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EXECUTIVE SUMMARY

Hartill, B.; Bian, R.; Armiger, H.; Vaughan, M.; Rush, N. (2007). Recreational marine harvest estimates of snapper, kahawai, and kingfish in QMA 1 in 2004–05.

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In this report we provide estimates of the recreational harvest of snapper, kahawai, and kingfish, from East Northland, the Hauraki Gulf, the Bay of Plenty, and the whole of QMA 1, for 1 December 2004 to 30 November 2005. These estimates were largely derived using an aerial overflight method that combines aerial counts of recreational fishing vessels at midday with boat ramp interview data to estimate a species harvest for each surveyed day. These daily harvest estimates are averaged and scaled up to provide day-type, seasonal, and/or annual harvest estimates for any given area. Harvests associated with other sources of fishing that were not directly assessed, such as those from moving boats and shore-based fishers, are accounted for, respectively, by applying scalars derived from concurrently collected boat ramp data and historical diarist data collected in 2000.

We estimated the recreational harvest from SNA 1 from stationary fishing vessels to be 2210.8 t, of which 503.3 t was taken from East Northland, 1276.0 t from the Hauraki Gulf, and 431.5 t from the Bay of Plenty. The SNA 1 harvest estimate increases to 2419.0 t once other indirectly assessed sources of harvest are taken into account. The total Hauraki Gulf harvest estimate of 1345.4 is very similar to the estimate of 1334.2 t from the previous year, although there is a marked difference in the relative dominance of the summertime harvests associated with these two estimates. In 2003–04, 86% of the harvest was taken between December and April, but in 2004–05, only 55% was taken during these months. This suggests that there could be far greater interannual variability in recreational harvests than a comparison of the two annual estimates would suggest. The spatial patterns of all three fisheries are very different, with the Hauraki Gulf accounting for 56% of the SNA 1 fishery; the Bay of Plenty accounting for 57% of the KAH 1 fishery; and East Northland accounting for 72% of the KIN 1 fishery.

The aerial overflight harvest estimate for KAH 1 is 227.5 t, which increases to 529.7 t once all forms of recreational fishing are considered. Over a third of the overall kahawai harvest estimate is attributed to shore-based fishing methods. We estimate that only 39.8 t of kingfish were taken by recreational fishers from stationary fishing vessels, but the harvest estimate increases to 106.3 once shore and mobile fishing methods are taken into account. The precision of the kingfish estimate (0.30) is far lower than those for the snapper and kahawai harvest estimates (0.06 and 0.09 respectively) reflecting the relatively low incidence of observed kingfish landings. All estimates of precision are thought to be conservative but their relative magnitude is informative.

The aerial overflight method is most suited to estimating the recreational harvest from stationary fishing vessels, and the degree to which expansion factors are required to account for other forms of fishing should be considered when interpreting our results. Almost the entire recreational harvest of snapper is taken from stationary boats, and our estimates are thought to be broadly accurate. A significant proportion of the KAH 1 catch is taken from the shore, however, and the scalar used to account for this comes from historical diarist data, which may be either out of date or atypical of the fishery at the time of collection. The kingfish estimate is probably the least reliable, both because of the degree to which scalars are required to account for the total harvest, and because of the low frequency of landings, which makes precise harvest estimation more problematic.

Boat ramp traffic rate data, collected using web cameras at selected boat ramps, have been used to assess how representative the surveyed days were in terms of fishing effort, and the relationship between traffic at these ramps and daily harvest estimates in the local fishing area. These data suggest that the days we randomly selected, a priori, were broadly typical of the survey period, and that there is a reasonable relationship between daily traffic rates and snapper harvest levels in the inner gulf.

1. INTRODUCTION

In 2003–04 an aerial overflight methodology was developed to directly assess the recreational snapper fishery in the Hauraki Gulf. Early results suggested that this might provide reasonably reliable harvest estimates and a second larger scale survey was commissioned for 2004–05 to provide recreational harvest estimates for snapper, kahawai, and kingfish for QMA 1. This report provides harvest estimates for these species for three regions within QMA 1: East Northland, Hauraki Gulf, and the Bay of Plenty. The methods used to obtain these estimates are closely based on those developed for the earlier Hauraki Gulf survey, and are most suited to assessing those fisheries where most of the harvest is taken from stationary fishing vessels.

Data from previous telephone diary surveys (R. Boyd et al; Kingett Mitchell, unpublished results) suggest that almost all of the SNA 1 harvest is taken from stationary vessels, but that in some regions a higher proportion of kahawai is taken by shore-based fishers, with an appreciable proportion of the kingfish harvest taken from vessels towing lures. The aerial overflight methodology can, therefore, be used to directly assess almost the entire SNA 1 fishery, whereas a proportion of the KAH 1 fishery must be assessed using indirectly collected telephone dairy data, and the KIN 1 assessment is strongly influenced by other data, collected at boat ramps. Further, the incidence of kingfish landings is far lower than for the other two species, with landings from individual boats having a potentially marked effect on a final estimate. We, therefore, consider our estimates of snapper harvest to be plausible, and to a lesser extent those for kahawai, but suggest that the kingfish estimates should be treated with caution.

The results from this and a Hauraki Gulf survey in the previous year provide estimates of the recreational harvest over a one, and in the case of the Hauraki Gulf, a two year period. Recreational fishing effort is a key determinant of harvest levels, however, and previous modelling (Watson & Hartill 2005) suggests that boat ramp traffic can vary markedly from year to year. It may be possible to monitor changes in fishing effort by monitoring traffic at key boat ramps on a daily basis. As part of this programme, we continued to maintain two web camera systems previously installed at boat ramps in the Hauraki Gulf for a further year, and installed four further cameras, two in East Northland and two in the Bay of Plenty. In this report we look at the relationship between the count of boats returning to the Takapuna boat ramp, and daily estimates of fishing effort and snapper harvest derived from the overflight survey in 2004–05.

Objective

To estimate the recreational harvest of priority fish species in selected fisheries.

Specific objective

1. To estimate the recreational harvest of priority finfish species (snapper, kahawai, and kingfish) in QMA 1 using alternative methods to the national telephone diary survey.

2. METHODS AND RESULTS

2.1 Aerial overflight methodology overview

Daily harvest estimates, collected according to a randomised, temporally stratified design, were weighted together appropriately to give either seasonal or annual harvest estimates. Each daily harvest estimate was derived from an estimate of the level of instantaneous fishing effort at around midday, which was then used to scale up diurnal profiles of effort and related harvest.

Daily estimates of the level of instantaneous fishing effort at around midday were derived from counts of recreational fishing boats made by observers flying at 500 feet, for a given area. On the same day, fishers were interviewed at key boat ramps between approximately dawn and dusk, and these data were used to generate diurnal profiles of relative fishing effort (boats or people fishing) and harvest (weight or number of fish). The ratio of the number of boats fishing (i.e., fishing parties) as observed from the air at a given time, relative to the number of interviewed fishing parties claiming to be fishing at that time, was used to scale up the profiles mentioned above. These scaled profiles were integrated (i.e., the area under the curve was summed) and the resulting daily estimates of effort and harvest were weighted together to produce larger scale temporal harvest estimates based on the original random stratified sample design.

The method used here is, therefore, the same as that used to assess the Hauraki Gulf recreational fishery in the previous year. This method is based on that described by Pollock et al. (1993) as used for the Lake Taupo trout fishery (Department of Conservation 1991) and for the western Hauraki Gulf snapper fishery in 1994 (T. Sylvester, MAF Fisheries, unpublished results). These studies used flights at several times of the day to provide estimates of fishing effort and catch at different periods of the day, whereas we use counts from a single overflight which are used to scale up profiles derived from boat ramp interviews.

The analytical approach used is discussed throughout the next few sections, to provide a framework for the survey results. A more succinct description of the analytical approach is given in Appendix 1 of Hartill et al. (2007), which includes mathematical formulae.

2.2 Temporal stratification

The highly variable nature of recreational fishing effort was accommodated in a stratified sampling design based on fisher behaviour relative to the conventional working week (weekend/public holiday vs midweek day-types) and season (summer – 1 December 2004 to 30 April vs winter – 1 May 2005 to 30 November 2005). These are the same definitions as were used in a survey of the Hauraki Gulf fishery in 2003–04. Fishing effort is generally higher and more variable (in an absolute sense) during the summer when catch rates are higher, daylight hours peak, and weather conditions are generally more favourable for recreational fishing. Most sampling effort was therefore allocated to this seasonal stratum.

Summer sampling effort was allocated on the basis of daily aerial overflight counts of trailer boats observed during surveys in 1994 and 2004. Data collected between 1 January and 30 April in 1994, and 1 December 2003 and 30 April in 2004 were used in parametric bootstrap simulations of the precision of estimates of fishing effort (Figure 1). These simulations suggested that the optimal allocation of sampling effort was to survey 21 weekend/holiday days and 8 midweek days. Simulations based on data collected in 2004 suggested that greater relative effort should be allocated to the weekday stratum, and we chose an intermediate allocation of 19 weekend/holiday days and 10 weekdays (Table 1). During the quieter winter months, flights and boat ramp interviews took place on eight days in each of the day-type strata.

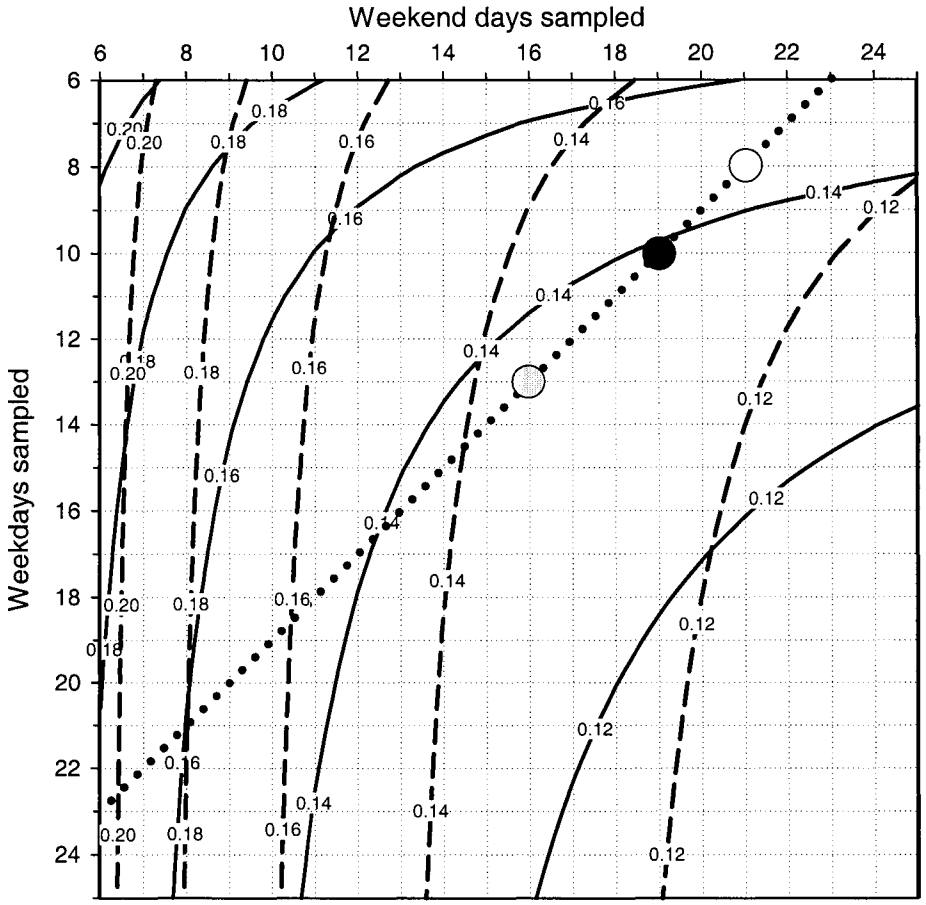


Figure 1: Simulated precision (coefficients of variation) of fishing effort estimates given different levels of midweek and weekend sampling during summer (December to April). Estimates are based on midday aerial counts of recreational trailer boats in 1994 (dashed isopleths) and 2004 (solid isopleths). The sample design used in the 2003–04 programme, of 21 weekend days and 8 weekday days (denoted by the open circle), was based on 1994 data only. Given a similar overall level of sampling effort of 29 days (different day-type allocations denoted by the dotted line) the optimal allocation of sampling effort, based on data collected in 2004–04, is 16 weekend days and 13 weekday days (denoted by the grey circle). For this survey we have adopted an intermediate allocation of sampling effort of 19 weekend days and 10 weekdays (denoted by the solid circle) to allow for interannual variation in the relative intensity of fishing effort.

Table 1: Sample design for the summer (1 December 2004 to 30 April 2005) and winter (1 May to 30 November 2005) seasons.

Season	Temporal strata	No. of days in strata	Days flown	Sampling intensity
Summer	Midweek days	97	10	0.10
	Weekends/holidays	51	19	0.37
	Lion Red Furuno Fishing Tournament	3	3	1.00
Winter	Midweek days	151	8	0.05
	Weekends/holidays	63	8	0.13

The scale of the Lion Red Furuno Tournament has decreased in recent years and after reviewing the results of the 2004 tournament we decided to reallocate the three tournament days to the appropriate midweek/weekend summer strata. This reallocation boosted the number of days available in the midweek summer strata to 99 and in the weekend summer strata to 52. Many local fishing competitions also take place in the Hauraki Gulf in the summer. Because of their numerous and localised nature, these were generally treated as random occurrences and their harvest was not considered separately.

2.3 Spatial stratification

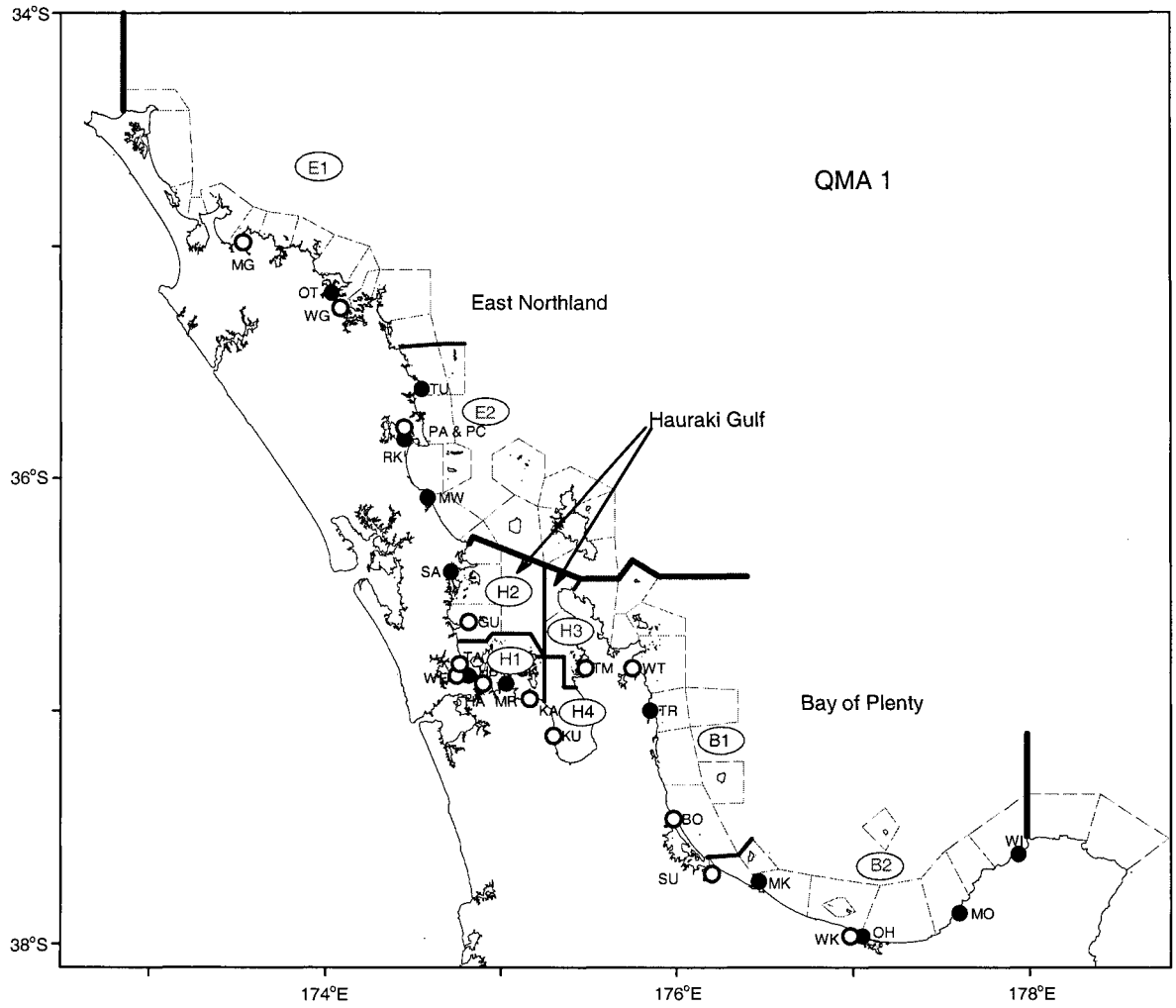
Four planes were required to cover the coastal extent of QMA 1 in as brief an interval as possible. QMA 1 was therefore divided up into four regions termed East Northland, Western Hauraki Gulf, Eastern Hauraki Gulf, and the Bay of Plenty (Figure 2). Single engined Cessna 172s were used to cover the first three regions, and a faster twin engined Piper Aerostar was used to assess the Bay of Plenty, which covered a far greater spatial area than the other three planes

Although instantaneous counts provide unbiased estimates of fishing effort (Pierce & Bindman 1994) the time taken to census any of these regions in a single flight would necessitate a progressive count methodology, which has inherent biases that are difficult to overcome reliably (Hoenig et al. 1993). We therefore spatially stratified each of the regions, shown in Figure 2, into smaller areas which are readily defined by local landmarks apparent from 500 ft. Counts of vessels within these areas are treated as instantaneous counts, as the time taken for an aircraft to traverse each area is many times less than vessels would take to cover the same distance.

