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EXECUTIVE SUMMARY

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Landing sampling programmes are often used to provide length and age data for fisheries assessments. Usually, commercial landings are sampled as they provide the most insight into changes in length and age structure through time. Kahawai school by size, however, and commercial landings are usually composed of fish from only one or two schools. Length and age distributions sampled from individual landings therefore tend to be narrow and highly variable between landings, and are therefore limited in their utility. Recreational fisheries, however, are composed of thousands of trips, which sample a greater number of schools at a much lower level of intensity, and are therefore more likely to reflect changes in the underlying population. Resultant length frequency distributions tend to be more unimodal, with any secondary peaks probably reflecting strong year classes rather than the influence of individual schools. Further, there is no minimum legal size for kahawai and recreational fishers therefore tend to land a greater size range of kahawai, in addition to providing a more accurate insight into the population in the area fished.

Dedicated sampling of recreational landings of kahawai was initiated (as part of the Ministry of Fisheries programme KAH2000/01) in the summer of 2000–01, and continued for a further two years. This report documents the results of an additional two years sampling, undertaken as part of the Ministry of Fisheries programme KAH2003/01. The methods and sample design used in 2003–04 and 2004–05 were closely based on that used in the preceding three years. Noticeably fewer kahawai were encountered by boat ramp interviewers in the Hauraki Gulf and Bay of Plenty, despite far more intensive sampling effort resulting from another two concurrent programmes (REC2002/02 and REC2004/01). Sampling in the eastern Bay of Plenty in 2004 was also hampered by a rahui (fishery closure by local iwi) which halted fishing for several months, and also by staff shortages. Despite these problems, regional kahawai length and age compositions were described with satisfactory precision.

Regional length and age compositions derived from recreational landings sampled in both 2003–04 and 2004–05 are broadly consistent with patterns and trends seen in previous years. The East Northland population has become increasingly dominated by larger, older fish, and the age composition is now far more similar to that of the Bay of Plenty than it was five years ago. In contrast, the Hauraki Gulf population is composed of smaller, younger fish, with poor representation of the older age classes seen elsewhere. Probably the most abundant component of the KAH 1 population is that found in the Bay of Plenty, which now has a broad age distribution, predominantly composed of 3 to 11 year old fish.

When the results from this survey are combined with those of the previous three years, a time series of regional length and age distributions emerges which provides a key component of any future stock assessment of KAH 1. The manner in which these data will be used is partially dependent on our understanding of movement by a species which is commonly regarded as highly mobile. A cursory examination of data available from tagging programmes conducted in the early 1980s and in 1991 suggest that despite this mobility, 80–90% of kahawai remain resident within KAH 1, and that emigration within and between stocks/substocks is at least partially size dependent. If future stock assessments move away from the single stock approach used previously, and focus on KAH 1 (the only Quota Management Area for which an age structured modelling approach is currently possible), the possible influence of size-dependent movement should be explicitly considered. This may involve a more detailed analysis of the available tag/recapture data, which should consider the relative exploitation rates of substocks, and non-independence of observations arising from recapture events involving more than one fish, that were tagged during the same release event.

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, which may be used to monitor the fishery. For this reason, dedicated sampling of recreational landings of kahawai was initiated in the summer of 2000–01, and continued for a further two years, as part of the Ministry of Fisheries programme KAH2002/02 (Hartill et al. 2004). This report documents the results of a further two years sampling, undertaken as part of the Ministry of Fisheries programme KAH2003/01.

Overall Objective

1. To monitor the status of the kahawai (*Arripis trutta*) 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 2003/04 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. To conduct the sampling and determine the length and age composition of the recreational landings of kahawai in KAH 1 for the 2004/05 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).

3. To assess the feasibility of using recreational CPUE as an index of kahawai abundance.

Work associated with the third specific objective is documented in a Final Research Report for KAH200401, which characterises New Zealand's fisheries (Hartill & Walsh 2005).

2. METHODS

2.1 Previous boat ramp surveys

In 1990–91, a survey was conducted to collect baseline information on harvest rates by recreational fishers interviewed at boat ramps throughout the Auckland Fisheries Management Area (Sylvester 1993). Most interviewing occurred on weekends between Boxing Day 1990 and June 1991. The main objective of a further survey in 1994 was to verify aspects of a concurrent recreational fisher diary

survey. The length compositions of recreational catches measured during boat ramp interviews were compared with those reported by diarists. These boat ramp data were also used in conjunction with an aerial survey to estimate harvest from the Hauraki Gulf, which was compared with that derived from the diary programme (Sylvester 1994). In 1996, a nationwide boat ramp survey was carried out to estimate the mean weights of fish species caught by recreational fishers (Hartill et al. 1998). These mean weights were used in conjunction with estimates of the numbers of fish taken, derived from a telephone diary survey, to provide estimates of the national recreational harvest of key species (Bradford 1998a).

Although kahawai length frequency data are available from these boat ramp interviews, the 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. 2004). 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.

This programme is essentially a two year extension of the previous three year programme. The methods used in this programme are therefore essentially the same as those used previously (KAH2000/01) and are discussed below.

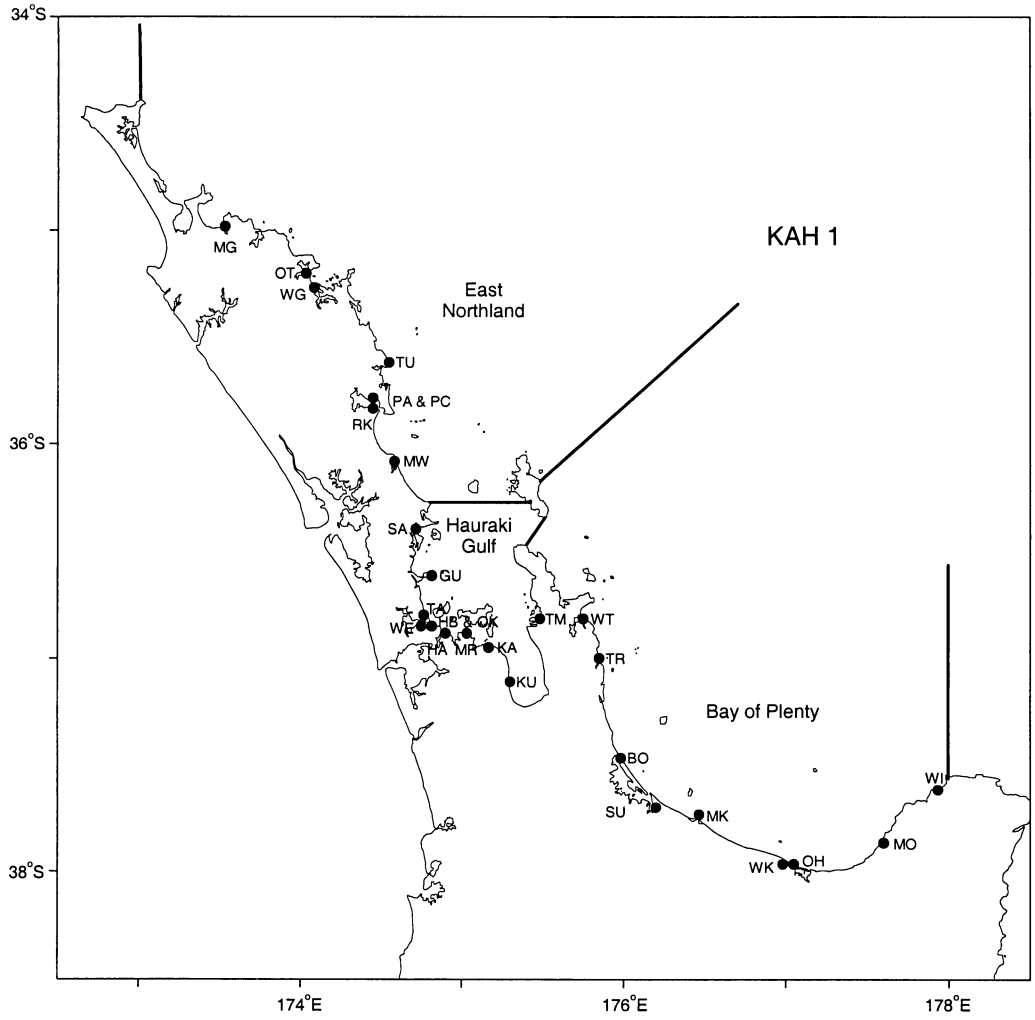
2.2 Sample design

The sample design used in the 2003–04 and 2004–05 surveys was based on data collected from boat ramp surveys conducted in 2000–01, 2001–02, and 2002–03. Kahawai length data and age distributions from these surveys (and length data from previous surveys in 1991, 1994, and 1996) strongly suggest that there were 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 (excluding synergies arising from REC2002/02 and REC 2004/01 as discussed below) were based on those used in the three 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 2000–01, 2001–02, and 2002–03 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 objectives.



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
KU Kaiaua
MR Maretai
OK Okahu Bay
SA Sandspit
TA Takapuna
TM Te Kouma
WE Westhaven

Bay of Plenty

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

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

Sampling sessions at each ramp were randomly assigned to weekends and public holidays between 1 January and 30 April. In 2003–04, interviewing in East Northland and the Bay of Plenty took place solely on weekends and public holidays, when most recreational fishing usually occurs. If East Northland and Bay of Plenty based interviewers found that there were strong onshore winds or local competitions on any of the randomly preassigned dates, sampling took place on the next available weekend/holiday day. In the Hauraki Gulf, however, sampling effort was augmented by a concurrent

recreational harvest programme in the Hauraki Gulf in 2003–04 (REC2002/02) which involved intensive boat ramp interviewing.

Table 1: Sample design used in KAH 1 recreational fishery sampling programmes since 2000–01.

Region	Number of ramps	Session length (h)	Number of sessions	Total hours interviewing	Target no. measured	Target age sample
East Northland	8	6	28	1 344	1 500	500
Hauraki Gulf	11	6	21	1 386	1 500	500
Bay of Plenty	9	4	12	432	1 500	500

In 2004–05, the number of hours of interviewing in all three areas greatly exceeded the sampling design because of a large scale concurrent recreational harvest estimation programme (REC200401). Boat ramp interviewers were therefore present on randomly preassigned days only, regardless of the prevailing weather conditions. Nonetheless, more fishers were interviewed than in previous years, although much of this additional interviewing took place during the working week. The introduction of weekday sampling in the Hauraki Gulf in 2003–04 and all three areas in 2004–05 is unlikely to influence the size and age composition of landings, as results from the 1996 boat ramp survey demonstrated that there were no substantive differences between length frequencies of commonly caught species during weekdays and weekends (Hartill et al. 1998).

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 of recreational fishers permitted 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 1998b). 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 artists 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, as 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.

3. RESULTS

3.1 The 2003–04 sampling season

A network of interviewers was established at 28 key boat ramps in East Northland, the Hauraki Gulf, and the Bay of Plenty (Figure 1). During the 2003–04 sampling season in the Hauraki Gulf the number of hours spent interviewing recreational fishers was almost twice that of previous years, yet far fewer kahawai were encountered than in previous years (Table 2). In same year in the eastern Bay of Plenty there was a rahui in place which halted all fishing effort at the Motu River and Waihau Bay. Very few hours of interviewing therefore took place at these ramps, although good numbers of kahawai were measured when fishing took place.

3.2 The 2004–05 sampling season

In 2004–05, the number of hours of interviewing in all three regions greatly exceeded the sampling design because of a parallel large scale recreational harvest survey (REC2004/01). Again, far fewer kahawai were encountered, especially in the Hauraki Gulf and Bay of Plenty regions (Table 2). In the eastern Bay of Plenty, lack of suitable interviewers at the Motu River, and to a lesser extent Waihau Bay, limited the data that could be collected from these areas.

3.3 Length and age distributions

3.3.1 East Northland

The length distribution of East Northland recreational kahawai landings in both 2003–04 and 2004–05 was 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). This progression has resulted in an increasingly even and broad age distribution, reflecting either better than average year class strengths 9 or 10 years ago, or poor recruitment in recent years relative to that of the older age classes. Length and age distributions were both described with reasonable precision, with mwcvs of 0.20 in 2003–04 and 0.19 in 2004–05 (Appendix 1) and 0.14 for both years (Appendix 2). 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).

