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EXECUTIVE SUMMARY

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This report documents an eighth consecutive year of recreational catch sampling in KAH 1 and, for the first time, catch sampling from KAH 8. These data are used to both describe the length and age composition of recreational landings and to monitor the wider KAH 1 and KAH 8 stocks. Recreational landings have been sampled instead of those from the commercial sector because amateur fishers land a wider size range of kahawai from a far greater number of geographically dispersed schools than any other fishery. This is desirable, as kahawai school by size and, therefore, in an aggregated and non-random manner. This schooling behaviour, and the mobility of schools in response to biological and environmental influences, limits the extent to which landings from any fishery represent the wider population structure.

The number of kahawai measured and aged in the Hauraki Gulf was fewer than in previous years, with the lowest number of measurable kahawai encountered in the Gulf since the first survey in 2000–01. In East Northland and the Bay of Plenty, however, the number of fish measured was slightly more than in the previous two years. Nonetheless, the regional length and age compositions obtained in 2007–08 are broadly similar to those obtained in previous 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 2000–01. The Hauraki Gulf continues to be largely composed of 3 year olds, although these fish are not as prevalent as in previous years. There is a strengthening of the 50 to 60 cm size category, with a broader age distribution and greater representation of older fish. Low catch rates in the Gulf suggest that the recruitment of 3 year olds had been particularly poor in 2007–08, and hence the 2004 year class was weak. In the Bay of Plenty the length and age distributions remain typically broad.

The number of kahawai measured and aged from KAH 8 in the first four months of 2006–07 is probably too low to provide an adequate descriptor of recreational landings from this fishery at this time. There are several reasons for this. Firstly, the KAH 8 coastline is extensive and diverse, and this is reflected in differences seen between the length compositions of landings taken from harbours, and open waters both to the north and to the south of Mount Taranaki.. Secondly, the number of kahawai measured and aged was low, despite a high level of sampling effort, which was only possible due the concurrent SNA 8 harvest estimation survey. There was also practically no sampling from the shore based fishery, which probably accounts for a higher proportion of the total recreational harvest than in KAH 1. Sampling in 2006–07 has, therefore, provided some insights into population structure in this stock, but these suggest that catch sampling from this recreational fishery is probably not feasible given this heterogeneity, and the relatively low intensity of recreational fishing effort.

1. INTRODUCTION

Many fisheries are monitored using catch-at-age and catch-at-length collected from commercial landings. Kahawai (*Arripis trutta*) school by size, however, and individual commercial landings, composed of fish from only one or two schools, can provide a very misleading description of the wider population structure when a limited number of landings are sampled. 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 began in the summer of 2000–01, and continued for a further seven 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) and KAH2006/02 (Hartill et al. 2008c). This report documents the results of a further year of sampling, undertaken as part of the Ministry of Fisheries programme KAH2007/01.

Additional summer sampling was also conducted on the west coast of the North Island in KAH 8 as an adjunct to a SNA 8 recreational harvest estimation survey in 2006–07 (REC200501). This report describes the results of this sampling, and discusses the feasibility of sampling recreational landings to monitor changes in the stock structure of KAH 8.

Overall objective

1. To monitor the status of the kahawai (*Arripis trutta* and *Arripis xylabion*) stocks.

Specific objectives

1. To conduct representative sampling and determine the length and age composition of the recreational landings of kahawai in KAH 1 for the 2007/08 fishing year to monitor the KAH 1 stock. The target coefficient of variation (c.v.) for the catch at age will be 30% (mean weighted c.v. across all age classes), including demonstrating that the sampling was representative of the fishery.

2. To conduct representative sampling and determine the length and age composition of the recreational landings of kahawai in KAH 8 for the 2006/07 fishing year to monitor the KAH 1 stock. The target coefficient of variation (c.v.) for the catch at age will be 30% (mean weighted c.v. across all age classes), including demonstrating that the sampling was representative of the fishery.

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 means of sampling kahawai populations than the conventional commercial port 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.

Consequently, a three year recreational catch sampling programme began in January 2001 (KAH2000/01; Hartill et al. 2007a). In the first four months of each year, when fishing effort peaked, recreational landings of kahawai were sampled at key boat ramps throughout KAH 1. 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 three putative KAH 1 substocks: East Northland, Hauraki Gulf, and the Bay of Plenty. A further three years of sampling were conducted in 2004 and 2005 as part of KAH2003/01 (Armiger et al. 2006) and in 2006 and 2007 as part of KAH2005/02 and KAH2006/02 respectively (Hartill et al. 2007b, 2008a).

In 2006–07 recreational landings were also sampled from KAH 8, as a cost effective add on to an existing survey of the recreational SNA 8 fishery (REC2005/01; Hartill et al. 2008b). The sampling methods used were the same as those used in KAH 1, to determine whether future sampling for kahawai was feasible for this area.

This programme provides recreational catch-at-age data from KAH 1 for an eighth consecutive year and, for the first time, from KAH 8. The methods used in this programme are, therefore, essentially the same as those used since 2001, and are 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 2007. 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 substantive regional differences in 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. Additional sampling was also conducted at ramps along the west coast of the North Island (KAH 8) during the first four months of 2007.

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.

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 was therefore required in space and time so that appreciable landings of kahawai can be sampled, if and when they occur. In the seven previous years surveyed, 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 generated from this programme is 0.30, as specified in the objective above.

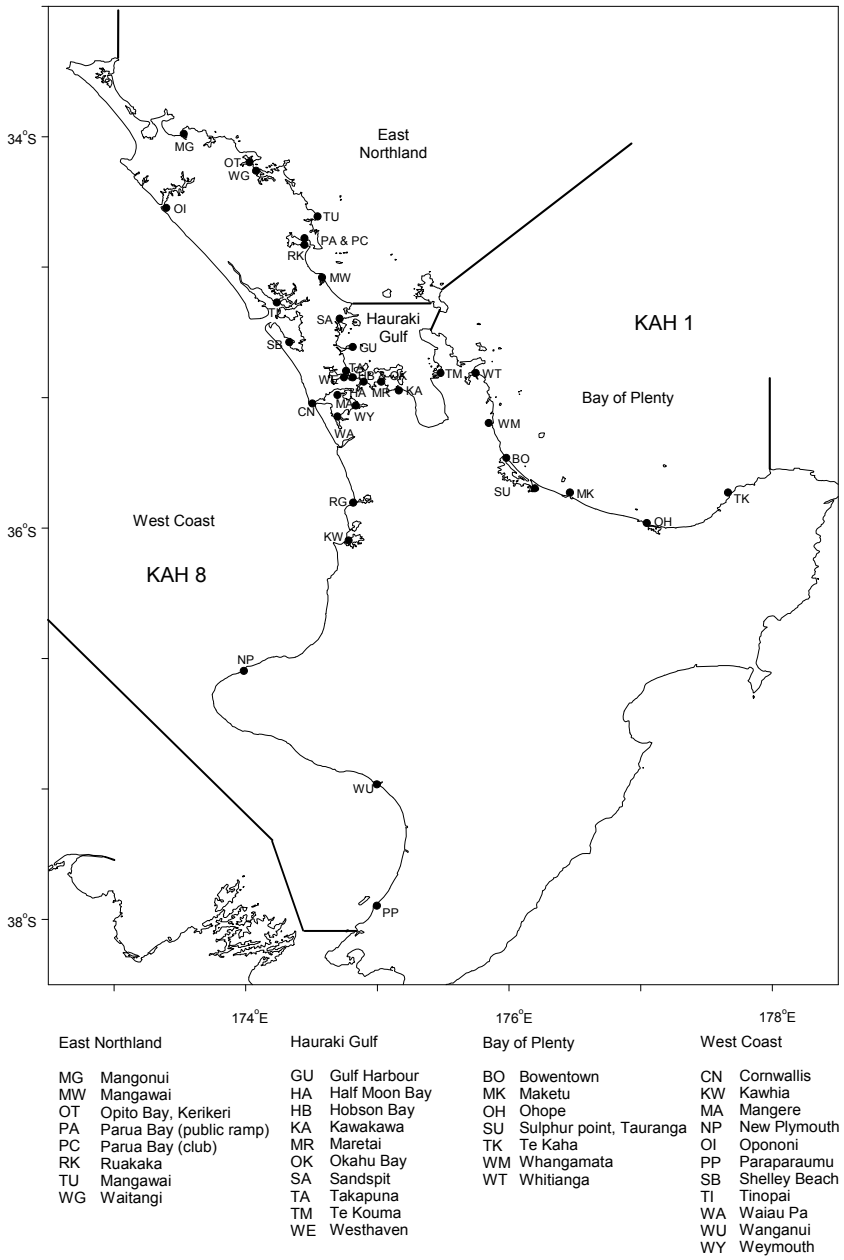

Figure 1: KAH 1 and KAH 8 substock boundaries and location of boat ramp interview sites.

In KAH 1, we have mostly surveyed the same ramps since 2001. Sampling sessions at each ramp were randomly assigned to weekend and public holiday days between 1 January and 30 April. 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. Additional midweek interviewing took place at four ramps in the inner Hauraki Gulf in 2007, as part of an overlapping FRST funded programme (CO1X0506). These data have been excluded from Tables 1 and 2, in the interests of consistency with previous years.

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, however, 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 level of effort.

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

	Number of hours		Number of kahawai measured		Number of kahawai aged	
Region	Target	Actual	Target	Actual	Target	Actual
East Northland	1 152	1 015	1 500	874	500	539
Hauraki Gulf	1 320	1 464	1 500	477	500	227
Bay of Plenty	704	535	1 500	1 156	500	552

Midweek interviewing also took place at 12 ramps in KAH 8, between Opononi and Paraparaumu, which were already being surveyed as part of a SNA 8 recreational harvest estimation survey (Table 3). Some of the KAH 8 data were collected during midweek sampling, and we have used these data here to boost the limited data collected during weekend sampling.

All interviews conducted in KAH 1 and KAH 8 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. When fishers landing kahawai were encountered, all fish, including kahawai, were measured, where possible. For ageing, kahawai were selected at random from each vessel's catch, from which no more than four fish were taken. As age samples were collected randomly, the length distribution of the age sample should broadly reflect the length distribution of the landed catch. Vessels landing four or more kahawai are relatively uncommon.

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. These slides were then sprayed with artist's lacquer.

To improve clarity, a thin layer of immersion oil was brushed over each slide and reading took place under transmitted light. Three readers were used to interpret the thin sectioned otoliths and disagreements in interpretation were resolved using a method similar to that used for snapper (Davies & Walsh 1995) which was as follows.

- Each reader independently read all otoliths collected from a region.
- Disagreements between the three readers' initial age estimates were identified and where one or more readers failed to agree in their initial interpretation of an otolith, those readers reread the otolith with no knowledge of any prior age estimates.
- Remaining disagreements were resolved by discussing images of otoliths projected onto a video screen until a consensus was reached.
- If no consensus could be reached, the otolith was discarded from the dataset.

Only four otoliths were actually, discarded, and when this occurred, both otoliths were usually deformed and, hence, unreadable.

2.4 Data analysis

Proportional catch-at-length and catch-at-age distributions and analytical variance estimates were calculated for each region using a FORTRAN program developed for a snapper market sampling programme (Davies & Walsh 1995). Vessels landing kahawai were regarded as individual strata, which were weighted on the basis of the number of kahawai landed. 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 age classes recruited, with the maximum age being an aggregate of all age classes greater than 19 years. 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 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 each month 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 these histograms. Estimates of precision (mwcvs) were not calculated for monthly distributions due to low sample sizes in the component strata.

Fishers from East Northland and the Bay of Plenty were asked how far they were offshore when they caught their kahawai. These data were plotted and regressed against fish length to explore ontogenetic shifts in habitat usage. Fishers from the Hauraki Gulf were not asked how far off the shore they were fishing, as the u-shaped coastline and presence of islands makes interpretation of this variable impossible.