Maps separating coastal regions of the North Island into small areas have been used since the first marine recreational fishing survey was conducted in 1990–91. We used the same spatial definitions in this survey, as they broadly described areas of differing fishing intensity, and consistency with previous boat ramp surveys was considered desirable. These spatial stratifications were used in all aspects of this programme, although some areas were coalesced into larger subdivisions for analysis. This is necessary because very little fishing occurs in some areas, and the amount of information available to generate diurnal profiles of fishing effort and catch rates is considered too limited to derive sensibly precise harvest estimates over smaller spatial scales. A further consideration in defining these areas is the proximity of boat ramps in neighbouring areas, and the likely range of boats on daily fishing trips.

2.4 Aerial overflights – estimating instantaneous fishing effort

On each randomly predetermined survey day, late morning aerial overflights (starting at approximately 10:00 a.m.) were conducted, weather permitting. This corresponds to the time of peak fishing activity (boat ramp interview data suggest that this was the case on most days). Flights followed roughly the same route each time, based upon the need to cover the survey area as efficiently as possible. The busiest area surveyed in QMA 1 was Motuihe Channel, which was surveyed at the beginning and end of each western gulf flight; there was usually very little difference between the two counts.



East Northland

MG	Mangonui (2)
MW	Mangawai
OT	Opito Bay, Kerikeri
PA	Parua Bay (public ramp - 2)
PC	Parua Bay (club ramp - 2)
RK	One Tree Point, Ruakaka
TU	Tutukaka
WG	Waitangi (2)

Hauraki Gulf

GU	Gulf Harbour (2)
HA	Half Moon Bay (4)
HB	Hobson Bay
KA	Kawakawa (2)
KU	Kaiaua (2)
MR	Maretai
OK	Okahu Bay
SA	Sandspit
TA	Takapuna (2)
TM	Te Kouma (2)
WE	Westhaven (2)

Bay of Plenty

BO	Bowentown (2)
MK	Maketu
MO	Motu River
OH	Ohope
SU	Sulphur Point, Tauranga (4)
TR	Tairua
WI	Waihau Bay
WK	Whakatane (2)
WT	Whitianga (2)

Figure 2: Spatial stratifications used for three regions of QMA 1: East Northland, the Hauraki Gulf, and the Bay of Plenty. Areas of water defined by bold lines, with labels surrounded by ellipses, are those for which harvest estimates were calculated. Dashed lines denote smaller sub areas which were commonly used by aerial observers and boat ramp interviewers. Two intensities of boat ramp interviewing took place. At the most frequently used ramps, denoted by open circles, interviewing took place from approximately dawn to dusk. Two letter codes are used to identify all ramps and the numbers beside ramp names, in the table below, indicate the number of interviewers required to give approximate dawn to dusk coverage (at these key ramps). At the less frequently used ramps, denoted by closed circles, interviewing took place for six hours only.

Aerial observers used standard laminated maps to record the approximate positions of all boats thought to be involved in stationary recreational fishing, and noted the time at which their plane passed from one area to another. Pilots acted as secondary observers, counting all boats on their side of the plane. This necessitated clear communication between the two parties, as to who was counting which boats in which areas, with overall responsibility resting with the primary observer. Navigation was left to the pilot, although intervention by the observer was sometimes necessary when they felt that the area was not being covered to their satisfaction, or when the pilot was not affording the observer the best possible view of most of the boats. Only a limited pool of pilots was used, and they soon became very proficient at optimising the routes flown and spotting vessels. Nine observers were used to cover the four regions, and the days and routes flown by each observer were selected randomly to minimise any observer bias.

Boats were classified as either: trailer boats (T, usually with outboards and of trailerable size); launches (L); yachts (Y); charter boats (C, usually based on the number of visible fishers and the general appearance of the boat); or kayaks (K). Boats which were underway were ignored, as were stationary boats obviously involved in non-line fishing activity, such as swimming or picnicking close inshore. Observers and pilots were instructed to count boats as fishing when there was any doubt. Daily environmental conditions were also recorded by each observer.

In the Hauraki Gulf and Bay of Plenty, about 85% of the vessels considered to be fishing were trailer boats, with most of the remainder being launches (Table 2). In East Northland a higher proportion of the boats were launches, although trailer boats still accounted for 72–79% of the vessels counted by aerial observers.

Very few fishers appeared to fish from yachts and kayaks, although the former are more likely to employ trolling methods to catch pelagic species such as kahawai, because of their suitable cruising speed. Counts of charter boats used here are probably underestimates, as only boats with at least 6 to 8 fishers which appeared to be equipped for large numbers of fishers were so classified by observers. Charter boats with fewer occupants would have been classified as either trailer boats or launches.

Table 2: Percentage of vessel types observed during midday flights off East Northland, the Hauraki Gulf, and Bay of Plenty, by season and day type.

		Summer		Winter	
		Weekend	Midweek	Weekend	Midweek
East Northland	Trailer boat	78	72	79	72
	Launch	17	22	18	22
	Yacht	4	4	2	4
	Charter boat	1	1	1	1
	Kayak	1	1	1	1
Hauraki Gulf	Trailer boat	83	84	83	86
	Launch	13	12	14	11
	Yacht	3	3	2	1
	Charter boat	1	1	1	1
	Kayak	1	1	1	1
Bay of Plenty	Trailer boat	86	87	84	82
	Launch	11	10	13	13
	Yacht	1	1	1	1
	Charter boat	1	1	2	2
	Kayak	1	1	1	1

For the most part, only trailer boats return to boat ramps, so it is necessary to transform counts of other boat types into trailer boat counts to account for differing levels of boat occupancy on these vessels. The data used for this transformation of launch, yacht, charter boat, and kayak counts were those collected during an on the water survey of boat type occupancy as part of a series of eight on-the-water surveys conducted in the Hauraki Gulf in 2003–04 (Hartill et al. 2007). These results suggested that average occupancy rates were: trailer boats, 2.5 fishers; launches, 2.9 fishers; yachts, 2.6 fishers; charter boats, 10.4 fishers; kayaks, 1.6 fishers. All charter boat counts, for example, were multiplied by 10.4/2.5, to account for the higher occupancy of this vessel type relative to that encountered at boat ramps, i.e., trailer boats. In doing this we assumed that vessel type has no influence on either catch rates or fishing durations.

Consistent patterns were evident in the spatial and temporal distribution of fishing vessels counted by aerial observers. Fishing effort was generally highest in the summer months, and, within a season, higher on weekends and public holidays (Figure 3). On most days, almost half of the fishing effort observed took place in the Hauraki Gulf, mostly close to Auckland and the islands surrounding Coromandel. Overall levels of fishing effort in East Northland were similar to those in the Bay of Plenty, surprisingly so at the day-to-day level given the potential differences in weather conditions across this spatial scale. Regardless of the region flown, most fishing effort appears to take place in sheltered waters close to population centres. Fishing effort was highly variable from day to day within any temporal/spatial stratum, and this is thought to be largely due to local weather conditions as suggested by Watson & Hartill (2005).

Flights were cancelled on some of the randomly preselected days due to low cloud. In the summer weekend stratum, all flights were cancelled on 06/02/05, as were all East Northland and Bay of Plenty flights on 29/12/05, and flights over East Northland and the western Bay of Plenty on 31/01/05. All flights were cancelled on two summer midweek survey days, 12/12/04 and 28/02/05. During the winter, only midweek survey days were affected, with flights cancelled for all areas on 06/07.05, for East Northland on 01/06/05, and for the eastern Bay of Plenty on 24/08/05.

Estimates of the number of boats fishing at midday are required for all survey days, however, as cancellations were weather dependent, and not random. Estimates of the number of boats that would have been counted from the air on these days were, therefore, based on the relationship between aerial counts and numbers of boats which were fishing at the time of the overflight, which returned to surveyed ramps on those days (Figure 4). Estimates of the number of boats fishing at the time of the overflight were based on profiles of fishing effort, which are discussed in the next section. Regressions based on boat ramp data suggest that fishing activity was generally low on all the days for which flights were cancelled.

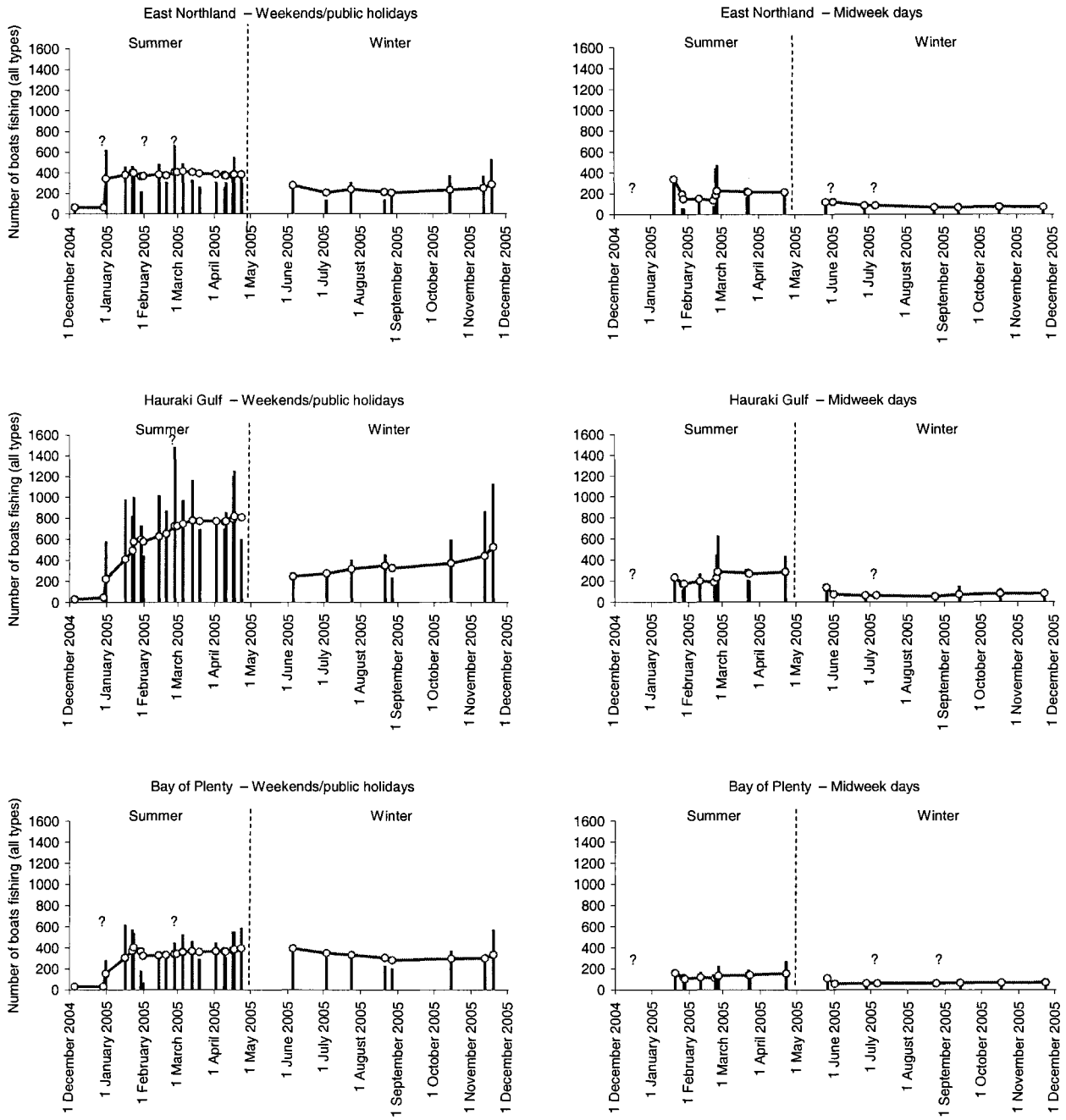


Figure 3: Regional counts of recreational fishing boats (all types combined) made by airborne observers on late morning flights during weekends/public holidays (left panel) and midweek days (right panel). Running averages are given for each season, denoted by closed circles. Question marks denote days on which low cloud prevented aerial counts of recreational fishing vessels.

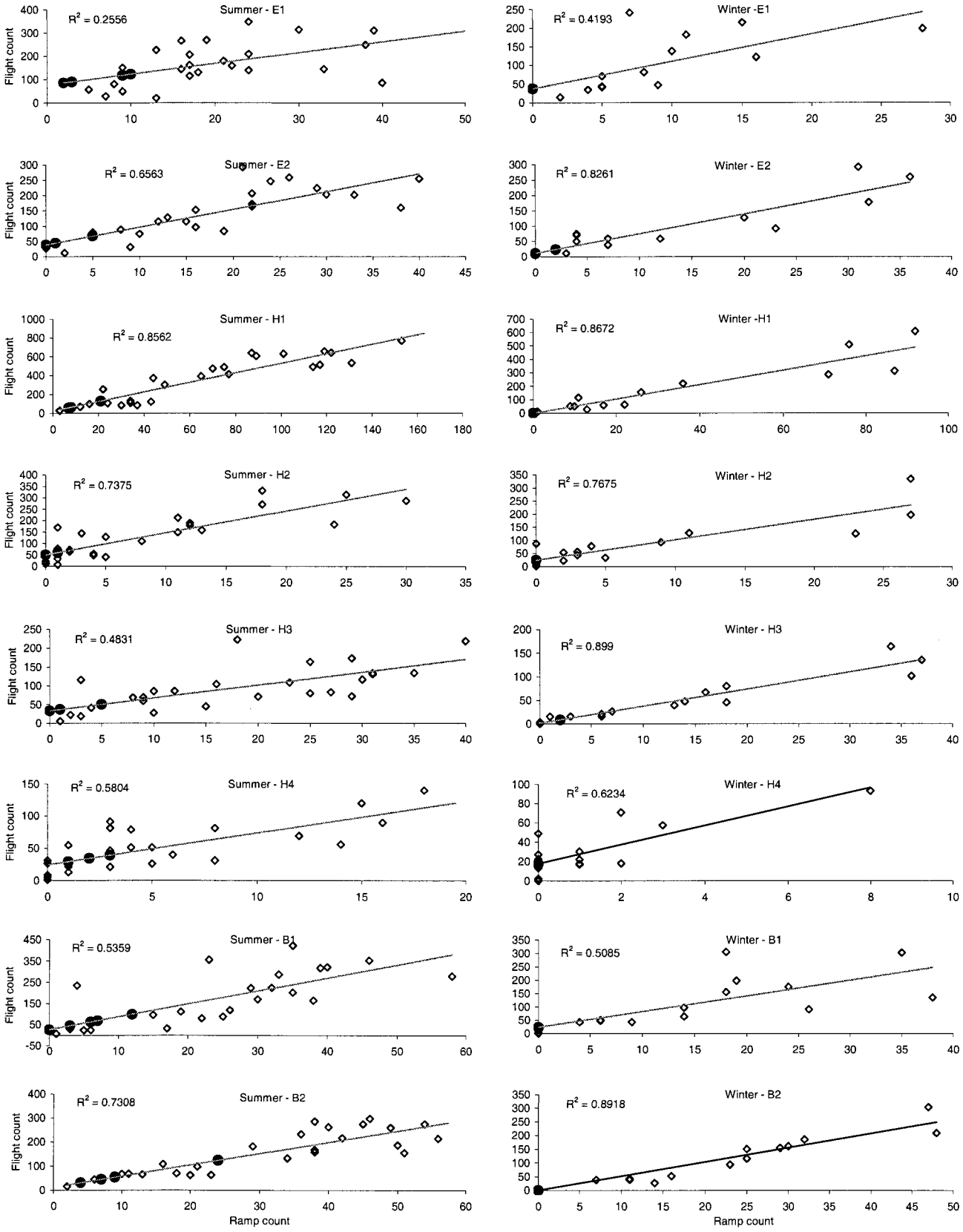


Figure 4: Season/area specific relationships between daily counts of the number of boats observed from the air and those estimated from boat ramp data at the time at which the flight took place. These relationships were used to predict the number of vessels that would have been counted on those days when flights were cancelled due to weather conditions. Solid dots denote estimated aerial counts for unflown days.

