roving creel surveys (Pollock et al. 1994). To expand this type of survey to include the Hauraki Gulf and other areas in the scallop management area (SCA CS) or rock lobster management area (CRA 2) would require a significant increase in resources in order to cover many more access points and thousands of trips with very low effort for the main species of interest.

The spatial and temporal stratification were aligned with other concurrent amateur harvest surveys in 2011–12; the aerial overflight survey in Fisheries Management Area 1 (FMA1) (Hartill et al. 2013) and the National Panel Survey (NPS) national offsite survey (Wynne-Jones et al. 2014). The temporal strata used were defined as summer, seven months (1 October to 30 April) and winter, five months (1 May to 30 September) and within these weekdays were separated from weekends and holidays (Hartill et al. 2007; Hartill et al. 2011). A total of 45 survey days were selected at random for the four main survey strata in each year as shown in Table 1.

Table 1: The number of days in each survey strata, days surveyed and sampling fraction used in the 2010–11 and 2011–12 fishing years.

Season 2010–11	Stratum	Total days	% of survey period	Survey days	Sampling fraction
Summer	Weekday	137	38%	13	0.095
Summer	Weekend/Hol	75	20%	16	0.213
Winter	Weekday	109	30%	8	0.073
Winter	Weekend/Hol	44	12%	8	0.182
Total		365		45	0.123

Season 2011–12	Stratum	Total days	% of survey period	Survey days	Sampling fraction
Summer	Weekday	135	37%	13	0.096
Summer	Weekend/Hol	78	21%	16	0.205
Winter	Weekday	108	30%	8	0.074
Winter	Weekend/Hol	45	12%	8	0.178
Total		366		45	0.123

Care was taken not to survey the same days as the kahawai monitoring project MAF-2010-01 (Armiger et al. 2014) operating at selected boat ramps between January and March 2011 and the boat ramp surveys for MAF-2011-03 (Hartill & Davey 2015) in support of the NPS survey 1 October 2011 to 30 September 2012. Interviewee burden is too high if two surveys with different objectives and survey requirements operate at the same time, especially during busy periods. Our survey days were fixed and work proceeded in all weather conditions. The interview for fishers not targeting or catching

scallops or rock lobster was deliberately kept short to minimise the chance of missing boats that may have scallops or rock lobster.

Access points covered

Survey sites were assessed and selected using data from a pilot survey in 2007–08 (Holdsworth & Walshe 2014), and site inspections. We surveyed 46 access points between Port Charles (north) to Maketu (south). Six of the busiest ramps spread across the survey area (main ramps), were selected for all day coverage during daylight hours with two interviewer shifts to give up to 14 hours coverage in summer. The four marinas in the area were covered with a single survey shift of 7 hours in the afternoon and evening when most vessels return to their berths. Also, 36 secondary ramps were covered in 6 areas (routes) using the bus route method with two survey shifts to give up to 14 hours coverage. A start location and direction around the bus route is selected at random. Wait time is set by the principal investigator roughly in proportion to the expected fishing effort from each site. The location of access points covered is presented in Figure 1. Two of these ramps were dropped from the routes because no fishing activity or interviewees were captured during the first summer. Detailed maps of access point locations surveyed are provided in Appendix 1.

The survey did not cover the access points at the private waterways at Pauanui and Whitianga. Also many boats on swing moorings are not assessed from boat ramps covered in this survey.

Data collection

Interviewers collect data on the return time of vessels, whether they were fishing or not, what they targeted and what they caught, using paper forms. Details of fishing method and time spent fishing were collected if scallops or rock lobster were targeted on that trip. A subsample of between 10 and 20 scallops were selected at random from the landed catch and measured in millimetres (rounded down). Interviewers were trained to measure the tail width and sex of all red rock lobster using vernier callipers. Tail length and sex was collected for packhorse rock lobster. Counts of empty boat trailers were made at the start and the finish of each survey session. The two data sheets used are shown in Appendix 2. This includes some additional fields used in the 2011–12 season to collect more specific information on fishing effort and to separate the catch of rock lobster by individual fisher. Data is entered into a MS Access relational database using field names and codes compatible with the MPI rec_data database.

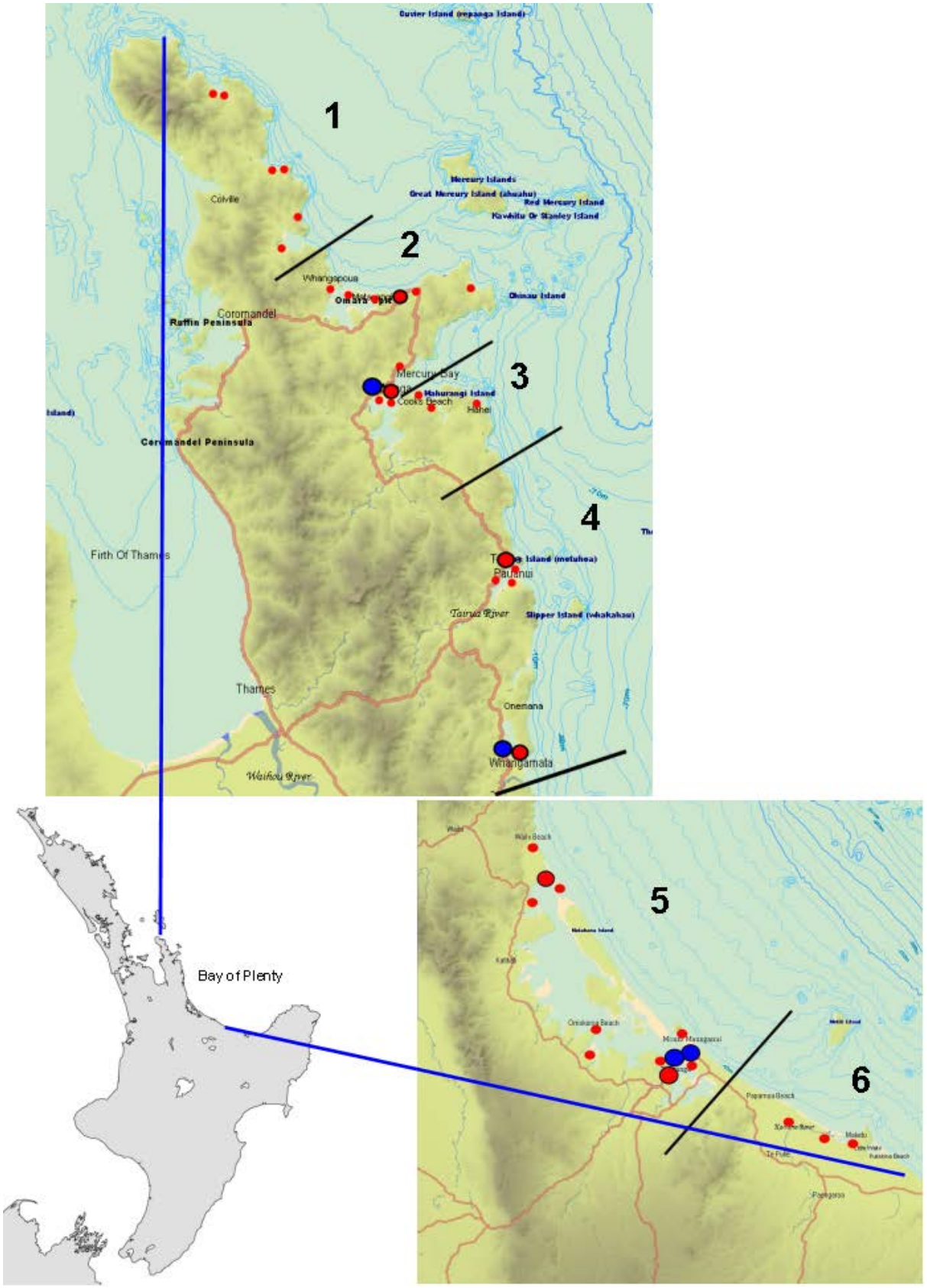

Figure 1: Location of access points surveyed on the Coromandel Peninsular and in the Tauranga area in the western Bay of Plenty. Marinas (blue dots), main ramps (larger red dots), secondary ramps (small red dots) and boundaries between numbered survey routes (black lines).

Survey assumptions

- That the stratified random sampling design adequately captures the mean daily harvest at each main access point or bus route.
- Those fishers who refuse to be interviewed or who return to the main ramps after the survey finishes for the day (numbers estimated by trailer counts at the end of the day) have the same mean harvest of the survey species per trip as the fishers interviewed that day at that location.
- Roving wait times are roughly in proportion to the number of boat trips. Data from 2010–11 was used to adjust scheduled wait times at ramps for 2011–12. However, a minimum wait time of 20 minutes was set to increase the probability of intercepting and interviewing fishers at that site.
- Vessels using marinas land almost all their harvest of survey species in the afternoon and evening when interviewers are present. No data has been collected or adjustment made for vessels that return from fishing in the morning.
- The length of the fishing day used in the bus route harvest expansion is the same as the hours covered on the all day survey ramps.
- Mean weights for kahawai and red gurnard in 2010–11 are the same as the estimates from project MAF-2011/03 in 2011–12 (Hartill & Davey 2015).
- In 2011–12 data from four summer survey days were missing for the North Coromandel bus route. The mean catch per day during that month was used to impute the catch for the missed days. For the roving component of harvest only, this imputation increased the unscaled rock lobster harvest by 3% and increased the unscaled kahawai harvest by 1%, with no change in scallop or red gurnard estimates.
- In 2011–12 data from five half days were missing from the bus route survey, mainly in the Tauranga area. Data was imputed using the mean catch from the half day survey on that route and doubling the number of trips from the half day. For the roving component of harvest only, this increased the scaled harvest of kahawai by 5%, scallops by 3%, and red gurnard by 2%. The rock lobster harvest was unchanged.

Rena disaster and biotoxin warnings

The 2011–12 fishing season was hampered by man-made and natural threats. On 5 October the cargo ship *Rena* hit Astrolabe Reef 10 km from Tauranga. The area covered by oil spill contamination and marine traffic exclusion zones changed over time (see Appendix 5).

In addition biotoxin warnings were in place over summer in 2011–12 for Paralytic Shellfish Poisoning (PSP) toxin. The affected area included the entire coastline from Tairua (including Tairua Harbour), east along the Bay of Plenty coastline, including Tauranga Harbour, Maketu and Waihi estuaries, to Whakatane Heads. Also included in the warning were Matakana and Motiti islands, and all other inshore islands along this coastline.

The health warning applied to all bi-valve shellfish including mussels, pipi, tuatua, cockles, oysters and scallops as well as catseyes and kina (sea urchin). The public was warned that shellfish in the affected area should not be taken or consumed. Paua, crayfish and crabs could still be taken but the public was warned that, as always, the gut should be removed before cooking. Details of changes to the biotoxin warning are in Appendix 5.

Estimating Total Harvest - main ramp (and marina) expansion

We interviewed most groups of fishers returning via these access points and counted the groups that were not interviewed (M) or refused to be interviewed (R). We also counted 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*

For each stratum (season, day type and type of site) we scale the observed mean harvest per boat trip (C_{ij}/I_{ij}) for non-interviewed trips by multiplying by $(I_{ij}+ M_{ij}+ R_{ij}+ B_{ij})/I_{ij}$ and then summed over sites to give harvest on day *j*

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

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

$$Var(D) = \sum_j (D_j - D_m)^2/(n - 1) \quad (3)$$

Then the estimated variance of the mean harvest within each stratum is

$$Var(D_m) = \{Var(D)/n\}\{1 - n/N\} \quad (4)$$

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).

The estimated total harvest in the whole stratum is

$$H = N.D_m \quad (5)$$

with estimated variance

$$Var(H) = N.Var(D_m) \quad (6)$$

Estimating Total Harvest - bus route direct expansion

For rock lobster and scallops we use the sum of the number of trips at each ramp because the number kept is often determined by the bag limit, dive time or number of pots rather than time on the water. The definitions below are used for bus route rock lobster and scallop harvest expansion. However for expansion of the observed kahawai and gurnard harvest, trip duration and number of fishers is used as a measure of fishing effort so that e_{ij} is the sum of trip minutes for all fishers for the *i*th ramp on day *j* and E_j is the total estimated effort in minutes for the bus route on day *j*.

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 of wait time 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

$$E_j = T_j \sum_i (e_{ij}/w_{ij}), \qquad (7)$$

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 each bus route on day *j* by multiplying by the expanded total number of trips on day *j*, i.e.

$$D_j = E_j \sum C_{ij}/\sum e_{ij} \qquad (8)$$

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

$$\mathrm{Var}(D_m) = (\mathrm{Var}(D)/\sqrt{n})\sqrt{(1 - n/N)} \qquad (9)$$

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

$$\mathrm{Var}(H) = N.\mathrm{Var}(D_m) \qquad (10)$$

The total harvest was estimated by summing the harvest for each day type/access type/season strata. Overall harvest variance was derived from bootstrap resampling of the daily harvest within each stratum to give estimates of the daily mean (equation 2 for main ramps and marinas and equation 8 for bus routes) multiplied by the number of days in each stratum and summed for the survey year. This was resampled 1000 times and the standard error and coefficient of variation calculated from those results.

Harvest estimates in number of fish are converted to total harvest weight by multiplying by mean weight estimates.

For rock lobster separate length weight regressions for male and female fish were used to estimate the weight of measured catch in each 1 mm size class, these were summed and divided by the number of measured fish to get the mean weight. The same method was used for scallop harvest weights based on length frequencies collected in this survey and a length weight regression for the commercial Coromandel scallop fishery.

Average weights for kahawai and red gurnard in 2011–12 for the Western Bay of Plenty and whole QMAs were supplied by NIWA project MAF-2011/03. There were significant differences between the summer and winter strata mean weights for these species (Hartill & Davey 2015). We used the proportion of kahawai harvest in terms of the numbers of fish estimated in our on-site survey for summer and winter; together with the NIWA seasonal mean weights to estimate the mean weight for each fishing year.

Expanding harvest to whole Quota Management Areas

The off-site NPS survey estimated the harvest for whole Quota Management Areas (QMAs) and a subset of these for the Western Bay of Plenty survey area in 2011–12. The initial harvest estimates are available by platform (type of boat or land based structure fished from) which allows boat based harvest to be separated from land based methods. The ratio of NPS harvest for the whole QMA versus the portion of harvest estimated for the Western Bay of Plenty for all boat based methods was used to scale up the boat based harvest in the Western Bay of Plenty from this access point survey.

The following definitions are used for the estimates used in the expansion to harvest for the whole QMA:

H	Harvest estimate from the access point survey of boat based fishers for the Western Bay of Plenty in 2011–12
K	NPS boat based harvest estimate for the Western Bay of Plenty in 2011–12
L	NPS boat based harvest estimate for the whole Quota Management Area in 2011–12
O	NPS land based and other fishing platform based harvest estimate for the whole Quota Management Area in 2011–12
R	Scaled access point boat based harvest to the whole QMA
Q	Scaled access point harvest to the whole QMA on all platforms

Based on these definitions it follows that the access point harvest scaled to the whole QMA is

$$R = H \times L/K. \qquad (11)$$

Also the total harvest for all platforms for the whole QMA based on the access point estimate in this survey is Q:

$$Q = R + R \times O/L \qquad (12)$$

To estimate the standard deviations of the scaled on-boat based and other estimates a bootstrap method was used. The calculated standard deviations for the estimated numbers for the on-site access point survey, the off-site NPS survey for the Western Bay of Plenty, and the off-site NPS survey for SCA CS, all for 2011–12, were assumed to be close to the true values. Random values for these

estimates were then generated from distributions with these standard deviations and with mean values equal to the estimated values. This then allowed for the calculation of bootstrap values for the estimates of interest. In this way, 25 000 bootstrap sets of data were generated and the standard deviation of the values obtained provided estimates of the standard errors for the parameters of interest.

3. RESULTS

Boats intercepted

Harvest and effort information were collected by interviewing returning fishers at 46 boat access points between Port Charles and Maketu. A summary of survey outcomes from 16 803 boats intercepted or observed in 2010–11 is provided in Table 2. There were fewer (12 514) boat trips in 2011–12 (Table 3). Over 80% of boat trips where interviews were complete involved some fishing. Less than 1% of groups intercepted refused to be interviewed.

Table 2: The number of boats intercepted by interview outcome by season for 2010–11. Also boats missed by interviewers and trailer counts at the end of the survey day.

