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EXECUTIVE SUMMARY

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This report documents a sixth consecutive year of recreational catch sampling in KAH 1. The intention of this, and the preceding catch sampling programmes, was to describe the length and age composition of recreational landings, but these data are also regarded as a means of monitoring the wider KAH 1 fishery. 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 a highly 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.

For the first time in six years, more than 500 pairs of otoliths were collected in the Hauraki Gulf, yet in East Northland and the Bay of Plenty the number of fish measured was far less than in previous years. This is in contrast to previous years, when kahawai samples were more easily obtained in East Northland and the Bay of Plenty. The 2005–06 East Northland length and age compositions are very similar to those collected in the previous year, and reflect an age distribution which has broadened since 2000–01. The Hauraki Gulf is dominated by 3 year olds, as in previous years, although good catch rates suggest that the recruitment of this year class has been particularly strong this year. The Bay of Plenty length and age distributions are typically broad, with no variability in year class strength evident in 2005–06.

1. INTRODUCTION

Many fisheries are monitored using catch-at-age and catch-at-length data which have been 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from commercial purse seine landings in 1990–91 and 1991–92 were multimodal, and McKenzie & Trusewich (NIWA, Auckland, unpublished results) concluded that this was probably an artefact of the way the purse seine fleet operated, rather than an intrinsic feature of the Bay of Plenty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 kahawai in KAH 1.

Dedicated sampling of recreational landings of kahawai was initiated in the summer of 2000–01, and continued for a further five years, as part of the Ministry of Fisheries programmes KAH2002/02 (Hartill et al. 2007) and KAH2003/01 (Armiger et al. 2006). This report documents the results of a further year of sampling, undertaken as part of the Ministry of Fisheries programme KAH2005/02.

Overall objective

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

Specific objectives

1. To conduct the sampling and determine the length and age composition of the recreational landings of kahawai in KAH 1 for the 2005/06 fishing year. The target coefficient of variation (c.v.) for the catch at age will be 30% (mean weighted c.v. across all age classes).

2. METHODS

2.1 Overview of recreational kahawai catch sampling programmes

In the 1990s, in QMA 1, recreational fishers were interviewed at boat ramps to monitor aspects of the recreational fishery (see Sylvester 1993, Hartill et al. 1998). An unintentional 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 no age data were collected concurrently. 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 was initiated in January 2001 (KAH2000/01; Hartill et al. 2007). 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. All available kahawai were measured, 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 two years of sampling were conducted in 2004 and 2005 as part of KAH2003/01 (Armiger et al. 2006).

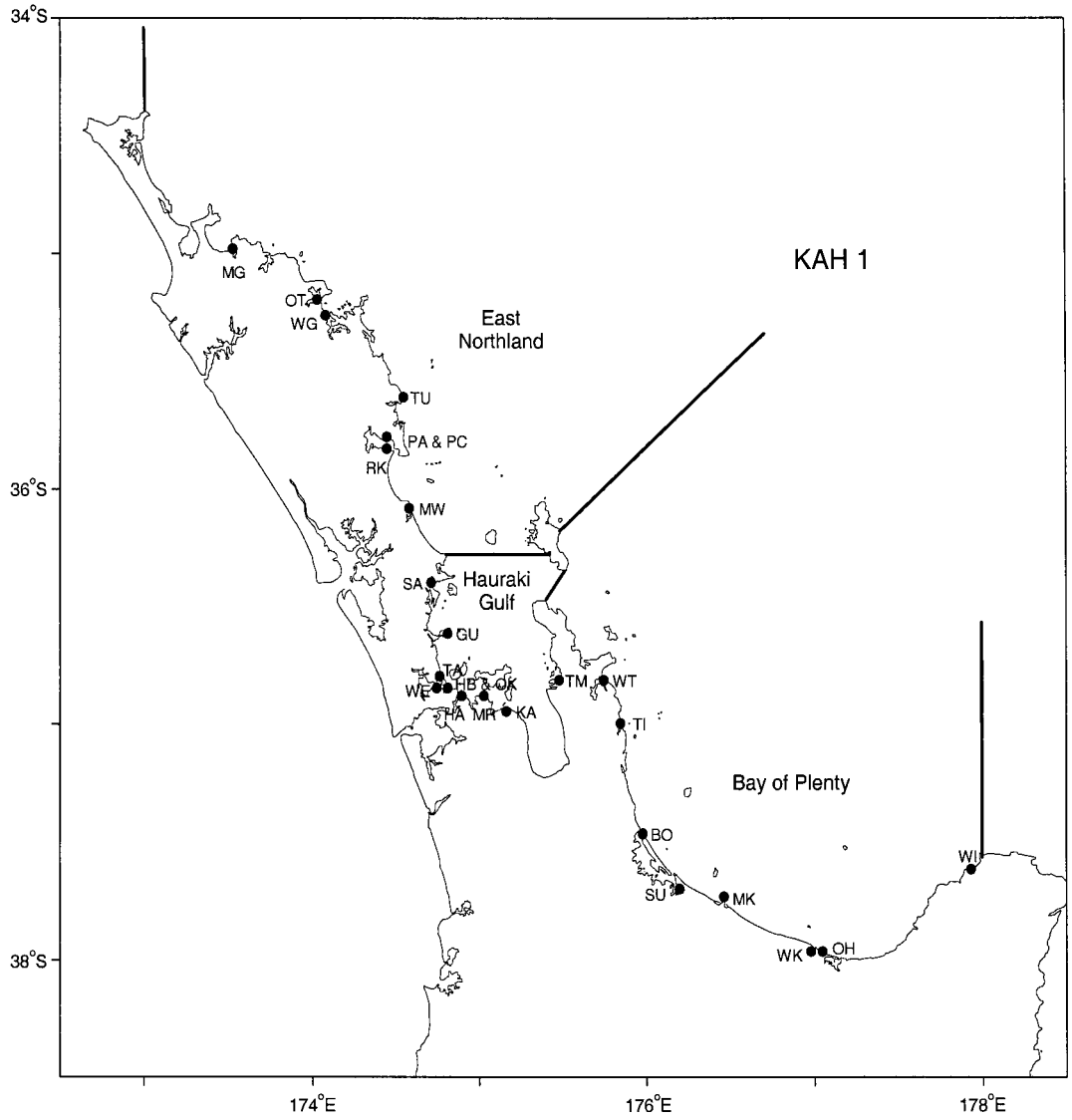
This programme provides recreational catch at age data from KAH 1 for a sixth consecutive year. The methods used in this programme are, therefore, essentially the same as those used since 2001, and are discussed below.

2.2 Sample design

The sample design used this survey was based on data collected from boat ramp surveys conducted between 2001 and 2005. 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, 2004). 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.

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 an age-length-key. 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 five previous 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 generated from this programme is 0.30, as specified in the objective above.



East Northland

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

Hauraki Gulf

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

Bay of Plenty

BO	Bowentown
MK	Maketu
OH	Ohope
SU	Sulphur Point, Tauranga
TI	Tairua
WI	Waihau Bay
WK	Whakatane
WT	Whitianga

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

Where possible, the same ramps have been surveyed since 2001, but in 2006 sampling was discontinued at the Motu River, as we were unable to recruit an interviewer in this sparsely populated region. To compensate for this, the target number of survey hours at Whakatane was doubled.

Sampling sessions at each ramp were randomly assigned to weekends and public holidays 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.

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

Region	Number of hours	Average no. of fish landed/interview h	Estimated no. of kahawai measured	Design Kahawai aged
East Northland	1 152	1.3	1 498	500
Hauraki Gulf	1 200	1.1	1 320	500
Bay of Plenty	512	3.5	1 792	500

Region	Number of hours	Average no. of fish landed/interview h	Estimated no. of kahawai measured	Actual Kahawai aged
East Northland	1 083	0.5	537	321
Hauraki Gulf	1 317	0.9	1 170	526
Bay of Plenty	497	1.3	656	497

Interviews 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 before landing. When fishers landing kahawai were encountered, all fish, including kahawai, were measured. For ageing purposes, 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. 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; and
- If no consensus could be reached, the otolith was discarded from the dataset.

