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Length and age composition of KAH 1 purse seine, set net, and ring net landings sampled in 2011 and 2012

New Zealand Fisheries Assessment Report 2013/53

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EXECUTIVE SUMMARY

Hartill, B.; Rush, N.; Armiger, H.; Buckthought, D.; Smith, M. (2013). Length and age composition of KAH 1 purse seine, set net, and ring net landings sampled in 2011 and 2012.

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This report describes catch sampling from three commercial KAH 1 fisheries during the 2011 and 2012 calendar years: the Bay of Plenty purse seine and Hauraki Gulf set net and ring net fisheries. Initial target sample sizes of 12 landings were set for each fishery, with a 10 t minimum landing sampling threshold for the purse seine fishery and a 1 t threshold for the set net and ring net fisheries. These thresholds were subsequently reduced to 3 t and 300 kg respectively, to increase the number of landings that were potentially available for sampling.

Two fishing companies operated purse seine vessels that caught kahawai in the Bay of Plenty, and both were cooperative; giving NIWA as much notice as possible of potential landings, to which we had full access. The number of available landings was less than expected however, and some smaller bycatch landings were missed because insufficient notice was given of an unloading event. In 2011, seven purse seine landings of kahawai from the Bay of Plenty were sampled over a five month period, which accounted for over 55% of the tonnage landed by this method in that year. The length and age compositions of kahawai from these landings were dominated by the recent strong recruitment of the 2007 four year old age class that accounted for over half the sampled catch, with most of the remainder being 5 to 8 year old fish. In 2012, eleven landings were sampled, which accounted for 45% of the total purse seine catch. The age distribution in 2012 was equally broad, dominated by the same year classes (2003–2007) as the year before, now five to nine years old. Sampling in both years was conducted during the second half of the calendar year which is when most purse seine targeting of kahawai occurs. Mean weighted coefficients of variation for the purse seine age compositions in the 2011 and 2012 calendar years, calculated according to the random age frequency approach, were 41% and 18%, respectively.

Although we initially intended to sample the Hauraki Gulf set net and ring net fisheries independently of each other, we were only able to identify one cooperative "set net" fisher who occasionally landed reasonably large catches of kahawai. All other fishers claimed to mainly use ring netting to catch kahawai, as set netting usually resulted in only small catches. The limited availability of set net landings confirmed earlier enquiries that suggested that most of the reported set net catch was in fact caught when ring netting. We sampled eleven ring net landings in 2011, but were only able to sample four set net landings, as they were relatively uncommon. Candid and detailed discussions with cooperative fishers suggest that many gear configurations and deployment methods could be reasonably classified as being either set net or ring net fishing, and they should be regarded collectively as one method. Further, the length compositions of kahawai landings by the two fishing methods were broadly similar, regardless of whether the method definition was based on that claimed at the time of sampling, or that ultimately reported on catch effort returns (these definitions differed for some landings).

The length and age compositions of combined set net/ring net landings of kahawai from the Hauraki Gulf in 2011 were dominated by the recently recruited 2008 year class, which made up almost three-quarters of the catch by number. These 3 year old fish were evident as a strong mode, with lengths ranging from 34 to 41 cm. In 2012 we were only able to sample eleven landings, because two of the more successful fishers denied us access to their landings. The 2008 age class was also clearly evident in the 2012 set net/ring net age distribution (now as 4 year olds) alongside a newly recruited 2009 year class (3 year olds), and these were seen in the combined landing length composition as strong modes centred at 35 and 43 cm respectively.

Mean weighted coefficients of variation for the combined set net/ring net age compositions during the 2011 and 2012 calendar years, calculated according to the random age frequency method were 18% and 39%, respectively. A random age frequency analytical approach was used to analyse data collected from the set net and ring net landings, because the age-length key approach is considered to be inappropriate given the length of the sampling season.

We conclude that the proportional length and age estimates presented here provide adequate and representative descriptions of the catches landed by the Bay of Plenty purse seine and Hauraki Gulf set net/ring net fisheries during the 2011 and 2012 calendar years.

1. INTRODUCTION

Kahawai (*Arripis trutta*) are highly valued by the customary, recreational and commercial sectors, and have been managed under the Quota Management System since 1 October 2004. The most recent stock assessment for KAH 1, in 2007, highlighted the need to characterise removals by key commercial fisheries, to describe the age composition of commercial landings and to improve selectivity estimation (Hartill 2009).

Most kahawai catch sampling in recent years has focussed on recreational landings, but relatively little information is available on the length and age composition of commercial landings, which account for over half of the total catch taken from KAH 1. Approximately two thirds of the commercial catch from KAH 1 is taken by the purse seine fleet, with most of the remainder taken by set net and ring net vessels. Purse seine landings have previously been sampled in 1990–91, 1991–92 and 1992–93 (Hartill & Walsh 2005), and in 2005–06 (Devine 2007), but the scale of the fishery warrants further examination and up to date catch sampling to describe the current length and age composition of this fishery. No historical data are available on the composition of set net and ring net landings, despite the fact that these fisheries often account for about a third of the commercial catch taken from KAH 1.

This report describes the length and age composition of purse seine, set net and ring net landings sampled in 2011 (under MPI project KAH201003) and 2012 (under MPI project KAH201101).

Specific objective for KAH201003

- To conduct the sampling and determine the length and age composition of purse seine and set net landings of kahawai from KAH 1 during the 2010–11 fishing year, given a characterisation completed before sampling commences.

Specific objective for KAH201101

- To conduct the sampling and determine the length and age composition of purse seine and set net landings of kahawai from KAH 1 during the 2011–12 fishing year.

2. CHARACTERISATION OF THE KAH 1 COMMERCIAL FISHERY

The kahawai catch sampling design in 2011 and 2012 was initially based on a characterisation of commercial catch effort data for KAH 1 submitted during the five most recent fishing years (2005–06 to 2009–10). In early 2013 a further catch effort extract was obtained that included data from the more recent 2010–11 and 2011–12 fishing years, which was used to update the characterisation of the

KAH 1 fishery and to assess the representativeness of sampling undertaken in 2012. The spatial extent of the KAH 1 fishery and associated statistical reporting areas is shown in Figure 1.

