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Length and age compositions of recreational landings of kahawai in KAH 1 from January to April in 2011 and 2012

New Zealand Fisheries Assessment Report 2014/60

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This report documents the ninth and tenth years of recreational catch sampling in KAH 1; conducted in the first four months of 2011 and 2012. Sampled landings of kahawai provide the length and age composition of recreational landings, used to monitor the wider KAH 1 stock. Amateur fishers land a wider size range of kahawai, from a far greater number of geographically dispersed schools, than any commercial fishery. This is desirable, as kahawai school by size in an aggregated and non-random manner.

The number of kahawai encountered and measured in East Northland and the Hauraki Gulf in 2011 was greater than in any other survey since the first in 2001. This trend continued in the Hauraki Gulf in 2012, with large numbers of boats with kahawai being encountered across all ramps. Conversely, in East Northland, fewer kahawai were landed and boats interviewed in 2012 than in any previous year, given the number of hours interviewers spent on ramps. Nonetheless, the regional length and age compositions obtained in 2011and 2012 are broadly similar to those obtained in previous years, except in the Hauraki Gulf where substantial numbers of large kahawai were landed over both survey years. In East Northland, the length and age compositions appear consistent with trends seen in previous years, with an age distribution which has broadened since 2003. There is a small peak of younger fish evident in the 2012 distribution. In the Bay of Plenty the length and age distributions remain typically broad. No kahawai otoliths were collected from Hauraki Gulf landings in 2011 and 2012. The levels of precision associated with the regional length and age distributions (MWCVs ranging from 0.11 to 0.20 and from 0.15 to 0.16 respectively) are all within the required target level (0.30).

A time series of total mortality estimates (Z) derived from East Northland and Bay of Plenty age distributions has also been generated, which can be used to infer changes in stock status. This time series suggests that there has been a general decline in mortality rates in both stocks, which will be partially attributable to the approximate halving of commercial landings in KAH 1 over the past 10 to 15 years.

All recreational length and age collected since 2001 were reanalysed using software recently developed by NIWA (CALA – Catch At Length & Age). This software combines the functionality of two other exiting catch sampling analysis programmes, and data collected between 2001 and 2008 were previously analysed using one of these programmes; LFVAR8. Mean weighted coefficients of variation (MWCVs) calculated by CALA are compared with those calculated by LFVAR8 for all years. Although MWCVs generated by CALA are slightly higher, they are of a very similar magnitude to those estimated by LFVAR8. The difference is probably attributable to the fact that LFVAR8 estimates variances analytically, whereas CALA estimates are based on nonparametric bootstrapping routines.

The high level of precision associated with recreational catch-at-age and catch-at-length distributions has led to suggestions that variance estimates are artificially low because of the use of a plus group for older fish, and because landings data should be stratified by interview session rather than by boat. Although fish older than 20 years are potentially assignable to a 20+ age group, we have yet to observe any fish this old, which means that there is in effect no 20+ age group. Separate analyses of boat and session stratified data were undertaken of landings data collected in 2011. The MWCVs resulting from both forms of stratification were very similar, although slightly higher when the data were stratified by session.

1 INTRODUCTION

Many fisheries are monitored using catch-at-age and catch-at-length data collected from commercial landings. Kahawai (*Arripis trutta*) school by size, however, and commercial landings comprised of fish from a small number of schools may not reliably represent the age and size structure of the population. For example, amalgamated length frequencies collected from commercial purse seine landings in 1990–91 and 1991–92 were multimodal, and McKenzie & Trusewich (NIWA, Auckland, unpublished results) concluded that this was probably an artefact of the way the purse seine fleet operated, rather than an intrinsic feature of the Bay of Plenty population. While comprehensive sampling of commercial catches can be used to characterise commercial extraction, these samples cannot be considered indicative of the underlying population length and age structure, as the fishery operates non-randomly in space and time.

Recreational fisheries probably provide a more representative description of the local kahawai population, as a wider range of schools is sampled at a far lower intensity, thus lessening the influence of any single school (Bradford 2000). Further, recreational fishers catch, and tend to land, a wider size range of fish than their commercial counterparts (Bradford 1999). A time series of recreational catch-at-age estimates should, therefore, provide better insight into changes in population age composition given the manner in which the recreational fishery interacts with the wider stock.

Dedicated sampling of recreational landings of kahawai was initiated in the summer of 2000–01 (January to April 2001), and continued for a further eight years as part of the Ministry of Fisheries' programmes KAH2002/02 (Hartill et al. 2007a), KAH2003/01 (Armiger et al. 2006), KAH2005/02 (Hartill et al. 2007b), KAH2006/02 (Hartill et al. 2008a) and KAH2007/01 (Armiger et al. 2009). This report documents the results of a further two years of sampling, undertaken as part of the Ministry of Primary Industries programme MAF201003.

Objectives

1. To conduct representative sampling and determine the length, sex, and age composition of the amateur landings of kahawai in KAH 1 for the 2010/11 fishing year to monitor the KAH 1 stock. The target coefficient of variation (CV) for the catch at age will be 30% (mean weighted CV across all age classes).

2. To conduct representative sampling and determine the length, sex, and age composition of the amateur landings of kahawai in KAH 1 for the 2011/12 fishing year to monitor the KAH 1 stock. The target coefficient of variation (CV) for the catch at age will be 30% (mean weighted CV across all age classes).

2 METHODS

2.1 Overview of recreational kahawai catch sampling programmes

In the 1990s, recreational fishers in QMA 1 were interviewed at boat ramps to monitor aspects of the recreational fishery (see Sylvester, 1993, Hartill et al. 1998). An incidental outcome of these surveys was the realisation that recreational fishers potentially provided a much more random and potentially representative means of sampling kahawai populations than the conventional commercial catch sampling approach (given selectivity and spatial availability). Although recreational kahawai length frequency data were collected during the 1990s, underlying survey designs differed both spatially and temporally, and there was no concurrent collection of age data from this fishery. Nonetheless, in a review of data collected from these surveys, Bradford (2000) suggested that sufficient kahawai were landed by recreational fishers to support a length and age catch sampling programme in KAH 1.

Recreational landings have since been sampled annually for length and age between 2001 and 2008, in three putative KAH 1 substocks: East Northland, Hauraki Gulf, and the Bay of Plenty. Recreational fishers were interviewed in the first four months of each year, when fishing effort peaked. Kahawai were measured where possible, and otoliths were collected from a sizeable proportion of these fish. These data were then used to derive length and age distributions for each substock of KAH 1.

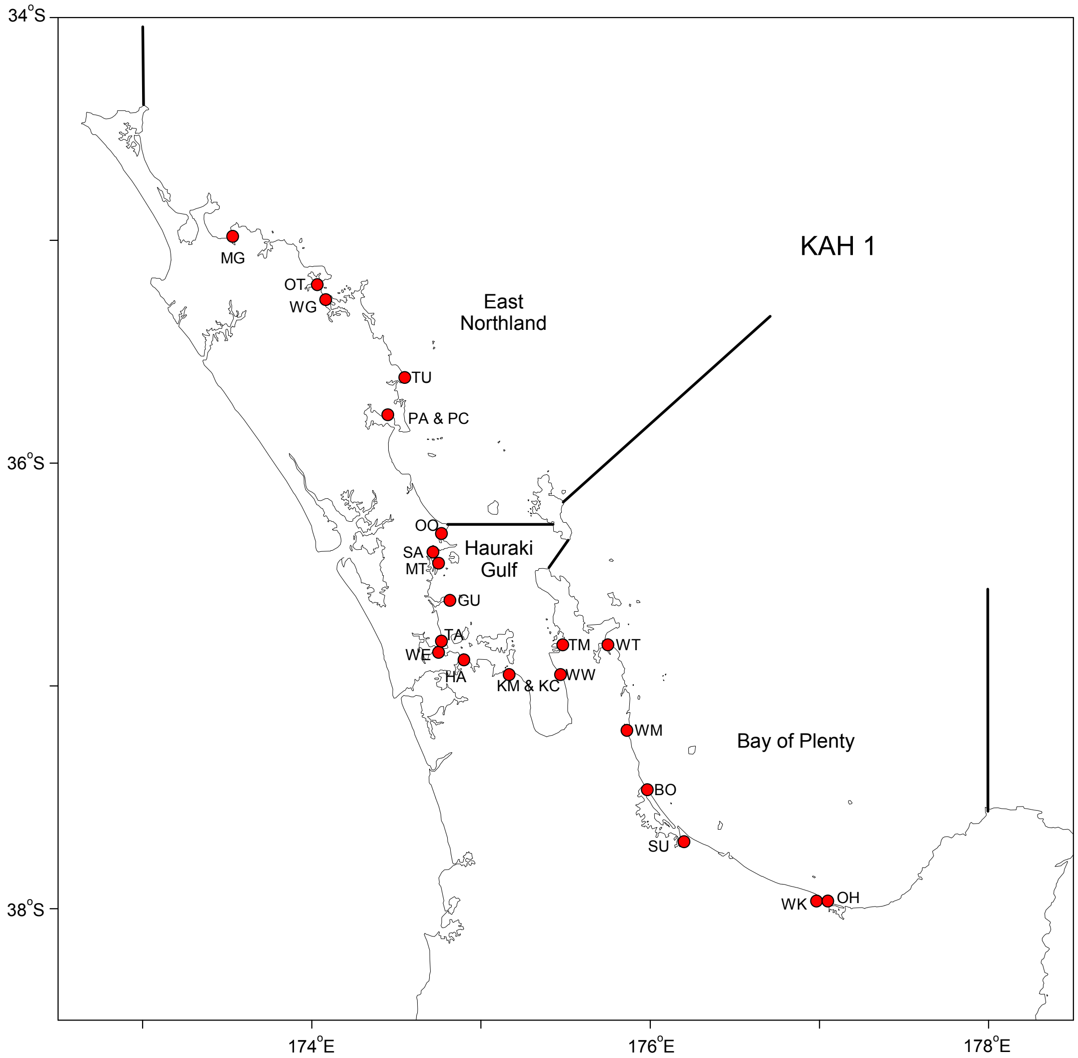
This programme provides recreational catch-at-age data from KAH 1 for a ninth and tenth year, in 2011 and 2012, following a two year hiatus in 2009 and 2010. No age data have been collected in the Hauraki Gulf in 2011 and 2012, because the Northern Inshore Working Group concluded that this fishery is usually dominated by only one or two age classes and a time series of age distributions from this substock tells us little about changes in stock status. Recreational landings in the Hauraki Gulf were sampled for length only in 2011 and 2012.

The methods used in 2011 and 2012 are essentially the same as those used since 2001, as discussed below.

2.2 Sample design

The sample design used in this survey was based on data collected from boat ramp surveys conducted between 2001 and 2008. Kahawai length data and age distributions from these surveys (and length data from previous surveys in 1991, 1994, and 1996) strongly suggest that there continue to be significant regional differences between the length frequency compositions of kahawai caught by recreational fishers in East Northland, the Hauraki Gulf, and Bay of Plenty (Bradford 1999, Hartill et al. 1998). Separate boat ramp surveys were, therefore, conducted in each of these regions (Figure 1) with concurrent collection of length and age samples from recreational landings of kahawai. There has been very little change in the selection of boat ramps where interviewing has taken place since 2001.

Sampling of recreational catches was restricted to a four-month season (1 January to 30 April) which corresponds approximately to the peak of the recreational fishing season when kahawai landings were likely to be most abundant. Restriction of sampling to a four-month season was also desirable, as a longer collection period would have increased the likelihood of growth distorting the age-length-keys. Further, as otolith ring deposition occurs during the onset of winter (Stevens & Kalish 1998), collection of otoliths in early winter should be avoided, as ambiguous structures on the edge of the otolith may result in ageing error.



East Northland

MG	Mangonui
OT	Opito Bay, Kerikeri
PA	Parua Bay (public ramp)
PC	Parua Bay (club ramp)
TU	Tutukaka
WG	Waitangi

Hauraki Gulf

GU	Gulf Harbour
HA	Half Moon Bay
KM	Kawakawa (public ramp)
KC	Kawakawa (club ramp)
MT	Martins Bay
OO	Omaha
SA	Sandspit
TA	Takapuna
TM	Te Kouma
WE	Westhaven
WW	Waikawau

Bay of Plenty

BO	Bowentown
OH	Ohope
SU	Sulphur Point, Tauranga
WK	Whakatane
WT	Whitianga
WM	Whangamata

Figure 1: KAH 1 substock boundaries and location of boat ramp interview sites.

Target levels of sampling effort were based on those used in the previous years, and are given in Table 1. The basis for these targets is a recommendation by Bradford (2000) that 400–500 kahawai should be aged to give a reasonable approximation of the relationship between length and age, and hence, potentially, a population's age structure. A further recommendation from this study was that as many fish as possible, preferably 1500 (E. Bradford, pers comm.) should be measured to provide a reliable length frequency distribution. The timing and intensity of recreational landings of kahawai is, however, difficult to predict given interannual variability in fishing effort and the spatially dynamic nature of kahawai schooling behaviour. A reasonable intensity of sampling effort is therefore required in space and time so that appreciable landings of kahawai can be sampled, if and when they occur. In the previous eight survey years, this level of sampling yielded sufficient length and age data to characterise catch distributions with mean weighted coefficients of variation (MWCVs) of generally less than 0.20, which is considered an acceptable level of precision. The required level of precision for catch-at-age distributions required for this programme is 0.30, as specified in Objectives 1 and 2.

Table 1: Numbers of hours worked, kahawai measured and aged relative to the survey design.

2011	Number of hours		Number of kahawai measured		Number of kahawai aged	
Region	Target	Actual	Target	Actual	Target	Actual
East Northland	1 152	1 105	1 500	1 462	500	497
Hauraki Gulf	1 320	1 059	1 500	3 784	–	–
Bay of Plenty	504	555	1 500	1 300	500	499

2012	Number of hours		Number of kahawai measured		Number of kahawai aged	
Region	Target	Actual	Target	Actual	Target	Actual
East Northland	1 152	1 452	1 500	770	500	485
Hauraki Gulf	1 320	2 346	1 500	2 732	–	–
Bay of Plenty	504	1 607	1 500	1 891	500	492

For the 2011 sampling season, sessions at each ramp were randomly assigned to weekend and public holiday days between 1 January and 30 April in both fishing years. If interviewers found that there were strong onshore winds or local competitions on any of the randomly preassigned dates, sampling took place on the next available weekend/holiday day.