Comparisons of monthly age distributions (across all ramps) suggest that there are some temporal changes in the age composition of kahawai landings during the survey (Figure 3). In all years, 2 to 4 year old fish were more predominant at the beginning of the survey, in January, than later, in April. There was usually a marked increase in the number of kahawai encountered by boat ramp interviewers in March and April, which suggests that changes in the age composition of recreational landing may be due to a mechanism such as onshore movement of schools of older fish in later months.

As 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, and 83% in 2003–04 (Figure 4). Most of recreational fishing effort takes place close to shore, however, and it is possible that numerous schools of offshore kahawai were not encountered. Despite the paucity of information on offshore catches, there appears to be some evidence of increasing fish size with increasing distance offshore. These data were not collected in the 2004–05 fishing year.

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 2003–04 and 2004–05. Regional summary statistics from previous survey years are given for comparative purposes.

Region	Year	Ramp	Number of sessions	Number of hours	Boats interviewed (fishing)	Boats with measurable kahawai	Kahawai measured	Kahawai aged
East Northland	2005	Mangonui	62	411	462	129	309	104
		Opito Bay	31	192	280	52	111	60
		Waitangi	31	390	506	99	261	132
		Tutukaka	32	193	170	23	55	43
		Parua Bay (public)	63	415	398	40	67	40
		Parua Bay (club)	62	412	558	83	137	88
		Ruakaka	32	196	185	10	12	11
		Mangawhai	31	197	193	23	41	36
		Total	344	2 407	2 752	459	993	514
	2004	Mangonui	19	123	367	78	154	72
		Opito Bay	21	109	204	54	97	64
		Waitangi	24	140	259	89	269	90
		Tutukaka	23	120	219	45	106	73
		Parua Bay (public)	26	150	339	47	111	62
		Parua Bay (club)	28	158	478	81	178	90
		Ruakaka	26	156	254	9	18	12
		Mangawhai	23	139	307	36	82	54
		Total	190	1 096	2 427	439	1 015	517
	2003		186	1 049	2 089	436	1 171	504
	2002		199	1 110	1 878	491	1 318	526
	2001		196	1 129	2 233	474	1 236	517
Hauraki Gulf	2005	Sandspit	35	228	143	8	9	3
		Gulf Harbour	63	404	499	24	39	12
		Takapuna	62	399	849	40	94	36
		Westhaven	64	406	836	28	44	32
		Hobson Bay	20	121	118	2	2	1
		Okahu Bay	25	150	308	11	19	11
		Half Moon Bay	97	611	1 458	51	94	25
		Maraetai	30	181	256	2	6	6
		Kawakawa Bay	64	414	993	71	214	93
		Kaiaua	32	193	181	–	–	–
		Te Kouma	63	411	761	56	85	70
		Total	557	3 529	6 402	293	606	289
	2004	Sandspit	20	124	139	11	26	26
		Gulf Harbour	44	267	426	26	44	23
		Takapuna	44	290	814	39	146	52
		Westhaven	46	278	744	33	56	32
		Hobson Bay	22	133	344	11	23	15
		Okahu Bay	16	96	277	12	18	11
		Half Moon Bay	85	505	1 637	89	187	91
		Maraetai	23	139	299	11	15	14
		Kawakawa Bay	47	278	889	86	193	47
		Kaiaua	23	135	193	4	11	–
		Te Kouma	38	230	460	23	45	39
	2004	Total	408	2 475	6 222	345	764	350
	2003		231	1 301	3 432	395	880	527
	2002		204	1 138	3 348	339	786	500
	2001		212	1 174	2 706	435	892	500
Bay of Plenty	2005	Whitianga	50	346	358	51	116	60
		Tairua	32	209	269	32	54	10
		Bowentown	62	419	603	65	116	66
		Sulphur Point	121	780	1 476	226	613	78
		Maketu	26	157	242	58	136	29
		Whakatane	64	415	441	74	294	86
		Ohope	27	164	111	37	107	64
		Motu	15	94	11	9	28	–
		Waihau Bay	9	54	100	13	19	–
		Total	406	2 636	3 611	565	1 483	393
	2004	Whitianga	15	60	170	26	67	47
		Tairua	14	47	131	19	37	19
		Bowentown	16	68	111	18	46	37
		Sulphur Point	16	65	177	60	155	113
		Maketu	15	63	62	34	77	34
		Whakatane	10	39	201	85	326	74
		Ohope	16	61	54	24	58	57
		Motu	5	23	41	35	198	–
		Waihau Bay	1	5	5	5	31	31
		Total	108	429	952	306	995	412
	2003		120	462	1 246	357	1 133	477
	2002		141	474	1 197	457	1 476	495
	2001		100	319	934	294	1 104	457

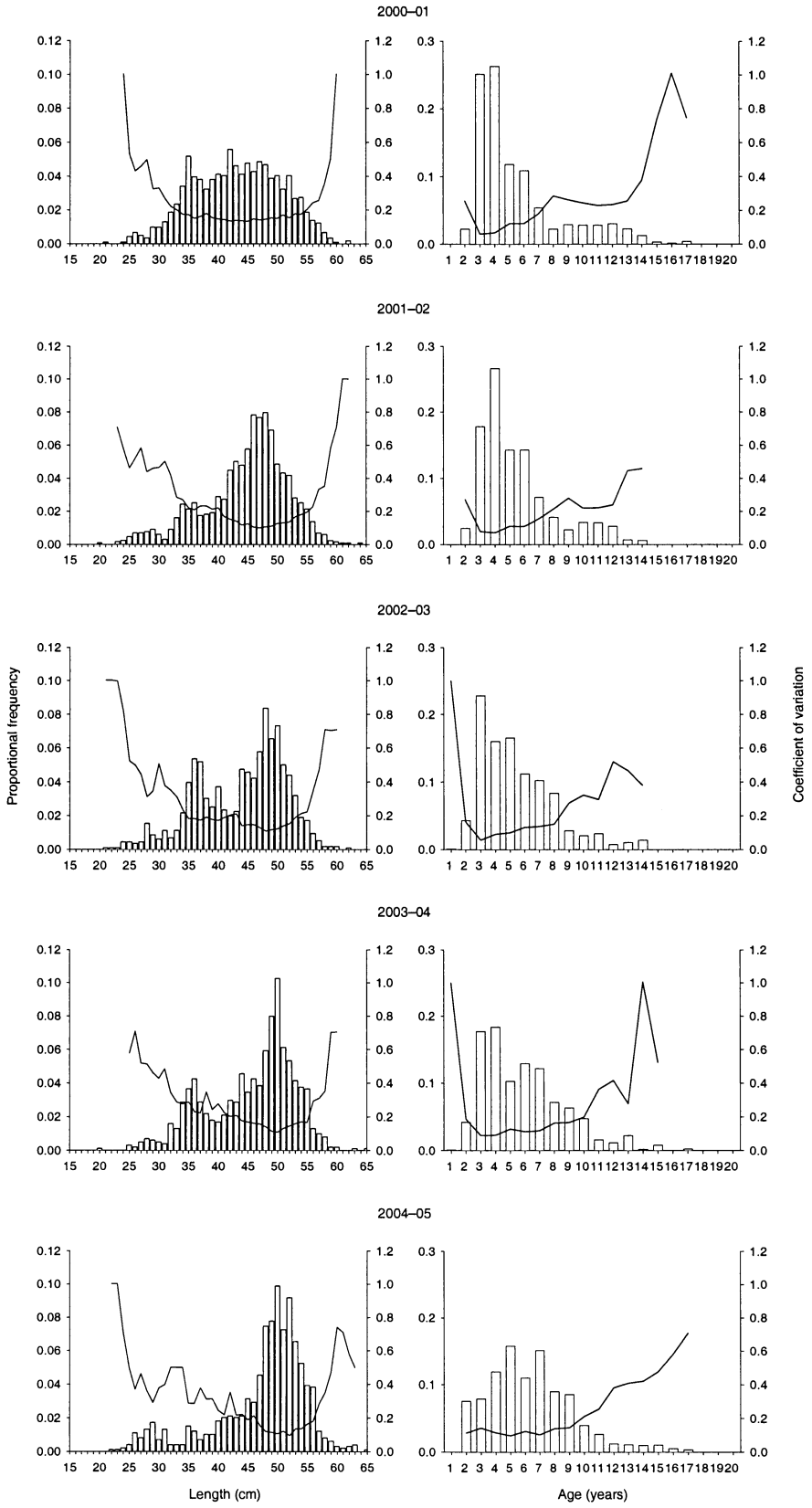


Figure 2: Length and age distributions (histograms) and c.v.s (solid line) of recreational landings of kahawai in East Northland in 2000–01, 2001–02, 2002–03, 2003–04, and 2004–05.

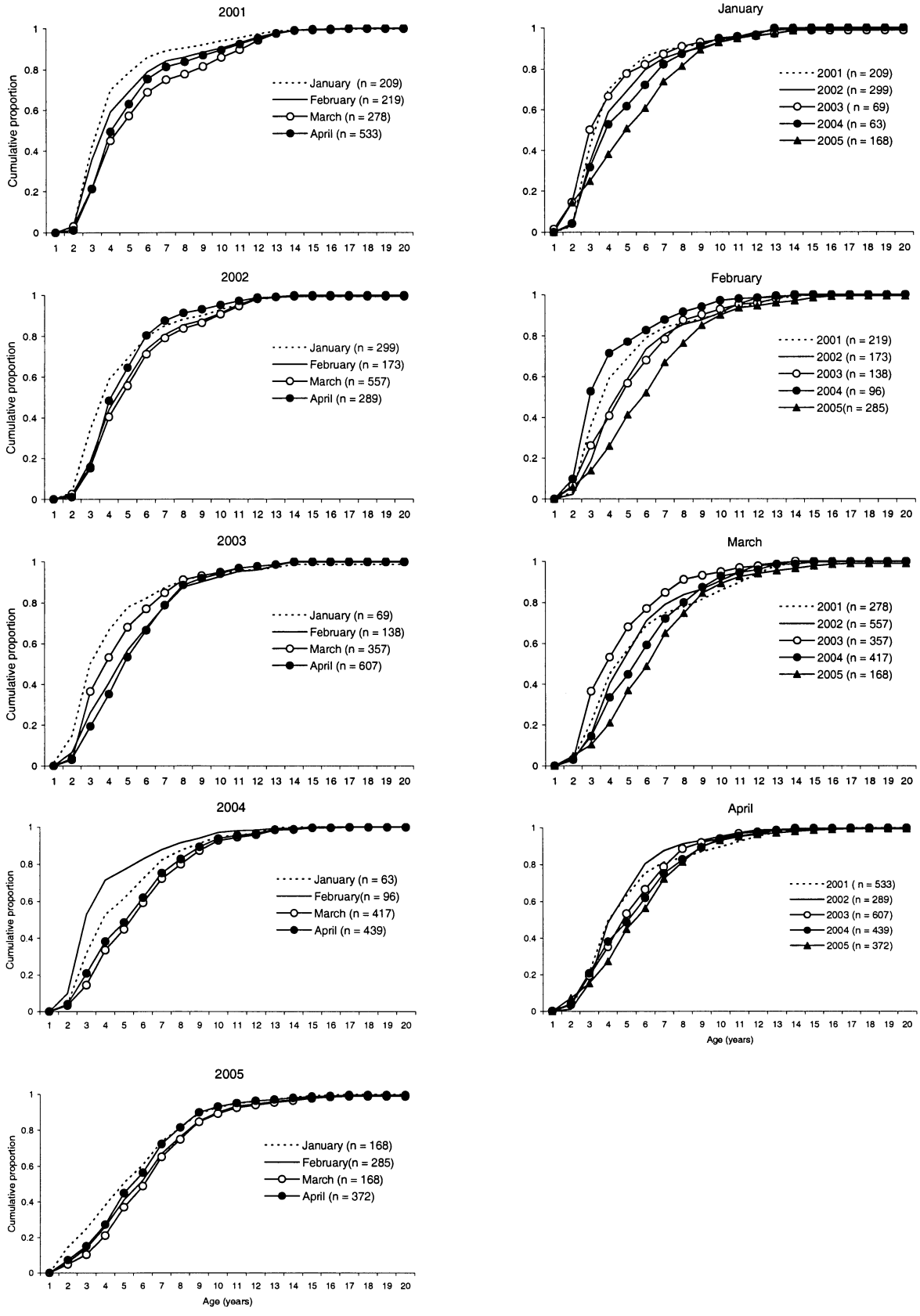


Figure 3: Cumulative age distributions by month for East Northland in 2000–01, 2001–02, 2002–03, 2003–04, and 2004–05. Left hand panels compare monthly age distributions within fishing years and right hand panels compare annual age distributions for each of the four months. The number of fish measured is given for each month.