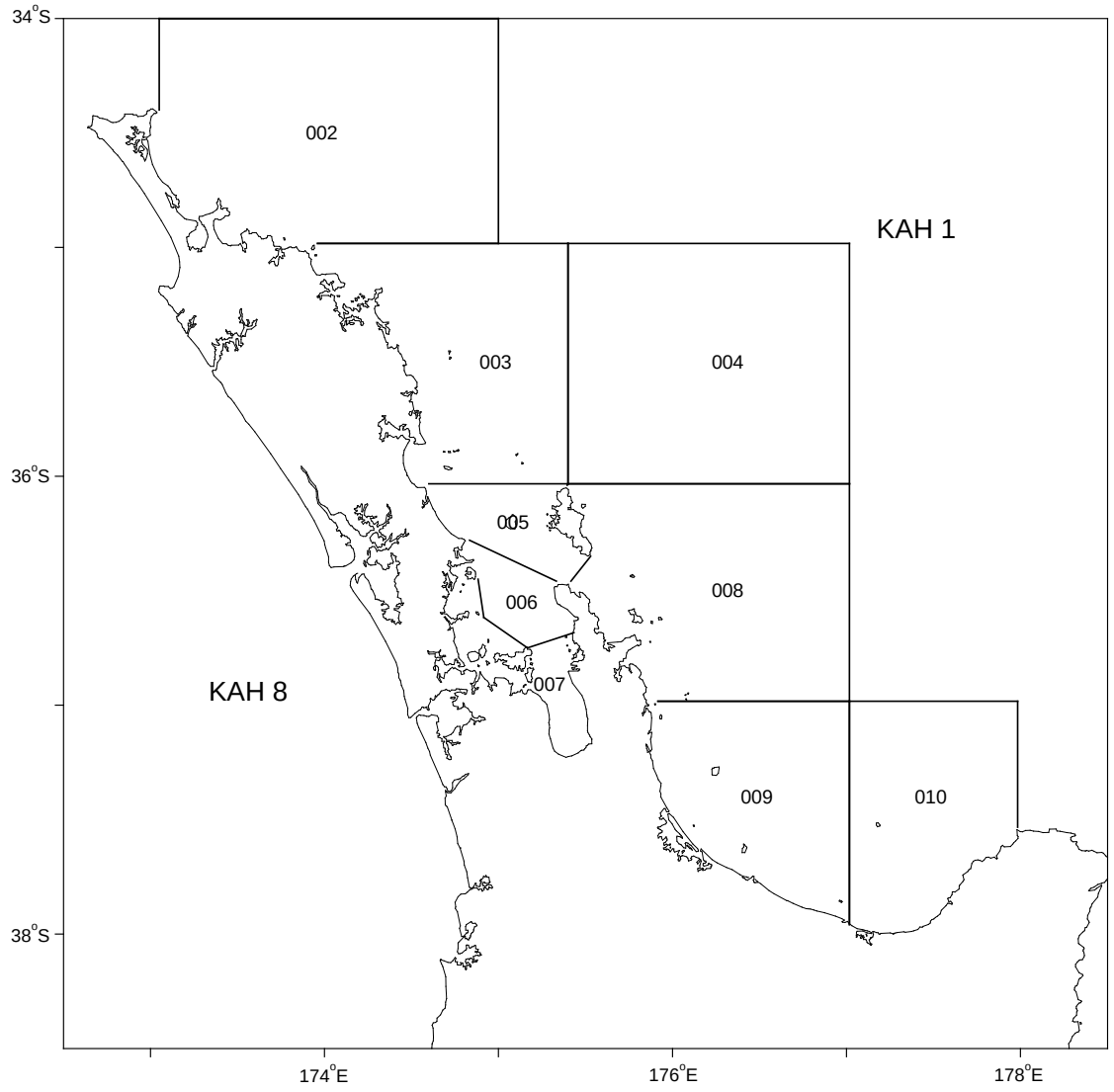

Figure 1: Statistical reporting areas for KAH 1.

The reliability of available catch effort data was initially assessed by comparing annual landing tonnages of kahawai with those reported via Monthly Harvest Returns (MHR). This comparison highlighted some errors, and a closer examination of the data suggested that most of these errors were attributable to the set net/ring net fishery. Although some apparent errors were easily resolved, there was no obvious solution to some discrepancies that were associated with the use of destination code "Q" (holding on land). Net fishers commonly use this code when they retain a catch in a chiller for a period of time, or when they combine it with catches from other trips before delivery to a Licenced Fish Receiver (LFR). A chronological examination of each fisher's data sometimes highlighted a very poor correspondence between reported fishing effort and the magnitude of the stored catch for a period of time. The convention of dropping all landed weights assigned to the destination code "Q" resulted in a significant "undercatch" of the MHR total for that period, however, and in some instances the decision was made to retain these potentially erroneous records. There is therefore a broad correspondence between catch totals reported on Catch Effort Landing Returns (CELRs) and MHR totals for the seven fishing years, but some discrepancy remains (Figure 2).

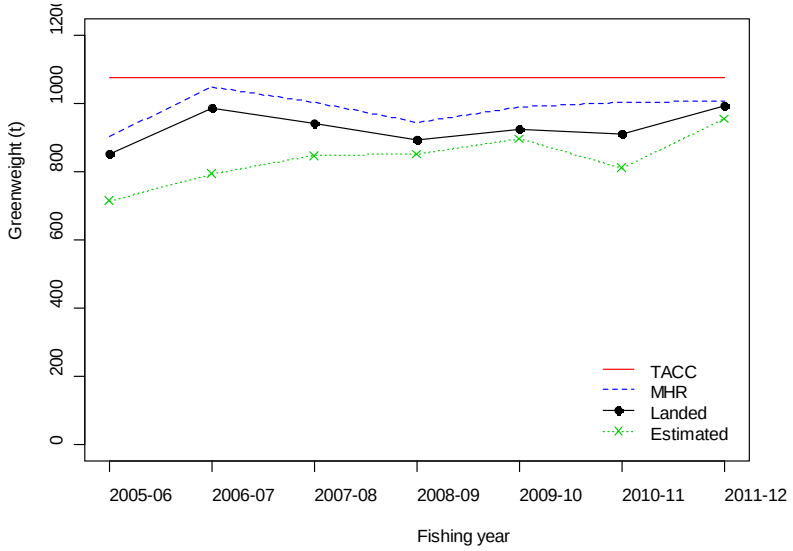

Figure 2: Comparison of landed and estimated catch tonnages reported for KAH 1 on Catch Effort Landing Returns (CELRs) with those reported on Monthly Harvest Returns for the period 2005–06 to 2011–12. Some catch effort records have been adjusted or dropped from the data set when obvious reporting errors were apparent.

The majority of the commercial catch landed from KAH 1 between 2005–06 and 2011–12 was taken by purse seine (PS), with most of the remaining catch taken by set net (SN) (Figure 3). Preliminary enquiries suggested that much of the set net catch is probably taken by fishers using ring net (RN) type methods. We were told by commercial fishers that set net fishing is now relatively uncommon, because better prices are usually achieved when fishers ring net their catch, typically at night. The meshing of fish in set nets and prolonged soak times causes damage to the catch, reducing its marketable value. We therefore concluded that ring netting was potentially the second most important commercial fishing method in KAH 1, despite the low incidence of reported RN landings relative to those reported against the SN method code. Additional sampling was therefore proposed, as we were concerned that we could be unable to sample an adequate number of set net landings if we ignored landings which were reported to us as ring net landings.

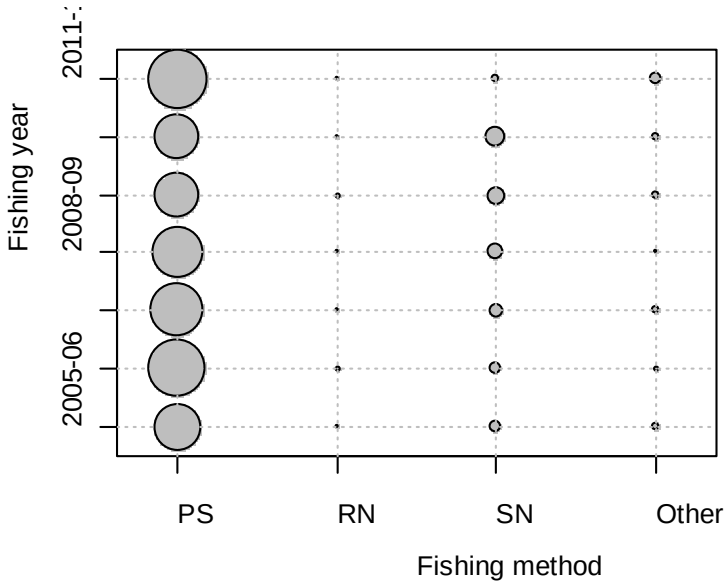

Figure 3: Relative commercial catch by fishing method from KAH 1, for the 2005–06 to 2011–12 fishing years.

The KAH 1 purse seine fishery

The purse seine fishery in KAH 1 lands kahawai throughout the year, but 80–90% of the catch caught since 2006 was landed between June and December (Figure 4). The purse seine season for kahawai usually spans the fishing year boundary (September/October) and the calendar year was therefore considered to be a more sensible sampling year rather that one defined by the fishing year.

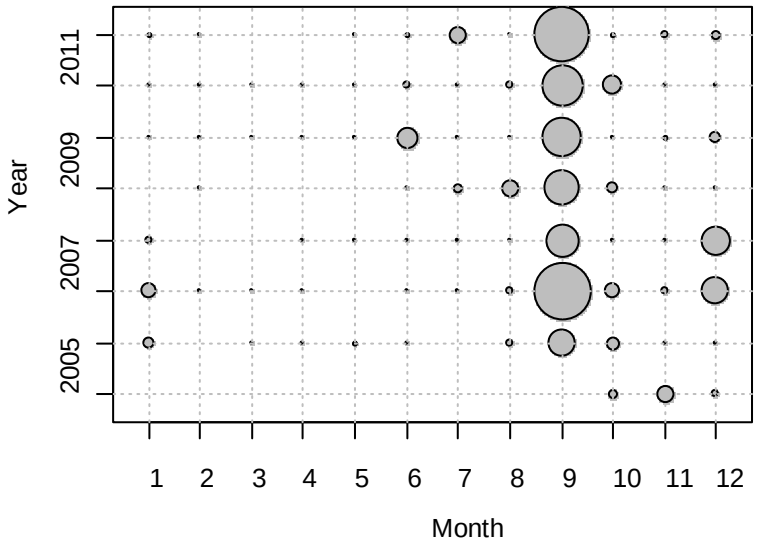

Figure 4: Seasonality of purse seine landings from KAH 1 for the 2005 to 2012 calendar years.

Between 83 and 100% of the KAH 1 purse seine catch has been taken from the Bay of Plenty in recent years, predominantly from statistical reporting area 009 (Figure 5). Sampling was therefore restricted to purse seine catches caught in the Bay of Plenty, and a target of 12 sampling events was set. There are two operators which account for all the kahawai landed by purse seiners from the Bay of Plenty: Sanford Ltd and Pelco NZ Ltd.