In 2012, interviews were also conducted on midweek days, as part of a concurrent large recreational harvest estimation programme in QMA 1 (MAF2011/02). Boat ramp interviewers were therefore present on randomly preassigned days throughout the week, from dawn to dusk, regardless of the prevailing weather conditions. The introduction of midweek sampling in all three areas in 2011–12 is unlikely to influence the size and age composition of landings, however, as results from the 1996 boat ramp survey demonstrated that there were no substantive differences between length frequencies of commonly caught species during weekends and weekdays (Hartill et al. 1998). Only data collected during the months of January to April 2012 are considered here, to maintain consistency with previous years, although interviews were conducted throughout the 2011–12 fishing year, as part of MAF201102.

In the first KAH 1 surveys in this time series, the level of sampling effort was based on recreational fishery survey data collected in the 1990s (See Table 1 of Hartill et al. 2007a). These data were also used to identify the most "productive" ramps. Additional sampling at less productive ramps since 2001 was necessary, however, to increase the number and spatial range of kahawai which we could potentially encounter and sample. In recent years, levels of sampling effort have been based on the number of kahawai encountered per hour in preceding surveys. Nonetheless, the levels of precision achieved since 2001 have been within that specified by the Ministry of Fisheries in any survey year, and we continue to survey the fishery at about the same level of effort.

In previous years, sampling has been conducted at Sandspit, but traffic volumes at this ramp have decreased because there are now fewer parking spaces available for boats with trailers. Consequently in 2011, sampling was conducted at Omaha, Sandspit and Martins Bay to determine which of these ramps was the busiest in the Warkworth region. It was concluded that sampling would take place at Omaha from 2012 onwards, as there was more boat traffic at that ramp.

The sampling effort at the Tairua ramp in the Bay of Plenty was also transferred to Whangamata due to a decline in boat ramp traffic at Tairua as the channel silted up. A further sampling site at Waikawau was added to the Hauraki Gulf to better describe landings from the Firth of Thames area.

Subsequent analyses on length and age data suggest that the inclusion or exclusion of these new ramps has little discernible impact on the shape of length and age distributions in each of the respective substocks.

All interviews conducted in KAH 1 followed the format of those undertaken in all previous surveys to ensure that the data were collected in a consistent manner. When more than one vessel approached a ramp simultaneously, a vessel was chosen randomly for interviewing. All landed fish, including kahawai, were measured when permission was given by the fisher. Cooperation rates were generally very high. For ageing purposes, up to four kahawai were selected at random from each vessel's catch, although most landings are of only one or two kahawai. The length distribution of the age sample should broadly reflect the length distribution of the landed catch, as age samples were collected at random from each catch.

Kahawai otoliths are fragile and time consuming to extract and interviewers therefore asked permission to cut the head off at the gills. Most recreational fishers allowed the interviewer to remove heads from their kahawai. These heads were retained by the interviewer together with a record of the fish's length, and a code linking the head to other data collected during the interview. Kahawai were not sexed, as there is no apparent sexual dimorphism in growth rates (Bradford 1998). Otoliths were extracted from these heads at a later date.

2.3 Ageing of kahawai otoliths

Kahawai otoliths were prepared using the thin section method described by Stevens & Kalish (1998). Each otolith was marked across an intended sectioning plane passing through the nucleus. Each otolith was then imbedded in a disposable epoxy mould with three other otoliths so that their nuclei were at the same level. Once the resin hardened, a thin transverse section was cut out of each epoxy block with a Struers Accutom-2 low speed saw. One side of this section was then ground, polished, and mounted polished side down on a slide using 5-minute epoxy resin. After at least 1 hour, the material attached to each slide was sectioned again (to a thickness of approximately 250 to 350 μm) and briefly polished with 400 grit carborundum paper.

To improve clarity, a thin layer of immersion oil was brushed over each slide and reading took place under transmitted light. Two readers were initially used to interpret the thin sectioned otoliths and any disagreements in interpretation were ultimately resolved in conjunction with a third reader when necessary. All three otolith readers were very experienced and the two main readers have been involved in the reading of kahawai otoliths collected by this and similar programmes since 2001.

- Each reader independently read all otoliths collected from each region;
- Disagreements in initial age estimates resulted in the otoliths being re-read with no knowledge of any prior age estimates;
- Remaining disagreements were resolved by discussing images of otoliths projected onto a video screen with a third experienced reader until a consensus was reached;
  If no consensus could be reached, the otolith was discarded from the dataset.

It is only very rarely necessary to discard an otolith, and when this occurs it is usually because both otoliths are deformed and unreadable.

Otolith reading precision was quantified by carrying out between-reader comparison tests and comparisons between initial reads and final agreed ages for each reader as recommended by Campana et al. (1995). An Index of Average Percentage Error (IAPE, Beamish & Fournier 1981) statistic, and mean coefficient of variation (CV, Chang 1982), was calculated for each comparative test.

Interannual variability in a reader's interpretation of an otolith (known as "drift") can lead to spurious changes of age compositions over time. The consistency of an experienced kahawai otolith reader was examined in 2007. The reader was asked to re-read a random sample of otoliths collected between 2001 and 2005, which had previously been assigned across seven age groups; ages 2 to 8 (Hartill et al. 2008a). These results suggested a very high level of agreement despite the fact that the reader had no information about their previous interpretation, nor the size of the fish that were being aged. This reader is one of the two key readers used to interpret otoliths collected in 2011 and in 2012.

A forced margin was implemented to anticipate *a priori* the otolith margin type (wide, line, narrow) for the month in which the fish was sampled to provide guidance in determining age. The forced margin method reduces any misinterpretation of a fish's age that may arise when otoliths are collected over a four month period, given variable rates of otolith material deposition between fish. The nominal birth date of kahawai is taken as 1 January.

2.4 Data analysis

Length and age data derived from recreational landings of kahawai sampled between 2001 and 2008 have previously been analysed using a FORTRAN program developed for a snapper market sampling programme – LFVAR8 (Davies & Walsh 1995). This software was used to generate proportional catch-at-length and catch-at-age distributions and analytical variance estimates. Vessels landing kahawai were regarded as individual strata, which were weighted together on the basis of the number of kahawai landed by each vessel. The distribution of fish at age within length classes (an age-length key) was derived for each region, and used to translate the regional length distributions into estimates of recreational catch-at-age. Proportional catch-at-age estimates were calculated for the range of recruited age classes. No kahawai older than 20 years have been encountered to date, and there is therefore no need to combine older fish into a broad plus group. Recreational catch-at-age and length frequency distributions and their associated variances were presented in the form of histograms and tables.

For each region, catch-at-age distributions were also derived for each of the four months sampled using the same analytical approach used to derive regional distributions. Regional age-length keys were used to derive these age distributions, because the number of kahawai aged from individual months was considered insufficient to describe the underlying length-age relationship. This assumes that the month of sampling has little influence on the relationship between length and age within a region. Temporal trends in the underlying age composition of the regional kahawai populations fished by recreational fishers were then inferred from cumulative monthly proportional age distributions. Estimates of precision (MWCVs) were not calculated for monthly distributions due to low sample sizes in the component strata.

Length and age data collected in 2011 were also analysed using LFVAR8 to ensure consistency, but NIWA has also recently developed a new software programme that has greater functionality – CALA (Catch At Length & Age – Francis & Bian 2011). The variance estimates provided by LFVAR8 are based on analytical calculations, whereas the estimates generated by CALA are based on nonparametric bootstrapping routines. Data from all years have been reanalysed using the CALA software and the results presented here. The results are very similar to those generated by LFVAR8 and the intention is to use CALA to analyse all future data.

The levels of precision associated with catch-at-length and catch-at-age distribution derived from these programmes are routinely well within specified levels, and a potential reason for this was explored to ensure that the variance estimates were generated in an appropriate manner. Data collected in 2011 were stratified by boat and alternatively by session to determine whether the current practice of stratifying by boat resulted in artificially low variance estimates.

3 RESULTS

Results for each region of KAH 1 are given and discussed in separate sections, but overall sampling summary statistics are given in Table 2.

Table 2: Summary statistics by region of the number of interview sessions, hours surveyed, vessels interviewed, vessels with measurable kahawai, kahawai measured, and kahawai aged in 2010–11 and 2011–12. Regional summary statistics from previous survey years are given for comparison.

Year	Ramp	Number of sessions	Number of hours	Boats interviewed (fishing)	Boats with measured kahawai	Measurable kahawai landed*	Kahawai measured	Kahawai aged
East Northland								
2011–12	Mangonui	34	232	373	80	290	201	126
	Opito Bay	36	231	139	56	168	148	97
	Waitangi	38	262	300	88	295	167	117
	Tutukaka	33	230	133	12	22	20	10
	Parua Bay (public)	36	231	216	56	122	108	60
	Parua Bay (club)	40	267	285	53	242	126	75
	Total	217	1 452	1 446	345	1 139	770	485
2010–11		144	1 105	1 980	552	1 713	1 462	497
2007–08		172	1 015	2 068	416	1 137	874	539
2006–07		178	1 049	1 836	331	769	726	471
2005–06		183	1 083	1 714	274	619	537	321
2004–05		344	2 407	2 752	459	1 134	993	514
2003–04		190	1 096	2 427	439	1 119	1 015	517
2002–03		186	1 049	2 089	436	1 316	1 171	504
2001–02		199	1 110	1 878	491	1 437	1 318	526
2000–01		196	1 129	2 233	474	1 377	1 236	517
Hauraki Gulf								
2011–12	Omaha	36	232	289	44	135	83	–
	Gulf Harbour	35	231	358	92	403	260	–
	Takapuna	41	260	524	107	787	233	–
	Westhaven	34	231	570	64	325	120	–
	Half Moon Bay	77	490	1 190	295	1 125	791	–
	Kawakawa Bay (club)	34	230	512	151	554	431	–
	Kawakawa Bay (main)	34	220	302	100	445	405	–
	Te Kouma	35	222	396	35	131	68	–
	Waikawau	36	232	742	173	465	341	–
	Total	362	2 347	4 883	1 061	4 370	2 732	–
2010–11		176	1 059	3 255	1 139	5 586	3 784	–
2007–08		230	1 464	2 787	216	694	477	227
2006–07		223	1 391	3 543	332	1 216	632	398
2005–06		229	1 317	4 034	530	1 556	1 170	526
2004–05		557	3 529	6 402	293	899	606	289
2003–04		408	2 475	6 222	345	1 015	764	350
2002–03		231	1 301	3 432	395	1 035	880	527
2001–02		204	1 138	3 348	339	924	786	500
2000–01		212	1 174	2 706	435	1 081	892	500
Bay of Plenty								
2011–12	Whitianga	36	233	141	57	137	134	6
	Whangamata	36	233	512	101	203	197	122
	Bowentown	35	232	260	53	207	172	58
	Sulphur Point	65	416	1 152	325	912	744	199
	Whakatane	38	262	419	170	866	518	78
	Ohope	36	232	217	57	265	126	29
	Total	246	1 607	2 701	763	2 590	1 891	492
2010–11		145	555	1 703	547	2 329	1 300	499
2007–08		134	535	1 405	462	1 272	1 156	552
2006–07		121	485	1 226	397	1 473	1 072	472
2005–06		106	497	678	232	982	656	497
2004–05		406	2 636	3 611	565	2 703	1 483	393
2003–04		108	429	952	306	1 256	995	412
2002–03		120	462	1 246	357	1 260	1 133	477
2001–02		141	474	1 197	457	1 746	1 476	495
2000–01		100	319	934	294	1 277	1 104	457

* Excludes kahawai which were released, used for bait, or landed filleted.

3.1 East Northland

Catch sampling in 2011

Interviewers were present at ramps in East Northland for a similar number of hours to that in most previous years (Table 2). Kahawai were landed in relatively high numbers at all ramps throughout the East Northland region. The number of boats interviewed is similar to previous years, however the number of boats returning with measurable kahawai increased. The number of kahawai measured in East Northland in 2010–11, is greater than kahawai numbers measured in earlier survey years.

The level of agreement between initial otolith readings was very high, with initial agreement for 85% of otoliths (Appendix 7). Almost all of the remaining initial reads were within one year of each other and neither reader appeared to be generally biased towards over or under interpreting an otolith's age. Comparisons of initial readings with final agreed ages resulted in IAPE scores of 0.81% and 0.36% (values of 5% or less suggest high levels of agreement in interpretation).

The length and age distributions in 2010–11 are broadly similar to those obtained in recent years (Figure 2). The length distribution is typically broad, peaking at about 51–53 cm. The age distribution also remains broad, with most fish between 3 and 13 years of age, with older fish being more prevalent in this year's landings. The length and age distributions were both described with reasonable precision, with MWCVs of 0.19 (Appendix 1) and 0.16 (Appendix 2) respectively. The estimate of precision for length and age are similar to earlier years.

There is evidence of a strong year class which recruited to the fishery in 2005–06 as 3 year olds, which can now be seen as a strong mode of 8 year olds (Figure 2). A similar trend can be seen in the 3 year old year class of 2003–04, which has progressed through to the 10 year old year class appearing in 2010–11.

Most kahawai in this region recruit into the fishery at about 3 years of age, which corresponds to a length mode of about 30 to 40 cm (Appendix 3). As with previous years, 2 to 4 year old fish were more predominant in January (Figure 3b). There was an increase in the proportion of older fish appearing in April compared to previous survey years.

Catch sampling in 2012

Interviewers were present for a greater number of days and hours per day during the first four months of 2012, because of a concurrent recreational harvest estimation survey for QMA 1 (MAF201102). The number of kahawai encountered was reduced, however, compared to the previous year, when less sampling effort occurred (Table 2).The number of kahawai landed were similar to the 2007–08 fishing year, with a similar number of measured kahawai recorded. The number of boats interviewed coming across the ramp, was the lowest since the survey began in 2001. This decline in apparent fishing effort may be partially due to the decline in the level of weekend sampling, which was offset by sampling on midweek days, when fewer boats go fishing.

The level of agreement between initial otolith readings was very high, with initial agreement for 80% of otoliths (Appendix 8). Almost all of the remaining initial reads were within one year of each other, although one reader appeared to be slightly biased towards underestimating an otolith's age. Comparisons of initial readings with final agreed ages resulted in IAPE scores of 1.33% and 0.25% (values of 5% or less suggest high levels of agreement in interpretation).

The length distribution for 2011–12 was bimodal with a peak of smaller fish between 33 and 35 cm and a broader distribution peaking at 51–53 cm (Figure 2). The age distribution is still typically broad, with most fish between 3 and 13 years of age, with a continuing tail of older fish. The length and age distributions were both described with reasonable precision, with MWCVs of 0.20 (Appendix 1) and 0.16 (Appendix 2) respectively. The estimate of precision for length and age are similar to earlier years.