2.5 Boat ramp interviews – estimation of diurnal fishing profiles

The analytical approach used to estimate harvest tonnages follows that of Hartill et al. (2007). In this approach we use boat ramp interview data to create profiles of how the intensity of fishing effort (and associated catch) changes during each of the days sampled. These profiles, however, are based on a subsample of the daily fisher population, as we conducted interviews at only some of the ramps used. It is, therefore, necessary to scale up our profiles by instantaneous counts of all fishing vessels, which are made from the air, at a given time of day. Because of this, boat ramp interviews must take place on the same days that aerial overflights take place, to ensure that the daily profiles are scaled up by concurrently collected aerial estimates of total effort.

The original sampling design was closely adhered to at most boat ramps, with only one or two sessions missed at a few ramps due to staffing issues (which were not weather related) (Table 3). Interviewers at quieter ramps were instructed to be present over a six hour period, and to vary the timing of these sessions from day to day. On the busier ramps two consecutive 6.5 hour shifts were worked, with at least one interviewer present at all times (two interviewers were present at Half Moon Bay and Sulphur Point because of heavy traffic levels). The timing of this 13 hour survey period varied with the time of year, given the timing of dawn and dusk, but always ended at dusk (very few fishers return to boat ramps in the early morning, before the first interviewer would normally arrive).

Ultimately, only data collected at boat ramps from around early morning to dusk (termed "all day" ramps) were used to generate profiles of fishing effort, and hence, harvest estimates. Data from the lesser ramps, which were staffed for only six hours a day, were not used for profiling as there was no means of building a profile of activity for the entire day based on such short periods. Data collected from "all day" ramps account for 82% of all of the boats interviewed and 86% and 83% of the snapper and kahawai which were encountered by boat ramp interviewers in QMA 1 (Table 3).

Interviews of recreational fishers followed the format of those undertaken in all previous boat ramp surveys conducted by MAF Fisheries and NIWA, ensuring that data were collected in a consistent and rigorously tested manner. Data collected as part of these interviews can be used to determine where fishing took place, at what time, which methods were used, and which fish were caught by each fisher, for any given combination of method, area, and time. Usually the interviewer was able to measure the catch, but when this was not possible, a count or estimate of the number of fish of each species was made and the nature of that count recorded. From these data it is possible to estimate average catch rates (or harvest rates when fish were landed) in terms of the number of fish and the weight of fish (via length weight relationships).

Interviewers were instructed to note the time at which each boat returned to the ramp, and classify them as interviewed, interviewed but not fishing, refused but fishing, refused (activity unknown), or, not interviewed. From these data it is possible to establish how many boats approached the ramp over any period, and to estimate how many had been fishing, given the proportion of those who had been spoken to that claimed to have been fishing. At busy ramps, or at busy times of day, the interviewer may have been unable to interview all fishing parties approaching the ramp. In such instances, the interviewer was instructed to select boats at random.

Profiles of fishing effort and catch (relative to the time of overflight) were generated by combining interview data collected from those fishers fishing in each area, on each survey day. Each survey day was divided into 15 minute periods, and effort profiles were generated by counting up the number of fishers (or boats) who reported fishing activity within each 15 minute period. The shape of an effort profile will be distorted when the interviewer noted that a boat returned to the ramp, but was unable to interview the occupants to determine whether, and for how long, the party had been fishing. When there was no information available for a returning boat, we substituted the uninterviewed boat's data with that of the next boat for which data was available. This should not introduce any bias in terms of the number, or nature, of boats fishing (or otherwise) if the boats were originally selected at random.

Table 3: Summary statistics, by region, by boat ramp, of the number of days surveyed, total hours of interviewing, numbers of parties and fishers interviewed, and numbers of snapper, kahawai, and kingfish landed at these boat ramps during interview sessions.

Region	Ramp	Season	Days sampled	Hours worked	Parties Interviewed	Fishers Interviewed	Snapper landed	Kahawai landed	Kingfish landed
East Northland	Mangonui*	Summer	32	411	490	1 050	899	546	24
		Winter	16	175	154	331	317	63	14
	Opito Bay	Summer	32	198	327	808	773	181	9
		Winter	15	85	109	265	310	44	–
	Waitangi*	Summer	31	390	544	1 354	1 384	407	90
		Winter	15	170	109	280	262	33	19
	Tutukaka	Summer	32	193	179	470	221	73	3
		Winter	16	87	49	111	117	20	4
	Parua Bay (public)*	Summer	32	415	433	1 108	1 506	87	8
		Winter	16	192	129	325	389	17	1
	Parua Bay (club)*	Summer	32	412	592	1 408	2 905	153	18
		Winter	16	177	167	379	796	47	–
	Ruakaka	Summer	31	196	196	474	880	13	1
		Winter	11	58	41	92	67	17	–
	Mangawai	Summer	31	197	211	517	895	52	13
		Winter	16	96	80	172	337	45	–
	Total			3 454	3 810	9 144	12 058	1 798	204
Hauraki Gulf	Sandspit	Summer	32	228	151	387	623	15	6
		Winter	16	101	45	105	168	28	1
	Gulf Harbour*	Summer	32	404	522	1 268	2 304	64	10
		Winter	16	193	194	487	915	40	2
	Takapuna*	Summer	32	362	753	1 957	3 595	150	6
		Winter	15	141	202	485	635	124	–
	Westhaven*	Summer	32	406	858	2 249	4 871	105	2
		Winter	17	156	224	568	625	41	–
	Hobson Bay	Summer	18	115	120	290	427	2	1
		Winter	14	84	25	57	53	10	–
	Okahu Bay	Summer	25	150	321	842	2 049	40	2
		Winter	13	78	55	129	146	6	–
	Half Moon Bay*	Summer	32	579	1 356	3 688	10 606	244	23
		Winter	16	168	363	958	1 864	284	2
	Maretai	Summer	30	181	268	608	1 669	72	1
		Winter	14	84	67	147	417	43	–
	Kawakawa Bay*	Summer	33	414	1 038	2 775	7 485	396	15
		Winter	17	187	360	979	3 043	227	1
	Kaiaua*	Summer	31	187	184	438	1 133	10	–
		Winter	13	79	12	31	56	4	–
	Te Kouma*	Summer	32	411	816	2 660	6 451	105	3
		Winter	17	185	290	959	3 228	90	–
	Total			4 898	8 226	22 071	52 380	2 106	75
Bay of Plenty	Whitianga*	Summer	33	346	385	1 100	1 131	181	17
		Winter	16	148	104	273	221	38	1
	Tairua	Summer	32	209	275	747	951	66	25
		Winter	15	99	56	145	246	17	–
	Bowentown*	Summer	32	419	632	1 601	2 960	256	13
		Winter	16	182	145	327	435	85	2
	Sulphur Point*	Summer	32	780	1 537	3 653	7 136	1 164	67
		Winter	16	243	464	1 138	1 543	236	10
	Maketu	Summer	26	157	92	417	324	286	1
		Winter	14	85	44	161	283	76	–
	Whakatane*	Summer	32	415	448	1 210	2 360	905	31
		Winter	16	185	162	388	973	412	3
	Ohope	Summer	27	164	124	312	313	174	1
		Winter	13	74	34	77	160	21	–
	Motu River	Summer	15	94	7	11	–	34	1
		Winter	–	–	–	–	–	–	–
	Waihau Bay	Summer	9	54	100	193	55	24	3
		Winter	11	69	19	42	59	11	–
	Total			3 720	4 628	11 795	19 150	3 986	175
QMA 1	All day ramps			8 933	13 667	35 427	72 028	6 514	382
	6 hour ramps			3 139	2 997	7 583	11 560	1 376	72
	Total			12 072	16 664	43 010	83 588	7 890	454

* denotes ramps at which interviewing took place over a 13 hour period; termed "all day ramps

Catch profiles were also generated by apportioning each fisher's catch (numbers and weight of fish) across the period fished, and summing these apportioned values within each 15 minute period. Daily fishing, or harvest estimates, were derived by summing up the area underneath a profile, and scaling up this number by the ratio of the aerial count by the number of interviewed boats which claimed to be fishing in that area at the time of the overflight.

Although interview rates at "all day ramps" mostly resulted in sufficient data to yield meaningful diurnal profiles of fishing effort for most areas, this was not always the case. Usually this was because very little fishing activity took place in some weather conditions, and concomitantly, few fishers were encountered on ramps on these days. Insufficient data were more common for weekdays, when less fishing took place. The criteria for deciding whether or not meaningful profiles of fishing effort and catch rates could be derived were as follows.

1) Ignore a day's data if boat ramp interviewers did not encounter any fishers who had fished in a given area.

2) Ignore all boat ramp interview data on those days when the number of boats observed from the air in a given area was thirty or more times greater than the number of boats interviewed at boat ramps which reported fishing activity at the time of the overflight.

3) Ignore interview data on those days when aerial counts suggested that one or more boats fished a given area, but none of the fishers encountered by boat ramp interviewers reported any fishing activity in that area at the time of the overflight.

Often, more than one of these criteria applied. Combinations of days and areas where these criteria were met, and profiles were subsequently generated from boat ramp interview data, are given in Table 4. For most combinations of temporal and spatial strata, profiles were generated for most, if not all, of the survey days. There was a higher incidence of rejection for weekday strata days, especially during the winter; more so in areas which were less heavily fished. Nonetheless, profiles were generated for at least half of the days sampled in any given strata

On days when there were insufficient interview data to build meaningful profiles, profiles were still required to describe changes in catch and effort throughout the day. These were derived by averaging the profiles from those days when there was enough data for profiling purposes, from the same seasonal/day type/area stratum. For most of the days when average profiles were required, their use would have created very little bias in the final harvest estimate, as aerial counts suggest that very little catch was taken on these days, regardless.

Table 4: Days where there were sufficient boat ramp data available in a given area to satisfy the criteria given on p. 15. Data meeting these criteria were used to generate diurnal profiles of fishing effort and catch, which were scaled by aerial counts of fishing boats.

			East Nortland areas				Hauraki Gulf areas		Bay of Plenty areas	
Season	Day type	Date	E1	E2	H1	H2	H3	H4	B1	B2
Summer	Weekend/	05/12/04	Y	Y	Y	–	Y	–	Y	Y
	Public holiday	29/12/04	–	–	Y	–	Y	–	Y	Y
		31/12/04	Y	Y	Y	Y	Y	Y	–	Y
		16/01/05	Y	Y	Y	Y	Y	Y	Y	Y
		22/01/05	Y	Y	Y	Y	Y	Y	Y	Y
		23/01/05	Y	Y	Y	Y	Y	–	Y	Y
		29/01/05	Y	Y	Y	–	Y	Y	Y	Y
		31/01/05	Y	–	Y	–	Y	–	Y	Y
		06/02/05	–	–	Y	–	Y	Y	Y	Y
		13/02/05	Y	Y	Y	Y	Y	Y	Y	Y
		19/02/05	Y	Y	Y	Y	Y	–	Y	Y
		05/03/05	Y	Y	Y	Y	Y	Y	Y	Y
		19/03/05	Y	Y	Y	–	Y	Y	Y	Y
		02/04/05	Y	Y	Y	Y	Y	Y	Y	Y
		09/04/05	Y	Y	Y	Y	Y	Y	Y	Y
		10/04/05	Y	Y	Y	–	Y	Y	Y	Y
		16/04/05	Y	Y	Y	Y	Y	Y	Y	Y
		17/04/05	Y	Y	Y	Y	Y	Y	Y	Y
		23/04/05	Y	Y	Y	–	Y	Y	Y	Y
	Weekday	15/12/04	–	Y	Y	–	–	Y	Y	Y
		20/01/05	Y	Y	Y	Y	Y	Y	Y	Y
		27/01/05	Y	–	Y	Y	Y	–	Y	Y
		28/01/05	Y	–	Y	–	Y	Y	Y	Y
		10/02/05	Y	Y	Y	–	Y	Y	Y	Y
		22/02/05	Y	Y	Y	–	–	Y	Y	Y
		28/02/05	Y	–	Y	–	–	Y	–	Y
		22/03/05	Y	Y	Y	Y	Y	–	Y	Y
		23/03/05	Y	Y	Y	Y	Y	Y	Y	Y
		22/04/05	Y	Y	Y	Y	Y	Y	Y	Y
Winter	Weekend/	27/08/05	Y	Y	Y	Y	Y	–	Y	Y
	Public holiday	21/08/05	Y	Y	Y	Y	Y	–	Y	Y
		24/07/05	Y	Y	Y	Y	Y	Y	Y	Y
		05/06/05	Y	Y	Y	–	Y	–	Y	Y
		03/07/05	Y	Y	Y	Y	Y	Y	Y	Y
		15/10/05	Y	Y	Y	Y	Y	Y	Y	Y
		12/11/05	Y	Y	Y	Y	Y	Y	Y	Y
		19/11/05	Y	Y	Y	Y	Y	Y	Y	Y
	Weekday	24/08/05	Y	Y	Y	–	–	–	–	–
		13/09/05	Y	Y	Y	Y	Y	Y	Y	Y
		26/05/05	Y	Y	Y	Y	Y	Y	Y	Y
		01/06/05	–	Y	–	–	–	–	–	–
		27/06/05	Y	Y	Y	–	Y	–	Y	Y
		06/07/05	–	–	–	–	Y	–	–	–
		17/10/05	Y	Y	Y	Y	Y	Y	Y	Y
		23/11/05	Y	Y	Y	Y	Y	Y	Y	Y

2.6 Snapper, kahawai, and kingfish harvest estimates

Area-specific harvest estimates were generated for each species, for each survey day, by summing up the area under each species' catch profile. Daily harvest estimates were then generated by combining all spatial estimates calculated for a given day. These daily harvest estimates were averaged and weighted up on the basis of the number of days occurring in each seasonal/day-type stratum, which were combined to give annual regional harvest estimates.

Stratum specific variance estimates were generated by a bootstrapping procedure. Survey days from each seasonal/day-type/area stratum were selected with replacement. In turn, data from fishing parties interviewed on that day were selected with replacement, and were used to construct profiles of fishing effort, catch, and catch rate. Each bootstrapped profile was then scaled up by the aerial count on the associated day. When there were insufficient interview data for profiling on the selected day, profile data were selected at random from one of the stratum days which meet the criteria on p. 15. Bootstraps were performed 1000 times, from which mean, median, and 5% and 95% percentile profiles were generated.