Very few otoliths were discarded in practice, 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 the low sample sizes of 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 meaningless.

3. RESULTS

3.1 East Northland

The number of hours interviewers were present at ramps in East Northland was similar to that in 2001 to 2004 (Table 2). Some sampling in late April was cancelled due to poor weather. As with previous years, most kahawai were landed at the northern ramps, but the number of kahawai landed throughout the region on survey days was far less than usual. Consequently, only 537 kahawai were measured and encountered in East Northland, which is about half the number measured in previous years.

The length and age distributions in 2005–06 are very similar to those obtained in 2004–05 (Figure 2). The length distribution is typically broad and dominated by a mode at about 50 cm, which has been progressing through length compositions described over the last five years (Figure 2). The age distribution continues to broaden with most fish between 3 and 10 years of age, although older fish are still evident in this year's landings. The length and age distributions were both described with reasonable precision, with mwcvs of 0.23 (Appendix 1) and 0.19 (Appendix 2) respectively. These estimates of precision are lower than in previous years, reflecting both the low sample sizes and the broad distributions. In this region,

most kahawai recruit into the fishery at about 3 years of age, which corresponds to a length mode of about 30 to 40 cm (Appendix 3).

In previous years, comparisons of monthly age distributions (across all ramps) suggested that 2 to 4 year old fish were more predominant at the beginning of the survey, in January, than later, in April (Figure 3). In 2005–06, this trend was not apparent, with younger age classes accounting for a smaller proportion of the catch in all months.

Table 2: Summary statistics by region of the number of interview sessions, hours surveyed, vessels with measurable kahawai, kahawai measured, kahawai measured per hour, and kahawai aged in 2005–06. Regional summary statistics from previous survey years are given for comparison.

Region	Year	Ramp	Number of sessions	Number of hours	Boats interviewed (fishing)	Boats with measurable kahawai	Measurable kahawai landed*	Kahawai measured	Kahawai aged
East Northland	2005–06	Mangonui	24	143	302	66	152	132	62
		Opito Bay	22	128	133	49	136	101	69
		Waitangi	26	152	190	74	158	154	70
		Tutukaka	19	114	200	33	64	61	49
		Parua Bay (public)	16	96	168	12	36	21	21
		Parua Bay (club)	28	163	184	22	40	35	34
		Ruakaka	24	144	259	7	16	16	6
		Mangawhai	24	144	278	11	17	17	10
		Total	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	2005–06	Sandspit	21	136	142	14	21	21	12
		Gulf Harbour	21	126	377	52	118	92	42
		Takapuna	20	114	242	32	87	70	41
		Westhaven	21	126	336	42	136	87	59
		Hobson Bay	17	99	233	13	45	36	22
		Okahu Bay	19	114	224	15	65	28	18
		Half Moon Bay	38	228	1 174	108	354	219	110
		Maraetai	20	122	317	11	34	27	25
		Kawakawa Bay	31	126	620	170	563	467	107
		Te Kouma	21	126	369	73	133	123	90
		Total	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	2005–06	Whitianga	16	64	69	48	138	127	92
		Tairua	10	45	90	5	20	13	6
		Bowentown	16	64	80	11	51	22	22
		Sulphur Point	14	60	148	55	126	100	95
		Maketu	12	62	52	23	116	115	49
		Whakatane	14	113	160	53	419	161	151
		Ohope	12	48	46	13	60	60	36
		Waihau Bay	12	42	33	24	58	58	46
		Total	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.

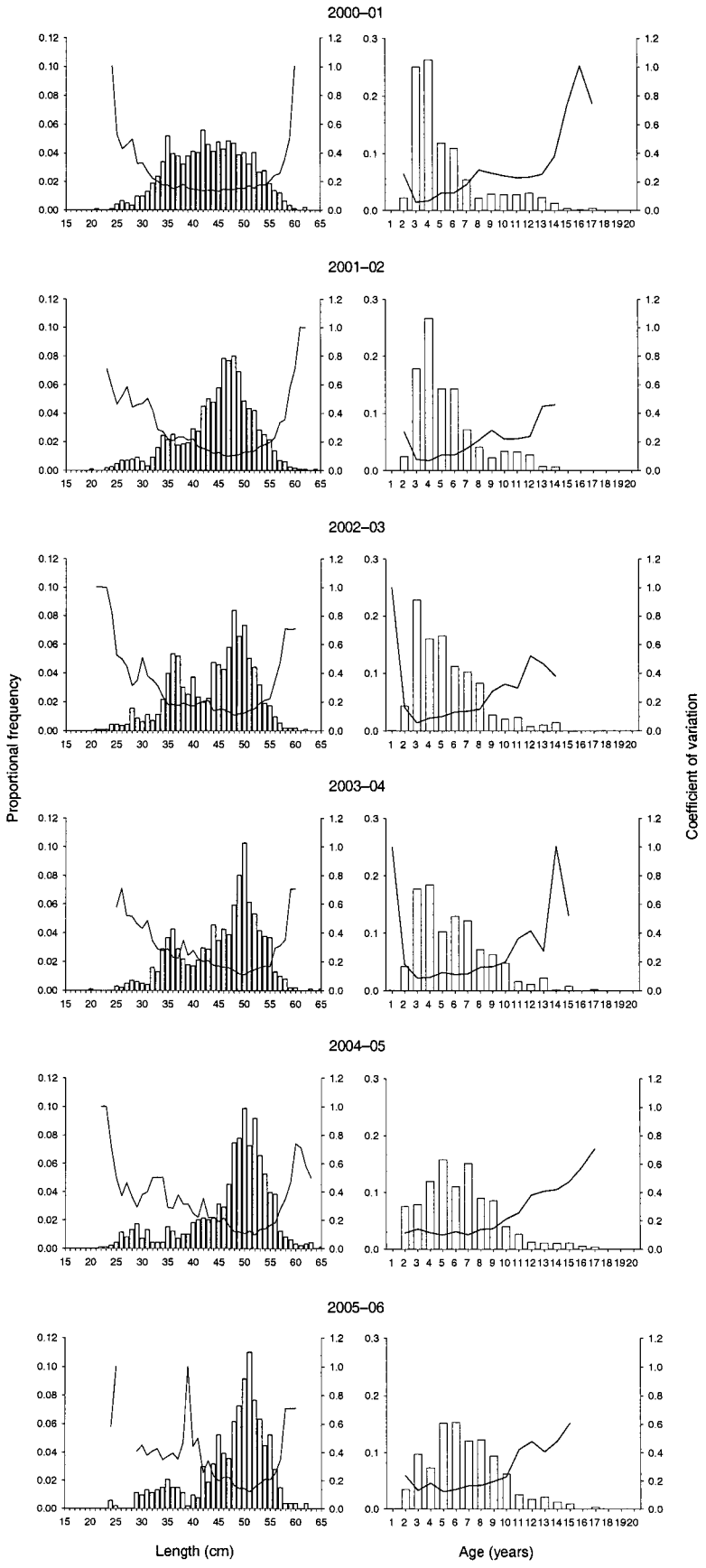


Figure 2: Length and age distributions (histograms) and c.v.s (solid line) of recreational landings of kahawai in East Northland annually since 2000–01.

