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Characterisation of recreational fishing in FMA 2 and options for access point harvest surveys

New Zealand Fisheries Assessment Report 2017/04

J.C. Holdsworth

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Fisheries Management Area 2 includes the waters east of Cape Runaway, East Coast, Poverty Bay, Hawke Bay, Wairarapa and Wellington. There have been six regional or national surveys to estimate marine recreational harvest in FMA 2 since 1993. Raw data from diarists and access point surveys contained in the *rec_data* research data base was extracted and analysed to help characterise the species, methods and areas which contribute most to recreational harvest.

A total of 7544 diarists provided some information on fishing effort and catch across five off-site surveys available for this report. About half the diarists reported fishing between one to three times over 12 months. Fishing effort peaks in January tailing off towards May and is generally low June to September.

Line fishing, diving and potting were the main methods used with some set netting and hand gathering. The main species caught were blue cod, kahawai, tarakihi, red gurnard and rock lobster. Paua was also an important component of the catch, especially in southern FMA 2. A high proportion of rock lobster catch came from boat based diving and potting especially from Cape Kidnappers to Cape Palliser (southern Hawkes Bay and Wairarapa regions).

Some consistent spatial differences in catch composition were present across all surveys. More blue cod, tarakihi and paua are harvested in the southern half of FMA 2, with more red gurnard and snapper in the northern half. Hawke Bay in particular provided most of the gurnard catch. Kahawai harvest was spread across regions and boat and shore based methods.

The only full year on-site access point data was collected in 1999–00 from Napier, Castlepoint and Wellington launch sites. Data was collected from 1447 fishing trips, many on weekend and holiday afternoons. The main purpose was to collect length composition by species from recreational fishers in FMA 2. This was used to generate mean weight estimates for converting off-site survey estimates of from numbers of fish to total harvest weight. The top 10 species encountered in the 1999–00 access point survey were, in descending order: rock lobster; blue cod; gurnard; kahawai; tarakihi; hapuku/bass; kina; snapper; paua and sea perch.

Counts of stationary vessels were made from the air for the whole of FMA 2 on two fine days during January 2012. A total of 162 boats engaged in recreational fishing was seen on 4 January and 401 counted on 21 January. Vessel locations are plotted showing the highest counts in Hawke Bay and the Wellington Region.

For region wide surveys, on the scale of FMA 2, an onsite census approach that covers all access points all-day is impractical and unnecessary. Coverage of all access points for shore based fishers is problematic at best. Coverage of all boat launch sites is more tractable. A high proportion of catch of most key species is taken on day trips on trailer boats and there are only a few sheltered, well used launch sites in FMA 2. The rugged coastline and limited road access also restricts the number of secondary launch sites available.

Potential methods for collecting harvest information from access points and total effort information from access points or aerial surveys are discussed. The bus route method could provide a total harvest estimate of boat based fishing from all identified access points. In more remote locations local people could be used as interviewers and scheduled to start and stop in sequence along the coast, like a bus route survey but eliminating the travel time.

The recommended approach is to estimate an instantaneous total count of trailer boats on the water by counting empty trailers at all access points. Interviewers at the main boat ramps and regionally important access points would collect harvest for a subset of returning vessels. The harvest profile for the boats interviewed would be scaled up using the instantaneous total trailer count in the same way as the aerial-access surveys.

1. INTRODUCTION

1.1. Overview

Fisheries Management Area FMA 2 extends for 1130 km of coastline from Cape Runaway (in the eastern Bay of Plenty) to Titahi Bay on the south-west coast of the North Island (Figure 1). There have been a number of surveys of recreational fishing effort across New Zealand including FMA 2. The survey with the most information on fishing methods and harvest at the time this analysis was done was an off-site telephone diary survey initially conducted in 1999–2000, and followed-up with further data collection in 2000–01 (Boyd & Reilly 2004). Line fishing, diving and potting were the main recreational fishing methods used with some set netting and hand gathering. Anecdotal information suggests that there has been an increase in the number of people fishing from kayaks and from shore with longlines since 2001. These fishers are less likely to be intercepted at traditional boat ramp access points. Blue cod, kahawai, tarakihi, red gurnard, snapper and rock lobster are the main recreational target species. Paua was also an important component of the catch.

The Draft National Inshore Fisheries Plans for shellfish and finfish rank rock lobster and paua as the highest priority for management services and stock monitoring. In FMA 2 blue moki, hapuku/bass, kahawai, red gurnard, snapper and tarakihi are listed as second tier species (Group 3 and 4) in the inshore finfish plan (Appendix 1).

To date all recreational harvest estimates in FMA 2 have come from off-site surveys with mean fish weight estimated from on-site surveys[1]. Changes in method and the presence of some very avid fishers have provided variable results (Table 1). A technical working group convened to review all survey data in 2003 recommended that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and c) the 2000 and 2001 estimates are implausibly high for many important fisheries. Relative comparisons may be possible between stocks within these surveys.

This report presents results from investigations undertaken under Ministry for Primary Industries (MPI) contract MAF2011/06. The contracted research study had three overall objectives:

1. To contribute to the design and implementation of an integrated amateur harvest estimation system.

2. To provide absolute estimates of total amateur harvest on a stock basis to inform fisheries management.

3. To derive methods to provide amateur harvest estimates which are comparable with future amateur harvest estimates.

Specific objectives were:

1. To undertake a characterisation of amateur fisheries in FMA 2 based on historical information.

[1] The most recent national off-site survey was conducted under MPI project MAF2010/01 (Wynne-Jones et al. 2014: http://www.mpi.govt.nz/document-vault/4719) but data from that study were not available when this analysis was conducted.

2. To summarise and synthesise information pertinent to conducting on-site surveys in FMA 2 in the future.

3. To provide a synthesis of the feasible options for the delivery of future on-site surveys in FMA 2 for key species.

Table 1: Recreational harvest estimates (tonnes) from FMA 2 for the main species by survey and the total allowable commercial catch for FMA 2 in the year 2011–12.

		Amateur harvest point estimate (t)				Range (t)	Range (t)	TACC (t)
Species	QMA	2011–12	2000–01	1999–00	1996	1996	1993	2011–12
Kahawai (KAH)	KAH 2	228	800	2937	217	190–240	245–350	823
Snapper (SNA)	SNA 2	57	173	322	40	25–55	25–55	315
Groper (HPB)	HPB 2	69	627	457	100	75–125	50–95	266
Paua (PAU)	PAU 2	82	200	415		45–65	37–89	121
Rock Lobster (CRA)	CRA 3	8	168	212				164
Rock Lobster (CRA)	CRA 4	44	350	311	73		40	467
Tarakihi (TAR)	TAR 2	74	298	191	64	55–75	20–40	1 796
Blue cod (BCO)	BCO 2	28	282	161	81	70–90	55–85	10
Trevally (TRE)	TRE 2	11	339	160	13	10–15	15–25	241
Flatfish (FLA)	FLA 2		75	160	24	15–35	20–40	726
Kingfish (KIN)	KIN 2	41	124	138	70	60–80	65–120	63
Blue moki (MOK)	MOK 1		136	131	93	80–110	45–95	403
Red gurnard (GUR)	GUR 2	38	123	127	16	10–15	50–125	726
Butterfish (BUT)	BUT 2		30	26	59	45–75		63

2. METHODS

2.1 Study approach

There have been a number of surveys of recreational harvest in FMA 2 since 1993, but this is the first review of all available data up to and including 2011. Data were available from regional and national off-site "diary" surveys of recreational harvest from 1993, 1999–00 and 2000–01. In 2011–12 an improved survey approach was being used to estimate amateur harvest. Results from the National Panel Survey have been added to Table 1, but finalised data was not available for analysis at the time this work was untaken (Wynne-Jones et al. 2014). While there have been concerns expressed about the accuracy of the estimates of total harvest expanded to the whole population from the 2000–01 and earlier surveys there is good information in the diary and boat ramp data for characterising the fishery and informing future survey design. Access point surveys can collect accurate information from fishers that are intercepted but have their own challenges achieving good coverage and estimating total recreational fishing effort.

Some of the key elements we identified to achieve project objectives were:

- Identify sources of recreational fishing data, including recent qualitative surveys.
- Characterise amateur fisheries temporally and spatially by method and species.
- Utilise the local knowledge base of fishing clubs, the Regional Recreational Fishing Forum, fishing tackle and equipment retailers and MPI Fisheries Officers to identify important access

points and recent trends in the fishing methods and platforms used by recreational fishers (e.g. kayaks, kontikis, etc).

- Discuss with MPI the key species of interest to this project and specific survey constraints of possible methods
- Undertake two aerial overflights on peak days to help describe the distribution of fishing effort by area and access points.
- Synthesise and summarise all of the available data.
- Consider how to achieve future recreational fishing monitoring objectives using a variety of survey methods, ranging from low-level webcam coverage to area-wide aerial overflight and on-site surveys.
- Develop sound recommendations for a range of feasible options for the delivery of future on-site surveys in FMA 2 for key species, bearing in mind the need for surveys to be cost effective.

2.2 Data extracts

Offsite diary or panel surveys track the fishing activity of individuals for 365 days a year. This makes these approaches good for characterising all fishing activity, particularly when sample sizes are large enough and diarists are representative of the population as a whole. Sometimes, however, there are doubts about how accurately catch is self-reported by diarists.

Recreational fishing zones identify broad regions where catch was taken. Zones 14 to 17 cover all of FMA 2 (Figure 1). Many of the rock lobster records did not have these fishing zones but catch was coded by rock lobster area, which does not match the FMA or the recreational fishing zone boundaries well. For summary purposes, rock lobster records were coded into the recreational fishing zones so that they could be plotted alongside other species by zone.

On-site boat ramp or access point surveys are good at sampling the catch and fishing effort from trailer boats at one or more well used locations. Data can be collected on the day of the trip, with a face to face interview and a short recall period, which will have fewer potential biases. However, the boat ramp surveys used in FMA 2 were designed to estimate the average size of fish and shellfish harvested in support of off-site surveys. Catch was usually sampled from trailer boats in the afternoon at the best/busiest ramps on weekends or holidays in order to obtain a large sample. This sampling may therefore not be representative of the catch as a whole, even for trailer boat catch.

Recreational catch and effort information from diary and boat ramp surveys for fishing in FMA 2 was extracted from the MPI *rec-data* database by the MPI Data Management Group as CSV files. These files were imported to Microsoft Access and linked by key fields to create a relational database. Tables used for analysis were generated from the required fields and exported to Microsoft Excel for plotting.

Some of the 1999–00 diary survey harvest estimates from FMA 2 were implausibly high for some species (Ministry for Primary Industries 2011). The harvest estimates from the follow-on diary survey in 2000–01 were significantly lower using a different set of diarists. We removed data from the analysis in this report for two diarists from 1999–00 and one in 2000–01 who reported large daily catches, often many times the individual daily bag limit. In total 3724 fish were removed including 1201 kina, 609 kahawai, 354 paua and 273 rock lobster for the three fishers. Reported daily catch exceeded the bag limit for 92% of paua recorded, 75% of rock lobster, 73% of tarakihi, 43% of kahawai and 42 % of kina for these three fishers combined. All data for these selected diarists were removed as unreliable. Removing one diarist from the NAT00 survey reduced the unweighted diarist harvest by 28% for kahawai, 20% for kina, 14% for paua, and 2% for rock lobster for that survey. Removing the other two diarists from the NAT01 survey reduced the unweighted diarist harvest by 6% for kahawai, 53% for kina, 6% for paua, and 12% for rock lobster for that survey.

Fishing method codes used in the 1993 central diary survey were different to those used in subsequent surveys. A standardised set of codes, as used in surveys after 1993, were used for all surveys in this analysis.

An extract of data from Fisheries Officer activity monitoring system data was supplied by the MPI Data Management Group with information from Fisheries Officer interviews including: date; location; type of intercept; number of active fishers in a group; the species and number they had harvested. This was imported to Microsoft Excel for tabulation and plotting.

The charter boat reporting system was instigated by the Ministry of Fisheries in 2010. However, for the first two years, charter fishers in FMA 2 reported only their fishing activity, and no information related to actual catches was available for this analysis. From 1 October 2012, charter reporting in FMA 2 will include the collection of catch data on the number of bass, hapuku, kingfish and rock lobster retained per charter trip. The catch of Southern bluefin tuna and Pacific bluefin tuna will also be required; however currently catch of these species by recreational fishers in FMA 2 is rare. No amateur charter vessel activity data was sourced for this report.

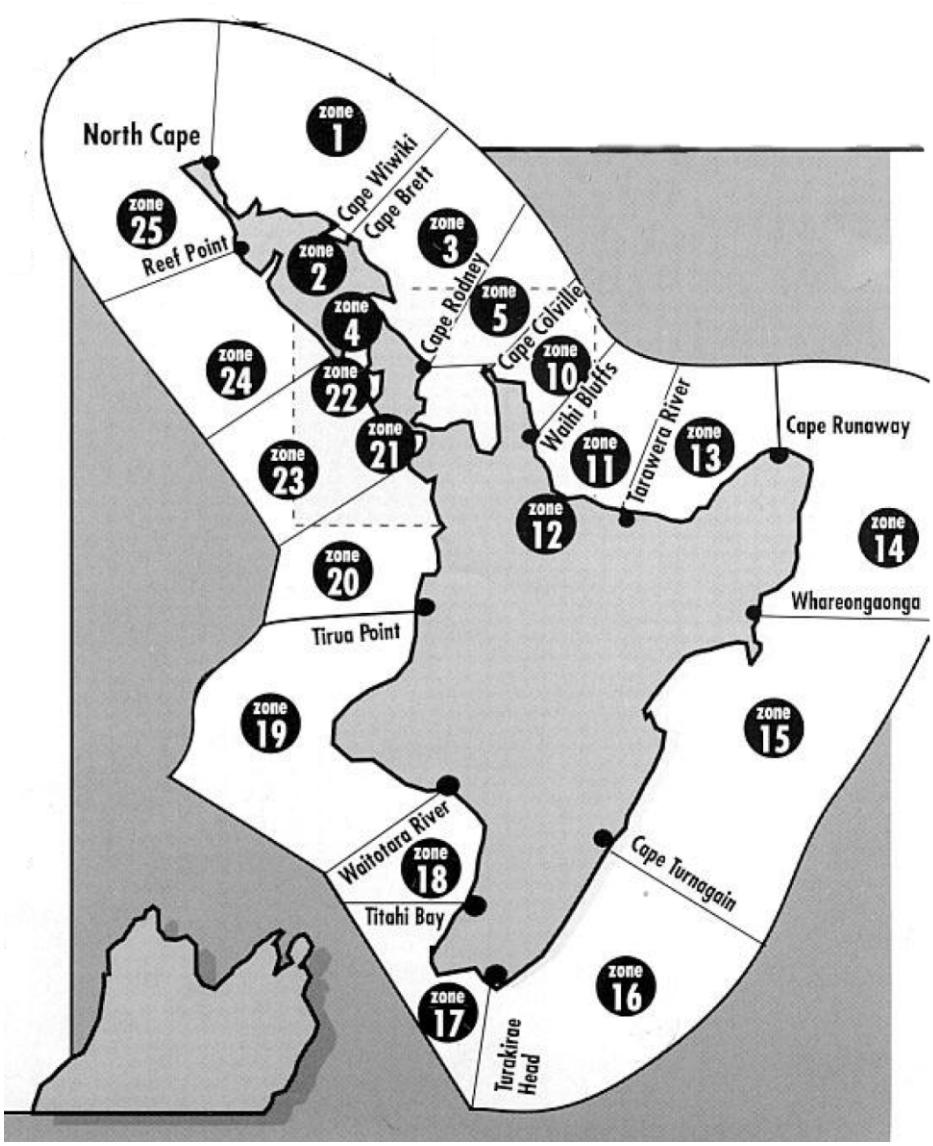


Figure 1: Fishing zones used in the recreational fishing database for finfish. FMA 2 comprises of zones 14 to 17.

2.3 Aerial Survey

An aerial survey was conducted on two fine summer days to count boats engaged in recreational fishing for the whole of FMA 2. Flights were chartered from Air Napier using a twin engine Piper Seneca. A planned survey day scheduled for 28 or 29 of December 2011 was postponed due to poor weather forecasts. The first flight was on 4 January 2012 starting at Titahi Bay at 1110 hrs. The plane landed in Napier at 1330 hrs for refuelling and continued north at 1415 hrs reaching Cape Runaway at 1630 hrs. Conditions were breezy (15 to 20 knots) in Cook Strait and around East Cape but calm (5 to 10 knots) elsewhere. Passage through controlled airspace around Wellington Airport is restricted and there were delays passing to the south of the runway. Flight access to central and western areas of Wellington Harbour (Port Nicholson) was restricted by air traffic control.