Stratum specific profiles (associated bootstrap distributions) of effort (numbers of boats and fishers) catch (numbers of fish and weight caught), and catch rates were generated, which are too numerous to present here. Effort profiles tended to be dome shaped, peaking between 10 a.m. and 1 p.m., and were broader in summer, when daylight length is at its greatest. Catch profiles tended to be flatter than, and not as smooth as, effort profiles, with wider confidence intervals. Catch rate profiles (catch profiles divided by their respective effort profiles) tended to peak at dawn and dusk, were often very irregular, and had broad confidence intervals. In those strata where higher levels of fishing effort occurred, increased encounter rates at surveyed ramps resulted in smoother profiles, with mean and median bootstrap distributions closely matching those derived from the original data. Profiles in the less heavily fished strata tended to be irregular, with asymmetrical confidence intervals and less similarity between the mean and median bootstrap profiles and those derived from the original data. In some strata (usually midweek days in the less commonly fished areas), either no kahawai or no kingfish catches were encountered by boat ramp interviewers, and consequently the estimated harvest of the species was zero. It is highly unlikely that no kahawai, and, to a lesser degree, no kingfish, were landed in these areas during these times, although the data suggest that such occurrences were uncommon, and they would add little to the annual harvests of these species.

As with the previous survey of the Hauraki Gulf (REC200202), we initially treated the days from the Lion Red Furuno Fishing Tournament as a separate temporal stratum, but no longer do so, as there was no reliable means of generating appropriate daily profiles for these days. Instead we increased the number of days available to the summer midweek and weekend strata by two and one days respectively. Nonetheless, additional harvesting would have taken place as a result of the tournament, and we adopted the simple expedient of adding the weighed in tournament harvest to our estimates. Over a three day period, 1435 kg of snapper, 229 kg of kahawai, and 308 kg of kingfish were weighed in at Kawau Island. These weights are considerably lower than reported for previous tournaments, and their addition has little influence on overflight harvest estimates.

The aerial overflight method does not account for vessel-based harvests resulting from trolling, longlining, and set netting. We used region-specific boat ramp interview data on the number of snapper, kahawai, and kingfish landed by these methods to estimate appropriate scalars, which were then applied to overflight estimates. Only a small proportion of snapper (Table 5) are taken by these methods, but in East Northland and the Bay of Plenty, a considerable proportion of kahawai (Table 6) and kingfish (Table 7) are taken from boats where these methods are employed. Consequently, they have a marked influence on our final harvest estimates.

Other recreational harvests, which were not directly considered in our survey, were those associated with shore-based fishing methods such as surfcasting, beach seining, and kite fishing. We used regional data on the method specific catch of snapper, kahawai, and kingfish from the 2000 telephone diary survey (Boyd et al., unpublished data) to estimate appropriate scalars to account for shore-based harvests (Tables 5, 6 &

7). These data suggest that a substantial proportion of the kahawai catch, and that of all three species in the Bay of Plenty, was taken by shore-based fishers. Variances associated with both the indirectly assessed boat based, and shore-based telephone diary scalars were estimated by bootstrapping the underlying data sources 1000 times, and then applying these bootstrap scalars to the 1000 bootstrap estimates generated from the overflight survey.

When all sources of fishing are taken into account, we estimate that the 2004–05 harvest of snapper from SNA 1 was 2418.9 t (Table 5; see Appendix 1 for results for individual strata). This estimate has a c.v. of only 0.06 once the three regional strata are combined, which probably doesn't fully reflect the true level of variance expected. Only a small proportion of the SNA 1 harvest is not directly estimated by the aerial overflight survey, and our estimates for this fishery are considered plausible. The Hauraki Gulf harvest estimate of 1345.4 t is very close to that of the previous year, 1334.2 t, although there is a marked interannual difference in the seasonal estimates. In 2003–04, 86% of the Gulf harvest was taken between December and April, but in 2004–05, only 55% was taken in the summer. Interannual variability could, therefore, be far greater than a comparison of the two annual estimates suggests. In 2004–05, the proportion of the catch which was taken during the summer is very similar across all three regions, ranging from 55.1% in the Gulf, to 57.0% in East Northland. Our estimates suggest that 56% of the SNA 1 harvest was taken from the Hauraki Gulf, which is higher than the estimates of 42% and 52% derived from the 2000 and 2001 telephone diary surveys (which also included catches from around Little Barrier and Great Barrier Islands). Our estimates suggest that the East Northland snapper harvest is slightly higher than in the Bay of Plenty, both in the summer and in the winter. There is a reasonable level of precision associated with almost all regional and seasonal harvest estimates, with c.v.s ranging from 0.08 to 0.21.

The aerial overflight harvest estimate for KAH 1 is 227.5 t, which increases to 529.7 t once all forms of recreational fishing are considered (Table 6; see Appendix 2 for results for individual strata). The scalars used to account for indirectly assessed fishing methods, therefore, have a marked influence on the magnitude of our overall harvest estimates for this species, especially the diary-based shore-fishing scalars, which estimate that a third of all kahawai caught in KAH 1 are taken from the shore. Reliance on these indirect scalars may reduce confidence in kahawai harvest estimates. Our estimates suggest that 57% of the kahawai harvest is taken from the Bay of Plenty, compared with 18% from the Hauraki Gulf. These percentages are very similar to those obtained from the 2000 and 2001 telephone diary surveys. The East Northland fishery is mostly a summer fishery, where 76% of the annual catch was taken, compared to 50% for the Hauraki Gulf and 54% for the Bay of Plenty.

We estimate that 72% of the 106.3 t of kingfish caught in 2004–05 was taken from East Northland (Table 7; see Appendix 3 for results for individual strata). Only 6% of the KIN 1 harvest estimate was from the Hauraki Gulf. The kingfish fishery was the most seasonal of those assessed, with 61% of the East Northland harvest taken during the summer, compared with 86% in the Bay of Plenty and 99% in the Hauraki Gulf. The c.v.s associated with all of the kingfish harvest estimates are far higher than those derived for snapper and kahawai, which is not surprising given the low numbers of kingfish which were encountered by boat ramp interviewers (see Table 3). Aerial overflights probably provide poor estimates of the kingfish harvest from those charter boats which target the species. Data from the last three telephone diary surveys suggest that 13 to 16% of the KIN 1 harvest is taken by the charter boat fleet. All kingfish harvest estimates should be treated with caution.

Estimates of the daily harvest of snapper, kahawai, and kingfish for each combination of area, season, and day type, and their associated variance estimates, are given in Appendices 1, 2, and 3, respectively. Distributions of the bootstrap estimates associated with each species' seasonal harvest estimates are also given in these appendices. All of the bootstrap distributions are approximately normally distributed, although those associated with small winter kingfish harvest estimates in the Hauraki Gulf and Bay of Plenty are truncated at zero. The means and medians of any given bootstrap distribution are usually very similar to the actual harvest estimate.

Table 5: Estimates of the 2004–05 recreational harvest of snapper in the three regions of SNA 1 (East Northland, Hauraki Gulf, and the Bay of Plenty) for each stratum in summer (1 December 2004 to 30 April 2005) and winter (1 May 2005 to 30 November 2005) with associated bootstrap statistics. Days from the Lion Red Furuno Tournament strata given in Table 1 have been reallocated to the appropriate day-type strata (two midweek days and one weekend day). Overflight survey estimates are adjusted to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach, harvests by shore-based fishers, and the landed catch of fishers participating in the 2004 Lion Red Furuno Fishing Tournament.

Region		Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	C.V.
East Northland	Weighted summer total	287.1	295.7	292.0	219.5	387.1	0.17
	Weighted winter total	216.2	230.3	224.7	161.1	315.8	0.21
	Weighted annual total	503.3	526.0	523.8	419.3	644.9	0.13
	Scaled to account for 1.5 % of catch by unassessed vessel based methods[1]	510.8	534.6	532.6	424.6	656.5	0.13
	Scaled to account for 8.3 % of catch by shore based methods[2]	557.0	583.1	580.0	464.5	713.1	0.13
Hauraki Gulf	Weighted summer total	703.6	726.6	724.7	634.8	827.8	0.08
	Weighted winter total	572.4	577.9	566.4	404.2	773.3	0.19
	Weighted annual total	1 276.0	1 304.5	1 295.4	1 117.2	1 523.7	0.10
	Scaled to account for 0.5 % of catch by unassessed vessel based methods[1]	1 282.2	1 310.5	1 301.8	1 123.1	1 529.7	0.10
	Scaled to account for 4.6 % of catch by shore based methods[2]	1 344.0	1 380.3	1 371.8	1 181.4	1 607.2	0.10
	Including weighed in catch from Furuno Fishing Tournament (1 435 kg)	1 345.4	1 381.7	1 373.2	1 182.8	1 608.7	0.10
Bay of Plenty	Weighted summer total	244.0	246.8	245.9	198.0	301.8	0.13
	Weighted winter total	187.6	189.3	188.8	146.1	234.6	0.14
	Weighted annual total	431.5	436.1	436.6	368.8	503.0	0.10
	Scaled to account for 4.41 % of catch by unassessed vessel based methods[1]	451.5	456.3	456.5	385.5	525.7	0.10
	Scaled to account for 12.6 % of catch by shore based methods[2]	516.5	522.0	521.5	441.2	602.6	0.10
SNA 1	Weighted summer total	1 234.7	1 269.1	1 264.7	1 145.8	1 401.8	0.06
	Weighted winter total	976.2	997.5	992.8	795.1	1 203.6	0.13
	Weighted annual total	2 210.8	2 266.6	2 260.9	2 051.6	2 512.9	0.06
	Scaled to account for catch by unassessed vessel based methods[1]	2 244.4	2 301.4	2 295.5	2 080.7	2 550.1	0.06
	Scaled to account for catch by shore based methods[2]	2 417.5	2 485.4	2 479.9	2 247.4	2 751.0	0.06
	Including weighed in catch from Furuno Fishing Tournament (1 435 kg)	2 419.0	2 486.8	2 481.3	2 248.8	2 752.5	0.06

1 - Derived from concurrent boat ramp interview data.

2 - Derived from regional telephone diary survey data collected in 2000.

Table 6: Estimates of the 2004–05 recreational harvest of kahawai in the three regions of KAH 1 (East Northland, Hauraki Gulf, and the Bay of Plenty) for each stratum in summer (1 December 2004 to 30 April 2005) and winter (1 May 2005 to 30 November 2005) with associated bootstrap statistics. Days from the Lion Red Furuno Tournament strata given in Table 1 have been reallocated to the appropriate day-type strata (two midweek days and one weekend day). Overflight survey estimates are adjusted to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach, harvests by shore-based fishers, and the landed catch of fishers participating in the 2004 Lion Red Furuno Fishing Tournament.

Region		Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	C.V.
East Northland	Weighted summer total	45.7	45.4	44.8	35.4	56.5	0.15
	Weighted winter total	14.2	13.3	13.0	7.8	19.7	0.28
	Weighted annual total	59.9	58.8	58.5	47.1	72.0	0.13
	Scaled to account for 26.35 % of catch by unassessed vessel based methods[1]	81.3	80.0	79.3	64.0	98.0	0.13
	Scaled to account for 36.8 % of catch[2] by shore based methods	128.7	126.7	125.3	99.4	156.3	0.14
Hauraki Gulf	Weighted summer total	36.1	35.8	34.8	21.7	54.1	0.28
	Weighted winter total	36.2	35.7	35.5	24.5	47.0	0.20
	Weighted annual total	72.4	71.5	71.2	53.0	93.5	0.17
	Scaled to account for 4.7 % of catch by unassessed vessel based methods[1]	76.0	75.0	74.6	55.6	98.2	0.17
	Scaled to account for 22.5 % of catch[2] by shore based methods	98.0	97.0	96.3	71.9	128.4	0.18
	Including weighed in catch from Furuno Fishing Tournament (229 kg)	98.2	97.2	96.6	72.1	128.7	0.18
Bay of Plenty	Weighted summer total	78.0	77.5	77.0	57.7	100.4	0.17
	Weighted winter total	67.2	67.3	66.0	45.9	91.4	0.21
	Weighted annual total	145.3	144.8	143.7	115.2	178.0	0.13
	Scaled to account for 21.88 % of catch by unassessed vessel based methods[1]	185.9	185.4	184.9	147.0	227.6	0.13
	Scaled to account for 38.6 % of catch[2] by shore based methods	302.8	302.8	303.6	239.3	372.9	0.14
KAH 1	Weighted summer total	159.8	158.7	158.7	130.5	186.4	0.11
	Weighted winter total	117.7	116.4	115.3	91.1	144.8	0.14
	Weighted annual total	277.5	275.1	275.0	235.5	314.9	0.09
	Scaled to account for catch by unassessed vessel based methods[1]	343.2	340.5	340.5	291.9	388.3	0.09
	Scaled to account for catch by shore based methods[2]	529.5	526.5	526.8	449.4	607.8	0.09
	Including weighed in catch from Furuno Fishing Tournament (229 kg)	529.7	526.7	527.0	449.6	608.0	0.09

1 - Derived from concurrent boat ramp interview data.

2 - Derived from regional telephone diary survey data collected in 2000.

Table 7: Estimates of the 2004–05 recreational harvest of kingfish in the three regions of KIN 1 (East Northland, Hauraki Gulf, and the Bay of Plenty) for each stratum in summer (1 December 2004 to 30 April 2005) and winter (1 May 2005 to 30 November 2005) with associated bootstrap statistics. Days from the Lion Red Furuno Tournament strata given in Table 1 have been reallocated to the appropriate day-type strata (two midweek days and one weekend day). Overflight survey estimates are adjusted to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach, harvests by shore-based fishers, and the landed catch of fishers participating in the 2004 Lion Red Furuno Fishing Tournament.

Region		Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	C.V.
East Northland	Weighted summer total	14.17	13.59	12.87	4.73	24.37	0.46
	Weighted winter total	9.23	11.30	10.33	2.40	23.09	0.57
	Weighted annual total	23.41	24.88	24.27	11.49	40.54	0.37
	Scaled to account for 68.5 % of catch by unassessed vessel based methods[1]	74.23	79.94	76.68	34.61	136.24	0.39
	Scaled to account for 3.7 % of catch[2] by shore based methods	77.09	83.26	79.80	35.49	141.45	0.39
Hauraki Gulf	Weighted summer total	4.60	4.18	3.96	1.25	7.72	0.46
	Weighted winter total	0.04	0.04	0.03	0.00	0.14	1.08
	Weighted annual total	4.64	4.23	4.00	1.32	7.75	0.46
	Scaled to account for 17.3 % of catch by unassessed vessel based methods[1]	5.61	5.11	4.84	1.59	9.37	0.46
	Scaled to account for 5.9 % of catch[2] by shore based methods	5.96	5.14	4.88	1.65	9.40	0.47
	Including weighed in catch from Furuno Fishing Tournament (308 kg)	6.27	5.45	5.18	1.96	9.70	0.47
Bay of Plenty	Weighted summer total	9.27	9.04	8.84	4.69	14.25	0.33
	Weighted winter total	1.51	1.86	1.63	0.36	4.17	0.66
	Weighted annual total	10.78	10.90	10.67	6.19	16.64	0.29
	Scaled to account for 37.7 % of catch by unassessed vessel based methods[1]	17.30	17.58	17.18	9.76	27.34	0.30
	Scaled to account for 24.7 % of catch[2] by shore based methods	22.98	23.41	22.74	12.95	36.34	0.31
KIN 1	Weighted summer total	28.0	26.8	26.2	15.5	39.7	0.28
	Weighted winter total	10.8	13.2	12.3	4.2	24.8	0.49
	Weighted annual total	38.8	40.0	39.3	25.3	57.5	0.25
	Scaled to account for catch by unassessed vessel based methods[1]	97.1	102.6	99.3	56.0	160.3	0.31
	Scaled to account for catch by shore based methods[2]	106.0	112.1	108.1	62.3	172.3	0.30
	Including weighed in catch from Furuno Fishing Tournament (229 kg)	106.3	112.4	108.4	62.6	172.6	0.30

1 - Derived from concurrent boat ramp interview data.

2 - Derived from regional telephone diary survey data collected in 2000.

The regional significance of harvests of each species differs, with the Hauraki Gulf accounting for 56% of the SNA 1 fishery, the Bay of Plenty accounting for 57% of the KAH 1 fishery, and East Northland accounting for 72% of the KIN 1 fishery. The influence of the expansion factors used to account for indirectly assessed fishing methods also differs markedly between the fisheries. The aerial overflight method can be used to directly assess almost the entire SNA 1 fishery, whereas a significant proportion of the KAH 1 fishery must be assessed using telephone dairy data, and the kingfish assessment is strongly influenced by scalars which account for the harvest from moving boats and those using longlines.