	Interviewed		Not interviewed			
2010–11	Fishing	Not Fishing	Refused	Missed	Trailer only	Total
Summer						
Number of Boats	9 436	1 764	91	1 036	1 104	13 431
Proportion of total	0.703	0.131	0.007	0.077	0.082	
Winter						
Number of Boats	2 360	316	9	367	320	3 372
Proportion of total	0.700	0.094	0.003	0.109	0.095	
Proportion of all interviewed	0.850	0.150				

Table 3: The number of boats intercepted by interview outcome by season for 2011–12. Also boats missed by interviewers and trailer counts at the end of the survey day.

2011–12	Interviewed		Not interviewed			
	Fishing	Not Fishing	Refused	Missed	Trailer only	Total
Summer						
Number of Boats	7 207	1 714	45	206	699	9 871
Proportion of total	0.730	0.174	0.005	0.021	0.071	
Winter						
Number of Boats	2 014	411	14	28	176	2 643
Proportion of total	0.762	0.156	0.005	0.011	0.067	
Proportion of all interviewed	0.813	0.187				

Survey day harvest and length frequency

The six main ramps with all day interviewer cover provided most of the observed harvest, with large numbers of scallops being landed in both fishing years (Tables 4 and 5). Kahawai landings were over double the red gurnard landings observed. The observed harvest by species was significantly lower in 2011–12 (57% to 74%) than in 2010–11 (Table 5).

Table 4: The survey day harvest by access point type and species for the 2010–11 fishing year.

2010–11	SCA	CRA	KAH	GUR
Main ramps	19 632	1 033	7 890	4 012
Marinas	2 584	183	1 321	573
Bus-route	9 638	432	2 160	778
2010–11 survey day total	31 854	1 648	11 371	5 363

Table 5: The survey day harvest by access point type and species for the 2011–12 fishing year with the relative proportion by species 2011–12 divided by 2010–11.

2011–12	SCA	CRA	KAH	GUR
Main ramps	15 290	809	4 729	2 187
Marinas	3 188	173	1 055	383
Bus-route	4 171	231	1 521	508
2011–12 observed total	22 649	1 213	7 305	3 078
Proportion of 2010–11	0.71	0.74	0.64	0.57

The size distribution of red rock lobster in 2010–11 was quite broad. There were more females than males between 60 and 70 mm tail width, however there were more males 70 to 90 mm than females (Figure 2). There were a reasonable number of female rock lobster under the 60 mm minimum legal size (MLS). Data from one interviewer who was found to be incorrectly measuring fish was removed. These undersize female fish appear to be real, spread across a number of interviewers including some of the most reliable.

In 2011–12 there were fewer red rock lobster observed and the proportion of fish (males and females) between 60 and 67 mm was lower (Figure 3). There are still some undersized female rock lobster landed but numbers are lower and the proportion of females in the catch (37%) is also lower than in 2010–11.

The size distribution of scallops subsampled from the landed catch by recreational fishers in the survey area in 2010–11 also had 461 measurements, which were considered unreliable, and the results from that interviewer were removed. There remain a number (4.6%) of shell widths under the 100 mm MLS (Figure 4).

There were more scallops around 110 mm in the 2011–12 sample and fewer under the 100 mm MLS (2.2%) (Figure 5). In that year interviewers were told that measuring a random selection of 10 scallops per trip was sufficient, this was less than in 2010–11. This led to a smaller sample size in 2011–12.

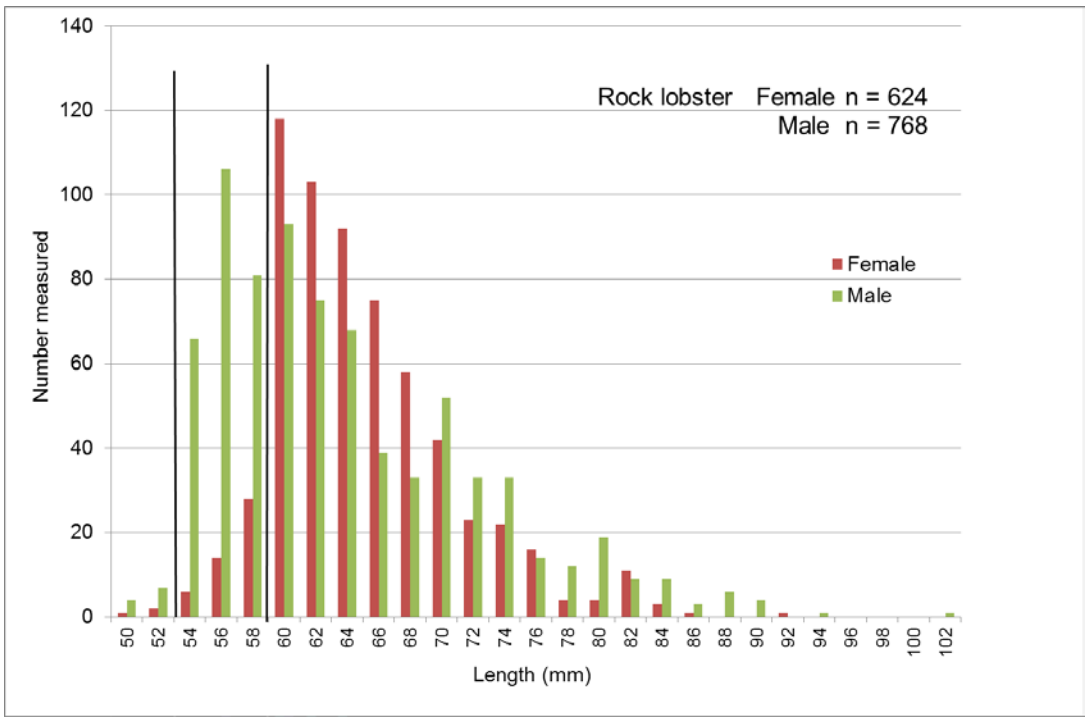

Figure 2: Tail width frequency distribution of rock lobster measured between 1 October 2010 and 30 September 2011 by sex with minimum legal size for males (54 mm) and females (60 mm) indicated.

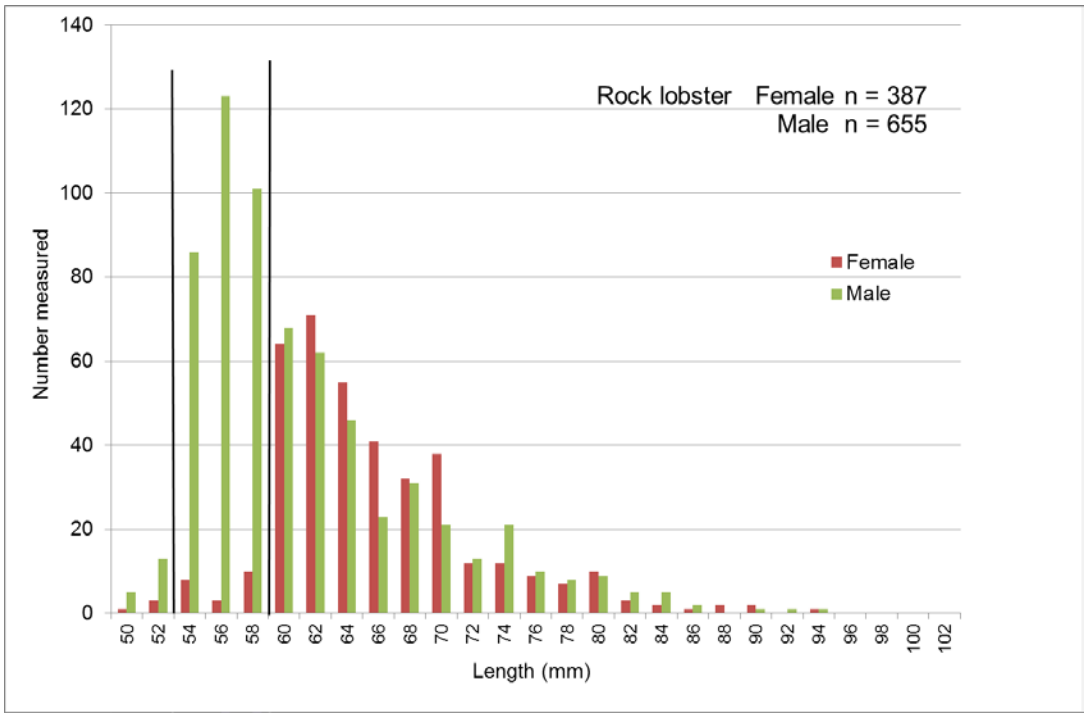

Figure 3: Tail width frequency distribution of rock lobster measured between 1 October 2011 and 30 September 2012 by sex.

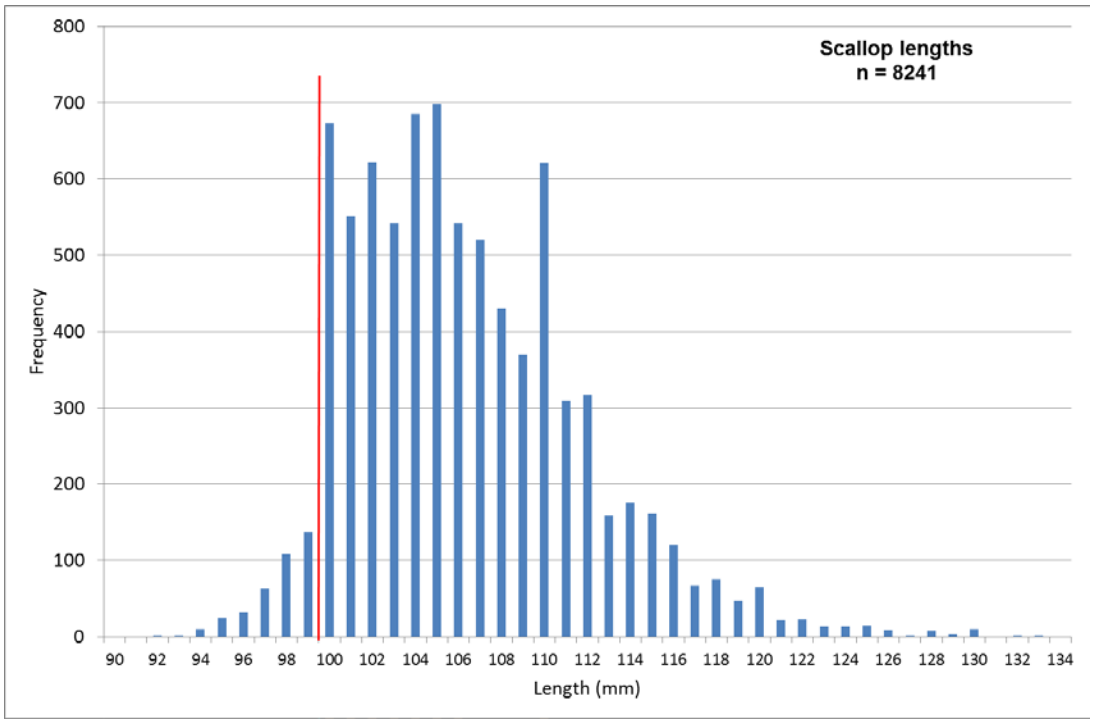

Figure 4: Length frequency distribution of scallops measured between 1 October 2010 and 30 September 2011.

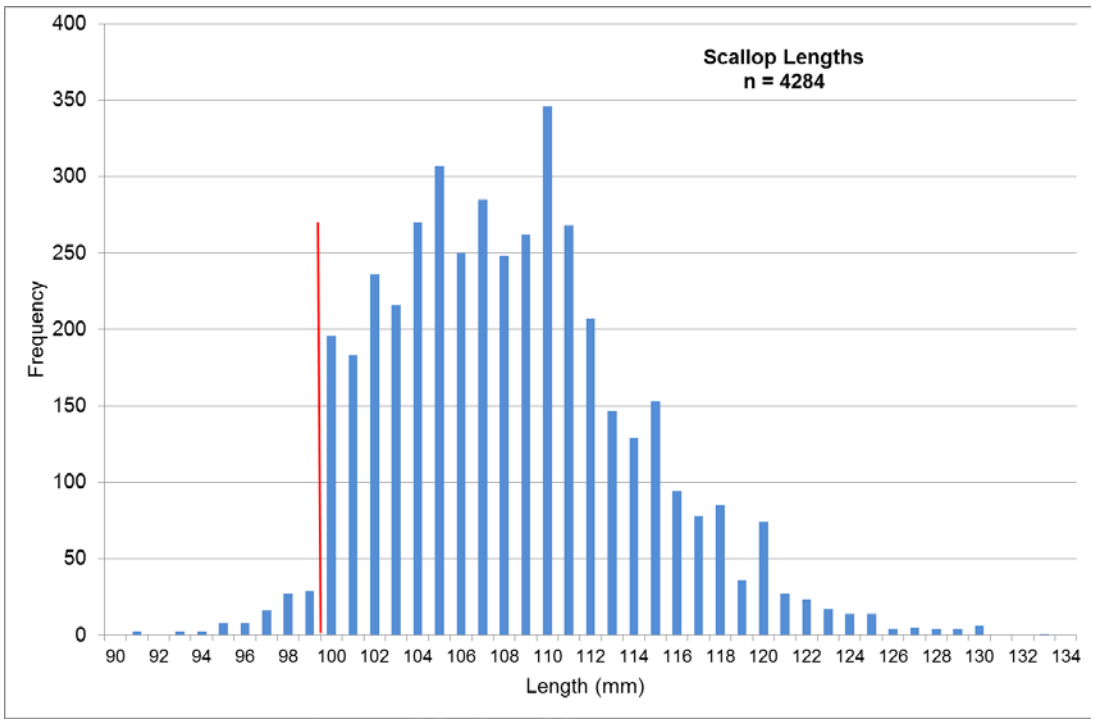

Figure 5: Length frequency distribution of scallops measured between 1 October 2011 and 31 March 2012. The season was closed for amateur fishers from 1 April to 31 August. Few scallops were sampled in September 2012.

The estimated survey day harvest , scaled up for the total boat trips each day, for scallops in 2011–12 shows three peak days of harvest in January and February. These days contribute significantly to the final harvest estimate (Figure 6). Very few scallops were intercepted by interviewers on survey days in September 2012 at the start of the new season due to poor weather conditions.

While there is a clear peak in rock lobster harvest on survey days in January there is a much broader spread of other (mainly weekend W/E) days where 40 to 100 rock lobster per day were intercepted (Figure 7).

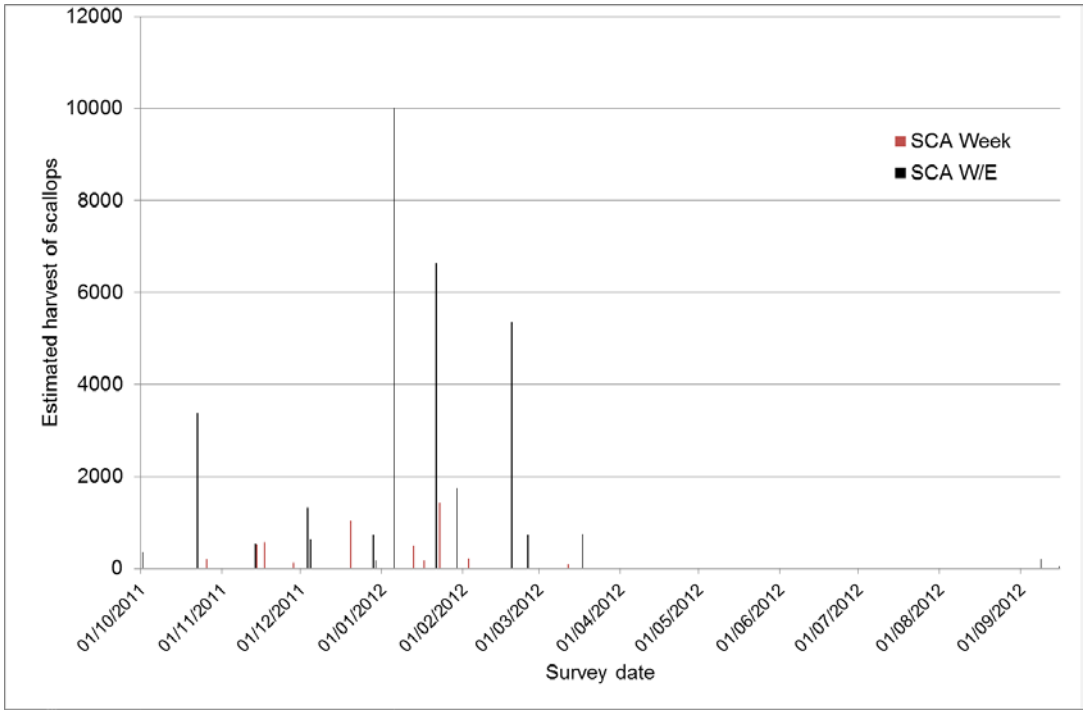

Figure 6: Daily harvest estimates (numbers) of scallops in 2011–12 survey period by day type.