Saturday 21 January was selected for the second aerial survey day. While it presented a rather narrow weather window it was the first day of Wellington anniversary weekend and thus it was expected that recreational fishing effort would be relatively high. There had been strong NW winds the day before and some wind swell remained on the west coast. The wind was predicted to pick up from the northwest on Saturday night starting in the Wellington region. The best sea conditions in the south were in the morning so the survey started at Titahi Bay at 1000 hrs. Passage through Wellington Airport controlled airspace was quicker this time and access was granted to the eastern and central areas of the Wellington Harbour. The first flight that day landed in Napier at 1215 hrs for refuelling. The second part of the survey started in central Hawke Bay at 1300 hrs and reached Lottin Point at 1445hrs. Very few boats were sighted between Tokomaru Bay and Lottin Point and the survey terminated there.

Location and type of vessel seen fishing was recorded on a laptop computer with 12 volt power supply from the aircraft. Maps were displayed in Maxsea software (Maxsea International, Bidart, France) with a real-time track of the flight path with data from a plug-in GPS receiver. Generally, the survey portions of the flights were conducted at a height of 150 m (500 ft) about 2.5 km from the coast. This allowed reasonable identification of boats between the aircraft and the coast and, on both days, boats could be seen for a further 5 to 7 km further out to sea. The main recorder was in the co-pilot's seat with good forward vision. A recorder in the left rear kept a paper record of vessels seen between the aircraft and the coast, and a third spotter in the right rear checked for vessels at the edge of visual range at 90 degrees to the flight path. Away from the main population centres most stationary vessels seen were assumed to be fishing or diving. Larger vessels were checked to establish whether they were commercial or recreational.

3. RESULTS

3.1 Offsite surveys to characterise marine recreational harvest

A series of regional and national diary surveys provides the largest database for characterising the fisher effort and harvest across the full range of fishing methods and the whole of FMA 2. These surveys were for a full 12 month period which generally started in December and finished the following November. A central region survey (CEN93) was conducted in 1992–93. The first national diary survey (NAT96) was conducted in 1995–96. A Wellington region survey was run in 1998–99. The national telephone diary survey in 1999–00 (NAT00) recruited 260 fishers in FMA 2 and was continued with new diarists in 2000–01 (NAT01) (Table 2).

The first CEN93, NAT96 and NAT00 surveys recruited a similar number of diarists in FMA2 (mean = 243 SD = 18) and recorded a similar number of trips (mean = 1360 SD = 38). The NAT01 survey in 2000–01 trialled shorter diary periods and continued recruitment during the year for a total of 336 diarists (Table 2).

Table 2: The number of diarists fishing by survey, the number of trips by fishing zone and the average number of trips per diarist for each survey.

		Fishing trips per recreational zone						Trips /diarist
	Diarists	Zone 14	Zone 15	Zone 16	Zone 17	Zone 18	Total	
CEN93	224	141	614	268	363		1 386	6.19
NAT96	246	160	447	359	411	16	1 393	5.66
WLG99	196			222	1127		1 349	6.88
NAT00	260	200	504	286	326	419	1 735	6.67
NAT01	336	260	479	298	309	335	1 681	5.00

The number of fishing trips diarists took per year is similar across surveys (Figure 2). About half the diarists surveyed reported fishing 1 to 3 times over 12 months. Just 1.4% (SD = 0.4%) of diarists in these surveys reported fishing for 40 days or more (Figure 2). This analysis excludes data from two "super avid" diarists in the 1999–00 national survey who reported multiples of the bag limit in a single day. They may have been reporting their household catch and effort rather than their individual catch and effort.

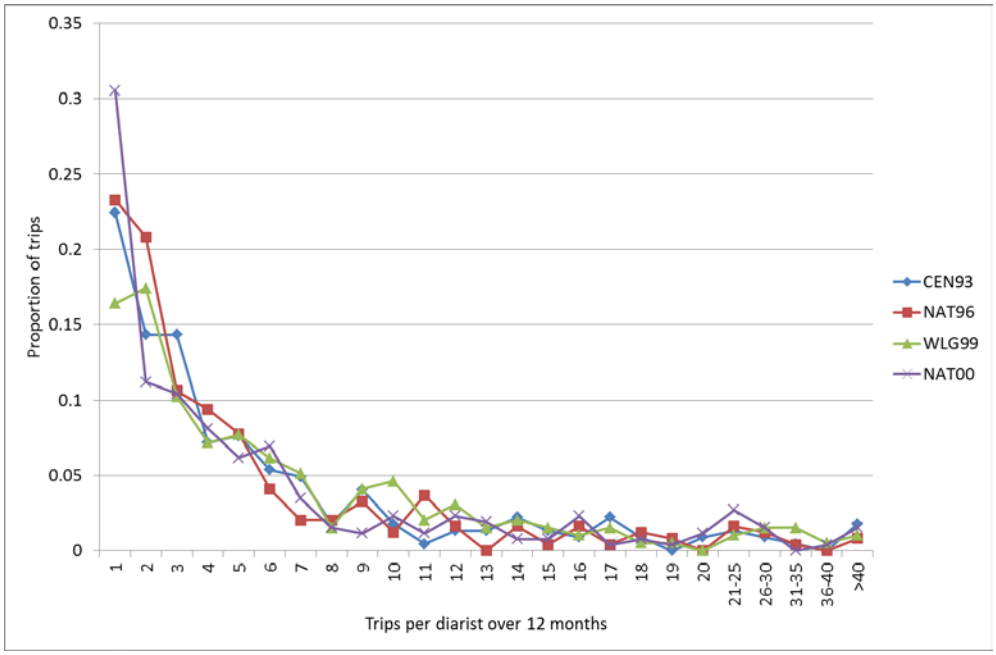


Figure 2: The proportion of diarists making different numbers of trips over 12 months by survey.

Fishers who undertake few trips each year contribute relatively little to the total fishing effort across all diarists. A plot of the cumulative proportion of hours fished in the diary surveys show that the 50% of people reporting three or fewer trips contributed only 15% of the total effort. Fifty percent of all hours fished are reported by diarists completing 10 or more trips per year in the NAT96 survey and 14 or more trips per year in the CEN93 survey (Figure 3).

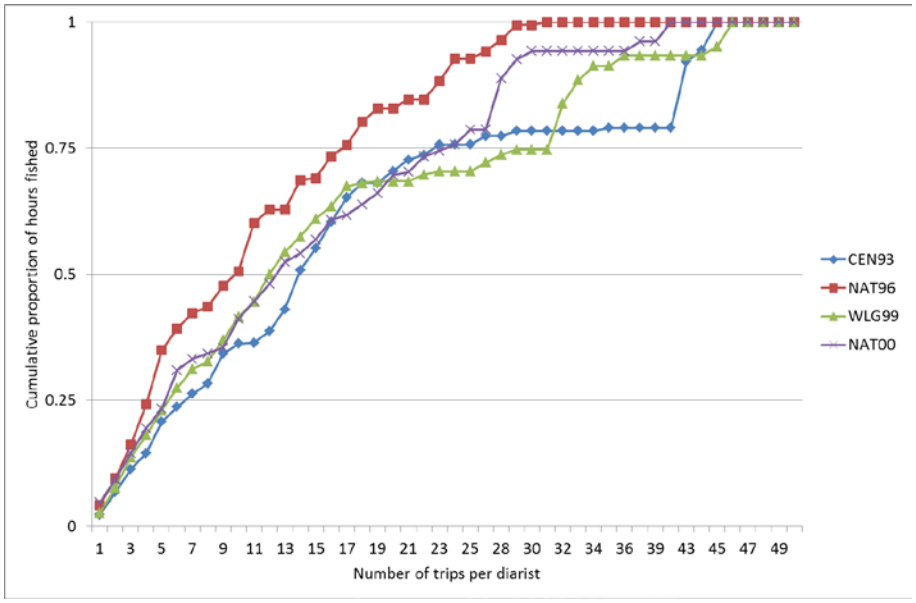


Figure 3: Cumulative proportion of total hours fishing per survey by the number of trips per diarist.

Recreational fishing in FMA 2 has a strong seasonal bias with a strong peak in January. A third of all trips in some surveys are in this month. Effort is low from June to September (Figure 4). There may be a slight bias in this plot as fishers recruited in December may resign from the survey before completing the full 12 months. The proportion of January fishers is lower in the 2000–01 survey, but these diarists were rotated through the survey for periods of 3 to 6 months through the year. It is interesting to note that the 2000–01 survey had the highest trip rate in spring, late in the survey. Recruitment in the Wellington regional survey is also spread over summer so not all diarists were participating in December and January (Figure 4).

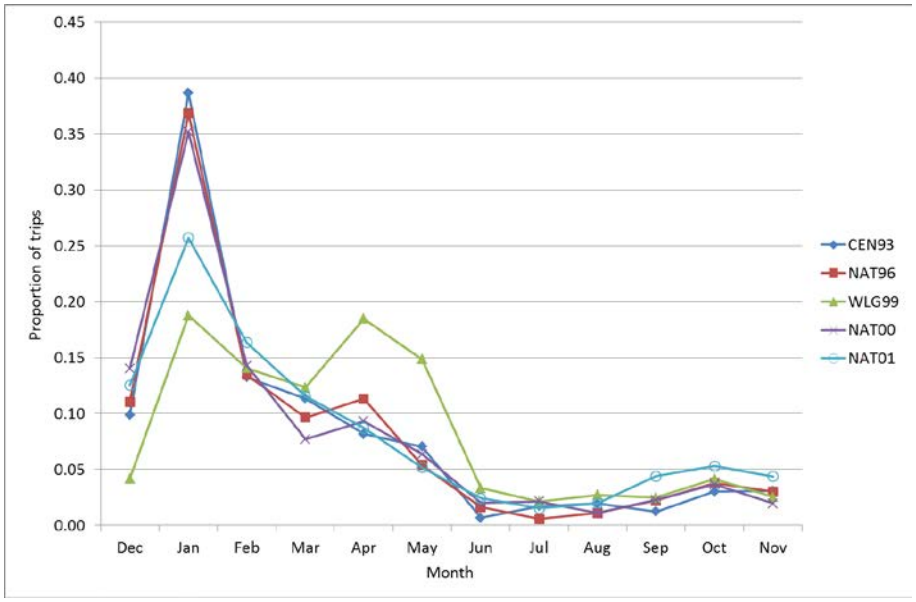


Figure 4: Proportion of fishing trips by month reported by diarists in each survey.

Large-scale offsite surveys also characterise the full range of fishing methods used by fishers during the year. For all surveys combined, line fishing trips from private boats and line fishing from shore are the most common methods used (Figure 5). Diving from shore and potting are similar (10%), followed by set net trips (8%) mostly for butterfish, flatfish and blue moki. Diving from boats accounted for about 5% of trips, while line fishing from charter boats and hand gathering trips account for about 2.5 % each (Figure 5).

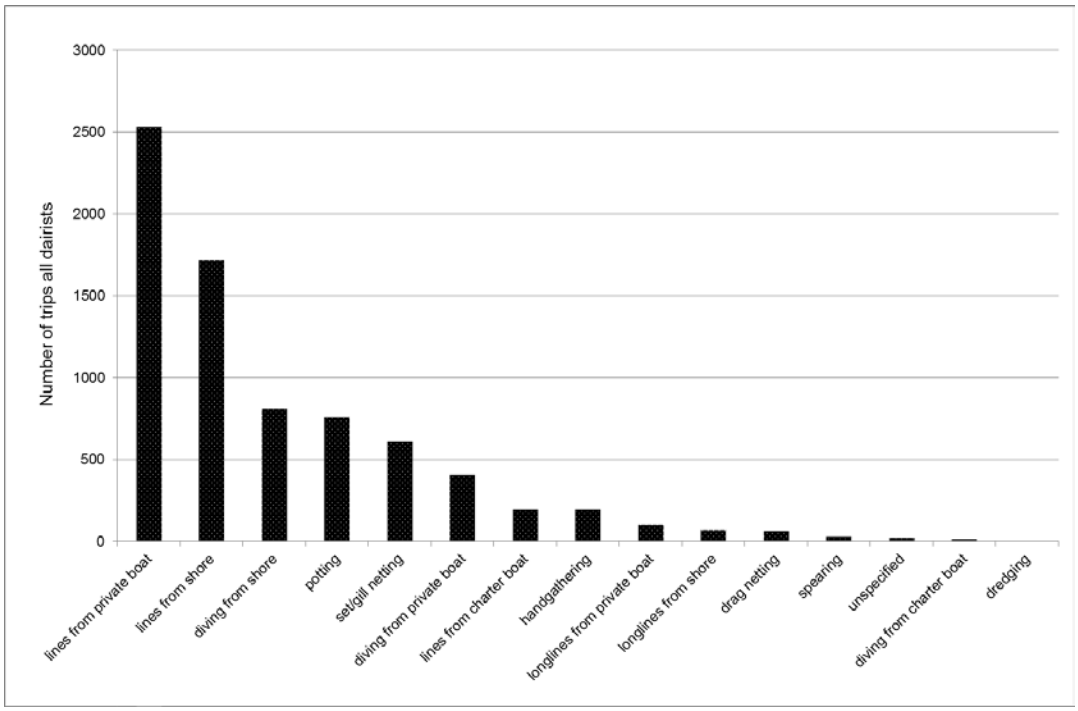


Figure 5: Number of fishing trips by method reported by diarists in all surveys.

Harvest by species varies by region within FMA 2. The sample sizes are small for some species but combined harvest across all surveys provide an indicator of relative harvest in FMA 2. Harvest of the top 20 species in numbers of fish and shellfish reported across all surveys are plotted in Figure 6 (n=53 063). Kahawai, blue cod and tarakihi top harvest numbers for finfish, while gurnard is mostly taken in Hawke Bay (zone 15). Paua, rock lobster and kina top the harvest number for non-finfish species.

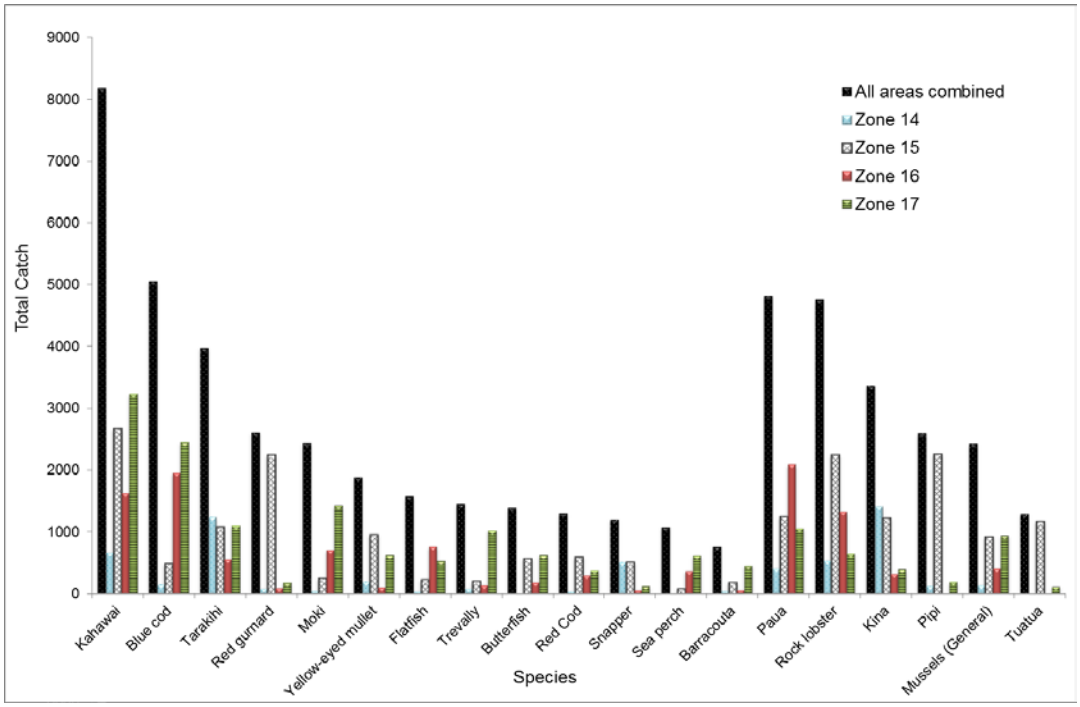


Figure 6: The top 20 species harvested from all diary surveys combined, by recreational fishing zone.

Total harvest numbers will be higher in the zones with more diarists or effort. The importance of species within each zone is more apparent when plotted as a proportion of the catch within each zone (Figure 7). Kahawai stands out in the finfish plot as being available across all zones. Blue cod, moki, flatfish, sea perch and skate are taken mainly in the two southern zones (16 and 17), while tarakihi, gurnard and snapper are more prevalent in the zones 14 and 15 in the north (Figure 7).