There is a marked discrepancy between our kingfish harvest estimates and those derived from the 2000 and 2001 telephone diary surveys (1:7.0) which is far greater than for snapper (1:2.5) and kahawai (1:4.4). These different ratios could, in part, be due to year specific differences in the underlying fisheries, but their variability is perhaps greater than expected. It has been suggested that one reason for this high ratio is that the minimum legal size limit for kingfish increased from 65 cm to 75 cm in January 2004, and a greater proportion of the recreational catch would therefore have been returned to the sea during our survey. Only 16% of kingfish (by weight) landed at boat ramps during the 2000 survey was from fish between 65 cm and 75 cm, which does not explain the relatively high discrepancy between the harvest estimates from the two programmes.

2.7 Indices of catch and effort derived from web camera data

Traffic was been monitored at six key boat ramps throughout QMA 1 for two reasons: to monitor changes in fishing effort over the long term, and to determine whether survey days were selected in a representative manner. Web cameras were established at two boat ramps in the Hauraki Gulf (at Takapuna and Half Moon Bay) as part of a previous programme (REC200202) and preliminary results suggested that there was a clear relationship between daily traffic levels at these ramps and the harvest in local waters. Four more web cameras were, therefore, installed as part of this programme, two in East Northland (at Waitangi and at Parua Bay in Whangarei Harbour) and two in the Bay of Plenty (at Sulphur Point in Tauranga Harbour and at Whakatane). Installation of these cameras provided 24 hour coverage at two ramps in each of the three regions.

Time-stamped images from these cameras are stored on a minute by minute basis on a secure server. Although the interpretation of these images is not an objective of this programme, traffic counts from the Takapuna ramp are available for the period of our survey from another programme (REC200506 – Monitoring recreational effort and catches in QMA 1). We use these data here to determine whether our harvest estimates are based upon a representative selection of survey days.

Twenty-four hour coverage was available for only 345 days between 1 December 2004 and 30 November 2005 due to occasional system malfunctions. Traffic levels on the remaining 20 days were, therefore, based on average levels observed from those days when images were available for a full 24 hours from the relevant seasonal/ day type stratum.

Trailer boat effort (and we assume fishing effort) was highly variable from day to day, although fishing effort was usually higher during the weekend (Figure 5). There is still a high degree of variation evident in a seven day moving average, although there was a distinct seasonality in the time series, with a generally higher level of effort between late October and April. These data, therefore, suggest that the definition of the "summer" season we used in our survey (December to April) did not fully represent the peak season of the fishery, which would lead to a decrease in the precision of our estimate. Future surveys should conform to the fishing year, to allow for optimal definitions of seasonal strata, and to provide recreational harvest estimates which can be directly related to those from the commercial sector.

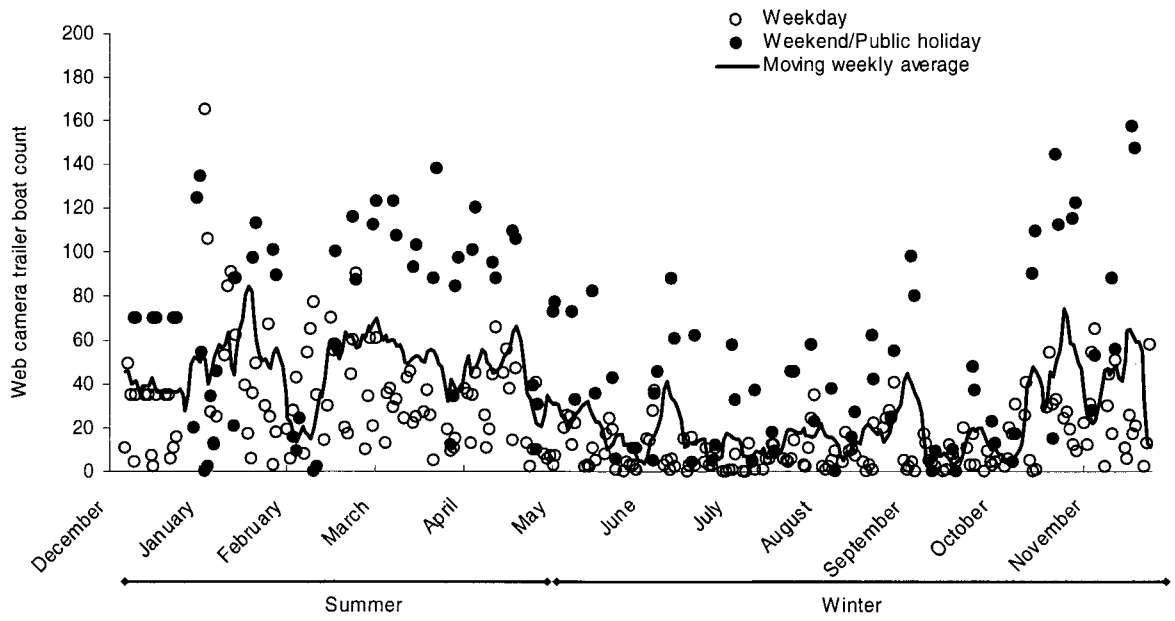


Figure 5: Daily counts of trailer boats returning to the Takapuna boat ramp from web camera footage. Open and closed circles denote daily counts on weekdays and weekend days, and the solid line denotes a seven day moving average of these counts.

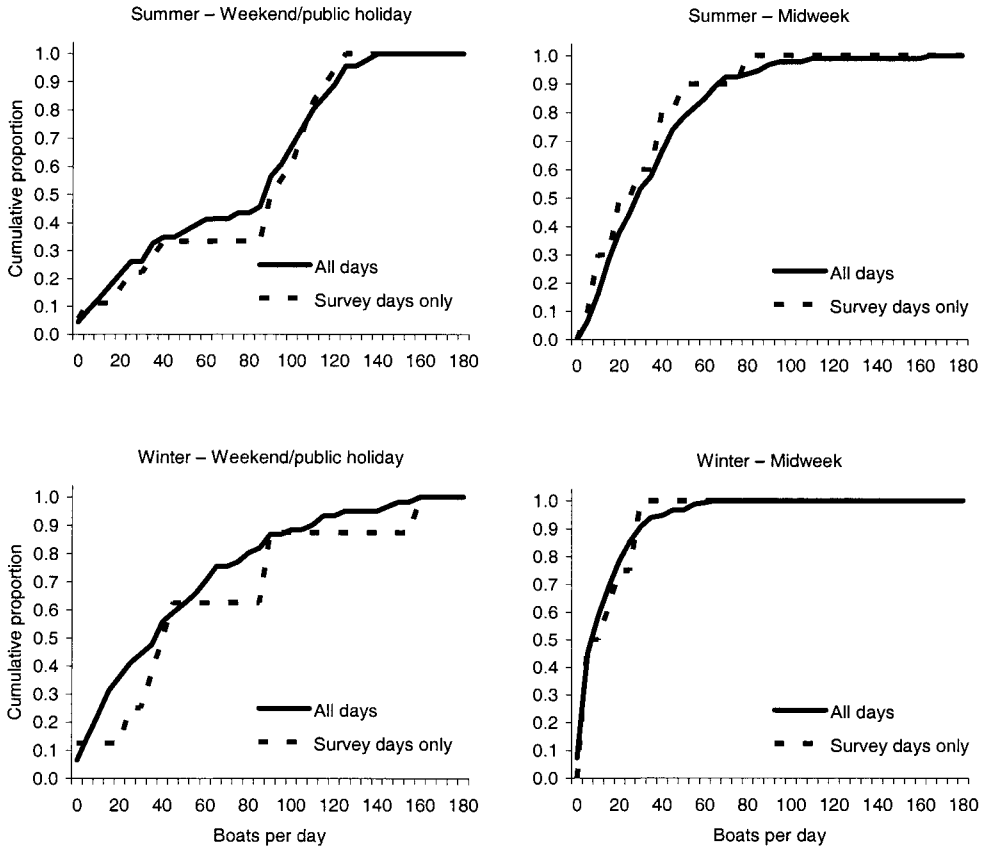


Figure 6: Comparisons of daily boat ramp traffic rates on survey days relative to the numbers observed on all days, including survey days. The number of days is expressed cumulatively in terms of increasing daily traffic rates.

Cumulative comparisons of daily boat ramp traffic rates on survey days, relative to those on all days, suggest that survey days were selected in an unbiased manner, at least in terms of boating effort (Figure 6). There is a slight tendency towards surveying low effort days in the summer midweek stratum, whereas the reverse may be true for the winter weekend/public holiday stratum. Any biases are minimal, however, and are unlikely to influence our harvest estimates to any significant degree.

Patrons of the Takapuna boat ramp will account for only a small proportion of fishing effort in the Gulf, so web camera data may provide a misleading interpretation of fishing levels, especially as some of the boats counted will not have fished. There appear, however, to be reasonable correlations between web camera based counts of trailer boats at Takapuna and estimates of effort and harvest derived from the aerial overflight survey on survey days (Figure 7). The degree of correlation between camera and aerial counts is very similar at two spatial scales, for the inner Hauraki Gulf (area H1) and for the entire Gulf, but this is perhaps not surprising given that fishers in area H1 usually account for half of the fishing effort in the Hauraki Gulf, and the fact that weather conditions in the Gulf are generally homogeneous. There is a similar, though slightly lower, level of correlation between daily traffic rates and daily harvest estimates, although fishing effort still appears to be the main determinant of recreational harvest levels.

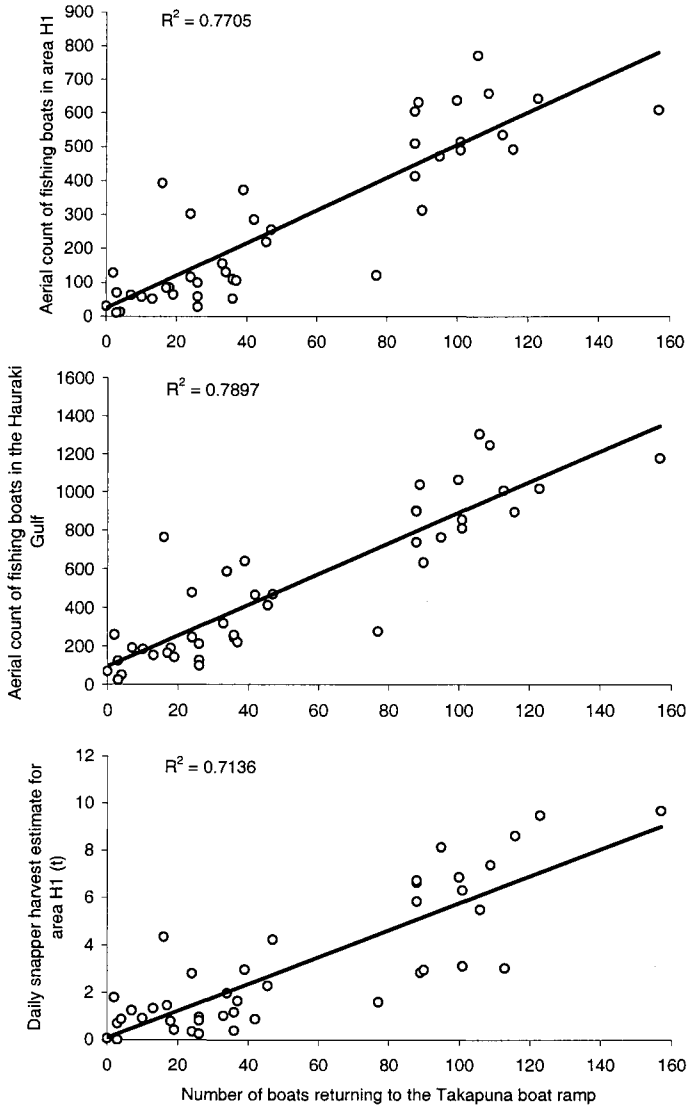


Figure 7: Relationships between web camera based counts of trailer boats returning to the Takapuna boat ramp on survey days, and overflight estimates of fishing effort and snapper harvest. Aerial counts of fishing boats include all vessel types, with non-trailer boat counts rescaled on the basis of the average number of occupants (see section 2.4).

3.0 CONCLUSIONS

- An aerial overflight method was used to estimate recreational harvests of snapper, kahawai, and kingfish in QMA 1 between 1 December 2004 and 30 November 2005. The annual harvest estimates obtained from this survey were: snapper 2210.8 t, kahawai 277.5 t and kingfish, 38.8 t.

- The overflight method used assessed harvests only by fishers fishing from stationary vessels. We indirectly assessed other sources of harvest by applying relative scalars to allow for fishing from moving vessels, or vessels deploying longlines (from concurrent boat ramp data) and fishing from the shore (telephone diary data).

- When all these harvest sources are combined, the 2004–05 recreational harvest estimates for QMA 1 increased to 2419.0 t for snapper, 529.7 t for kahawai, and 106.3 t for kingfish.

- The snapper and kahawai estimates have a high degree of precision associated with them (c.v.s of 0.06 and 0.09 respectively), but the low precision of the kingfish estimate (0.30) reflects the low numbers of kingfish which were landed at boat ramps during our survey.

- Almost all of the snapper harvest was estimated directly using aerial overflights, although over a third of our kahawai harvest estimate is derived by applying a scalar to account for shore-based fishing, and over half of the kingfish harvest is estimated by applying a scalar which allows for catches from moving vessels.

- The degree to which our estimates for each species are reliant on scalars to account for additional sources of harvest influences their plausibility. The overflight method is most suited to frequently caught species which are harvested from stationary fishing vessels. Consequently, the snapper harvest estimates are considered plausible, and to a lesser extent those for kahawai, but the kingfish estimates should be treated with caution.

- We estimate that 56% of the snapper harvest from SNA 1 was taken in the Hauraki Gulf, compared to estimates of 42% and 52%, which were derived from the 2000 and 2001 telephone diary surveys. Fishers in the Bay of Plenty accounted for 57% of the KAH 1 fishery, whereas 72% of the kingfish harvest was taken from East Northland waters.

- The Hauraki Gulf harvest estimate, of 1345.4 t is very close to that of the previous year, 1334.2 t, although there is a marked interannual difference in the seasonal estimates. In 2003–04, 86% of the Gulf harvest was taken between December and April, but in 2004–05, only 55% was taken in the summer. Interannual variability could, therefore, be far greater than a comparison of the two annual estimates suggests.

- Comparisons of daily boat ramp traffic rates at Takapuna, on survey days and on all available days, suggests that survey days were selected in an generally unbiased manner with respect to fishing effort.

4.0 ACKNOWLEDGMENTS

This work was funded by the Ministry of Fisheries under project REC200401. We wish to thank the numerous aerial observers and boat ramp interviewers who made this study possible.

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Appendix 1: Regional estimates of the 2004–05 recreational harvest of snapper in summer (1 December 2004 to 30 April 2005) and winter (1 May 2004 to 30 November 2005) with associated bootstrap distributions derived from the main overflight survey.

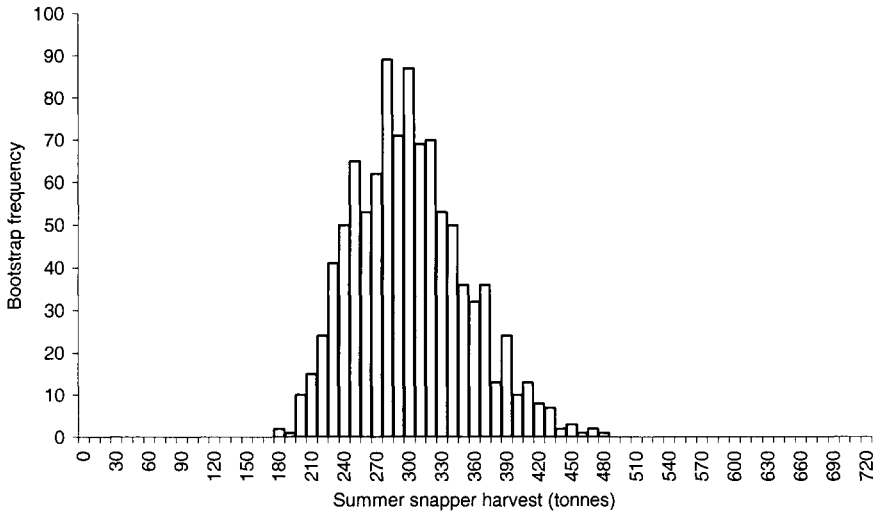
Appendix 1a: Estimates of the recreational harvest of snapper in East Northland for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach and harvests by shore-based fishers.