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 2007–08. 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								
2007-08	Mangonui	21	126	254	48	92	91	52
	Opito Bay	23	144	219	81	195	182	127
	Waitangi	24	142	470	148	536	352	206
	Tutukaka	18	87	119	21	66	40	18
	Parua Bay (public)	20	118	206	41	116	93	48
	Parua Bay (club)	22	133	422	54	97	83	64
	Ruakaka	22	132	170	6	11	10	10
	Mangawhai	22	132	208	17	24	23	14
	Total	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								
2007-08	Sandspit	20	136	120	11	24	24	6
	Gulf Harbour	20	121	349	45	180	95	38
	Takapuna	26	169	300	11	26	20	18
	Westhaven	26	169	361	15	50	27	18
	Hobson Bay	13	78	132	14	52	44	31
	Okahu Bay	12	73	179	10	35	12	12
	Half Moon Bay	48	314	746	37	123	78	41
	Maraetai	18	114	98	10	36	36	4
	Kawakawa Bay	26	166	239	31	103	84	21
	Te Kouma	21	126	263	32	65	57	38
	Total	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								
2007-08	Whitianga	18	74	257	52	116	81	75
	Whangamata	20	78	323	71	176	165	73
	Bowentown	20	81	260	93	281	249	104
	Sulphur Point	16	64	350	83	222	205	102
	Maketu	18	74	31	90	290	284	38
	Ohope	24	90	121	64	165	158	148
	Te Kaha	18	75	63	9	22	14	12
	Total	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

Interviewers were present at ramps in East Northland for a similar number of hours to those in 2000–01 to 2003–04, 2005–06, and 2006–07 (Table 2). As with previous years, most kahawai were landed at the northern ramps. The number of kahawai landed throughout the region on survey days was similar to those in 2000–01 to 2004–05, which has seen an increase in numbers in relation to the two previous years. Number of kahawai measured and encountered was 874 in East Northland, which is slightly up on the number measured in the previous year but lower than in earlier survey years.

The length and age distributions in 2007–08 are similar to those obtained in previous years (Figure 2). The length distribution is typically broad, peaking at about 49–51 cm. The age distribution also remains broad, with most fish between 3 and 11 years of age, with older fish being more evident in this year's landings. The length and age distributions were both described with reasonable precision, with mwcvs of 0.19 (Appendix 1) and 0.14 (Appendix 2) respectively. The estimate of precision for length and age are similar to those of earlier years.

A strong year class which entered the fishery at 3 years of age in 2000–01 could be tracked across years until 2007–08 when it was 10 years old. The 3 year old year class in 2001–02 was relatively weak and can be seen progressing through each successive year, appearing as a weak 9 year old year class in 2007–08 (Figure 2). A similar trend can be seen in the 3 year old year class of 2004–05, with the progression of a weak year class, through to the 6 year old year class appearing in 2007–08. There is also evidence of a stronger 3 year old age class which recruited to the fishery 2005–06, and can now be seen as a strong mode of 5 year olds.

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 predominant in January (Figures 3a and 3b).

As seen in previous years, most kahawai were caught within 5 km of the mainland coast, where most fishing effort occurs: 84% in 2001–02, 97% in 2002–03, 83% in 2003–04, 92% in 2005–06, 86% in 2006–07, and 91% in 2007–08 (Figure 4). Fishers were not asked how far they fished offshore in 2004–05. Most recreational fishing effort takes place close to shore, however, and it is possible that numerous schools of offshore kahawai were not encountered. These data do, however, provide a description of where recreational catches of kahawai took place. Despite the scarcity of information on offshore catches, there appears to be some evidence of increasing fish size with increasing distance offshore. Closer examination of the data indicates that this may be driven by low numbers of juvenile fish further than 5 km from the coast, rather than an increase in the size of mature fish with distance from the shore.

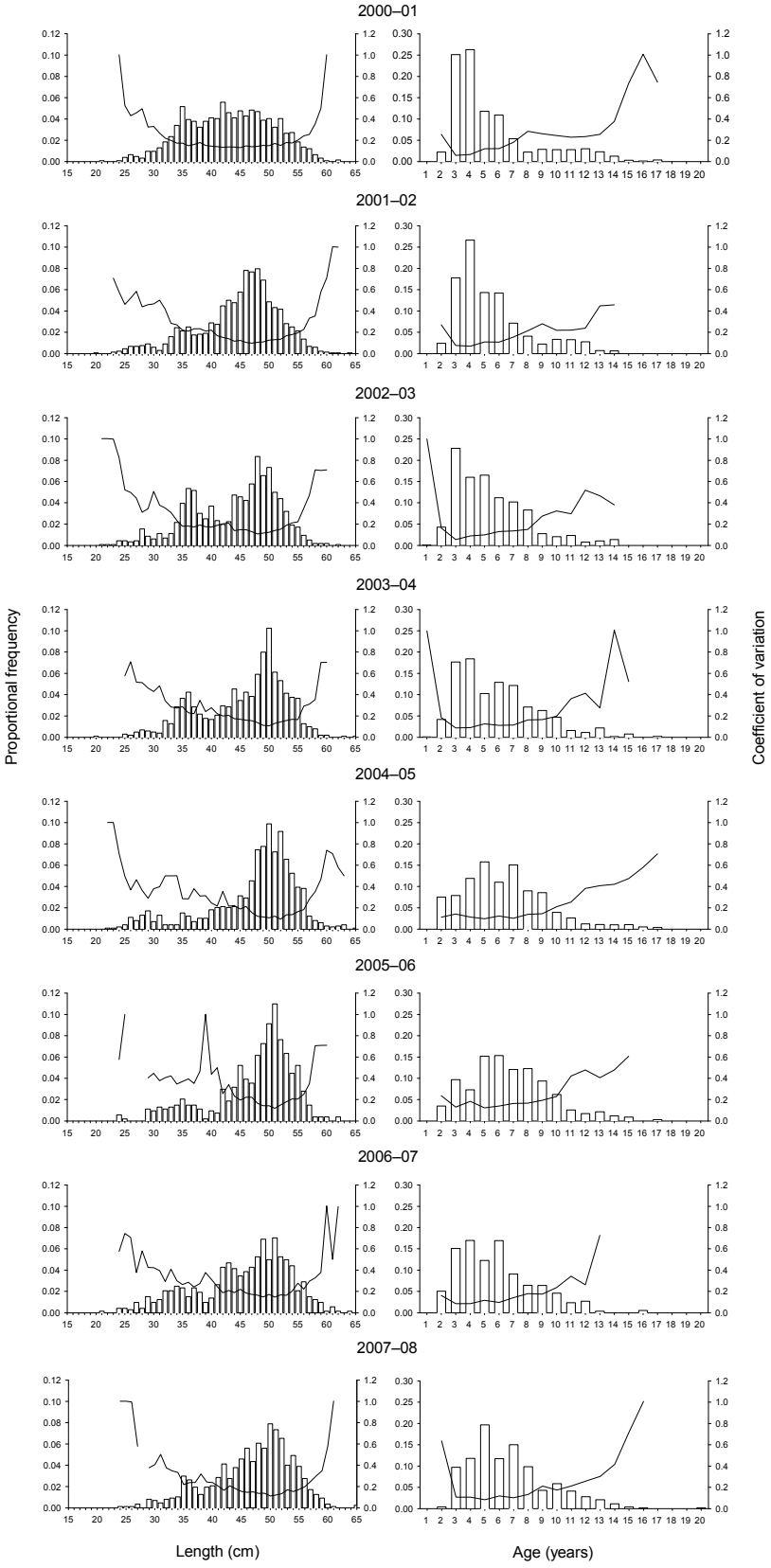

Figure 2: Length and age distributions (histograms) and c.v.s (solid lines) of recreational landings of kahawai in East Northland annually since 2000–01.

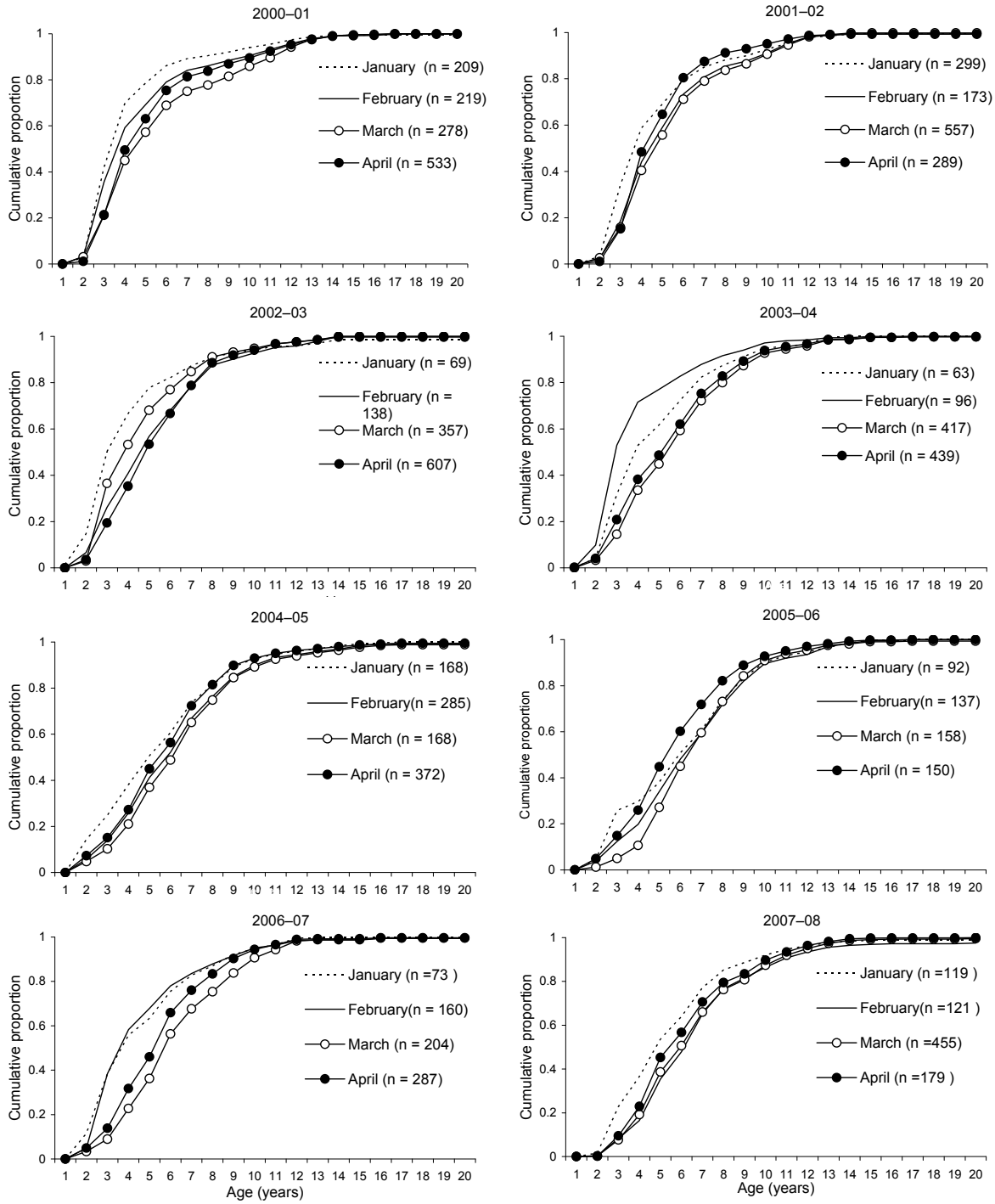

Figure 3a: Cumulative age distributions by month for East Northland since 2000–01. Graphs compare monthly age distributions within fishing years. The number of fish measured is given for each month.