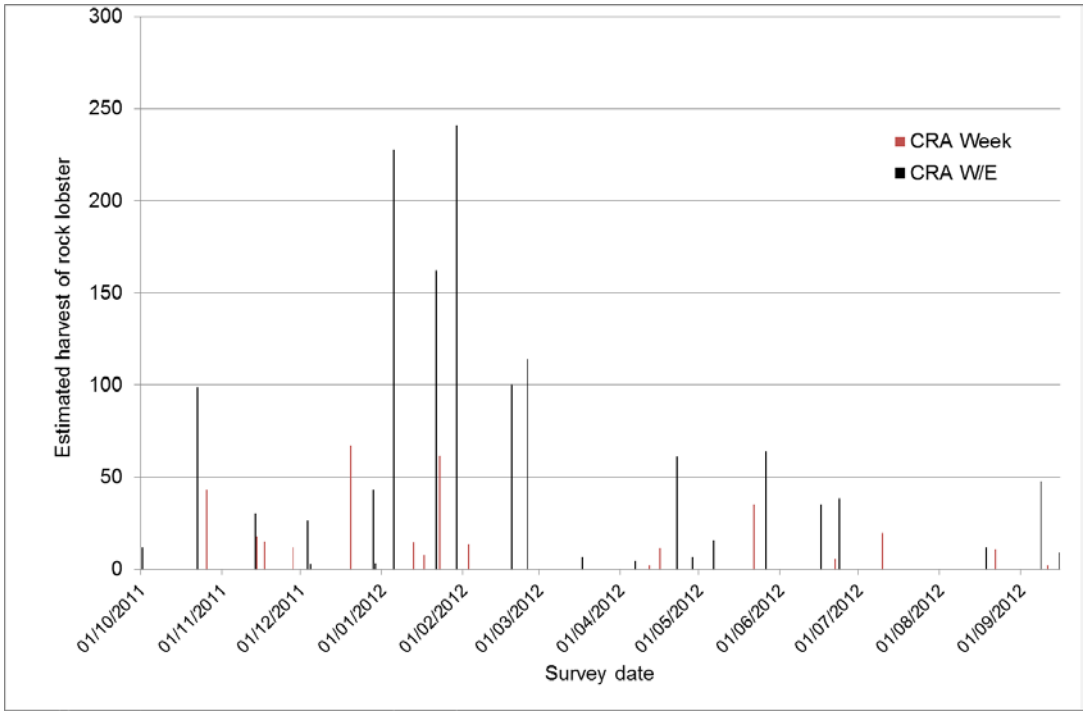

Figure 7: Daily harvest estimates (numbers) of rock lobster in 2011–12 survey period by day type.

Kahawai harvest by day in 2011–12 was more broadly spread across the year and day type than other species in the survey with peak landings in January but also in April and May (Figure 8). The median of all days combined was 246 fish with a peak of 1362 kahawai estimated for 22 April 2012.

Red gurnard harvest on survey days in 2011–12 was largest in spring and summer, without the autumn peak shown in kahawai (Figure 9). The median of all days combined was 53 fish with a peak of 627 red gurnard estimated for 5 January 2012.

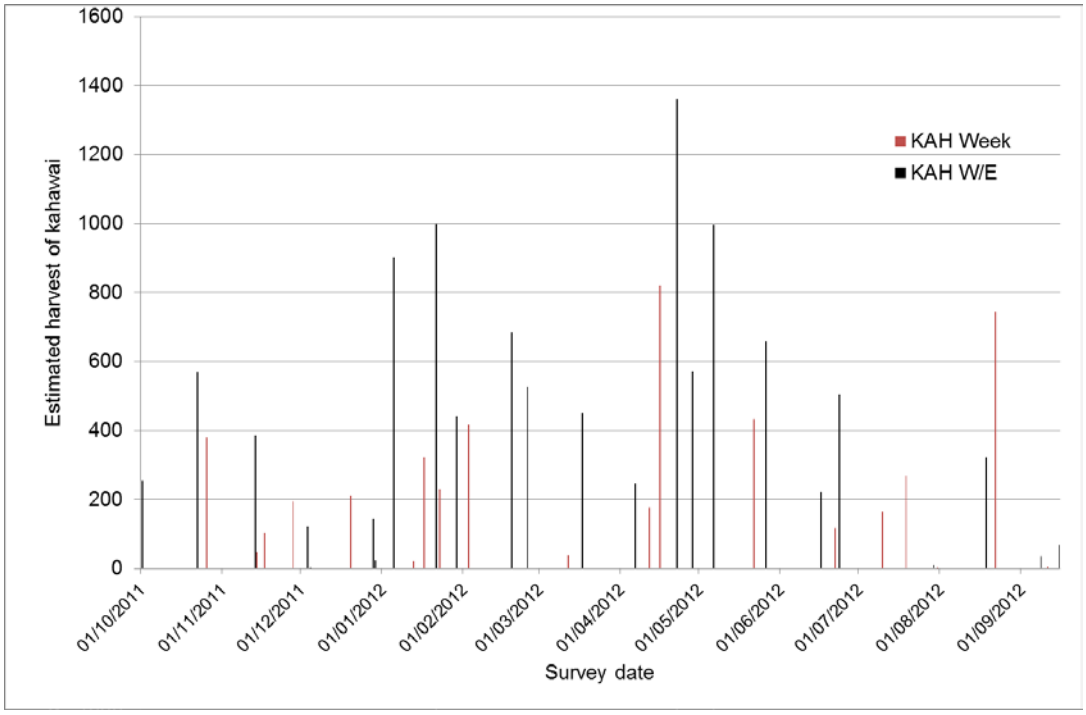

Figure 8: Daily harvest estimates (numbers) of kahawai in 2011–12 survey period by day type.

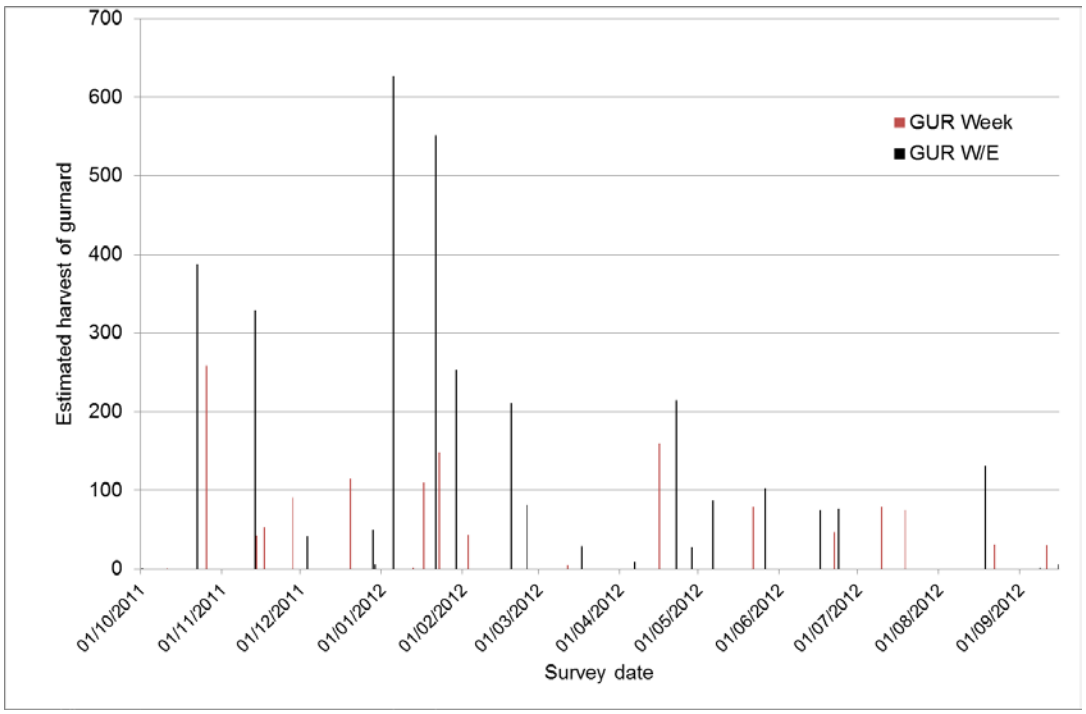

Figure 9: Daily harvest estimate (numbers) of red gurnard in 2011–12 survey period by day type.

The size distribution of red rock lobster by access point type is generally similar when stratified by year and sex (Figure 10). The main difference is for male rock lobster measured on roving surveys in 2010–11, which shows fewer fish under 60 mm tail width than were encountered on the main ramps or marinas. Measurements from one main ramp interviewer who was found to be incorrectly measuring fish in 2010–11 were removed. There is enough similarity between access point types to combine these length frequency distributions to look for differences by bus route areas.

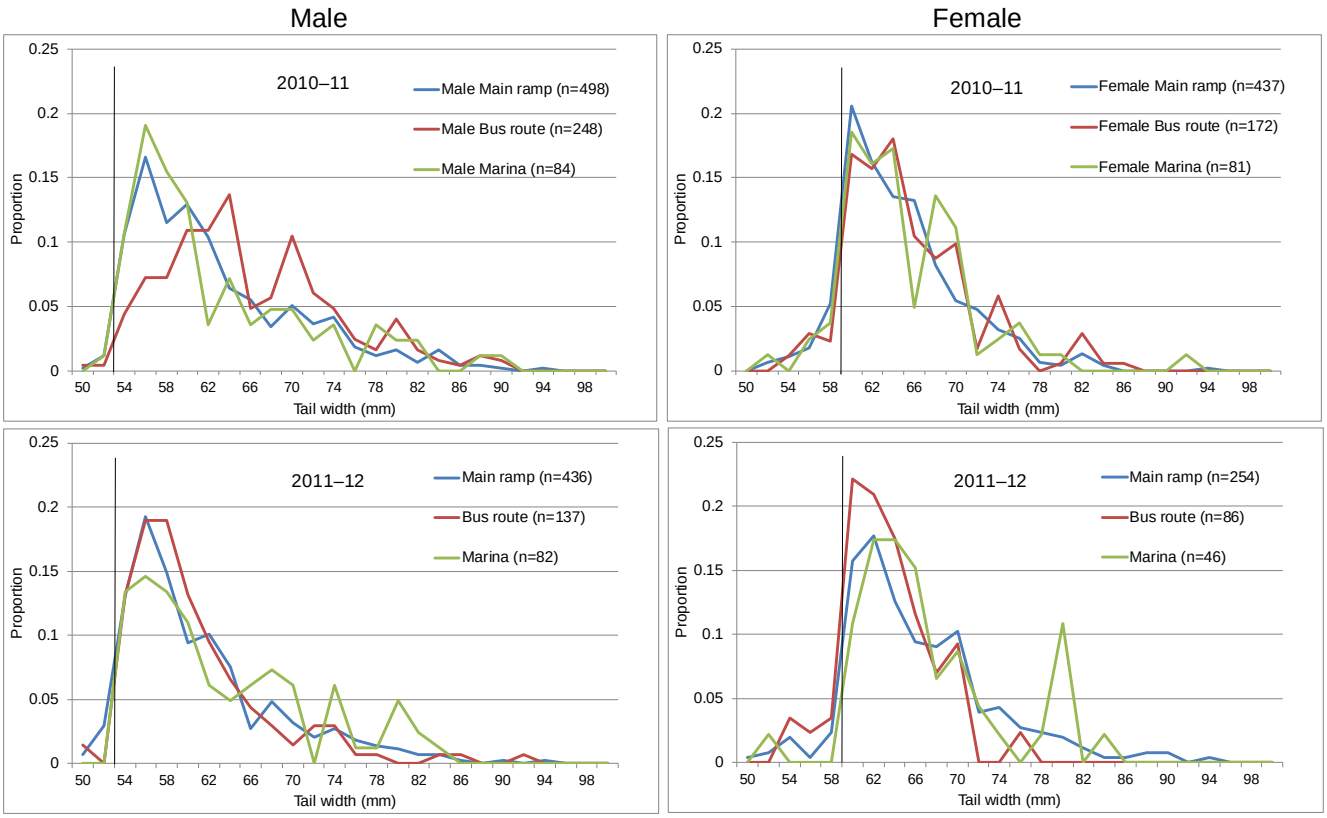

Figure 10: Rock lobster tail width distribution by sex and fishing year as a proportion of those measured at each survey site strata.

The three bus routes with the most data also have main ramps and marinas within each area. Rock lobster lengths from all access points in the Whangapoa to Whitianga area (route 2), Tairua to Whangamata area (route 4), and Waihi to Tauranga area (route 5) are compared in Figure 11. In 2010–11 the southern area has a larger proportion of large rock lobster (females greater than 70 mm and males greater than 75 mm tail width) than the other two areas, which show similar distributions. In 2011–12 the southern region has a lower sample size with a few larger rock lobster, but overall a similar distribution to the other areas (Figure 11). Catch in the southern area was affected by the *Rena* disaster especially in the summer strata.

Sample sizes of rock lobster for the three bus route areas which do not have main ramps or marinas were small and no conclusions should be drawn. These were the Port Charles to Kennedy Bay route (far north, route 1), Cooks Beach to Hahei (mid-north, route 3), and Bell Road to Maketu (far south, route 6) (Figure 12).

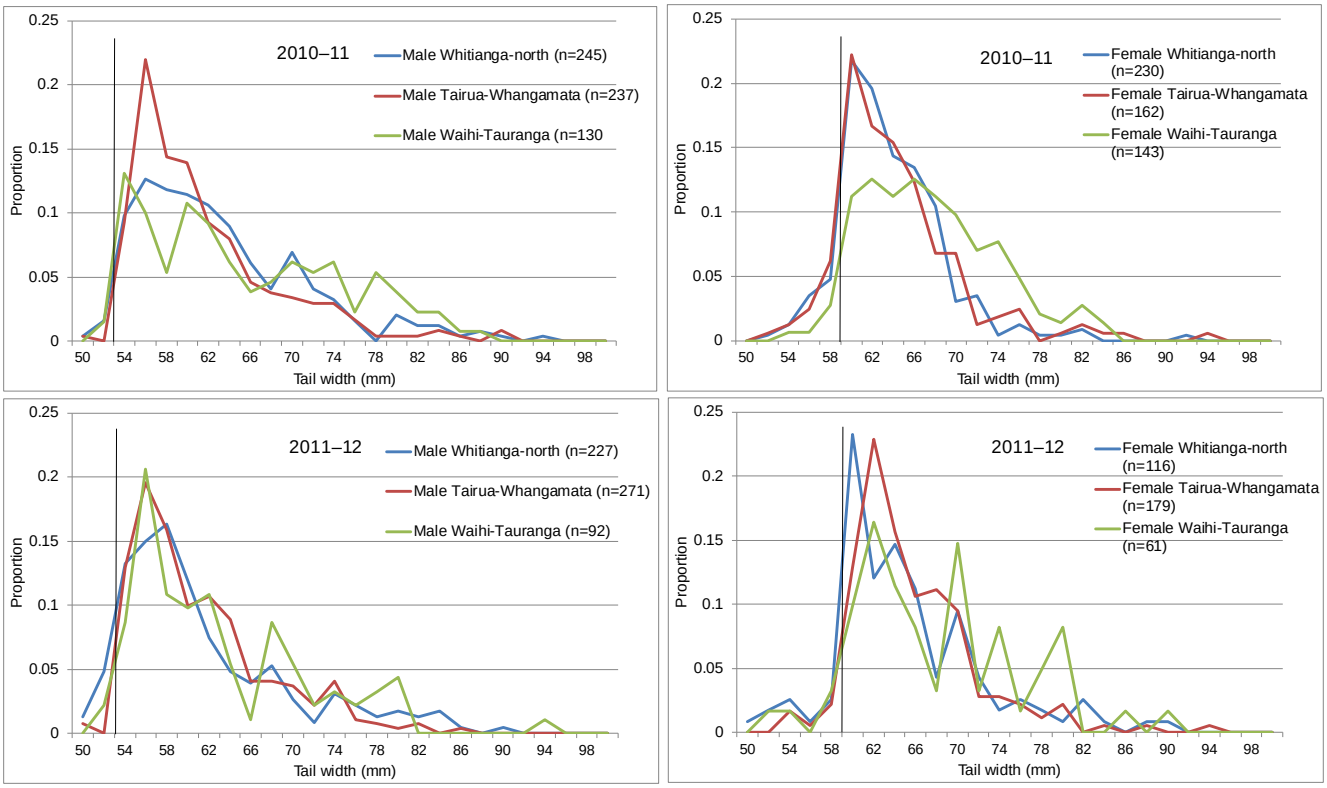

Figure 11: Red rock lobster tail width distribution as a proportion of measured fish by year (2010–11 top row) and sex (male left column) for three bus route strata, including fish landed at main ramps and marinas in that area.