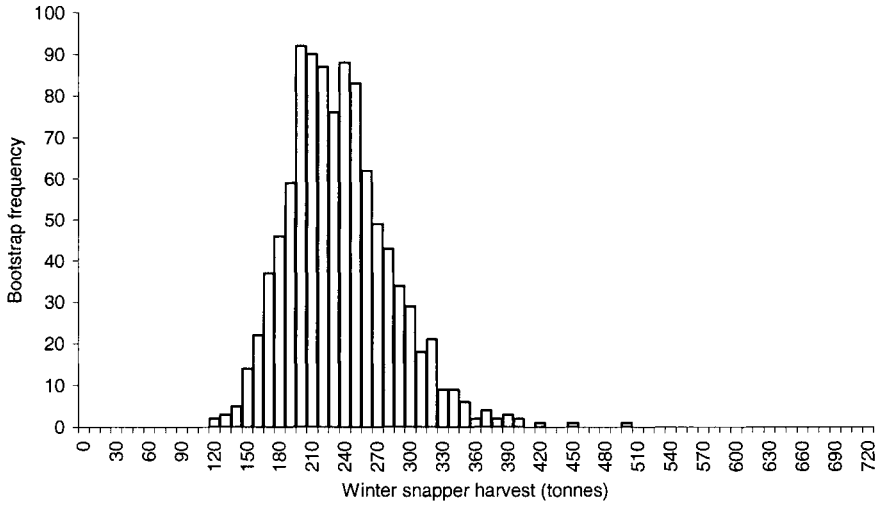
Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
1	Summer	Weekend/PH	52	1.738	1.802	1.722	1.035	2.818	
		Midweek	99	0.743	0.771	0.729	0.278	1.407	
	Winter	Weekend/PH	63	0.949	0.988	0.972	0.560	1.498	
		Midweek	151	0.379	0.437	0.385	0.197	0.838	
2	Summer	Weekend/PH	52	1.147	1.168	1.161	0.834	1.524	
		Midweek	99	0.641	0.655	0.651	0.430	0.914	
	Winter	Weekend/PH	63	0.944	0.964	0.958	0.448	1.500	
		Midweek	151	0.262	0.274	0.260	0.093	0.496	
Weighted summer total				287.1	295.7	292.0	219.5	387.1	0.17
Weighted winter total				216.2	230.3	224.7	161.1	315.8	0.21
Weighted annual total				503.3	526.0	523.8	419.3	644.9	0.13
				291.4					
Scaled to account for 1.5 % of catch				219.4					
by unassessed vessel based methods[1]				510.8	534.6	532.6	424.6	656.5	0.13
				317.7					
Scaled to account for 8.3 % of catch[2]				239.2					
by shore based methods				557.0	583.1	580.0	464.5	713.1	0.13

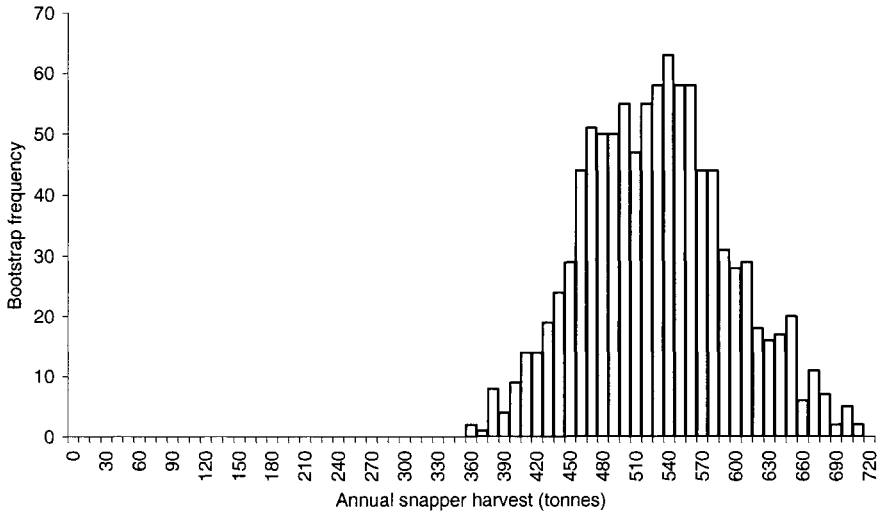
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for East Northland in 2000.

Appendix 1b: Distribution of bootstrap estimates of the East Northland snapper harvest for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods which are given in Appendix 1a.







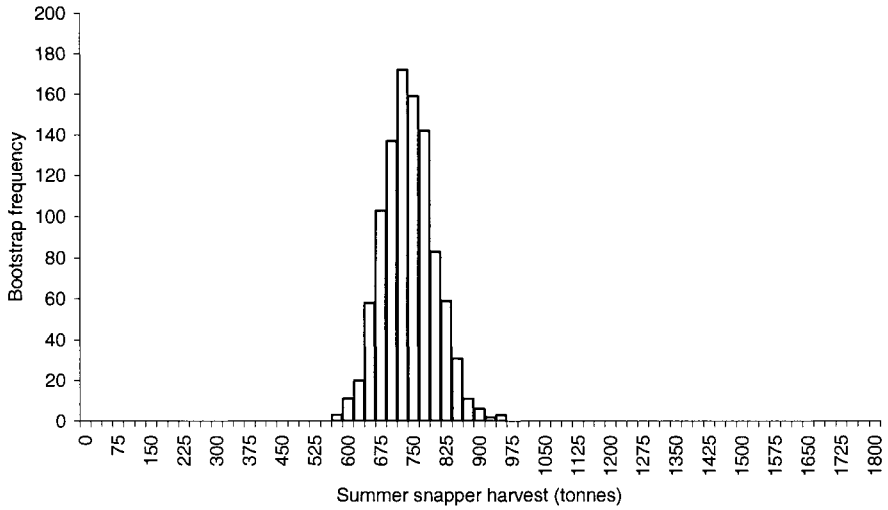
Appendix 1c: Estimates of the recreational harvest of snapper in Hauraki Gulf for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach, harvests by shore-based fishers, and the landed catch of fishers participating in the 2005 Lion Red Furuno Fishing Tournament. Days from the Lion Red Furuno Tournament strata given in Table 1 have been reallocated to the appropriate day-type strata (two midweek days and one weekend day).

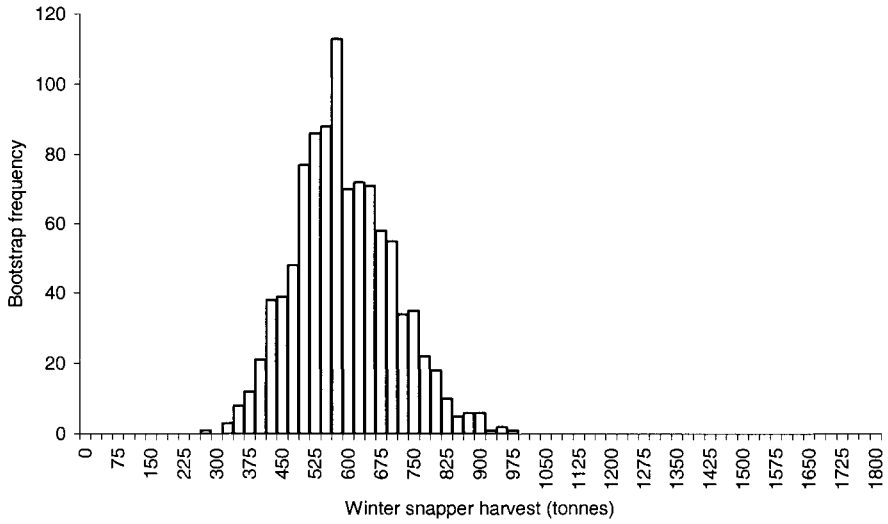
Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
1	Summer	Weekend/PH	52	4.616	4.640	4.638	3.629	5.707	
		Midweek	99	1.469	1.532	1.481	1.077	2.172	
	Winter	Weekend/PH	63	3.031	3.040	2.951	1.239	5.014	
		Midweek	151	0.422	0.455	0.409	0.177	0.866	
2	Summer	Weekend/PH	52	1.435	1.497	1.474	1.006	2.046	
		Midweek	99	0.336	0.336	0.316	0.165	0.560	
	Winter	Weekend/PH	63	1.062	1.036	1.014	0.454	1.643	
		Midweek	151	0.164	0.163	0.156	0.063	0.295	
3	Summer	Weekend/PH	52	1.389	1.424	1.414	1.107	1.737	
		Midweek	99	0.689	0.734	0.706	0.482	1.067	
	Winter	Weekend/PH	63	1.440	1.452	1.412	0.869	2.099	
		Midweek	151	0.278	0.316	0.295	0.106	0.606	
4	Summer	Weekend/PH	52	0.834	0.943	0.907	0.564	1.443	
		Midweek	99	0.267	0.270	0.261	0.141	0.437	
	Winter	Weekend/PH	63	0.810	0.848	0.727	0.312	1.781	
		Midweek	151	0.281	0.233	0.214	0.070	0.461	
Weighted summer total				703.6	726.6	724.7	634.8	827.8	0.08
Weighted winter total				572.4	577.9	566.4	404.2	773.3	0.19
Weighted annual total				1 276.	1 304.5	1 295.4	1 117.2	1 523.7	0.10
				707.					
Scaled to account for 0.5 % of catch				575.2					
by unassessed vessel based methods[1]				1 282.2	1 310.5	1 301.8	1 123.1	1 529.7	0.10
				741.1					
Scaled to account for 4.6 % of catch[2]				602.9					
by shore based methods				1 344.	1 380.3	1 371.8	1 181.4	1 607.2	0.10
				742.5					
Including weighed in catch from				602.9					
Lion Red Furuno Fishing Tournament (1 435 kg)				1 345.4	1 381.7	1 373.2	1 182.8	1 608.7	

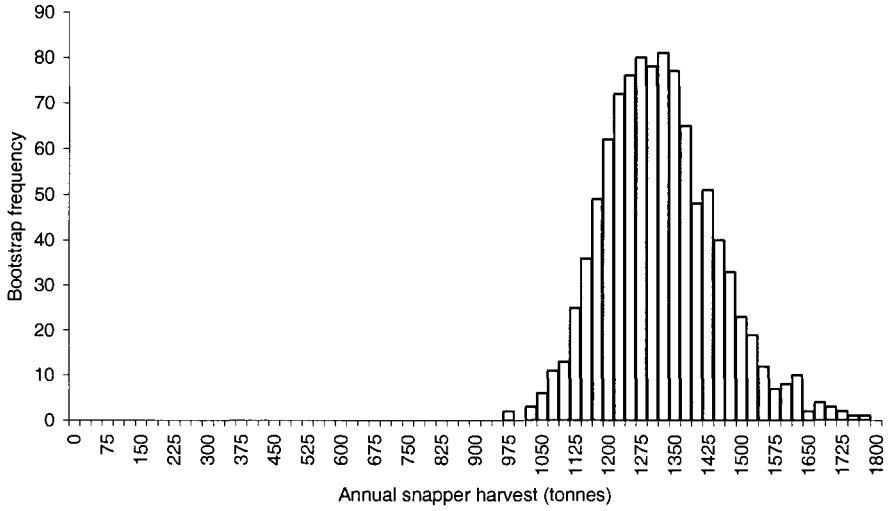
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for the Hauraki Gulf in 2000.

Appendix 1d: Distribution of bootstrap estimates of the Hauraki Gulf snapper harvest for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods and the Lion Red Furuno Fishing Tournament, which are given in Appendix 1c.







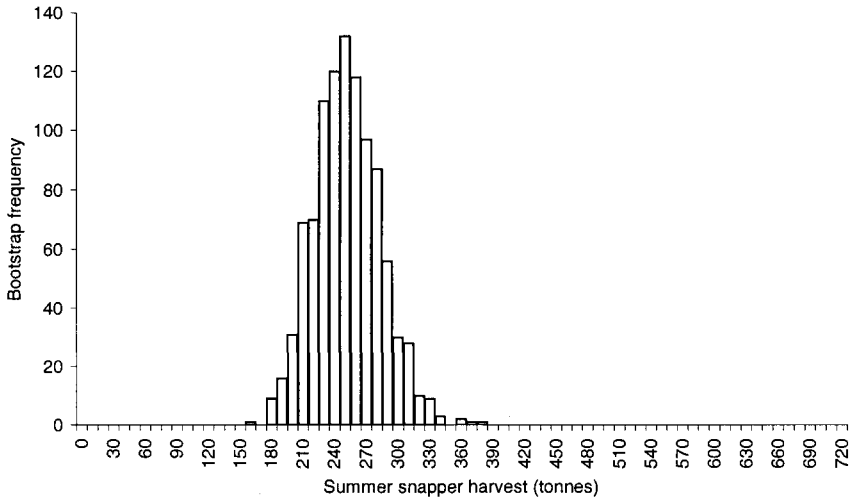
Appendix 1e: Estimates of the recreational harvest of snapper in the Bay of Plenty for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach and harvests by shore-based fishers.

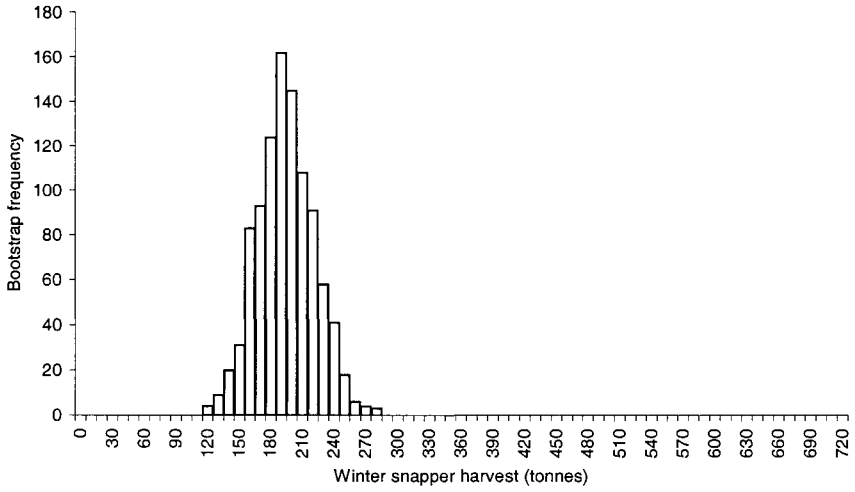
Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
1	Summer	Weekend/PH	52	1.300	1.307	1.289	0.905	1.778	
		Midweek	99	0.511	0.502	0.491	0.182	0.872	
	Winter	Weekend/PH	63	0.834	0.845	0.812	0.583	1.207	
		Midweek	151	0.152	0.157	0.152	0.070	0.254	
2	Summer	Weekend/PH	52	1.302	1.306	1.298	0.941	1.686	
		Midweek	99	0.587	0.618	0.604	0.413	0.855	
	Winter	Weekend/PH	63	1.290	1.284	1.278	0.882	1.729	
		Midweek	151	0.204	0.208	0.203	0.078	0.355	
Weighted summer total				244.0	246.8	245.9	198.0	301.8	0.13
Weighted winter total				187.6	189.3	188.8	146.1	234.6	0.14
Weighted annual total				431.5	436.1	436.6	368.8	503.0	0.10
				255.2					
Scaled to account for 4.41 % of catch				196.2					
by unassessed vessel based methods[1]				451.5	456.3	456.5	385.5	525.7	0.10
				292.0					
Scaled to account for 12.6 % of catch[2]				224.5					
by shore based methods				516.5	522.0	521.5	441.2	602.6	0.10

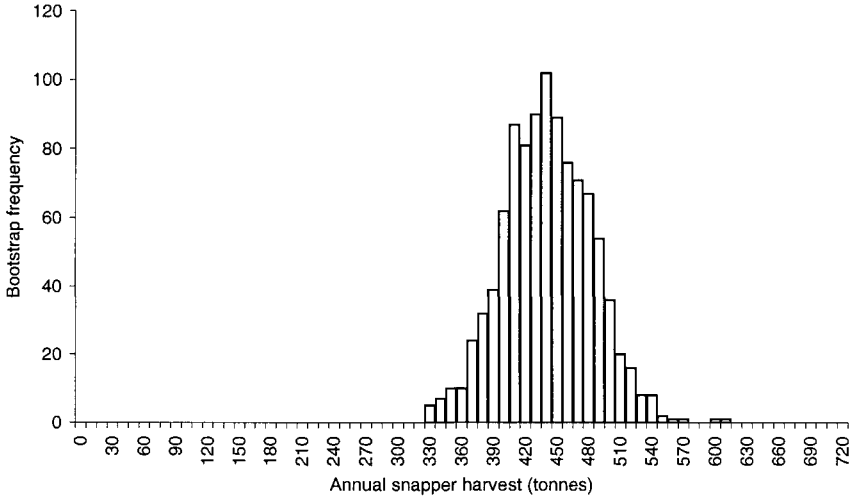
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for Bay of Plenty in 2000.