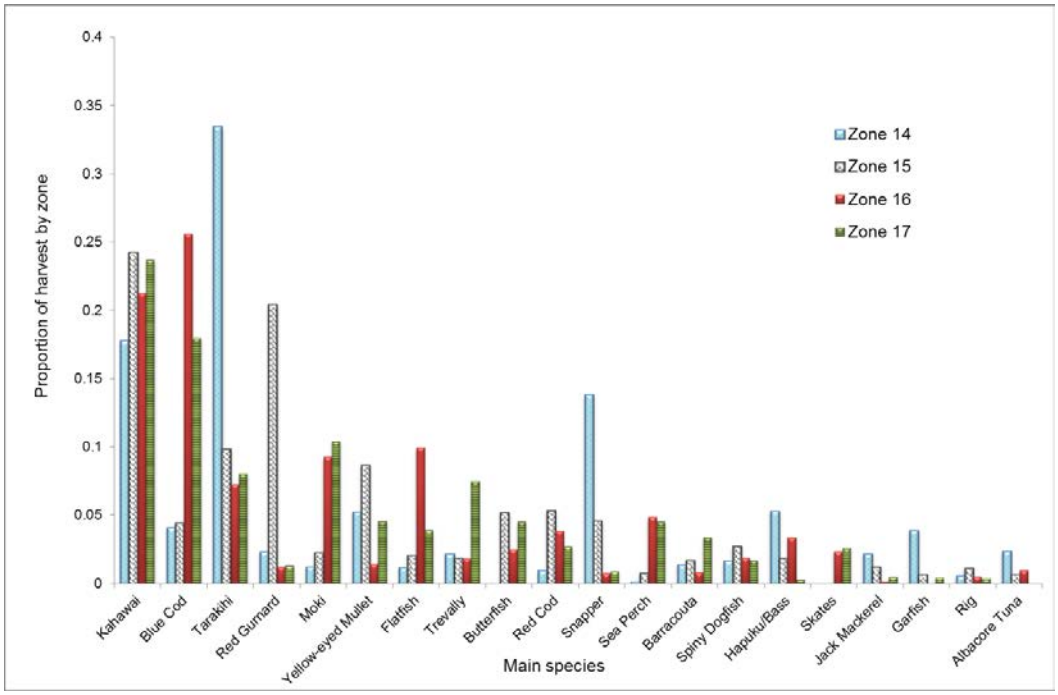


Figure 7: The proportion of finfish species harvested by zone from all diary surveys combined.

About 70% of paua is harvested from the southern regions (zone 16 and 17), while kina, pipi and tuatua are mainly harvested in the northern zones 14 or 15 (Figure 8).

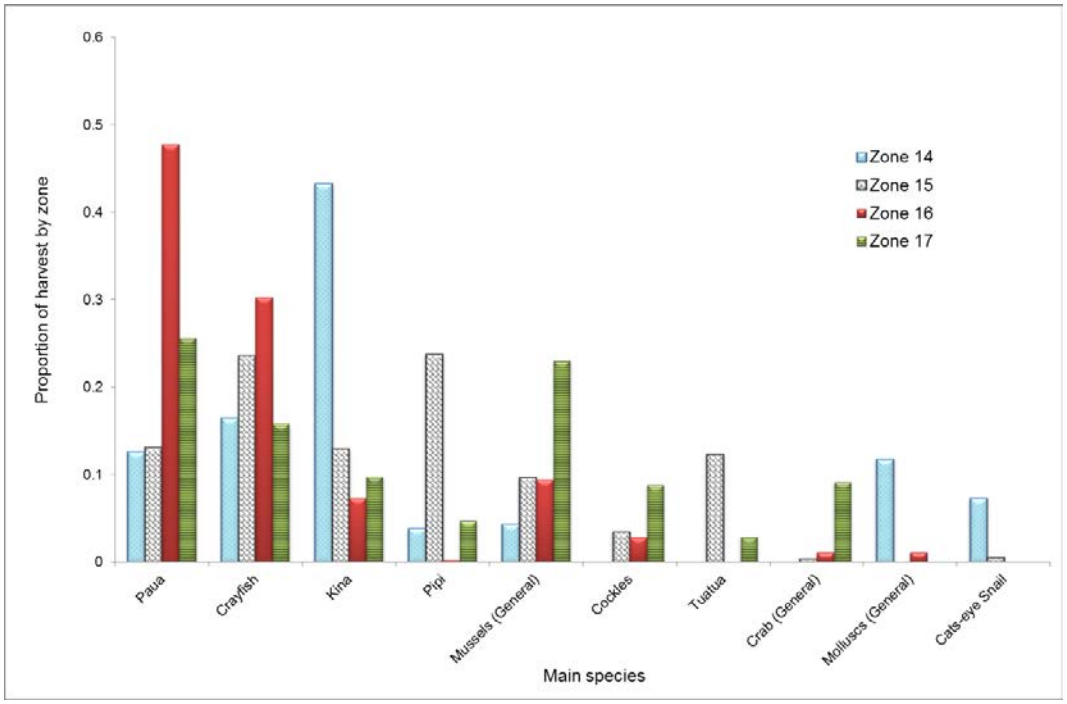


Figure 8: The proportion of non-finfish harvested by zone from all diary surveys combined.

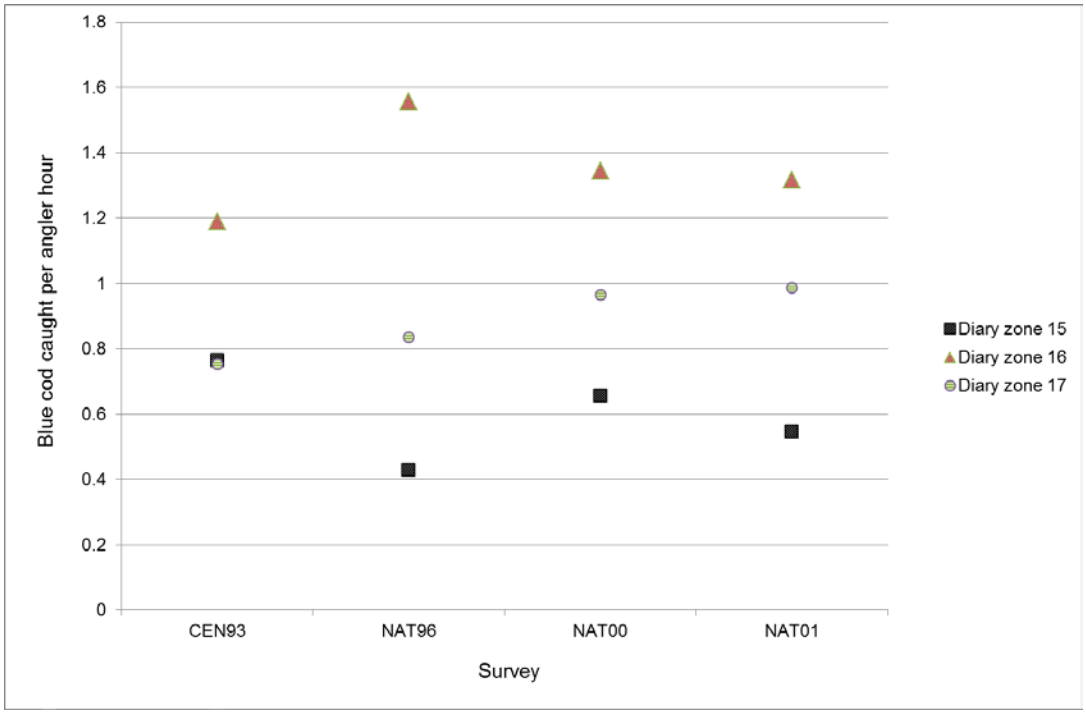


Figure 9: Blue cod harvest per angler hour line fishing from a boat by survey and zone.

Catch rates for the main species can be compared across surveys. Blue cod harvest per angler hour line fishing from a boat is fairly consistent for surveys from 1993 to 2001 within each fishing zone (Figure 9). Blue cod CPUE was higher in zone 16 across all surveys and generally lower in zone 15. Overall these catch rates include 41% of angler trips where blue cod was among the target species but was not caught.

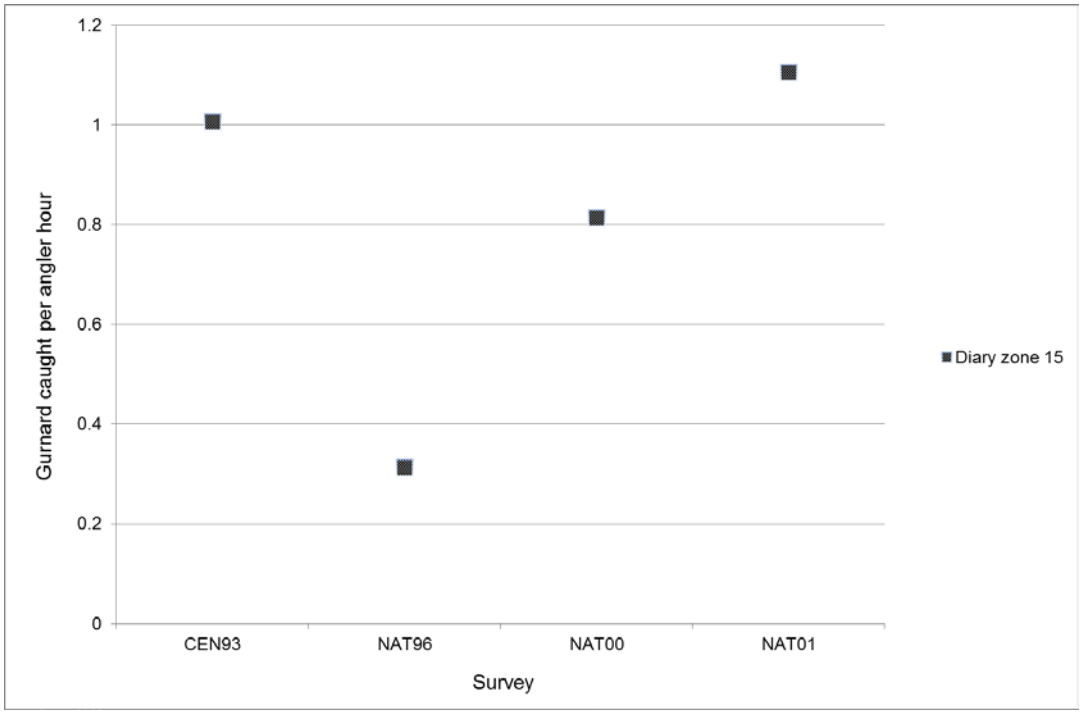


Figure 10: Red Gurnard caught per angler hour line fishing from a boat by survey and zone.

Zone 15 was the only area with sufficient gurnard harvest data to analyse. The average harvest was low in the NAT96 survey (0.31 gurnard/hour, SD = 0.81) and over one gurnard per angler hour in the CEN93 and NAT01 surveys (Figure 10). Overall this includes 34% of unsuccessful trips where gurnard was among the target species but was not caught.

Offsite surveys can collect information on the recreational fishing across all methods and species used by respondents. Fishing with hook and line was the common method used across all surveys, followed by diving, potting and set netting. Also the platform used for fishing (private or charter boat, or from shore) is generally recorded in the method codes used with diary data (Table 3).

Table 3: The number of trips recorded in FMA 2 by diarists by survey and method and platform.

	Method							
Platform	Code	Method Description	CEN93	NAT96	WLG99	NAT00	NAT01	Total
Boat	1	Lines from private boat	554	416	759	352	449	2 530
	2	Lines from charter boat	7	21	18	67	87	200
	3	Longlines private boat		6	2	36	61	105
	6	Diving from private boat	50	76	99	86	96	407
	7	Diving from charter boat	1	3	1	7	1	13
	13	Potting	82	106	23	319	231	761
	9	Dredging						0
Shore	4	Lines from shore	303	350	219	435	410	1 717
	5	Longlines from shore		12	3	23	33	71
	8	Diving from shore	140	199	156	163	155	813
	11	Drag netting	3	14	4	29	14	64
	12	Hand gathering	19	67	4	77	33	200
Other	10	Set/gill netting	225	112	50	131	94	612
	14	Spearing	2		10	10	8	30
	15	Unspecified		13			9	22
		Total	1 386	1 395	1 348	1 735	1 681	7 545

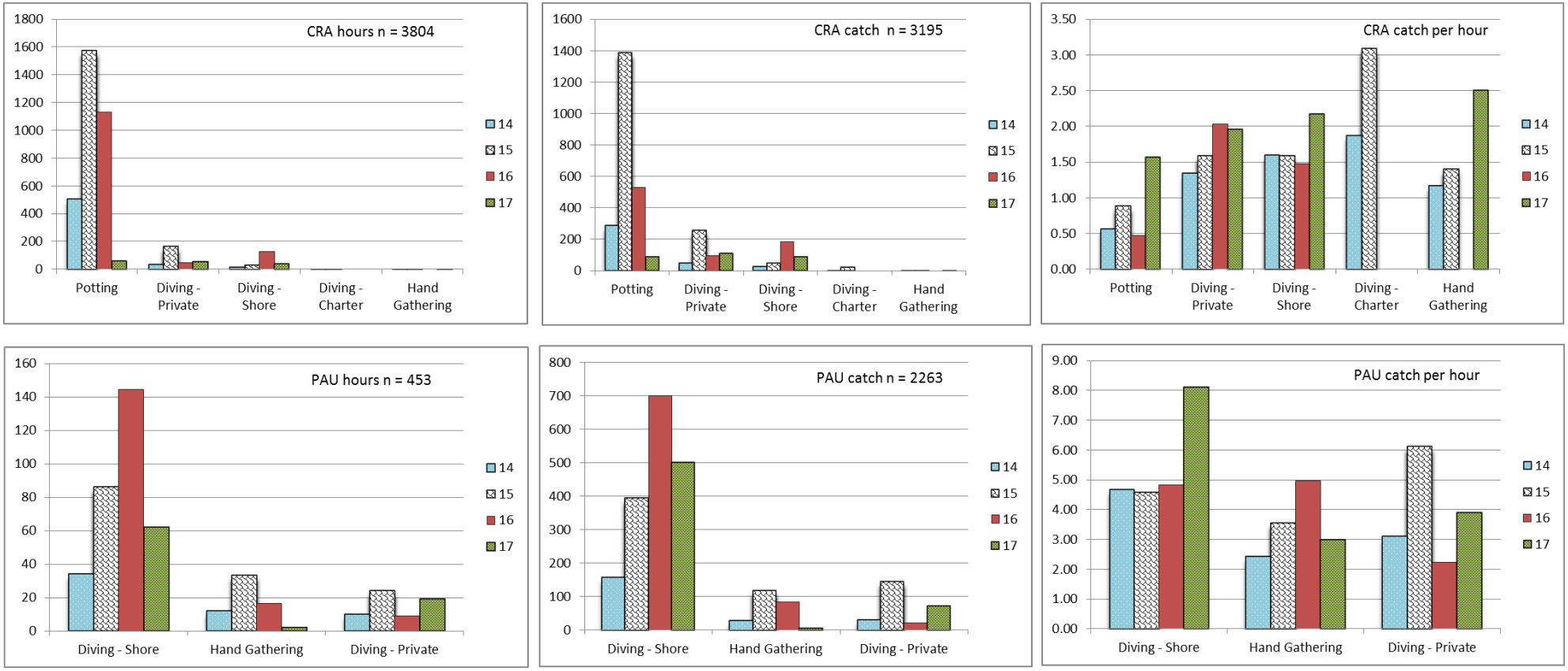


Figure 11: Top panels: Rock Lobster data by method from NAT00 and NAT01 diary surveys combined (top row); hours fished for CRA (left); numbers of CRA caught (centre); and CRA catch per hour (right) by fishing zone. Bottom panels: Paua data by method from NAT2000 and NAT2001 diary surveys combined (bottom row); hours fished for PAU (left); numbers of PAU caught (centre); and PAU catch per hour (right) by fishing zone.

Some diarists continued after the NAT00 survey for part of the NAT01 survey year. The hours fished, harvest, and CPUE by method and zone are combined across these two consecutive years for rock lobster and paua in Figure 11. Most rock lobster catch is taken by potting, especially in fishing zones 15 and 16. The relatively high effort (and low CPUE) for potting is because the soak time between lifts is often reported as the hours fished. Shore diving for rock lobster with relatively few hours has a reasonable catch rate, and accounts for 11% of FMA 2 harvest in these surveys.

Paua harvest is quite different, being mainly taken by diving and hand gathering from shore with just 12% of harvest coming from boat based methods. Effort and harvest were highest in zone 16 along the Wairarapa coast.