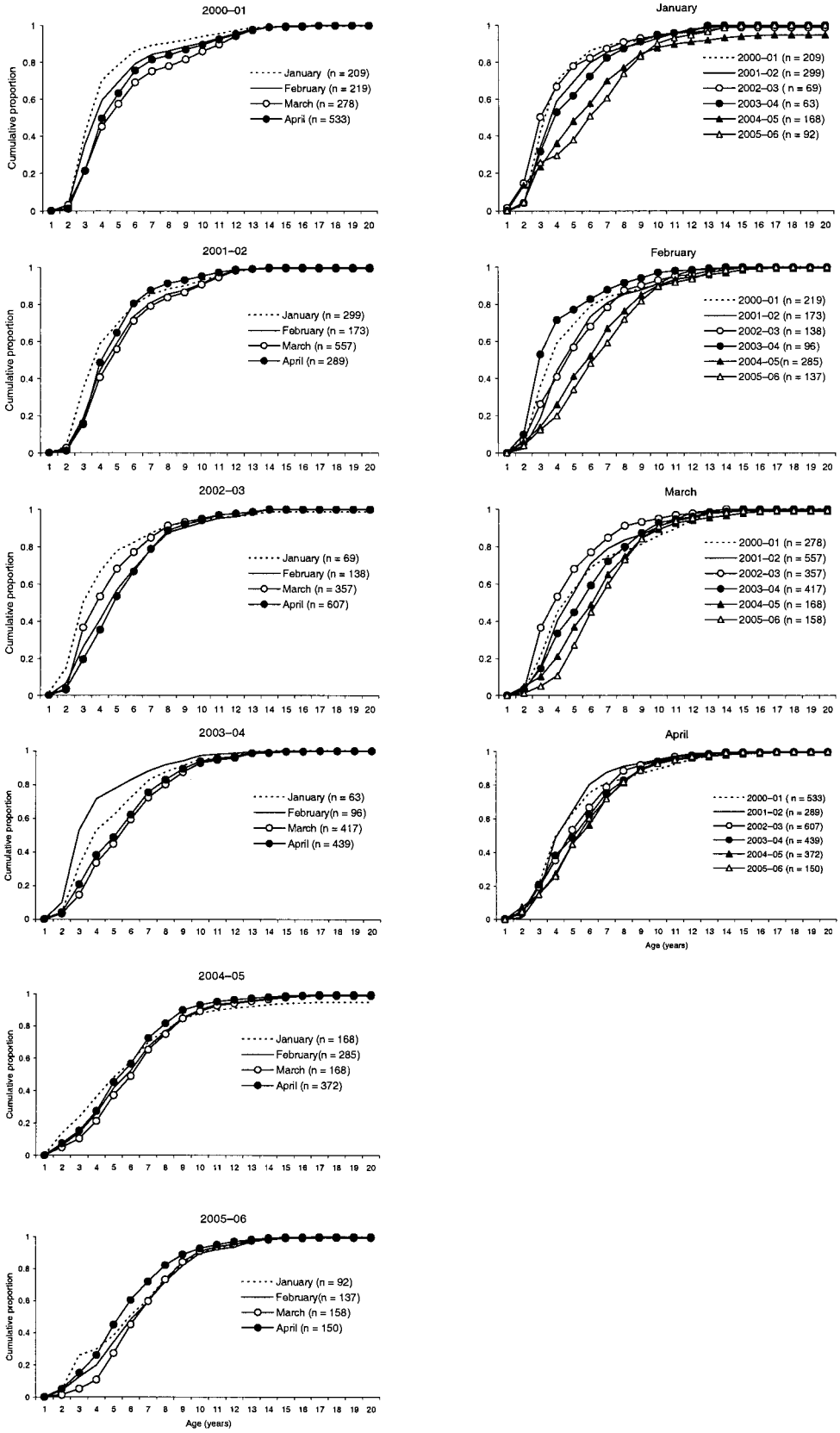


Figure 3: Cumulative age distributions by month for East Northland since 2000–01. Left hand panels compare monthly age distributions within fishing years and right hand panels compare annual age distributions for each of the four months. The number of fish measured is given for each month.

As usual, 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, and 92% in 2005–06 (Figure 4). Fishers were not asked how far they were fishing 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 paucity of information on offshore catches, there appears to be some evidence of increasing fish size with increasing distance offshore.

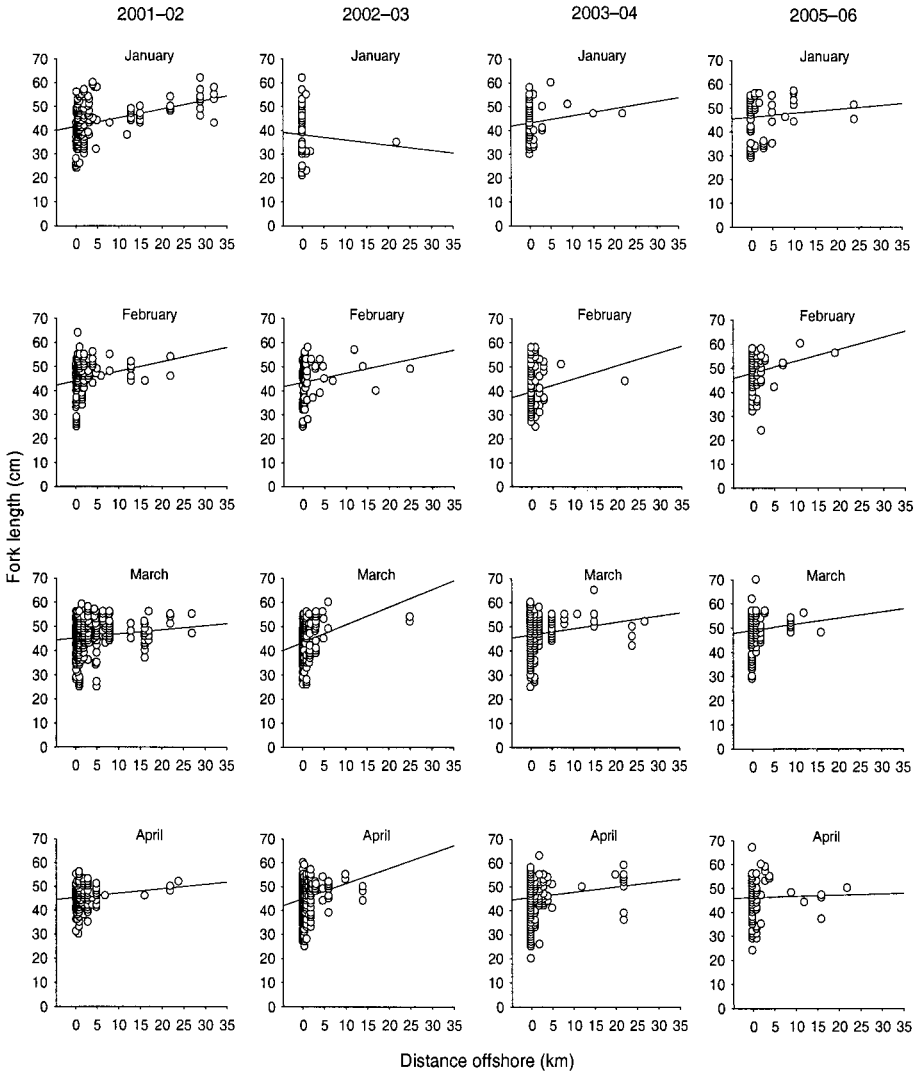


Figure 4: Length of landed kahawai relative to the estimated distance off the East Northland coastline at which they were caught. Results from three previous years are given for comparison. Data on the distance fished offshore were not collected in 2004–05.

3.2 Hauraki Gulf

After two poor seasons of kahawai landings in the Hauraki Gulf in 2003–04 and 2004–05, the number of kahawai encountered by interviewers increased substantially in 2005–06, with 1170 fish measured compared to 606 to 892 in previous years (Table 2). Consequently, for the first time in six years, the target sample size for age of 500 was easily achieved. The length and age distributions are similar to those collected in 2000–01, with a strong mode peaking at 35 cm which corresponds to a dominating 3 year old age class (Figure 5, Appendix 3). The precision (mwcvs) of the length and age distributions was 0.18 and 0.10 respectively (Appendices 1 & 2).