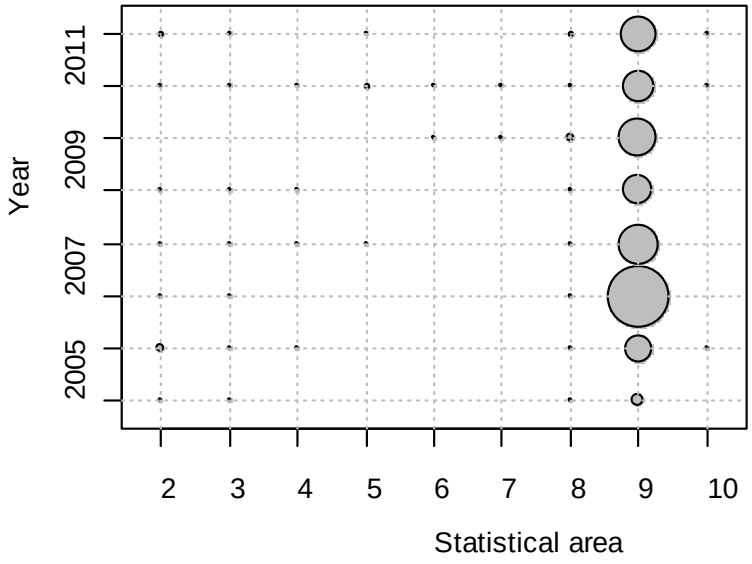

Figure 5: Spatial distribution of catches taken by the KAH 1 purse seine fishery by statistical reporting area since 2005.

The KAH 1 set net and ring net fisheries

There was no existing information available on the catch composition of set net and ring net landings in previous years. We sampled landings taken by both of these fishing methods to describe the harvest and to compare the composition of the catch taken by each method. Anecdotal reports suggest that the relative mix of the ring net/set net fishery has changed markedly over recent years, with an increase in the overall tonnage taken by these two methods, and a shift from set netting towards ring netting which yields a more marketable product. An examination of recent catch effort data suggests that set net landings still dominate the Hauraki Gulf fishery (see Figure 3), but this is likely to be due to misreporting.

Set net and ring net catches of kahawai in previous years mostly occurred between April and December, but in 2011 and 2012 the main seasons were shorter, starting in late March and ending in September (Figure 6). Although set netting has been more commonly reported in recent years, ring netting was the dominant reported method in 2012. The majority of kahawai caught by set net and ring net in recent years was taken in statistical reporting area 007 (Figure 7), mostly in the Firth of Thames and the inshore coastal waters of the southern Hauraki Gulf. However, considerable catches were also taken by ring net in statistical reporting area 005 in 2006 and 2007.

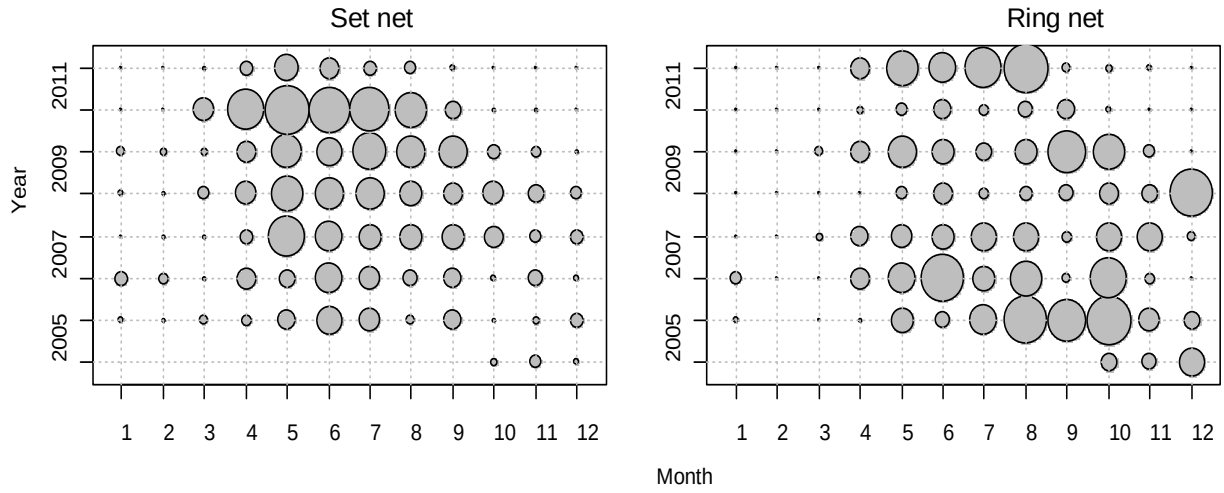

Figure 6: Seasonality of set net (left panel) and ring net landings (right panel) from KAH 1 for the 2005 to 2012 calendar years.

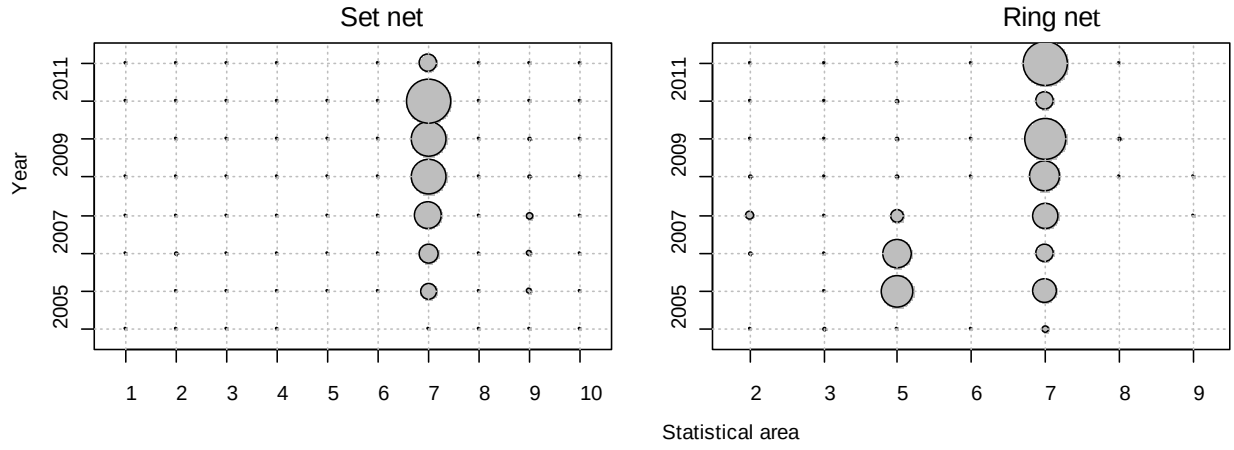

Figure 7: The spatial distribution of set net (left panel) and ring net landings (right panel) in KAH 1 by statistical reporting area since 2005.

3. METHODS

Sampling of purse seine catches from the Bay of Plenty

When sampling first began in 2011 a threshold of 10 t was initially set, which was used to determine whether or not a landing should be sampled. This limit was later reduced to 3 t because a number of early landings were not sampled as they did not meet the initial threshold, but were nonetheless reasonably substantial.

A two stage sampling approach was used to estimate the length and age composition of each kahawai landing, with a sample of fish initially selected for measurement, from which a smaller subsample was set aside for taking otoliths. At least 200 kahawai were randomly selected for measurement from each landing, but if a vessel held kahawai in more than one hold, a random sample of 100 fish was taken from each hold. Every third fish measured was put aside for taking otoliths, resulting in an age sample of approximately 60 fish. Kahawai were not sexed when otoliths were taken because there is no apparent sexual dimorphism in growth rates (Bradford 1998). Length and age samples were collected from each landing so that a comparison could be made of age distributions calculated by both the age-length key (AL key) and random age frequency (RAF) analytical methods. All of the available age data were included in the 2011 and in the 2012 age-length keys because we sampled fewer landings than originally intended. The age-length key was therefore based on a random age sample, rather than a fixed number of fish targeted per size class.

Sampling of set net and ring net catches from the Hauraki Gulf

Preliminary enquiries suggested that the number of set net fishers in the Hauraki Gulf has declined in recent years, and that there has been a shift towards ring net fishing. The initial intention was to sample 12 landings from each of the set net and ring net fisheries in each calendar year, but it became clear that fishers had differing interpretations of when they were set netting and ring netting and some unintentional misreporting of method codes has probably occurred. At each sampling event we asked the fisher to describe their fishing method. Questions were asked about net length, mesh size, soak time, use of anchors or net weights, and the configuration of the net. The answers to these questions were used to determine which method was the most likely, which was usually that suggested by the fisher. Most of the ambiguity over the definition and reporting of set netting and ring netting was shown by one fisher, who coincidentally landed the most kahawai in 2011. His answers suggested that he was ring netting, but he often recorded his effort as SN on CELRs. It should be noted, however, that the distinction between these two methods is blurred because of a range of factors including: whether or not anchors are used, the shape of the set, proximity to land, and soak time. Any distinction between set netting and ring netting is therefore often arbitrary to some extent.