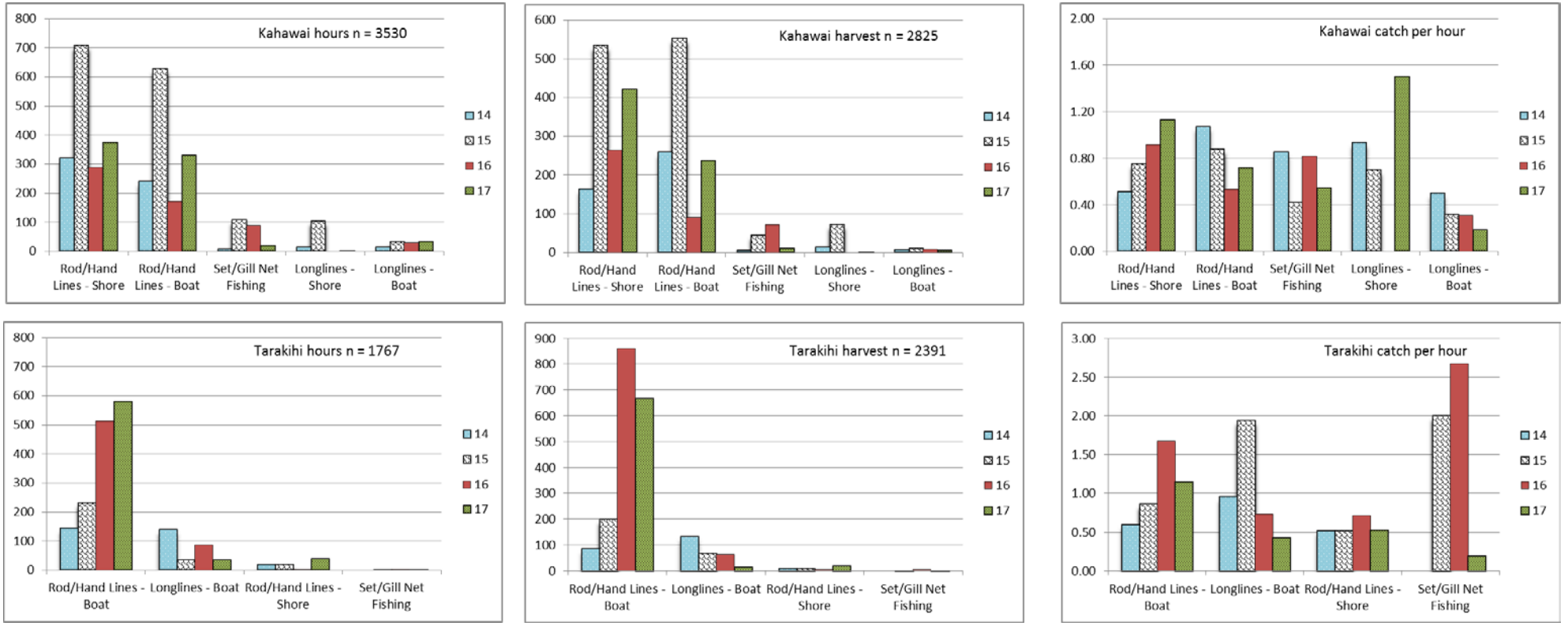


Figure 12: Top panels: Kahawai data by method from NAT00 and NAT01 diary surveys combined (top row); hours fished for kahawai (left); numbers of kahawai caught (centre); and kahawai catch per hour (right) by fishing zone. Bottom panels: Tarakihi data by method from NAT2000 and NAT2001 diary surveys combined (bottom row); hours fished for tarakihi (left); numbers of tarakihi caught (centre); and tarakihi catch per hour (right) by fishing zone.

The hours fished and numbers of kahawai kept by diarists seem to be about equal for line fishing from shore and boat (Figure 12). Catch was highest in the Hawkes Bay region (zone 15) but catch per hour fished increased for shore based methods by zone from north to south (Figure 12 top right).

Tarakihi harvest was highest in the southern zones and almost all came from boat based fishing. Tarakihi and blue cod are key target species in Wairarapa and Wellington zones. Possibly the bycatch of kahawai is less for fishers targeting these species than the gurnard and snapper target fisheries in Gisborne and Hawkes Bay regions.

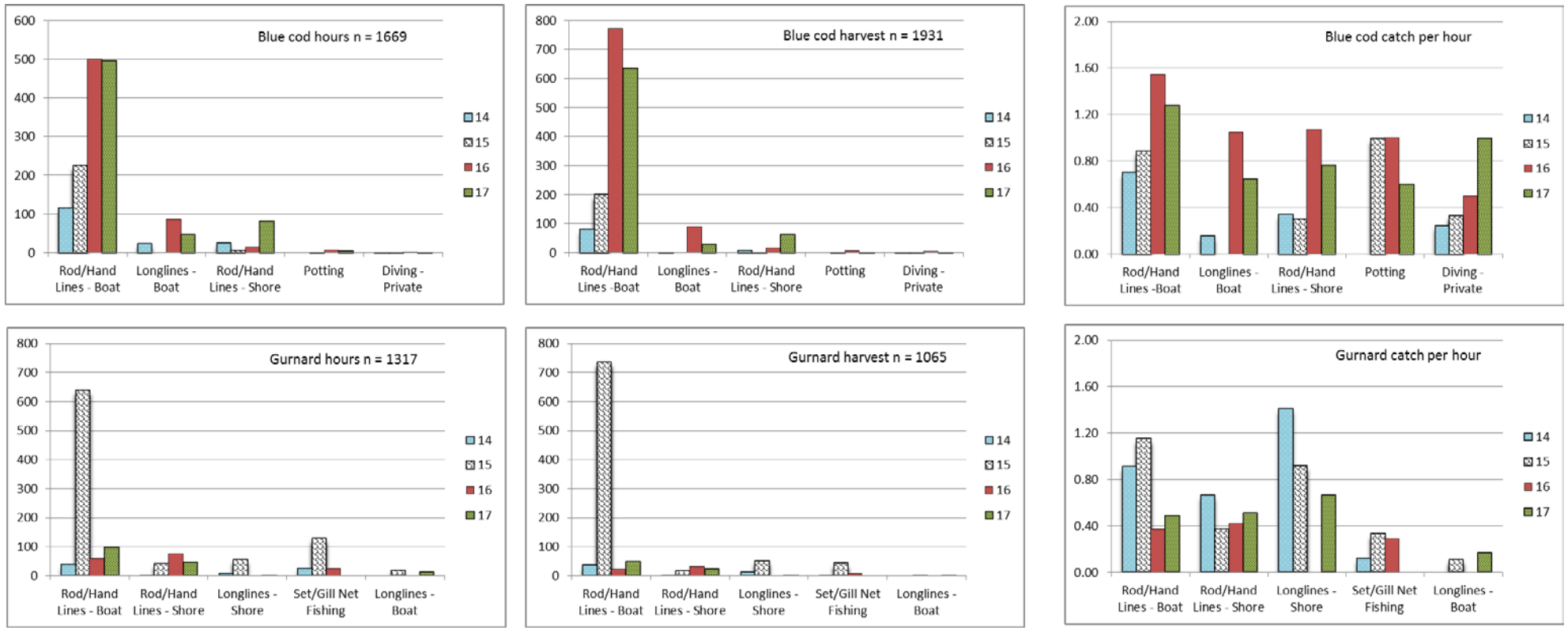


Figure 13: Top panels: Blue cod data by method from NAT00 and NAT01 diary surveys combined (top row); hours fished for blue cod (left); numbers of blue cod caught (centre); and blue cod catch per hour (right) by fishing zone. Bottom panels: Red gurnard data by method from NAT2000 and NAT2001 diary surveys combined (bottom row); hours fished for gurnard (left); numbers of gurnard caught (centre); and gurnard catch per hour (right) by fishing zone.

Blue cod harvest and CPUE was highest in the southern zones for boat based fishers using hook and line or longlines (Figure 13). A small amount of catch came from potting and shore based fishing.

Gurnard harvest and hours fished when gurnard was caught where highest in the Hawkes Bay region (zone 15). A range of methods caught gurnard but most harvest was from fishers on boats using rod or hand lines.

Snapper catch (not shown) was higher in the north (zones 14 and 15) and a third was taken by shore based methods and two thirds by boat methods including charter trips.

Diary surveys collect information on the number of fish harvested across all methods and species in an area. There are some concerns about the quality of recall and recording, particularly if diaries are not completed regularly and fishers estimate what they caught (recall bias). There have been difficulties accessing a random sample frame of New Zealand residents and recruiting a representative sample of fishers from that population, especially where the survey is based on landline telephones. Regional diary surveys may miss collecting data from visitors from outside the region. The most recent National Panel Survey (Wynne-Jones et al. 2014) has addressed some of these issues, but even these surveys do not sample catch from tourists or children under the age of 16. Offsite surveys have been found not to generate useful information on the size of fish caught so rely on an estimate of average weight from ramp surveys to estimate harvest in tonnes. The existing diary data has been useful for characterising the distribution of fishing effort, main species taken and methods used in FMA 2.

3.2. On-site surveys of marine recreational harvest

3.2.1. Boat ramp survey data summary

The Ministry for Primary Industries *rec_data* database includes catch recorded by trained interviewers at boat ramps. The two largest data sets are from surveys in 1992–93 and 1999–00 with over 1400 fishing trips recorded in each of these surveys (Table 4). Fishers on 8 trips (0.3%) refused to be interviewed but may have been fishing. The main purpose of these surveys was to measure fish and shellfish landed to calculate the average weight per species and convert total harvest in numbers of fish from the dairy surveys to harvest weight in tonnes. Boat ramp interviewing sessions tend to be four hours long in the afternoon on weekends or holidays when fisher intercepts are highest and most fish can be sampled.

Data collected by boat ramp interviewers is regarded as accurate as it is collected in a consistent way on the day of fishing, the fish are mostly measured and correctly identified. Information on the time spent fishing, methods and areas fished should have minimal recall bias (Hartill et al. 2007). However, the catch from trailer boats will probably not be representative of other forms of fishing such as from the shore with lines or nets.

Another consideration when interpreting data from boat ramp surveys is spatial coverage. Fishers launching from a particular ramp will tend to fish similar areas. If trailer boat fishers want to try further afield it is easier (cheaper) to tow the boat and launch from a different ramp. Catch composition and the size of fish may be affected by the area fished. Note that only Hawke Bay ramps were sampled in 1992–93 and almost half of the interviews came from trips in January. Napier, Castle Point and Wellington ramps were sampled over a 12 month period in 1999–00 with 22% of interviews in March and with a low point in August (Figure 14).

Table 4: Number of trips recorded in MPI-funded FMA 2 boat ramp surveys to the end of 2011 by year and location.

Year	Gisborne	Napier Fishing Club	Napier Sailing Club	Clifton	Castle Point	Wellington	Total	First Date	Last Date
CEN93		498	470	519			1 487	20/12/1992	9/04/1993
NAT00		507			324	616	1 447	22/12/1999	30/11/2000
NAT11(partial)	20	64			14	88	186	1/10/2011	30/12/2011
Total	20	1 069	470	519	338	704	3 120		

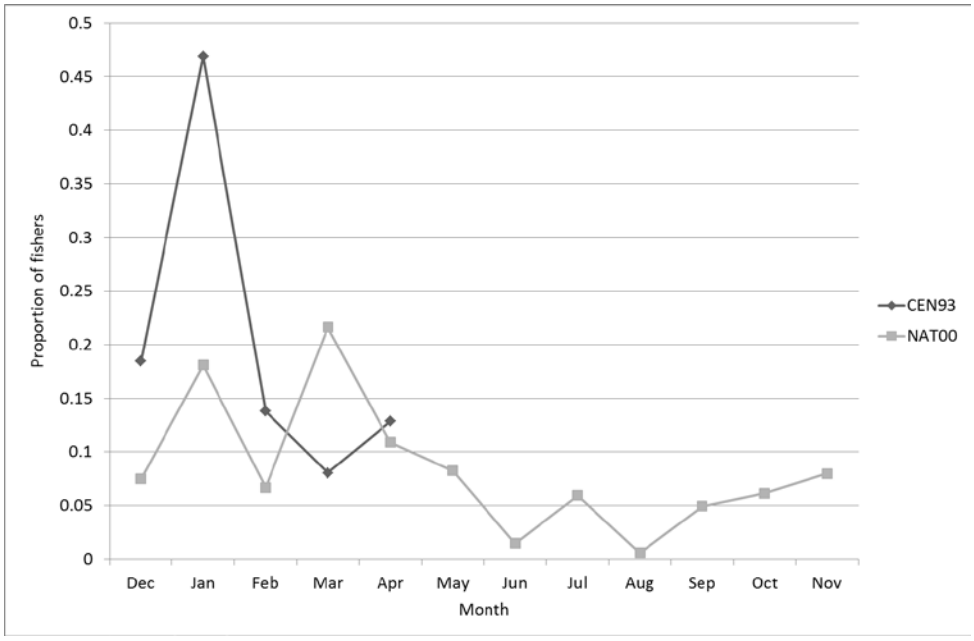


Figure 14: Proportion of individual fisher trips by month and survey in FMA 2.

The number of fish intercepted in the 1999–00 ramp survey suggests that rock lobster were the most numerous species harvested followed by blue cod (Figure 15). There is a spatial component to the species composition with few rock lobster and blue cod landed at Hawke Bay Ramps. The large number of rock lobster recorded from Zone 15 in the diary survey came mainly from areas south of Cape Kidnappers, like Waimarama and Porangahau. As in the diary survey, fishers in Hawke Bay recorded almost all the red gurnard and most of the kahawai and snapper. Wellington had almost all the kina and sea perch (Figure 15).

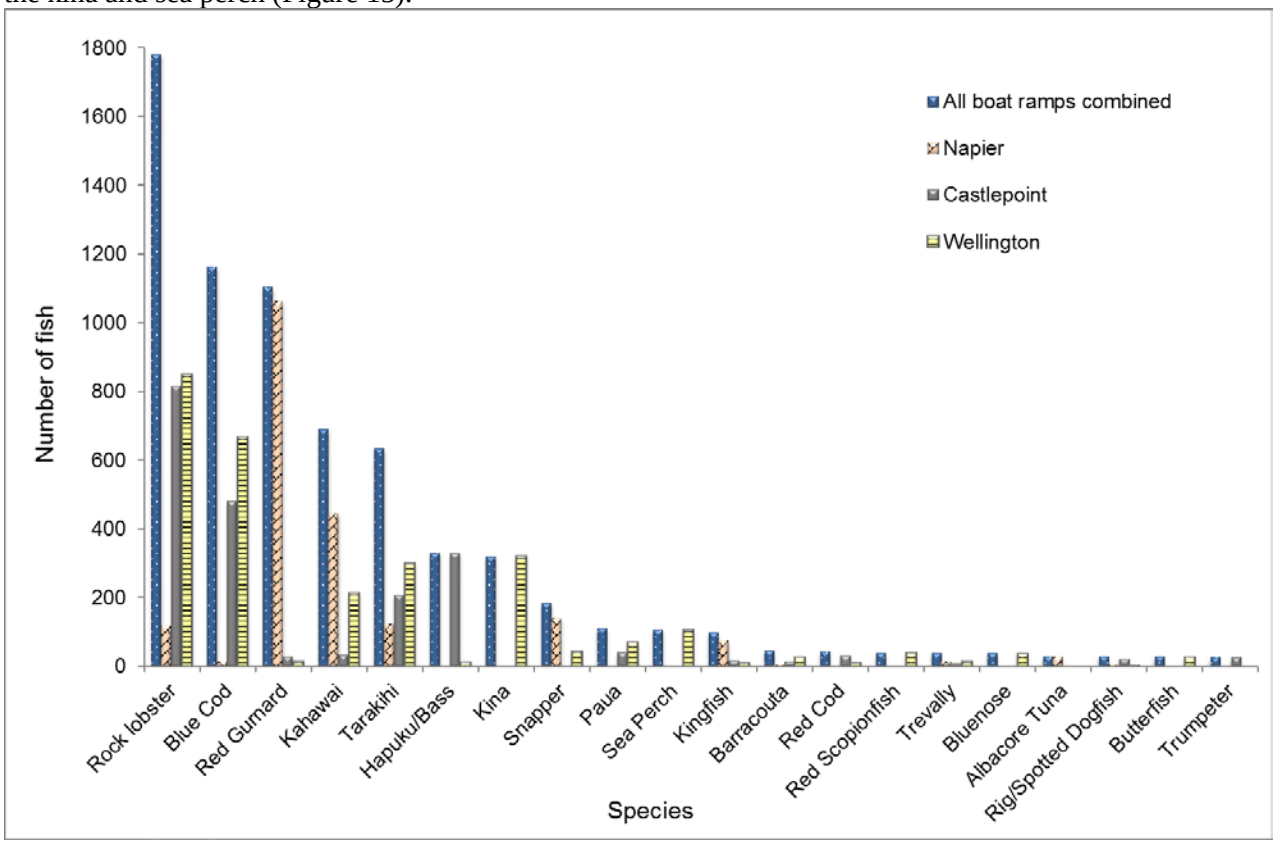


Figure 15: The top 20 species comprising total recreational catch from each boat ramp surveyed and overall, in numbers of fish from the 1999-00 survey.

The absolute number of fish sampled at each ramp can be affected by interview time, local weather conditions and other variables. The proportion of fish landed at each ramp shows that over a third of the catch intercepted at Castlepoint and Wellington were rock lobster and a quarter were blue cod, while over half of the catch landed at Napier was gurnard (Figure 16). Paua made up less than 3% of catch by number at the surveyed ramps.