Appendix 1f: Distribution of bootstrap estimates of the Bay of Plenty snapper harvest estimates for summer, winter, and for summer and winter combined. Note that these do not estimates include adjustments for unassessed fishing methods which are given in Appendix 1e.







Appendix 2: Regional estimates of the 2004–05 recreational harvest of kahawai in summer (1 December 2004 to 30 April 2005) and winter (1 May 2004 to 30 November 2005) with associated bootstrap distributions derived from the main overflight survey.

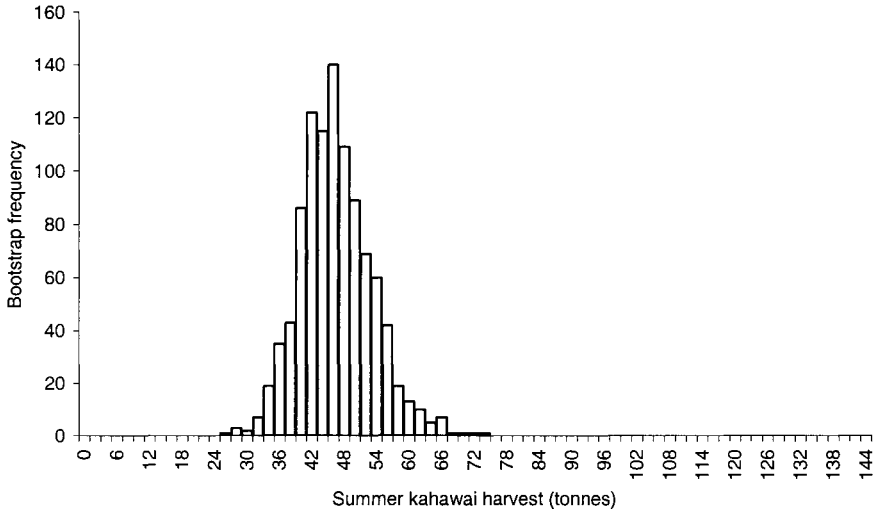
Appendix 2a: Estimates of the recreational harvest of kahawai in East Northland for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach and harvests by shore-based fishers.

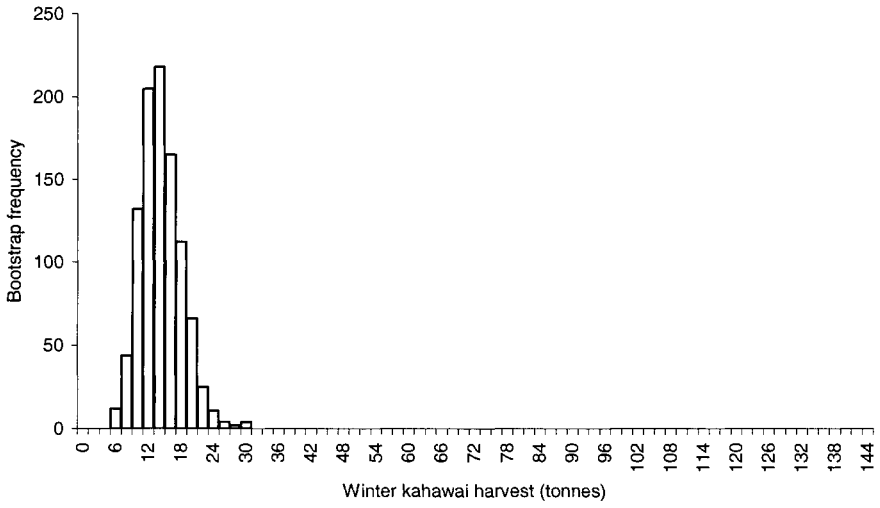
Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
1	Summer	Weekend/PH	52	0.431	0.434	0.432	0.319	0.560	
		Midweek	99	0.151	0.149	0.146	0.076	0.236	
	Winter	Weekend/PH	63	0.071	0.072	0.070	0.032	0.120	
		Midweek	151	0.034	0.027	0.024	0.001	0.060	
2	Summer	Weekend/PH	52	0.113	0.116	0.113	0.070	0.171	
		Midweek	99	0.025	0.020	0.018	0.005	0.041	
	Winter	Weekend/PH	63	0.043	0.044	0.041	0.015	0.081	
		Midweek	151	0.013	0.013	0.011	0.000	0.033	
Weighted summer total				45.7	45.4	44.8	35.4	56.5	0.15
Weighted winter total				14.2	13.3	13.0	7.8	19.7	0.28
Weighted annual total				59.9	58.8	58.5	47.1	72.0	0.13
				62.0					
Scaled to account for 26.35 % of catch				19.3					
by unassessed vessel based methods[1]				81.3	80.0	79.3	64.0	98.0	0.13
				98.2					
Scaled to account for 36.8 % of catch[2]				30.5					
by shore based methods				128.7	126.7	125.3	99.4	156.3	0.14

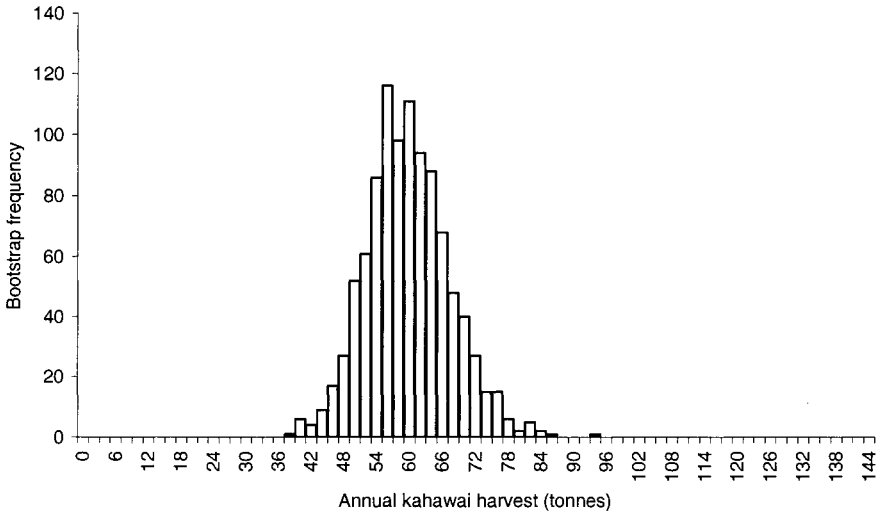
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for East Northland in 2000.

Appendix 2b: Distribution of bootstrap estimates of the East Northland kahawai harvest for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods which are given in Appendix 2a.







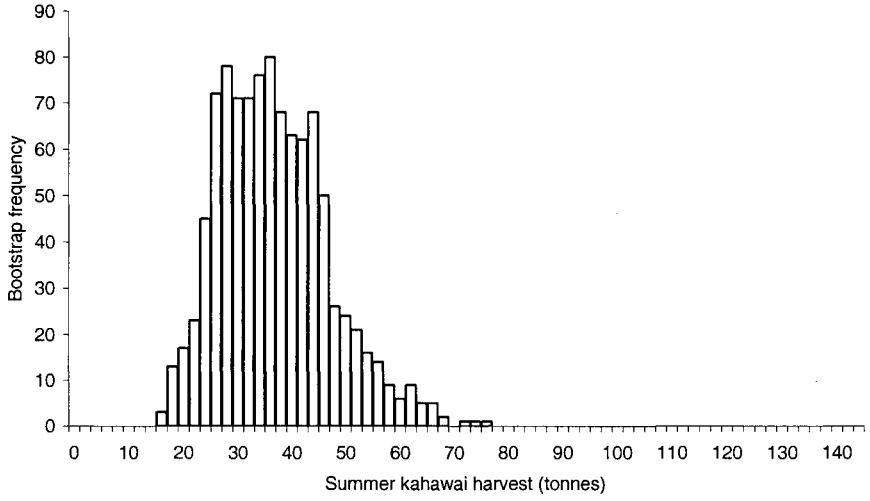
Appendix 2c: Estimates of the recreational harvest of kahawai in Hauraki Gulf for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach, harvests by shore-based fishers, and the landed catch of fishers participating in the 2005 Lion Red Furuno Fishing Tournament. Days from the Lion Red Furuno Tournament strata given in Table 1 have been reallocated to the appropriate day-type strata (two midweek days and one weekend day).

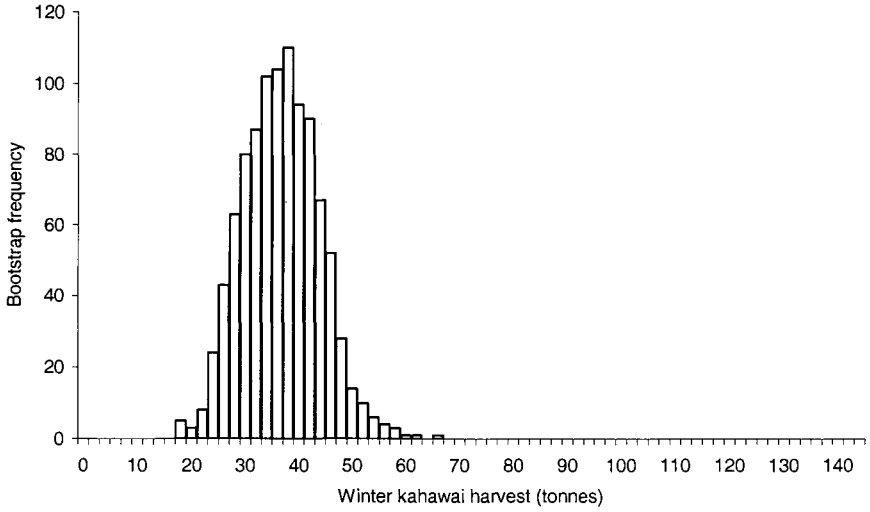
Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
1	Summer	Weekend/PH	52	0.257	0.257	0.251	0.151	0.374	
		Midweek	99	0.120	0.122	0.113	0.014	0.280	
	Winter	Weekend/PH	63	0.216	0.204	0.199	0.107	0.310	
		Midweek	151	0.042	0.044	0.042	0.009	0.089	
2	Summer	Weekend/PH	52	0.080	0.082	0.079	0.040	0.131	
		Midweek	99	0.000	0.000	0.000	0.000	0.000	
	Winter	Weekend/PH	63	0.059	0.055	0.046	0.005	0.139	
		Midweek	151	0.023	0.026	0.024	0.006	0.054	
3	Summer	Weekend/PH	52	0.043	0.044	0.043	0.020	0.071	
		Midweek	99	0.001	0.000	0.000	0.000	0.001	
	Winter	Weekend/PH	63	0.050	0.050	0.049	0.025	0.078	
		Midweek	151	0.005	0.005	0.004	0.001	0.011	
4	Summer	Weekend/PH	52	0.069	0.060	0.039	0.005	0.191	
		Midweek	99	0.008	0.007	0.006	0.000	0.021	
	Winter	Weekend/PH	63	0.035	0.034	0.031	0.002	0.080	
		Midweek	151	0.020	0.019	0.019	0.007	0.031	
Weighted summer total				36.1	35.8	34.8	21.7	54.1	0.28
Weighted winter total				36.2	35.7	35.5	24.5	47.0	0.20
Weighted annual total				72.4	71.5	71.2	53.0	93.5	0.17
				37.9					
Scaled to account for 4.7 % of catch				38.0					
by unassessed vessel based methods[1]				76.0	75.0	74.6	55.6	98.2	0.17
				48.9					
Scaled to account for 22.5 % of catch[2]				49.1					
by shore based methods				98.0	97.0	96.3	71.9	128.4	0.18
				49.2					
Including weighed in catch from				49.1					
Lion Red Furuno Fishing Tournament (229 kg)				98.2	97.2	96.6	72.1	128.7	0.18

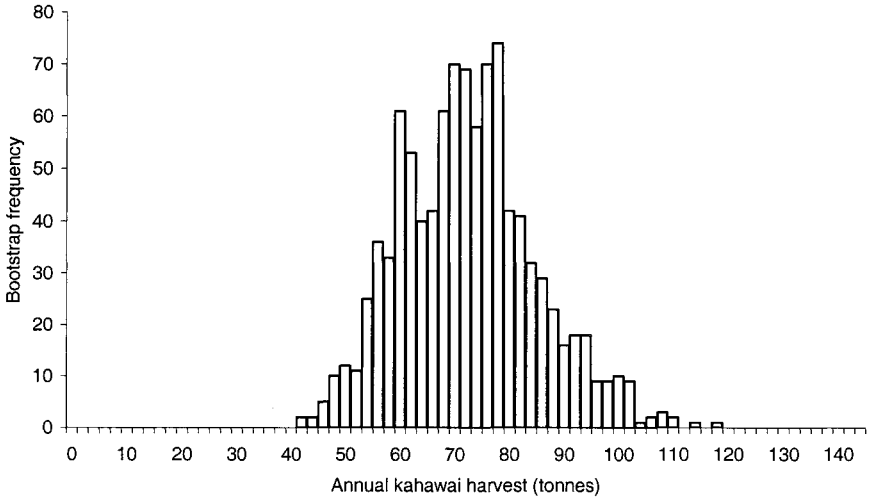
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for Hauraki Gulf in 2000.

Appendix 2d: Distribution of bootstrap estimates of the Hauraki Gulf kahawai harvest for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods and the Lion Red Furuno Fishing Tournament, which are given in Appendix 2c.







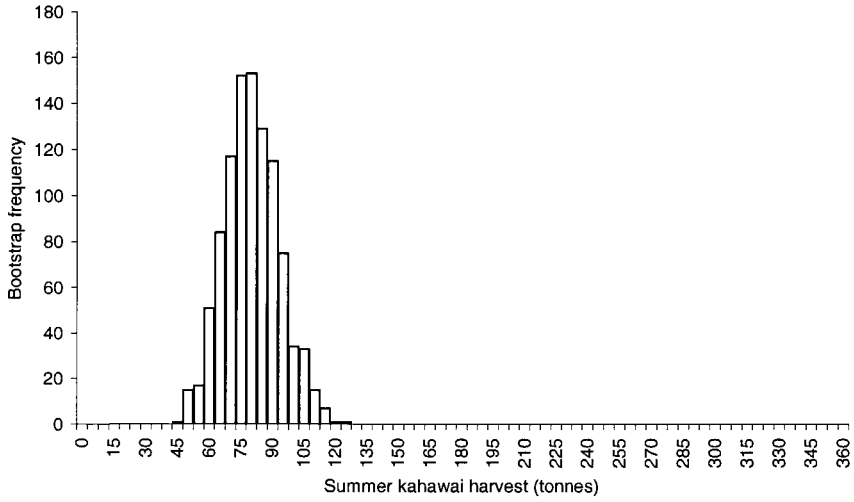
Appendix 2e: Estimates of the recreational harvest of kahawai in the Bay of Plenty for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach and harvests by shore-based fishers.