Originally a sample weight threshold was set at 1000 kg, but it became apparent that catches in excess of this weight were landed by only a small number of fishers. The threshold was then reduced to 300 kg to increase the number of landings potentially available for sampling, but only a limited number of landings were available regardless, because only three of the cooperating fishers regularly landed catches in excess of even the reduced threshold. A small number of landings weighing less than 300 kg were sampled regardless. Other cooperative fishers tended to land catches that weighed 100 kg or less. Unfortunately two fishers who landed larger catches in 2012 refused to cooperate.

A sample of 150 kahawai were randomly sampled from each landing and measured. Every fourth fish was put aside into a separate bin for taking otoliths, resulting in an age subsample of approximately 40 fish. Length and age samples were collected from each landing so that a comparison could be made of age distributions calculated by both age-length key and random age frequency analytical methods. An analysis of data collected in 2011 suggested that a random age frequency approach was most appropriate given the potentially prolonged length of the fishing seasons.

Otolith preparation and ageing

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

To improve clarity, a thin layer of immersion oil was brushed over each slide, which was read under transmitted light. Two readers were initially used to interpret the thin sectioned otoliths and any disagreements in interpretation were ultimately resolved in conjunction with a third reader when necessary.

All three otolith readers were very experienced and the two main readers (Matt Smith and Dane Buckthought) have been involved in the reading of kahawai otoliths collected from recreational landings since 2001, ensuring consistency of interpretation. The third reader was Cameron Walsh (Stock Monitoring Services) who is one of New Zealand's most experienced otolith readers.

The following process was followed:

- Each otolith section was read independently by two readers;
- Disagreements between initial age interpretations for each otolith were identified then resolved by discussing images of these otoliths projected onto a video screen, which were discussed with a third experienced reader until a consensus was reached;
- If no consensus could be reached, the otolith was discarded from the dataset.

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

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

The precision of otolith readings was quantified by comparing initial readings provided by the two readers, and also by comparing initial reads with final agreed ages for each reader as recommended by Campana et al. (1995). An Index of Average Percentage Error (IAPE, Beamish & Fournier 1981) statistic, and mean coefficient of variation (CV, Chang 1982), was calculated for each comparative test.

Catch-at-age analysis

Two methods were used to calculate proportion-at-age and bootstrap variance estimates; a Random Age Frequency (RAF) approach and a quasi age-length key approach, which were both implemented using NIWA's C++ software tool CALA (Catch-at-age and -length, Francis & Bian 2011).

Under the Random Age Frequency approach, landing specific age samples were weighted together by the estimated number of fish in each landing, to produce proportion-at-age estimates for the wider fishery. With the quasi age-length key approach, the age samples randomly selected from each

landing were pooled to produce a single age-length key, which was not therefore, based on the collection of a fixed number of fish sampled from each length class over a limited time period.

4. RESULTS

4.1 The Bay of Plenty purse seine fishery

Landings of kahawai from the Bay of Plenty purse seine fishery in 2011 and 2012 were typically seasonal, occurring in the latter half of the year with the largest catches taken in September. Although no samples were taken in some months, overall, sampling effort was distributed in reasonable proportion to, and was representative of the fishery (Figure 8). In 2011, seven landings were sampled, which accounted for 55% of the total purse seine catch of kahawai in that year. In 2012, eleven landings were sampled accounting for 45% of the total catch. Landings were occasionally missed because insufficient notice was given about the time of unloading. Some small landings were not sampled because they were well below the minimum sampling weight threshold (Figure 8).

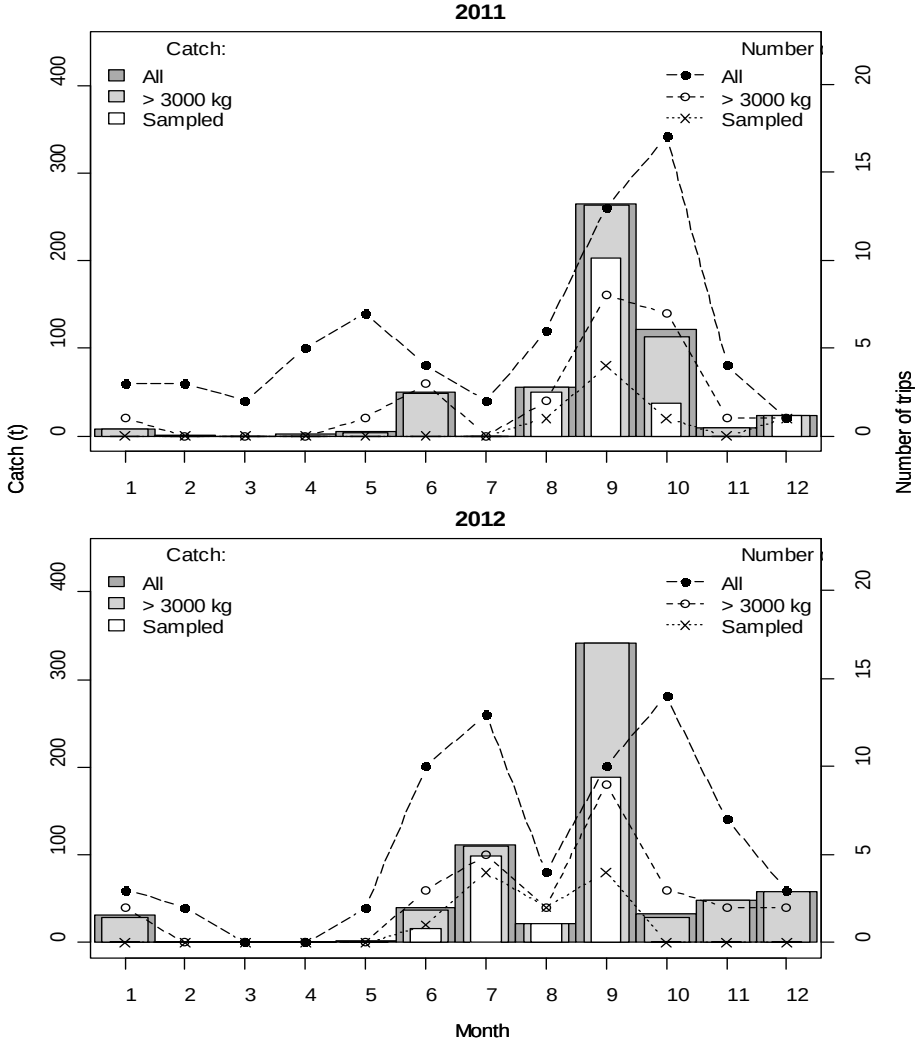

Figure 8: Representativeness of Bay of Plenty purse seine landings sampled during the 2011 and 2012 calendar years, in terms of weight and number of landing events.

Approximately three quarters of the kahawai landed by purse seiners from the Bay of Plenty during the 2011 and 2012 calendar years was caught when targeting kahawai, with the remainder caught mainly when targeting jack mackerel (Figure 9). Catch sampling was broadly representative in terms of target species, with some oversampling of targeted kahawai landings and under sampling of jack mackerel landings. Any bias towards kahawai target landings reflects the fact that bycatch landings of kahawai were often relatively small and fell well below set sampling threshold weights.

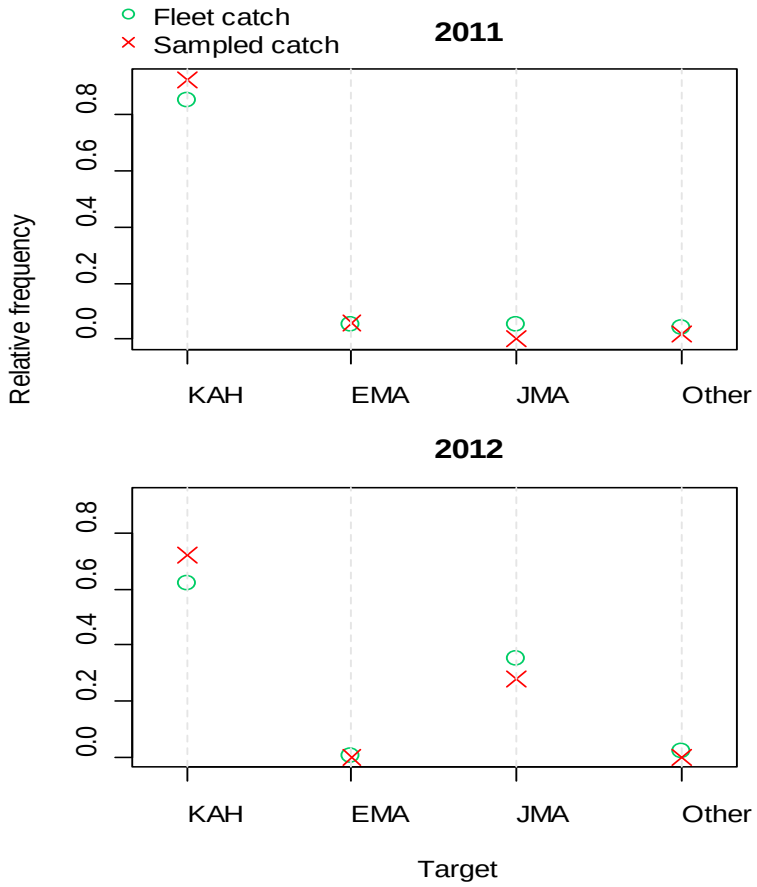

Figure 9: Representativeness of Bay of Plenty purse seine landings sampled during the 2011 and 2012 calendar years, in terms of target species.