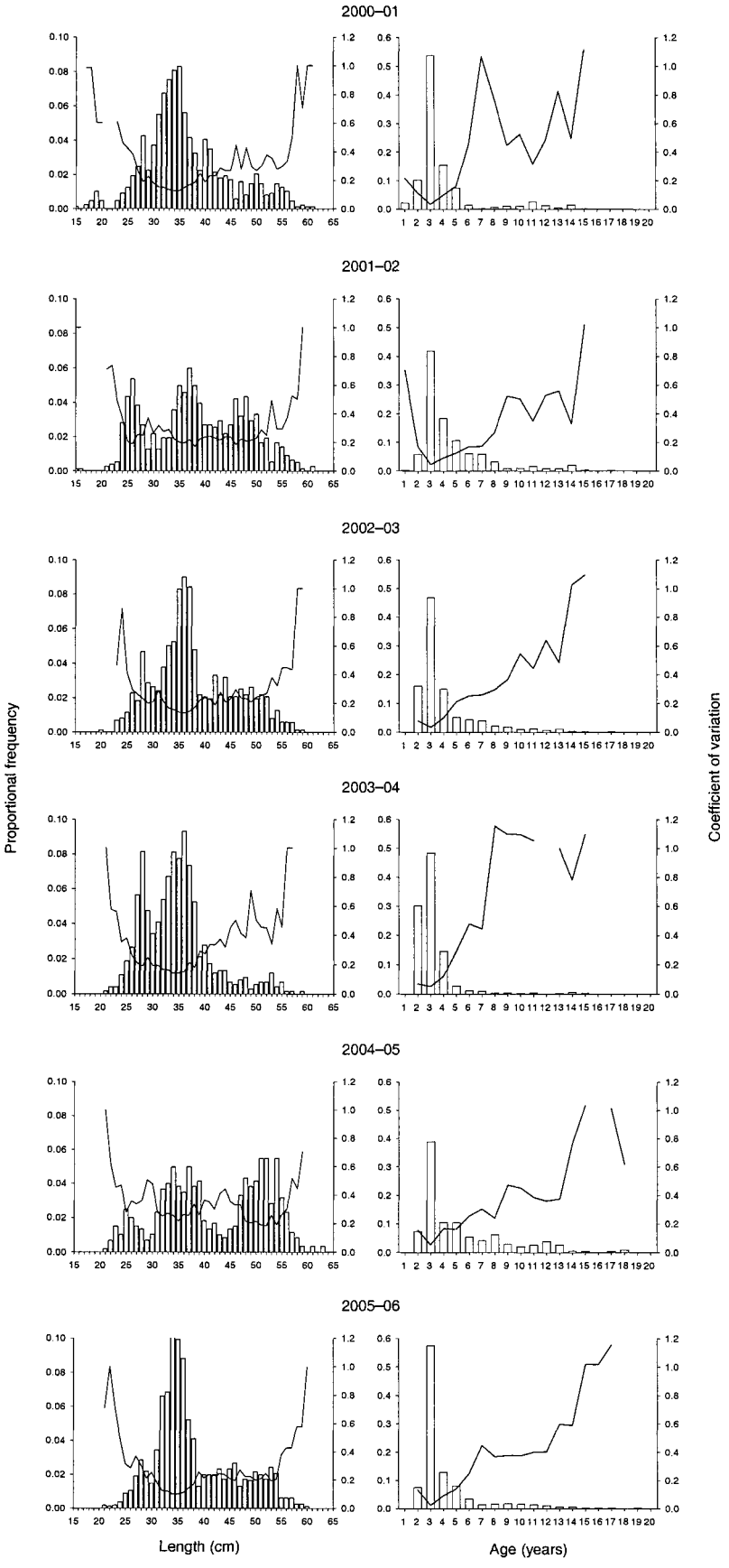


Figure 5: Length and age distributions (histograms) and c.v.s (solid line) of recreational landings of kahawai in the Hauraki Gulf since 2000–01.

The similarity of the age distribution with that of 2000–01 is clearly evident in the cumulative monthly distributions given in Figure 6.

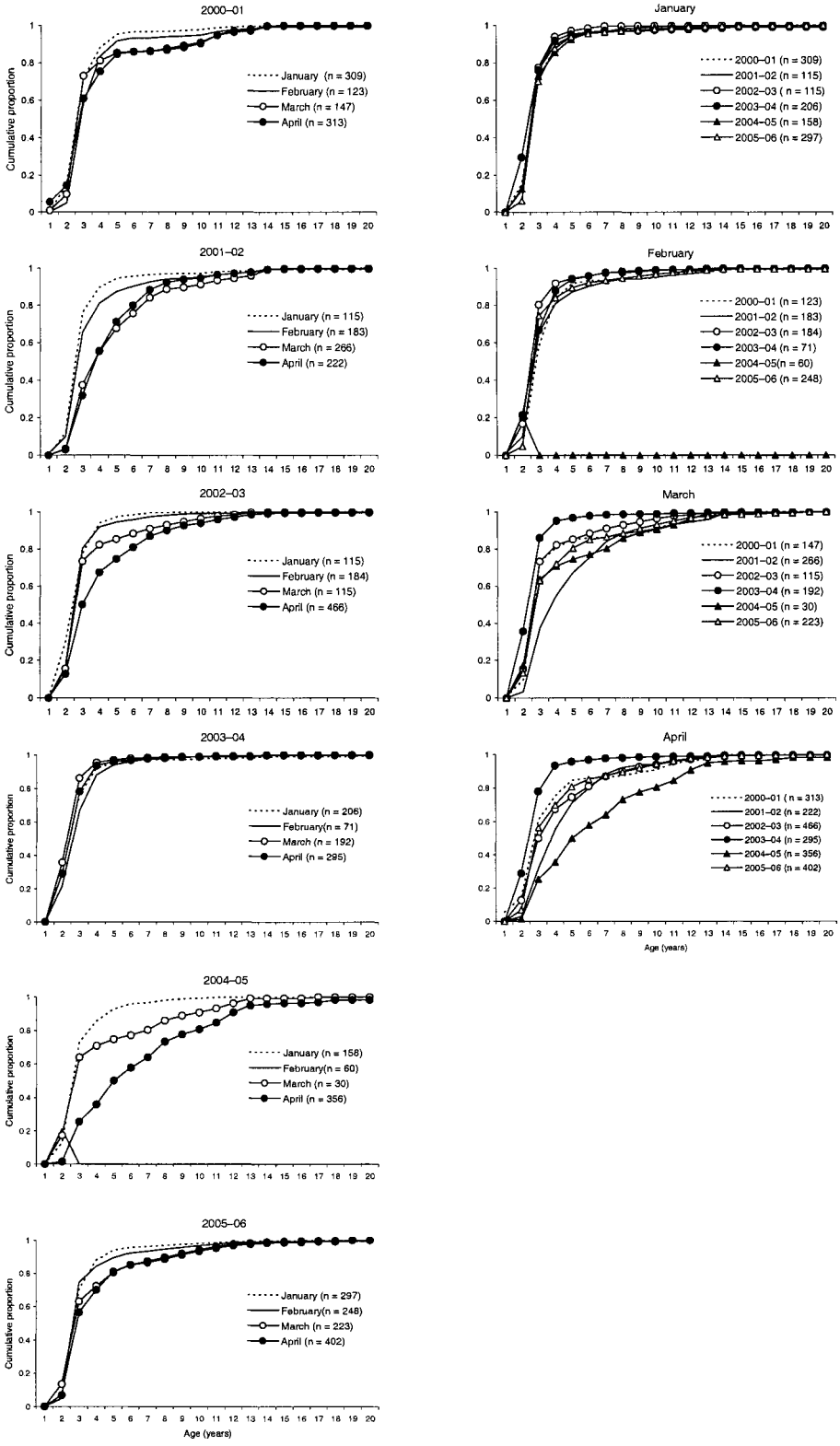


Figure 6: Cumulative age distributions by month for the Hauraki Gulf since 2000–01. Left hand panels compare monthly age distributions within fishing years and right hand panels compare annual age distributions for each of the four months. The number of fish measured is given for each month.

3.3 Bay of Plenty

The number of kahawai measured by boat ramp interviewers in the Bay of Plenty was far lower than in any previous year, despite similar sampling effort to that in 2001 to 2004. A higher proportion of these fish were aged, and the target sample size of 500 otoliths was almost reached (Table 2). The precision of the length distribution was therefore lower than usual (mwcv of 0.23), but that of the age distribution (0.14) was similar to that obtained in previous years (Appendices 1 and 2). As with previous years, a dominant mode of 45–50 cm fish dominates the Bay of Plenty length distribution (Figure 7). The age distribution is also characteristically broad, although there is no clear evidence of any strong or weak year classes. Age distributions do not appear to change very much from month to month (Figure 8). When comparisons are made across years, for each of the four months, the only year which appears atypical is 2004–05.

The relationship between fish size and the distance they were caught from the mainland is poorly defined, despite the fact that a significant proportion of kahawai are caught some distance offshore (Figure 9).