The strong 6 year old year class from 2011–12 is evident as a 7 year old year class in 2011–12 (Figure 2). There is still a prevailing strength in the year class which recruited to the fishery in 2005–06 as 3 year olds, which can now be seen as a solid mode of 9 year olds. A similar trend can be seen in the 3 year old year class of 2003–04, which has progressed through to the 11 year old year class appearing in 2011–12.

Again, most kahawai in this region recruit into the fishery at about 3 years of age, which corresponds to a length mode of about 30 to 40 cm (Appendix 5). As with previous years, younger fish were more predominant in January whereas older fish are more prevalent in landings in March and April (Figure 3b).

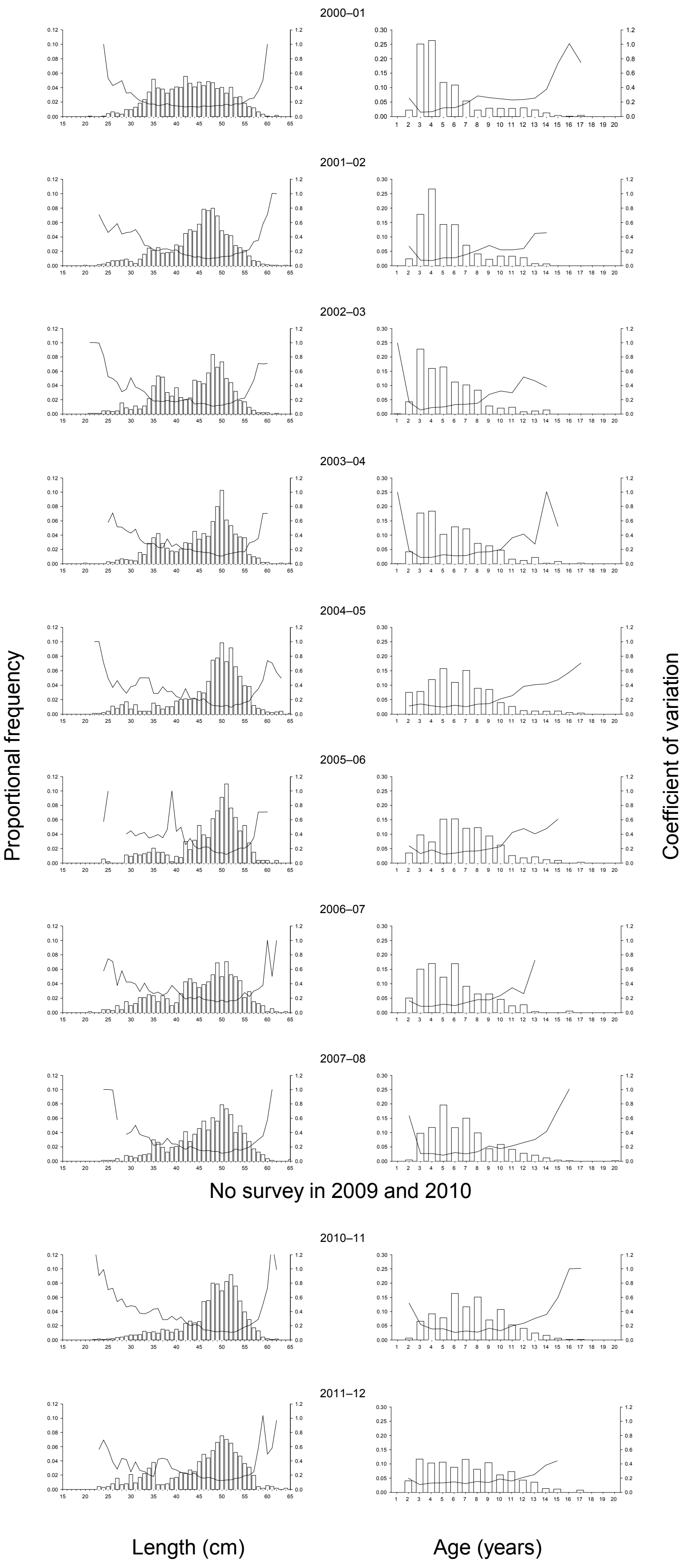


Figure 2: Length and age distributions (histograms) and CVs (solid lines) of recreational landings of kahawai in East Northland annually since 2000–01.

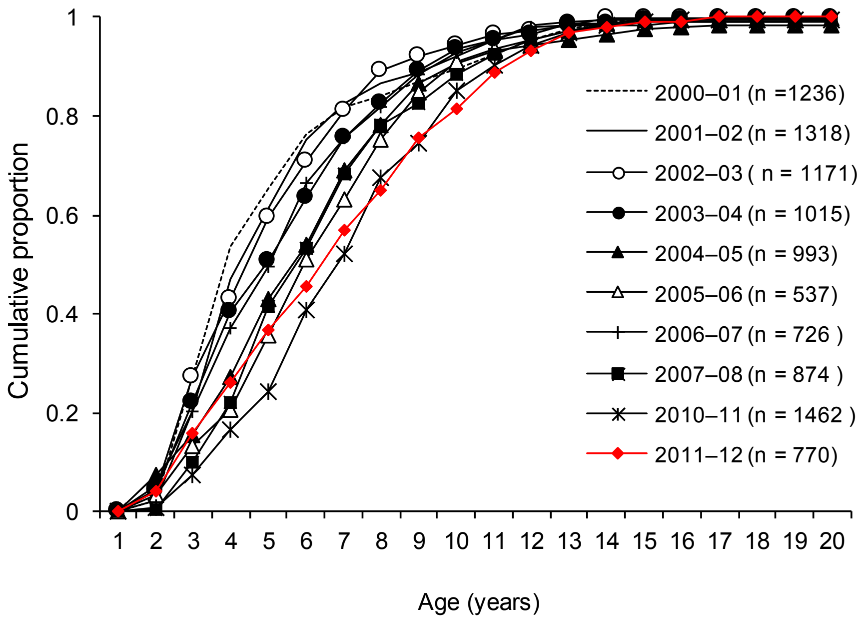


Figure 3a: Cumulative annual age distributions for East Northland since 2000–01. The number of fish measured is given for each year.

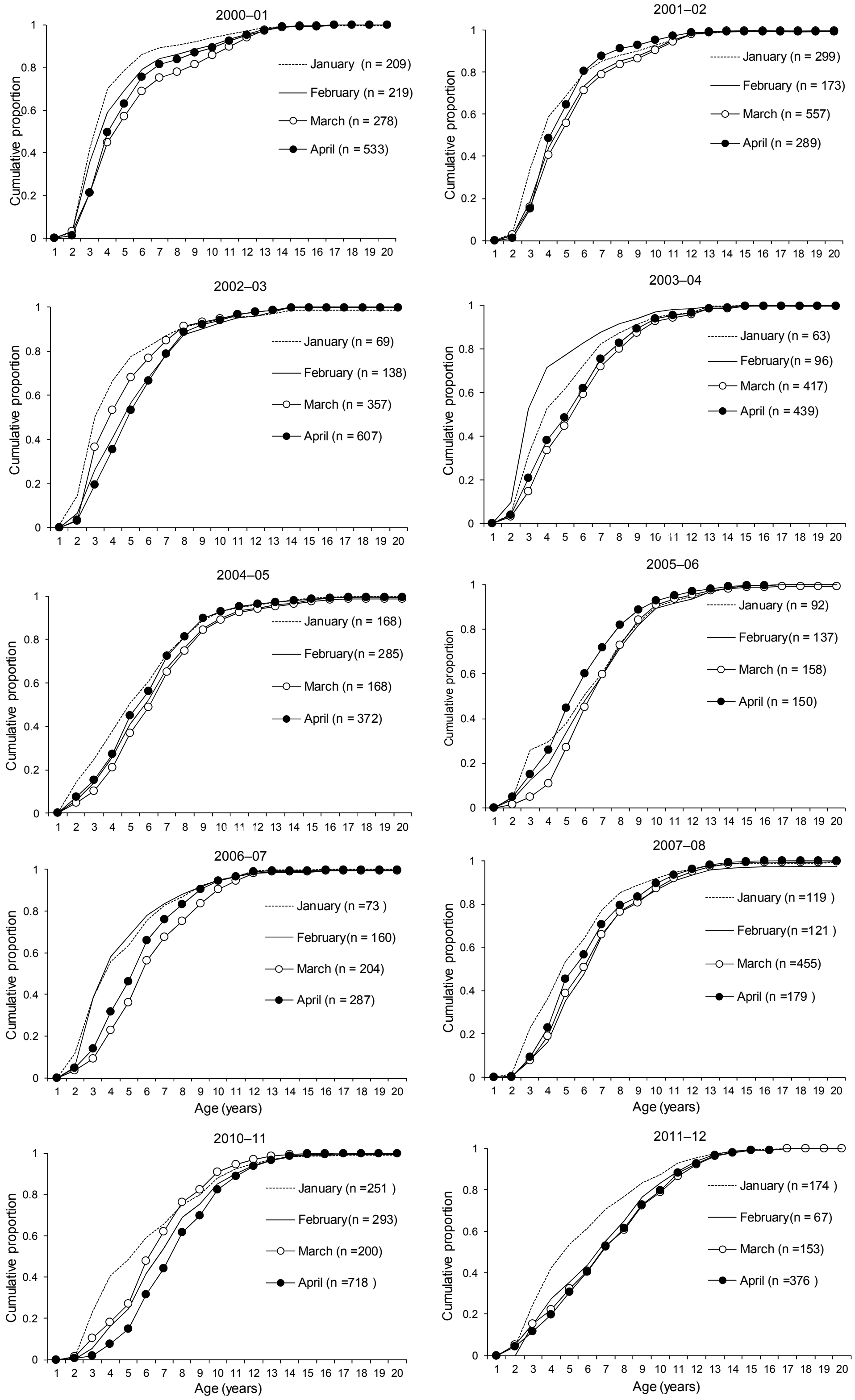


Figure 3b: Cumulative age distributions by month for East Northland since 2000–01. Graphs compare monthly age distributions within fishing years. The number of fish measured is given for each month.

3.2 Hauraki Gulf

Catch sampling in 2011

The number of kahawai landed per survey hour and per boat in the Hauraki Gulf in 2010–11 was far higher than in previous years (Table 2). This substantial increase in landings is mostly attributable to increased landings of larger fish, from 50 to 60 cm in length (Figure 4). The number of kahawai encountered and measured was the highest recorded since the beginning of the surveys in 2000–01 (Table 2), with 5586 measureable kahawai encountered and 3784 kahawai measured by boat ramp interviewers. Kahawai were measured in large numbers across all ramps surveyed in the Hauraki Gulf, compared to previous years. The levels of precision achieved in this area are well within that specified in Objective 1 of this programme (Appendix 1).

This is the first survey year in which kahawai from the Hauraki Gulf were not aged.

The length distribution in 2010–11 is dominated by a high proportion of larger fish (Figure 4). There is still a small peak of smaller fish appearing in the length distribution from 32 to 38 cm but the relative weakness of this mode is probably due to a recent substantial increase in the local abundance of larger fish, rather than poor recruitment. The precision (MWCV) of the length distribution was 0.12 (Appendices 1).

Catch sampling in 2012

In 2012 the number of kahawai landed per boat in the Hauraki Gulf was slightly lower than in 2011, but still far greater than surveys in years prior to 2010–11 (Table 2). This substantial increase in landings is again mostly attributable to the increased incidence of larger fish, from 45 to 60 cm in length (Figure 4).

The number of kahawai encountered and measured was the second highest recorded since the beginning of the surveys in 2000–01 (Table 2), with 4370 measureable kahawai and 2732 kahawai measured by boat ramp interviewers in the Hauraki Gulf. Kahawai were measured in large numbers across all ramps in the Hauraki Gulf Region, similar to that seen in 2011. The levels of precision achieved in this area are well within that specified in Objective 1 of this programme.

This is the second survey year in which kahawai from the Hauraki Gulf were not aged.

The length distribution in 2011–12 is similar to that seen in 2010–11. Again there is a much greater proportion of larger fish landed in 2011–12 (Figure 4), peaking at 49–53 cm. There is still a small peak of smaller fish appearing in the length distribution from 30 to 36 cm. The precision (MWCV) of the length distribution was 0.11 (Appendices 1).

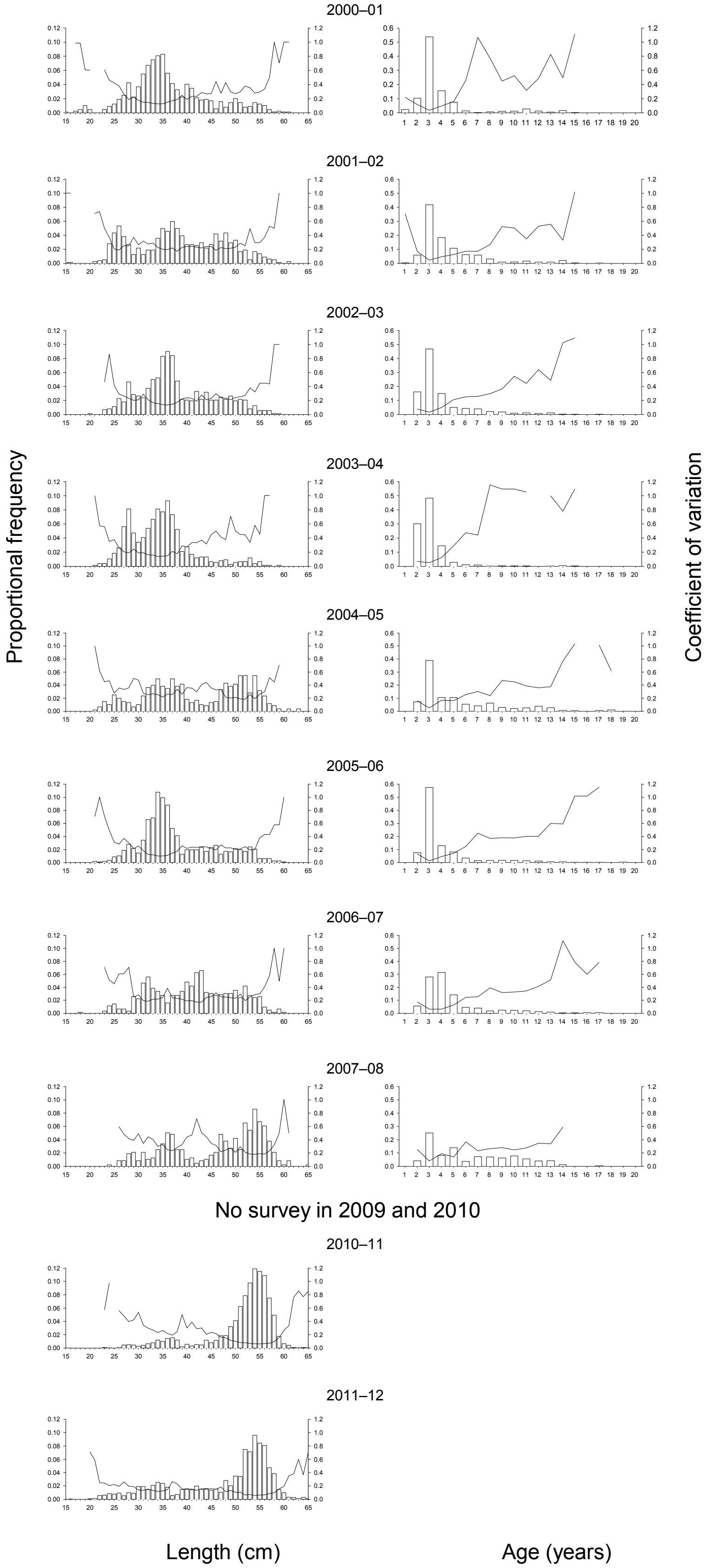


Figure 4: Length and age distributions (histograms) and CVs (solid lines) of recreational landings of kahawai in the Hauraki Gulf since 2000–01.