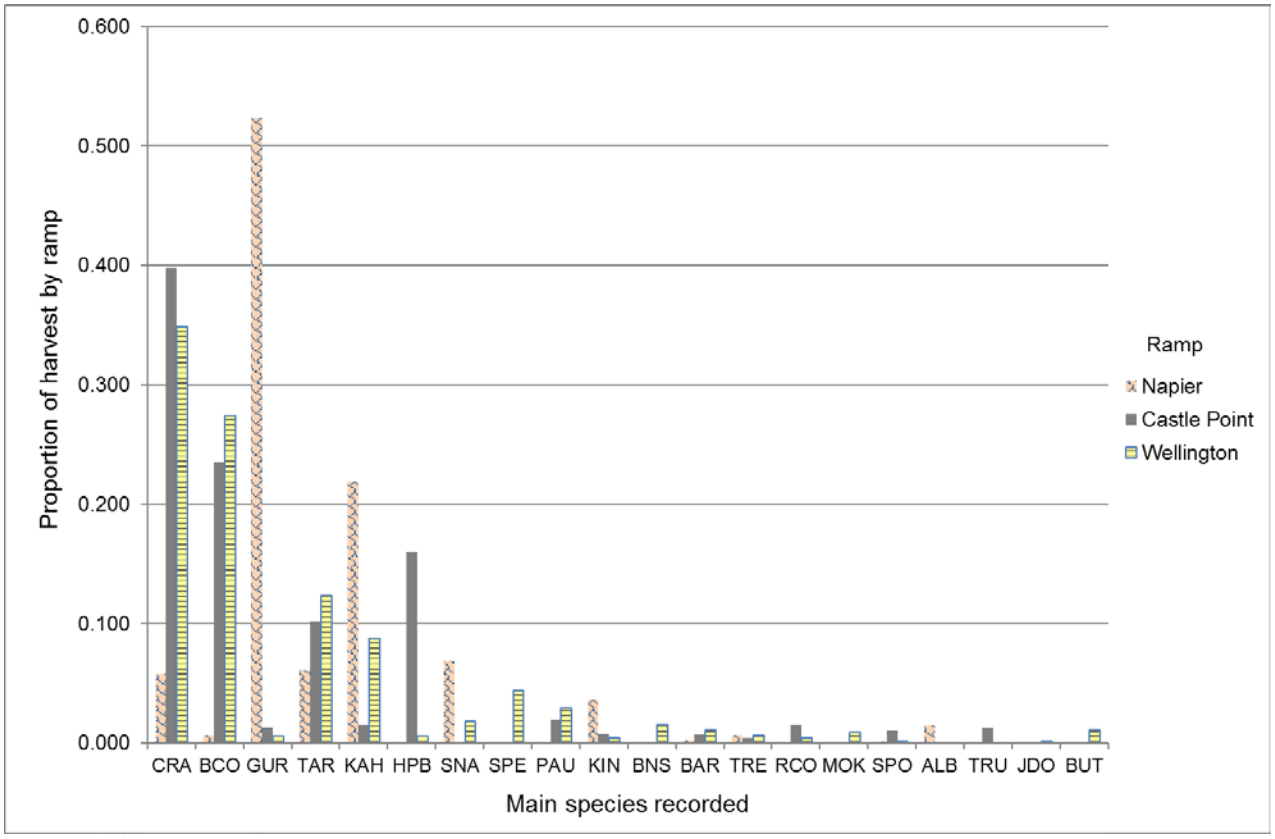


Figure 16: The proportion of catch (numbers) by species at each boat ramp surveyed in FMA 2 1999-00.

Line fishing with bait was the most common method encountered at all ramps with potting important at Castlepoint and diving with SCUBA and snorkel important for fishers in the Wellington region in 1999–00.

3.2.2. Boat ramp survey data 2011

Boat ramp interview data collected in 2011 was made available from project MAF2011/03 (Hartill & Davey 2015). This was a nationwide project to measure fish for use with the National Panel Survey estimates of amateur harvest in numbers of fish (Wynne-Jones et al. 2014). Interview sessions at FMA 2 boat ramp were scheduled mainly during weekends and holidays when weather is reasonable. Access points in Gisborne, Napier, Castle Point and Wellington were included and data was available from 1 October to 31 December 2011 (only the first quarter of the 12-month sampling period for that project). In total 187 fishing trips were recorded, with most interviews in Napier and at the Seaview ramp in Wellington (Table 5). There are two main ramps in Napier and most of the data was collected from the fishing club ramp which has general public access. Intercept rates were generally not high during this period with the Napier ramp being the most consistent.

Over 1400 finfish were measured in this survey, of which 415 (29%) were gurnard, 276 (20%) blue cod, and 271 (19%) were kahawai (Figure 17). These are similar proportions to those recorded in the 1999–00 ramp survey. The proportion of tarakihi and hapuku in 2011 was lower than in the 1999–00

ramp survey. There may be less fishing effort targeting these species at this time of year (October – December).

Kina (SUR) and scallops were the other main species caught (Figure 17). Only 83 rock lobster were recorded on all ramps over those three months. Most rock lobster were taken by divers.

Table 5: Number of trailer boats intercepted with fishers aboard on FMA 2 ramps by date and ramp.

					Wellington	
Date	Gisborne	Napier	Castlepoint	Owhiro Bay	Seaview ramp	Tarakena Bay
1/10/2011	1			3	14	
2/10/2011			4			
8/10/2011	2					
9/10/2011			6			
15/10/2011				6		
16/10/2011		12			14	
21/10/2011		13				
29/10/2011	3					
30/10/2011					5	2
6/11/2011	7	8				
19/11/2011					1	
20/11/2011		11				
27/11/2011					8	
3/12/2011	2					
4/12/2011				4		
10/12/2011		16			21	
11/12/2011	3					
17/12/2011	2					
24/12/2011			4			2
27/12/2011					8	
31/12/2011		5				
Number of sessions	7	6	3	3	7	2
Total fishing trips	20	65	14	13	71	4
Trips per session	2.9	10.8	4.7	4.3	10.1	2

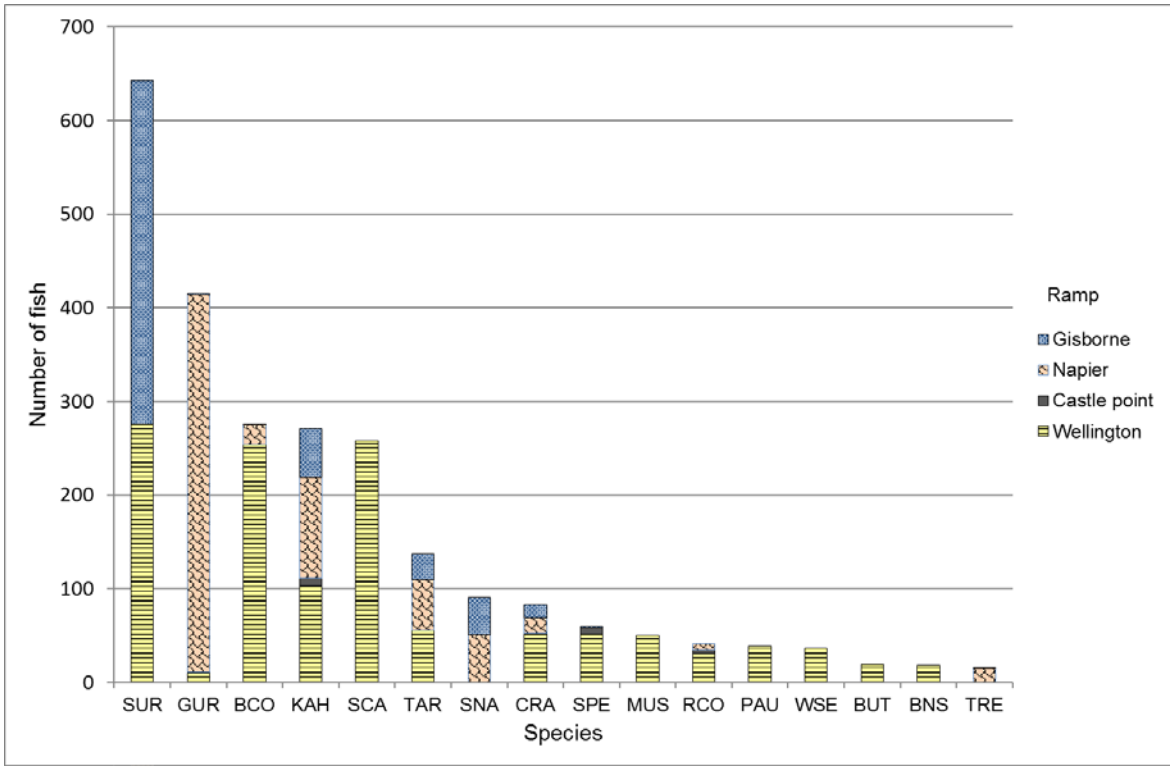


Figure 17: Number of fish harvested by species and ramp from FMA 2 boat ramps October to December 2011.

Kahawai, tarakihi and rock lobster were recorded on most ramps but the distribution of other species was less broad than in the 1999–00 survey. Kina were landed in large numbers at Gisborne and over 50% of the harvest at Napier was gurnard. Most blue cod and all the scallops were recorded from Wellington ramps while Castlepoint recorded most of the sea perch and red cod (Figure 18).

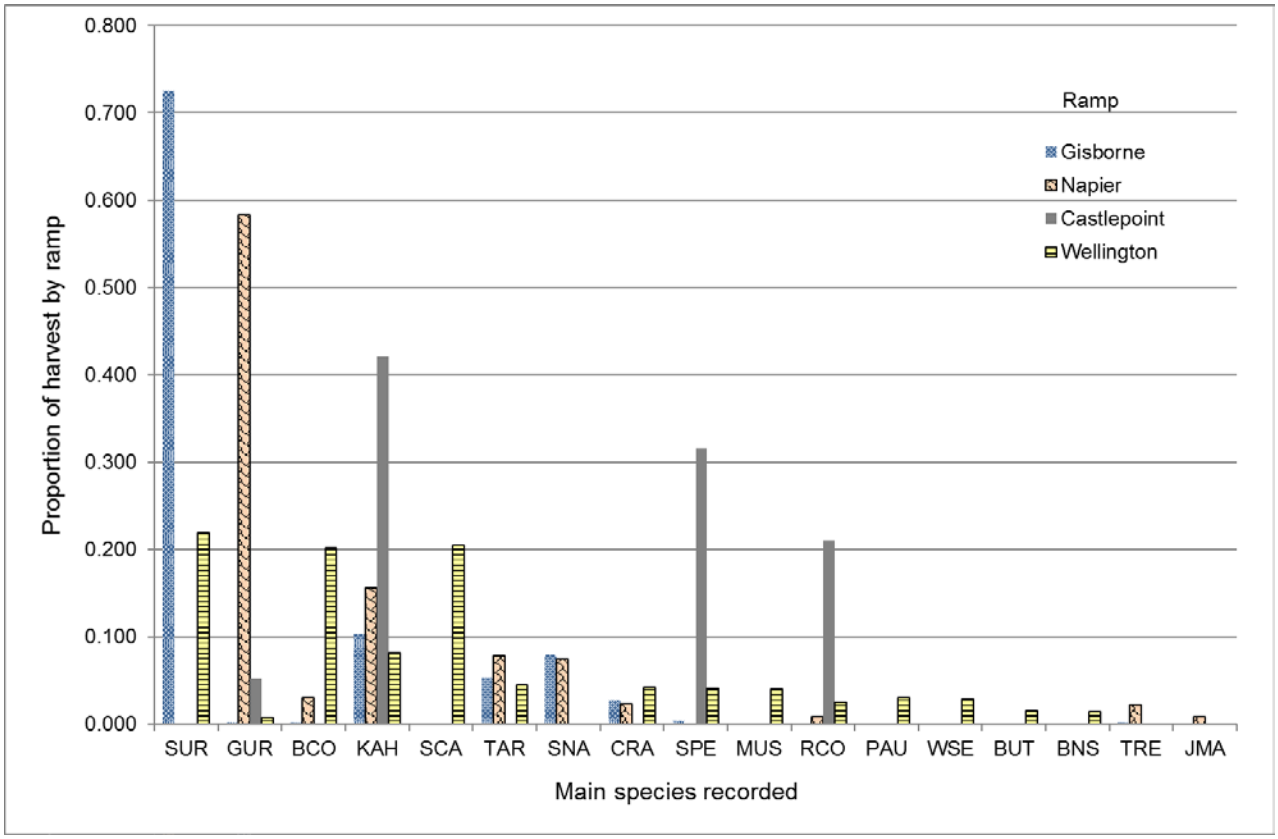


Figure 18: Harvest proportions by species by area from surveyed ramps October to December 2011.

3.2.3. Napier fishing contest ramp surveys

Hawke's Bay Sports Fishing Club have conducted on-site surveys of trailer boats during fishing contest weekends for several years. Fishers returning to the club ramp (main ramp in Napier) are interviewed and the following is recorded:

- Number of anglers entered in the contest (as all are registered.)
- Number of boats entered in the contest
- Boat name
- Catch of target species (kept and released)
- Catch of bycatch species (kept and released)
- Number of anglers surveyed
- Number of boats surveyed

The survey fishing period is from October to the following April each season for up to 17 competition days. A range of species are eligible for contests and it is not known if the proportion of effort targeting some species has changed over time. The daily catch rates of contest fishers recorded when they return to the ramp show some inter annual variability (Table 6, Figure 19).

These data have been collected in a consistent way and provide qualitative comparisons between seasons for the main species. There is concern among club members about the decline in some of these species. Anecdotal information is that some of the declines in abundance happened prior to the survey period. There are declines in gurnard and hapuku / groper raw CPUE in the survey, but these may be within the bounds of confidence intervals (not calculated from summary data provided) (Figure 19).

Table 6: Boat ramp club contest day surveys (summary supplied by Colin Murray, HBSFC).

2006–07 season (16 competition days)		Surveyed 1691 anglers:
Snapper	= 0.94 fish per angler day	
Gurnard	= 2.19 fish per angler day	
Tarakihi	= 0.44 fish per angler day	
Trevally	= 0.15 fish per angler day	
Groper	= 0.23 fish per angler day	
2007–08 season (17 competition days)		Surveyed 2700 anglers:
Snapper	= 0.85 fish per angler day	
Gurnard	= 1.55 fish per angler day	
Tarakihi	= 0.36 fish per angler day	
Trevally	= 0.10 fish per angler day	
Groper	= 0.09 fish per angler day	
2008–09 season (17 competition days)		Surveyed 2352 anglers:
Snapper	= 0.94 fish per angler day	
Gurnard	= 1.98 fish per angler day	
Tarakihi	= 0.43 fish per angler day	
Trevally	= 0.08 fish per angler day	
Groper	= 0.07 fish per angler day	
2009–10 season (13 competition days)		Surveyed 2252 anglers:
Snapper	= 0.66 fish per angler day	
Gurnard	= 1.42 fish per angler day	
Tarakihi	= 0.48 fish per angler day	
Trevally	= 0.11 fish per angler day	
Groper	= 0.09 fish per angler day	
2010–2011 season (17 competition days)		Surveyed 2150 anglers:
Snapper	= 0.85 fish per angler day	
Gurnard	= 1.70 fish per angler day	
Tarakihi	= 0.37 fish per angler day	
Trevally	= 0.17 fish per angler day	
Groper	= 0.04 fish per angler day	

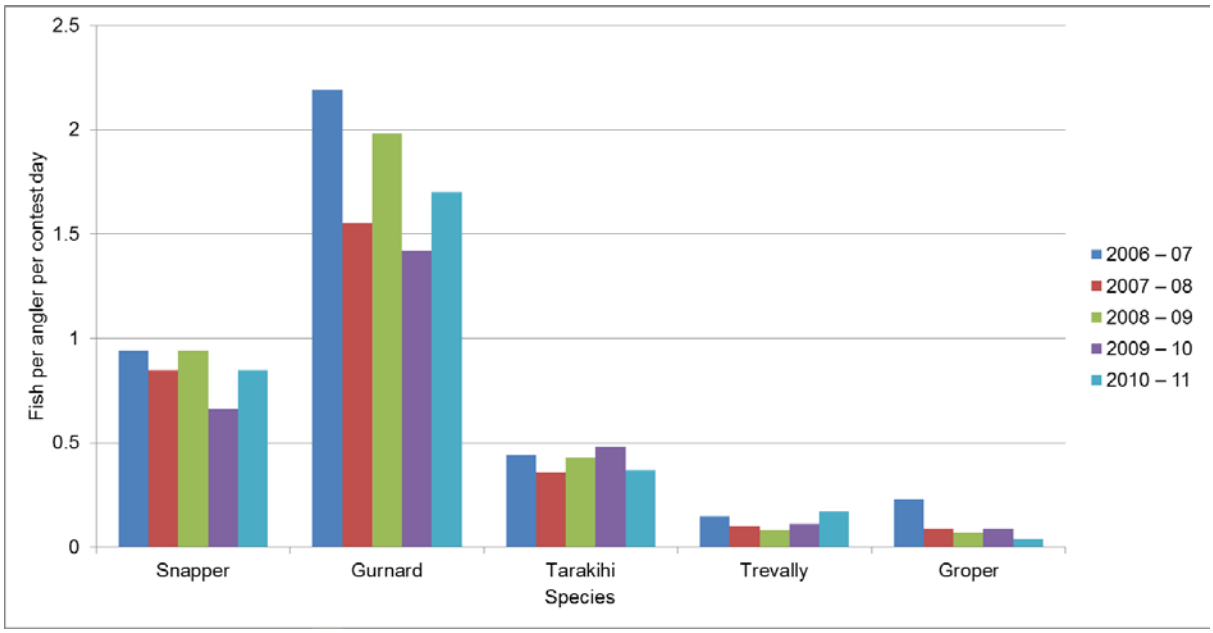


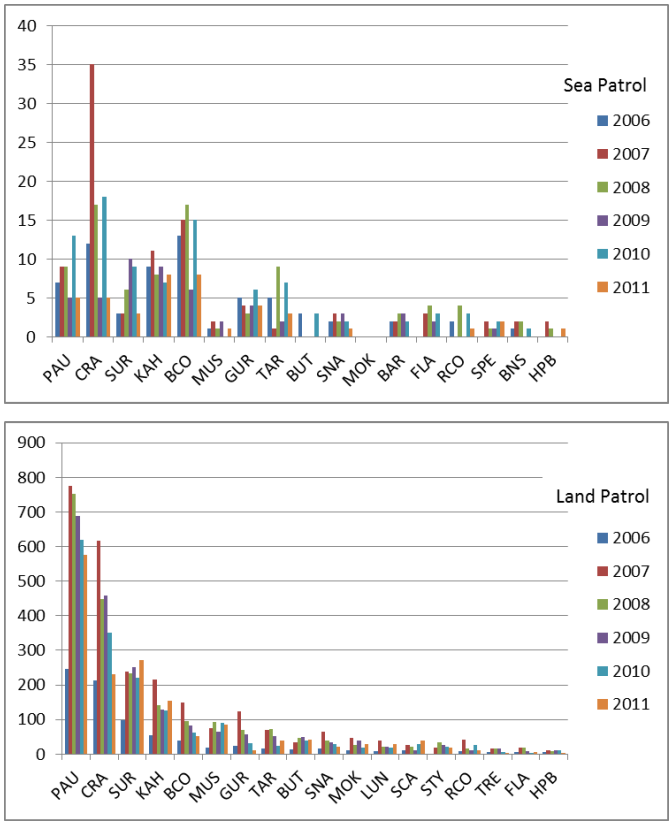
Figure 19: Catch per angler per contest day by species and fishing year from the Hawke's Bay Sports Fishing Club survey (data supplied by Colin Murray).