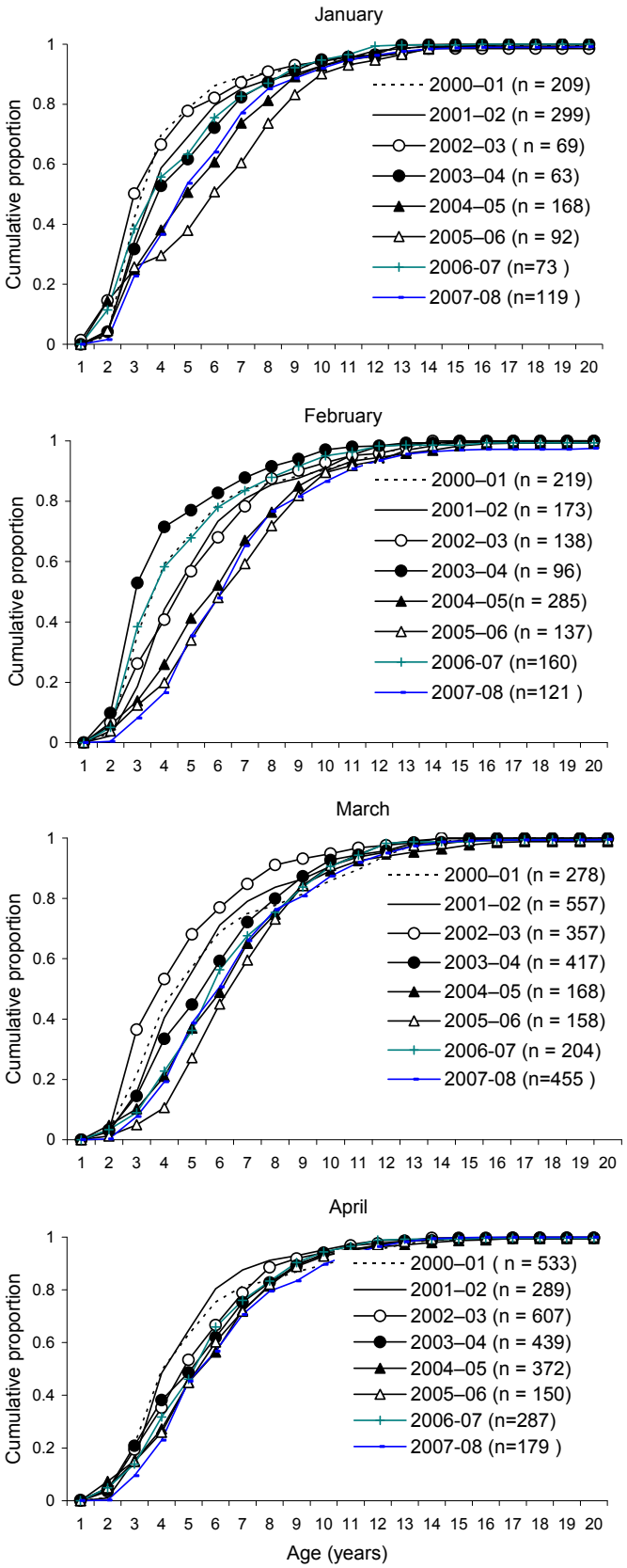

Figure 3b: Cumulative age distributions by month for East Northland since 2000–01. Graphs compare annual age distributions for each of the four months. The number of fish measured is given for each month.

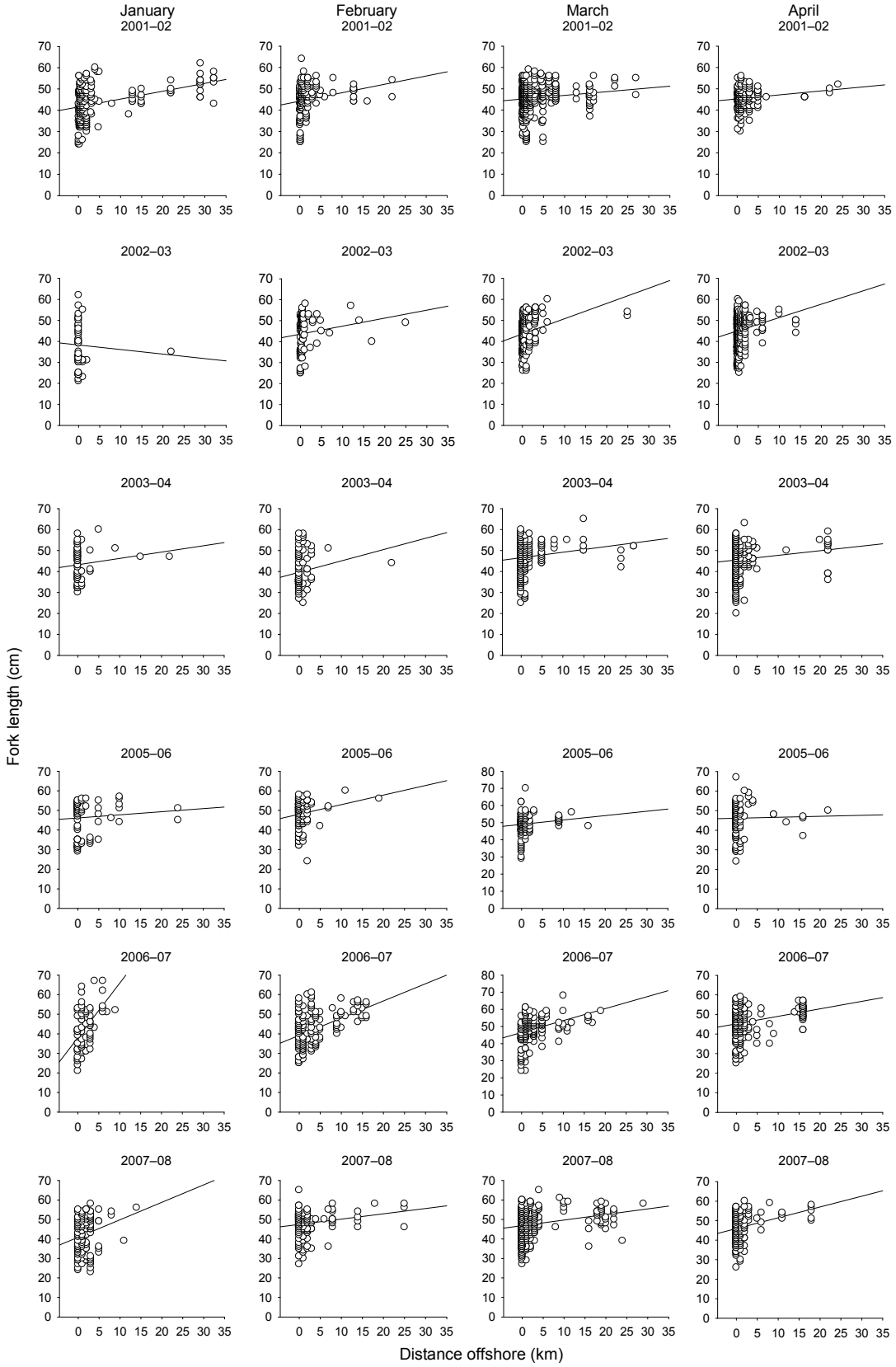

Figure 4: Length of landed kahawai relative to the estimated distance off the East Northland coastline at which they were caught. Results from five previous years are given for comparison. Data on the distance fished offshore were not collected in 2004–05.

3.2 Hauraki Gulf

A high proportion of the kahawai encountered in the Hauraki Gulf in 2007–08 were measured compared to the two previous years, but despite this, the number of kahawai measured and aged was the lowest recorded since the beginning of the surveys in 2000–01 (see Table 2). Nonetheless, the levels of precision achieved in this area are within that specified in Objective 1 of this programme.

The length distribution is bimodal and similar to that collected in 2004–05, when there was a greater proportion of older fish (Figure 5). The relative strength of the 50 to 60 cm size class, together with a decline in the number of kahawai landed, suggests that recruitment (and hence the number of kahawai encountered by interviewers) has again been low. The age distribution is still dominated by the 3 year old year class, but to a lesser extent than in previous years, which indicates that the Hauraki Gulf catch remains dominated by juvenile fish. The precision (mwcvs) of the length and age distributions was 0.28 and 0.20 respectively (Appendices 1 & 2).

Monthly age distributions from 2007–08 indicate that older fish tended to be landed in the Hauraki Gulf in March, instead of April as in previous years (Figures 6a and 6b).

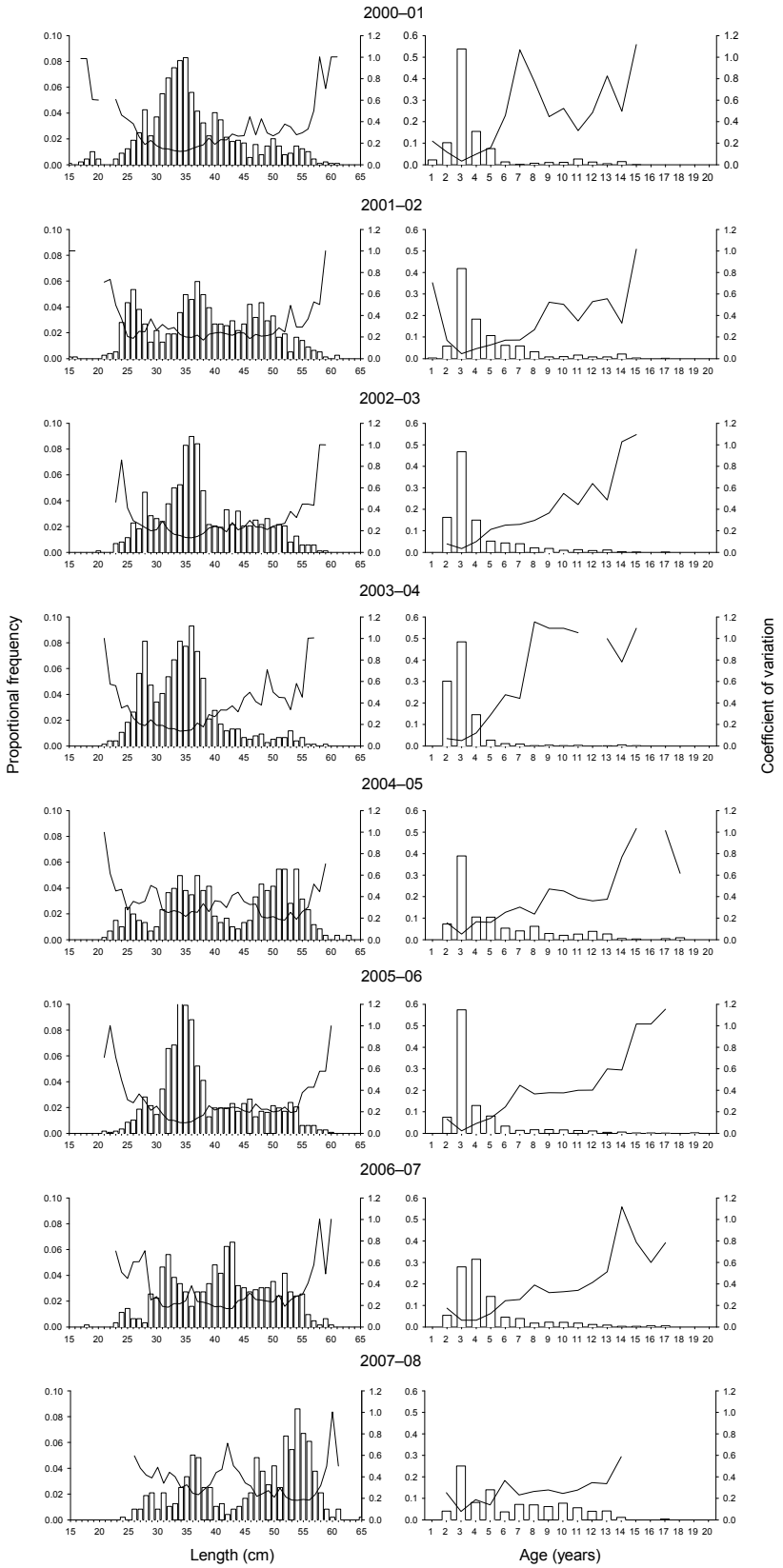

Figure 5: Length and age distributions (histograms) and c.v.s (solid lines) of recreational landings of kahawai in the Hauraki Gulf since 2000–01.