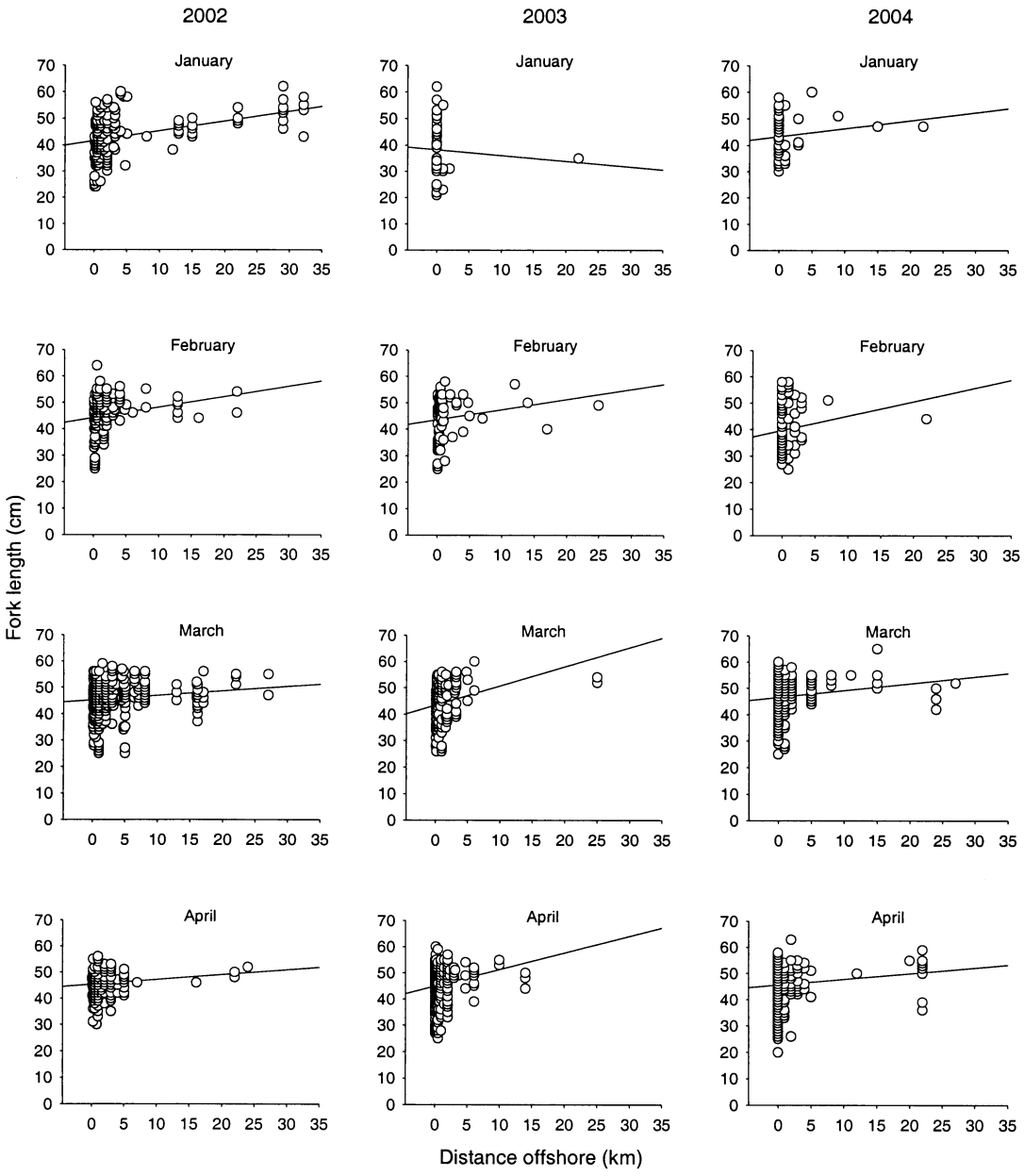


Figure 4: Length of landed kahawai relative to the estimated distance off the East Northland coastline at which they were caught. Results from the previous two years are also given for comparison. Data on the distance fished offshore were not collected in 2004–05.

3.3.2 Hauraki Gulf

Fewer kahawai were encountered by boat ramp interviewers in the Hauraki Gulf than in previous years, despite an almost doubling of the number of hours that interviewers were present at ramps (Table 2). The length and age compositions were still described to a reasonable level of precision, however, with respective mwcvs of 0.22 and 0.10 in 2003–04 and 0.28 and 0.18 in 2004–05 (Appendices 1 & 2).

As in previous years, the 2003–04 length composition was dominated by 30 to 40 cm kahawai, although the proportion of larger fish was much lower than seen before. This is reflected in the age distribution, which is composed almost entirely of 2 to 4 year old fish. The results from this year's sampling therefore support a previous suggestion that the Hauraki Gulf is a juvenile fishery (Hartill et al. 2004). The relative strength of the 2 year old age class was the strongest observed to date, which is clearly evident as a mode of 25 to 35 cm fish in the length frequency distribution (Figure 5, Appendix 3). It is unclear whether the relative strength of the 2 year age class is due to a year of strong recruitment, or the low abundance of older fish. Low catch rates suggest the latter.

The 2004–05 length composition is multimodal with a greater proportion of larger fish than seen in previous years. The strength of the 50 to 55 cm cohort, coupled with the decreased incidence of kahawai landings generally, suggests that in the last two years, recruitment in the Gulf has been poor. The corresponding age distribution is still largely dominated by three year old age class, however, which indicates that the Hauraki Gulf remains a juvenile fishery.

In 2003–04, there was very little difference in the monthly age distribution of kahawai landings (Figure 6). The age distributions of kahawai landed in March and April in 2004–05 are markedly broader than seen in previous years, however, possibly due to an influx of larger, older fish coupled with lower levels of recruitment by juveniles. The relationship between the abundance and size of kahawai landed with respect to distance offshore was not assessed, as the shape of the coastline, and abundance of islands makes any such interpretation difficult.

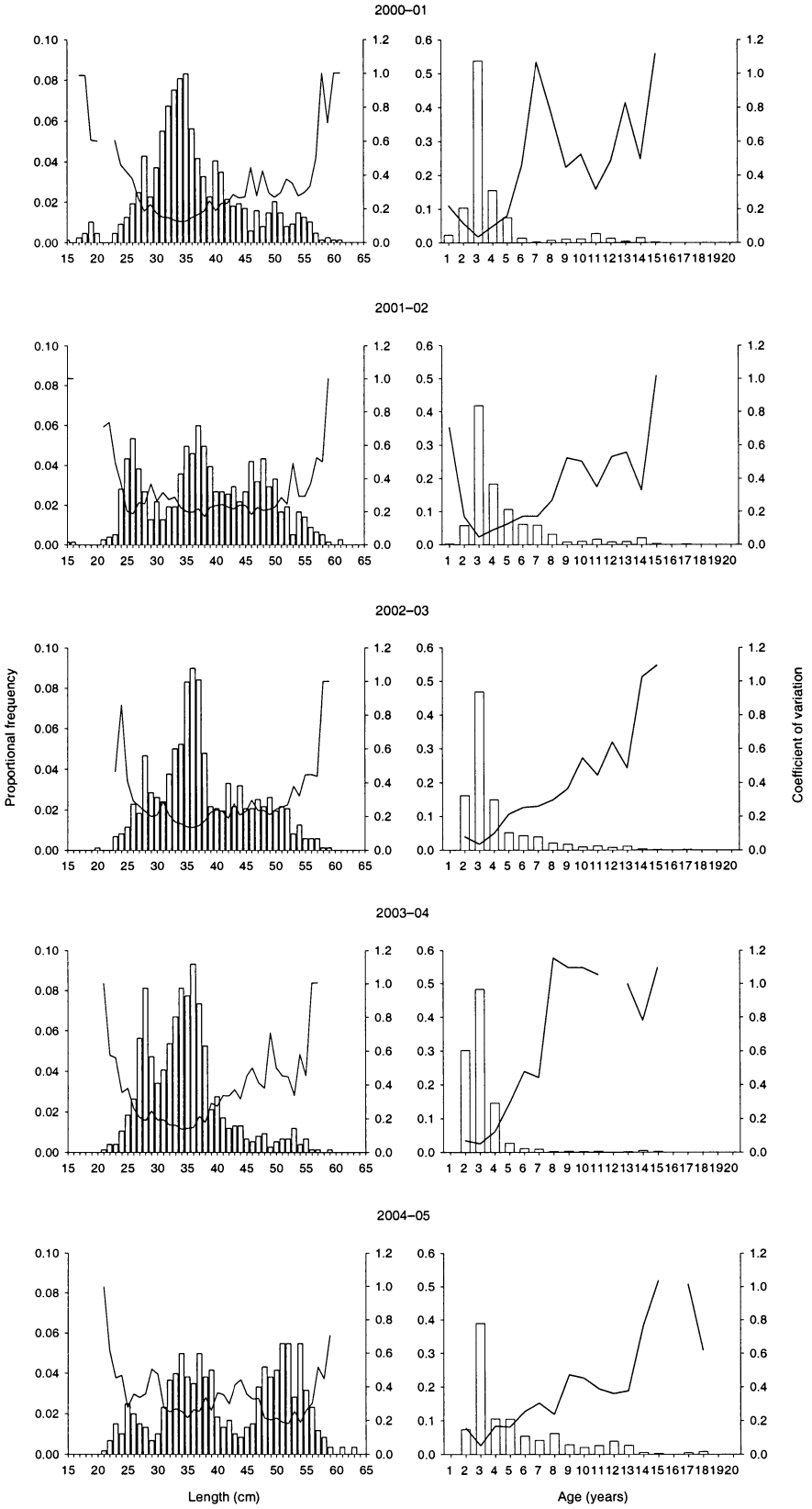


Figure 5: Length and age distributions (histograms) and c.v.s (solid line) of recreational landings of kahawai in the Hauraki Gulf in 2000–01, 2001–02, 2002–03, 2003–04, and 2004–05.