3.3 Bay of Plenty

Catch sampling in 2011

The number of kahawai measured by boat ramp interviewers in the Bay of Plenty was 1300, which is similar to that measured in 2001–02 and 2004–05. Kahawai were encountered in good numbers across all ramps throughout the region and the number of boats interviewed was greater than previous surveys (Table 2).

The level of agreement between initial otolith readings was very high, with initial agreement for 85% of otoliths (Appendix 7). Almost all of the remaining initial reads were within one year of each other and neither reader appeared to be generally biased towards over or under interpreting an otolith's age. Comparisons of initial readings with final agreed ages resulted in IAPE scores of 0.67% and 0.85% (values of 5% or less suggest high levels of agreement in interpretation).

The precision of the length and age distributions were similar to previous years (MWCVs of 0.18 and 0.16 respectively) (Appendices 1 and 2). As with previous years, a mode of 45–55 cm fish consistently dominates the Bay of Plenty length distribution (Figure 5). The age distribution is also characteristically broad, as in earlier years (Figure 6a).

There are several strong year classes that can be followed through into the 2010–11 age distribution. The 3 year old cohort in 2005–06 can be followed through to 2010–11, when it appears as an 8 year old cohort. Similarly the 3 year old year cohort for the next two years appear to be relatively strong and can also be tracked through as 6 and 7 year old cohorts respectively, in 2010–11.

The monthly variation in 2010–11 age compositions was greater than in any other year except 2007–08 (Figure 6b). Younger fish were more evident in January, whereas older fish were more prevalent in landings in March and April.

Catch sampling in 2012

The number of kahawai measured by Bay of Plenty boat ramp interviewers was the most since surveys began in 2001. The total number of kahawai measured was 1891, with 2590 measurable kahawai encountered at the ramps. Kahawai were evident in good numbers across all ramps throughout the region and the number of boats interviewed was greater than most of the previous survey years; at least partially because of increased sampling effort associated with the QMA 1 harvest estimation survey (Table 2).

The level of agreement between initial otolith readings was very high, with initial agreement for 85% of otoliths (Appendix 8). Almost all of the remaining initial reads were within one year of each other, although one reader appeared to be slightly biased towards underestimating the age of otoliths. Comparisons of initial readings with final agreed ages resulted in IAPE scores of 4.67% and 3.79% (values of 5% or less suggest high levels of agreement in interpretation).

The precision of the length and age distributions were similar to previous years (MWCVs of 0.13 and 0.15 respectively) (Appendices 1 and 2). Again, the length distribution is similar to previous years, with a mode of 40–55 cm fish consistently dominating the Bay of Plenty length distribution (Figure 5). The age distribution is also characteristically broad, as in earlier survey years (Figure 6a).

There are still several strong year classes that can be followed through into the 2011–12 age distribution. The 3 year old cohort in 2005–06 can be followed through to 2011–12, when it appears as a 9 year old cohort. Similarly the 3 year old year cohort for the following year appears to be relatively solid and can also be tracked through as an 8 year old cohort in 2011–12.

The variation in monthly 2011–12 age compositions was similar to most years, with the exception of 2007–08 and 2010–11 (Figure 6b). Younger fish were not as evident in January as in the previous year, with little change in age compositions in this region between January and April for 2012.

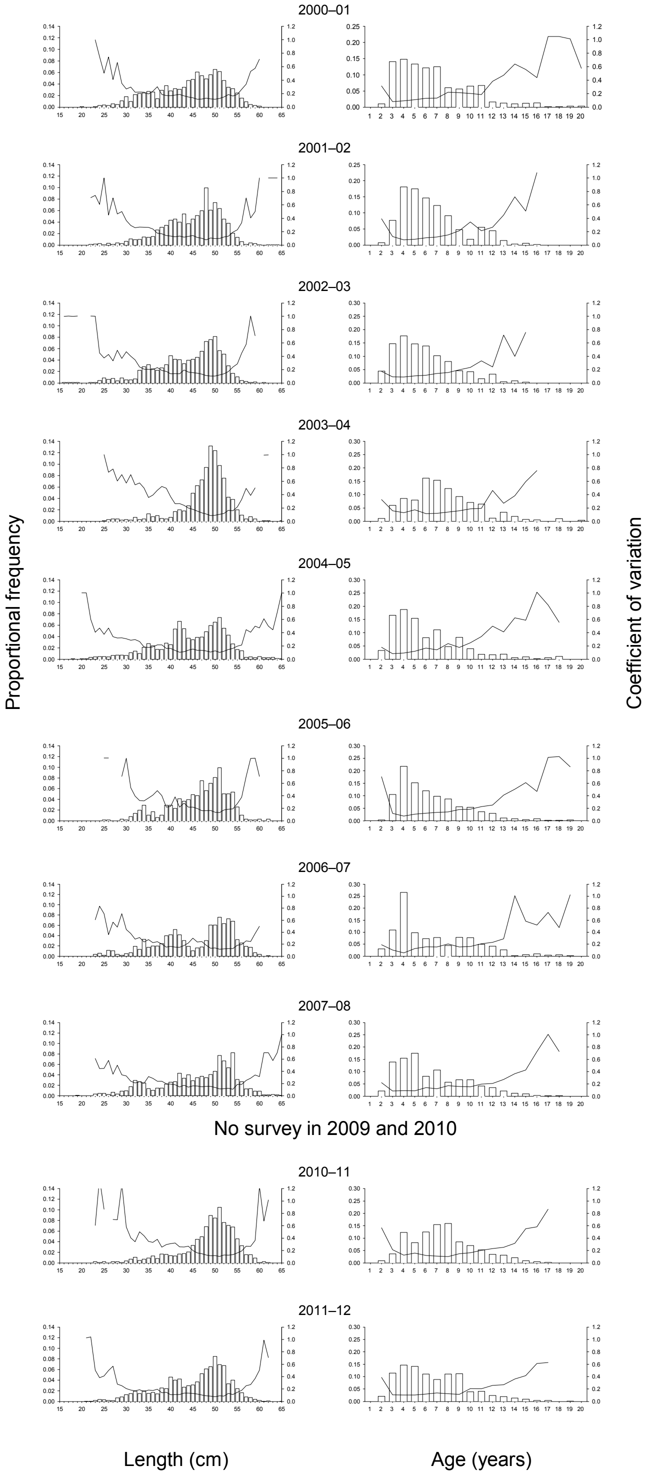


Figure 5: Length and age distributions (histograms) and CVs (solid lines) of recreational landings of kahawai in the Bay of Plenty since 2000–01.

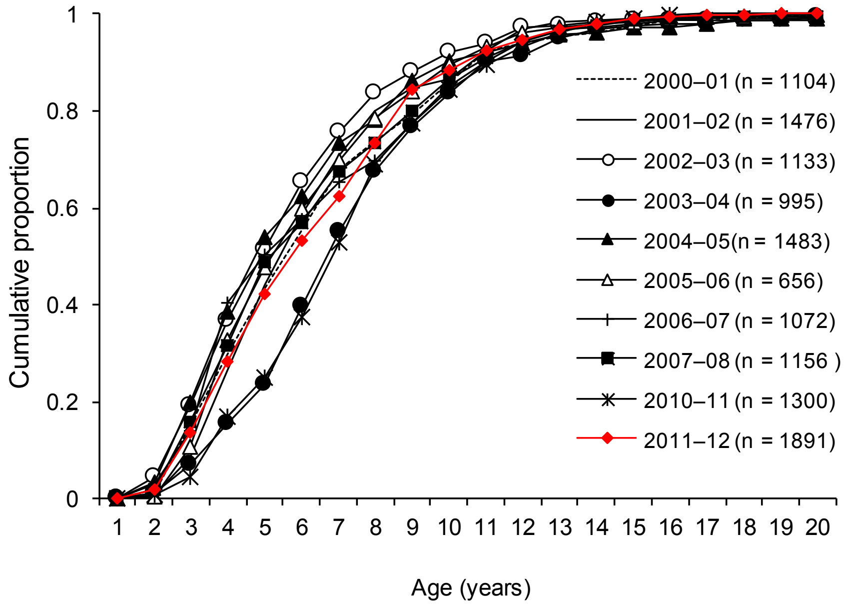


Figure 6a: Cumulative annual age distributions for the Bay of Plenty since 2000–01. The number of fish measured is given for each year.

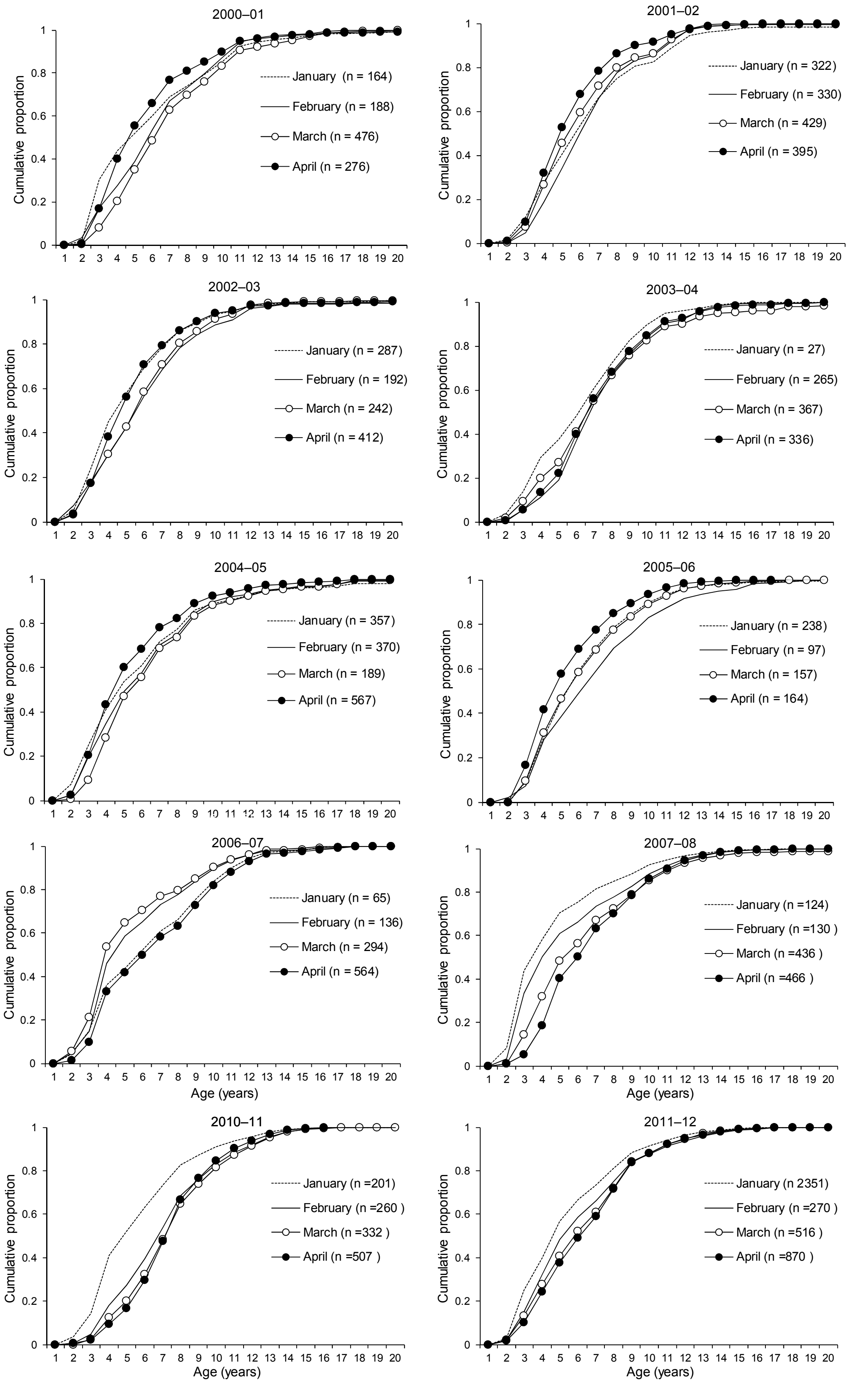


Figure 6b: Cumulative age distributions by month for the Bay of Plenty since 2000–01. Graphs compare monthly age distributions within fishing years. The number of fish measured is given for each month.

3.4 Monitoring fishing pressure

A time series of total mortality (Z) estimates can be used to monitor trends in fishing pressure over time, given the assumption of constant natural mortality (M). Dunn et al. (2002) used simulation modelling to compare the performance of alternative catch curve based estimators of Z, and found that the most accurate estimates were provided by the method proposed by Chapman & Robson (1960). The Chapman-Robson estimator assumes that the descending limb of an age distribution declines exponentially, but unlike other methods that are regression based, the estimate is based on the mean number of years above an assumed age at recruitment (ā).

$$Z = \log_e \left(\frac{1 + \bar{a} - 1/n}{\bar{a}} \right)$$

where n is the sample size.

The Chapman Robson estimator is sensitive to the assumed age at recruitment, which we assume to be at 4 years of age. A double normal selectivity ogive was fitted to recreational catch-at-age data as part of the 2006 stock assessment for KAH 1 (Hartill 2009), which peaked at a length equating to 4 years of age. Estimates associated with recruitment of a range of years (3 to 6 years) are given for comparison (Table 3). Although the estimates of total mortality given in Table 3 mostly increase with each successive assumed age at recruitment, this trend is at least partially explainable by decreasing cumulative commercial fishing pressure over time, and an age at recruitment of 4 years is still assumed to be most appropriate.