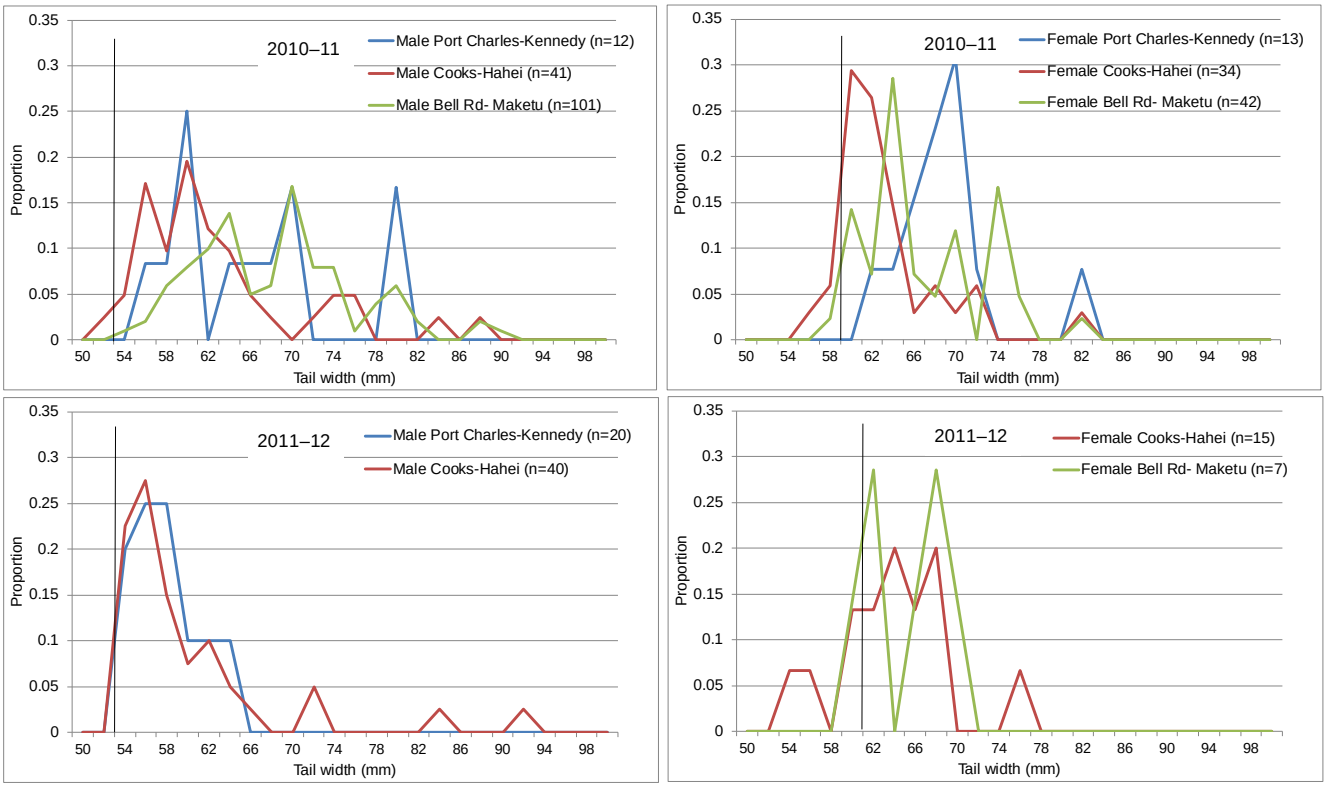

Figure 12: Rock lobster tail width distribution as a proportion of those measured by year and sex for three bus route strata with few rock lobster encountered. Route six Bell Road to Maketu males 2011–12 and route one Port Charles to Kennedy Bay females 2011–12 were left out because they had very small sample sizes.

The return time of vessels was recorded by interviewers. The proportion of vessels returning by hour across all ramps and seasons was very similar for the main ramps and bus route ramps (Figure 13). The start time for the seven hour marina sessions changed with time at dusk. On the longest days marina sessions would start at 1400 hrs and on the shortest winter days sessions would start at 1100 hrs. Data from 1400 hrs on show that the proportion by hour of vessels returning to marinas is similar to that at ramps, but with the peak hour between 1600 and 1700 hrs, one hour later than at the ramps (Figure 14).

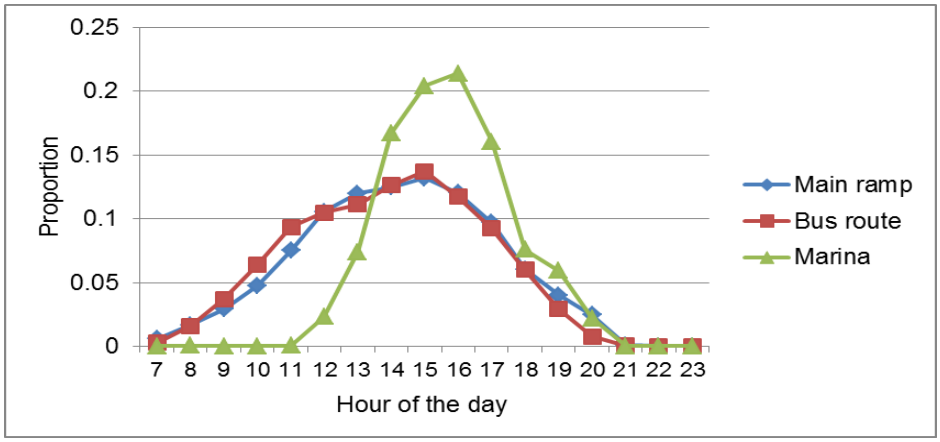

Figure 13: Vessel return times for all boats fishing and not fishing and all seasons by access point type.

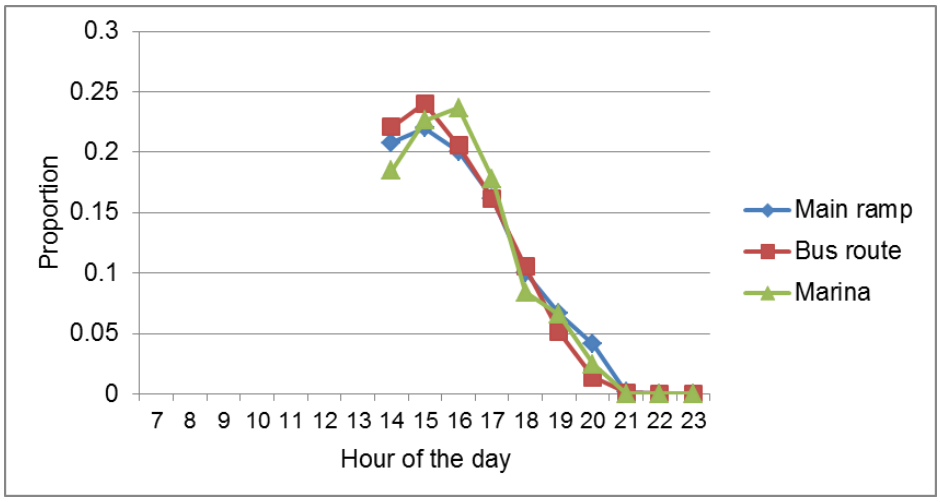

Figure 14: Vessel return times for all boats fishing and not fishing and all seasons after 1400 hours by access point type.

Most of the completed interviews for trips that included some fishing were recorded on the main ramps (70%), while 19% were recorded at bus route ramps. To look for differences in return time by area, data from main ramps and bus routes was combined in 20 minute time steps for each bus route. The winter data, which came from shorter survey days, was not included (Figure 15). Bus routes 1, 3 and 6 had no main ramps. Route 1 had few interviews with fishers and is not shown. Bus routes 2, 4 and 5 include two main ramps each (Appendix 1). The distribution of summer return times for each route is very similar between years, especially where sample size is large. The distribution for route 2 is more domed than the others with no value reaching 0.05 for a 20 minute time bin, but when overlaid on distributions from other areas there is little difference (Figure 15). Return rates at boat ramps are generally high between 1200 and 1800 hrs for all routes shown summed by 2 hour time bins (Table 6).

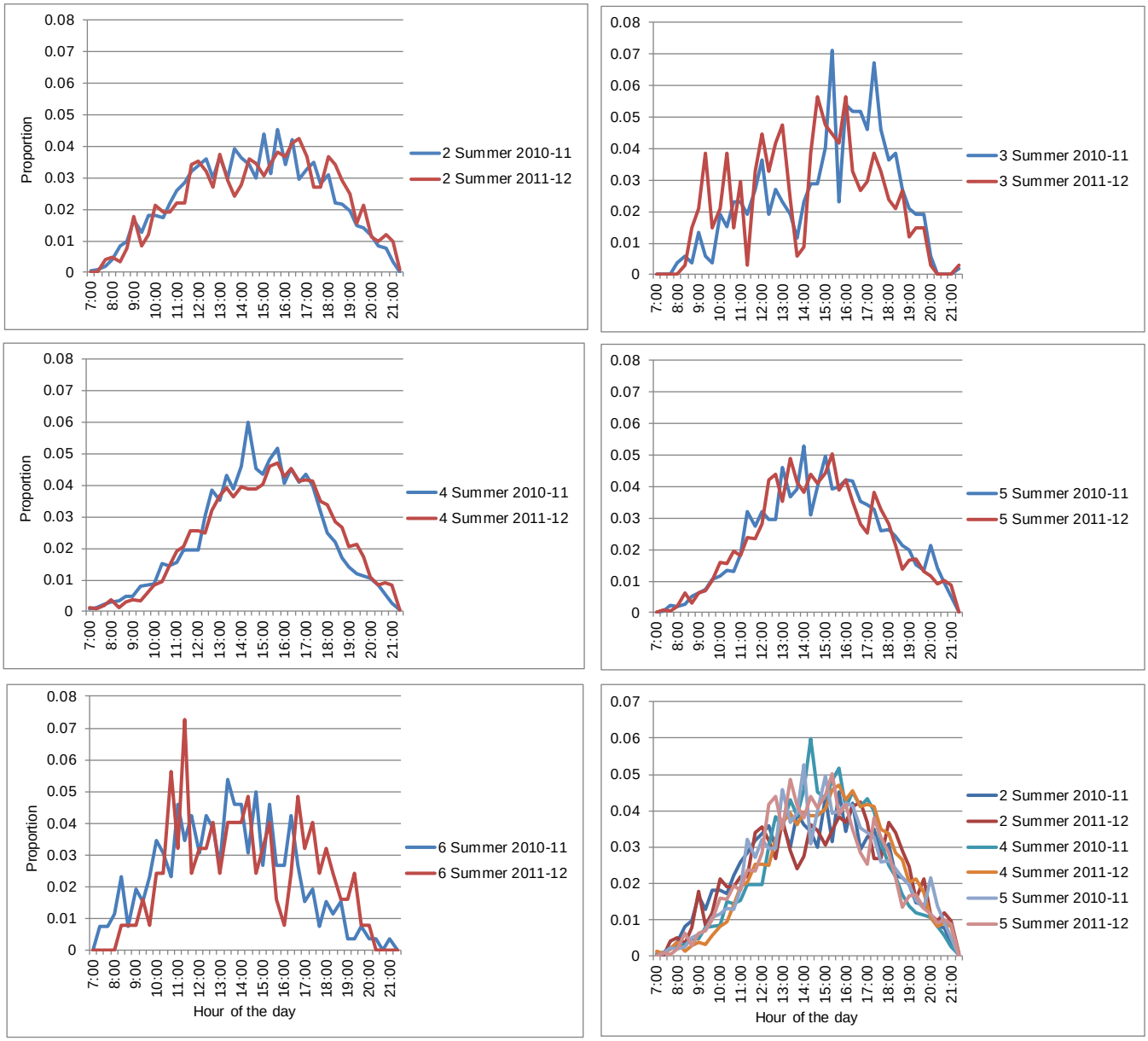

Figure 15: Proportion of return times for boats fishing by bus route and year for routes 2 to 6 for summer strata only and overlaid for main routes (bottom right) in 20 minute time steps.

Table 6: Proportion of return times for boats fishing for bus routes 2 to 6 for summer strata by fishing year in 2 hour time bins.

	Route 2		Route 3		Route 4		Route 5		Route 6	
2 hour time bin	Sum. 10/11	Sum. 11/12	Sum 10/11	Sum 11/12	Sum 10/11	Sum 11/12	Sum 10/11	Sum 11/12	Sum 10/11	Sum 11/12
8:00	0.070	0.055	0.036	0.092	0.032	0.021	0.034	0.035	0.100	0.048
10:00	0.144	0.137	0.127	0.139	0.093	0.097	0.115	0.117	0.212	0.234
12:00	0.206	0.185	0.136	0.196	0.206	0.195	0.213	0.239	0.238	0.210
14:00	0.221	0.202	0.215	0.237	0.294	0.251	0.252	0.256	0.227	0.202
16:00	0.202	0.211	0.317	0.217	0.242	0.248	0.212	0.201	0.138	0.177
18:00	0.123	0.162	0.161	0.113	0.101	0.148	0.120	0.110	0.058	0.121
20:00	0.031	0.044	0.008	0.006	0.028	0.037	0.050	0.040	0.012	0.008

Expanded amateur harvest by number

The mean harvest per day within each stratum is used to estimate the total harvest by species in numbers of fish, with variance, for the fishing year using the expansion methods described above (adapted from Pollock et al. 1994). There are effectively six strata for each species in each season and year (2 day types × 3 location types). The expanded harvest estimates and variance in numbers of fish for each stratum and the combined total by species from boat based fishers in the survey area for each season are provided in Tables 7 to 10.

Table 7: Scallop harvest estimates (numbers of fish) and CVs by season for 2010–11 and 2011–12.

		Summer 2010–11		Winter 2010–11		Summer 2011–12		Winter 2011–12	
		Harvest SCA	%CV SCA	Harvest SCA	% CV SCA	Harvest SCA	% CV SCA	Harvest SCA	% CV SCA
Main ramps	WkDay	55 143	27.7	12 225	95.3	28 242	29.0	0	0.0
	WE/Hol	73 170	21.2	8 390	38.4	70 598	36.0	317	89.4
Marinas	WkDay	2 900	64.1	3 960	31.8	8 175	46.7	563	94.9
	WE/Hol	11 563	25.2	1 680	37.1	17 495	20.6	0	0.0
Bus-Stop	WkDay	63 307	51.0	11 917	95.3	15 725	55.2	0	0.0
	WE/Hol	90 677	19.5	3 032	1.7	76 412	36.0	238	154.9
Scallop harvest total		296 760	14.5	41 204	40.4	216 647	18.3	1 117	63.4
Percentage of previous year						73%		3%	

Table 8: Rock lobster harvest estimates (numbers of fish) and CVs by season for 2010–11 and 2011–12.