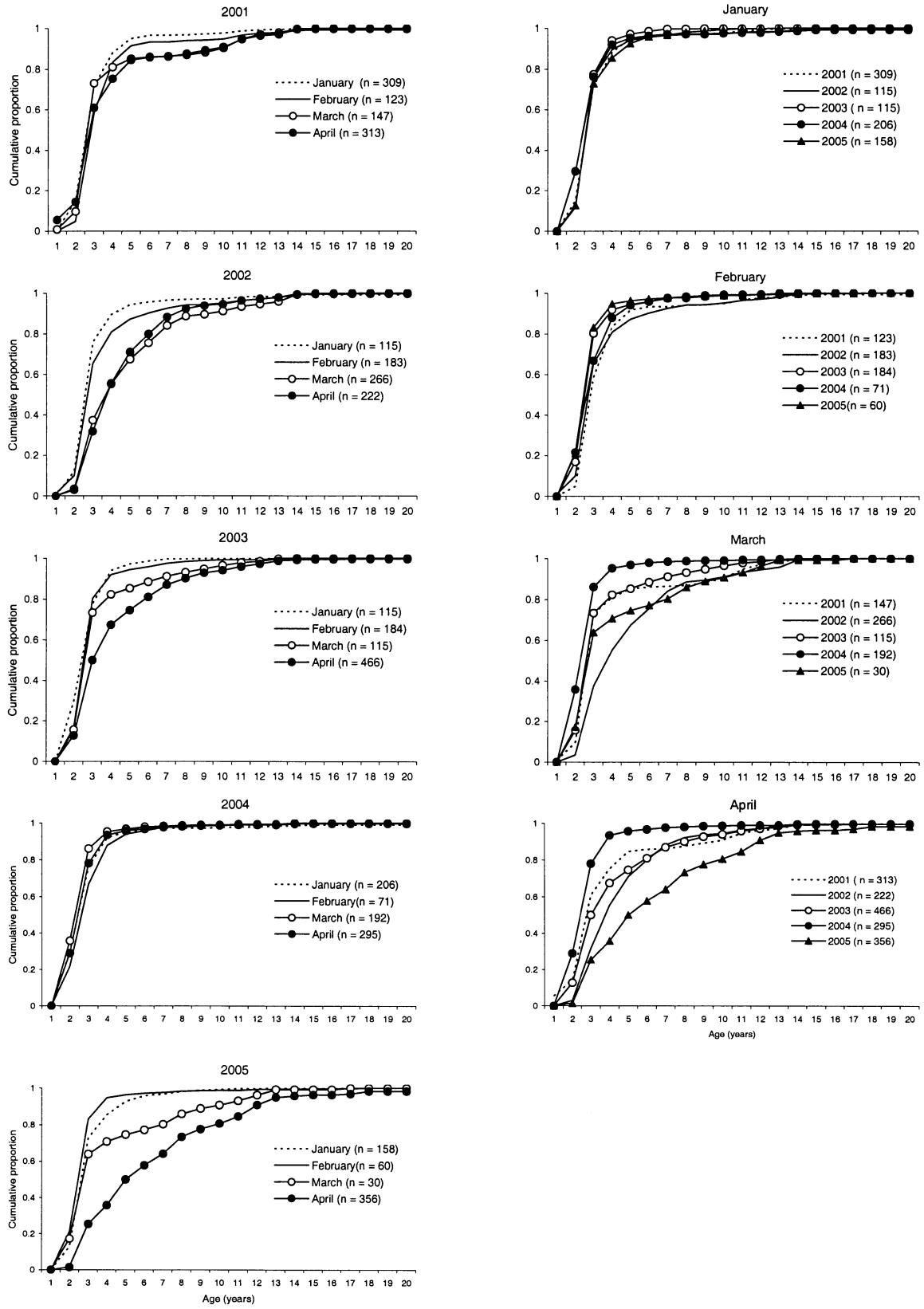


Figure 6: Cumulative age distributions by month for the Hauraki Gulf in 2000–01, 2001–02, 2002–03, 2003–04, and 2004–05. Left hand panels compare monthly age distributions within fishing years and right hand panels compare annual age distributions for each of the four months. The number of fish measured is given for each month.

3.3.3 Bay of Plenty

The Bay of Plenty length distribution has been consistently dominated by larger length classes over the last five years, although a secondary mode of 50–45 cm is clearly evident in 2004–05 (Figure 7). The availability of larger fish in the Bay of Plenty may influence fisher selectivity, however, with a greater likelihood that smaller kahawai will be released, and hence not measured. The age distribution remains broader than in the other two regions, and there is evidence of a strong recruitment of 3, 4, and 5 year olds in 2004–05.

The number of kahawai encountered by boat ramp interviewers per hour remains far higher in the Bay of Plenty than in the other two regions (Table 2), but the number of kahawai measured in a season can fall well short of 1500 fish, as low as 995 in 2003–04. In the last two years only about 400 kahawai heads were collected during interviews, largely because of a lack of suitable staff in the far eastern Bay of Plenty. Nonetheless, the precision of the length (mwcvs of 0.17 and 017) and age (0.17 and 0.17) distributions were within acceptable levels (Appendix 1 and 2). Comparison of cumulative monthly age distributions from the Bay of Plenty suggests that there is very little change in age compositions in this region between January and April (Figure 8). This is in contrast to East Northland and the Hauraki Gulf, where marked changes can occur over the survey period (see Figures 3 & 6).

In 2003–04, almost all (97%) of kahawai were caught within 5 km of the mainland, and consequently, the relationship between fish size and the distance they were caught from the mainland is poorly defined (Figure 9). Nonetheless, results from the previous two years suggest that no clear trend exists. These data were not collected in the 2004–05 fishing season.

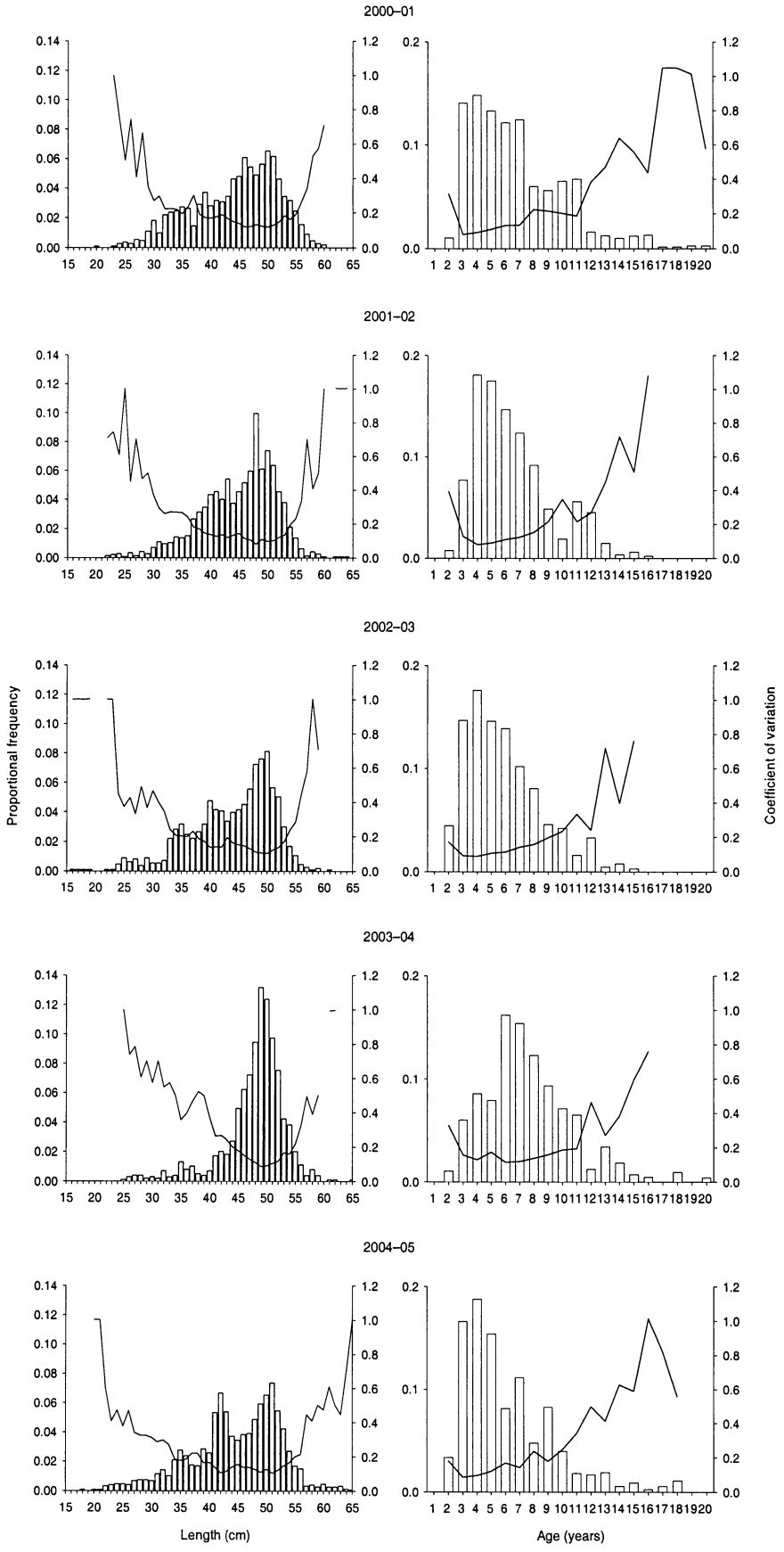


Figure 7: Length and age distributions (histograms) and c.v.s (solid line) of recreational landings of kahawai in the Bay of Plenty in 2000–01, 2001–02, 2002–03, 2003–04, and 2004–05.

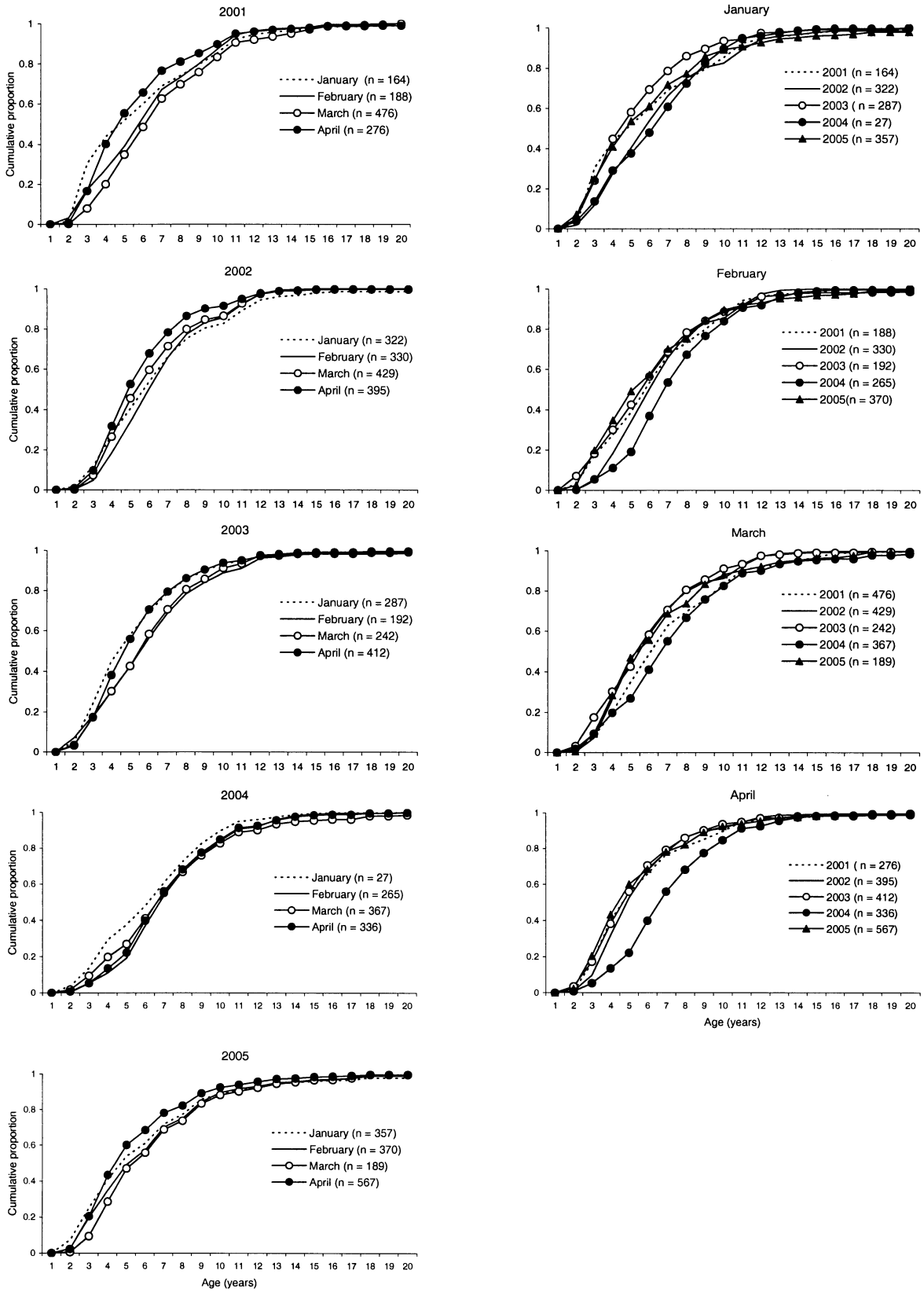


Figure 8: Cumulative age distributions by month for the Bay of Plenty in 2000–01, 2001–02, 2002–03, 2003–04, and 2004–05. Left hand panels compare monthly age distributions within fishing years and right hand panels compare annual age distributions for each of the four months. The number of fish measured is given for each month.