3.3. Fisheries Officer activity monitoring reports

Fisheries Officers keep a record of their intercepts and inspections. Information including date, area, number of active fishers and catch by species that is collected goes into the Fisheries Officer activity monitoring system. Data is not coded by FMA, but an extract of FMA 2 regions and locations was made in December 2011 for this project. Over 43 000 active fishers have been recorded on the Fisheries Officer activity monitoring system, mainly from land patrols since 2006 (Table 7).

Table 7: Number of active fishers recorded in the Fisheries Officer activity monitoring system by year and patrol mode.

Calendar Year	Checkpoint	Land Patrol	Sea Patrol	Total
2001		27		27
2002		1		1
2005		9		9
2006	103	2 631	257	2 991
2007	710	8 969	364	10 043
2008	544	7 311	415	8 270
2009	270	8 216	210	8 696
2010	87	6 427	418	6 932
2011	92	5 825	249	6 166
Total	1 806	39 416	1 913	43 135



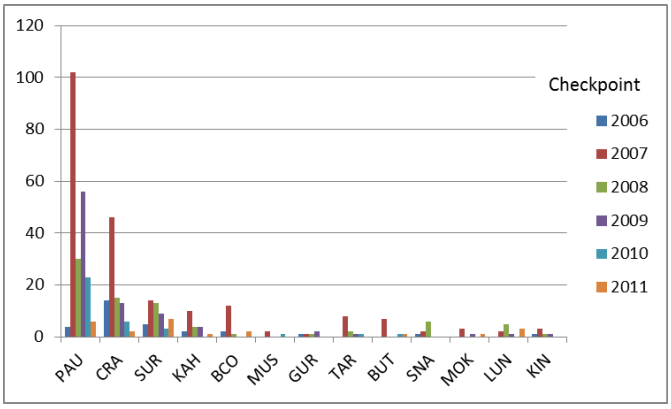


Figure 20: Number of fish and shellfish reported in the Fisheries Officer activity monitoring system by species code, year and patrol mode.

The number of fish harvested by species at the time of interview is also recorded and can give an indication of where shore based effort is occurring. However, the Fisheries Officer patrols are often targeted at particular species or areas and may not be representative of the true distribution of recreational harvest.

Paua, rock lobster and kina were the most common species encountered by land patrol and checkpoint since 2006 (Figure 20). A higher proportion of finfish were encountered in sea patrols.

Wairarapa and Wellington are where most paua and rock lobster harvest has been recorded by Fisheries Officers. Land patrol data around Wellington is recorded at specific sites like Moa Point and Makara, while Wairarapa, Hawke's Bay and Gisborne are identified by region (Table 8). It is not possible from these records alone to identify or rank specific sites that could be targets in surveys of recreational harvest.

Table 8: Number of fish by species code recorded since 2007 by Fisheries Officers land patrols in FMA 2.

Place field	PAU	CRA	SUR	KAH	BCO	MUS	GUR	TAR	BUT	SNA	MOK
Wairarapa	815	454	39	75	123	2	16	33	20	5	24
Napier	582	584	227	204	39	17	181	47	7	49	23
Breaker Bay	234	39	66	17	13	12	1	2	28	2	7
Eastbourne	197	26	26	38	9	132	4	7	9	1	6
Central Hawkes Bay	196	75	75	24	5	1	21	6	2	3	7
Moa Point	190	49	68	8	29	3	6	10	20	2	14
Makara	173	71	49	27	41		5	22	55	9	14
Gisborne	170	323	251	65	6	2	9	32	1	46	14
Southern Suburbs	146	36	43	19	19	41	3	8	14		5
Red Rocks	88	35	29	2	6				21		10
Lyall Bay	84	20	30	9	10			2	9		8
Worser Bay	75	3	30	3	2	61	1	1	5		
Wainuiomata	64	18	11	1		1			2		1
Island Bay	51	31	23	24	38	2	5	9	9	1	9
Porirua	51	10	17	28	22	1	1	18	4	6	4
Hastings	43	88	21	22	2	4	21	2		9	2
Port Wellington	34	4	12	38	2	25	1		2	1	
Evans Bay	30	5	18	55	20	31	4	9	1	6	1

3.4. Aerial survey of vessels fishing in FMA 2

An aerial survey of FMA 2 counting boats engaged in recreational fishing was conducted as part of project MAF2011/06. This was intended to characterise fishing intensity during the peak holiday period from late December to end of January. In order to keep costs down, only two days flying on fine weather days were conducted. Flights were chartered from Air Napier using a twin engine Piper Seneca (Figure 21). The aerial survey was conducted with assistance of MPI staff from the Napier and Wellington offices on Wednesday 4 January 2012 close to the New Year's holidays and Saturday 21 January 2012 at the start of Wellington / Wairarapa Anniversary Weekend. On both days the survey started at Titahi Bay and finished near Cape Runaway. It was difficult to predict perfect weather for the whole day this summer across the whole FMA. There was fine weather with reasonable visibility on both flying days but some wind in places. There was 15 to 20 knots of wind in Cook Strait on the

first day and about 15 knots in Poverty Bay on the second day. Generally the wind was 10 knots or less elsewhere on both days. Even with combined vessel counts across the two days the intensity of fishing activity around Wellington and Poverty Bay on peak days may be under estimated (Table 9).

Figure 21: Air Napier Piper Seneca.

Overall 95% of the vessels counted from the air were trailer boats and most (63%) were seen in Zone 15. There were more boats in the northern zone during the first flight (12% of the daily count) and more in the Wellington area on the second flight (23% of the daily count) (Table 9). This is driven largely by the weather.

Table 9: The number of vessels counted in FMA 2 during aerial survey by day, fishing zone and vessel type.

Survey day 1, 4 January

Zone	Trailer	Kayak	Launch	Charter	Total	Percent
14	20	0	0	0	20	12.3
15	88	3	0	0	91	56.2
16	38	3	0	0	41	25.3
17	10	0	0	0	10	6.2
Total	156	6	0	0	162	Percent

Survey day 2, 21 January

Zone	Trailer	Kayak	Launch	Charter	Total	Percent
14	9	2	1	0	12	3.0
15	252	1	8	0	261	65.1
16	34	1	0	0	35	8.7
17	84	2	5	2	93	23.2
Total	379	6	14	2	401	

Survey days 1 and 2 combined

Zone	Trailer	Kayak	Launch	Charter	Total	Percent
14	29	2	1	0	32	5.7
15	340	4	8	0	352	62.5
16	72	4	0	0	76	13.5
17	94	2	5	2	103	18.3
Total	535	12	14	2	563	
Percent	95.0	2.1	2.5	0.4		

There were 189 stationary trailer boats and 8 launches counted in Hawke Bay on 21 January, mostly in the southern half of the bay and off Cape Kidnappers. Few launches or kayaks were seen in any area and all yachts seen were moving so not counted as fishing (although some may have been towing lures). It was estimated that about 10% of vessels were moving in the Hawke Bay area on 21 January in addition to the vessels counted as not fishing.

A count of empty boat trailers at or near Napier launch sites was made at mid-day on 21 January 2012. The count of stationary trailer boats plus the estimate of moving vessels can be compared with the number of vessels expected to be on the water based on the observed trailer count (Table 10).

Table 10: Count of recreational boat trailers on 21 January 2012 at three main Napier ramps and moored at Clifton.

Location	Time	Single axle	Tandem	Total
Hawkes Bay Sport Fishing Club (notes 1,2)	1200 hrs	97	48	145
Yacht Club (notes 3,4)	1230 hrs	80	20	100
Bridge ramp (note 5)	1240 hrs	11	1	12
Moored at Clifton (note 6)	1205 hrs	40		40
	Total	228	69	297

Note 1 Counted road parking, Club parking and Grass area towards heads
Note 2 2 boats ready to launch and 3 boats coming in. These not counted
Note 3 2 boats coming in. Not counted.
Note 4 4 (at least) trailers belong to yachts. These were counted
Note 5 1 coming out and one coming in. Not counted
Note 6 Empty trailers moored off the Clifton ramp counted from the air.

There were 14 vessels recorded as not fishing in the wider Hawke Bay area. Assuming an additional 10% of total trailer boats fishing were on the move, or trailer yachts not counted adds 19 vessels. The total of all trailer boats not fishing (33) and stationary vessels counted (189) is 222. This estimate is 75 vessels short of the concurrent trailer count. It appears we could have missed 25% of trailer vessels fishing that day. The bulk of these vessels may have been fishing in deep water more than 7 km outside Cape Kidnappers and some may have been south of the cape as far as Bare Island. Transects flown east–west would have made sure that vessels in deep water were counted, rather than the north–south transects used on 21 January.

The East Cape area is a popular summer holiday destination, but even in January there were few boats present in the afternoon overflights (Figure 22). Catch from zone 14 was generally lower than for other zones in the diary surveys and most of that came from fishers resident in the Gisborne area.

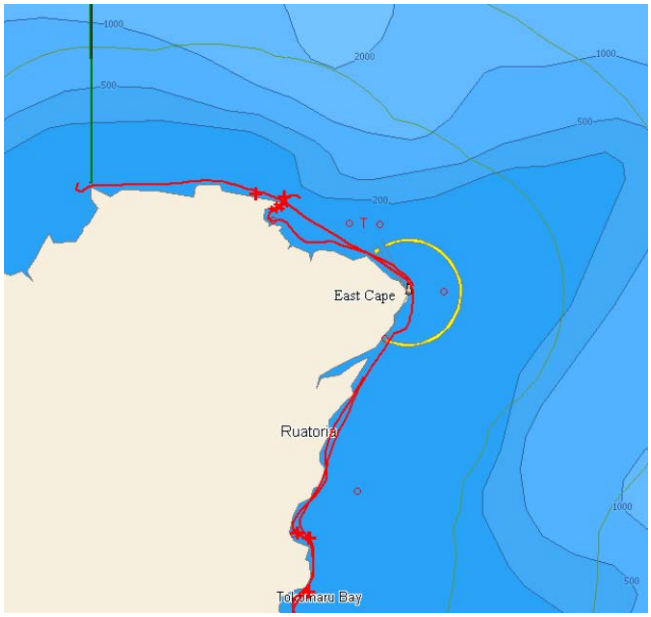


Figure 22: Fight path (red line) and vessel locations (+) observed around East Cape for two flights in January 2012.

Mahia Peninsula is also a popular holiday destination for boat owners. Much of the fishing effort was close to shore even in calm conditions (Figure 23). There was very little recreational fishing effort in northern Hawke Bay and no vessels around Wairoa on the days flown. Vessels were spread through southern Hawke Bay with a concentration of effort north of Cape Kidnappers and further south at Bare Island (Figures 23 and 25).

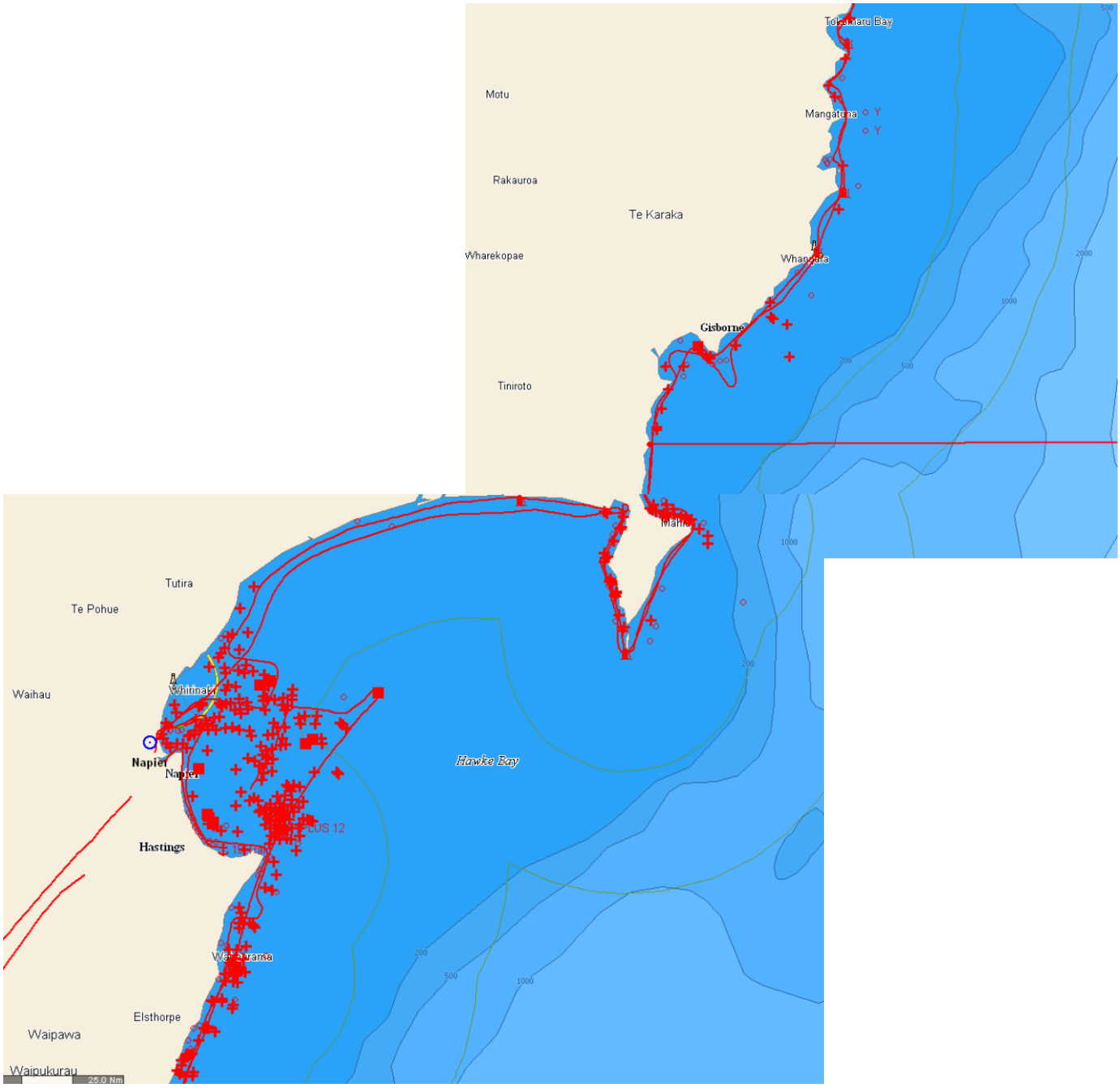


Figure 23: Fight path (red line) and vessel locations (+) observed in central FMA 2 for two flights in January 2012.