Estimates of Z were calculated for all East Northland and Bay of Plenty age distributions generated since 2001. Age distributions from the Hauraki Gulf were not estimated, because until recently, fully recruited fish comprised a small proportion of the fish landed (see Figure 4). Recruitment and emigration appear to have largely determined the age composition of landings in the Hauraki Gulf up until 2008–09, violating two key assumptions associated with catch-curve mortality estimators: constant recruitment and a closed population.

Table 3: Estimates of Z derived from recreational catch sampling in East Northland and the Bay of Plenty by survey year by assumed age at recruitment.

Age at											East Northland
recruitment	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	0.33	0.33	0.32	0.28	0.24	0.23	0.28	0.24	–	–	0.20	0.21
4	0.34	0.38	0.35	0.31	0.28	0.26	0.32	0.28	–	–	0.23	0.22
5	0.30	0.37	0.39	0.33	0.33	0.32	0.35	0.33	–	–	0.27	0.25
6	0.30	0.40	0.41	0.38	0.36	0.36	0.41	0.34	–	–	0.32	0.28

Age at											Bay of Plenty
recruitment	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	0.23	0.25	0.28	0.20	0.27	0.25	0.24	0.24	–	–	0.20	0.23
4	0.26	0.30	0.32	0.23	0.29	0.30	0.27	0.27	–	–	0.23	0.26
5	0.28	0.33	0.34	0.26	0.30	0.30	0.24	0.29	–	–	0.26	0.29
6	0.30	0.36	0.38	0.32	0.30	0.32	0.26	0.29	–	–	0.31	0.31

The level of natural mortality is assumed to be constant over time, with changes in total mortality levels being driven by changes in fishing pressure if all other assumptions also hold true. Total mortality rates are generally higher in East Northland than in the Bay of Plenty. There is some evidence of declining mortality rates in both regions over time, although the degree of change has been less in the Bay of Plenty. This could be partially attributable to reduced fishing pressure, as commercial landings from KAH 1 have almost halved over the last 10 to 15 years. Size-dependent movement between the areas could, however, influence respective age structures, and consequently this could result in misleading estimates of total mortality. These estimates should therefore be regarded with some caution, although the trends are probably indicative of actual changes in mortality rates.

Bootstrapped estimates of total mortality are compared with optimal reference point based estimates generated from the 2006 KAH 1 stock assessment (Hartill 2009) (Figure 7). The reference estimates given here are combinations of equilibrium reference levels of fishing mortality ($F_{0.1}$ taken from a Yield-per-Recruit curve, and F40% taken from a Spawner-per-Recruit curve) and a natural mortality estimate of 0.18 (Jones et al. 1992). These comparisons suggest that levels of fishing pressure over at least the last 10 years have not exceeded optimal levels of fishing pressure and consequently the status of the stock should have improved over that period.

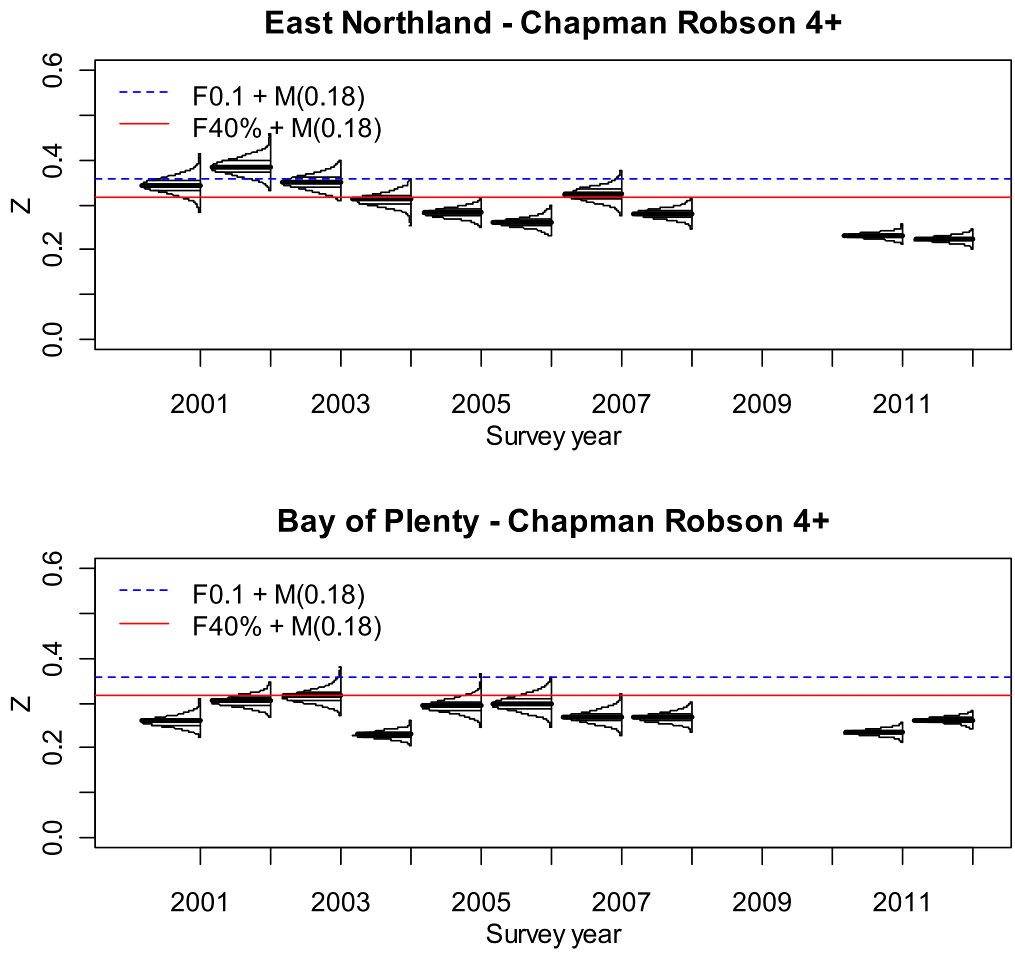


Figure 7: The distribution of bootstrap estimates of total mortality (Z) by survey year for East Northland (top two panels) and the Bay of Plenty (lower two panels). Theoretical optimal levels of Z derived from the YPR and SPR curves calculated in Hartill et al. (2008a) are denoted as horizontal lines, for reference purposes.

3.5 Comparing estimates generated by LFVAR 8 and CALA

Estimates of proportions at length and proportions at age generated by these two software programmes are almost identical. Variance estimates (MWCVs) generated by CALA are slightly higher than those calculated by LFVAR8 in most years, but their overall magnitude is still similar (Table 4). Any difference is probably due to the fact that CALA's estimates are generated by nonparametric bootstrapping procedures, whereas the estimates provided by LFVAR8 are calculated analytically.

A more detailed comparison of variance estimates provided by the two programmes is given in Table 5 and Figure 8. The relative magnitude of variance estimates generated for individual length and age classes by both programmes for data collected in 2011 is very similar. Effective sample sizes have also been calculated for data collected in 2011, to provide an alternative measure of precision.

Table 4: A comparison of variance estimates generated by two software programmes: LFVAR8 and CALA.

Year	Kahawai measured	MWCV (length) LFVAR8	MWCV (length) CALA	Kahawai aged	MWCV (age) LFVAR8	MWCV (age) CALA
East Northland						
2000–01	1236	0.17	0.21	517	0.13	0.15
2001–02	1318	0.17	0.21	526	0.13	0.14
2002–03	1171	0.18	0.22	504	0.13	0.16
2003–04	1015	0.2	0.23	517	0.14	0.17
2004–05	993	0.19	0.23	514	0.14	0.16
2005–06	537	0.23	0.28	321	0.19	0.21
2006–07	726	0.23	0.28	471	0.14	0.17
2007–08	874	0.19	0.23	539	0.14	0.16
2010–11	1462	0.15	0.19	497	0.14	0.16
Hauraki Gulf						
2000–01	892	0.22	0.26	500	0.14	0.15
2001–02	786	0.25	0.29	500	0.13	0.16
2002–03	880	0.22	0.25	527	0.12	0.15
2003–04	764	0.22	0.26	350	0.1	0.13
2004–05	606	0.28	0.33	289	0.18	0.23
2005–06	1170	0.18	0.21	526	0.1	0.13
2006–07	632	0.25	0.27	398	0.14	0.17
2007–08	477	0.28	0.33	227	0.2	0.26
2010–11	3784	0.09	0.12	–	–	–
Bay of Plenty						
2000–01	1104	0.18	0.23	457	0.13	0.19
2001–02	1476	0.15	0.18	495	0.13	0.16
2002–03	1133	0.17	0.22	477	0.13	0.17
2003–04	995	0.17	0.21	412	0.14	0.19
2004–05	1483	0.17	0.20	393	0.14	0.18
2005–06	656	0.23	0.27	497	0.14	0.18
2006–07	1072	0.19	0.24	472	0.15	0.19
2007–08	1 156	0.18	0.22	552	0.14	0.16
2010–11	1300	0.15	0.18	499	0.14	0.16

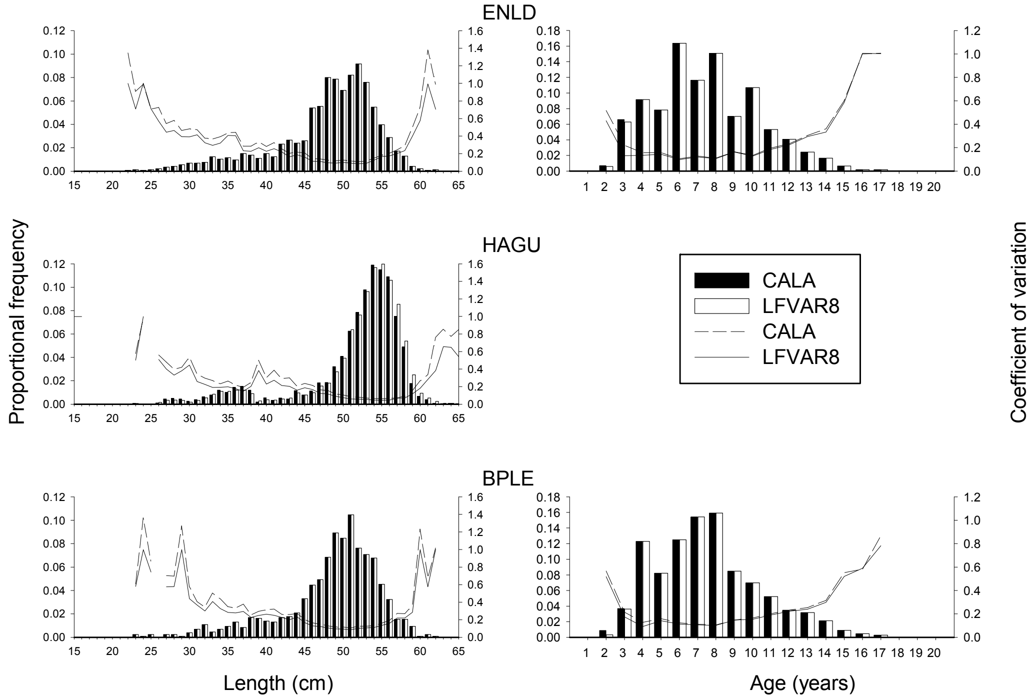


Figure 8: Length and age distributions (histograms) and CVs (solid lines) of recreational landings of kahawai by region for 2010–11, generated by LFVAR8 and CALA.

Table 5: Comparisons of mean weighted coefficients of variation generated by LFVAR8 and CALA, for length and age data collected in 2010–11. Estimates of effective sample size are also provided for each length and age distribution for comparative purposes.

Region	MWCV LFVAR8 (length)	MWCV CALA (length)	Effective Sample Size (length)	MWCV LFVAR8 (age)	MWCV CALA (age)	Effective Sample Size (age)
East Northland	0.15	0.19	1615	0.14	0.16	937
Hauraki Gulf	0.09	0.12	4024	–	–	
Bay of Plenty	0.15	0.18	1644	0.14	0.16	954

3.6 Exploring the extent to which the level of stratification influences variance precision

Variance estimates for catch-at-length and catch-at-age distributions derived from sampled recreational landings of kahawai are routinely low relative to those obtained from sampling of commercial landings. It has been suggested that these low variances could be partially an artefact of the methods used to generate variance estimates. Two suggested hypotheses have been: that the use of a plus group combines data from several year classes which homogenises their variance, and that catch data has been stratified at too fine a level with the resulting pseudo replication implying a misleadingly high sample size.

The suggestion that the use of a plus group could lead to lower variances does not apply here, as landed kahawai rarely if ever approach 20 years of age, and there is therefore no need to assign older fish to a plus group.

The potential for pseudo replication was examined by combining landings at the level of the interview session (during which landings from multiple boats could be sampled) and comparing the results with those obtained when landings are stratified by boat. This comparison suggests that, for data collected in 2011, the standard practice of stratifying by boat does not lead to significantly lower variance estimates (Figure 9, Table 6). We conclude that the low levels of variance achieved by programmes such as this are probably a function of the large number of landings that are sampled in any given year and region, and the degree of consistency in age/size compositions between landings, rather than an inappropriate level of stratification.

Kahawai from between 300 to 500 boats are usually sampled in any given region in any given year (see Table 2) which results in MWCVs of around 20 to 25% for length and 15 to 20% for age distributions. These levels of precision are in fact very similar to those obtained by some commercial catch sampling programmes, such as those for snapper (see Walsh et al. 2011).