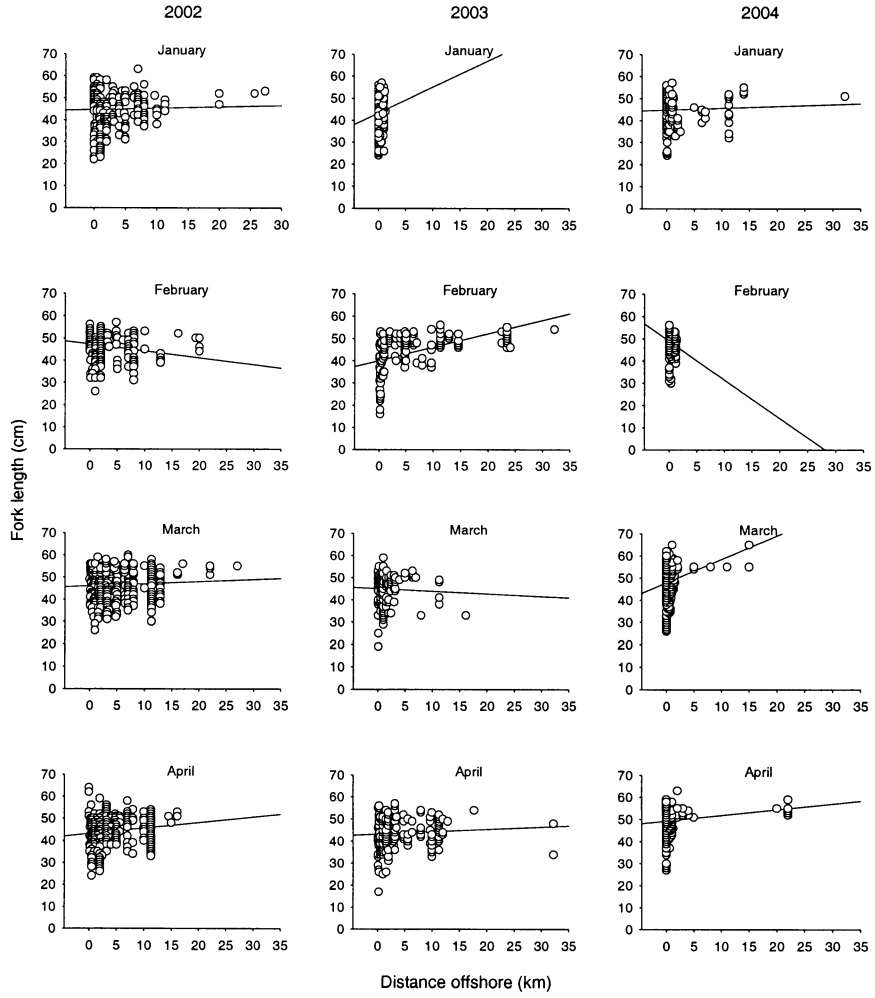


Figure 9: Length of landed kahawai relative to the estimated distance off the Bay of Plenty coastline at which they were caught. Results from the previous two years are also given for comparison.

3.4 Comparison of analytical and bootstrap variance estimation techniques

Since the inception of this time series, all length-based and age-based variance estimates have been calculated using analytical techniques, but it has been suggested that a bootstrapping approach could provide more appropriate variance estimates. Analytical and bootstrap variance estimates were therefore calculated for two data sets: Hauraki Gulf 2004–05 and Bay of Plenty 2004–05. These data sets were chosen because of the marked differences in their length and age compositions, and because their age-length keys were based on comparatively low sample sizes.

In both cases, there was very little difference between the variances estimated by the analytical and bootstrapping techniques (Figure 10). The length-based variance estimates were very similar across the entire length range, but there were subtle differences between the age-based variance estimates for both sets. The bootstrapping approach gave slightly higher variance estimates for the younger, more common age classes, but higher estimates for the older, less common age classes. The mean weighted c.v.s were almost identical for the length distributions, but the age-based bootstrap estimates were lower than their length-based counterparts. These results suggest that there is little merit in recalculating bootstrap c.v.s for all of the kahawai length and age data sampled from recreational fishers since 2001.

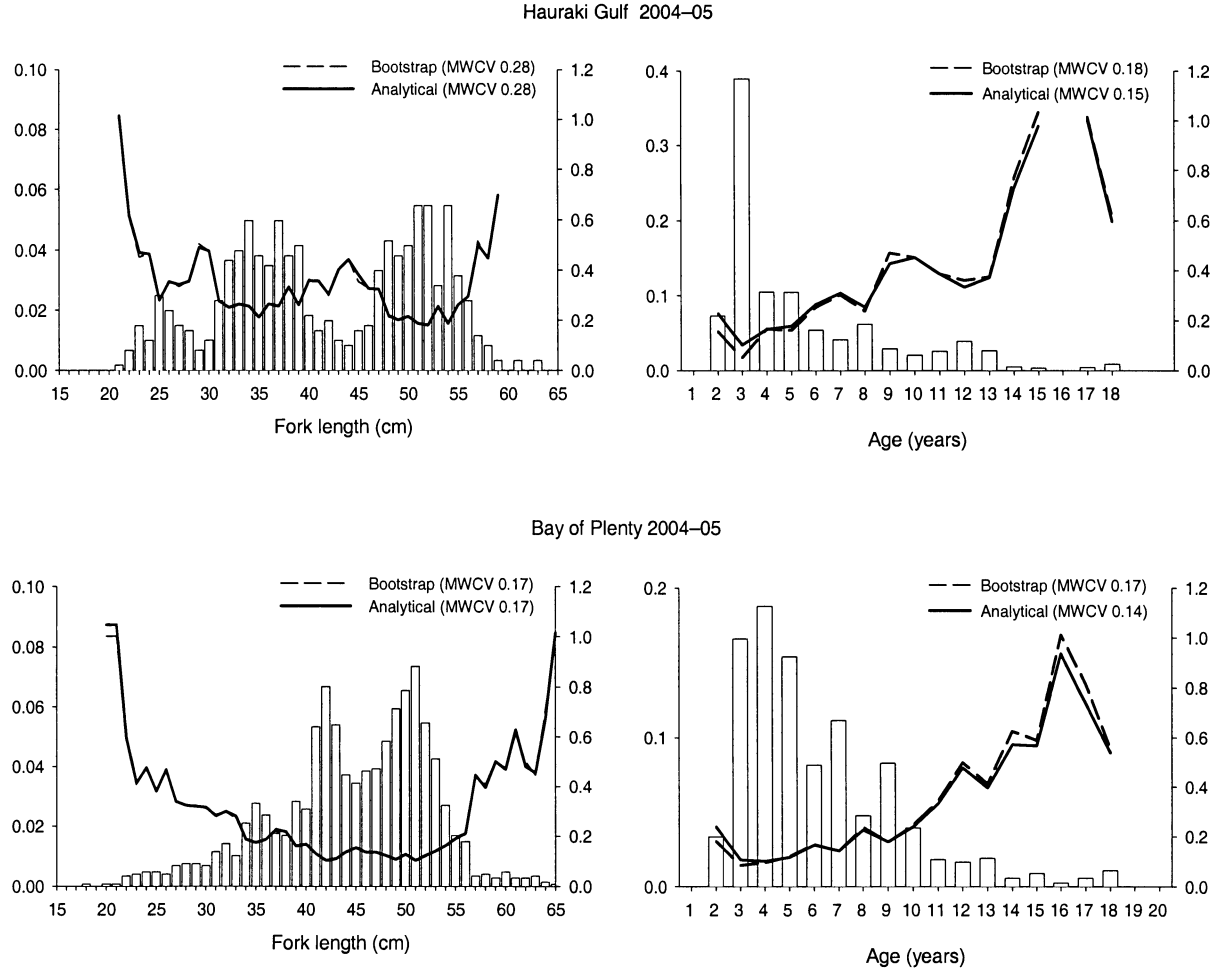


Figure 10: Comparison of analytical and bootstrap variance estimates calculated for recreational landings of kahawai in the Hauraki Gulf and Bay of Plenty in 2004–05.

Variance can be underestimated when boats fish in a non-independent manner, leading to correlated landings in space and/or time. We examined catch data collected in the Bay of Plenty in 2005 for evidence of such correlations. Cursory examination of the average size of fish landed by ramp, by survey day, suggested that there was no pattern in catches across ramps, within a survey day, or with any given ramp throughout the sampling season. It is perhaps not surprising that there was no marked similarity between the average size of fish landed across ramps on any given survey day, as in most cases there is a marked distance between ramps, and the number of kahawai encountered at most ramps is very low. Of those boats that land kahawai, 70% land between one and three fish.

Over 40% of the kahawai landed in the Bay of Plenty in 2005 were landed at Sulphur Point, and we tested these landings for autocorrelation. Landings were chronologically sorted and autocorrelation functions were calculated on the average size of the kahawai measured from each boat, at different lags between observations (Figure 11). Significant autocorrelation only occurs at a lag of every seventh boat, and this is probably due to chance given the non-significance of other lag statistics calculated. This suggests that, in this case at least, there is no significant correlation between landings, and hence no concomitant underestimation of variance.

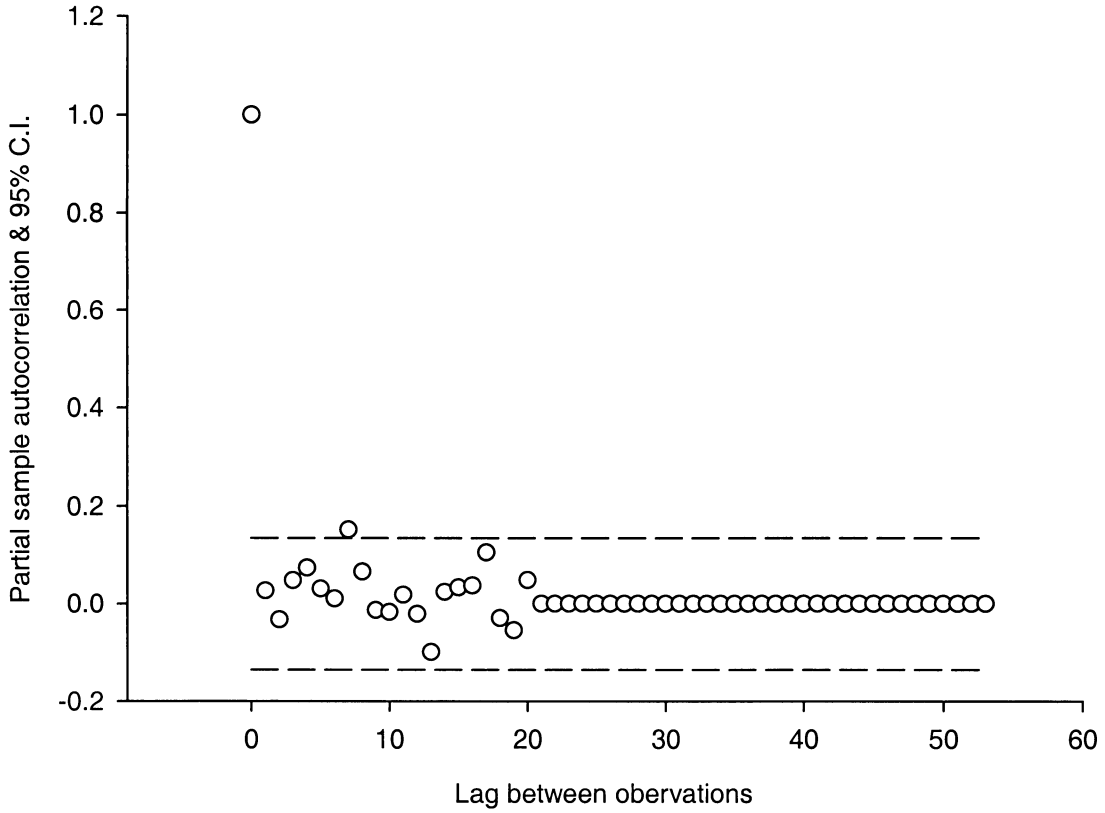


Figure 11: Autocorrelation between the average length of kahawai landed by boats at Sulphur Point, in the Bay of Plenty in 2005. Dashed lines denote 95% confidence intervals.