In 2011, a total of 1880 kahawai were measured for length from seven sampled purse seine landings, of which 449 were subsequently aged. The degree of correlation between the two readers was very high, with 91% agreement in initial readings (Appendix 1). The few outliers seen in the ageing precision plots were mostly associated with older fish that are usually harder to age. The age distributions derived from the age-length key and random age frequency analytical approaches were very similar, with a very strong age class of 4 year old fish (spawned in 2007) with a corresponding mean length of about 43 cm (Figure 10, Appendix 3). Most of the remaining fish were between 5 and 8 years old.

A total of 2444 kahawai were measured for length from eleven purse seine landings in 2012, of which 619 fish were aged. The level of initial agreement (89%) by the two primary otolith readers was almost as high as in 2011 (Appendix 2). The five most predominant age classes seen in the 2011 age distribution were also evident in 2012 landings, although the 2007 cohort was of a similar relative strength to the four other age classes in this year.

Two analytical methods were used to calculate generate age distributions, and although they generated similar age distributions (Figure 10), the random age frequency approach is preferred. The level of precision achieved in 2012 was far higher than in 2011 (Table 1).

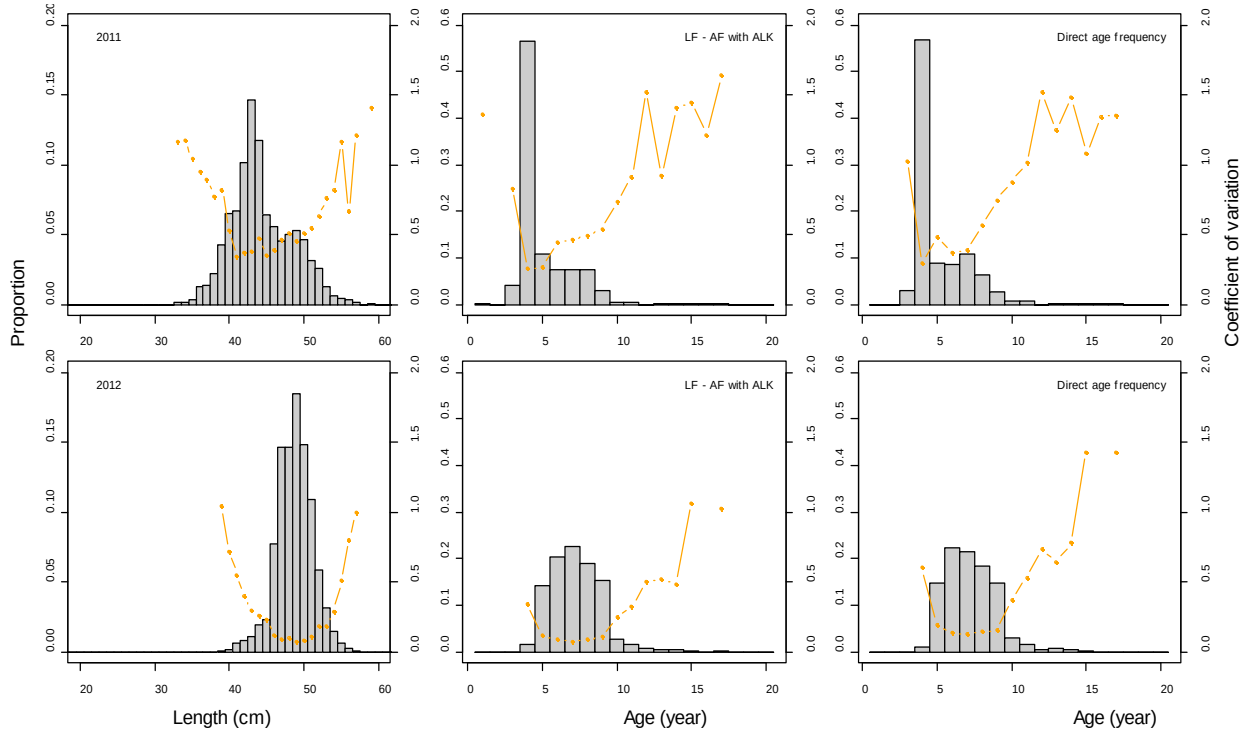

Figure 10: Length and age composition of the Bay of Plenty purse seine fishery in 2011 (top panels) and in 2012 (bottom panels) calculated by an age-length key approach and a random age frequency approach

Table 1: MWCV's for the Bay of Plenty purse seine fishery in 2011 and 2012 calculated by both methods used for analysis, an age-length key and random age frequency approach.

	Length	Age (RAF)	Age (AL key)
2011	0.49	0.41	0.37
2012	0.13	0.18	0.12

4.2 The Hauraki Gulf set net and ring net fishery

The set net/ring net kahawai season for kahawai in 2011 finished in September (Figure 11), two to three months earlier than in previous years (see Figure 6). The shortened season coupled with a lack of cooperating fishers claiming to use "set net" methods meant that we were only able to sample four landings taken by this method, despite attempting to sample twelve, (Table 2).

The 2012 kahawai season was even shorter than in 2011, with the majority of the catch landed over a five month period between April and August (Figure 11). Set net/ring net fishers landed a smaller tonnage of kahawai in 2012, and many of these landings were too small to warrant sampling. There were also fewer landings in 2012, partially because one major operator swapped to other target species early in the season and left the running of his vessel to a less experienced crew. We were also aware of two fishers who frequently landed large catches of net caught kahawai, but they refused us access to their landings. Consequently, we were only able to sample eleven landings in 2012, despite attempting to sample 24 from the combined set net/ ring net fishery.

Table 2: Number of Hauraki Gulf kahawai set net and ring net landings sampled in 2011 and 2012, as defined by the fisher at the time of sampling and as reported by the fisher on their catch effort return.

	Method as reported in 2011		
Method at time of sampling in 2011	Ring net	Set net	Total
Ring net	6	5	11
Set net	–	4	4
Total	6	9	

	Method as reported in 2012		
Method at time of sampling in 2012	Ring net	Set net	Total
Ring net	7	–	7
Set net	–	4	4
Total	7	4	

Although kahawai were landed by this fishery throughout both fishing years, the weight of most early and late landings was comparatively low, and these were considered to be far too small to warrant sampling. Nonetheless, the sampling season in both years broadly followed that of the fishery.