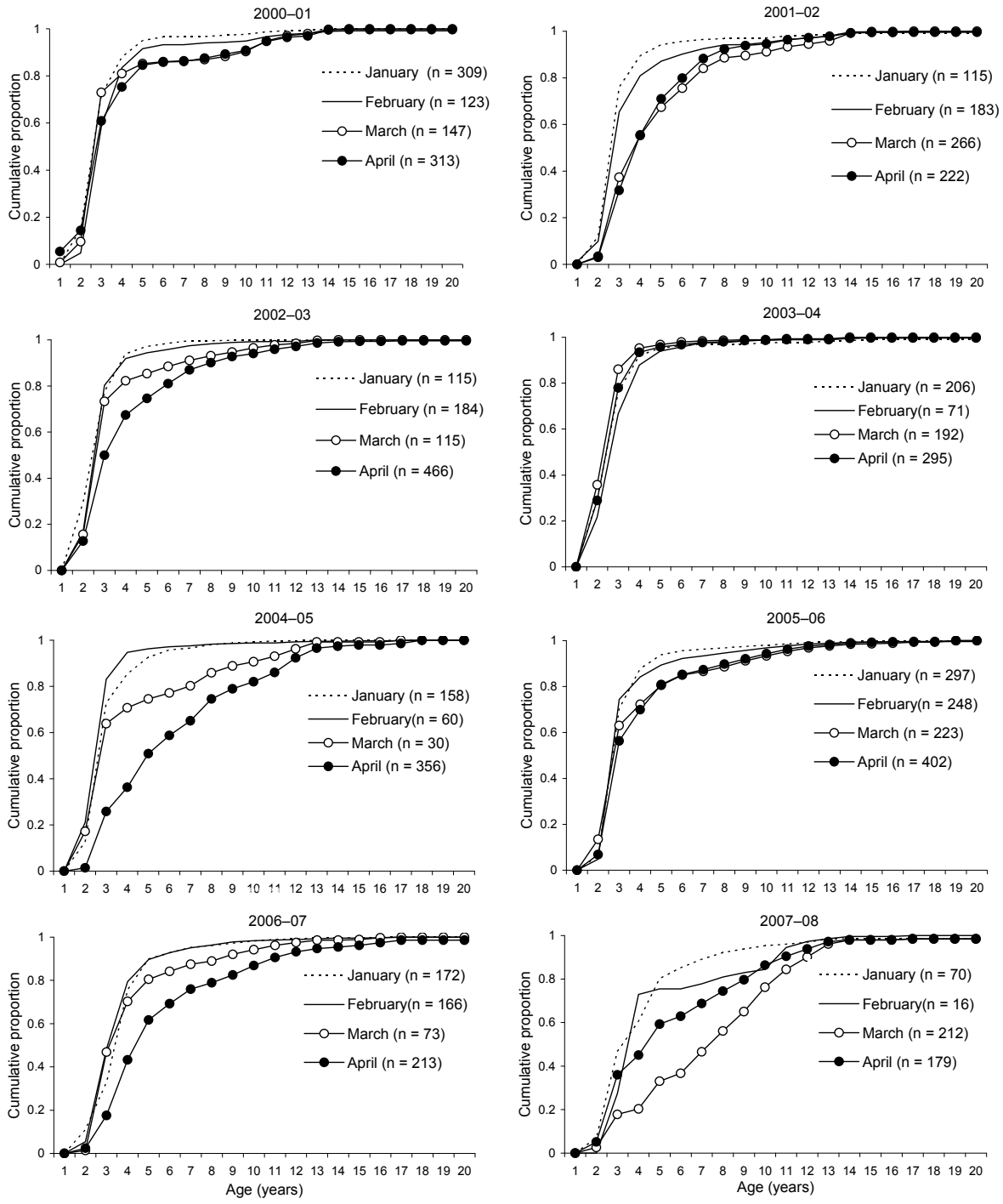

Figure 6a: Cumulative age distributions by month for the Hauraki Gulf since 2000–01. Graphs compare monthly age distributions within fishing years. The number of fish measured is given for each month.

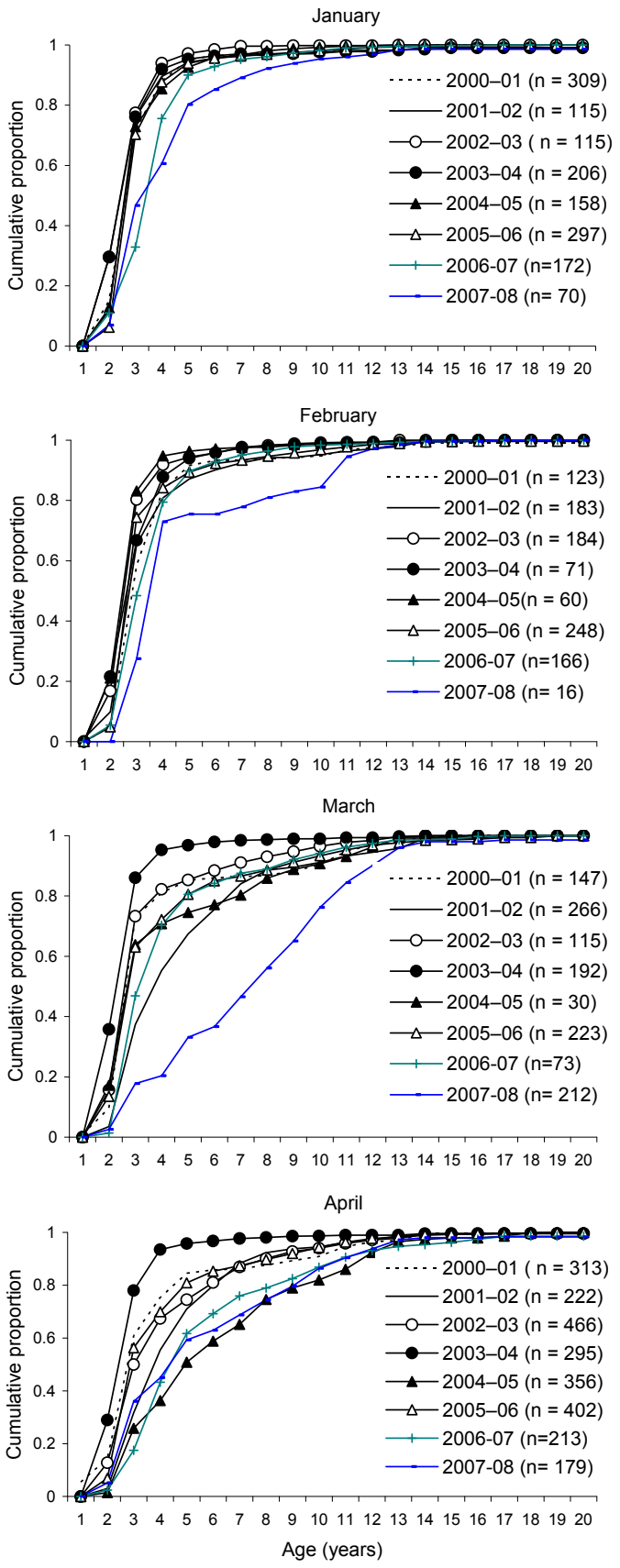

Figure 6b: Cumulative age distributions by month for the Hauraki Gulf since 2000–01. Graphs compare annual age distributions for each of the four months. The number of fish measured is given for each month.

3.3 Bay of Plenty

The number of kahawai measured by boat ramp interviewers in the Bay of Plenty was 1156, which is similar to that measured in the earlier years of sampling, despite a lower level of effort in 2007–08. The increased incidence of landed kahawai meant that the target sample size of 500 otoliths was exceeded,(seeTable 2).

The precision of the length and age distributions were similar to that in previous years (mwcvs of 0.18 and 0.14 respectively) (Appendices 1 and 2) and within acceptable levels. As with previous years, a mode of 45–55 cm dominated the Bay of Plenty length distribution (Figure 7). The age distribution is also characteristically broad, as in earlier years. However, there is no indication of any strong or weak year classes.

There is a higher proportion of younger fish in the January and February age distributions, similar to the two other regions (Figures 8a and 8b). This contrasts with age distributions from previous years which show very little change in age composition between January and April in the Bay of Plenty.

In 2007–08, almost all (94 %) kahawai were caught within 5 km of the mainland. As a result the relationship between the size of fish and the distance they were caught from the mainland is poorly defined, despite the fact that a proportion of kahawai were caught some distance offshore (Figure 9). Results from previous years suggest that no clear trend exists.

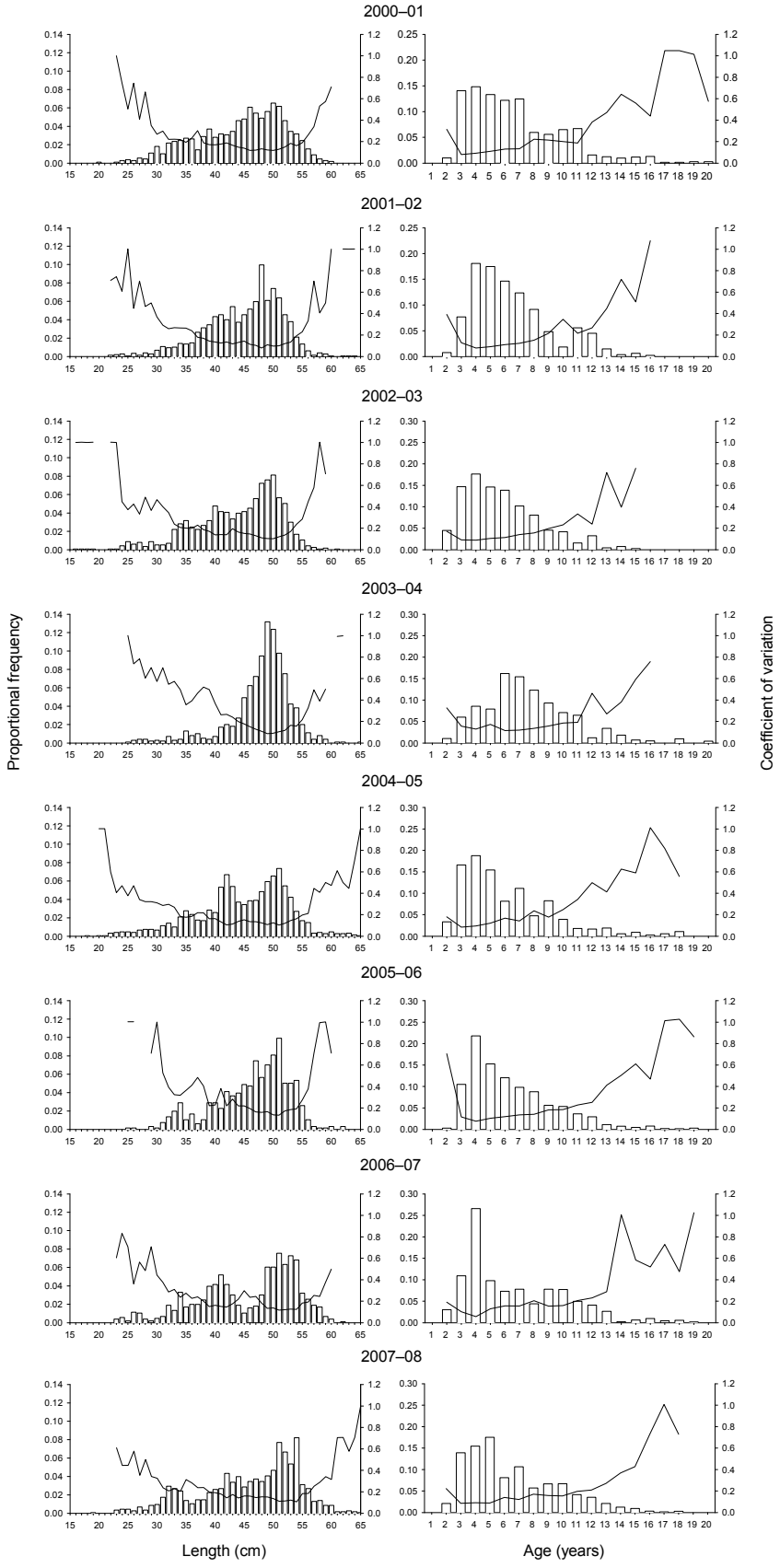

Figure 7: Length and age distributions (histograms) and c.v.s (solid lines) of recreational landings of kahawai in the Bay of Plenty since 2000–01.