3.5 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 of 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					Bay of Plenty				
	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005
3	0.33	0.33	0.32	0.28	0.24	0.23	0.25	0.28	0.20	0.27
4	0.34	0.38	0.35	0.31	0.28	0.26	0.30	0.32	0.23	0.29
5	0.30	0.37	0.39	0.33	0.33	0.28	0.33	0.34	0.26	0.30
6	0.30	0.40	0.41	0.38	0.36	0.30	0.36	0.38	0.32	0.30

4. DISCUSSION

Obtaining sufficient length-at-age samples from a region's recreational fishery to adequately describe catch compositions will always be an uncertain process. Unlike commercial fisheries, where annual catch levels are largely determined by TACCs, recreational fishing effort and kahawai landings vary interannually depending on prevailing weather patterns and local catch rates. In 2003–04, in the Hauraki Gulf, and in 2004–05, throughout KAH 1, fewer kahawai were encountered than in previous years despite heightened levels of sampling effort resulting from synergies with other programmes (REC2002/02 and REC2004/01). In the eastern Bay of Plenty, very little sampling took place in 2004 due to a rahui, which closed fishing areas off the Motu River and Waihau Bay for several months. Similarly, little sampling took place at these two ramps, because of a lack of suitable applicants for interviewing positions. Although fewer kahawai were encountered than desired, the length and age compositions of the regional populations were still described with reasonable precision (mwcvs mostly below 0.20, with the exception of Hauraki Gulf length distributions with mwcvs of 0.22 in 2003–04 and 0.28 in 2004–05), well within the target level of precision of 0.30. We have compared our analytical variance estimates with bootstrapped estimates in two instances, which suggest that there is very little difference whichever approach is used.

Regional length and age compositions derived from recreational landings sampled in 2003–04 and 2004–05 are broadly consistent with patterns and trends seen in previous years (see Bradford 1999, Hartill et al. 2004). The East Northland population has become increasingly dominated by larger, older fish, and the age composition is now more similar to that of the Bay of Plenty than it was 5 years ago. In contrast, the Hauraki Gulf population has become composed of increasingly smaller, younger fish, with poor representation of the older age classes seen elsewhere. The only year in which appreciable proportions of older kahawai were observed was in 2004–05 when catch rates were low. This suggests lower recruitment than usual, which would increase the relative dominance of older fish. The broadest age distribution is found in the Bay of Plenty, which is usually composed of 3 to 11 year old fish. Although part of the recreational kahawai catch is used for bait, or returned to the sea, the landed catch in East Northland and the Hauraki Gulf should broadly reflect the overall catch, as discard rates are very low in this area (Hartill & Walsh 2005). Discard rates are higher in the Bay of Plenty, and these, coupled with a possible tendency to release smaller fish, may result in some bias towards older fish in this region.

The division of KAH 1 into three regions/substocks was based upon current research conventions and geographical boundaries, but consistent differences in regional kahawai population compositions, as

seen in this and previous years, suggest that these divisions have some biological relevance. Nonetheless, regional population compositions should not be regarded in isolation, as some inter-regional exchange is inevitable given the mobility of this species. This is evident in the Hauraki Gulf, for example, where the low availability of fish longer than 40 cm strongly suggests that schools of larger fish tend to emigrate to more open waters after 3–4 years of age. The low proportion of sexually mature fish in the Hauraki Gulf suggests, however, that at least some of the predominantly juvenile kahawai caught in this area must have been spawned elsewhere.

The manner in which the current time series of regional length and age data are used will be partially dependent on our understanding of the nature and degree of movement patterns. Some information on kahawai movement patterns can be inferred from tagging programmes conducted throughout New Zealand waters in the early 1980s (Wood et al. 1990) and in the Bay of Plenty and Tasman Bay in 1991 (Griggs et al. 1998). Between 1981 and 1984, 13 911 kahawai were tagged from a range of fisheries, resulting in 1105 returns for which the area of recapture was known. Of the 199 fish tagged and released in KAH 1 and subsequently caught, 80% were recaptured in KAH 1, with the majority of the remainder caught in the Hawke Bay/Gisborne area. Conversely, only 1–2% of fish tagged in other areas appear to have emigrated to KAH 1.

Of the 4622 kahawai tagged in the Bay of Plenty, and 4984 in Tasman Bay, recapture locations were known for 351 and 702 fish respectively. These data suggest that 90% of fish in the Bay of Plenty were resident over the next 7 years, and 98% in Tasman Bay, although a lower proportion were recaptured in this area after 3 years.

Both these studies suggest that "residency" at the scale of the Quota Management Area ranges from 70–100% depending on the population length composition. In KAH 1, a cursory examination of the data suggests that 80–90% of fish remain resident in this area. Larger fish appear to be more mobile, and those that emigrate from KAH 1 have a tendency to migrate towards the Hawke Bay/Gisborne Area. These studies therefore provide only a limited insight into the nature and extent of large-scale movements, but enough to suggest that seasonal migrations along the New Zealand coastline, as exhibited by species such as gemfish (Hurst & Bagley 1998) and blue moki (Francis 1981), are unlikely for this species. Previous stock assessments (Bradford 1996, Bradford 1997) have regarded New Zealand's kahawai as belonging to a single stock. We suggest that an assessment of solely the KAH 1 stock is feasible given this degree of emigration, and minimal evidence of immigration from other Quota Management Areas. Such an assessment should, however, consider size-specific movement both between KAH 1 substocks and from KAH 1. Size-specific movement within KAH 1 could also influence the reliability of the total mortality estimates as discussed earlier. A more detailed analysis of the available tag/recapture data is required to do this, which should consider the relative exploitation rates of localised fishstocks, and non-independence of observations arising from recapture events involving more than one fish, which were tagged during the same release event. A review of this nature may well suggest that we have insufficient data to describe movement patterns in a meaningful way, and any modelling based on currently available data may involve some broad assumptions about this behaviour.

There is some suggestion of smaller scale behavioural movement patterns. In all three regions, in most years, the number of kahawai encountered by boat ramp interviewers was noticeably greater in the second half of the survey. These observations are consistent with either an onshore migration of sexually mature kahawai in the autumn or increased catachability, following spawning in deeper waters in January and February (60–100 m; Annala et al. 2003). This suggestion is further supported by evidence of an increase in the average size of fish caught off the East Northland as the distance from the mainland increases. In the Bay of Plenty, however, this trend is not clearly evident, despite a greater number of kahawai caught further offshore in 2001–02 and 2002–03.

The issue of ageing error was discussed at the Pelagic Working Group, and, as a result, we compared regional mean length-at-age estimates collected between 2001 and 2005. There were clear trends of progressively increasing mean length-at-age in all three regions, for which there are at least four

possible reasons: ageing error, changes in the timing of otolith collection, changes in selectivity, and increasing growth rates through time.

Ageing error will occur in most, if not all, stock monitoring programmes, but the progressive nature of the trends observed suggest that this is not the case, as ageing error is more likely to be a random process. Changes in readers can influence results, but most readers have read at least three years of data, and the trends were still clearly evident in the ages determined by the most experienced and proficient reader, who has read all sets to date. There has been no progressive change in the timing of otolith collecting, so this explanation is unlikely, especially given the short sampling season. There is also no evidence to suggest that recreational selectivity would have changed to any extent through time. The final explanation, of changes in growth rates through time, is possible, as it has been clearly shown for snapper (Davies et al. 2003), which is a comparatively easy species to age. Nonetheless, further work will be required if we are to determine whether the putative changes in growth rates are biologically real, or if they are an artefact of our sampling programme. As a first step, otoliths collected over several years should be selected at random and read over a short period by a single experienced reader, to test the proposition that ageing error has taken place in a progressive manner.

5. ACKNOWLEDGMENTS

We thank the numerous boat ramp interviewers, most of whom took part in all three surveys. The Pelagic Working Group, and particularly, Paul Taylor, provided some useful comments on an earlier draft. Funding for this project, KAH2003/01, 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 2003–04 and 2004–05

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 2003–04 and 2004–05

Length	2003–04		2004–05	
(cm)	*P.i.*	*c.v.*	*P.i.*	*c.v.*
10	0.0000	0.00	0.0000	0.00
11	0.0000	0.00	0.0000	0.00
12	0.0000	0.00	0.0000	0.00
13	0.0000	0.00	0.0000	0.00
14	0.0000	0.00	0.0000	0.00
15	0.0000	0.00	0.0000	0.00
16	0.0000	0.00	0.0000	0.00
17	0.0000	0.00	0.0000	0.00
18	0.0000	0.00	0.0000	0.00
19	0.0000	0.00	0.0000	0.00
20	0.0010	1.00	0.0000	0.00
21	0.0000	0.00	0.0000	0.00
22	0.0000	0.00	0.0010	1.00
23	0.0000	0.00	0.0010	1.00
24	0.0000	0.00	0.0020	0.71
25	0.0030	0.58	0.0040	0.50
26	0.0020	0.71	0.0111	0.37
27	0.0049	0.52	0.0081	0.46
28	0.0069	0.51	0.0131	0.36
29	0.0059	0.46	0.0171	0.29
30	0.0049	0.43	0.0070	0.38
31	0.0039	0.48	0.0131	0.40
32	0.0158	0.34	0.0040	0.50
33	0.0128	0.29	0.0040	0.50
34	0.0286	0.27	0.0040	0.50
35	0.0365	0.29	0.0151	0.29
36	0.0424	0.23	0.0121	0.28
37	0.0286	0.22	0.0070	0.38
38	0.0217	0.35	0.0101	0.31
39	0.0177	0.24	0.0101	0.31
40	0.0167	0.28	0.0181	0.24
41	0.0207	0.22	0.0201	0.22
42	0.0296	0.20	0.0211	0.35
43	0.0286	0.21	0.0201	0.22
44	0.0453	0.17	0.0211	0.22
45	0.0345	0.17	0.0312	0.19
46	0.0424	0.16	0.0292	0.21
47	0.0384	0.16	0.0453	0.16
48	0.0591	0.14	0.0745	0.12
49	0.0798	0.11	0.0775	0.11
50	0.1025	0.11	0.0987	0.11
51	0.0611	0.13	0.0725	0.12
52	0.0532	0.14	0.0916	0.09
53	0.0414	0.16	0.0655	0.14
54	0.0374	0.17	0.0524	0.14
55	0.0365	0.17	0.0393	0.16
56	0.0128	0.29	0.0383	0.18
57	0.0099	0.31	0.0121	0.28
58	0.0079	0.35	0.0081	0.35
59	0.0020	0.70	0.0060	0.47
60	0.0020	0.70	0.0030	0.74
61	0.0000	0.00	0.0020	0.71
62	0.0000	0.00	0.0030	0.58
63	0.0010	1.00	0.0040	0.50
64	0.0000	0.00	0.0000	0.00
65	0.0010	1.00	0.0010	1.00
66	0.0000	0.00	0.0000	0.00
67	0.0000	0.00	0.0000	0.00
68	0.0000	0.00	0.0000	0.00
69	0.0000	0.00	0.0000	0.00
70	0.0000	0.00	0.0000	0.00
n	1 015		993	
m.w.c.v.		0.20		0.19

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Hauraki Gulf in 2003–04 and 2004–