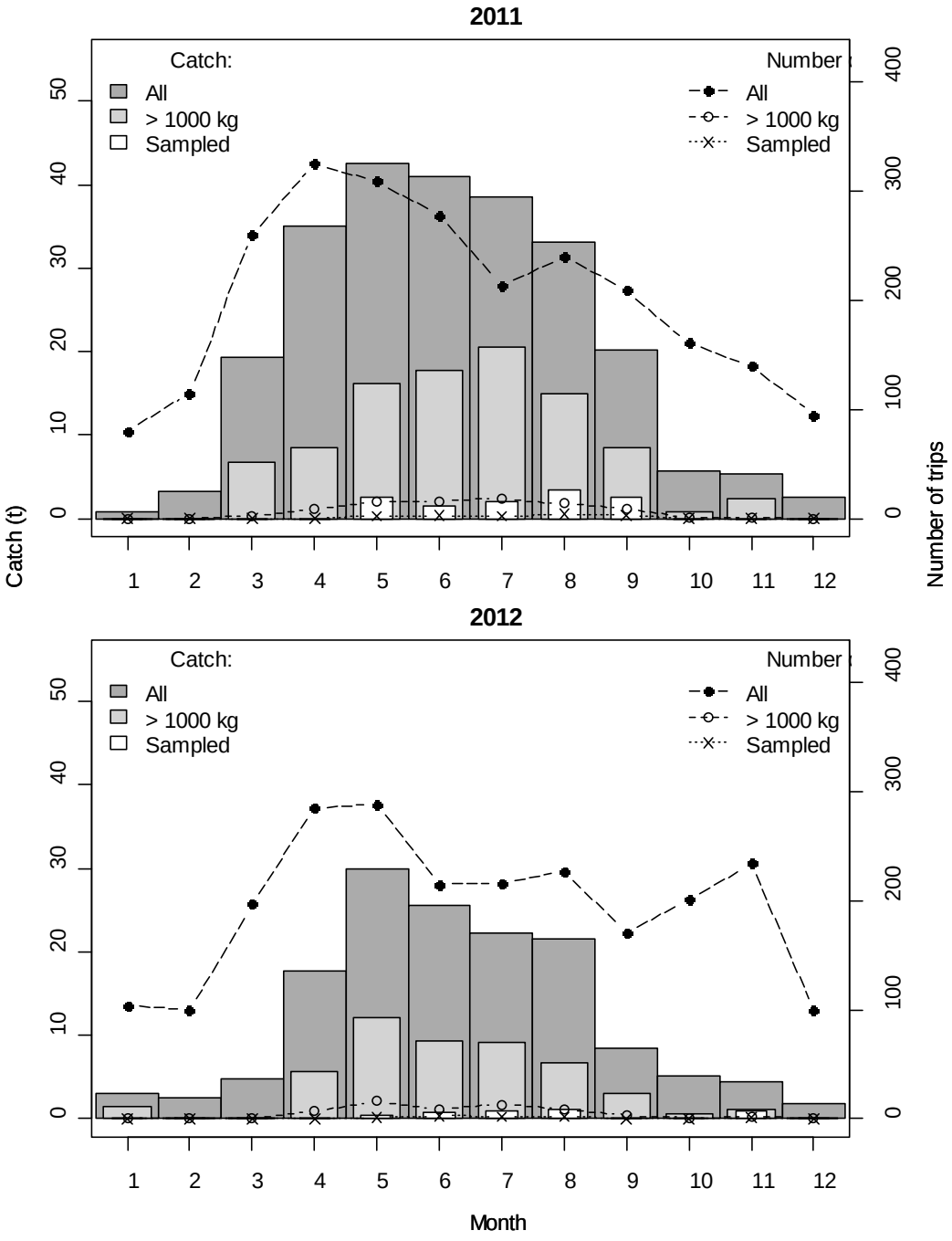

Figure 11: Representativeness of Hauraki Gulf set net/ring net landings sampled during the 2011 and 2012 calendar years, in terms of weight and number of landing events sampled.

Almost all of the landings that were sampled in 2011 were caught when targeting kahawai, with the two bycatch landings (that targeted grey mullet) being among the smallest landings sampled (Figure 12). Targeting behaviour changed in 2012, with more fishers targeting grey mullet, although kahawai was still the most common target species. As in 2011, most bycatch landings of kahawai were far too small to warrant sampling, and most of the sampled landings were caught while targeting kahawai. The proportionality of the sampled component to that of the fishery suggests that the sampled landings, by and large, are representative of the operation of the KAH 1 set net/ring net fishery fleet as a whole.

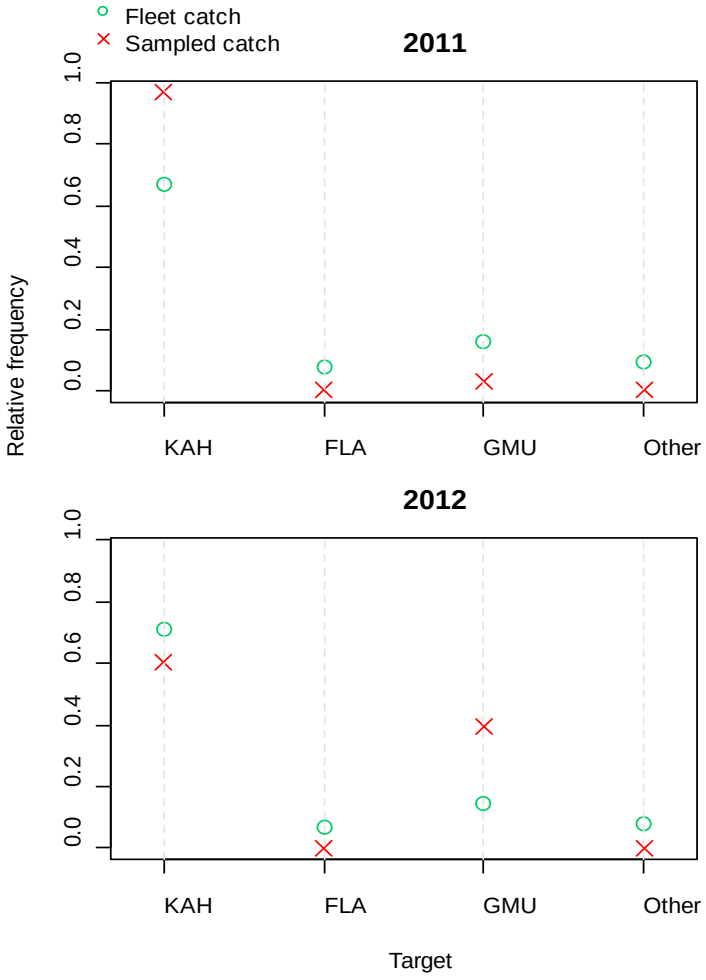

Figure 12 Representativeness of Hauraki Gulf set net/ring net landings sampled during the 2011 and 2012 calendar years, in terms of target species.

The length compositions of set net and ring net landings of kahawai in 2011 were very similar, regardless of whether the method definition was based on that claimed by the fishers at the time of sampling, or when they reported their trip on CELRs (Figure 13). Most of the difference between the 2011 set net and ring net distributions is attributable to the influence of a single landing comprised of large kahawai that the fisher claimed to have caught by ring netting, which they then went on to record as a set net landing on their CELR (Appendix 11).

In 2012, the method that fishers claimed to have used at the time that their landing was sampled matched that reported on their CELR, in every instance (Table 2). The difference between the set net and ring net length distributions in 2012 was more marked than in 2011, but once again, this

difference is probably due to the chance influence of individual landings rather than any systematic difference between the selectivity of the two methods (see Appendix 12).

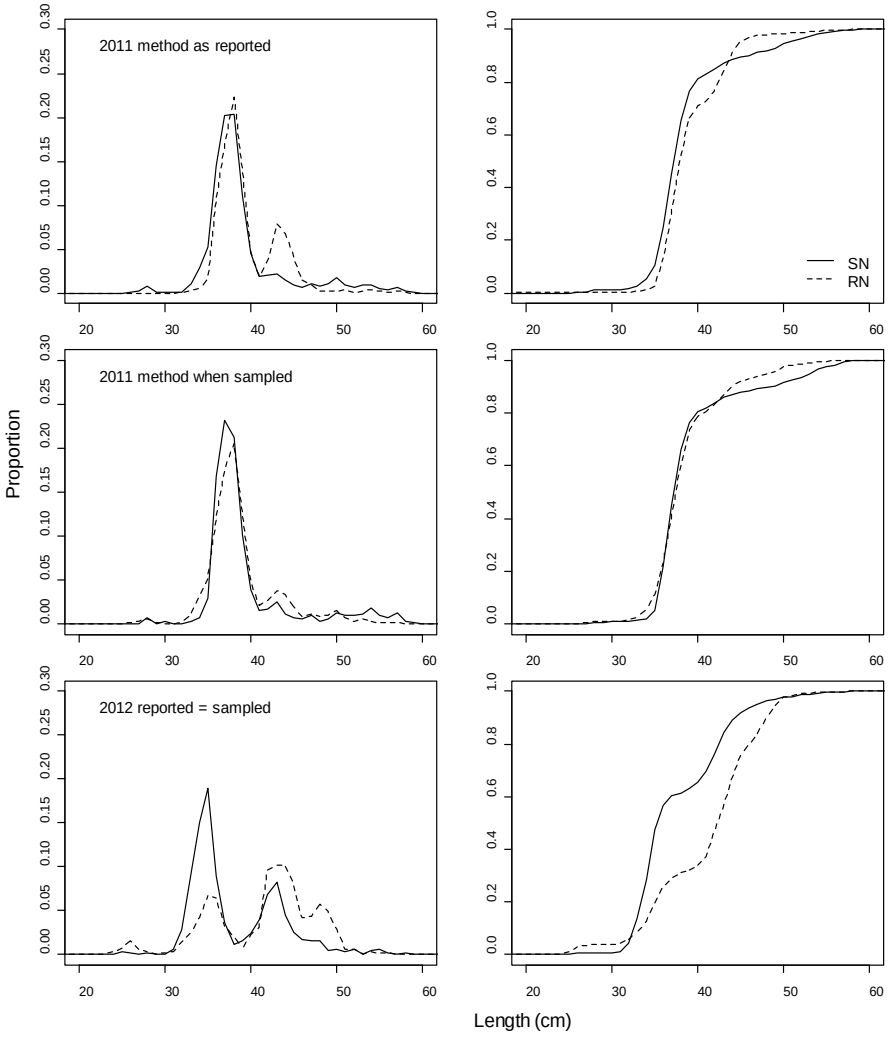

Figure 13: Proportional and cumulative comparisons of the length distributions of sampled set net and ring net landings as reported by fishers on Catch Effort Landing Returns (CELRs) during the 2011 and 2012 calendar years.