Vessels were fairly sparse on the southern Hawke Bay and Wairarapa coast. Activity tended to cluster around settlements like Porangahau, Castlepoint and Riversdale Beach (Figures 24 and 26).

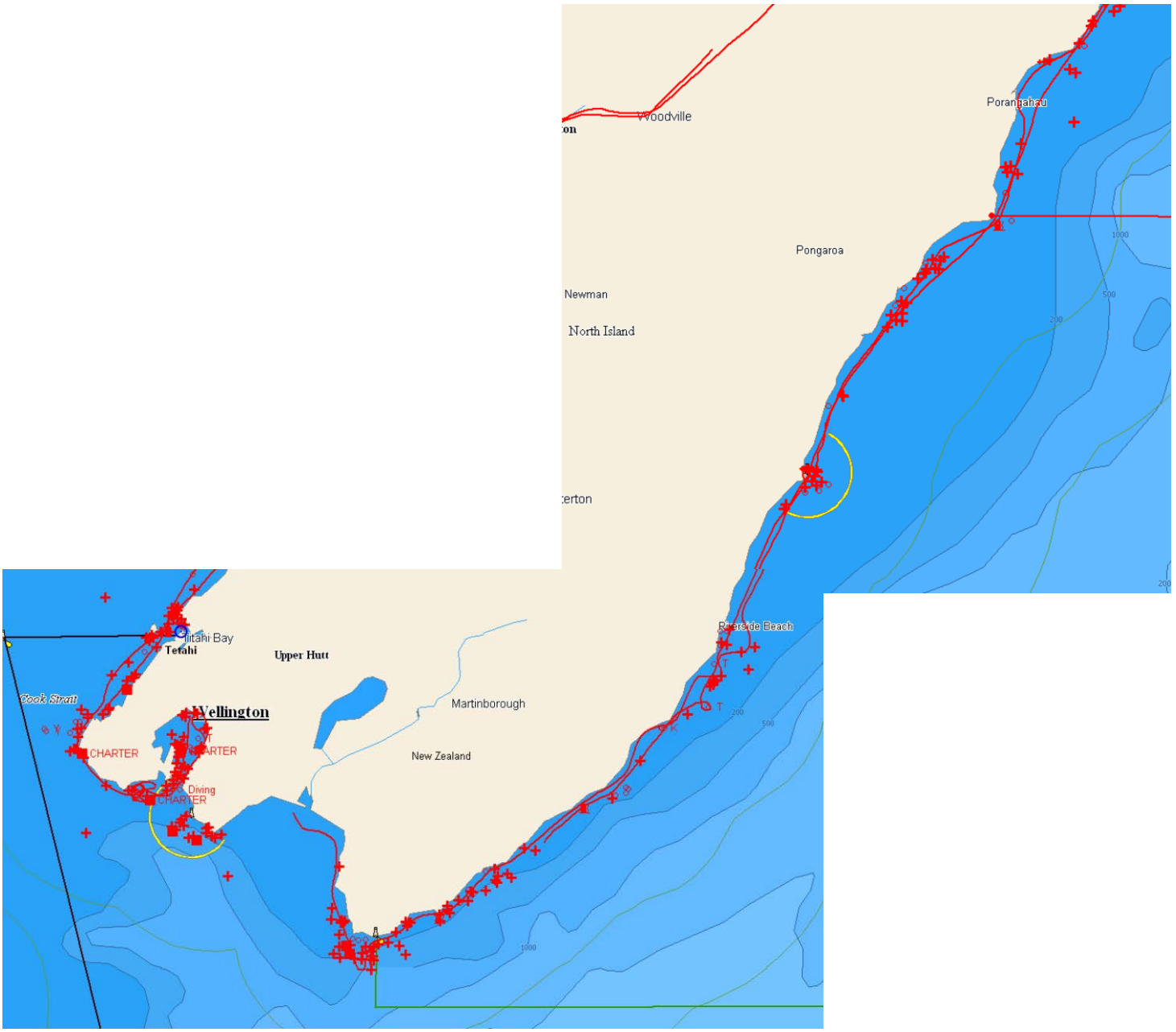


Figure 24: Fight path (red line) and vessel locations (+) observed around Wairarapa and Wellington for two flights in January 2012.

Figure 25: Settlements and access points in southern FMA 2.

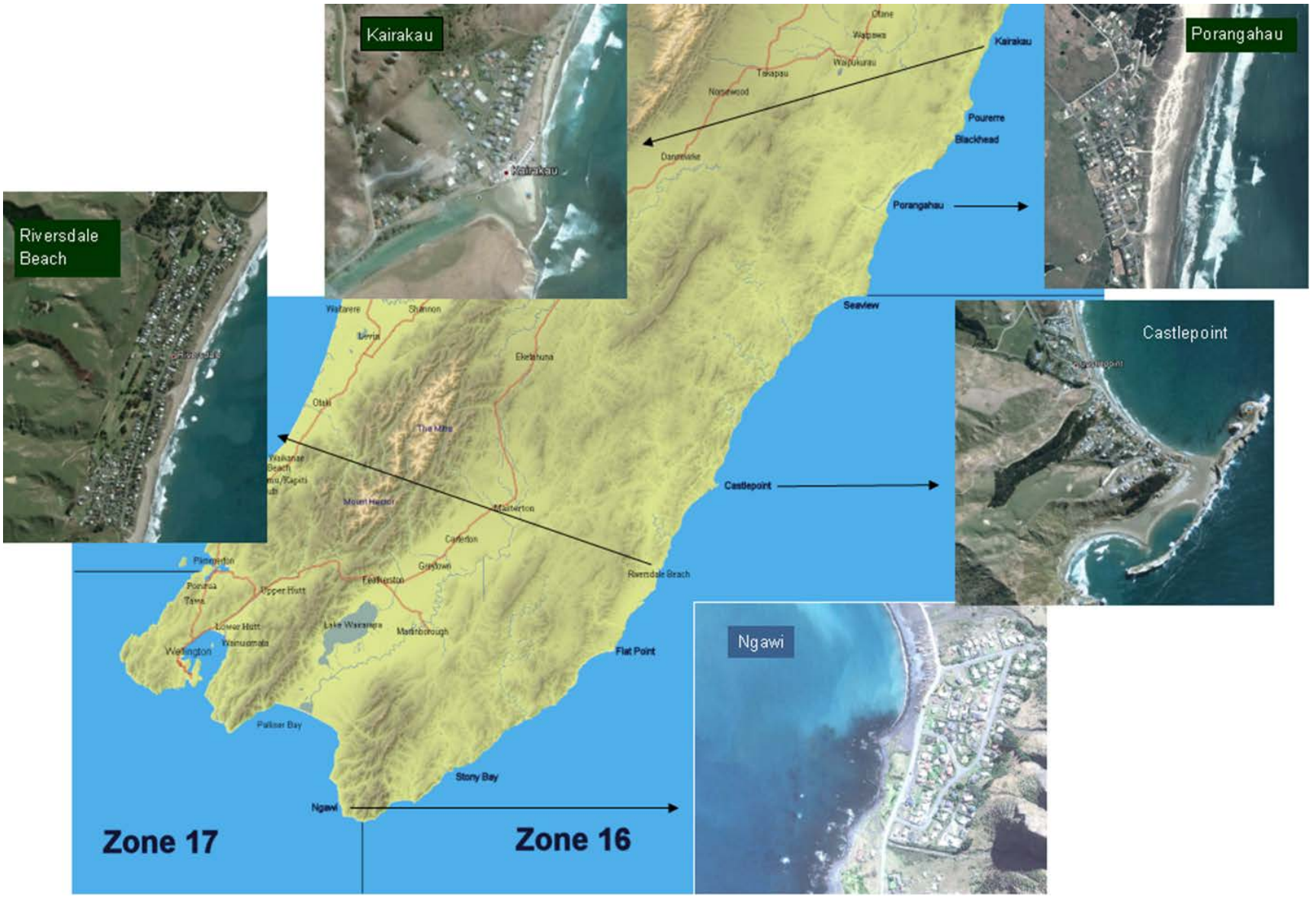


Figure 26: Settlements and access points in southern FMA 2.

4. DELIVERY OF FUTURE ON-SITE SURVEYS IN FMA 2

4.1. Characteristics of the FMA 2 survey area

The survey area has a number of features that are worth noting. The largest population centre is in the Wellington region. These fishers can access enclosed waters in Wellington Harbour and have options to fish different coasts oriented to the west, south or east. There are also reports that some fishers travel outside FMA 2, to the Marlborough sounds for example, and return to Wellington with fish from FMA 7. Diving or hand gathering from shore is a popular method when the sea conditions and temperature are favourable.

There are no other large fishable harbours in FMA 2 but the ports at Napier and Gisborne provide a range of access opportunities for larger vessels. For most other coastal settlements, only beach or river mouth launch sites are available (Figures 25 and 26). Generally, these coastal settlements are small (compared with those in the western Bay of Plenty) and there is no "coastal" highway linking them. Roads head inland from seaside settlements and travel times between them can be long.

It is likely that, in the Wairarapa and East Coast regions, a high proportion of fishers live and work in rural communities where the working week is less well defined than in cities. If conditions are favourable people will make time to fish or dive whether it is the weekend or not.

The Draft National Fisheries Plan for Inshore Shellfish has rock lobster (CRA 3 and CRA 4 stocks) and paua (PAU 2 stock) listed as group 1 species. This means they are a management priority and a specific service strategy to "Improve the reliability of non-commercial catch estimates and (commercial) mandatory reporting information used in stock assessments". All of CRA 3 and part of CRA 4 and PAU 2 is in FMA 2. See Appendix 1 for group 1 species and management approach.

The Draft National Fisheries Plan for Inshore Finfish has FMA 2 blue moki, hapuku/bass, kahawai, snapper and tarakihi listed as Group 3 stocks. Red gurnard is Group 4 while blue cod, kingfish and trevally are listed in Group 6. Species in Groups 3 to 6 are less of a management priority, they may be important to some sectors, but are thought not to be as "biologically vulnerable" as other stocks. See Appendix 1 for Draft National Fisheries Plan Group 3 to 6 species and management approach.

4.2. Potential methods for the delivery of future on-site surveys in FMA 2 for key species

On-site surveys typically collect information on fishing effort, catch (the number of fish caught whether kept or released) and harvest (the number of fish kept). It is also a reliable way to undertake biological sampling of length, weight and in some cases age of fish kept. Sampling a few well used access points spread across the survey area may provide enough information to characterise a recreational fishery. This is a description of fishing methods, catch composition, catch rates and fish size distributions.

In order to convert on-site survey data into estimates of total harvest a complete sample frame is required. This could be a list of all the access points and all possible days to sample or an estimate of total fishing effort. It is also important to use probability sampling, where all possible samples have a known probability of being drawn from the sample frame. This allows the use of statistical inference and probability theory to establish the properties of the estimators obtained from the sample, such as bias, precision and accuracy. The availability of good sample frames and the cost of large scale onsite surveys tend to limit the use or frequency of on-site surveys at larges scales such as a Fisheries Management Area.

On-site census
In small areas, a total census approach may be used, with the intention of covering all access points throughout a survey day and intercepting all fishers at the end of their fishing trip. The sampling frame is simply all the days in the survey period. This is neither affordable nor feasible on the scale of FMA 2 which has 1130 km of coastline. It is particularly difficult to cover shore based fishers who may have many possible access sites and highly variable fishing effort.

On-site surveys in New Zealand have focused on boat fishers, usually trailer boat fishers, who use access points such as boat ramps or specific beach launch areas. These are key access points that most fishers from a wide area have to cross, which allows the opportunity to count or interview many fishers at a single site. There are only a few (6) sheltered easy to use launch sites in FMA 2 close to the main population centres of Wellington, Napier/Hastings and Gisborne. There are a number (8) of important secondary access points which are less sheltered but still regularly used (Moa Point, Ngawi, Castlepoint, Waimarama, Clifton, Mahia Beach, Tatapuri, and Tolaga Bay). A survey of 14 to 16 access points would collect a large proportion of the boat based catch in FMA 2. However, it is not possible to tell what proportion of the total could be collected without some additional data on fishing effort and or harvest from other access points.

Additional on-site information
There is potential for auxiliary data to be collected to help quantify total effort on survey days or for days between surveys. This can be used to scale up harvest per trip or harvest per angler hour to total harvest. We have called these "supplemented access point surveys" and some potential approaches are described in the following sections.

Bus route
Bus route surveys deploy a roving interviewer to travel around a series of access points on the survey day, intercepting fishers who have completed their fishing trip (Pollock et al. 1994). They do not collect a census of all effort but when a series of survey days are sampled using a random start location and random travel direction it is possible to estimate a mean harvest of the ramps on the route for each survey stratum. This approach has been used with some success in the western Bay of Plenty for secondary and smaller boat ramps as part of a wider access point survey. There the ramps are reasonably close together with the shortest "bus route" having three launch sites around Maketu and the longest having 12 launch sites from Waihi Beach to Mount Mauganui. It is important that interviewers follow the route timetable and do not decide for themselves how long to wait at each launch site.

Web camera
In New Zealand there are a number of MPI projects operated by NIWA to install and monitor web cameras at key boat ramps (Hartill et al. 2010). They record a photograph every minute, which is sufficient to make counts of returning vessels. Vessel counts from every day could provide an alternative way of scaling up harvest information from average catch per vessel interviewed to total harvest for a ramp (rather than expanding average catch per day by total days in the stratum for that ramp). If there is no difference between average catch per vessel on week days compared with weekends, then that stratification (which is mainly to capture different levels of effort) could be dropped where web cameras were used. Seasonal strata would still be required because target species and catch composition vary with season. The advantage of collecting web camera data is that it can stored, then sampled or sub sampled as required.

A web cam has been used to count vessels leaving from and returning to Raglan Harbour. This can capture the number of vessels from all launch sites that where active during daylight hours (Hartill et al 2015). In a location like Napier where the harbour has a number of boat ramps and several sites for moored vessels a web camera pointed out the harbour entrance could be used to count all recreational vessels as they return (Figure 27).

Figure 27: Location of boat ramps and moored vessels in Napier harbour.

The alternative could be to use interviewers to cover all boat access points around Napier Harbour. This could require all day coverage (two people per ramp) at the two main ramps plus a roving surveyor to cover the bridge ramp, marina and wharf moored vessels, and the secondary ramp near Port Napier (not shown in Figure 27), which is five people for 45 to 60 survey days a year. Half of those survey days may have little or no vessel movements but need to be fully covered if there is no auxiliary data. If web camera vessel counts could be used as a count of total vessel returns on survey days, then two interviewers could cover all access points on a bus stop schedule to provide an average harvest per vessel (whether fishing or not).

A similar approach could be used for vessels returning to Wellington Harbour, but a trial may be required to determine the feasibility. A site near Seatoun School may be suitable with the camera facing east. Glare from the water and distance from the camera can be a problem at some sites. Height above the shore and vibration from wind gusts may also need to be considered when siting a camera.

An alternative approach to web camera is to have an observer recording the time and type of vessels passing by their vantage point on survey days. Binoculars could be used and more detailed information could be collected. Also this would avoid problems with interpreting vessel counts from low resolution still images, which could be difficult on busy days. An all-day survey by observers would require two shifts on survey days.

Traffic counter

There may be several ways of collecting a count of vehicles using an access point. In New South Wales a pneumatic “road tube” vehicle counter was used to record the number of vehicles accessing a surveyed boat ramp (Steffe et al. 2008). Counts from non-survey days were used to improve the accuracy and precision of harvest estimates. Road tubes wear out and need to be checked regularly. Induction loops permanently installed in the ground are more expensive but can provide direction of travel as well as counts. Radar-based sensors are also available with count recorders that can detect vehicles up to 9 meters away from the sensor (eg SenSource TC-RS50-R). They are cheaper and easier to install than underground loops but a power supply and housing for the data recorder are required. Some ramps have swipe card entry so traffic counts may be available. Vehicle counts will not differentiate the type of vessel (e.g. commercial boat from recreational boat) but also do not require gigabytes of storage and hours of reviewing to interpret. Supplementing interview data with

accurate all day vessel counts improved accuracy and precision of harvest estimates from a boat based fishery in New South Wales (Steffe et al. 2008).

Trailer counts

Bradford (2000) investigated existing data on trailer counts made at the beginning or end of a ramp interview session and aerial overflight counts made in 1994 in the Hauraki Gulf. Not all ramps were surveyed and it was not possible to attribute overflight counts from one area to a particular ramp. The means of overflight counts were compared with the means of trailer counts at the start and end of survey sessions. Analysis showed that most of the data on vessel and trailer counts were at the lower end of the range and there was considerable variability about the regression line. Even so, trailer counts from boat ramp car parks can give a rough estimate of the fishing effort (Bradford 2000).

Our trailer count at the ramps in Napier at noon on 21 January 2012 suggest that this method may provide a good instantaneous count of the number of trailer boats on the water at a particular point in time. Complete coverage of launch sites would be more tractable in Hawkes Bay than in the Hauraki Gulf. As we found in our aerial survey, counting vessels from the air in FMA 2 on high use days when there are several hundred boats on the water, also has its pitfalls. However, a very high percentage (96%) of stationary vessels counted from the air in zone 15 were trailer boats.