		Summer 2010–11		Winter 2010–11		Summer 2011–12		Winter 2011–12	
		Harvest CRA	% CV CRA	Harvest CRA	% CV CRA	Harvest CRA	% CV CRA	Harvest CRA	% CV CRA
Main ramps	WkDay	2 325	30.1	418	63.2	1 710	30.9	674	47.5
	WE/Hol	3 805	16.3	889	44.0	2 629	26.0	767	34.2
Marinas	WkDay	142	44.7	14	96.3	354	49.8	317	64.6
	WE/Hol	1 000	19.9	119	57.9	474	24.6	317	37.9
Bus-Stop	WkDay	3 382	33.5	0	0.0	710	42.6	0	0.0
	WE/Hol	5 517	20.9	881	56.8	2 461	30.5	162	86.5
Rock lobster harvest total		16 171	11.6	2 320	29.8	8 338	14.4	2 236	22.2
Percentage of previous year						52%		96%	

Table 9: Kahawai harvest estimates (numbers of fish) and CVs by season for 2010–11 and 2011–12.

		Summer 2010–11		Winter 2010–11		Summer 2011–12		Winter 2011–12	
		Harvest KAH	% CV KAH	Harvest KAH	% CV KAH	Harvest KAH	% CV KAH	Harvest KAH	% CV KAH
Main ramps	WkDay	19 360	23.6	1 227	32.1	7 585	37.4	6 498	36.64763
	WE/Hol	26 541	19.4	9 916	32.5	14 870	21.6	6 271	30.2
Marinas	WkDay	4 117	15.4	184	70.6	1 250	40.0	596	65.3
	WE/Hol	5 202	20.5	2 159	29.5	3 483	24.1	1 495	54.8
Bus-Stop	WkDay	25 898	20.6	2 273	39.1	21 907	24.7	16 319	46.1
	WE/Hol	32 694	14.6	8 555	39.4	19 132	14.8	8 055	31.7
Kahawai harvest total		113 812	8.8	24 313	19.8	68 228	11.0	39 233	21.8
Percentage of previous year						60%		161%	

Table 10: Red gurnard harvest estimates (numbers of fish) and CVs by season for 2010–11 and 2011–12.

		Summer 2010–11		Winter 2010–11		Summer 2011–12		Winter 2011–12	
		Harvest GUR	% CV GUR	Harvest GUR	% CV GUR	Harvest GUR	% CV GUR	Harvest GUR	% CV GUR
Main ramps	WkDay	5 758	27.5	1 828	77.5	3 857	33.0	3 600	26.31227
	WE/Hol	13 841	21.1	6 946	28.4	6 963	27.9	2 096	27.5
Marinas	WkDay	1 497	18.6	502	93.3	763	41.0	227	38.1
	WE/Hol	2 320	25.9	856	46.3	1 208	24.7	408	33.0
Bus-Stop	WkDay	5 977	31.3	723	92.9	6 068	27.7	762	63.9
	WE/Hol	12 075	22.0	4 643	35.8	5 582	25.8	200	30.3
Red Gurnard harvest total		41 469	11.3	15 497	19.9	24 441	13.2	7 292	16.8
Percentage of previous year						59%		47%	

Harvest weight by species in the survey area

Total harvest in tonnes greenweight by fishing year and species are shown in Table 11. Project MAF-2011/03 collected length frequency data in the survey area in 2011–12. This was combined with length frequency data collected in this survey to give estimates of mean weight of the survey species (Hartill and Davey 2015). The estimated scallop harvest for boat based amateur fishers in the western Bay of Plenty during 2010–11 is 35.5 t greenweight, which is equivalent to 4.7 t meatweight using standard conversion factors (Ministry of Fisheries 2011). The mean weight was heavier in 2011–12 but fewer scallops were recorded, giving a harvest estimate of 24.1 t which is equivalent to 3.0 t meatweight (Table 11).

The scallop season is closed for most of the winter strata, opening on 1 September. The survey days in September 2012 all suffered from high winds and few boat trips or scallops were recorded. For management purposes September 2012 is part of the 2012–13 scallop fishing year. The amateur harvest from 1 September 2011 to 30 April 2012 totalled 255 744 scallops or 28.3 t (15.8) using the 2011–12 mean greenweight. This is equivalent to 3.5 t meatweight for the survey area.

The rock lobster harvest by boat based amateur fishers in the western Bay of Plenty was estimated at 9.2 t (8.3) in 2010–11, with fewer fish recorded but a heavier mean weight in 2011–12 giving an estimate of 7.4 t (12.3) (Table 11). However, the survey year is not aligned to the rock lobster fishing year used for management. The estimated boat based amateur harvest for 1 April 2011 to 31 March 2012 is 9.1 t (14.8) for the survey area using the 2011–12 mean weight.

Table 11: Harvest estimates by species and access point strata for 2010–11 and 2011–12 surveys in greenweight (t). Mean weights for scallop and rock lobster are estimated from the length frequency of measured fish each year.

		Scallop		Rock lobster		Kahawai		Red Gurnard	
2010–11 Mean Weight (g)		104.905		741.020		1487.276		403.261	
Year	Access point type	Green Wt (t)	% CV	Green Wt (t)	% CV	Green Wt (t)	% CV	Green Wt (t)	% CV
2010–11	Main	15.6	16.7	5.5	14.1	84.8	13.4	11.4	14.5
2010–11	Marina	2.1	18.6	0.9	17.3	17.3	12.0	2.1	17.4
2010–11	Bus route	17.7	22.8	7.2	17.3	103.2	8.0	9.4	9.9
2010–11	**Total**	**35.5**	**13.6**	**13.7**	**10.8**	**205.4**	**6.5**	**23.0**	**7.8**

		Scallop		Rock lobster		Kahawai		Red Gurnard	
2011–12 Mean Weight (g)		110.472		699.648		1521.225		403.261	
Year	Access point type	GreenWt (t)	% CV	Green Wt (t)	% CV	Green Wt (t)	% CV	Green Wt (t)	% CV
2011–12	Main	11.0	26.9	4.0	16.7	53.6	16.7	6.7	16.7
2011–12	Marina	2.9	20.1	1.0	18.6	10.4	18.6	1.1	18.6
2011–12	Bus route	10.2	31.3	2.3	30.6	91.0	12.7	5.1	30.6
2011–12	**Total**	**24.1**	**18.2**	**7.4**	**12.3**	**155.0**	**9.2**	**12.8**	**10.9**

The lower number of trips recorded in the second year of the survey translates into lower harvest for the species surveyed. Red Gurnard harvest weight was 44% lower in 2011–12 than in the previous year and kahawai harvest was down by 26%. It is possible that the grounding of the *Rena* affected the harvest in the Tauranga area (Waihi to Maketu) especially in the summer strata of 2011–12. However the proportion of total red gurnard harvest taken from the Tauranga area in summer 2011–12 (39%) was only slightly down on the proportion harvested in the area in 2010–11 (43%). The harvest in number of red gurnard by area had CV values between 16% and 23%.

The summer harvest of kahawai from the Tauranga area in 2011–12 was 56% of the total for the whole survey area. This proportion was only slightly less than the 2010–11 summer harvest of kahawai from the Tauranga area (59%). The harvest in number of kahawai by area had CV values between 9% and 16%.

There was a more significant reduction in the proportion of summer harvest of scallops and rock lobsters taken in the Tauranga area in 2011–12. The proportion of the surveyed harvest of scallops in this area declined from 11% in 2010–11 to 5% in 2011–12, with CVs between 15% and 28% by area. The proportion of annual harvest of rock lobster from the Tauranga area fell from 29% to 12% in 2011–12, with CVs between 14% and 25% by area.

Harvest from areas closed to commercial scallop fishing

Fishers were asked to identify where they fished on a show card with area grids. These maps also identified areas closed to commercial scallop fishing and fishers were asked whether the scallops landed came from inside or outside these areas (maps in Appendix 3). A high proportion of amateur scallop harvest came from the closed areas especially in 2011–12 (88%) (Table 12). The proportion of harvest from closed areas was smaller in 2010–11, especially at secondary ramps surveyed using the bus route method (Table 12). Overall the estimated greenweight of scallops harvested from boats by amateur fishers in these areas was 19.2 t (13.8) in 2010–11 and 21.2 t (18.4) in 2011–12.

Table 12: Number of scallops harvested from areas closed to commercial scallop fishing by access point type for 2010–11 and 2011–12 survey year and the proportion of the harvest from all areas surveyed. Annual totals are converted to greenweight (t),

					Scallop
Year	Access point type	Harvest	SE	% CV	Proportion
2010–11	Main	130 891	22 771	17.4	0.88
2010–11	Marina	12 347	2 583	20.9	0.61
2010–11	Bus route	40 067	10 890	27.2	0.24
2010–11	Total	183 305	25 373	13.8	0.54
Greenweight (t)		**19.2**			
Year	Access point type	Harvest	SE	% CV	
2011–12	Main	87 482	23 874	27.3	0.88
2011–12	Marina	22 693	4 858	21.4	0.87
2011–12	Bus route	82 083	25 720	31.3	0.89
2011–12	Total	192 258	35 428	18.4	0.88
Greenweight (t)		**21.2**			

Expansion of harvest to whole quota management areas

The off-site NPS survey generates harvest estimates for whole Quota Management Areas (QMAs) and for the same western Bay of Plenty area as this access point survey. The initial harvest estimates are available by area and platform (type of boat or land based fishing). The boat based rock lobster harvest from the access point survey was scaled up 2.46 times to give the boat based harvest estimate

for all of CRA 2 (Table 13 and 14). The red gurnard estimate was scaled up 6.57 times for all of GUR 1 which is a large area from Tirau Point on the west coast to Cape Runaway on the east coast. The harvest from land based methods is added to the scaled boat based estimate. (See Appendix 4 for data tables used in scaling).

The harvest estimates generated for QMAs should be treated with caution (Tables 13 and 14). They rely on the accuracy of NPS harvest estimates by area and method. In fisheries with lower participation rates such as scallop and rock lobster the catch of a few diarists may be unduly influential. The estimate and parametric SE for each value was used to bootstrap values and estimate CVs for 2011–12. This was a relatively simple way to find the standard errors.

Table 13: Harvest estimates from this survey scaled up to QMAs for each species using boat based harvest from the NPS boat based harvest by area (QMA:Western Bay of Plenty) and the proportion of harvest from other methods for 1 October 2010 to 30 September 2011.

2010–11	Scallops		Rock lobster		Kahawai		Red Gurnard	
QMA	SCA CS	% CV	CRA 2	% CV	KAH 1	% CV	GUR 1	% CV
Boat based scalar	4.13	53.70	2.46	46.8	4.34	30.7	6.57	46.5
Scaled on-site boat based harvest (numbers)	1 373 945		45 489		598 725		374 401	
Scaled for other harvest	207 729		9 772		277 829		54 568	
Total numbers	1 581 674		55 260		876 554		428 969	
Weight (t) by QMA	165.9		40.9		1332.4		173.4	
Meatweight	21.8							

Table 14: Harvest estimates from this survey scaled up to QMAs for each species using boat based harvest from the NPS boat based harvest by area (QMA:Western Bay of Plenty) and the proportion of harvest from other methods for 1 October 2011 to 30 September 2012.

2011–12	Scallops		Rock lobster		Kahawai		Red Gurnard	
QMA	SCA CS	% CV	CRA 2	% CV	KAH 1	% CV	GUR 1	% CV
Boat based scalar	4.13	53.70	2.46	46.8	4.34	30.7	6.57	46.5
Scaled on-site boat based harvest (numbers)	895 693	57.30	26 014	48.8	441 668	32.3	208 564	46.7
Scaled for other harvest	135 421	141.9	5 588	51.2	204 949	35.0	30 398	53.5
Total numbers	1 031 115	56.8	31 602	47.1	646 617	32.0	238 961	45.3
Weight (t) by QMA	113.9		22.1		982.9		96.6	
Meatweight	14.2							

Plotting Rho for the bus routes

The ratio of the expanded catch to the observed catch (Rho) is highest for the bus route method. Total daily harvest for each species and route is scaled up by the length of the fishing day and ramp wait times (Equations 5 and 6). Rho is highest in route 1 which traversed the beaches in the remote north eastern Coromandel, and only had half day survey coverage (Figure 16). Data for rock lobster are

plotted but Rho for other species will be the same for those days. Days when no rock lobster were caught are not plotted. Wait times were revised at the end of 2010–11 for the 2011–12 survey period. Rho changes for route 1 in 2011–12 and as there was only one day with observed rock lobster catch in routes 5 and 6, these data are not plotted (Figure 17).

Route 3 had two larger ramps (Cooks Beach and Hahei) and most of the survey day was split between them. Route 4 had one large ramp (Pauanui) and most time was spent there in 2011–12 as there was little effort at other ramps on the route (Figure 17). Kahawai was encountered on most routes when the weather was favourable. Plots of Rho for this species show that Rho is highest on routes which have more small ramps with short wait times (Figure 18).

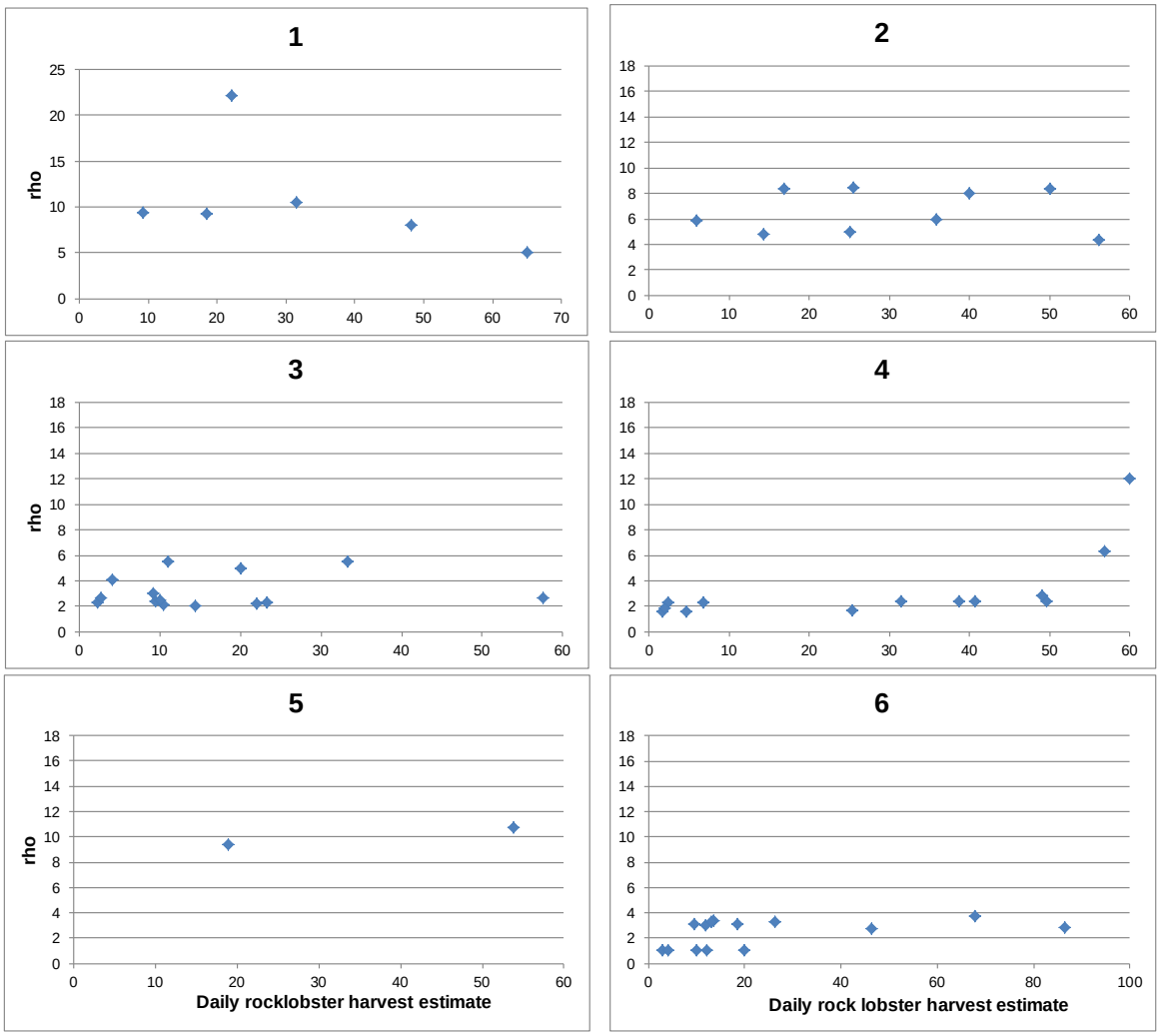

Figure 16: Rho for rock lobster harvest estimates for each survey day with catch in 2010–11, with expanded harvest total for that day on the x axis for bus routes 1 to 6.