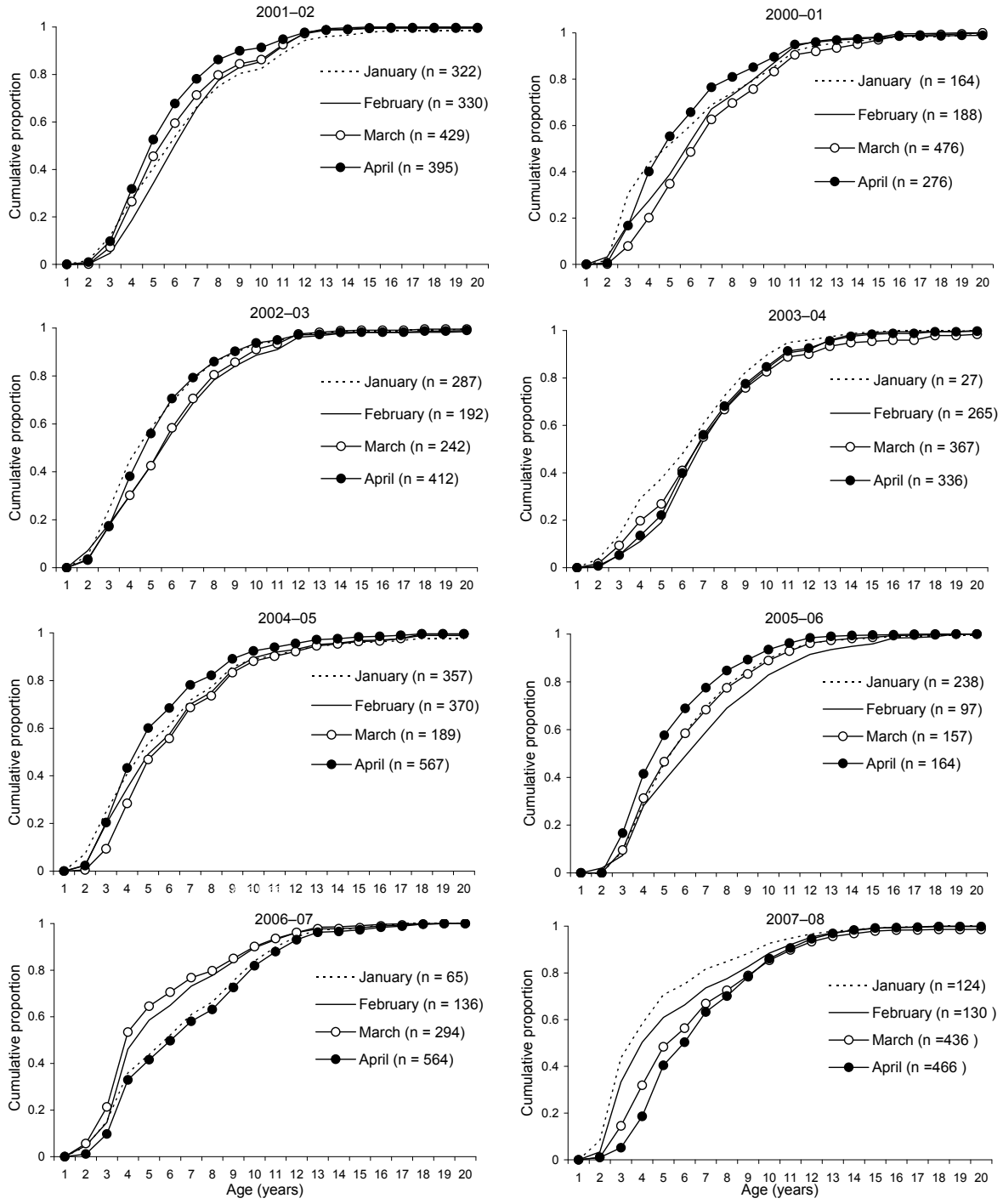

Figure 8a: Cumulative age distributions by month for the Bay of Plenty since 2000–01. Graphs compare monthly age distributions within fishing years. The number of fish measured is given for each month.

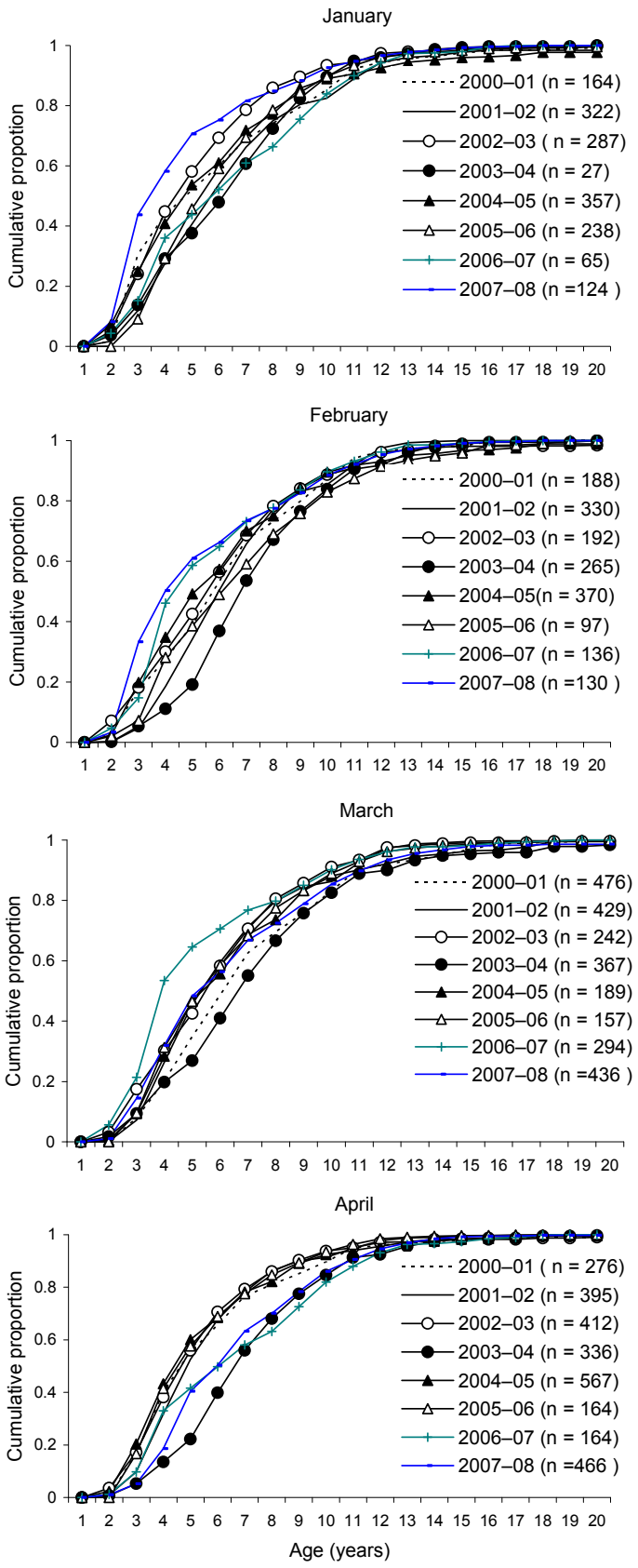

Figure 8b: Cumulative age distributions by month for the Bay of Plenty since 2000–01. Graphs compare annual age distributions for each of the four months. The number of fish measured is given for each month.

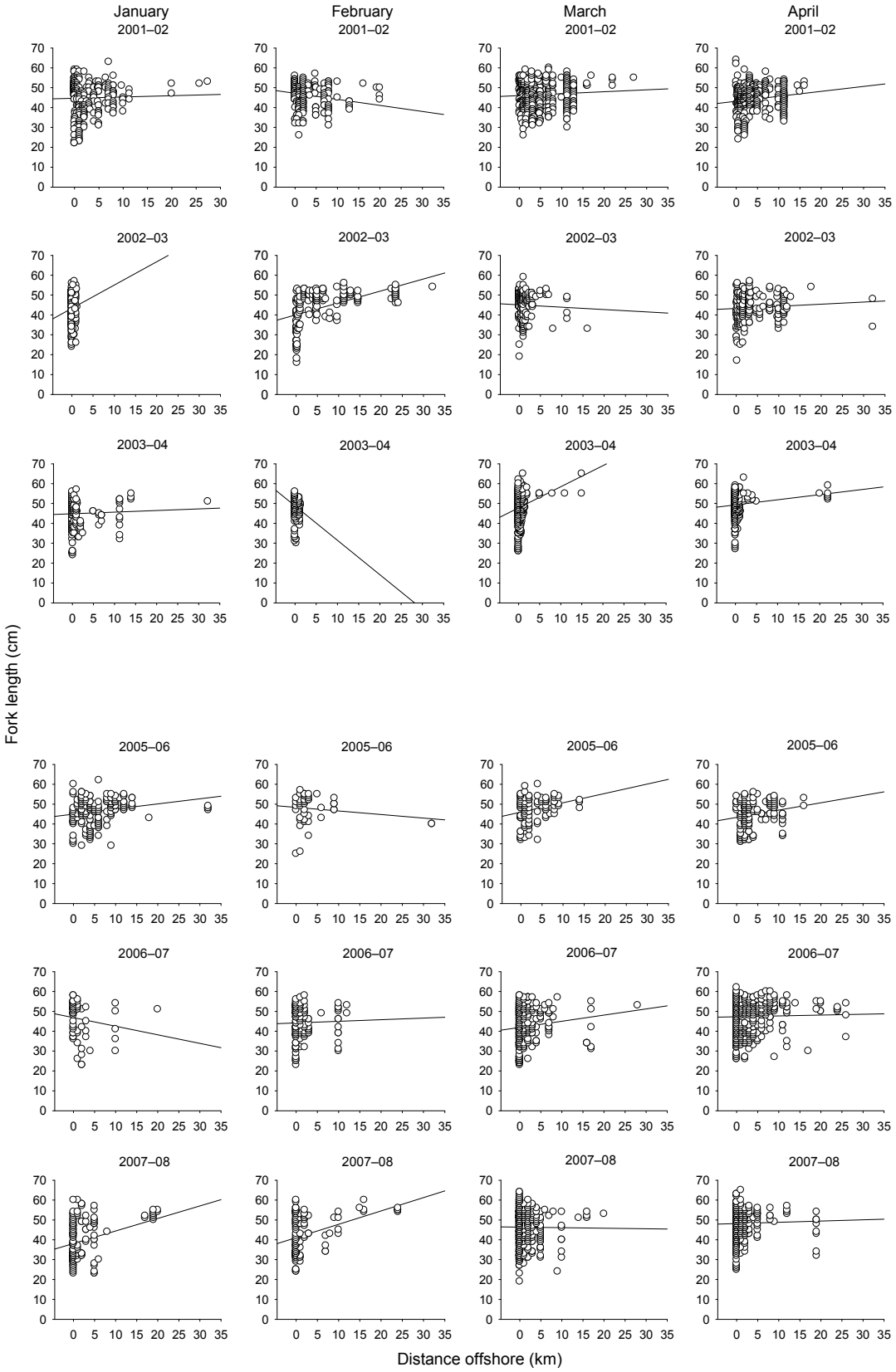

Figure 9: Length of landed kahawai relative to the estimated distance off the Bay of Plenty coastline at which they were caught. Results from five previous years are given for comparison. Data on the distance fished offshore were not collected in 2004–05.

3.4 KAH 8

The number of KAH 8 (west coast, North Island) kahawai measured and aged was low compared to the sample sizes achieved elsewhere (Table 3), despite a substantially larger number of interview hours.

Table 3: Summary statistics for KAH 8, of the number of interview sessions, hours surveyed, boats interviewed, vessels with measurable kahawai, kahawai measured, and kahawai aged for the first four months of 2007.

Ramp	Number of sessions	Number of hours	Boats interviewed (fishing)	Boats with measured kahawai	Measurable kahawai landed*	Kahawai measured	Kahawai aged
KAH 8							
Opononi	15	141	152	28	109	87	2
Tinopai	26	169	263	16	75	28	10
Shelley Beach	25	168	675	25	417	58	17
Cornwallis	23	147	279	28	311	114	28
Mangere	26	164	91	1	3	1	0
Weymouth	25	157	287	7	174	10	0
Waiau Pa	26	171	300	21	48	44	25
Raglan	15	95	269	33	255	102	45
Kawhia	22	152	525	13	187	26	6
New Plymouth	26	167	346	25	111	54	30
Wanganui	25	165	525	30	222	70	51
Paraparaumu	26	171	523	56	169	137	31
Total	280	1 865	4 235	283	2 081	731	245

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

The length distribution is broad, peaking between 49 and 51 cm (Figure 10). The age distribution, whilst broad, is not dominated by any particular year class. The length and age distributions were both described with reasonable precision, with mwcv's of 0.23 (Appendix 1) and 0.25 (Appendix 2) respectively.