Length	2003–04		Length	2004–05	
(cm)	*P.i.*	*c.v.*	(cm)	*P.i.*	*c.v.*
10	0.0000	0.00	10	0.0000	0.00
11	0.0000	0.00	11	0.0000	0.00
12	0.0000	0.00	12	0.0000	0.00
13	0.0000	0.00	13	0.0000	0.00
14	0.0000	0.00	14	0.0000	0.00
15	0.0000	0.00	15	0.0000	0.00
16	0.0000	0.00	16	0.0000	0.00
17	0.0000	0.00	17	0.0000	0.00
18	0.0000	0.00	18	0.0000	0.00
19	0.0000	0.00	19	0.0000	0.00
20	0.0000	0.00	20	0.0000	0.00
21	0.0013	1.00	21	0.0017	1.00
22	0.0039	0.57	22	0.0066	0.61
23	0.0039	0.56	23	0.0149	0.45
24	0.0105	0.35	24	0.0099	0.47
25	0.0183	0.38	25	0.0248	0.28
26	0.0262	0.26	26	0.0199	0.36
27	0.0563	0.21	27	0.0149	0.33
28	0.0812	0.19	28	0.0132	0.36
29	0.0471	0.25	29	0.0066	0.50
30	0.0340	0.19	30	0.0099	0.48
31	0.0406	0.19	31	0.0232	0.28
32	0.0537	0.16	32	0.0364	0.25
33	0.0668	0.16	33	0.0397	0.27
34	0.0812	0.14	34	0.0497	0.25
35	0.0772	0.14	35	0.0381	0.22
36	0.0929	0.15	36	0.0348	0.26
37	0.0733	0.21	37	0.0497	0.25
38	0.0524	0.18	38	0.0381	0.33
39	0.0209	0.29	39	0.0414	0.26
40	0.0275	0.27	40	0.0182	0.36
41	0.0170	0.34	41	0.0132	0.35
42	0.0118	0.33	42	0.0166	0.30
43	0.0131	0.37	43	0.0099	0.41
44	0.0131	0.32	44	0.0083	0.44
45	0.0065	0.45	45	0.0132	0.35
46	0.0052	0.50	46	0.0149	0.33
47	0.0079	0.41	47	0.0331	0.33
48	0.0092	0.38	48	0.0430	0.21
49	0.0026	0.71	49	0.0381	0.20
50	0.0052	0.50	50	0.0414	0.21
51	0.0065	0.45	51	0.0546	0.19
52	0.0065	0.45	52	0.0546	0.18
53	0.0118	0.34	53	0.0281	0.25
54	0.0039	0.58	54	0.0546	0.19
55	0.0065	0.45	55	0.0315	0.26
56	0.0013	1.00	56	0.0232	0.30
57	0.0013	1.00	57	0.0116	0.52
58	0.0000	0.00	58	0.0083	0.45
59	0.0013	1.00	59	0.0033	0.71
60	0.0000	0.00	60	0.0000	0.00
61	0.0000	0.00	61	0.0033	0.71
62	0.0000	0.00	62	0.0000	0.00
63	0.0000	0.00	63	0.0033	0.70
64	0.0000	0.00	64	0.0000	0.00
65	0.0000	0.00	65	0.0000	0.00
66	0.0000	0.00	66	0.0000	0.00
67	0.0000	0.00	67	0.0000	0.00
68	0.0000	0.00	68	0.0000	0.00
69	0.0000	0.00	69	0.0000	0.00
70	0.0000	0.00	70	0.0000	0.00
n	764			606	
m.w.c.v.		0.22			0.28

Appendix 1 – continued:
Estimates of the proportion at length of kahawai from the Bay of Plenty in 2003–04 and 2004–05

Length	2003–04		Length	2004–05	
(cm)	*P.i.*	*c.v.*	(cm)	*P.i.*	*c.v.*
10	0.0000	0.00	10	0.0000	0.00
11	0.0000	0.00	11	0.0000	0.00
12	0.0000	0.00	12	0.0000	0.00
13	0.0000	0.00	13	0.0000	0.00
14	0.0000	0.00	14	0.0000	0.00
15	0.0000	0.00	15	0.0000	0.00
16	0.0000	0.00	16	0.0000	0.00
17	0.0000	0.00	17	0.0000	0.00
18	0.0000	0.00	18	0.0007	1.00
19	0.0000	0.00	19	0.0000	0.00
20	0.0000	0.00	20	0.0007	1.00
21	0.0000	0.00	21	0.0007	1.00
22	0.0000	0.00	22	0.0034	0.60
23	0.0000	0.00	23	0.0040	0.41
24	0.0000	0.00	24	0.0047	0.47
25	0.0010	1.00	25	0.0047	0.38
26	0.0030	0.74	26	0.0040	0.47
27	0.0040	0.78	27	0.0067	0.34
28	0.0040	0.60	28	0.0074	0.32
29	0.0020	0.70	29	0.0074	0.32
30	0.0030	0.57	30	0.0067	0.31
31	0.0020	0.70	31	0.0115	0.29
32	0.0070	0.55	32	0.0142	0.30
33	0.0030	0.57	33	0.0101	0.27
34	0.0040	0.50	34	0.0209	0.19
35	0.0131	0.36	35	0.0276	0.18
36	0.0080	0.39	36	0.0236	0.19
37	0.0101	0.46	37	0.0175	0.22
38	0.0050	0.52	38	0.0169	0.22
39	0.0040	0.50	39	0.0283	0.16
40	0.0070	0.37	40	0.0256	0.16
41	0.0171	0.26	41	0.0533	0.13
42	0.0201	0.27	42	0.0668	0.10
43	0.0181	0.24	43	0.0539	0.11
44	0.0271	0.20	44	0.0371	0.14
45	0.0492	0.18	45	0.0344	0.15
46	0.0623	0.15	46	0.0384	0.14
47	0.0724	0.13	47	0.0391	0.14
48	0.0945	0.11	48	0.0486	0.12
49	0.1317	0.09	49	0.0593	0.11
50	0.1236	0.09	50	0.0654	0.13
51	0.0975	0.10	51	0.0735	0.10
52	0.0754	0.12	52	0.0546	0.12
53	0.0422	0.17	53	0.0425	0.15
54	0.0382	0.16	54	0.0270	0.16
55	0.0201	0.22	55	0.0169	0.20
56	0.0111	0.33	56	0.0148	0.21
57	0.0040	0.49	57	0.0034	0.45
58	0.0080	0.39	58	0.0040	0.41
59	0.0040	0.50	59	0.0027	0.50
60	0.0000	0.00	60	0.0047	0.47
61	0.0010	0.99	61	0.0027	0.61
62	0.0010	1.00	62	0.0027	0.50
63	0.0000	0.00	63	0.0034	0.45
64	0.0000	0.00	64	0.0013	0.71
65	0.0010	1.00	65	0.0007	1.00
66	0.0000	0.00	66	0.0000	0.00
67	0.0000	0.00	67	0.0000	0.00
68	0.0000	0.00	68	0.0007	1.00
69	0.0000	0.00	69	0.0000	0.00
70	0.0000	0.00	70	0.0007	1.00
n	995			1483	
m.w.c.v.		0.17			0.17

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 2003–04 and 2004–05.

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 2003–04 and 2004–05.

Age	2003–04		2004–05	
(years)	*P.j.*	*c.v.*	*P.j.*	*c.v.*
1	0.0010	1.00	0.0000	0.00
2	0.0418	0.18	0.0752	0.11
3	0.1766	0.09	0.0787	0.14
4	0.1838	0.09	0.1191	0.11
5	0.1026	0.13	0.1576	0.10
6	0.1290	0.11	0.1101	0.12
7	0.1214	0.12	0.1509	0.10
8	0.0711	0.16	0.0896	0.14
9	0.0628	0.17	0.0854	0.14
10	0.0472	0.20	0.0396	0.21
11	0.0159	0.36	0.0263	0.25
12	0.0112	0.41	0.0123	0.38
13	0.0218	0.28	0.0108	0.41
14	0.0016	1.01	0.0102	0.42
15	0.0079	0.52	0.0105	0.48
16	0.0000	0.00	0.0051	0.58
17	0.0022	1.01	0.0035	0.71
18	0.0000	0.00	0.0000	0.00
19	0.0000	0.00	0.0000	0.00
>19	0.0000	0.00	0.0000	0.00
n	517		514	
m.w.c.v.		0.14		0.14

Estimates of the proportion at age of kahawai from the Hauraki Gulf in 2003–04 and 2004–05.

Age	2003–04		2004–05	
(years)	*P.j.*	*c.v.*	*P.j.*	*c.v.*
1	0.0000	0.00	0.0000	0.00
2	0.3013	0.07	0.0730	0.16
3	0.4835	0.05	0.3894	0.05
4	0.1454	0.12	0.1049	0.17
5	0.0274	0.29	0.1044	0.16
6	0.0110	0.48	0.0538	0.25
7	0.0087	0.44	0.0412	0.30
8	0.0020	1.15	0.0621	0.24
9	0.0033	1.09	0.0289	0.47
10	0.0022	1.09	0.0203	0.45
11	0.0029	1.05	0.0259	0.39
12	0.0000	0.00	0.0389	0.36
13	0.0013	1.00	0.0265	0.38
14	0.0049	0.78	0.0051	0.77
15	0.0022	1.09	0.0033	1.03
16	0.0000	0.00	0.0000	0.00
17	0.0000	0.00	0.0042	1.01
18	0.0000	0.00	0.0084	0.62
19	0.0000	0.00	0.0000	0.00
>19	0.0000	0.00	0.0000	0.00
n	350		289	
m.w.c.v.		0.10		0.18

Appendix 2 – continued:
Estimates of the proportion at age of kahawai from the Bay of Plenty in 2003–04 and 2004–05 .

Age	2003–04		2004–05	
(years)	*P.j.*	*c.v.*	*P.j.*	*c.v.*
1	0.0000	0.00	0.0000	0.00
2	0.0106	0.33	0.0332	0.18
3	0.0601	0.16	0.1660	0.08
4	0.0855	0.13	0.1877	0.10
5	0.0792	0.17	0.1542	0.12
6	0.1619	0.11	0.0813	0.17
7	0.1541	0.12	0.1115	0.14
8	0.1228	0.14	0.0474	0.24
9	0.0932	0.16	0.0827	0.18
10	0.0709	0.19	0.0393	0.25
11	0.0648	0.19	0.0181	0.34
12	0.0121	0.46	0.0165	0.50
13	0.0340	0.27	0.0189	0.41
14	0.0182	0.38	0.0055	0.63
15	0.0071	0.59	0.0088	0.59
16	0.0048	0.76	0.0025	1.01
17	0.0000	0.00	0.0056	0.82
18	0.0096	0.34	0.0107	0.56
19	0.0000	0.00	0.0000	0.00
>19	0.0042	0.81	0.0000	0.00
n	412		393	
m.w.c.v.		0.17		0.17

Appendix 3: Age–length keys derived from otolith samples collected from recreational fishers from East Northland in 2003–04 and 2004–05.

Estimates of proportion of length at age for kahawai sampled from the East Northland recreational fishery, January to April 2004. (Note: Aged to 01/01/04)

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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
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	2
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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
29	0	1.00	0	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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
32	0	0.20	0.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
33	0	0.14	0.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
34	0	0.15	0.46	0.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
35	0	0.13	0.80	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
36	0	0	0.89	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
37	0	0	0.62	0.23	0.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
38	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
39	0	0	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
40	0	0	0.13	0.75	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
41	0	0	0.25	0.56	0.06	0.06	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	16
42	0	0	0.12	0.53	0.18	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
43	0	0	0.11	0.67	0.17	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
44	0	0	0.04	0.65	0.23	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
45	0	0	0.11	0.33	0.28	0.11	0.11	0.06	0	0	0	0	0	0	0	0	0	0	0	0	18
46	0	0	0.08	0.38	0.29	0.13	0.04	0.04	0	0.04	0	0	0	0	0	0	0	0	0	0	24
47	0	0	0.09	0.26	0.17	0.17	0.22	0.04	0	0	0	0	0.04	0	0	0	0	0	0	0	23
48	0	0	0	0.20	0.20	0.27	0.23	0.07	0.03	0	0	0	0	0	0	0	0	0	0	0	30
49	0	0	0	0.06	0.14	0.22	0.24	0.06	0.16	0.04	0.02	0.02	0.02	0.02	0	0	0	0	0	0	50
50	0	0	0	0.02	0.13	0.22	0.30	0.15	0.04	0.07	0.04	0	0.02	0	0	0	0	0	0	0	46
51	0	0	0	0	0.07	0.14	0.29	0.11	0.11	0.14	0.04	0.04	0.07	0	0	0	0	0	0	0	28
52	0	0	0	0	0.04	0.21	0.13	0.17	0.21	0.13	0	0.04	0	0	0.04	0	0.04	0	0	0	24
53	0	0	0	0	0.12	0.24	0.12	0.16	0.08	0.16	0.04	0.04	0.04	0	0	0	0	0	0	0	25
54	0	0	0	0	0	0.21	0.21	0.26	0.16	0.05	0.05	0.05	0	0	0	0	0	0	0	0	19
55	0	0	0	0	0	0.17	0.13	0.04	0.30	0.13	0	0.04	0.13	0	0.04	0	0	0	0	0	23
56	0	0	0	0	0	0	0.13	0.13	0.25	0.13	0.13	0	0.13	0	0.13	0	0	0	0	0	8
57	0	0	0	0	0	0	0	0.25	0.25	0	0.25	0	0	0	0.25	0	0	0	0	0	4
58	0	0	0	0	0	0	0	0.33	0	0.67	0	0	0	0	0	0	0	0	0	0	3
59	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	1
60	0	0	0	0	0	0	0	0	0	0	0	0	1.00	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																					517