Although there is some difference between the 2011 set net and ring net age distributions when the method definitions are based on those reported on CELRs (Figure 14), the age distributions for the two methods are more similar when the method split is based on conversations with fishers at the time of sampling (Figure 15). Both age distributions were broadly characterised by a strong 3 year old cohort of fish mainly 36 to 39 cm, and a less pronounced 4 year old cohort. The age distribution in 2012 was broader than in 2011, which may be due to the recruitment of the relatively strong 3 year old age class entering the fishery in 2012, and the progression of the two dominant age classes from 2011 now 4 and 5 year olds respectively (Figure 16).

Age distributions have been generated using both the age-length key and a random age frequency approaches, and although similar distributions and levels of precision were obtained (see Table 3) from these two analytical approaches, the random age frequency age distribution is preferred because the age-length key approach is considered unsuitable given the length of the sampling season. The age distributions of most set net and ring net landings were usually unimodal and largely comprised of

three year olds, although the age distributions of three landings were far broader (Appendices 13 and 14).

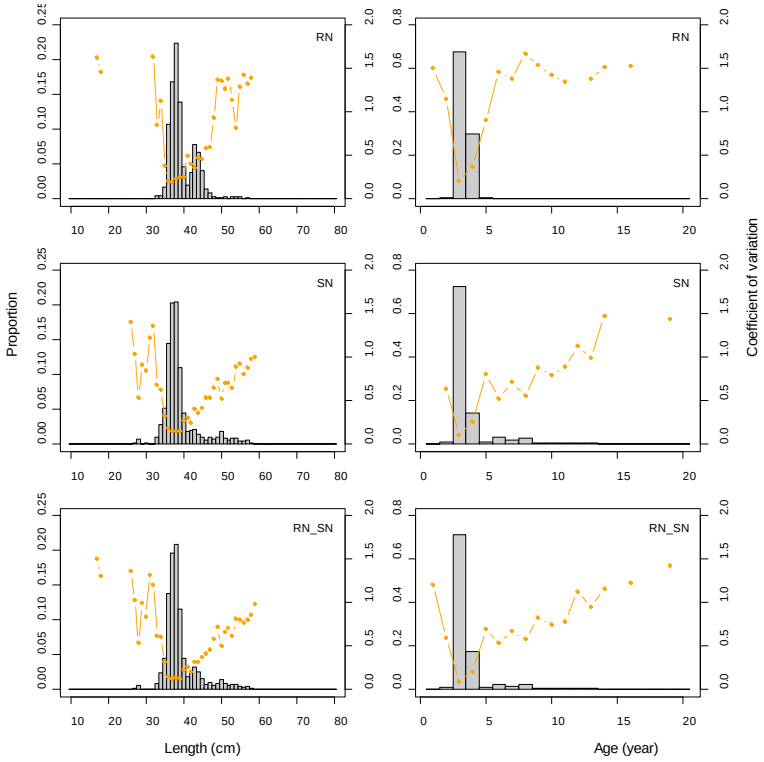

Figure 14: Length and age distributions for Hauraki Gulf ring net (top panels) and set net landings (middle panels) sampled in 2011, for the two methods as reported by fishers on their CELRs, and for both methods combined (bottom panels). The age distributions were calculated using a random age frequency approach.

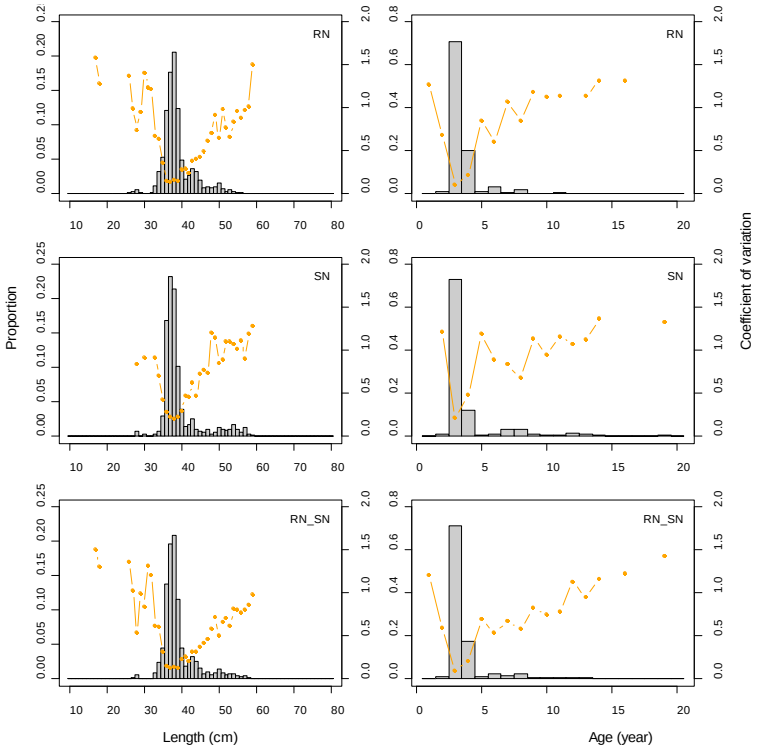

Figure 15: Length and age distributions for Hauraki Gulf ring net (top panels) and set net landings (middle panels) sampled in 2011, for the two methods as defined by fishers at the time that their landings were sampled, and for both methods combined (bottom panels). The age distributions were calculated using a random age frequency approach.

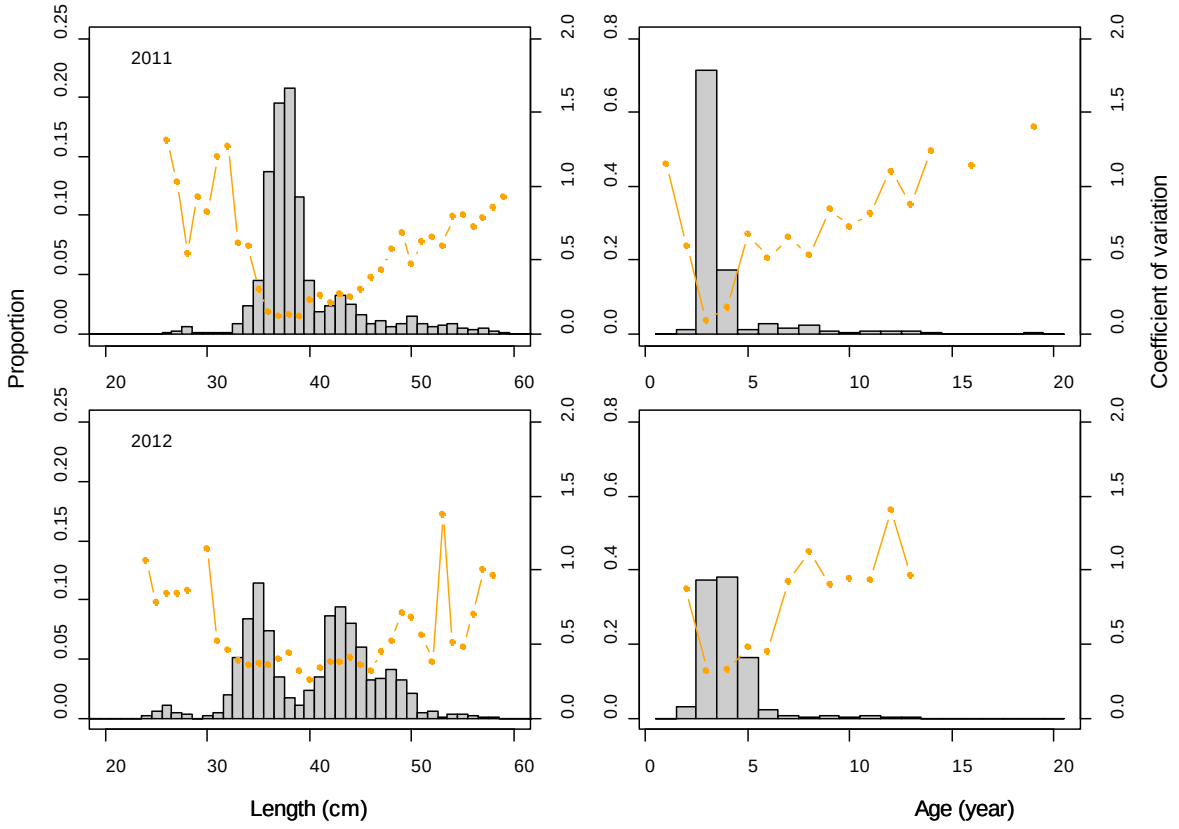

Figure 16: Length and age distributions for combined set net/ring net methods in 2011 and 2012 as reported by fishers on their CELRs. The age distributions were calculated using a random age frequency approach.