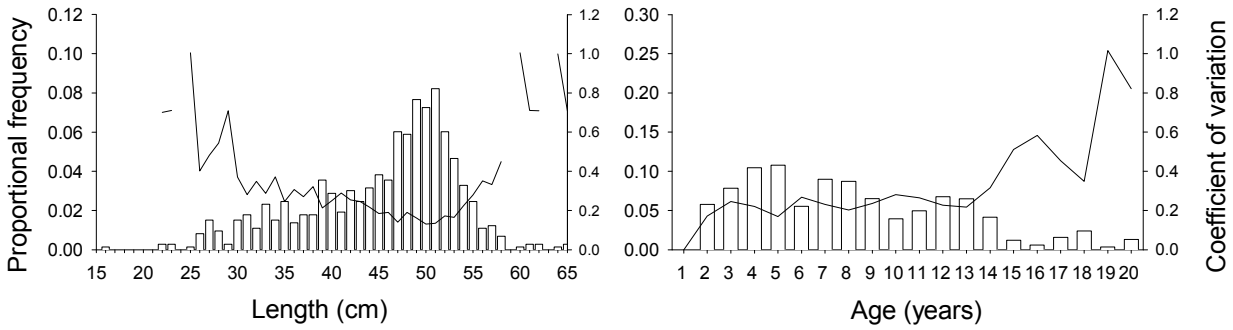

Figure 10: Length and age distributions (histograms) and c.v.s (solid lines) of recreational landings of kahawai in KAH 8, in the first four months of 2007.

There are, however, marked differences in the length structure of landings from different regions of the KAH 8 management area (Figures 11 and 12). The length composition of kahawai landed in the Hokianga and Kaipara harbours in the north is broad; primarily a result of higher relative proportions of small fish than observed further south. In the neighbouring Manukau harbour, however, a high proportion of the measured kahawai were 45 cm or longer. There is a similar latitudinal trend on the open coast, with a far greater proportion of larger kahawai being landed to the south of Mount Taranaki than to the north.

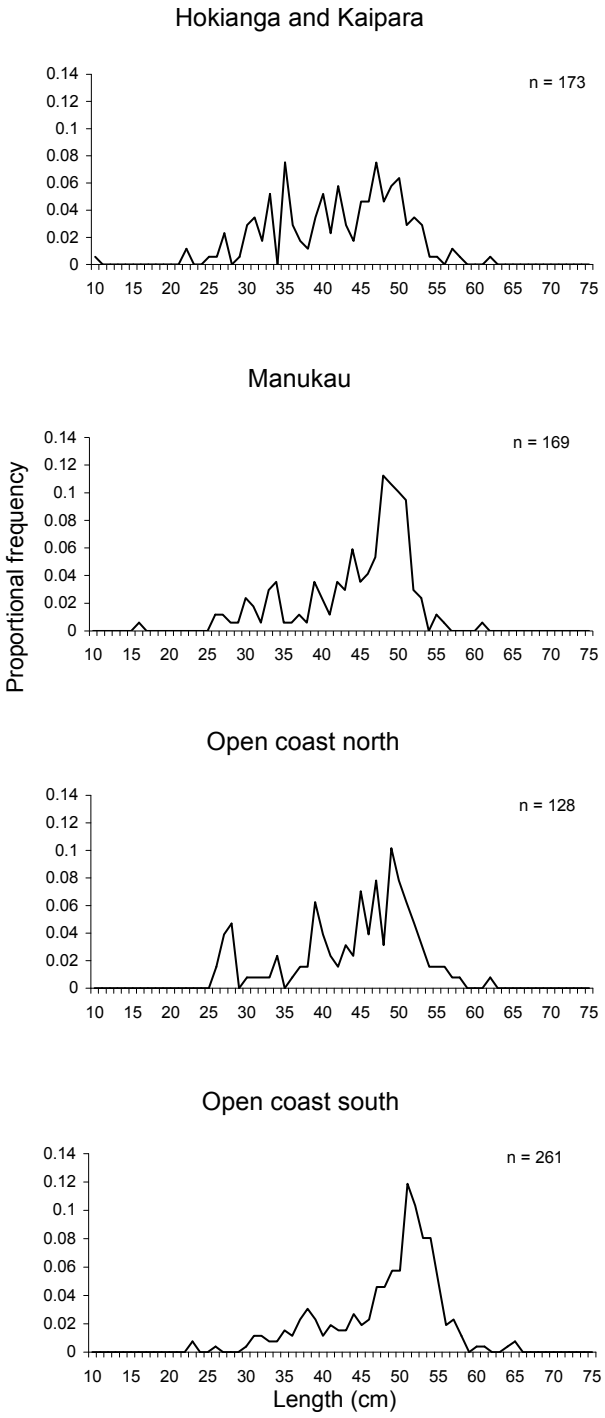

Figure 11: Length frequencies by area of recreational landings of kahawai in KAH 8, 2006–07.

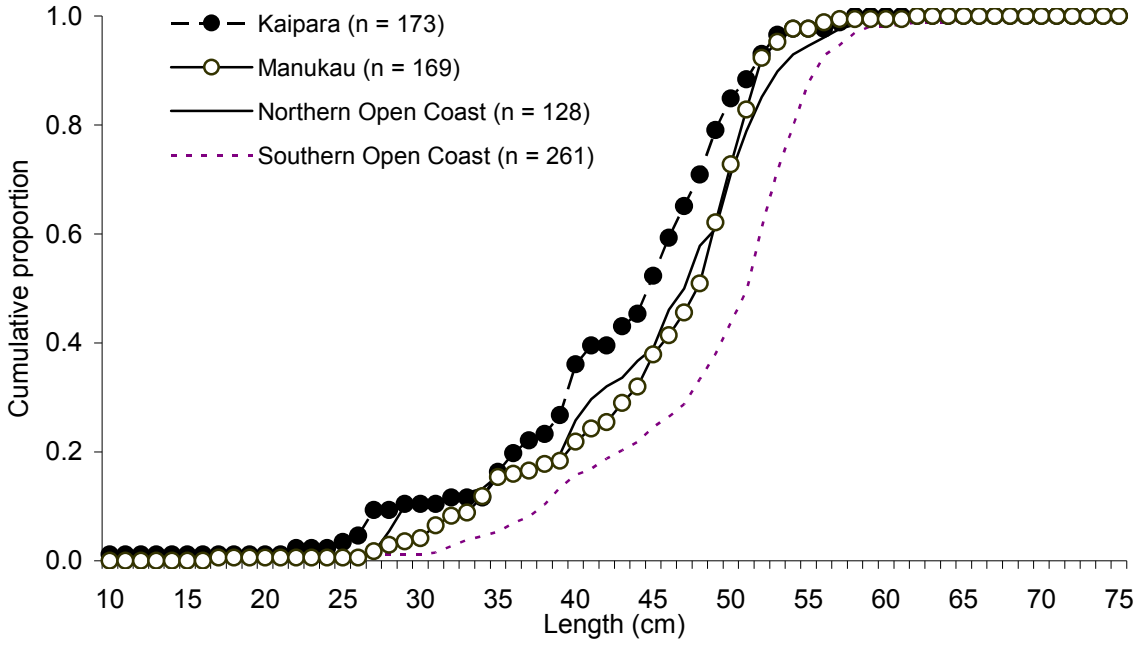

Figure 12: Cumulative length distributions by area of recreational landings of kahawai from KAH 8 in 2006–07.

3.5 Total mortality estimates

Estimates of total mortality (Z) have been generated as part of this programme for East Northland and the Bay of Plenty for 2007–08, and for KAH 8 for 2006–07. It has previously been suggested that these estimates can be used to monitor stock status. This approach, the methods used, and estimates for 2001 to 2007 were given by (Hartill et al 2008a).

Chapman & Robson (1960) estimates of Z were calculated for all the age distributions sampled from the East Northland and Bay of Plenty since 2000–01 (Table 4). Age distributions from the Hauraki Gulf were not considered, as this is essentially a juvenile fishery (Figure 13) with recruitment, and emigration, largely determining the age composition of landings in this region, not post-recruitment mortality. The Chapman Robson estimator is sensitive to the assumed age at recruitment, which we assume to be at 4 years of age, although estimates associated with recruitment ages of 3 to 6 years are given for comparison.

As before, these estimates suggest that mortality rates are generally higher in East Northland than in the Bay of Plenty. Size-dependent movement between the areas could, however, influence respective age structures, and consequently this could result in misleading estimates of total mortality, so they should be regarded with some caution. Estimates of Z were nevertheless at or below that associated the level of fishing mortality (F) that would produce a spawner biomass per recruit ratio of 40% of the unfished value (i.e. $F_{SB40\%}$) .

Estimates of Z were also calculated from the catch-at-age data collected from KAH 8 in 2006–07. These estimates should be treated with greater caution, as there are marked regional differences in length (see Figure 11) and hence age, structure, yet there is no defensible means of combining them given current information on stock dynamics. For this report, were have simply combined all data when producing catch-at-age estimates, yet it is quite conceivable that this places undue emphasis on schools encountered in harbours, which may only contribute a relativly small, and size selective, component of the stock.

There are also latitudinal trends in size structure which should be considered. One approach could be to generate catch-at-age distributions for each subarea, from which associated total mortality estimates could be generated. Unfortunately, however, the number of kahawai measured and aged in each subregion is too small to yield estimates of any useful precision. It is likely, however, that levels of mortality in KAH 8 are lower than in KAH 1, given the relative strength of older age classes in all areas, and consequently the Z estimates obtained.

Table 4: Estimates of Z derived from recreational catch sampling in East Northland, the Bay of Plenty, and in KAH 8, by survey year by assumed age at recruitment.

Age at recruitment	East Northland							
	2001	2002	2003	2004	2005	2006	2007	2008
3	0.33	0.33	0.32	0.28	0.24	0.28	0.28	0.24
4	0.34	0.38	0.35	0.31	0.28	0.32	0.32	0.28
5	0.30	0.37	0.39	0.33	0.33	0.35	0.35	0.33
6	0.30	0.40	0.41	0.38	0.36	0.41	0.41	0.34

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

Age at recruitment	KAH 8
	2007
3	0.17
4	0.18
5	0.19
6	0.20

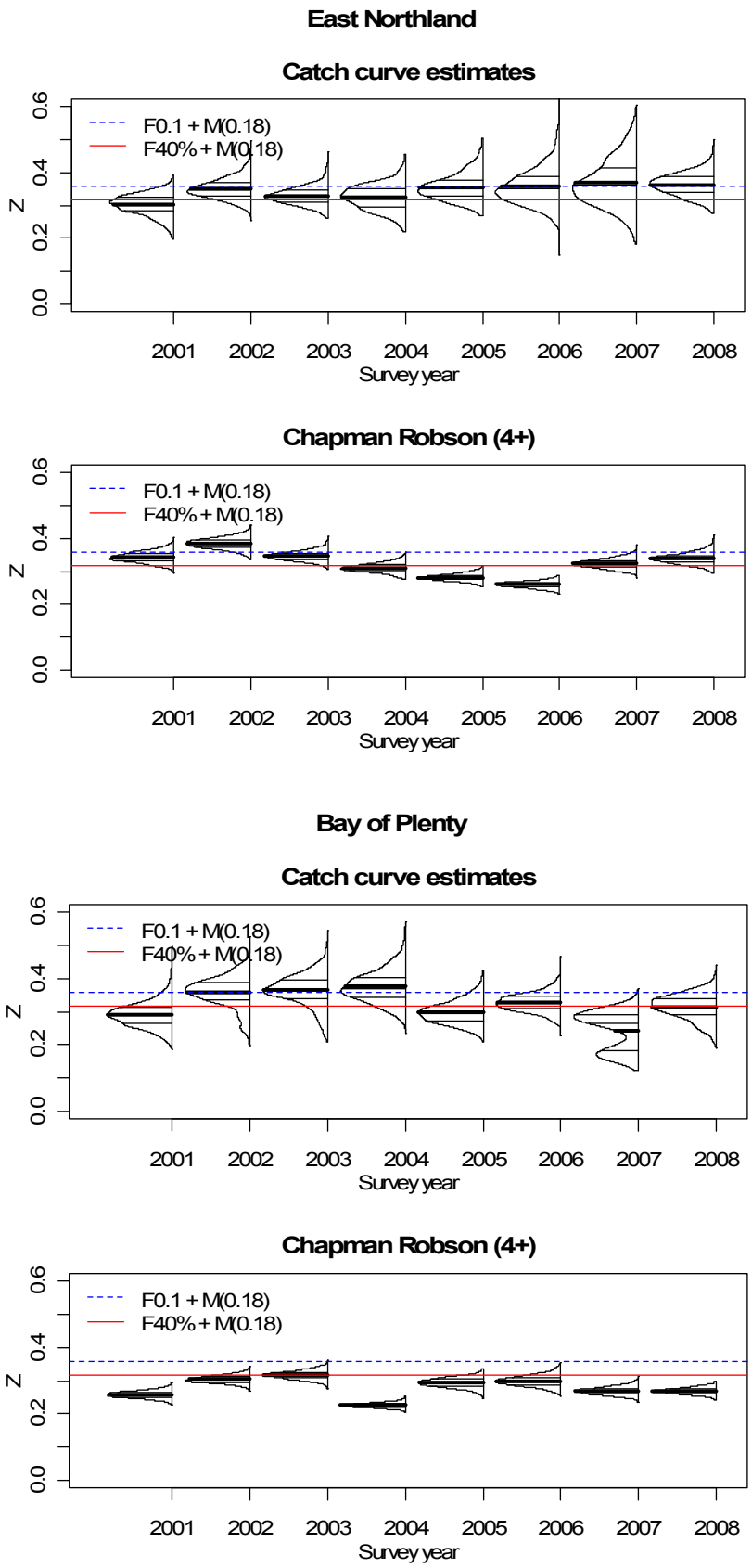

Figure 13: The distribution of bootstrap estimates of total mortality (Z) by survey year for East Northland and the Bay of Plenty. Theoretical optimal levels of Z derived from the YPR and SPR curves calculated in Hartill et al. (2008a) are denoted as horizontal line for reference.