Appendix 3 continued:

Estimates of proportion of length at age for kahawai sampled from the East Northland recreational fishery, January to April 2005. (Note: Aged to 01/01/05)

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	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	6
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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
29	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
30	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
31	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
32	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
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	2
35	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
36	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
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	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
39	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
40	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
41	0	0	0.08	0.77	0.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
42	0	0	0.40	0.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
43	0	0	0.33	0.11	0.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
44	0	0	0	0.62	0.23	0.08	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	13
45	0	0	0	0.44	0.28	0.11	0	0.11	0.06	0	0	0	0	0	0	0	0	0	0	0	18
46	0	0	0	0.26	0.16	0.32	0.11	0.11	0.05	0	0	0	0	0	0	0	0	0	0	0	19
47	0	0	0	0.22	0.37	0.07	0.22	0.04	0	0.07	0	0	0	0	0	0	0	0	0	0	27
48	0	0	0	0.14	0.36	0.11	0.22	0.11	0.03	0.03	0	0	0	0	0	0	0	0	0	0	36
49	0	0	0	0.11	0.33	0.18	0.13	0.09	0.11	0.02	0.02	0	0	0	0	0	0	0	0	0	45
50	0	0	0	0	0.27	0.13	0.25	0.17	0.13	0.02	0	0.02	0	0.02	0	0	0	0	0	0	48
51	0	0	0	0.03	0.14	0.26	0.20	0.14	0.20	0	0	0	0	0	0.03	0	0	0	0	0	35
52	0	0	0	0	0.09	0.20	0.20	0.11	0.20	0.09	0.04	0.02	0	0.04	0	0	0	0	0	0	45
53	0	0	0	0	0.11	0.14	0.38	0.11	0.11	0	0.03	0.05	0.03	0	0	0	0.05	0	0	0	37
54	0	0	0	0	0.03	0.14	0.14	0.07	0.14	0.14	0.10	0.03	0.10	0	0.03	0.07	0	0	0	0	29
55	0	0	0	0	0	0.05	0.21	0.32	0.05	0.16	0.11	0	0.05	0	0.05	0	0	0	0	0	19
56	0	0	0	0	0.04	0.04	0.16	0.16	0.04	0.16	0.24	0.04	0.04	0	0.04	0.04	0	0	0	0	25
57	0	0	0	0	0	0	0.33	0	0.11	0.22	0	0.11	0	0.22	0	0	0	0	0	0	9
58	0	0	0	0	0	0.17	0.17	0	0.50	0	0	0	0	0.17	0	0	0	0	0	0	6
59	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0.50	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																					514

Appendix 4: Age–length keys derived from otolith samples collected from recreational fishers from the Hauraki Gulf in 2003–04 and 2004–05.

Estimates of proportion of length at age for kahawai sampled from the Hauraki Gulf recreational fishery, January to April 2004 (Note: Aged to 01/01/04)

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	2
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	6
25	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
26	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
27	0	0.84	0.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
28	0	0.79	0.21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
29	0	0.69	0.31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
30	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
31	0	0.27	0.73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
32	0	0.10	0.81	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
33	0	0.24	0.72	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
34	0	0.19	0.77	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
35	0	0.14	0.77	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
36	0	0.21	0.74	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
37	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
38	0	0	0.82	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
39	0	0	0.17	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
40	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
41	0	0	0.13	0.63	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
42	0	0	0.17	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
43	0	0	0.40	0.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
44	0	0	0	0.57	0.43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
45	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
46	0	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
47	0	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
48	0	0	0	0.50	0	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
49	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	2
50	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	1
51	0	0	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
52	0	0	0	0	0.50	0	0	0	0.50	0	0	0	0	0	0	0	0	0	0	0	2
53	0	0	0	0	0.25	0.25	0	0	0	0	0.25	0	0	0.25	0	0	0	0	0	0	4
54	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0.50	0	0	0	0	0	0	2
55	0	0	0	0	0	0	0.33	0	0	0.33	0	0	0	0	0.33	0	0	0	0	0	3
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	1.00	0	0	0	0	0	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																					350

Appendix 4 – continued:

Estimates of proportion of length at age for kahawai sampled from the Hauraki Gulf recreational fishery, January to April 2005 (Note: Aged to 01/01/05)

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	2
22	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
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	0.83	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
25	0	0.70	0.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
26	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
27	0	0.25	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
28	0	0.38	0.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
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	0.80	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
31	0	0.14	0.71	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
32	0	0	0.94	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
33	0	0	0.85	0.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
34	0	0	0.82	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
35	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
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	0.80	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
38	0	0	0.83	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
39	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
40	0	0	0.75	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
41	0	0	0.80	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
42	0	0	0.20	0.40	0.20	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
43	0	0	0	0.75	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
44	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
45	0	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
46	0	0	0	0.60	0.20	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
47	0	0	0	0.40	0.40	0	0.10	0	0.10	0	0	0	0	0	0	0	0	0	0	0	10
48	0	0	0	0.17	0.42	0.25	0	0.08	0	0.08	0	0	0	0	0	0	0	0	0	0	12
49	0	0	0	0.08	0.31	0.31	0	0.15	0.08	0	0.08	0	0	0	0	0	0	0	0	0	13
50	0	0	0	0	0.82	0	0	0.18	0	0	0	0	0	0	0	0	0	0	0	0	11
51	0	0	0	0	0.18	0.18	0.27	0.09	0	0.09	0.18	0	0	0	0	0	0	0	0	0	11
52	0	0	0	0	0	0	0	0.38	0.08	0.15	0.15	0	0.15	0	0	0	0.08	0	0	0	13
53	0	0	0	0	0	0.14	0.14	0.29	0.14	0	0	0.14	0.14	0	0	0	0	0	0	0	7
54	0	0	0	0	0	0.14	0.29	0.14	0.07	0	0	0.14	0.21	0	0	0	0	0	0	0	14
55	0	0	0	0	0	0	0	0	0.33	0	0	0.67	0	0	0	0	0	0	0	0	3
56	0	0	0	0	0	0.14	0.14	0.14	0	0.14	0	0.14	0	0	0.14	0	0	0.14	0	0	7
57	0	0	0	0	0	0	0	0	0	0	0.40	0	0.20	0.20	0	0	0	0.20	0	0	5
58	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0.33	0	0	0	0.33	0	0	3
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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																					289

Appendix 5: Age–length keys derived from otolith samples collected from recreational fishers from the Bay of Plenty in 2003–04 and 2004–05.

Estimates of proportion of length at age for kahawai sampled from the Bay of Plenty recreational fishery, January to April 2004 (Note: Aged to 01/01/04)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
31	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
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	1
34	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
35	0	0	0.88	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
36	0	0	0.57	0.43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
37	0	0	0.67	0	0	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
38	0	0	0	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
39	0	0	0	0.33	0.33	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
40	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
41	0	0	0.14	0.79	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
42	0	0	0	0.77	0.15	0	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0	13
43	0	0	0.20	0.30	0.30	0	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	10
44	0	0	0	0.47	0.16	0.26	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	19
45	0	0	0.28	0.17	0.11	0.33	0.06	0.06	0	0	0	0	0	0	0	0	0	0	0	0	18
46	0	0	0	0.14	0.14	0.50	0.18	0	0.05	0	0	0	0	0	0	0	0	0	0	0	22
47	0	0	0	0.07	0.14	0.29	0.29	0.18	0	0	0.04	0	0	0	0	0	0	0	0	0	28
48	0	0	0	0	0.13	0.29	0.26	0.10	0.06	0.06	0.06	0	0.03	0	0	0	0	0	0	0	31
49	0	0	0	0	0.07	0.21	0.21	0.19	0.14	0.09	0.07	0.02	0	0	0	0	0	0	0	0	43
50	0	0	0	0	0.02	0.12	0.24	0.25	0.20	0.10	0.04	0	0.04	0	0	0	0	0	0	0	51
51	0	0	0	0	0.05	0.10	0.17	0.17	0.17	0.17	0.12	0.02	0	0.02	0.02	0	0	0	0	0	42
52	0	0	0	0	0.12	0.04	0.16	0.12	0.16	0.12	0.08	0	0.08	0.08	0.04	0	0	0	0	0	25
53	0	0	0	0	0	0	0.08	0.17	0.17	0.17	0.04	0.08	0.17	0.08	0.04	0	0	0	0	0	24
54	0	0	0	0	0	0	0	0.17	0.08	0.08	0.17	0.08	0.08	0.17	0.00	0.08	0	0	0	0.08	12
55	0	0	0	0	0	0	0	0.17	0	0.17	0.33	0	0.33	0	0	0	0	0	0	0	6
56	0	0	0	0	0	0	0	0	0.14	0.14	0.14	0	0.29	0	0	0.14	0	0.14	0	0	7
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	1
58	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	1
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	1.00	1
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																					412

Appendix 5 – continued:

Estimates of proportion of length at age for kahawai sampled from the Bay of Plenty recreational fishery, January to April 2005 (Note: Aged to 01/01/05)

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	3
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	4
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	1
28	0	0.25	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
29	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
30	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
31	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
33	0	0	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
34	0	0	0.77	0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
35	0	0	0.89	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
36	0	0	0.89	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
37	0	0	0.91	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
38	0	0	0.25	0.63	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
39	0	0	0.63	0.25	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
40	0	0	0.18	0.64	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
41	0	0	0.11	0.67	0.11	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
42	0	0	0.08	0.53	0.33	0.03	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	36
43	0	0	0	0.56	0.38	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
44	0	0	0.07	0.36	0.36	0.14	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	14
45	0	0	0	0.43	0.19	0.29	0.05	0	0.05	0	0	0	0	0	0	0	0	0	0	0	21
46	0	0	0	0.07	0.20	0.33	0.27	0.07	0.07	0	0	0	0	0	0	0	0	0	0	0	15
47	0	0	0	0	0.20	0.25	0.15	0.30	0.05	0.05	0	0	0	0	0	0	0	0	0	0	20
48	0	0	0	0.08	0.29	0.25	0.21	0	0.13	0.04	0	0	0	0	0	0	0	0	0	0	24
49	0	0	0	0.08	0.15	0.12	0.38	0.04	0.15	0.04	0.04	0	0	0	0	0	0	0	0	0	26
50	0	0	0	0	0.17	0.04	0.30	0.17	0.09	0.22	0	0	0	0	0	0	0	0	0	0	23
51	0	0	0	0	0.19	0.06	0.23	0.03	0.23	0.13	0.10	0	0	0.03	0	0	0	0	0	0	31
52	0	0	0	0	0.06	0.06	0.19	0.13	0.25	0.06	0	0.06	0.13	0	0.06	0	0	0	0	0	16
53	0	0	0	0	0.13	0	0.13	0.13	0.25	0	0	0.25	0	0	0	0	0	0.13	0	0	8
54	0	0	0	0	0	0.09	0	0.18	0.09	0	0.18	0.09	0.18	0	0.09	0.09	0	0	0	0	11
55	0	0	0	0	0	0	0.25	0	0.25	0	0	0	0.25	0	0	0	0.25	0	0	0	4
56	0	0	0	0	0	0	0	0	0.20	0.40	0	0	0.20	0	0.20	0	0	0	0	0	5
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	1
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0.50	0	0	2
59	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0.50	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	1.00	0	0	0	0	0	0	0	0	0	0	0	1
62	0	0	0	0	0	0	0	0	0.50	0	0.50	0	0	0	0	0	0	0	0	0	2
63	0	0	0	0	0	0	0	0	0.33	0	0.33	0	0	0.33	0	0	0	0	0	0	3
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																					393