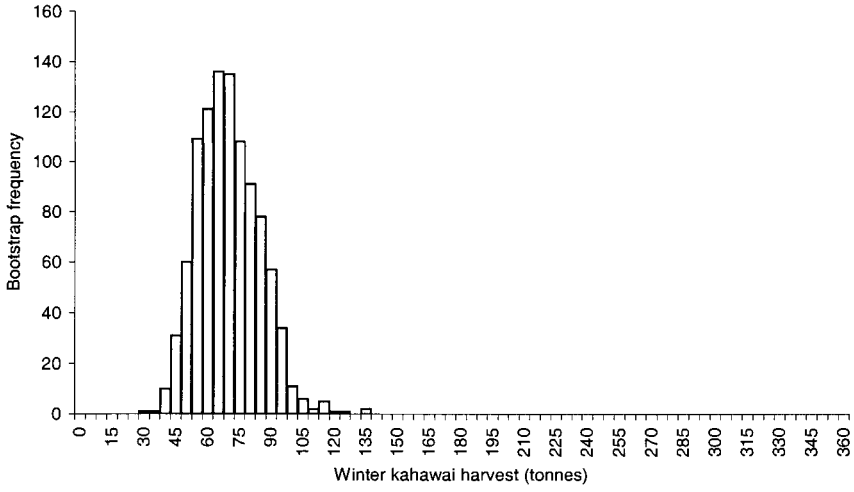
Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
1	Summer	Weekend/PH	52	0.184	0.186	0.185	0.108	0.274	
		Midweek	99	0.162	0.156	0.147	0.036	0.301	
	Winter	Weekend/PH	63	0.168	0.165	0.160	0.065	0.289	
		Midweek	151	0.040	0.039	0.038	0.013	0.070	
2	Summer	Weekend/PH	52	0.537	0.534	0.527	0.313	0.782	
		Midweek	99	0.248	0.249	0.245	0.150	0.360	
	Winter	Weekend/PH	63	0.577	0.576	0.561	0.334	0.856	
		Midweek	151	0.094	0.098	0.088	0.015	0.214	
Weighted summer total				78.0	77.5	77.0	57.7	100.4	0.17
Weighted winter total				67.2	67.3	66.0	45.9	91.4	0.21
Weighted annual total				145.3	144.8	143.7	115.2	178.0	0.13
				99.8					
Scaled to account for 21.88 % of catch				86.1					
by unassessed vessel based methods[1]				185.9	185.4	184.9	147.0	227.6	0.13
				162.6					
Scaled to account for 38.6 % of catch[2]				140.2					
by shore based methods				302.8	302.8	303.6	239.3	372.9	0.14

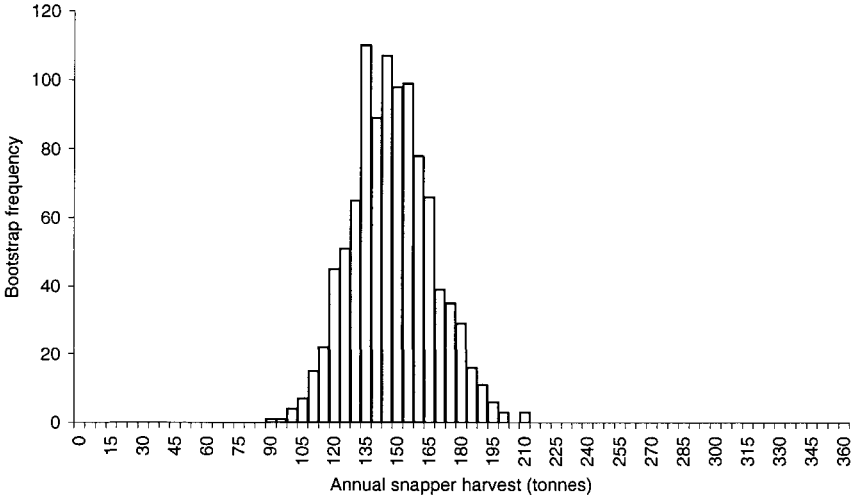
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for Bay of Plenty in 2000.

Appendix 2f: Distribution of bootstrap estimates of the Bay of Plenty kahawai harvest estimates for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods which are given in Appendix 2e.







Appendix 3: Regional estimates of the 2004–05 recreational harvest of kingfish in summer (1 December 2004 to 30 April 2005) and winter (1 May 2004 to 30 November 2005) with associated bootstrap distributions derived from the main overflight survey.

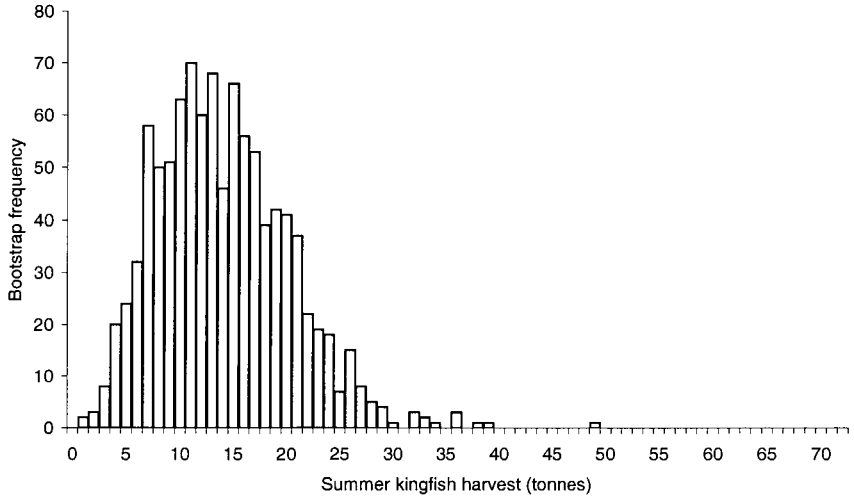
Appendix 3a: Estimates of the recreational harvest of kingfish in East Northland for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach and harvests by shore-based fishers.

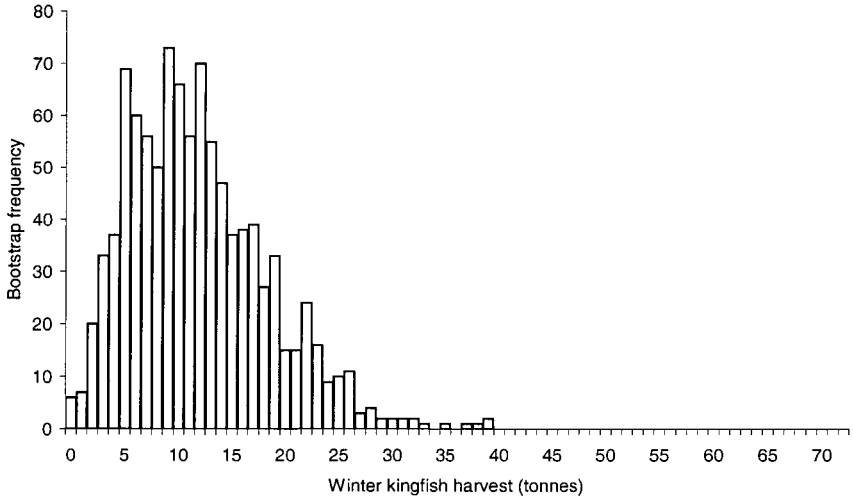
Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
Summer	Weekend/PH	52	0.059	0.052	0.049	0.012	0.105	
	Midweek	99	0.112	0.110	0.102	0.023	0.217	
Winter	Weekend/PH	63	0.124	0.184	0.164	0.031	0.403	
	Midweek	151	0.010	0.018	0.000	0.000	0.068	
Weighted summer total			14.17	13.59	12.87	4.73	24.37	0.46
Weighted winter total			9.23	11.30	10.33	2.40	23.09	0.57
Weighted annual total			23.41	24.88	24.27	11.49	40.54	0.37
			44.95					
Scaled to account for 68.5 % of catch			29.29					
by unassessed vessel based methods[1]			74.23	79.94	76.68	34.61	136.24	0.39
			46.68					
Scaled to account for 3.7 % of catch[2]			30.41					
by shore based methods			77.09	83.26	79.80	35.49	141.45	0.39

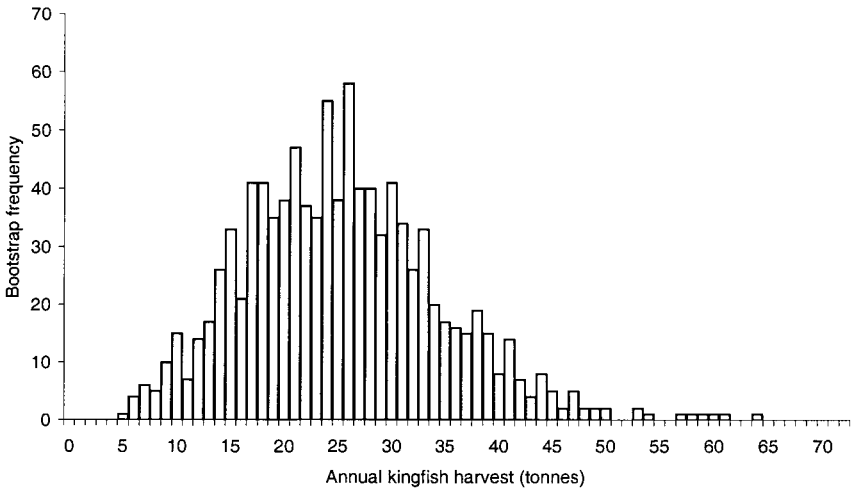
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for East Northland in 2000.

Appendix 3b: Distribution of bootstrap estimates of the East Northland kingfish harvest for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods which are given in Appendix 3a.







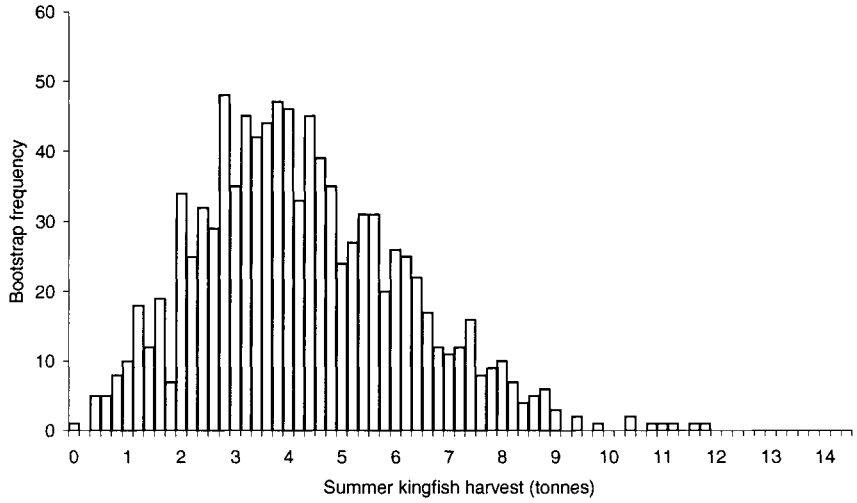
Appendix 3c: Estimates of the recreational harvest of kingfish in Hauraki Gulf for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach, harvests by shore-based fishers, and the landed catch of fishers participating in the 2005 Lion Red Furuno Fishing Tournament. Days from the Lion Red Furuno Tournament strata given in Table 1 have been reallocated to the appropriate day-type strata (two midweek days and one weekend day).

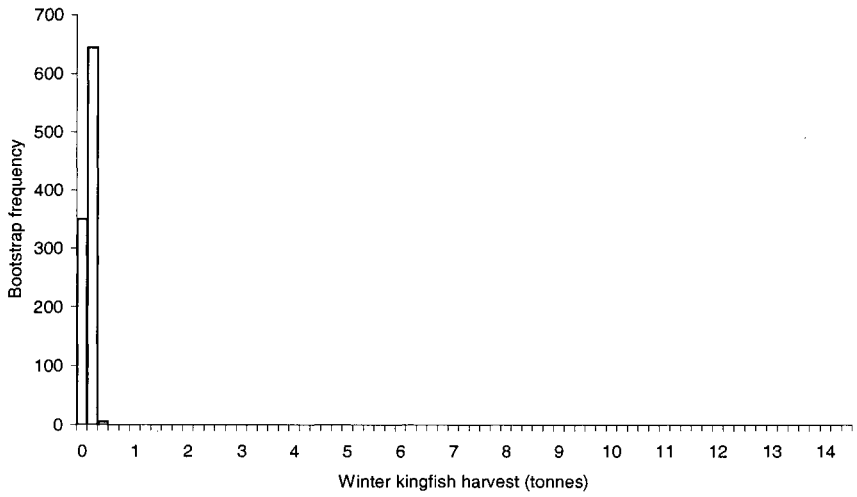
Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
Summer	Weekend/PH	52	0.068	0.064	0.060	0.019	0.119	
	Midweek	99	0.011	0.009	0.004	0.000	0.030	
Winter	Weekend/PH	63	0.001	0.001	0.000	0.000	0.002	
	Midweek	151	0.000	0.000	0.000	0.000	0.000	
Weighted summer total			4.60	4.18	3.96	1.25	7.72	0.46
Weighted winter total			0.04	0.04	0.03	0.00	0.14	1.08
Weighted annual total			4.64	4.23	4.00	1.32	7.75	0.46
			5.56					
Scaled to account for 17.3 % of catch			0.05					
by unassessed vessel based methods[1]			5.61	5.11	4.84	1.59	9.37	0.46
			5.91					
Scaled to account for 5.9 % of catch[2]			0.05					
by shore based methods			5.96	5.14	4.88	1.65	9.40	0.47
			6.22					
Including weighed in catch from			0.05					
Lion Red Furuno Fishing Tournament (308 kg)			6.27	5.45	5.18	1.96	9.70	0.47

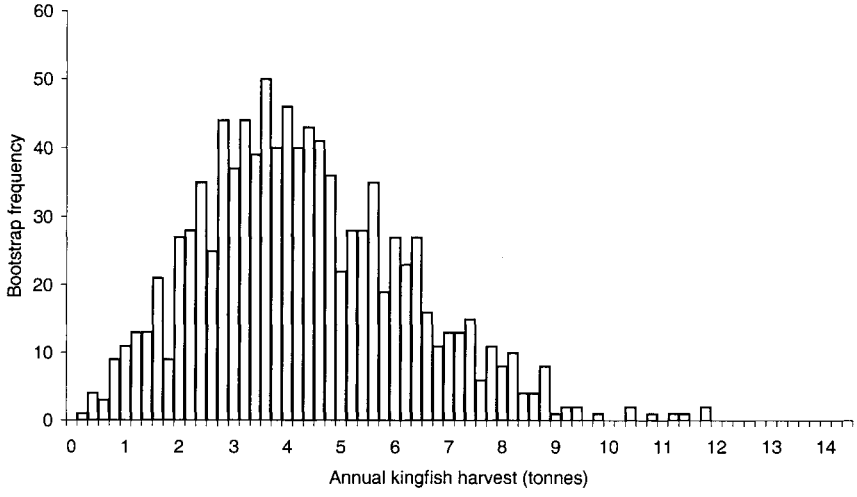
1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for Hauraki Gulf in 2000.

Appendix 3d: Distribution of bootstrap estimates of the Hauraki Gulf kingfish harvest for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods and the Lion Red Furuno Fishing Tournament, which are given in Appendix 3c.







Appendix 3e: Estimates of the recreational harvest of kingfish in the Bay of Plenty for each stratum with associated bootstrap statistics. Overflight survey estimates are adjusted in the second half of the table to account for harvests by vessel-based fishing methods which were not estimated by the overflight approach and harvests by shore-based fishers.

Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
Summer	Weekend/PH	52	0.106	0.104	0.099	0.043	0.179	
	Midweek	99	0.038	0.037	0.034	0.010	0.074	
Winter	Weekend/PH	63	0.023	0.018	0.015	0.003	0.041	
	Midweek	151	0.000	0.001	0.001	0.000	0.003	
Weighted summer total			9.27	9.04	8.84	4.69	14.25	0.33
Weighted winter total			1.51	1.86	1.63	0.36	4.17	0.66
Weighted annual total			10.78	10.90	10.67	6.19	16.64	0.29
			14.87					
Scaled to account for 37.7 % of catch			2.43					
by unassessed vessel based methods[1]			17.30	17.58	17.18	9.76	27.34	0.30
			19.75					
Scaled to account for 24.7 % of catch[2]			3.23					
by shore based methods			22.98	23.41	22.74	12.95	36.34	0.31

1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for Bay of Plenty in 2000.

Appendix 3f: Distribution of bootstrap estimates of the Bay of Plenty kingfish harvest estimates for summer, winter, and for summer and winter combined. Note that these estimates do not include adjustments for unassessed fishing methods which are given in Appendix 3e.