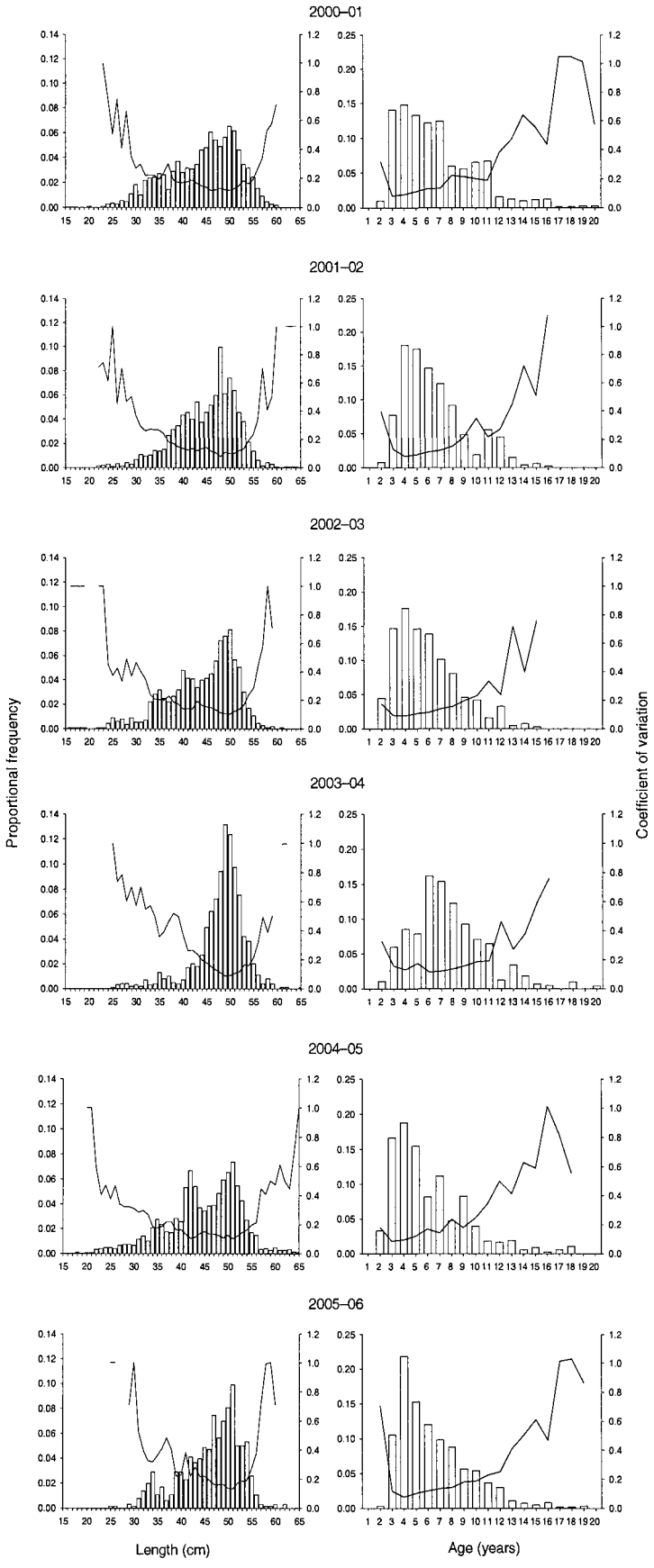


Figure 7: Length and age distributions (histograms) and c.v.s (solid line) of recreational landings of kahawai in the Bay of Plenty since 2000–01.

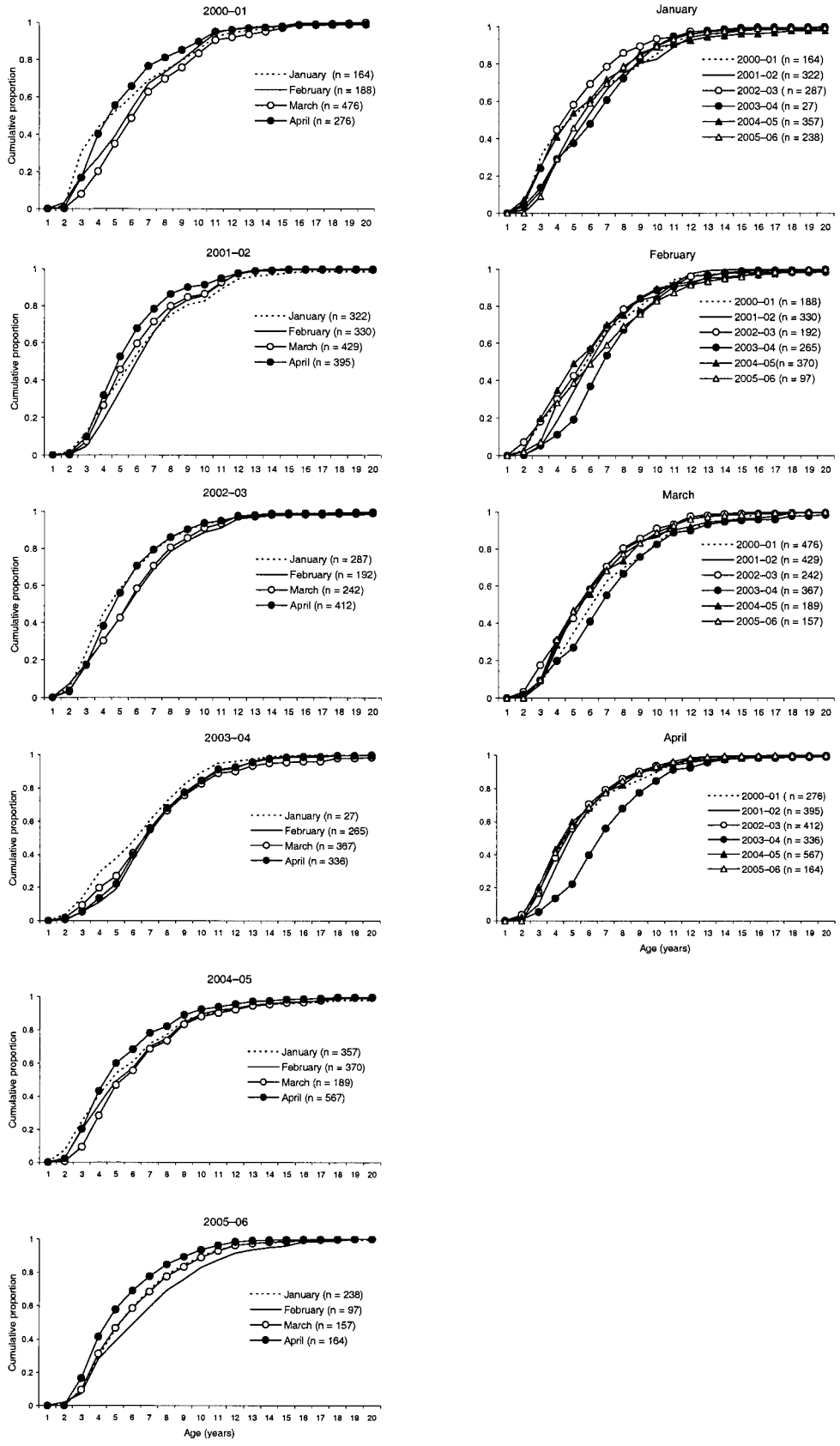


Figure 8: Cumulative age distributions by month for the Bay of Plenty since 2000–01. Left hand panels compare monthly age distributions within fishing years and right hand panels compare annual age distributions for each of the four months. The number of fish measured is given for each month.