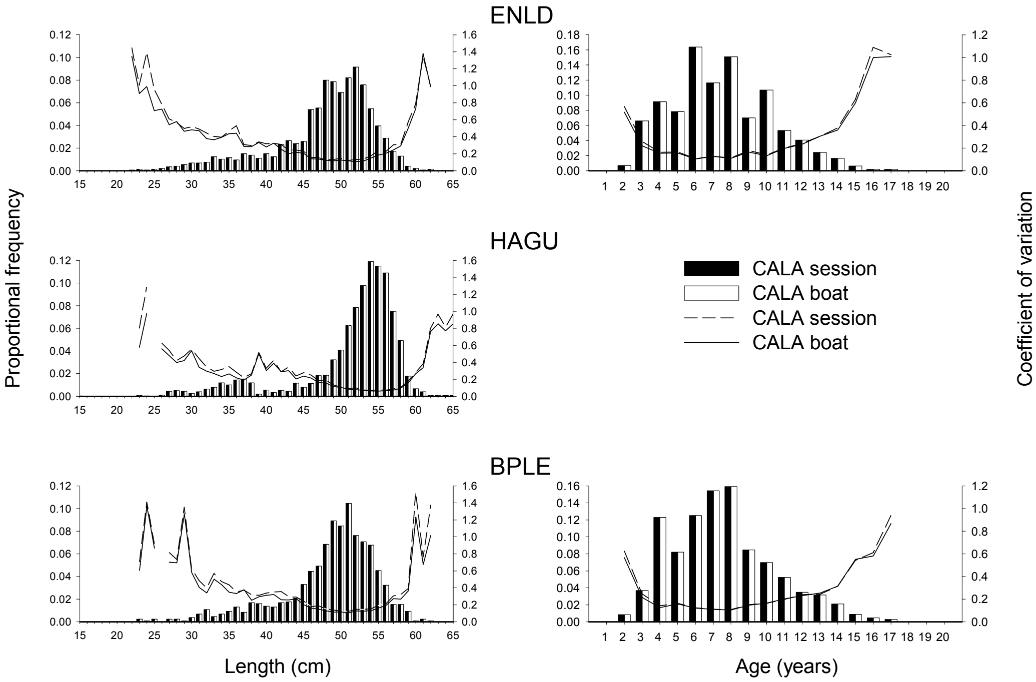


Figure 9: Comparisons between session and boat, for length and age MWCVs in 2010–11.

Table 6: Comparisons between session and boat, for length and age MWCVs in 2010–11.

Region	MWCV (length) Session	MWCV (length) Boat	MWCV (age) Session	MWCV (age) Boat
East Northland	0.21	0.19	0.17	0.16
Hauraki Gulf	0.13	0.12	–	–
Bay of Plenty	0.21	0.18	0.16	0.16

4 CONCLUSIONS

- Regional length and age compositions derived from recreational landings sampled in 2010–11 and 2011–12 are broadly consistent with patterns and trends seen in previous years for KAH 1 in East Northland and Bay of Plenty, but there has been a marked change in the size and age distribution of kahawai landed in the Hauraki Gulf in recent years.

- The East Northland age distribution is still broadly dominated by 3 to 13 year old fish. Progression of three strong year classes is evident in the age distributions over time. Most kahawai recruit into the area at about 3 years of age.

- There was a much greater proportion of larger fish present in landings from the Hauraki Gulf in 2010–11 and in 2011–12 than in previous years. The strength of the 45 to 60 cm cohort has significantly increased. The relatively high number of kahawai encountered and measured by boat ramp interviewers in 2010–11 and 2011–12 was the greatest number encountered by interviewers compared to previous survey years.

- The Bay of Plenty age distribution remains typically broad, as in previous years. There is a higher proportion of younger fish in January for 2011, which is similar to 2007–08, however monthly distributions for 2012 have typically showed little change in age composition compared to previous survey years.

- The levels of precision associated with these distributions are well within the target level.

- A time series of total mortality estimates for East Northland and the Bay of Plenty since 2001 suggests that mortality rates in these regions have been gradually declining, possibly because of reduced fishing pressure by the commercial sector. Estimates of total mortality have been well below F40%SBR in East Northland since 2008 onwards and from 2004 onwards for the Bay of Plenty.

- Estimates of proportions at length and at age generated by a previously used software package, LFVAR8, and a recently developed package, CALA, are very similar. The bootstrap variance estimates generated by CALA are only slightly higher than the analytical estimates produced by LFVAR8. Future analyses will be undertaken using CALA.

- A comparison of variance estimates generated when data collected in 2011 are stratified by interview session rather than by boat suggests that stratifying by boat does not lead to significantly lower variance estimates. We will continue to stratify data by boat for all future analyses. The low levels of variance achieved by programmes such as this are probably a function of the large number of landings that are sampled in any given year and region.

- The Marine Amateur Fisheries Working Group has recommended that similar surveys in the future should collect otoliths from Hauraki Gulf landings during the survey, so that they are available for ageing purposes if subsequently required.

5 ACKNOWLEDGMENTS

We thank the numerous boat ramp interviewers, who collected the data for this survey. We are also grateful to Cameron Walsh for his help as a third expert otolith reader and to Richard Bian for his assistance with CALA. The methods used in this project have also benefitted from numerous suggestions made by working group members over many years. Funding for this project, MAF201003, was provided by the Ministry of Primary Industries. We thank Darren Parsons for reviewing this report.

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Appendix 1: Estimated proportions at length and c.v.s fof kahawai sampled from recreational fishers in East Northland, Hauraki Gulf and the Bay of Plenty in 2010–11 and 2011–12

P.i. = proportion of fish in length class. *n* = total number of fish sampled.
c.v. = coefficient of variation. *m.w.c.v.* = mean weighted c.v.

Estimates of the proportion at length of kahawai from East Northland in 2010–11 and 2011–12

Length	CALA 2010–11		2011–12		LFVAR8 2010–11	
(cm)	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.
10	0.0000	0.00	0.0000	0.00	0.0000	0.0000
11	0.0000	0.00	0.0000	0.00	0.0000	0.0000
12	0.0000	0.00	0.0000	0.00	0.0000	0.0000
13	0.0000	0.00	0.0000	0.00	0.0000	0.0000
14	0.0000	0.00	0.0000	0.00	0.0000	0.0000
15	0.0000	0.00	0.0000	0.00	0.0000	0.0000
16	0.0000	0.00	0.0000	0.00	0.0000	0.0000
17	0.0000	0.00	0.0000	0.00	0.0000	0.0000
18	0.0000	0.00	0.0000	0.00	0.0000	0.0000
19	0.0000	0.00	0.0000	0.00	0.0000	0.0000
20	0.0000	0.00	0.0000	0.00	0.0000	0.0000
21	0.0000	0.00	0.0000	0.00	0.0000	0.0000
22	0.0007	1.35	0.0000	0.00	0.0007	0.9993
23	0.0014	0.91	0.0039	0.57	0.0014	0.7069
24	0.0007	0.99	0.0026	0.71	0.0007	1.0020
25	0.0014	0.71	0.0039	0.57	0.0014	0.7093
26	0.0021	0.73	0.0078	0.41	0.0021	0.5691
27	0.0034	0.54	0.0156	0.29	0.0034	0.4440
28	0.0041	0.58	0.0065	0.42	0.0041	0.4635
29	0.0055	0.46	0.0078	0.42	0.0055	0.3928
30	0.0068	0.48	0.0208	0.25	0.0068	0.3905
31	0.0068	0.47	0.0091	0.37	0.0068	0.4142
32	0.0075	0.38	0.0169	0.28	0.0075	0.3227
33	0.0123	0.37	0.0220	0.23	0.0123	0.2938
34	0.0103	0.39	0.0298	0.21	0.0103	0.3203
35	0.0116	0.44	0.0376	0.19	0.0116	0.4076
36	0.0096	0.44	0.0065	0.46	0.0096	0.4038
37	0.0150	0.29	0.0065	0.45	0.0150	0.2320
38	0.0137	0.28	0.0078	0.41	0.0137	0.2275
39	0.0109	0.33	0.0156	0.29	0.0109	0.2679
40	0.0150	0.28	0.0169	0.27	0.0150	0.2275
41	0.0123	0.32	0.0233	0.24	0.0123	0.2548
42	0.0233	0.25	0.0220	0.24	0.0233	0.2199
43	0.0267	0.20	0.0272	0.22	0.0267	0.1619
44	0.0239	0.22	0.0246	0.23	0.0239	0.1862
45	0.0260	0.20	0.0389	0.18	0.0260	0.1599
46	0.0540	0.14	0.0493	0.16	0.0540	0.1146
47	0.0554	0.14	0.0441	0.17	0.0554	0.1106
48	0.0800	0.12	0.0545	0.15	0.0800	0.0949
49	0.0787	0.11	0.0661	0.14	0.0787	0.0925
50	0.0691	0.12	0.0752	0.13	0.0691	0.0992
51	0.0821	0.12	0.0700	0.13	0.0821	0.0922
52	0.0917	0.11	0.0649	0.13	0.0917	0.0859
53	0.0759	0.11	0.0519	0.15	0.0759	0.0908
54	0.0547	0.15	0.0467	0.16	0.0547	0.1238
55	0.0397	0.18	0.0363	0.18	0.0397	0.1653
56	0.0287	0.21	0.0311	0.20	0.0287	0.1744
57	0.0171	0.24	0.0195	0.25	0.0171	0.2010
58	0.0130	0.29	0.0039	0.58	0.0130	0.2336
59	0.0041	0.50	0.0013	0.99	0.0041	0.4006
60	0.0021	0.73	0.0052	0.51	0.0021	0.5782
61	0.0007	1.38	0.0039	0.59	0.0007	0.9945
62	0.0014	0.99	0.0013	1.01	0.0014	0.7045
63	0.0000	0.00	0.0000	0.00	0.0000	0.0000
64	0.0000	0.00	0.0013	0.99	0.0000	0.0000
65	0.0000	0.00	0.0000	0.00	0.0000	0.0000
66	0.0000	0.00	0.0000	0.00	0.0000	0.0000
67	0.0000	0.00	0.0000	0.00	0.0000	0.0000
68	0.0000	0.00	0.0000	0.00	0.0000	0.0000
69	0.0000	0.00	0.0000	0.00	0.0000	0.0000
70	0.0000	0.00	0.0000	0.00	0.0000	0.0000
n	1 462		770			
m.w.c.v.		0.19		0.20		0.15

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Hauraki Gulf in 2010–11 and 2011–12

Length	CALA	2010–11		2011–12	LFVAR8	2010–11
(cm)	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.
10	0.0000	0.00	0.0000	0.00	0.0000	0.00
11	0.0000	0.00	0.0000	0.00	0.0000	0.00
12	0.0000	0.00	0.0000	0.00	0.0000	0.00
13	0.0000	0.00	0.0004	1.01	0.0000	0.00
14	0.0003	1.23	0.0004	0.98	0.0002	1.00
15	0.0003	1.38	0.0000	0.00	0.0002	1.00
16	0.0000	0.00	0.0004	0.95	0.0003	1.00
17	0.0000	0.00	0.0000	0.00	0.0000	0.00
18	0.0000	0.00	0.0000	0.00	0.0000	0.00
19	0.0000	0.00	0.0000	0.00	0.0000	0.00
20	0.0000	0.00	0.0007	0.71	0.0000	0.00
21	0.0000	0.00	0.0011	0.59	0.0000	0.00
22	0.0000	0.00	0.0055	0.25	0.0000	0.00
23	0.0008	0.58	0.0062	0.24	0.0007	0.50
24	0.0003	0.98	0.0084	0.20	0.0004	1.00
25	0.0000	0.00	0.0077	0.22	0.0000	0.00
26	0.0011	0.56	0.0091	0.19	0.0016	0.51
27	0.0045	0.48	0.0051	0.26	0.0033	0.40
28	0.0050	0.40	0.0099	0.19	0.0035	0.33
29	0.0045	0.42	0.0088	0.19	0.0032	0.38
30	0.0026	0.54	0.0190	0.14	0.0018	0.45
31	0.0040	0.34	0.0190	0.14	0.0032	0.26
32	0.0063	0.30	0.0143	0.15	0.0054	0.22
33	0.0079	0.27	0.0208	0.13	0.0085	0.19
34	0.0119	0.23	0.0252	0.12	0.0110	0.19
35	0.0100	0.26	0.0238	0.12	0.0111	0.20
36	0.0145	0.22	0.0179	0.14	0.0120	0.18
37	0.0153	0.19	0.0055	0.26	0.0119	0.15
38	0.0119	0.25	0.0073	0.23	0.0091	0.21
39	0.0018	0.50	0.0146	0.16	0.0028	0.38
40	0.0055	0.30	0.0157	0.15	0.0039	0.23
41	0.0032	0.39	0.0143	0.15	0.0034	0.27
42	0.0053	0.29	0.0197	0.13	0.0044	0.21
43	0.0045	0.30	0.0150	0.16	0.0054	0.20
44	0.0116	0.20	0.0161	0.15	0.0097	0.16
45	0.0079	0.24	0.0135	0.16	0.0080	0.19
46	0.0114	0.22	0.0154	0.15	0.0098	0.17
47	0.0182	0.16	0.0106	0.18	0.0156	0.12
48	0.0185	0.15	0.0282	0.11	0.0180	0.12
49	0.0322	0.12	0.0201	0.13	0.0278	0.09
50	0.0410	0.10	0.0347	0.10	0.0394	0.07
51	0.0624	0.08	0.0340	0.10	0.0636	0.06
52	0.0785	0.08	0.0750	0.06	0.0763	0.06
53	0.0978	0.07	0.0713	0.07	0.0963	0.05
54	0.1189	0.06	0.0962	0.06	0.1168	0.05
55	0.1150	0.06	0.0845	0.06	0.1198	0.04
56	0.1089	0.07	0.0808	0.07	0.1058	0.05
57	0.0751	0.07	0.0472	0.09	0.0854	0.07
58	0.0492	0.10	0.0384	0.10	0.0539	0.07
59	0.0177	0.16	0.0146	0.16	0.0252	0.12
60	0.0066	0.27	0.0095	0.19	0.0095	0.18
61	0.0040	0.34	0.0029	0.35	0.0054	0.28
62	0.0008	0.76	0.0026	0.38	0.0025	0.38
63	0.0005	0.85	0.0011	0.60	0.0009	0.66
64	0.0008	0.77	0.0026	0.37	0.0008	0.65
65	0.0005	0.85	0.0007	0.70	0.0009	0.54
66	0.0003	1.31	0.0007	0.70	0.0004	1.00
67	0.0003	1.30	0.0007	0.69	0.0002	1.00
68	0.0000	0.00	0.0007	0.71	0.0000	0.00
69	0.0000	0.00	0.0007	0.68	0.0000	0.00
70	0.0003	1.42	0.0004	0.98	0.0002	1.00
n	3 784		2 732			
m.w.c.v.		0.12		0.11		0.09

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Bay of Plenty in 2010–11 and 2011–12