4. CONCLUSIONS

- Regional length and age compositions derived from recreational landings sampled in 2007–08 are broadly consistent with patterns and trends seen in previous years for KAH 1.

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

- The East Northland age distribution is broadly dominated once again by 3 to 11 year old fish. Progression of two weaker year old year classes is evident in the age distributions over time. Most kahawai recruit into the area at about 3 years of age, which occurs mainly in January. Most of the fishing effort occurs within 5 km of the mainland coast line.

- The Hauraki Gulf length distribution in 2007–08 is bimodal, similar to the 2004–05 distribution pattern. The number of larger fish aged, coupled with poor returns of kahawai landed in the area, suggests that recruitment was poor. Age distribution is still dominated by younger fish, which indicates that the Hauraki Gulf is still a juvenile fishery.

- The Bay of Plenty age distribution remains typically broad, as in previous years. There is a higher proportion of younger fish in January and February, which contrasts to previous years, where distributions have typically showed little change in age composition. Almost all kahawai where caught within 5 km of the mainland coastline.

- The KAH 8 length and age distributions are broad, but are not dominated by any particular year class. Recreational landings of kahawai in this area are hard to characterise, due to the spatial extent of the coast line and the distinct latitudinal differences in the composition of landings from the open coast and harbours.

- A time series of total mortality estimates for East Northland and the Bay of Plenty since 2001 suggests that there has been little change in stock status over this period. In the Bay of Plenty, estimates of Z were at or below that associated with $F_{SB40\%}$.

- Total mortality estimates are also given for KAH 8 for 2006–07, but these should be regarded with some caution given our current poor knowledge of stock structure and movement dynamics.

5. ACKNOWLEDGMENTS

We thank the numerous boat ramp interviewers, most of whom took part in all three surveys. Funding for this project, KAH2007/01, was provided by the Ministry of Fisheries.

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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 2007–08 and West Coast, North Island in 2006–07

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 2007–08

Length	2007–08	
(cm)	*P.i.*	c.v.
10	0.0000	0.00
11	0.0000	0.00
12	0.0000	0.00
13	0.0000	0.00
14	0.0000	0.00
15	0.0000	0.00
16	0.0000	0.00
17	0.0000	0.00
18	0.0000	0.00
19	0.0000	0.00
20	0.0000	0.00
21	0.0000	0.00
22	0.0000	0.00
23	0.0000	0.00
24	0.0011	1.00
25	0.0011	1.00
26	0.0011	0.99
27	0.0034	0.58
28	0.0000	0.00
29	0.0080	0.38
30	0.0069	0.41
31	0.0046	0.50
32	0.0080	0.37
33	0.0092	0.35
34	0.0103	0.33
35	0.0297	0.22
36	0.0263	0.24
37	0.0195	0.24
38	0.0126	0.32
39	0.0195	0.24
40	0.0206	0.24
41	0.0286	0.20
42	0.0412	0.16
43	0.0275	0.21
44	0.0378	0.18
45	0.0458	0.15
46	0.0561	0.15
47	0.0435	0.15
48	0.0606	0.14
49	0.0561	0.14
50	0.0789	0.11
51	0.0732	0.12
52	0.0652	0.13
53	0.0400	0.17
54	0.0492	0.15
55	0.0389	0.17
56	0.0275	0.20
57	0.0172	0.25
58	0.0126	0.30
59	0.0092	0.35
60	0.0034	0.58
61	0.0011	1.00
62	0.0000	0.00
63	0.0000	0.00
64	0.0000	0.00
65	0.0023	0.71
66	0.0000	0.00
67	0.0000	0.00
68	0.0000	0.00
69	0.0000	0.00
70	0.0000	0.00
n	874	
m.w.c.v.		0.19

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Hauraki Gulf in 2007–08

Length (cm)	2007–08 *P.i.*	2007–08 c.v.
10	0.0000	0.00
11	0.0000	0.00
12	0.0000	0.00
13	0.0000	0.00
14	0.0000	0.00
15	0.0000	0.00
16	0.0000	0.00
17	0.0000	0.00
18	0.0000	0.00
19	0.0000	0.00
20	0.0000	0.00
21	0.0000	0.00
22	0.0000	0.00
23	0.0000	0.00
24	0.0021	1.00
25	0.0000	0.00
26	0.0084	0.60
27	0.0084	0.48
28	0.0189	0.42
29	0.0210	0.39
30	0.0084	0.49
31	0.0210	0.34
32	0.0105	0.44
33	0.0126	0.40
34	0.0252	0.30
35	0.0335	0.33
36	0.0503	0.25
37	0.0482	0.23
38	0.0252	0.28
39	0.0252	0.33
40	0.0105	0.44
41	0.0126	0.47
42	0.0042	0.71
43	0.0084	0.50
44	0.0105	0.44
45	0.0168	0.34
46	0.0210	0.31
47	0.0482	0.22
48	0.0377	0.24
49	0.0273	0.27
50	0.0419	0.21
51	0.0252	0.29
52	0.0650	0.21
53	0.0545	0.18
54	0.0860	0.18
55	0.0671	0.19
56	0.0608	0.18
57	0.0377	0.23
58	0.0210	0.32
59	0.0084	0.50
60	0.0021	1.00
61	0.0084	0.50
62	0.0000	0.00
63	0.0000	0.00
64	0.0000	0.00
65	0.0021	0.97
66	0.0042	0.71
67	0.0000	0.00
68	0.0000	0.00
69	0.0000	0.00
70	0.0000	0.00
n	477	
m.w.c.v.		0.28

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Bay of Plenty in 2007–08

Length (cm)	2007–08 *P.i.*	2007–08 c.v.
10	0.0000	0.00
11	0.0000	0.00
12	0.0000	0.00
13	0.0000	0.00
14	0.0000	0.00
15	0.0000	0.00
16	0.0000	0.00
17	0.0000	0.00
18	0.0000	0.00
19	0.0009	1.00
20	0.0000	0.00
21	0.0000	0.00
22	0.0000	0.00
23	0.0035	0.61
24	0.0043	0.45
25	0.0043	0.45
26	0.0026	0.58
27	0.0069	0.35
28	0.0035	0.50
29	0.0087	0.34
30	0.0095	0.33
31	0.0173	0.24
32	0.0294	0.21
33	0.0268	0.23
34	0.0242	0.20
35	0.0138	0.31
36	0.0104	0.28
37	0.0147	0.24
38	0.0147	0.24
39	0.0225	0.20
40	0.0260	0.19
41	0.0268	0.18
42	0.0433	0.14
43	0.0337	0.17
44	0.0398	0.14
45	0.0285	0.16
46	0.0346	0.16
47	0.0372	0.15
48	0.0346	0.15
49	0.0407	0.15
50	0.0467	0.14
51	0.0770	0.11
52	0.0666	0.12
53	0.0536	0.12
54	0.0822	0.11
55	0.0311	0.18
56	0.0268	0.18
57	0.0130	0.25
58	0.0138	0.29
59	0.0087	0.34
60	0.0087	0.32
61	0.0017	0.70
62	0.0017	0.71
63	0.0026	0.58
64	0.0017	0.71
65	0.0009	1.00
66	0.0000	0.00
67	0.0000	0.00
68	0.0000	0.00
69	0.0000	0.00
70	0.0000	0.00
n	1156	
m.w.c.v.		0.18

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from West Coast, North Island in 2006–07

Length (cm)	2006–07 *P.i.*	2006–07 c.v.
10	0.0014	1.00
11	0.0000	0.00
12	0.0000	0.00
13	0.0000	0.00
14	0.0000	0.00
15	0.0000	0.00
16	0.0014	1.00
17	0.0000	0.00
18	0.0000	0.00
19	0.0000	0.00
20	0.0000	0.00
21	0.0000	0.00
22	0.0027	0.70
23	0.0027	0.71
24	0.0000	0.00
25	0.0014	1.00
26	0.0082	0.40
27	0.0150	0.48
28	0.0096	0.54
29	0.0027	0.71
30	0.0150	0.37
31	0.0178	0.28
32	0.0109	0.35
33	0.0233	0.29
34	0.0150	0.37
35	0.0246	0.25
36	0.0137	0.31
37	0.0178	0.27
38	0.0178	0.32
39	0.0356	0.21
40	0.0287	0.25
41	0.0192	0.29
42	0.0301	0.25
43	0.0246	0.25
44	0.0315	0.22
45	0.0383	0.19
46	0.0356	0.19
47	0.0602	0.14
48	0.0588	0.19
49	0.0766	0.16
50	0.0725	0.13
51	0.0821	0.13
52	0.0602	0.17
53	0.0465	0.17
54	0.0328	0.23
55	0.0246	0.28
56	0.0109	0.35
57	0.0123	0.33
58	0.0068	0.45
59	0.0000	0.00
60	0.0014	1.00
61	0.0027	0.71
62	0.0027	0.71
63	0.0000	0.00
64	0.0014	1.00
65	0.0027	0.71
66	0.0000	0.00
67	0.0000	0.00
68	0.0000	0.00
69	0.0000	0.00
70	0.0000	0.00
n	731	
m.w.c.v.		0.23

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 2007–08. and West Coast, North Island in 2006–07

P.j. = proportion of fish in age 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 age of kahawai from East Northland in 2007–08.

Age (years)	2007–08	
	P.j.	c.v.
1	0.0000	0.00
2	0.0044	0.63
3	0.0972	0.11
4	0.1179	0.11
5	0.1966	0.08
6	0.1173	0.12
7	0.1501	0.10
8	0.0986	0.13
9	0.0430	0.21
10	0.0586	0.17
11	0.0413	0.21
12	0.0280	0.26
13	0.0207	0.30
14	0.0114	0.42
15	0.0041	0.72
16	0.0020	1.01
17	0.0000	0.00
18	0.0000	0.00
19	0.0000	0.00
>19	0.0020	1.01
n	539	
m.w.c.v.		0.14

Estimates of the proportion at age of kahawai from the Hauraki Gulf in 2007–08.

Age (years)	2007–08	
	P.j.	c.v.
1	0.0000	0.00
2	0.0411	0.25
3	0.2507	0.08
4	0.0810	0.19
5	0.1396	0.14
6	0.0369	0.37
7	0.0722	0.23
8	0.0697	0.26
9	0.0622	0.28
10	0.0777	0.25
11	0.0560	0.28
12	0.0404	0.35
13	0.0416	0.34
14	0.0120	0.59
15	0.0000	0.00
16	0.0000	0.00
17	0.0042	1.01
18	0.0000	0.00
19	0.0000	0.00
>19	0.0000	0.00
n	227	
m.w.c.v.		0.20

Appendix 2 – continued:
Estimates of the proportion at age of kahawai from the Bay of Plenty in 2007–08.