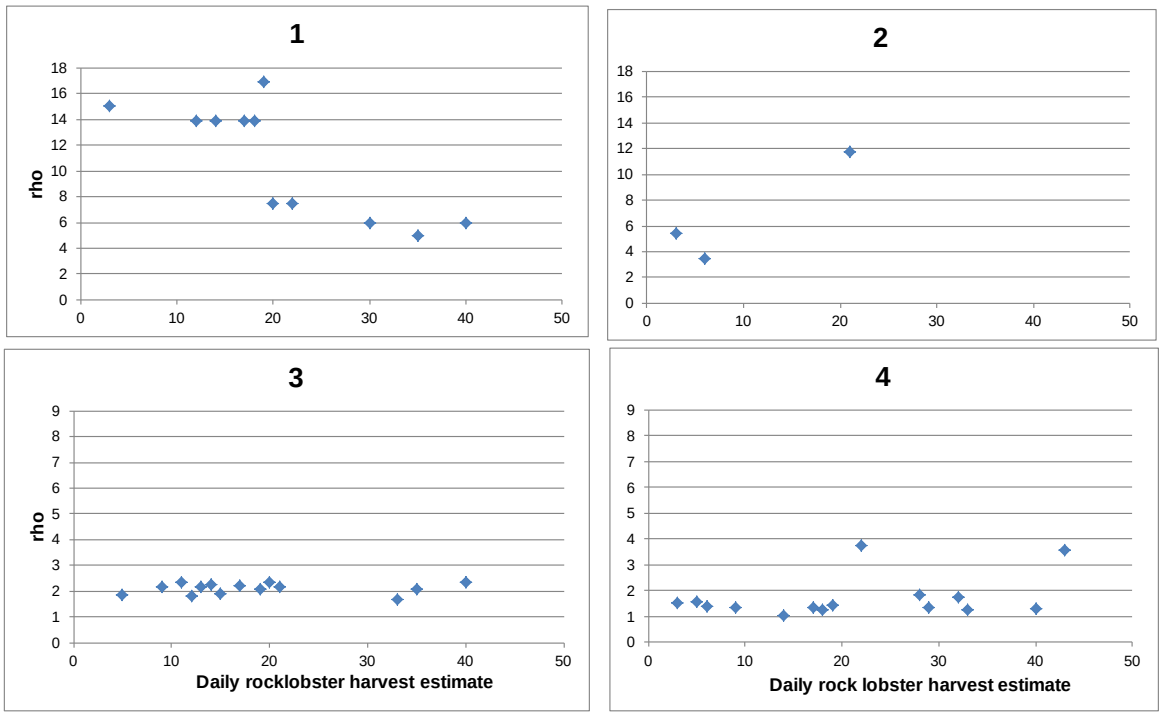

Figure 17: Rho for rock lobster harvest estimates for each survey day with catch in 2011–12, with expanded harvest total for that day on the x axis for bus routes 1 to 4. There was almost no data for routes 5 and 6.

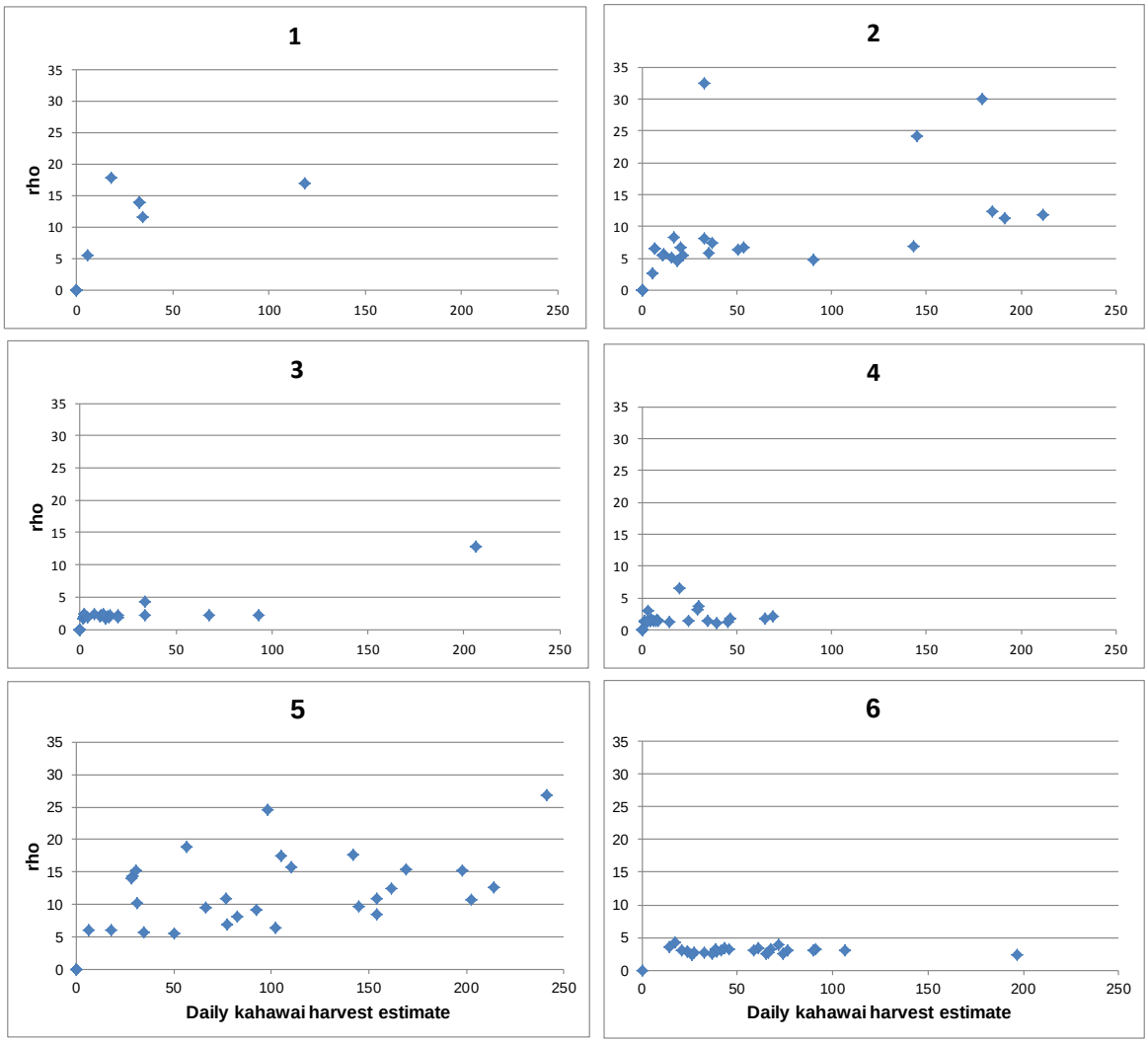

Figure 18: Rho for kahawai harvest estimates for each survey day with catch in 2011–12, with expanded harvest total for that day on the x axis for bus routes 1 to 6.

Catch rate for rock lobster

Interviewers recorded the number of people fishing or diving and the number of minutes diving for scallops or rock lobster. Data collected in 2010–11 did not separate diver effort for scallops and rock lobster when they were both targeted on the same trip. A redesigned form in 2011–12 allowed separate recording of effort by species. SCUBA was the most successful method for catching rock lobster with just 20% of trips unsuccessful and an average catch from positive trips of 1.85 harvested per person per trip (Table 14). Just over a quarter of free dive trips targeting rock lobster were reported as unsuccessful, with an average of 1.53 rock lobster per person or just over two per hour from positive trips. Eighty one trips were recorded where rock lobster pots were checked, with 53% of these unsuccessful. The average catch from positive potting trips was 1.33 per person but it is difficult to attribute the number of people involved or a fishing time for potting (Table 14).

Table 15: The proportion of trips targeting rock lobster with no catch (Pzero) and the mean catch rates per person and per hour by method when rock lobster were caught in 2011–12.

Rock lobster		Positive catch/person		Positive catch/hour	
	Pzero	Mean	SD	Mean	SD
SCUBA	0.20	1.85	1.50	3.42	3.12
Free dive	0.26	1.53	1.29	2.09	1.59
Pot	0.53	1.33	1.16		

4. CONCLUSIONS

The Western Bay of Plenty is popular with amateur fishers particularly during holiday periods, when it attracts people from nearby population centres in the Auckland, Waikato, and Bay of Plenty regions. This area is second only to the Hauraki Gulf for boat based amateur fishing effort in New Zealand (Hartill et al. 2007). Fishers target scallops and rock lobster as part of their day on the water or as the dedicated purpose of the trip.

This survey collected data for two years from 1 October 2010 to 30 September 2012 from amateur fishers using boats and access points between Port Charles and Maketu. Robust harvest estimates for scallop and rock lobster are the main focus of the survey. Harvest estimates are also calculated for kahawai and red gurnard to provide additional comparisons with two concurrent amateur harvest surveys, the national NPS survey by NRB (Wynne-Jones et al. 2014) and the FMA 1 aerial overflight survey by NIWA (Hartill et al. 2013).

It is useful to compare data from the two fishing years in this survey especially because of significant disruption following the grounding of the container vessel *Rena* and the subsequent oil spill 10 km from Tauranga in October 2011. A large exclusion zone was in place from 12 October 2011 until December 2011 (Appendix 5). This mostly affected fishing and diving effort in the Tauranga area but strong onshore winds also adversely affected fishing across the whole survey area in the summer of 2011–12.

A total of 16 803 boat trips were observed in 2010–11 across 45 survey days, including vessels not intercepted and trailers remaining at the end of the day at main ramps. The 13 876 completed interviews showed that 85% of trips involved some fishing activity with estimated harvest on survey days of over 31 000 scallops and 1600 rock lobster.

A total of 12 514 boat trips were observed in 2011–12 across 45 survey days, including vessels not intercepted and trailers remaining at the end of the day at main ramps. The 11 346 completed interviews show that 81% of trips involved some fishing activity with estimated harvest on survey days of over 22 000 scallops and 1200 rock lobster.

Catch and effort was not collected from boats returning to private waterways at Pauanui and Whitianga and many of the boats on swing moorings. Harvest from boats returning to marinas in the morning or staying out overnight on survey days could not be taken into account. Harvest estimates from this survey will underestimate the true boat based harvest from the survey area because not all boats were readily accessible on survey days.

Most of the observed harvest for all species (61% to 75%) was intercepted by interviewers at the main ramps. All day coverage meant that little scaling of this catch was required. It is difficult to survey all boats returning to large marinas because of the distance between vessels and poor visibility when interviewing from one of the marina piers. We employed one observer to record all vessels entering the marina and a second observer to conduct interviews. The most significant scaling was from the observed harvest on secondary ramps covered by roving interviewers. Wait times of several hours were used on larger ramps and these were scaled up to the length of the fishing day. The less used ramps tended to be beach launches, ramps further from population centres or more tidal. Scaling could overestimate harvest from low use ramps with short weight times if large catches were occasionally recorded. There were few instances where this occurred in this survey.

Return times for all boats are highest between 1200 and 1800 hrs. The distribution was similar within bus route areas for each year surveyed and broadly similar across the different areas. The proportion of return times by hour was very similar between the main ramps and secondary ramps with a peak between 1500 and 1600 hrs. The peak return time in marinas was a little later, 1600 to 1700 hrs.

Rock lobster harvest occurs year round with most catch recorded between November and March on weekends and holidays. Scuba is the main method from boats with about 10% taken by potting and 10% by free diving. There were more red rock lobster harvested with more fish 60 to 67 mm tail width in 2010–11 and more females than the following year. In 2011–12 there was an increase in the proportion of males between 54 and 60 mm. The size of rock lobster showed a slightly higher proportion of females greater than 70 mm and males greater than 75 mm in the Tauranga area in 2010–11. The Coromandel bus route areas had similar rock lobster size distributions.

The rock lobster harvest in numbers by amateur fishers in the survey area was estimated to be 18 491 in 2010–11 for a weight of 13.7 t (CV 10.8). The estimated harvest was significantly less in 2011–12 (10 574 rock lobster) giving a harvest weight of 7.4 t (12.3). Using the results of the NPS survey we scaled this estimate for all methods and all of CRA 2 to give an estimate of 22 t for 2011–12. The current allowance for amateur fishes in CRA 2 is 140 t for the 1 April to 31 March fishing year. The estimated harvest in the survey area only from 1 April 2011 to 31 March 2012 is 9.1 t (CV 14.8).

Scallop populations in the survey area are highly variable (Williams et al. 2013). There is a commercial dredge fishery on the main scallop beds in the area with a different open season (15 July to 21 December) and smaller size limit (90 mm) than the amateur fishery. Some near shore areas are closed to commercial fishers providing some spatial separation between commercial and amateur fishers (Appendix 3).

The open season for amateur fishers is 1 September to 31 March. Most catch recorded between November and March was on weekends and holidays with SCUBA the main harvest method from boats. In 2011–12 there were more scallops around 110 mm than in the previous season and fewer were under the 100 mm MLS (2.2%) and the mean weight increased by 5%. A higher proportion of amateur scallop harvest came from inside the closed areas in 2011–12 (88%), than in 2010–11 (55%).

The number of scallops harvested by amateur fishers in the survey area was estimated to be 338 000 in 2010–11 for a greenweight of 35.5 t (CV 13.6) and 4.7 t meatweight. The estimated harvest was significantly less in 2011–12 (218 000 scallops) but the mean weight from measured fish was higher giving a harvest weight of 24.1 t (CV 18.2) and 3.5 t meatweight. Using the results of the NPS survey we scaled this estimate for all methods and all of SCA CS to give a greenweight estimate of 114 t and a meatweight of 14.2 t for 2011–12. The allowance for amateur fishes in SCA CS was 10 t meatweight in 2010–11 and 7.5 t meatweight in 2011–12 for the 1 September to 31 March fishing year. The estimated harvest in the survey area only from 1 September 2011 to 31 March 2012 is 28.3 t (15.8) and 3.5 t meatweight.

Kahawai is an important component of amateur harvest in northern New Zealand, second to snapper in numbers. The fishing year is the same as the survey year and amateur harvest was estimated to be 138 125 fish in 2010–11 with a weight of 205 t in the survey area. Again the harvest was less in 2011–12 with 107 461 fish landed with a weight of 155 t in the survey area. Using the results of the NPS survey we scaled this estimate for all methods and all of KAH 1 to give an estimate of 1037 t for 2011–12. The current allowance for amateur fishes in KAH 1 is 900 t for the 1 October to 30 September fishing year.

Red gurnard is a popular target and bycatch species in northern New Zealand. Catches were highest from November to January in both years of the survey. The fishing year is the same as the survey year and amateur harvest was estimated to be 56 966 fish in 2010–11 with a weight of 23 t in the survey area. Again the harvest was less in 2011–12 with 31 733 fish landed with a weight of 13 t in the survey area. Using the results of the NPS survey we scaled this estimate for all methods and all of GUR 1 to give an estimate of 100 t for 2011–12. The TAC for red gurnard has not been reviewed so no allowance has yet been set for amateur fishes in GUR 1. The total allowable commercial catch is 2288 t for GUR 1 which spans the east and west coast of northern New Zealand.

This survey has provided detailed catch information for rock lobster and scallop fisheries for an area where boat based fishing takes a large component of the amateur harvest. The on-site coverage of all the main access points can provide robust harvest estimates for specialist fisheries that are difficult to survey in large scale off-site or overflight surveys. This method is most easily applied to areas with a limited number of high use access points suitable for all day coverage.