Length	CALA 2010–11		2011–12		LFVAR8 2010–11	
(cm)	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.
10	0.0000	0.00	0.0000	0.00	0.0000	0.00
11	0.0000	0.00	0.0000	0.00	0.0000	0.00
12	0.0000	0.00	0.0000	0.00	0.0000	0.00
13	0.0000	0.00	0.0000	0.00	0.0000	0.00
14	0.0000	0.00	0.0000	0.00	0.0000	0.00
15	0.0000	0.00	0.0000	0.00	0.0000	0.00
16	0.0000	0.00	0.0000	0.00	0.0000	0.00
17	0.0000	0.00	0.0000	0.00	0.0000	0.00
18	0.0000	0.00	0.0000	0.00	0.0000	0.00
19	0.0000	0.00	0.0000	0.00	0.0000	0.00
20	0.0000	0.00	0.0000	0.00	0.0000	0.00
21	0.0000	0.00	0.0005	1.02	0.0000	0.00
22	0.0000	0.00	0.0005	1.01	0.0000	0.00
23	0.0023	0.61	0.0021	0.50	0.0023	0.58
24	0.0008	1.36	0.0037	0.38	0.0008	1.00
25	0.0023	0.87	0.0032	0.41	0.0023	0.74
26	0.0000	0.00	0.0021	0.50	0.0000	0.00
27	0.0023	0.70	0.0016	0.57	0.0023	0.58
28	0.0023	0.70	0.0069	0.28	0.0023	0.58
29	0.0008	1.27	0.0085	0.25	0.0008	1.00
30	0.0038	0.58	0.0127	0.20	0.0038	0.44
31	0.0069	0.40	0.0148	0.19	0.0069	0.37
32	0.0108	0.34	0.0196	0.17	0.0108	0.30
33	0.0046	0.50	0.0148	0.18	0.0046	0.41
34	0.0069	0.44	0.0201	0.16	0.0069	0.33
35	0.0092	0.35	0.0153	0.18	0.0092	0.28
36	0.0131	0.33	0.0169	0.17	0.0131	0.28
37	0.0085	0.38	0.0143	0.19	0.0085	0.29
38	0.0169	0.25	0.0254	0.14	0.0169	0.23
39	0.0162	0.30	0.0243	0.15	0.0162	0.25
40	0.0138	0.31	0.0460	0.11	0.0138	0.26
41	0.0131	0.32	0.0402	0.11	0.0131	0.25
42	0.0169	0.26	0.0423	0.11	0.0169	0.23
43	0.0177	0.26	0.0270	0.14	0.0177	0.20
44	0.0208	0.27	0.0296	0.13	0.0208	0.23
45	0.0331	0.20	0.0312	0.13	0.0331	0.17
46	0.0446	0.16	0.0370	0.12	0.0446	0.13
47	0.0492	0.15	0.0524	0.10	0.0492	0.12
48	0.0685	0.13	0.0613	0.09	0.0685	0.11
49	0.0892	0.11	0.0656	0.08	0.0892	0.09
50	0.0846	0.12	0.0846	0.07	0.0846	0.09
51	0.1046	0.11	0.0693	0.08	0.1046	0.09
52	0.0762	0.13	0.0677	0.09	0.0762	0.10
53	0.0708	0.13	0.0333	0.12	0.0708	0.11
54	0.0677	0.13	0.0402	0.11	0.0677	0.11
55	0.0454	0.16	0.0243	0.14	0.0454	0.14
56	0.0323	0.19	0.0164	0.18	0.0323	0.16
57	0.0154	0.27	0.0085	0.25	0.0154	0.22
58	0.0154	0.27	0.0074	0.27	0.0154	0.22
59	0.0092	0.36	0.0042	0.34	0.0092	0.29
60	0.0008	1.23	0.0021	0.49	0.0008	1.00
61	0.0023	0.67	0.0005	0.98	0.0023	0.58
62	0.0008	1.02	0.0011	0.71	0.0008	1.00
63	0.0000	0.00	0.0000	0.00	0.0000	0.00
64	0.0000	0.00	0.0000	0.00	0.0000	0.00
65	0.0000	0.00	0.0005	1.00	0.0000	0.00
66	0.0000	0.00	0.0000	0.00	0.0000	0.00
67	0.0000	0.00	0.0000	0.00	0.0000	0.00
68	0.0000	0.00	0.0000	0.00	0.0000	0.00
69	0.0000	0.00	0.0000	0.00	0.0000	0.00
70	0.0000	0.00	0.0000	0.00	0.0000	0.00
n	1 300		1 891			
m.w.c.v.		0.18		0.13		0.15

Appendix 2: Estimated proportions at age and c.v.s of kahawai sampled from recreational fishers in East Northland, Hauraki Gulf and the Bay of Plenty in 2010–11.

P.i. = proportion of fish in length class.
c.v. = coefficient of variation.
n = total number of fish sampled.
m.w.c.v. = mean weighted c.v.

Estimates of the proportion at age of kahawai from East Northland in 2010–11.

Age	CALA 2010–11		2011–12		LFVAR8 2010–11	
(years)	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.
1	0.0000	0.00	0.0000	0.00	0.0000	0.00
2	0.0068	0.52	0.0403	0.20	0.0058	0.43
3	0.0659	0.22	0.1169	0.11	0.0628	0.13
4	0.0916	0.16	0.1030	0.13	0.0916	0.13
5	0.0782	0.16	0.1059	0.13	0.0782	0.14
6	0.1637	0.10	0.0885	0.14	0.1637	0.10
7	0.1164	0.13	0.1158	0.12	0.1164	0.12
8	0.1509	0.11	0.0808	0.16	0.1509	0.10
9	0.0702	0.16	0.1038	0.14	0.0702	0.16
10	0.1069	0.13	0.0611	0.19	0.1069	0.13
11	0.0532	0.20	0.0730	0.16	0.0532	0.19
12	0.0407	0.23	0.0432	0.22	0.0407	0.22
13	0.0242	0.30	0.0355	0.25	0.0242	0.29
14	0.0164	0.36	0.0130	0.40	0.0164	0.33
15	0.0063	0.60	0.0116	0.47	0.0063	0.59
16	0.0018	1.00	0.0000	0.00	0.0018	1.01
17	0.0019	1.01	0.0076	0.52	0.0019	1.00
18	0.0000	0.00	0.0000	0.00	0.0000	0.00
19	0.0000	0.00	0.0000	0.00	0.0000	0.00
>19	0.0000	0.00	0.0000	0.00	0.0000	0.00
n	497		485			
m.w.c.v.		0.16		0.16		0.14

Estimates of the proportion at age of kahawai from the Bay of Plenty in 2010–11.

Age	CALA 2010–11		2011–12		LFVAR8 2010–11	
(years)	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.
1	0.0000	0.00	0.0000	0.00	0.0000	0.00
2	0.0086	0.57	0.0209	0.38	0.0031	0.52
3	0.0368	0.22	0.1141	0.10	0.0362	0.17
4	0.1229	0.13	0.1466	0.10	0.1229	0.09
5	0.0820	0.16	0.1414	0.11	0.0820	0.14
6	0.1251	0.12	0.1105	0.12	0.1251	0.11
7	0.1544	0.11	0.0888	0.14	0.1544	0.11
8	0.1592	0.10	0.1104	0.13	0.1592	0.10
9	0.0848	0.15	0.1123	0.11	0.0848	0.15
10	0.0698	0.16	0.0386	0.21	0.0698	0.15
11	0.0523	0.20	0.0403	0.20	0.0523	0.19
12	0.0349	0.23	0.0240	0.25	0.0349	0.22
13	0.0317	0.25	0.0198	0.27	0.0317	0.24
14	0.0211	0.32	0.0133	0.35	0.0211	0.30
15	0.0088	0.55	0.0095	0.41	0.0088	0.52
16	0.0047	0.58	0.0039	0.59	0.0047	0.59
17	0.0028	0.87	0.0043	0.61	0.0028	0.78
18	0.0000	0.00	0.0000	0.00	0.0000	0.00
19	0.0000	0.00	0.0014	0.97	0.0000	0.00
>19	0.0000	0.00	0.0000	0.00	0.0000	0.00
n	499		492			
m.w.c.v.		0.16		0.15		0.14

Appendix 3: Age–length keys derived from otolith samples collected from recreational fishers from East Northland in 2010–11.

Estimates of proportion of length at age for kahawai sampled from the East Northland recreational fishery, January to April 2011. (Note: Aged to 01/01/11)

Length	Age (years)																				No.
(cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	aged
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
24	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
25	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
26	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
27	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
29	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
30	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
31	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
32	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
33	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
34	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
35	0.00	0.00	0.13	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8
36	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
37	0.00	0.00	0.38	0.50	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8
38	0.00	0.00	0.00	0.43	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7
39	0.00	0.00	0.00	0.50	0.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
40	0.00	0.00	0.00	0.75	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
41	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
42	0.00	0.00	0.00	0.56	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9
43	0.00	0.00	0.00	0.37	0.42	0.16	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19
44	0.00	0.00	0.00	0.27	0.18	0.27	0.18	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11
45	0.00	0.00	0.00	0.08	0.38	0.23	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13
46	0.00	0.00	0.00	0.06	0.19	0.45	0.16	0.06	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31
47	0.00	0.00	0.00	0.00	0.03	0.36	0.27	0.18	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33
48	0.00	0.00	0.00	0.07	0.07	0.37	0.23	0.19	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43
49	0.00	0.00	0.00	0.00	0.04	0.26	0.26	0.15	0.07	0.15	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46
50	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.35	0.04	0.09	0.04	0.09	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23
51	0.00	0.00	0.00	0.00	0.00	0.16	0.25	0.30	0.09	0.07	0.00	0.05	0.05	0.02	0.00	0.00	0.02	0.00	0.00	0.00	44
52	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.19	0.14	0.27	0.05	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37
53	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.27	0.18	0.16	0.20	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45
54	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.20	0.10	0.27	0.17	0.13	0.00	0.07	0.00	0.03	0.00	0.00	0.00	0.00	30
55	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.11	0.22	0.17	0.06	0.11	0.06	0.11	0.06	0.00	0.00	0.00	0.00	0.00	18
56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.31	0.23	0.15	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	13
57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.33	0.17	0.08	0.08	0.25	0.00	0.00	0.00	0.00	0.00	0.00	12
58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.14	0.00	0.14	0.00	0.29	0.00	0.14	0.00	0.00	0.00	0.00	0.00	7
59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Total																					497

Appendix 4: Age–length keys derived from otolith samples collected from recreational fishers from Bay of Plenty in 2010–11.

Estimates of proportion of length at age for kahawai sampled from the Bay of Plenty recreational fishery, January to April 2011 (Note: Aged to 01/01/11)

Length																			Age (years)		No.
(cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	aged
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
23	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
26	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
27	0.00	0.33	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
30	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
31	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8
32	0.00	0.00	0.83	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
33	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
34	0.00	0.00	0.67	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
35	0.00	0.00	0.33	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
36	0.00	0.00	0.20	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5
37	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
38	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9
39	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5
40	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10
41	0.00	0.00	0.00	0.75	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
42	0.00	0.00	0.00	0.75	0.08	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12
43	0.00	0.00	0.00	0.50	0.33	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
44	0.00	0.00	0.00	0.30	0.60	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10
45	0.00	0.00	0.00	0.11	0.44	0.22	0.11	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18
46	0.00	0.00	0.00	0.13	0.46	0.38	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24
47	0.00	0.00	0.00	0.00	0.25	0.50	0.15	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20
48	0.00	0.00	0.00	0.00	0.09	0.43	0.20	0.26	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35
49	0.00	0.00	0.00	0.00	0.03	0.31	0.38	0.15	0.10	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39
50	0.00	0.00	0.00	0.00	0.03	0.10	0.38	0.35	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40
51	0.00	0.00	0.00	0.00	0.02	0.05	0.29	0.34	0.17	0.05	0.02	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	41
52	0.00	0.00	0.00	0.00	0.03	0.00	0.18	0.15	0.26	0.21	0.10	0.00	0.05	0.00	0.03	0.00	0.00	0.00	0.00	0.00	39
53	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.30	0.15	0.15	0.15	0.00	0.10	0.00	0.03	0.05	0.00	0.00	0.00	0.00	40
54	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.26	0.09	0.14	0.14	0.11	0.06	0.11	0.00	0.00	0.00	0.00	0.00	0.00	35
55	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.03	0.10	0.45	0.07	0.07	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00	29
56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.19	0.00	0.25	0.25	0.13	0.00	0.06	0.00	0.06	0.00	0.00	0.00	16
57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.20	0.20	0.20	0.00	0.00	0.00	0.00	0.00	5
58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.25	0.50	0.00	0.13	0.00	0.00	0.00	0.00	8
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1
63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Total																					499

Appendix 5: Age–length keys derived from otolith samples collected from recreational fishers from East Northland in 2011–12.

Estimates of proportion of length at age for kahawai sampled from the East Northland recreational fishery, January to April 2012. (Note: Aged to 01/01/12)

Length	Age (years)																			No.
(cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	aged
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
23	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
24	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
25	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
26	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
27	0.00	0.88	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8
28	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
29	0.00	0.25	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
30	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7
31	0.00	0.00	0.67	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
32	0.00	0.00	0.86	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7
33	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10
34	0.00	0.00	0.76	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17
35	0.00	0.00	0.53	0.37	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19
36	0.00	0.00	0.20	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5
37	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
38	0.00	0.00	0.20	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5
39	0.00	0.00	0.00	0.86	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7
40	0.00	0.00	0.00	0.50	0.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
41	0.00	0.00	0.00	0.64	0.18	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11
42	0.00	0.00	0.00	0.38	0.50	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8
43	0.00	0.00	0.00	0.29	0.29	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14
44	0.00	0.00	0.00	0.21	0.57	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14
45	0.00	0.00	0.00	0.06	0.50	0.17	0.11	0.11	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18
46	0.00	0.00	0.00	0.00	0.33	0.22	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27
47	0.00	0.00	0.00	0.00	0.25	0.21	0.25	0.21	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24
48	0.00	0.00	0.00	0.00	0.08	0.16	0.24	0.28	0.00	0.20	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25
49	0.00	0.00	0.00	0.00	0.03	0.30	0.15	0.24	0.15	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33
50	0.00	0.00	0.00	0.00	0.00	0.05	0.39	0.16	0.18	0.08	0.05	0.03	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	38
51	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.13	0.35	0.10	0.10	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31
52	0.00	0.00	0.00	0.00	0.03	0.00	0.06	0.12	0.26	0.12	0.06	0.15	0.12	0.06	0.00	0.00	0.03	0.00	0.00	0.00	34
53	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.08	0.12	0.12	0.38	0.04	0.08	0.04	0.00	0.00	0.04	0.00	0.00	0.00	26
54	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.27	0.05	0.23	0.09	0.18	0.00	0.09	0.00	0.00	0.00	0.00	0.00	22
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.14	0.18	0.18	0.14	0.09	0.05	0.00	0.05	0.00	0.00	0.00	22
56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.09	0.36	0.09	0.09	0.00	0.18	0.00	0.00	0.00	0.00	0.00	11
57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.10	0.30	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	10
58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Total																					485