Where access points are all known and well defined it would be possible to do a total trailer count at peak time (say 12 noon) as a proxy for all trailer boats on the water at that time, on a survey day. The all-day ramp interviewers would ask for departure time and record return time to get the effort profile. Catch would be measured to provide a catch profile for that survey day for all boats returning (fishing and non-fishing), similar to the method used in the aerial survey (below). This would be scaled up by the trailer count for all access points. Most boat trips in FMA 2 are day trips as there are few sheltered anchorages for overnight stays.

Aerial counts

Aerial counts of vessels engaged in fishing have been used in many countries, including New Zealand, Australia, Canada and USA, to estimate total fishing effort for a survey day. In New Zealand the whole area is flown at a time of maximum effort to provide an "instantaneous" count of vessels. All-day ramp surveys collect harvest and fishing effort information, including whether the group was engaged in fishing at that time. Rather than calculate an average catch rate per vessel, the total harvest for all vessels is scaled up by the ratio of the number of interviewed parties who claimed to be fishing at a fixed time of day, relative to the aerial count of all fishing vessels observed from the air at that time. Details of the aerial-ramp census approach are given in Hartill et al. 2007 and a discussion on assumptions and possible biases in Hartill et al. 2013.

The aerial survey method works well where there are diffuse access points and there is relatively high recreational fishing effort. In an area like FMA 2 with an exposed coast and large areas of limited access there could be many flying hours counting just a few vessels. It is unlikely to be a cost effective option for a random stratified survey design for a whole year. It would be more suited to a sub-regional design estimating peak season (3 or 4 month) harvest for Hawke Bay or the Wellington region. However, management decisions are made for fish stocks at the QMA/FMA level and harvest estimates need to fit the management scale.

One of the uncertainties in the current aerial overflight method is that only stationary vessels believed to be fishing at the time of the flight are counted. Interviews at a few key ramps provide an estimate of the proportion of boats fishing exactly at that time. There may be some error around whether a stationary boat is fishing or not and whether a boat that was moving at the time of the overflight claims to have been fishing at the time

Off-site phone surveys
All the access survey methods discussed above are based on capturing boat based effort and catch. Shore diving, hand gathering and set netting are important methods for some key species in FMA 2. The approach taken in a number of previous surveys is to use a ratio of boat based catch vs shore based catch from the most recent off-site phone or diary survey to scale the observed boat based harvest to the total harvest for all methods (Hartill et al. 2007, 2013). It is important to ensure that on-site data collection and analysis is for the same temporal and spatial scale as the off-site data that will be used for scaling up harvest estimates.

Roving surveys of shore based fishers
It is possible to use a roving interviewer to move along the shore and count and interview fishers as they go. These surveys are best suited to survey areas with diffuse access which cannot be surveyed by a stationary interviewer. Sampling events are chosen randomly with known probability from a list of shore line segments and from all days of the fishing season. Data are collected from people still engaged in fishing which makes it complicated to estimate total catch for the end of the trip (Pollock et al. 1994). In FMA 2 it would be difficult to interview fishers and measure their catch while they were still engaged in the main shore based methods of interest, such as shore diving, hand gathering and set netting.

4.3. Feasible options for the delivery of future on-site surveys in FMA 2

Option 1: Baseline data collection
A combination of well sited web cameras and low level random stratified interview sessions in population centres would provide trends in fishing effort, length frequency and harvest rates for regionally important species. Cameras at harbour entrances in Wellington, Napier and Gisborne would capture most of the vessel activity in those areas. Harvest could be estimated for boat based methods in part of FMA 2 but would not, on its own, be scalable to the whole stock. Data collection could be ongoing with periodic analysis of trends. This is of a similar scale to the on-going web camera and survey projects underway in FMA 1, FMA 8 and FMA 9 (Hartill et.al 2015). Set up costs are hard to estimate but annual cost once established would be modest. Additional access or aerial survey projects could be added in every three to five years.

Option 2: Access-access bus route survey
An access-access survey uses an access point survey to estimate total boat fishing effort as well as harvest rates. The simple census approach, of covering all access points all-day on survey days, is not affordable on the scale of FMA 2. The bus route approach needs all access points identified and split into a series of routes. There are at least 40 boat launch sites and marinas in FMA 2. These could be split into 5 or 6 routes. Normally one or two interviewers would travel all of one route on a survey day. The distance by road between some of these sites would make this inefficient. Some extra time spent recruiting and training residents at each remote location would allow a virtual bus route survey to be used. The random start site and direction for the bus route would determine the start and finish times for interviewers at each site. As a session finished at one location the next would start at the next site on the route. There would be little or no travel time or expense on these routes. Occasionally a supervisor could drive the route and call on interviewers. A pilot study or "burn in" period at the start of a survey would help establish wait times roughly proportional to effort at different sites. Set up costs are hard to estimate but survey costs could be similar to MAF2010/02, the access point survey in western Bay of Plenty (Holdsworth 2016). This type of survey could also provide length distribution by species for the next National Panel Survey.

Option 3: Access-access vessel count and bus route survey
This option is a combination of options 1 and 2. Counts of returning vessels from web camera data could be used to scale up the harvest per vessel encountered from bus stop access point surveys within the Wellington, Napier and Gisborne harbours. The number of hours on ramp interviews could be scaled back if an independent estimate of vessel effort was available. There would need to be a

method of counting fishing boats inside Wellington Harbour or scaling up the harvest from vessels that did not get counted returning past the camera.

If web cameras are not installed, an alternative would be to have observers at vantage points near harbour entrances to classify and count returning vessels. An observer at Titahi Bay could also count vessels returning from the south to help determine total effort crossing the boundary of FMA 2.

Option 4: Aerial-access survey
The aerial-access survey method developed in New Zealand provides an alternative way of deriving total effort from an instantaneous maximum count of vessels. Given the size of FMA 2 two or three simultaneous fights would be required to count vessels at the peak period. Access point interviews would be all-day stationary sessions at a subsample of all ramps. A problem may be getting enough boats returning with harvest to scale up to vessel counts on the Wairarapa Coast and East Coast where effort is dispersed. For example on days were boats are counted on the Wairarapa coast but none launch from Castlepoint where the interviewer would most likely be stationed all day. The cost would be similar to project MAF2011/02 (Hartill et al. 2013) although fewer access points could be covered and fewer interviewers would be needed.

Option 5: Access-access trailer count survey
Is there a hybrid survey that can acquire an instantaneous maximum vessel count at the access points rather than from the air? On 21 January a higher estimate of total vessel effort was obtained from a trailer count of Napier and Clifton than obtained from the air. Given some experience and better definition of the fishing area this difference could be minimised. However, the limited number of launch sites makes it possible to estimate the trailer boat effort at a peak time. A number of small secondary launch sites in this area could be monitored for minimal cost. Onsite interviews could record departure time and harvest from returning vessels. Fishing and non-fishing vessels would be included to determine whether their trailer was present at the time of the trailer count. Scaling this method to the whole FMA would be more efficient and cost effective than a bus route survey of all access points or a full year aerial-access survey of the whole FMA 2.

There are inefficiencies in the full bus route survey. A wait time is required at all access points whether trailers are present or not. At smaller sites this may be 30 minutes. Trailer counts can be made but are not part of the expansion method. Only interviews with harvest are scaled to daily and mean daily harvest estimates. When weather is poor all sites still have to be covered with the assigned wait time.

The aerial-access surveys require all-day coverage at high traffic access points spread across an area or fishery. This can provide more interviews for less cost than a bus route survey of the same area. The assumption is that the harvest per vessel is similar across all access points in the area. The inefficiency with aerial surveys comes from the cost, time and discomfort of flying the routes in bad weather. It is just as important to fly these days, selected in the random stratified design, to estimate average daily harvest in each stratum but the costs of collecting a zero count are high. There would be many more zero (or close to zero) days in FMA 2 than in the Hauraki Gulf.

A trailer count survey could use the same all-day coverage on main ramps as the aerial access design. This requires two interviewers. In the main centres the afternoon interviewer would count trailers from outlying ramps before starting at the main ramp and recording the trailers there. The local residents at remote secondary access points may only need to take a trailer count at mid-day and phone or email that to the researcher. In peak holiday periods some interview time by these residents at beach settlements may be warranted to check the catch composition in the area. Protocols would need to be developed about how to record vessels leaving or returning at the time of the count, vessels left at anchor, tidal launch sites, and the proportion of vessels crossing the FMA boundary at Titahi Bay etc.

5. CONCLUSIONS

Sufficient data from existing off-site surveys and on-site ramp surveys exist to characterise recreational fishing in FMA 2. Most of the data available at the time of this report is from the 1990s and early 2000s. Since 2006 quite extensive records have been entered into the Fisheries Officer activity monitoring system detailing the number of fish harvested, the time and date of the interview, number of active fishers and number of people in the group. This provides an insight into the focus of enforcement effort but would have been more use for characterising shore based fishing if detailed locations rather than region were entered. Fish club members in Hawkes Bay, led by Colin Murray, collected their own catch and effort data from ramp surveys during fishing competitions. These data have been collected in a consistent way and provide at least semi-quantitative comparisons between seasons for the main species for five years since 2005–06.

Although some of the data are quite old there is some consistency across surveys and years. Fishing effort peaks in January tailing off to May and is generally low June to September. Line fishing, diving and potting were the main methods used with some set netting and hand gathering. The main species caught were blue cod, kahawai, tarakihi, red gurnard and rock lobster. Paua were also an important species in southern FMA 2 in telephone diary surveys which included shore based methods. A high proportion of rock lobster catch came from boat based diving and potting.

Kahawai catch was split almost equally between shore based and land based line fishing methods. The other finfish species were dominated by line fishing from boats with more blue cod and tarakihi in the southern half of FMA 2 with red gurnard and snapper a significant catch in northern areas. Hawke Bay in particular provided most of the gurnard catch.

Additional data on type and location of boat based fishing effort during peak summer periods was collected from an aerial survey on two days during January 2012. Ninety five percent of vessels recorded as recreational fishing or diving on those days were trailer boats. They ranged from small aluminium “tinnies” to substantial vessels, especially around Ngawi. The mostly rugged coast of FMA 2 has a limited number of access points for trailer boats and accessible “bottle necks” are reasonable places to intercept and interview recreational fishers. Intercepting boat based fishers would capture most of the amateur harvest of marine species. The main exceptions would be paua and kahawai caught from the shore and blue moki caught in set nets.

Web cameras are recommended if baseline annual data are required. However, even with concurrent ramp interviews on these ramps this approach will not provide adequate FMA 2-wide harvest estimates.

The bus route method could provide a total harvest estimate of boat based fishing from all identified access points. In more remote locations local people could be used as interviewers and scheduled to start and stop in sequence along the coast, emulating a bus route survey without the travel time. Better estimates of total fishing effort close to population centres may be obtained by making counts of vessels returning to harbours (Wellington, Napier or Gisborne) using web cameras or observers.

Amateur harvest from shore based fisheries in FMA 2 is captured to a limited extent from off-site surveys, such as the National Panel Survey (Wynne-Jones et al. 2014). This FMA has a rugged coast line and limited boat launch facilities. The recommended approach is to use a peak time total count of empty boat trailers, at all primary and secondary access points, to provide an instantaneous estimate of trailer boats on the water. Interviewers at the main boat ramps and other important launch sites would collect harvest and time on the water from returning vessels. The harvest profile for the boats interviewed would be scaled up using the instantaneous total trailer count in a similar way as the aerial-access survey uses counts of recreational fishing boats from the air (Hartill et. al 2013).

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8. APPENDIX 1

Inshore Finfish and Shellfish Fisheries Plans

The Ministry for Primary Industries has developed national Fisheries Plans with management objectives for most quota species. These will help direct what services are required for inshore finfish and shellfish fisheries. The management approach proposed in the draft plans for FMA 2 fish stocks is pertinent to conducting on-site surveys in FMA 2 in the future. Because of the large number of inshore fish stocks the draft plans group them in to one of seven groups. Group 1 contains some of the most important stocks which are likely to be fully utilised and for which there is some research on abundance or stock status. There are no FMA 2 finfish stocks in Group 1, 2 or 5. The main recreational species identified in this report are in finfish fisheries plan Groups 3, 4 and 6 (Table A1). The National Inshore Finfish Fisheries Plan (2012) remains in draft form and Fishstock Groups are not the only consideration used to determine management priorities.

The Draft Shellfish Fisheries Plan is structured similarly. Rock lobster and paua in FMA 2 are Group 1 species which are high value and should be monitored closely (Table A2).

Table A1: Draft Inshore Finfish Fisheries Plan (2012) species groups containing the main FMA 2 recreational fish stocks.

Group 3			
USE	ENVIRONMENT (Stock Sustainability)	**Stocks:** Blue cod (BCO 3, 4, 7, 8), Blue moki (MOK 1), Bluenose (BNS 1, 2, 3, 7, 8), Elephant fish (ELE 3), Gemfish (SKI 1, 2), Hapuku/Bass (HPB 1, 2, 3, 7), Kahawai (KAH 2, 3), Kingfish (KIN 1, 8), Ling (LIN 1), Snapper (SNA 2, 7), Tarakihi (TAR 2, 7)	**Management approach:** Stocks in this group are important to all sectors but less desirable than group 1 and 2 stocks. Biologically these stocks are relatively vulnerable. The management approach for this group is therefore cautious to ensure sustainability, while seeking opportunities to increase the benefits derived from these stocks.

Group 4			
USE	ENVIRONMENT (Stock Sustainability)	**Stocks:** Barracouta (BAR 1), Flatfish (FLA 1, 2, 7), Grey mullet (GMU 1), John dory (JDO 1), Red cod (RCO 7), Red gurnard (GUR 1, 2, 3, 7), Yellow-eyed mullet (YEM 3, 7)	**Management approach:** Stocks in this group are also important to all sectors but are less biologically vulnerable than those in group 3. The management approach for this group provides for this lower vulnerability by allowing a higher threshold to trigger a catch limit review. Opportunities to increase benefits derived from these stocks are provided.

Group 6			
USE	ENVIRONMENT (Stock Sustainability)	**Stocks:** Anchovy (ANC 1, 2, 3, 4, 7, 8), Blue cod (BCO 1, 2), Blue (English) mackerel (EMA 1, 2), Blue moki (MOK 3, 4, 5), Blue warehou (WAR 1, 2, 3, 7, 8), Butterfish (BUT 1, 2, 3, 4, 5, 6, 7), Elephant fish (ELE 1, 2, 5, 7), Frostfish (FRO 1, 2), Garfish (GAR 1, 2, 3, 4, 7, 8), Ghost shark, dark (GSH 1, 2, 3, 7, 8, 9), Grey mullet (GMU 2, 3, 7), Hapuku/Bass (HPB 4, 5, 8), Jack mackerel (JMA 1), John dory (JDO 2, 3, 7), Kahawai (KAH 4, 8), Kingfish (KIN 2, 3, 4, 7), Leatherjacket (LEA 1, 2, 3, 4), Ling (LIN 2), Parore (PAR 1, 2, 9), Pilchard (PIL 1, 2, 3, 4, 7, 8), Porae (POR 1, 2, 3), Red cod (RCO 1, 2), Red gurnard (GUR 8), Red snapper (RSN 1, 2), Ribaldo (RIB 1, 2, 9), Sea perch (SPE 1, 2, 8, 9), Snapper (SNA 3), Sprats (SPR 1, 3, 4, 7), Stargazer (STA 1, 2, 3, 4, 5, 7, 8), Tarakihi (TAR 3, 4, 5, 8), Trevally (TRE 2, 3), Trumpeter (TRU 1, 2, 3, 4, 5, 6, 7, 8, 9) , Yellow-eyed mullet (YEM 1, 2, 4, 5, 6, 8, 9)	**Management approach:** Stocks in this group are sought after by some sectors but fishing pressure is relatively low. Biological vulnerability of stocks in this group is variable. The management approach for stocks in this group provides for development opportunities while minimising management costs and monitors catch to ensure sustainability of the stocks.

Table A2: Draft Shellfish Fisheries Plan (2012) species group containing rock lobster and paua stocks in **FMA 2.**

Group 1			
USE	ENVIRONMENT (Stock sustainability)	**Stocks:** Spiny rock lobster (CRA 1, 2, 3, 4, 5, 6, 7, 8, 9), Dredge oyster (OYU 5), Paua (PAU 1, 2, 3, 4, 5A, 5B, 5D, 7)	**Management approach:** Stocks in this Group are valuable to the inshore commercial sector, are taonga to many iwi and prized by amateur fishers. They tend, therefore, to be already fully utilised. Given the high desirability and the relatively high biological vulnerability of these stocks, the management approach for this Group is to monitor and manage these stocks closely to ensure that full utilisation can continue in a sustainable way. Opportunities to enable even greater benefits to be derived from stocks in this Group will continue to be explored, including removing any unnecessary barriers to access and economic profitability, and supporting value-add initiatives by stakeholders and tangata whenua.