5. ACKNOWLEDGEMENTS

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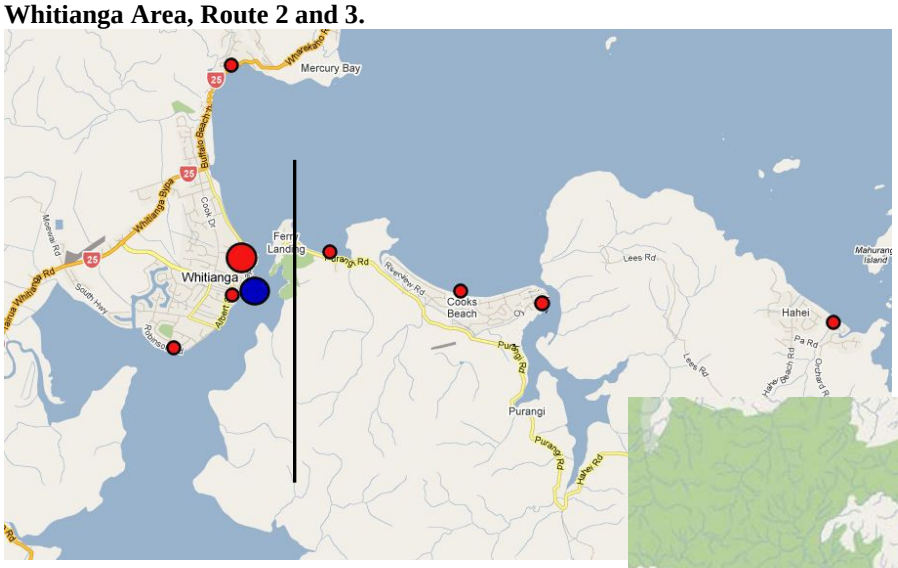
APPENDIX 1 ACCESS POINTS SAMPLED

Ramp_location	Ramp_Code	Route	
1: Northern Coromandel			
Kennedy Bay	KN	1	
Little Bay	LIB	1	
Port Charles	PCS	1	
Sandy Bay	SND	1	
Tuateawa	TUA	1	
Waikawau	WKU	1	
2: Whitianga North			
Buffalo Beach	BUF	2	
Kuaotunu	KU	2	
Kuaotunu beach (east) ramp	KUT	2	
Matarangi Ramp	MTR	2	
Matarangi ramp east	MTE	2	
Opito Bay Beach	OPB	2	
Roberstons Road	ROB	2	
Whangapoua Ramp	WGP	2	
Whitianga Marina	WTM	2	
Whitianga pontoon in Marina	WTN	2	
Whitianga Wharf Ramp	WT	2	
3: South of Whitianga			
Ferry Beach	FRY	3	Dropped
Cooks Beach	CKB	3	
Cooks Beach Marine Parade	CKM	3	
Hahei Beach	HAH	3	
4: Whangamata North			
Opoutere	OPU	4	
Pauanui	PN	4	
Paunui Pleasant Point	PNP	4	
Tairua Boat Club	TR(2)	4	
Tairua Ramp	TR	4	
Whangamata Marina	WGM	4	
Whangamata Ramp	WMR	4	
5: Tauranga Area			
Anzac Bay (Bowentown Reserve)	ANZ	5	
Bowentown	BO	5	
Fergusson Park	FGP	5	Dropped
Katikati/Tanners Point	KK	5	
Mount Maunganui Ramp	MMR	5	
Omokoroa	OMO	5	
Plummers Point	PLU	5	
Sulphur Point Marina	SUM	5	
Sulphur Point Ramp	SU	5	
Sulphur Point South	SUS	5	
Tauranga Bridge Marina	TRM	5	
Tauranga Harbour Bridge	TGH	5	
Te Puna Estuary	TPE	5	
Waihi Beach	WII	5	
6: Maketu Area			
Bells Road Papamoa	BEL	6	
Kaituna River	KR1	6	
Maketu	MK	6	

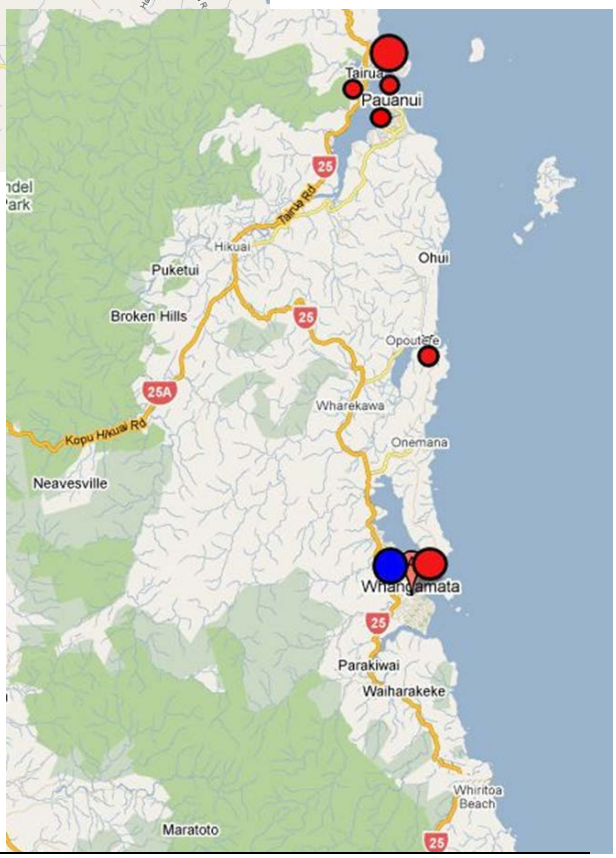
Location of Access points sampled

Northern Coromandel, Route 1 and 2

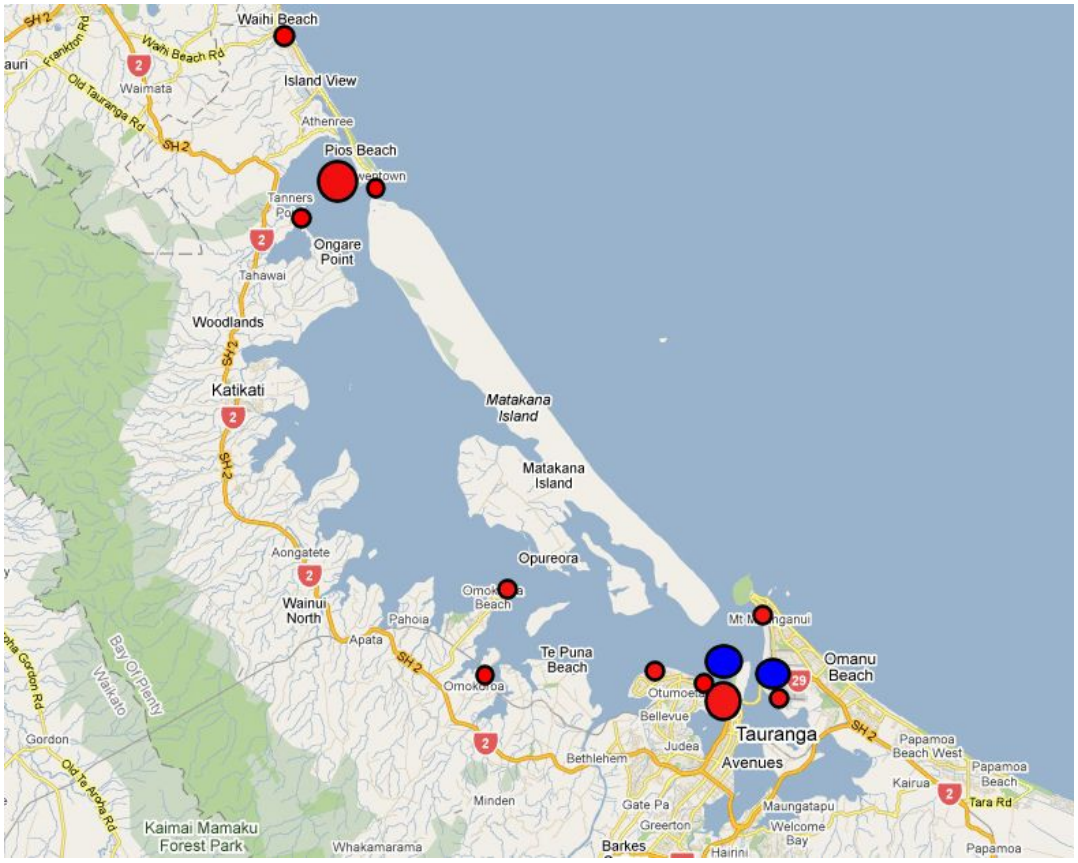
Whitianga Area, Route 2 and 3.



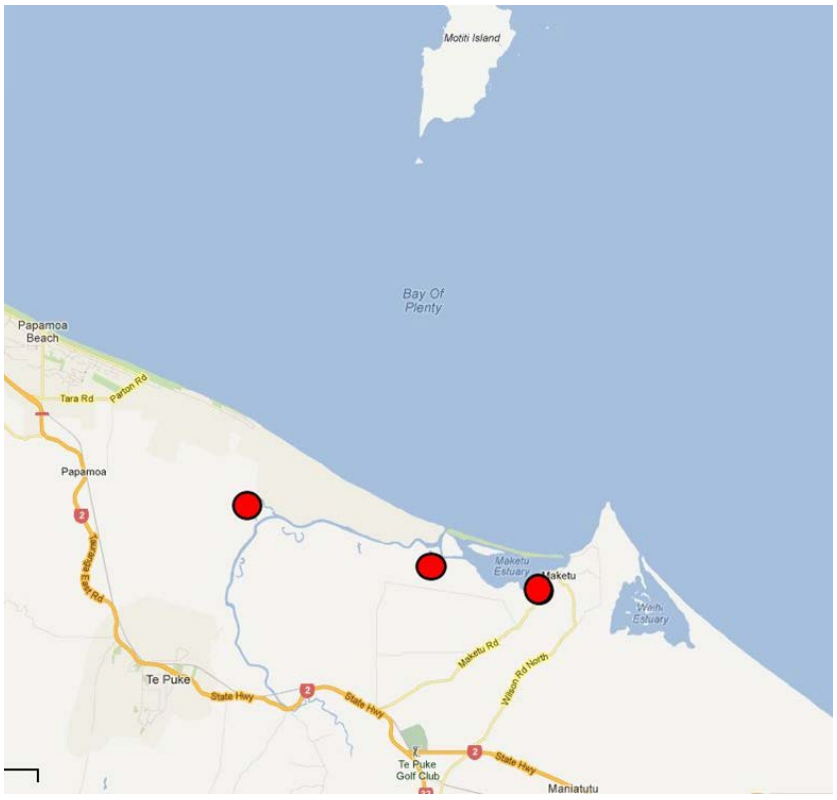
Tairua to Whangamata, Route 4



Waihi Tauranga, Route 5.



Bells Road to Maketu Route 6



APPENDIX 2
Survey Forms

Figure A1: Survey Session form as modified in August 2011

Harvest Survey Kahawai, Gurnard, 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 Name

Wind Strength Knots: Start | Finish

Wind Direction: Start | Finish

Sea state tick: Calm | Choppy | Rough | Storm

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

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

Boat codes: **T** Trailer; **L** Launch; **C** Charter; **Y** Yacht; **K** Kayak; **J** Jet ski

KAH fishing methods: **BA** Line bait; **BJ** Bait and jig; **TL** trolled lure; **JI** Rod jig; **LL** Longline; **SN** Set net; **PL** Soft bait

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

Boat #	Intercept Code	Return Time	Launch Time	Fishing Y/N	Main Target, Fishing For	Also Fishing For	Boat Code	# of People Fishing	KAH Method Code	# KAH kept	# GUR kept	KAH GUR Fishing Loc	SCA Method Code	# of People Fishing for SCA	# of Tanks Used SCA	Total Time (m) Diving Dredgin	# SCA Kept	SCA Fishing Loc	SCA Rec Area Y/N both	CRA Method Code	# of People Fishing for CRA	# of Tanks or Pots Used CRA	Total Time (m) Diving Potting	# CRA Kept	CRA Fishing Loc

Figure A2: Survey catch sampling sheet as modified in August 2011

Recreational Harvest Survey Scallops and Rock Lobster

Catch Sampling Sheet

Page of

Ramp Code	Date	Session #	Interviewer Name

Boat #	# Fishers	Boat #	# Fishers

Total # SCA:	Total # CRA	Total # SCA:	Total # CRA
# SCA Sample:	# CRA Measured	# SCA Sample:	# CRA Measured

SCA Lgth Damaged	Score	CRA tail width mm	Sex	Pack	Fisher #	SCA Lgth Damaged	Score	CRA tail width mm	Sex	Pack	Fisher #
<						<					
90						90					
91						91					
92						92					
93						93					
94						94					
95						95					
96						96					
97						97					
98						98					
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119						119					
120						120					

APPENDIX 3
Area locations codes and areas closed to commercial fishing

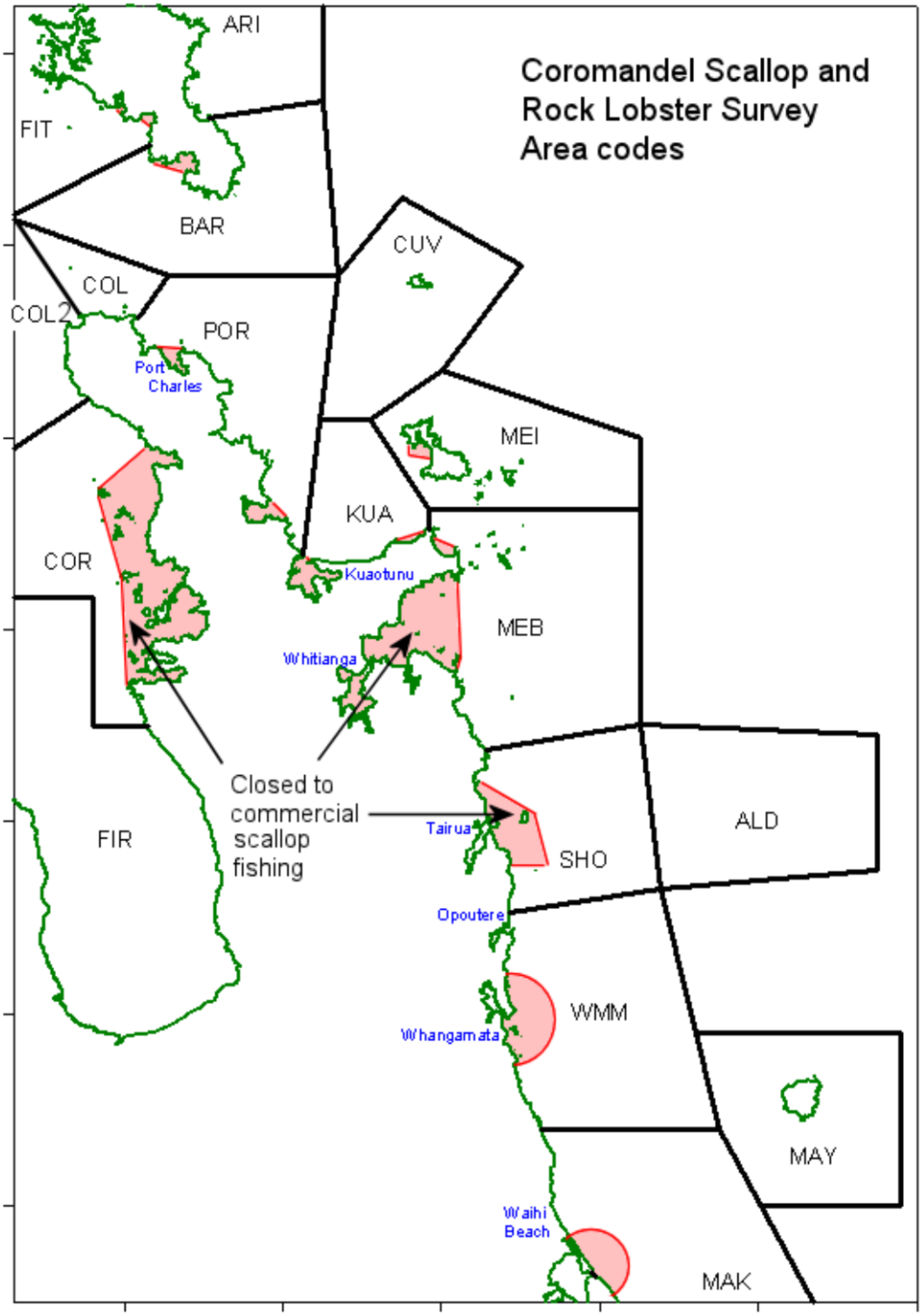


Figure A3: Area location codes in the Coromandel area.