Age (years)	2007–08 *P.j.*	2007–08 c.v.
1	0.0000	0.00
2	0.0208	0.22
3	0.1390	0.08
4	0.1546	0.09
5	0.1751	0.09
6	0.0811	0.14
7	0.1066	0.12
8	0.0570	0.17
9	0.0667	0.16
10	0.0668	0.15
11	0.0413	0.20
12	0.0353	0.21
13	0.0209	0.27
14	0.0123	0.37
15	0.0094	0.43
16	0.0032	0.73
17	0.0013	1.01
18	0.0027	0.73
19	0.0000	0.00
>19	0.0000	0.00
n	552	
m.w.c.v.		0.14

Estimates of the proportion at age of kahawai from West Coast, North Island in 2006–07.

Age (years)	2006–07 *P.j.*	2006–07 c.v.
1	0.0000	0.00
2	0.0576	0.17
3	0.0784	0.25
4	0.1046	0.22
5	0.1077	0.17
6	0.0555	0.27
7	0.0900	0.23
8	0.0872	0.20
9	0.0652	0.24
10	0.0395	0.28
11	0.0495	0.26
12	0.0677	0.23
13	0.0649	0.22
14	0.0416	0.32
15	0.0122	0.51
16	0.0060	0.58
17	0.0157	0.45
18	0.0238	0.35
19	0.0035	1.02
>19	0.0130	0.82
n	245	
m.w.c.v.		0.25

Appendix 3: Age–length keys derived from otolith samples collected from recreational fishers from East Northland in 2007–08.

Estimates of proportion of length at age for kahawai sampled from the East Northland recreational fishery, January to April 2008. (Note: Aged to 01/01/08)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
28	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
30	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
31	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
33	0	0	0.86	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
34	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
35	0	0	0.61	0.33	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
36	0	0	0.44	0.50	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
37	0	0	0.64	0.27	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
38	0	0	0.38	0.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
39	0	0	0	0.82	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
40	0	0	0.09	0.36	0.45	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
41	0	0	0	0.59	0.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
42	0	0	0.03	0.33	0.57	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
43	0	0	0	0.25	0.58	0.08	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	12
44	0	0	0	0.17	0.56	0.22	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	18
45	0	0	0	0.05	0.62	0.10	0.05	0.19	0	0	0	0	0	0	0	0	0	0	0	0	21
46	0	0	0	0.12	0.44	0.20	0.20	0.04	0	0	0	0	0	0	0	0	0	0	0	0	25
47	0	0	0	0	0.23	0.41	0.18	0.14	0	0.05	0	0	0	0	0	0	0	0	0	0	22
48	0	0	0	0.07	0.29	0.21	0.21	0.11	0.07	0.04	0	0	0	0	0	0	0	0	0	0	28
49	0	0	0	0	0.19	0.16	0.32	0.16	0.06	0.03	0.03	0	0	0	0.03	0	0	0	0	0	31
50	0	0	0	0	0.18	0.20	0.33	0.18	0.05	0	0.03	0.03	0.03	0	0	0	0	0	0	0	40
51	0	0	0	0	0.02	0.20	0.37	0.17	0.10	0.05	0.07	0.02	0	0	0	0	0	0	0	0	41
52	0	0	0	0	0	0.13	0.22	0.19	0.13	0.03	0.09	0	0.13	0.03	0	0.03	0	0	0	0.03	32
53	0	0	0	0	0	0.09	0.30	0.17	0.04	0.26	0	0.04	0.04	0.04	0	0	0	0	0	0	23
54	0	0	0	0	0	0.04	0.19	0.15	0.11	0.15	0.19	0.15	0.04	0	0	0	0	0	0	0	27
55	0	0	0	0	0	0	0.06	0.12	0.12	0.29	0.12	0.12	0	0.12	0.06	0	0	0	0	0	17
56	0	0	0	0	0	0.11	0.11	0.17	0.06	0.17	0.06	0.11	0.17	0.06	0	0	0	0	0	0	18
57	0	0	0	0	0	0	0	0.14	0.14	0.29	0.14	0.14	0.14	0	0	0	0	0	0	0	7
58	0	0	0	0	0	0	0	0.14	0	0.29	0.29	0.29	0	0	0	0	0	0	0	0	7
59	0	0	0	0	0	0	0	0	0	0.33	0.33	0.17	0	0.17	0	0	0	0	0	0	6
60	0	0	0	0	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	2
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																					539

Appendix 4: Age–length keys derived from otolith samples collected from recreational fishers from the Hauraki Gulf in 2007–08.

Estimates of proportion of length at age for kahawai sampled from the Hauraki Gulf recreational fishery, January to April 2008 (Note: Aged to 01/01/08)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
28	0	0.40	0.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
29	0	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
30	0	0.25	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
31	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
33	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
34	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
35	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
36	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
37	0	0	0.90	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
38	0	0	0.63	0.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
39	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
40	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
41	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
42	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
43	0	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
44	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
45	0	0	0	0.25	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
46	0	0	0	0.13	0.63	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
47	0	0	0	0.08	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
48	0	0	0	0	0.83	0	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0	6
49	0	0	0	0	0.50	0.25	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	4
50	0	0	0	0	0.43	0.29	0.29	0	0	0	0	0	0	0	0	0	0	0	0	0	7
51	0	0	0	0	0	0.17	0.50	0	0.17	0.17	0	0	0	0	0	0	0	0	0	0	6
52	0	0	0	0	0	0.13	0.20	0.20	0.13	0.13	0	0.07	0.13	0	0	0	0	0	0	0	15
53	0	0	0	0	0.07	0	0.14	0.21	0.14	0.07	0.14	0.07	0.14	0	0	0	0	0	0	0	14
54	0	0	0	0	0	0	0	0.10	0.20	0.40	0.10	0.10	0.10	0	0	0	0	0	0	0	10
55	0	0	0	0	0	0	0.13	0.06	0.06	0.06	0.25	0.25	0.06	0.06	0	0	0.06	0	0	0	16
56	0	0	0	0	0	0	0.24	0.18	0.18	0.12	0.12	0	0.12	0.06	0	0	0	0	0	0	17
57	0	0	0	0	0	0	0.11	0.22	0.11	0.11	0.22	0.11	0	0.11	0	0	0	0	0	0	9
58	0	0	0	0	0	0	0	0	0.25	0.13	0.25	0.13	0.25	0	0	0	0	0	0	0	8
59	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	1
60	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	1
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																					227

Appendix 5: Age–length keys derived from otolith samples collected from recreational fishers from the Bay of Plenty in 2007–08.

Estimates of proportion of length at age for kahawai sampled from the Bay of Plenty recreational fishery, January to April 2008 (Note: Aged to 01/01/08)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
24	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
25	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
26	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
27	0	0.75	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
28	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29	0	0.20	0.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
30	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
31	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
33	0	0	0.82	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
34	0	0	0.90	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
35	0	0	0.43	0.57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
36	0	0	0.43	0.57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
37	0	0	0.17	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
38	0	0	0.20	0.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
39	0	0	0.20	0.70	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
40	0	0	0.13	0.75	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
41	0	0	0	0.77	0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
42	0	0	0.06	0.56	0.17	0	0.11	0.06	0.06	0	0	0	0	0	0	0	0	0	0	0	18
43	0	0	0	0.37	0.42	0.16	0	0	0.05	0	0	0	0	0	0	0	0	0	0	0	19
44	0	0	0	0.15	0.55	0.20	0.05	0	0.05	0	0	0	0	0	0	0	0	0	0	0	20
45	0	0	0	0	0.88	0.06	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	16
46	0	0	0	0.15	0.42	0.19	0.08	0.08	0.08	0	0	0	0	0	0	0	0	0	0	0	26
47	0	0	0	0.11	0.61	0.11	0.11	0	0	0.06	0	0	0	0	0	0	0	0	0	0	18
48	0	0	0	0	0.50	0.06	0.17	0.06	0.06	0.17	0	0	0	0	0	0	0	0	0	0	18
49	0	0	0	0.05	0.23	0.32	0.14	0.05	0	0.18	0	0	0	0.05	0	0	0	0	0	0	22
50	0	0	0	0	0.17	0.06	0.39	0.11	0.17	0.06	0.06	0	0	0	0	0	0	0	0	0	18
51	0	0	0	0	0.19	0.08	0.19	0.11	0.16	0.08	0.05	0.05	0.03	0.03	0.03	0	0	0	0	0	37
52	0	0	0	0	0.09	0.09	0.24	0.16	0.16	0.09	0.07	0.09	0.02	0	0	0	0	0	0	0	45
53	0	0	0	0	0.02	0.14	0.14	0.14	0.10	0.12	0.05	0.10	0.10	0.05	0	0	0.02	0.02	0	0	42
54	0	0	0	0	0.02	0.15	0.17	0.08	0.08	0.08	0.23	0.08	0.06	0	0.02	0.02	0	0	0	0	48
55	0	0	0	0	0	0.06	0	0.06	0.18	0.29	0.06	0.24	0	0.06	0.06	0	0	0	0	0	17
56	0	0	0	0	0	0.13	0.25	0.06	0.13	0.13	0.13	0	0.13	0.06	0.00	0	0	0	0	0	16
57	0	0	0	0	0	0.06	0.12	0.12	0.12	0.24	0.06	0.12	0.06	0.06	0.06	0	0	0	0	0	17
58	0	0	0	0	0	0	0.22	0.11	0	0.22	0	0.11	0.11	0.11	0.11	0	0	0	0	0	9
59	0	0	0	0	0	0	0	0.17	0.17	0.33	0	0.33	0	0	0	0	0	0	0	0	6
60	0	0	0	0	0	0	0	0	0	0.17	0.17	0	0.17	0	0.17	0.17	0	0.17	0	0	6
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0.25	0.25	0.50	0	0	0	0	0	0	0	0	0	4
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	1
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																					552

Appendix 6: Age–length keys derived from otolith samples collected from recreational fishers from the West Coast, North Island in 2006–07.

Estimates of proportion of length at age for kahawai sampled from the West Coast, North Island recreational fishery, January to April 2007 (Note: Aged to 01/01/07)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
28	0	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
29	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
30	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31	0	0.25	0.50	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
32	0	0.33	0.33	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
33	0	0	0.83	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
34	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
35	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
36	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
37	0	0	0.50	0	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
38	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
39	0	0	0	0.29	0.71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
40	0	0	0	0.75	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	4
41	0	0	0	0.25	0.25	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	4
42	0	0	0	0.50	0	0	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	2
43	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
44	0	0	0	0.17	0.33	0.17	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0	6
45	0	0	0	0.09	0.45	0.18	0.09	0	0	0	0	0	0	0	0	0	0	0.09	0.09	0	11
46	0	0	0	0	0.36	0.27	0.27	0	0	0	0.09	0	0	0	0	0	0	0	0	0	11
47	0	0	0	0	0	0.17	0.17	0.17	0.17	0	0	0	0.17	0.17	0	0	0	0	0	0	12
48	0	0	0	0	0	0.09	0.27	0.27	0.09	0	0.09	0.18	0	0	0	0	0	0	0	0	11
49	0	0	0	0	0	0.09	0.09	0.09	0.18	0.18	0.14	0.14	0	0.05	0	0	0	0.05	0	0	22
50	0	0	0	0	0.06	0.06	0.18	0.06	0	0.06	0.06	0.18	0.24	0.12	0	0	0	0	0	0	17
51	0	0	0	0	0	0.10	0	0.19	0.19	0.10	0.05	0.14	0.05	0.10	0.05	0	0.05	0	0	0	21
52	0	0	0	0	0	0	0.06	0.22	0.06	0.06	0.06	0.17	0.22	0.06	0	0	0.11	0	0	0	18
53	0	0	0	0	0	0	0	0.13	0.13	0	0.20	0.13	0.07	0.07	0.13	0	0.07	0.07	0	0	15
54	0	0	0	0	0	0	0.06	0.17	0.11	0.11	0.17	0.17	0.06	0	0	0.06	0	0.06	0	0.06	18
55	0	0	0	0	0	0	0.17	0.17	0.08	0.17	0	0	0.08	0	0.08	0.17	0.08	0	0	0	12
56	0	0	0	0	0	0	0	0	0	0.20	0	0	0.60	0	0	0	0	0.20	0	0	5
57	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0	0	0.67	0	0	3
58	0	0	0	0	0	0	0	0	0	0	0	0	0.67	0	0	0	0	0	0	0.33	3
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	1
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																					245