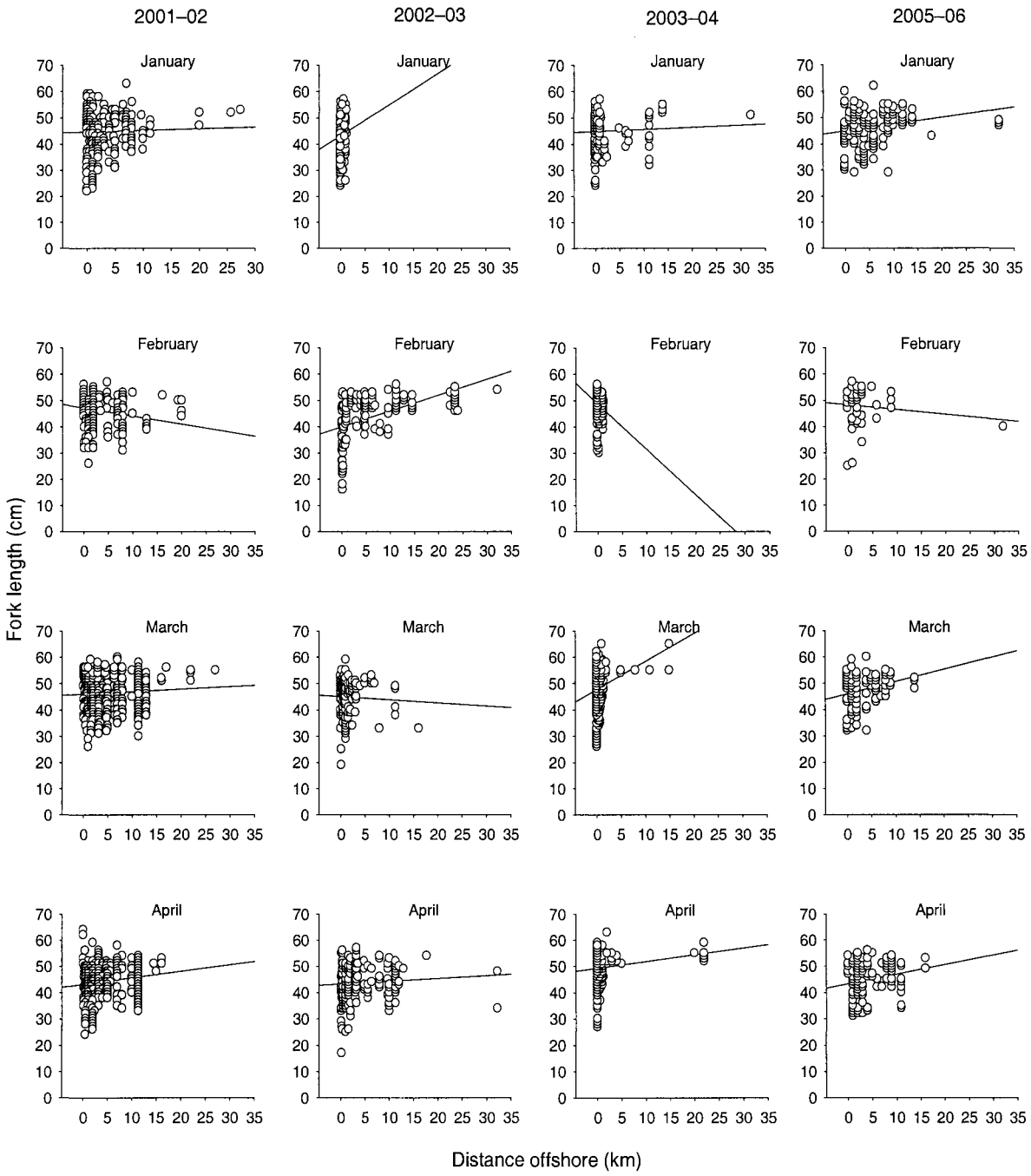


Figure 9: Length of landed kahawai relative to the estimated distance off the Bay of Plenty coastline at which they were caught. Results from three previous years are given for comparison. Data on the distance fished offshore were not collected in 2004–05.

3.4 Total mortality estimates

One of the original reasons for collecting a time series of catch-at-age data was to monitor changes in associated fisheries. One way of doing this is to monitor changes in total mortality estimates (Z). Chapman & Robson (1960) estimates of Z were calculated for all of the age distributions sampled from the East Northland and Bay of Plenty since 2001 (Table 3). Age distributions from the Hauraki Gulf were not considered, as this is essentially a juvenile fishery, with recruitment, and presumably 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. 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. Unfortunately, our understanding of the nature and magnitude of movement between areas is very limited, and these estimates should be treated with some caution. Natural mortality is assumed to be about 0.18.

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 recruitment	East Northland					
	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06
3	0.33	0.33	0.32	0.28	0.24	0.23
4	0.34	0.38	0.35	0.31	0.28	0.26
5	0.30	0.37	0.39	0.33	0.33	0.32
6	0.30	0.40	0.41	0.38	0.36	0.36

Age at recruitment	Bay of Plenty					
	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06
3	0.23	0.25	0.28	0.20	0.27	0.25
4	0.26	0.30	0.32	0.23	0.29	0.30
5	0.28	0.33	0.34	0.26	0.30	0.31
6	0.30	0.36	0.38	0.32	0.30	0.32

4. DISCUSSION

Obtaining sufficient length-at-age samples from a region's recreational fishery to adequately describe catch compositions from each region continues to be an uncertain process. The number of kahawai measured and aged in the Hauraki Gulf in 2005–06 was the highest in six years of sampling. In the preceding two years, however, far fewer kahawai were encountered by interviewers in the Gulf, despite far high levels of sampling effort, resulting from synergies with other programmes (REC2002/02 and REC2004/01). These fluctuations probably reflect differing levels of recruitment in a fishery which is dominated by juvenile fish. This year's substantial decline in the number of kahawai landed at East Northland and the Bay of Plenty, however, was not expected. Although not all of the kahawai landed were measured, the total number of kahawai landed to surveyed ramps was also far lower than in previous years. It is possible that this year's decline in the number of kahawai observed in East Northland and the Bay of Plenty reflects poor recruitment, as seen in the Hauraki Gulf in the two preceding years. Some of the fluctuations in landings over the last 6 years will reflect changes in levels of fishing effort in response to the weather, but conditions experienced in any one region are usually broadly indicative of those throughout KAH 1.

Regional length and age compositions derived from recreational landings sampled in 2005–06 are broadly consistent with patterns and trends seen in previous years (see Bradford 1999, Armiger et al. 2006, Hartill et al. 2007). The East Northland age distribution is no longer dominated by the younger recruited age classes, as 5 to 8 year olds are now more commonly caught. Most of the kahawai landed

in the Hauraki Gulf by recreational fishers in 2005–06 were three year olds, as seen in previous years, although good catch rates suggest better than average recruitment this year. The Bay of Plenty age distribution is still broad.

Although broad trends are evident in each of the three time series, there is only limited evidence of any progression of strong and week year classes. Possible explanations for this are relatively constant levels of recruitment, ageing error, insufficient sampling of recreational landings, and interannual variability in the size structure of kahawai available to the inshore recreational fishery. Constant levels of recruitment may explain generally smooth age distributions over one or two years, but when a time series of age distributions is found to be relatively featureless, while changing in overall composition through time, this explanation appears unlikely. The only two explanations which can be considered, without omniscient knowledge, are those relating to ageing error and levels of sampling effort. The explanation of ageing error is currently being explored, which will be reported along with the results from the 2006–07 fishing year. Regardless, some of the shifts in age composition between years are too extreme to be explained by ageing error alone (compare the 2003–04 and 2004–05 Bay of Plenty age distributions).

Individual year class strengths are less apparent in a time series when ageing error occurs, but unless there is a high degree of error, strong and weak year classes should still be apparent, to some diminished extent. A random selection of otoliths collected from the Bay of Plenty, between 2001 and 2005, is currently being reread to determine whether there has been a progressive increase in mean length-at-age over this period. As part of this exercise, we will be comparing these readings with those originally obtained, which may highlight ageing error.

It is possible that higher levels of sampling may help define year class strengths more clearly, but despite considerable levels of interviewing, we often collect less than our target of 500 otolith pairs per region, and have never been able to measure 1500 kahawai in any fishery. Nonetheless, the numbers of fish we age from each fishery are similar to those collected annually from the west coast snapper trawl fishery (which has a similar number of age classes) for which individual year classes are consistently evident, yet this is not the case for kahawai. In a final review of the feasibility of a recreational kahawai catch sampling programme, Bradford (2001) suggested that for an area supporting a wide range of age classes, such as the Bay of Plenty, a minimum of 400–500 was required to discern individual age classes with any confidence.