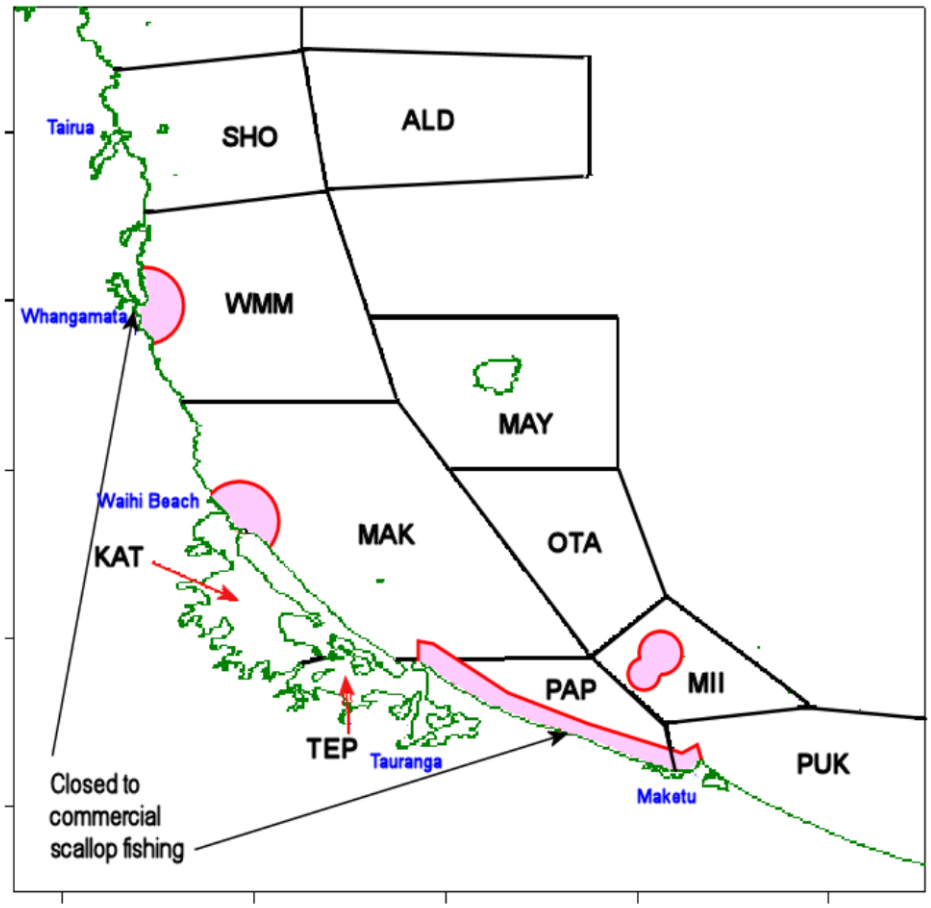


Figure A4: Area location codes in the southern Coromandel and Tauranga area.

APPENDIX 4
Scaling Western Bay of Plenty harvest to QMAs

Boat based amateur harvest from the Western Bay of Plenty access point survey area in 2011–12 was scaled to the respective QMAs for each species using NPS panel survey data for the Western Bay of Plenty and whole QMAs in 2011–12. Note, the survey period 1 October 2011 to 30 September 2012 does not match the scallop or rock lobster fisheries management year and QMA mean weights for kahawai and red gurnard are different to the Western Bay of Plenty area specific mean weights.

Table A1: Estimated mean weights (grams) for kahawai and red gurnard for 2011–12 and rock lobster and scallops by season used in estimating harvest weights.

	Fishtock	Substock	Estimate (g)	SE	n
Kahawai	KAH 1	BPLE west	1 489	15	1 959
	KAH 1	All	1 520	9	8 698
Red Gurnard	GUR 1	BPLE west	403	4	900
	GUR 1	All	421	3	3 928
Rock lobster	CRA 2	BPLE west 2010–11	499	11	1 392
	CRA 2	BPLE west 2011–12	700	10	844
Scallop	SCA CS	BPLE west 2010–11	104.9	1	8 241
	SCA CS	BPLE west 2011–12	110.5	1	4 284

Table A2: Estimated scallop harvest for SCA CS area by scaling up the Western Bay of Plenty access point survey area in 2011–12.

Scallop				On-site access point survey
Western Bay of Plenty	Number	SE	CV	Proportion of on-site
Boat based	216 647	39 676	20.60%	61.61%
Other	0			

Scallop				Off-site NPS survey
Western Bay of Plenty	Number	SE	CV	
Boat based	133 472	34 386	25.8%	
Other	0			

Scallop				Off-site NPS survey
SCA CS	Number	SE	CV	Proportion of boat based
Boat based	551 820	168 602	30.6%	100.00%
Other	83 431	105 037	125.9%	15.12%
All Platforms	635 251	198 644	31.3%	

Boat based scalar	4. 134

On-site scaled to SCA CS	Number
Scaled on-site boat based	895 693
Scaled for other	135 421
All Platforms	1 031 115

Weight (t)	113.9
Meatweight (t)	14.2

Table A3: Estimated rock lobster harvest for CRA2 area by scaling up the Western Bay of Plenty access point survey area in 2011–12.

Rock Lobster				On-site access point survey
Western Bay of Plenty	Number	SE	CV	Proportion of on-site
Boat based	10 575	1301	12.3	193.20%
Other	0			
Rock Lobster				Off-site NPS survey
Western Bay of Plenty	Number	SE	CV	
Boat based	20 430	8 369	41.0%	
Other	3 477	1768	50.9%	
Rock Lobster				Off-site NPS survey
CRA 2	Number	SE	CV	Proportion of boat based
Boat based	50 259	10 677	21.2%	100.00%
Other	10 796	2 856	26.5%	21.48%
All Platforms	61 055	11 052	18.1%	
Boat based scalar	2. 460			
On-site scaled to CRA 2	Number			
Scaled on-site boat based	26 014			
Scaled for other	5 588			
All Platforms	31 602			
Weight (t)	22.1			

Table A4: Estimated kahawai harvest for KAH 1 area by scaling up the Western Bay of Plenty access point survey area in 2011–12.

Kahawai				On-site access point survey
Western Bay of Plenty	Number	SE	CV	Proportion of on-site
Boat based	101 892	9 353	9.18%	101.28%
Other	0			

Kahawai				Off-site NPS survey
Western Bay of Plenty	Number	SE	CV	
Boat based	103 193	23 117	22.4%	
Other	64 113	12560	19.6%	

Kahawai				Off-site NPS survey
KAH 1	Number	SE	CV	Proportion of boat based
Boat based	447 308	37 731	8.4%	100.00%
Other	207 566	32 437	15.6%	46.40%
All Platforms	654 874	49 757	7.6%	

Boat based scalar	4. 335

On-site scaled to KAH 1	Number
Scaled on-site boat based	441 668
Scaled for other	204 949
All Platforms	646 617

Mean weight KAH 1 = 1520 g	
Weight (t)	982.9

Table A5: Estimated red gurnard harvest for GUR 1 area by scaling up the Western Bay of Plenty access point survey area in 2011–12.

Red Gurnard				On-site access point survey
Western Bay of Plenty	Number	SE	CV	Proportion of on-site
Boat based	31 733	3458	10.9	104.29%
Other	0			

Red Gurnard				Off-site NPS survey
Western Bay of Plenty	Number	SE	CV	
Boat based	33 096	8 361	25.3%	
Other	6 402	1747	27.3%	

Red Gurnard				Off-site NPS survey
GUR 1	Number	SE	CV	Proportion of boat based
Boat based	217 522	45 903	21.1%	100.00%
Other	31 703	10 967	34.6%	14.57%
All Platforms	249 225	47 195	18.9%	

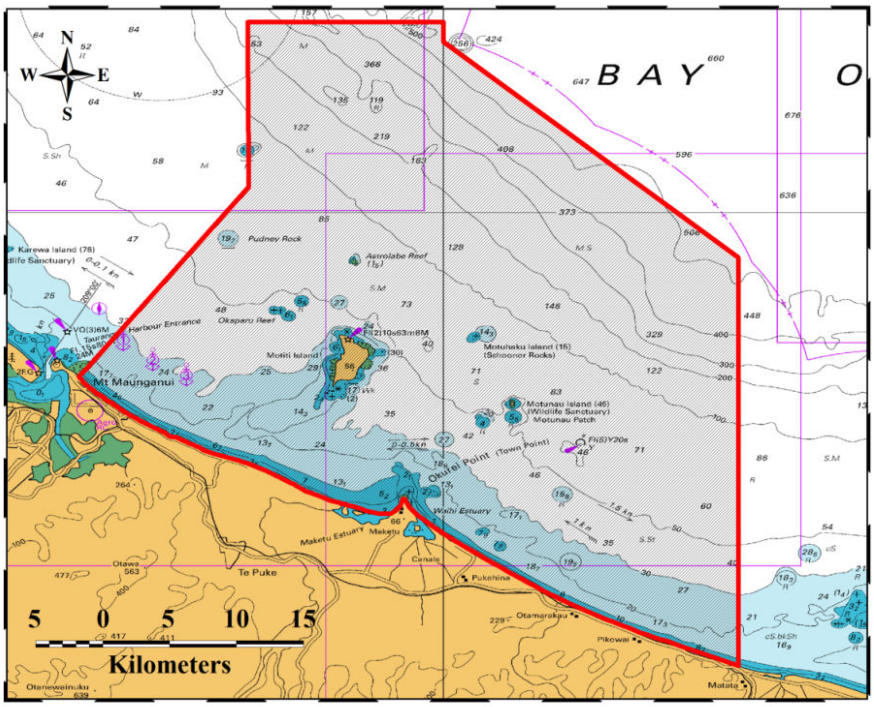
Boat based scalar	6. 572

On-site scaled to GUR 1	Number
Scaled on-site boat based	208 564
Scaled for other	30 398
All Platforms	238 961

Mean weight GUR 1 = 421 g	
Weight (t)	100.5

APPENDIX 5
Rena exclusion zones and health warnings

Rena exclusion zone 12 October 2011 2:20 p.m. to 21 October 2011



Rena exclusion zone 21 October 2011 at 1:30 p.m.

Recreational fishing (Finfish)

The current shipping exclusion zone should not be fished in. (below)

Outside of this area we specifically advise against taking fish from:

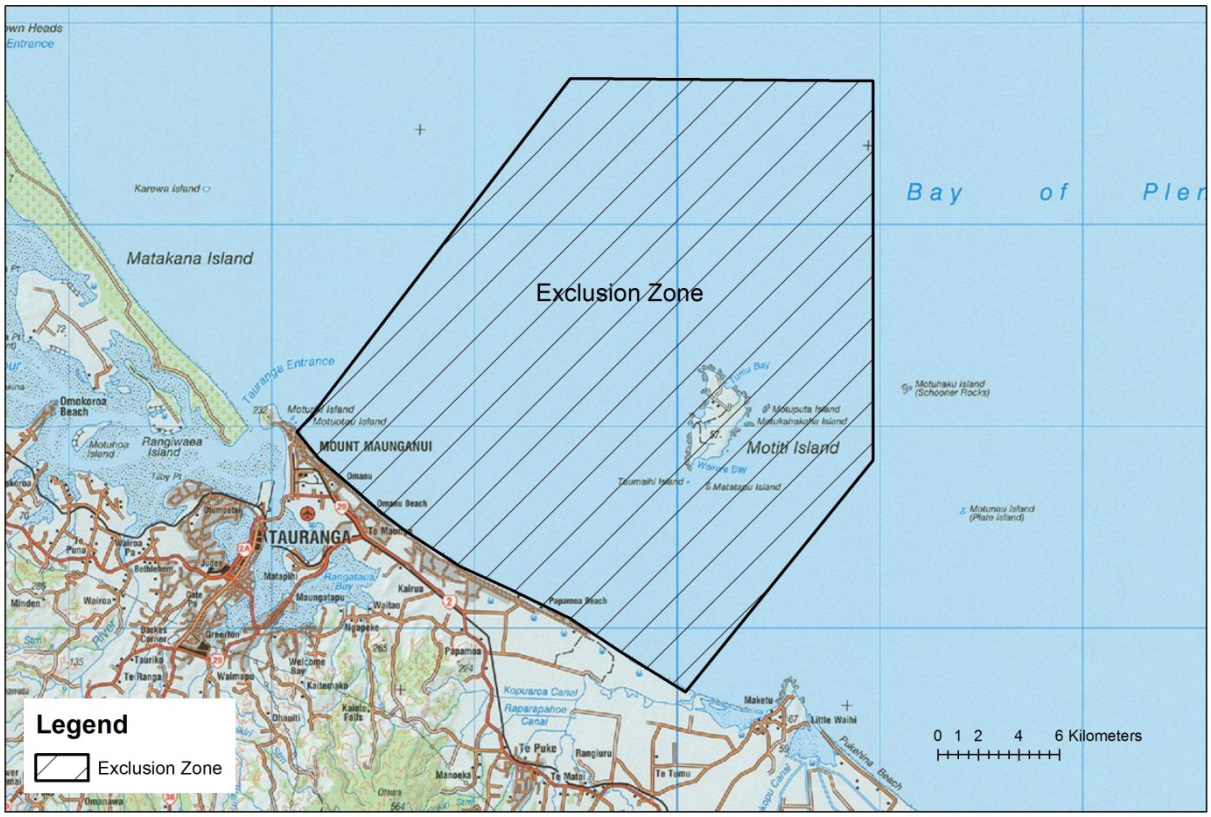
- Any area that has visible or known oil contamination
- Any area that has had recent oil contamination even if it has been cleaned up
- Any area where there is signage advising against fishing.

Any fish that have a petrol-like or fuel-like smell should definitely not be eaten.

The Rena exclusion zone has changed.

The revised co-ordinates of the exclusion zone are as follows:

Rabbit Island (Motuotau) at Mount Maunganui in position 37Â° 37.8’S 176° 11.7’E to



Shellfish, crustaceans, seaweed and kina

With changing wind patterns and currents and ongoing oil spills from the Rena the seabed and shoreline areas affected by oil are likely to change on a daily basis.

The advice below is provided to help guide the public about the collection of any seafood such as shellfish (e.g. pipi, mussels, cockles, scallops, tuatua, oysters, paua), crustaceans (e.g. crayfish and crabs), seaweed and kina.

The advice is precautionary and conservative. Any seafood that has a petrol-like or fuel-like smell should definitely not be eaten. Some taints may become more apparent once seafood is cooked.

A shellfish sampling programme has started but will only provide reliable results on safe areas when the situation has stabilised and there is no further risk of new oil exposure. The advice below is based on the best available information and risk assessment, and will be updated as the situation unfolds. This includes consideration of other possible sources of hazard - such as toxic substances from lost containers.

Shellfish Zone Map - Red, Amber and Green

Shellfish, crustaceans, seaweed and kina: Red Zone

The red zone includes all areas that:

- Are known to have current oil contamination; or,
- Are known to have had recent oil contamination even if it has been cleaned up; or,
- Have health warning signage; or,
- Are closed to the public; or,
- Have recently been closed to the public; or,
- Have a high risk of oil being found on them.

The red zone (as at October 21) currently extends from:

- Waihi Beach in the west to the entrance to Ohiwa Harbour in the east. (It should be noted that there is existing advice about not taking shellfish from Tauranga Harbour and the Waihi Estuary due to the possible presence of pathogens such as norovirus.)
- It includes inshore islands, rocky outcrops and estuaries in these areas.
- Specifically, it also includes Matakana island, Motiti island and Whale island.

The public are advised not to collect shellfish, crayfish or crabs in these areas until further notice.

Shellfish, crustaceans, seaweed and kina: Amber Zone

The amber zone includes areas where there are not yet confirmed reports of oil but there is a high risk of new oil contamination being found. In some of these areas oil contaminated debris from the Rena has been found.

The amber zone includes the coastline from:

- The Ohiwa Harbour entrance to Cape Runaway;
- It includes inshore islands, Ohiwa harbour, rocky outcrops and estuaries in these areas.

The public are advised that shellfish, crustaceans and kina in these areas are at significant risk of oil contamination and ideally should not be collected. Any seafood that has a petrol-like or fuel-like smell should definitely not be eaten.

Please report immediately any observed oil contamination in these areas to 0800 OIL SPILL.

Shellfish, crustaceans, seaweed and kina: Green Zone

Shellfish, crustaceans and kina may be taken from these areas but please exercise caution. To date neither oil or debris from the Rena has been identified on this coast but that could change at any time. Be vigilant for signs of oil contamination. If there are any signs of oil contamination on the beach or on rocks, or a petrol-like or fuel-like smell is present, seafood should not be taken or consumed. Any seafood that has a petrol-like or fuel-like smell should definitely not be eaten.

The green zone includes:

- The east coast of the Coromandel peninsula north from Waihi Beach