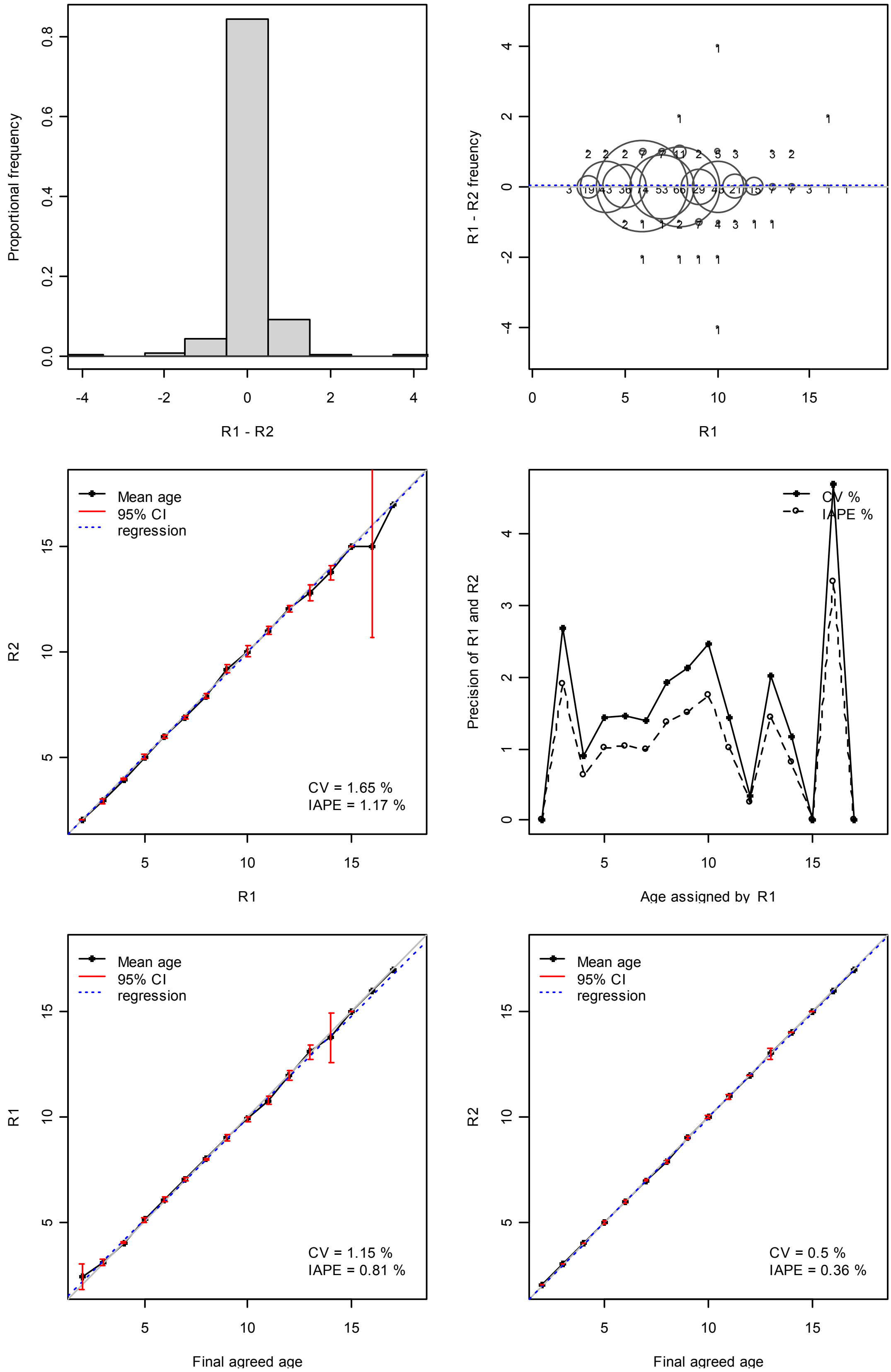
Appendix 6: Age–length keys derived from otolith samples collected from recreational fishers from Bay of Plenty in 2011–12.

Estimates of proportion of length at age for kahawai sampled from the Bay of Plenty recreational fishery, January to April 2012 (Note: Aged to 01/01/12)

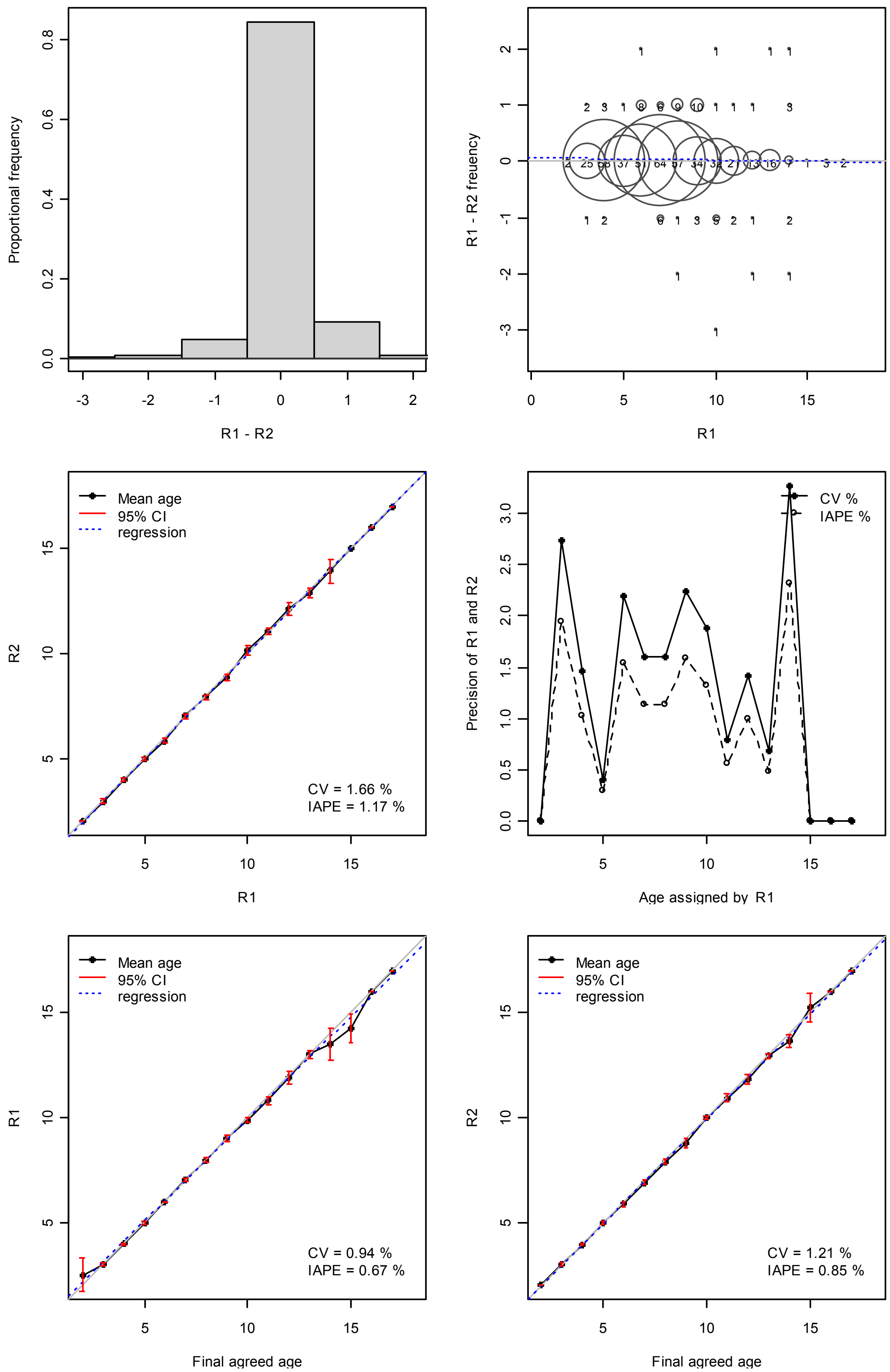
Length	Age (years)																			No.
(cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	aged
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
21	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
23	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
24	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
29	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
30	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
31	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10
32	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
33	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9
34	0.00	0.00	0.80	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10
35	0.00	0.00	0.33	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
36	0.00	0.00	0.83	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
37	0.00	0.00	0.25	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
38	0.00	0.00	0.20	0.60	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10
39	0.00	0.00	0.00	0.71	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14
40	0.00	0.00	0.00	0.60	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15
41	0.00	0.00	0.00	0.68	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19
42	0.00	0.00	0.00	0.38	0.50	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16
43	0.00	0.00	0.00	0.29	0.64	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14
44	0.00	0.00	0.00	0.25	0.38	0.19	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16
45	0.00	0.00	0.00	0.09	0.45	0.27	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11
46	0.00	0.00	0.00	0.06	0.33	0.50	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18
47	0.00	0.00	0.00	0.00	0.11	0.37	0.30	0.15	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27
48	0.00	0.00	0.00	0.00	0.14	0.29	0.21	0.21	0.04	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28
49	0.00	0.00	0.00	0.00	0.05	0.26	0.24	0.24	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42
50	0.00	0.00	0.00	0.00	0.02	0.10	0.20	0.22	0.37	0.05	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	41
51	0.00	0.00	0.00	0.00	0.00	0.05	0.14	0.26	0.36	0.10	0.05	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	42
52	0.00	0.00	0.00	0.00	0.00	0.12	0.08	0.31	0.23	0.08	0.15	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26
53	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.10	0.40	0.10	0.05	0.15	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00	20
54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.20	0.13	0.33	0.10	0.10	0.03	0.03	0.00	0.00	0.00	0.00	0.00	30
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11	0.11	0.00	0.22	0.11	0.06	0.06	0.11	0.06	0.00	0.06	0.00	18
56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.18	0.09	0.36	0.18	0.00	0.00	0.09	0.00	0.00	0.00	11
57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.14	0.14	0.14	0.00	0.14	0.14	0.00	0.00	0.00	0.00	7
58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.00	4
59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	0.00	3
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	2
63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Total																					492

Appendix 7: Age bias diagnostic plots of kahawai aged from recreational catches in East Northland and the Bay of Plenty in 2010–11.

Age bias diagnostic plot of kahawai aged from recreational catch from East Northland in 2010–11.

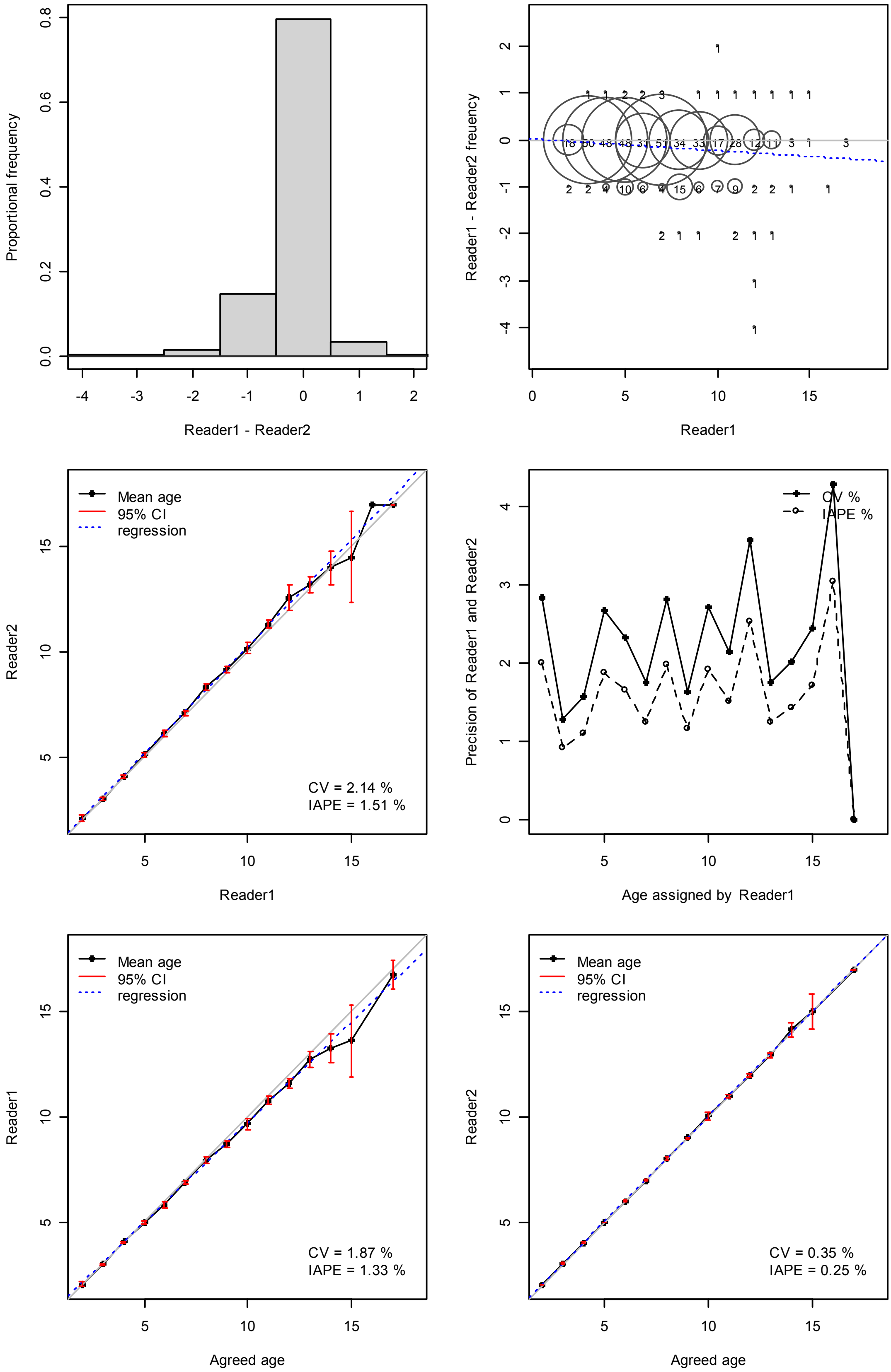


Appendix 7 – continued:
Age bias diagnostic plot of kahawai aged from recreational catch from Bay of Plenty in 2010–11.



Appendix 8: Age bias diagnostic plots of kahawai aged from recreational catches in East Northland and the Bay of Plenty in 2011–12.

Age bias diagnostic plot of kahawai aged from recreational catch from East Northland in 2011–12.



Appendix 8 – continued:
Age bias diagnostic plot of kahawai aged from recreational catch from Bay of Plenty in 2011–12.