Ultimately, the objective of this programme is to describe the length and age composition of recreational landings of kahawai, and although this may have been achieved, these compositions do not fully represent the underlying population structure. In part, this is due to the retention behaviour of fishers, and the selectivity of their gears, but it appears likely that there may be marked interannual variability in the size structure of kahawai available to fishers, and hence the size structure of their catch. Kahawai school by size, and this behaviour, and the seasonal location of these schools, may change in response to annual climatic conditions. While the spatial distribution of fishing effort may be predictable, the spatial distributions of each year class may differ, therefore distorting the apparent strength of each year class in a season's catch.

Regardless, the sampling of recreational landings is still the best available means of monitoring kahawai population age structures. One or more of the shortcomings discussed above lessens our ability to track the progression of age classes, and therefore, if age data are collected intermittently, or over too short a term, it is unlikely that we will be able to determine relative year class strengths.

5. ACKNOWLEDGMENTS

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6. REFERENCES

Armiger, H.; Hartill, B.; Tasker, R.; Smith, M.; Griggs (2006). Length and age compositions of recreational landings of kahawai in KAH 1 in January to April 2003–04 and 2004–05. *New Zealand Fisheries Assessment Report 2006/57.* 37 p.

Bradford, E. (1998). Unified kahawai growth parameters. *NIWA Technical Report 9.* 50 p.

Bradford, E. (1999). Size distribution of kahawai in commercial and recreational catches. *NIWA Technical Report 61.* 51 p.

Bradford, E. (2000). Feasibility of sampling the recreational fishery to monitor the kahawai stock. *New Zealand Fisheries Assessment Report 2000/11.* 34 p.

Bradford, E. (2001). Further considerations on the feasibility of sampling the recreational fishery to monitor the kahawai stock. *New Zealand Fisheries Assessment Report 2001/5.* 27 p.

Chapman, D.G.; Robson, D.S. (1960). The analysis of a catch curve. *Biometrics 16*: 354–368.

Davies, N.M.; Walsh, C. (1995). Length and age composition of commercial snapper landings in the Auckland Fisheries Management Area 1988–94. *New Zealand Fisheries Data Report No. 58.* 85 p.

Hartill, B.; Armiger, H.; Tasker, R.; Middleton, C.; Fisher, D. (2007). Monitoring the length and age composition of recreational landings of kahawai in KAH 1 in 2000–01, 2001–02 and 2002–03. *New Zealand Fisheries Assessment Report 2007/6.* 38 p.

Hartill, B.; Blackwell, R.; Bradford, E. (1998). Estimation of mean fish weights from the recreational catch landed at boatramps in 1996. *NIWA Technical Report 31.* 40 p.

Stevens, D.W.; Kalish, J. M. (1998). Validated age and growth of kahawai (*Arripis trutta*) in the Bay of Plenty and Tasman Bay. *NIWA Technical Report 11.* 33 p.

Sylvester, T. (1993). Recreational fisheries catch per unit effort trends in the North region (1990/91). Northern Fisheries Region Internal Report No. 14. 23 p. (Unpublished report held by Ministry of Fisheries, Auckland.)

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 2005–06

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 2005–06

Length	2005–06	
(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	0.0056	0.58
25	0.0019	1.00
26	0.0000	0.00
27	0.0000	0.00
28	0.0000	0.00
29	0.0112	0.40
30	0.0093	0.45
31	0.0130	0.38
32	0.0112	0.41
33	0.0130	0.42
34	0.0149	0.35
35	0.0205	0.37
36	0.0149	0.39
37	0.0149	0.35
38	0.0112	0.47
39	0.0019	1.00
40	0.0093	0.44
41	0.0074	0.50
42	0.0298	0.25
43	0.0186	0.34
44	0.0317	0.23
45	0.0521	0.20
46	0.0391	0.22
47	0.0354	0.22
48	0.0615	0.16
49	0.0726	0.14
50	0.0912	0.14
51	0.1099	0.12
52	0.0764	0.15
53	0.0633	0.18
54	0.0447	0.21
55	0.0521	0.21
56	0.0279	0.25
57	0.0149	0.35
58	0.0037	0.71
59	0.0037	0.71
60	0.0037	0.71
61	0.0000	0.00
62	0.0037	0.70
63	0.0000	0.00
64	0.0000	0.00
65	0.0000	0.00
66	0.0000	0.00
67	0.0019	1.00
68	0.0000	0.00
69	0.0000	0.00
70	0.0019	1.00
n	537	
m.w.c.v.		0.23

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Hauraki Gulf in 2005–06

Length (cm)	2005–06	
	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	0.0017	0.71
22	0.0009	1.00
23	0.0017	0.71
24	0.0034	0.50
25	0.0085	0.31
26	0.0103	0.28
27	0.0188	0.37
28	0.0282	0.30
29	0.0214	0.21
30	0.0145	0.25
31	0.0342	0.18
32	0.0658	0.12
33	0.0684	0.12
34	0.1077	0.10
35	0.0991	0.10
36	0.0880	0.11
37	0.0521	0.14
38	0.0410	0.17
39	0.0128	0.26
40	0.0197	0.22
41	0.0197	0.24
42	0.0197	0.23
43	0.0231	0.24
44	0.0171	0.24
45	0.0231	0.21
46	0.0265	0.19
47	0.0128	0.27
48	0.0171	0.22
49	0.0162	0.23
50	0.0214	0.20
51	0.0197	0.21
52	0.0171	0.24
53	0.0239	0.19
54	0.0205	0.20
55	0.0060	0.38
56	0.0060	0.43
57	0.0060	0.43
58	0.0026	0.58
59	0.0026	0.58
60	0.0009	1.00
61	0.0000	0.00
62	0.0000	0.00
63	0.0000	0.00
64	0.0000	0.00
65	0.0000	0.00
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	1 170	
m.w.c.v.		0.18

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Bay of Plenty in 2005–06

Length (cm)	2005–06	
	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	0.0000	0.00
25	0.0015	1.00
26	0.0015	1.00
27	0.0000	0.00
28	0.0000	0.00
29	0.0030	0.71
30	0.0015	1.00
31	0.0076	0.53
32	0.0137	0.39
33	0.0198	0.32
34	0.0290	0.32
35	0.0107	0.36
36	0.0168	0.41
37	0.0061	0.48
38	0.0107	0.40
39	0.0290	0.22
40	0.0290	0.23
41	0.0229	0.38
42	0.0412	0.22
43	0.0366	0.28
44	0.0396	0.22
45	0.0488	0.22
46	0.0473	0.20
47	0.0747	0.16
48	0.0564	0.16
49	0.0701	0.17
50	0.0808	0.14
51	0.0991	0.13
52	0.0503	0.17
53	0.0503	0.19
54	0.0534	0.19
55	0.0259	0.27
56	0.0107	0.38
57	0.0030	0.71
58	0.0015	1.00
59	0.0015	1.00
60	0.0030	0.71
61	0.0000	0.00
62	0.0030	0.71
63	0.0000	0.00
64	0.0000	0.00
65	0.0000	0.00
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	656	
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 2005–06.

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 2005–06.

Age (years)	2005–06	
	P.j.	*c.v.*
1	0.0000	0.00
2	0.0348	0.24
3	0.0972	0.13
4	0.0730	0.18
5	0.1518	0.12
6	0.1534	0.14
7	0.1207	0.16
8	0.1230	0.17
9	0.0936	0.19
10	0.0620	0.23
11	0.0256	0.42
12	0.0174	0.48
13	0.0214	0.41
14	0.0121	0.48
15	0.0091	0.61
16	0.0000	0.00
17	0.0030	1.01
18	0.0000	0.00
19	0.0000	0.00
>19	0.0000	0.00
n	321	
m.w.c.v.		0.19

Estimates of the proportion at age of kahawai from the Hauraki Gulf in 2005–06.

Age (years)	2005–06	
	P.j.	*c.v.*
1	0.0000	0.00
2	0.0752	0.13
3	0.5747	0.02
4	0.1292	0.09
5	0.0802	0.14
6	0.0341	0.25
7	0.0142	0.45
8	0.0162	0.37
9	0.0169	0.38
10	0.0156	0.38
11	0.0134	0.40
12	0.0112	0.40
13	0.0050	0.60
14	0.0055	0.59
15	0.0017	1.02
16	0.0017	1.02
17	0.0013	1.15
18	0.0000	0.00
19	0.0030	1.07
>19	0.0000	0.00
n	526	
m.w.c.v.		0.10

Appendix 2 – continued:
Estimates of the proportion at age of kahawai from the Bay of Plenty in 2005–06.

Age (years)	2005–06	
	P.j.	*c.v.*
1	0.0000	0.00
2	0.0030	0.70
3	0.1052	0.12
4	0.2179	0.08
5	0.1525	0.10
6	0.1202	0.12
7	0.0980	0.13
8	0.0877	0.14
9	0.0563	0.18
10	0.0537	0.19
11	0.0366	0.23
12	0.0295	0.25
13	0.0111	0.41
14	0.0073	0.51
15	0.0047	0.61
16	0.0079	0.47
17	0.0019	1.01
18	0.0019	1.03
19	0.0030	0.86
>19	0.0000	0.00
n	497	
m.w.c.v.		0.14

Appendix 3: Age–length keys derived from otolith samples collected from recreational fishers from East Northland in 2005–06.

Estimates of proportion of length at age for kahawai sampled from the East Northland recreational fishery, January to April 2006. (Note: Aged to 01/01/06)

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	3
25	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0.80	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
30	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
31	0	0.17	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
32	0	0.40	0.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
33	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
34	0	0.17	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
35	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
36	0	0	0.75	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
37	0	0	0.71	0.29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
38	0	0	0.75	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
39	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
40	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
41	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
42	0	0	0	0.50	0.20	0.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
43	0	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
44	0	0	0	0.29	0.43	0.14	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	14
45	0	0	0	0.14	0.59	0.14	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	22
46	0	0	0	0.13	0.50	0.31	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	16
47	0	0	0	0.14	0.36	0.29	0.14	0	0	0	0	0.07	0	0	0	0	0	0	0	0	14
48	0	0	0	0	0.43	0.14	0.33	0	0	0.05	0.05	0	0	0	0	0	0	0	0	0	21
49	0	0	0	0.08	0.13	0.21	0.33	0.08	0.13	0.04	0	0	0	0	0	0	0	0	0	0	24
50	0	0	0	0	0.06	0.31	0.19	0.19	0.19	0	0.06	0	0	0	0	0	0	0	0	0	16
51	0	0	0	0	0.04	0.24	0.20	0.36	0.08	0	0.04	0	0.04	0	0	0	0	0	0	0	25
52	0	0	0	0	0	0.27	0.09	0.18	0.18	0.09	0.09	0	0	0.05	0.05	0	0	0	0	0	22
53	0	0	0	0	0.05	0.14	0	0.19	0.29	0.24	0	0	0	0.05	0	0	0.05	0	0	0	21
54	0	0	0	0	0	0	0.13	0.38	0.13	0.13	0.13	0.13	0	0	0	0	0	0	0	0	8
55	0	0	0	0	0	0	0.07	0.07	0.14	0.36	0	0.14	0.14	0	0.07	0	0	0	0	0	14
56	0	0	0	0	0	0	0.14	0.14	0.29	0.29	0	0	0.14	0	0	0	0	0	0	0	7
57	0	0	0	0	0	0.13	0	0.38	0	0.13	0	0	0.25	0	0.13	0	0	0	0	0	8
58	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	2
59	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	1
60	0	0	0	0	0	0	0	0.50	0.50	0	0	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	1.00	0	0	0	0	0	0	0	0	0	0	0	1
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	1.00	0	0	0	0	0	0	0	0	1
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																					321

Appendix 4: Age–length keys derived from otolith samples collected from recreational fishers from the Hauraki Gulf in 2005–06.

Estimates of proportion of length at age for kahawai sampled from the Hauraki Gulf recreational fishery, January to April 2006 (Note: Aged to 01/01/06)

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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
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	1
24	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
26	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
27	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
28	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
29	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
30	0	0.14	0.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
31	0	0.06	0.94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48
33	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47
34	0	0	0.96	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73
35	0	0	0.98	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53
36	0	0	0.88	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43
37	0	0	0.96	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
38	0	0	0.83	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
39	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
40	0	0	0.15	0.77	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
41	0	0	0	0.93	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
42	0	0	0	0.88	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
43	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
44	0	0	0	0.78	0.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
45	0	0	0	0.45	0.45	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
46	0	0	0	0	0.67	0.17	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	6
47	0	0	0	0	0.80	0	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	5
48	0	0	0	0	0.67	0.11	0	0.11	0	0.11	0	0	0	0	0	0	0	0	0	0	9
49	0	0	0	0	0.70	0.10	0.10	0	0.10	0	0	0	0	0	0	0	0	0	0	0	10
50	0	0	0	0	0.17	0.42	0	0.08	0.17	0.08	0	0	0	0.08	0	0	0	0	0	0	12
51	0	0	0	0	0.22	0.22	0.11	0.11	0.11	0.11	0	0.11	0	0	0	0	0	0	0	0	9
52	0	0	0	0	0.11	0.22	0	0.22	0	0.11	0.22	0	0	0.11	0	0	0	0	0	0	9
53	0	0	0	0	0	0.21	0.14	0.07	0.07	0.07	0.14	0.14	0	0	0.07	0.07	0	0	0	0	14
54	0	0	0	0	0	0.09	0	0.09	0.09	0.09	0.09	0.27	0.18	0.09	0	0	0	0	0	0	11
55	0	0	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	2
56	0	0	0	0	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	2
57	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0	0	0	0	0.50	0	2
58	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0.50	0	0	0	2
59	0	0	0	0	0	0	0	0	0	0.50	0	0	0.50	0	0	0	0	0	0	0	2
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																					526

Appendix 5: Age–length keys derived from otolith samples collected from recreational fishers from the Bay of Plenty in 2005–06.

Estimates of proportion of length at age for kahawai sampled from the Bay of Plenty recreational fishery, January to April 2006 (Note: Aged to 01/01/06)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
30	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
33	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
34	0	0	0.80	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
35	0	0	0.80	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
36	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
37	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
38	0	0	0.25	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
39	0	0	0.13	0.88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
40	0	0	0.06	0.78	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
41	0	0	0	0.90	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
42	0	0	0	0.95	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
43	0	0	0	0.59	0.35	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
44	0	0	0	0.75	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
45	0	0	0	0.44	0.37	0.15	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	27
46	0	0	0	0.18	0.59	0.18	0	0.05	0	0	0	0	0	0	0	0	0	0	0	0	22
47	0	0	0	0.13	0.48	0.16	0.13	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0	0	31
48	0	0	0	0	0.31	0.27	0.23	0.08	0.08	0.04	0	0	0	0	0	0	0	0	0	0	26
49	0	0	0	0	0.13	0.34	0.11	0.13	0.18	0.08	0.03	0	0	0	0	0	0	0	0	0	38
50	0	0	0	0	0.07	0.26	0.19	0.24	0.07	0.02	0.05	0.02	0.05	0.02	0	0	0	0	0	0	42
51	0	0	0	0	0.06	0.10	0.25	0.17	0.13	0.19	0.06	0.04	0	0	0	0	0	0	0	0	48
52	0	0	0	0	0	0.13	0.22	0.17	0.13	0.13	0.09	0.13	0	0	0	0	0	0	0	0	23
53	0	0	0	0	0	0.08	0.15	0.23	0.04	0.08	0.23	0.15	0	0	0	0	0.04	0	0	0	26
54	0	0	0	0	0	0.10	0.07	0.20	0.13	0.17	0.10	0.10	0.07	0.07	0	0	0	0	0	0	30
55	0	0	0	0	0	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.14	0.07	0.14	0.07	0	0.07	0	0	14
56	0	0	0	0	0	0.18	0.18	0.09	0.09	0.18	0	0.18	0	0	0.09	0	0	0	0	0	11
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0.50	0	2
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	1
60	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0	0	0.50	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	1.00	0	0	0	0	1
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																					497