Table 3: Mean weighted coefficients of variation (MWCVs) obtained for Hauraki Gulf set and ring net landings, as defined by fishers when their landings were sampled, and for both methods combined. Both age-length key and random age frequency analytical approaches were used to calculate MWCVs.

		Length	Age (RAF)	Age (AL key)
2011	RN	0.28	0.20	0.27
	SN	0.37	0.36	0.37
	RN and SN	0.23	0.18	0.16
2012	RN	0.54	0.53	0.50
	SN	0.48	0.45	0.44
	RN and SN	0.41	0.39	0.38

5. DISCUSSION

The most recent assessment of the KAH 1 stock in 2007 highlighted the need to describe the length and age composition of commercial purse seine and set net/ring net landings for two reasons. Firstly, because the purse seine fishery usually accounts for two thirds of the commercial catch landed in any given fishing year, but the only source of information on the length and age composition of purse seine landings available at the time of the 2007 stock assessment was that collected in 1991, 1992, and 1993 (McKenzie, NIWA Fisheries Scientist unpub. data) and in 2005 (Devine 2007). The length and age composition of the purse seine catch can vary considerably from year-to-year, however, as landings are often composed of kahawai of similar size and age taken from a single school, with a few large landings often accounting for most of the annual catch taken by this method. Secondly, because this study also provides the first characterisation of catches taken by the set net/ring net fishery, which usually accounts for almost one third of the annual commercial harvest from KAH 1. Length composition data collected during the 2011 and 2012 calendar years provides data that can be used to estimate the selectivity of this fishery for the first time. Although the set net selectivity ogive used in the 2007 assessment was assumed and not based on any fit to length composition data, it was instrumental in determining how the 2007 CASAL model interpreted regional set net CPUE indices.

The purse seine and set net/ring net fisheries were sampled for both length and age, to determine whether proportion-at-age estimates should be generated via a random age frequency or an age-length key approach. The age-length key based proportion-at-age variance estimates provided here are only indicative, however, as each fishery's key was based on a pooling of the random age samples selected from all landings, rather than the selection of a fixed number of fish from each length class, collected over a limited time period. The Northern Inshore Working Group recommends that future kahawai catch sampling programmes should use a random age frequency approach to generate proportion-at-age estimates, because the set net/ring net and purse seine fishing seasons for this fast growing species tend to be protracted. The Working Group also recommended that samplers should continue to measure additional fish from commercial landings, to maximise the level of precision for associated proportion-at length distributions.

Most of the kahawai catch taken by the purse seine fleet is usually caught between June and December, and it was therefore more appropriate to sample the fishery over the calendar year, rather than the fishing year (October to September). The five most dominant year classes in 2011 were also clearly evident in 2012, although the 2007 cohort was far more dominant in 2011. Recreational catch-at-age distributions from the Bay of Plenty are usually far broader than purse seine age distributions, as amateur fishers land a broader size range of kahawai than seen in commercial landings (Armiger et al. 2013). The estimates of precision associated with the 2011 and 2012 purse seine length and age distributions were variable but of similar magnitude to those achieved by past catch sampling surveys (Devine 2007; J. McKenzie, NIWA Fisheries Scientist, unpub. data). The magnitude of the variance estimates given here reflect the high level of between landing variability in length and age catch composition, and the small number of landings occurring in each season. Potentially low levels of precision are not unexpected for this fishery given the small number of large purse seine landings that are available for sampling in any given year. Both of the companies operating purse seine vessels in 2011 and 2012 were very cooperative and we were able sample all available landings when sufficient notice was given of an impending landing. Mean weighted coefficients of variation for the purse-seine age compositions sampled during 2011 and 2012 were 41% and 18%, respectively, when a random age frequency approach was used.

Sampling from the set net/ring net fishery was far more problematic. The set net/ring net fishery operates from April to December and numerous catches weighing up to one tonne have been landed in recent years. In 2011 we were only able to sample landings from three fishers who were willing to give us access to their landings. Other fishers identified as catching substantial landings of kahawai were sometimes initially helpful when first called, but then became uncooperative, stating that they didn't want their catches sampled as they usually went straight to a licenced fish receiver early in the

morning after a long night of fishing. In 2012 we identified five fishers who were willing to cooperate, but we sampled fewer landings in this year for two reasons. Firstly, because the Hauraki Gulf set net fishery caught significantly less kahawai in 2012 than in 2011, and secondly, because the most prolific fisher in 2011 changed vessels early in the 2012 season to target a different species, leaving a less experienced crew to run the vessel. This replacement crew usually landed less than 300 kg of kahawai at the end of a trip.

Initial investigations of the set net and ring net fisheries highlighted the fact that fishers used a range of netting techniques to catch kahawai, and that some might regard a set to be a set net event whereas others might regard it to be a ring net event. In a generic sense, "set netting" is often used to describe the setting of a net held in place by anchors or weights, often at right angles to the shore. Set nets are usually left out for many hours, often throughout the night over a full tidal cycle. Conversely, "ring netting" involves enclosing a school of fish for a relatively short period before the net and catch is retrieved. Weights and anchors are rarely used by ring net fishers, requiring less effort, although they often set their catch across an embayment that helps to enclose the catch. Traditionally the mesh size of a set net is 125mm and of a ring net is 90–91mm, which could affect the size of the fish caught by each method. Many net fishers now used a single net/mesh for both purposes, however, and adapt their methods to maximise their catch given conditions encountered at the time. Short term set periods are now far more common than in the past, regardless of whether a net is set with anchors, or ringed, to maximise the condition of the catch. Nets are now usually set several times during the night to maximise catch and fish quality, regardless of how the net is deployed. When the water is turbid, fishers often deploy their nets in a line perpendicular to the shore (set netting?) but refrain from using anchors or weights, and drift with the net for an hour or so before retrieving it (ring netting?). One cooperative fisher often claimed to be set netting, but described a technique of throwing his net out around a school and then drifting down current with it until he was confident he had a catch. Weights were sometimes used however, depending on current strength and net length, but at times he described this as ring netting.

Further, we found that the choice of method defined and described to us at the time of sampling differed from that ultimately reported by the fisher on their CELR. The set net (SN) and ring net (RN) method codes often appear to be used in a very loose and interchangeable sense. One fisher we spoke to reasoned that many fishers who previously used set net methods still recorded their method as SN out of habit, even though they are technically ring netting.

In both years, set net and ring net length data were analysed independently and compared, to establish if there were method specific differences in length and age compositions, regardless of how these methods were defined. The length compositions associated with each method were broadly similar, especially given between landing variability in catch composition and the potential effect of differing mesh sizes. This comparison of length and age distributions and the discussions with fishers have led us and the Northern Inshore Working Group to conclude that the set net and ring net fisheries should be regarded collectively as a single method fishery.

The catch-at-age distributions for the ring net/set net fisheries in 2011 and 2012 were generally similar but narrower than those derived from recreational landings sampled in the Hauraki Gulf since 2001, which were also usually dominated by a small number of relatively young age classes (Armiger et al. 2013). The 2011 set net/ring net age distribution was dominated by the 2007 and 2008 year classes, which were also evident in the 2012 distribution, along with a strong recruiting 2009 year class. The fitting of this study's set net/ring net length data in the next stock assessment for KAH 1 should result in a more robust selectivity ogive, but this will probably be similar to that assumed in the 2007 assessment. Mean weighted coefficients of variation for the combined set net/ring net age compositions in the 2011 and 2012 calendar years using the random age frequency method were 18% and 39%, respectively.

6. ACKNOWLEDGMENTS

The authors are grateful to Ali Undorf-Lay, Steve Keeves, Dave Cowdrey, Geoff Plowman and other staff at Sanford Tauranga, and to Peter Reid at Pelco NZ, for keeping us informed about, and providing access to, purse seine landings of kahawai. We would also like to thank the net fishers who provided us with access to their catches and for their willingness to describe their fishing operation. Thanks are also due to Cameron Walsh from Stock Monitoring Services, and to the NIWA staff who helped with catch sampling including: Holly Ferguson, Catriona Stevenson, and Keren Spong. We also wish to thank Cameron Walsh who reviewed this report. This work was funded by two Ministry of Primary Industries' projects: KAH201003 and KAH201101.

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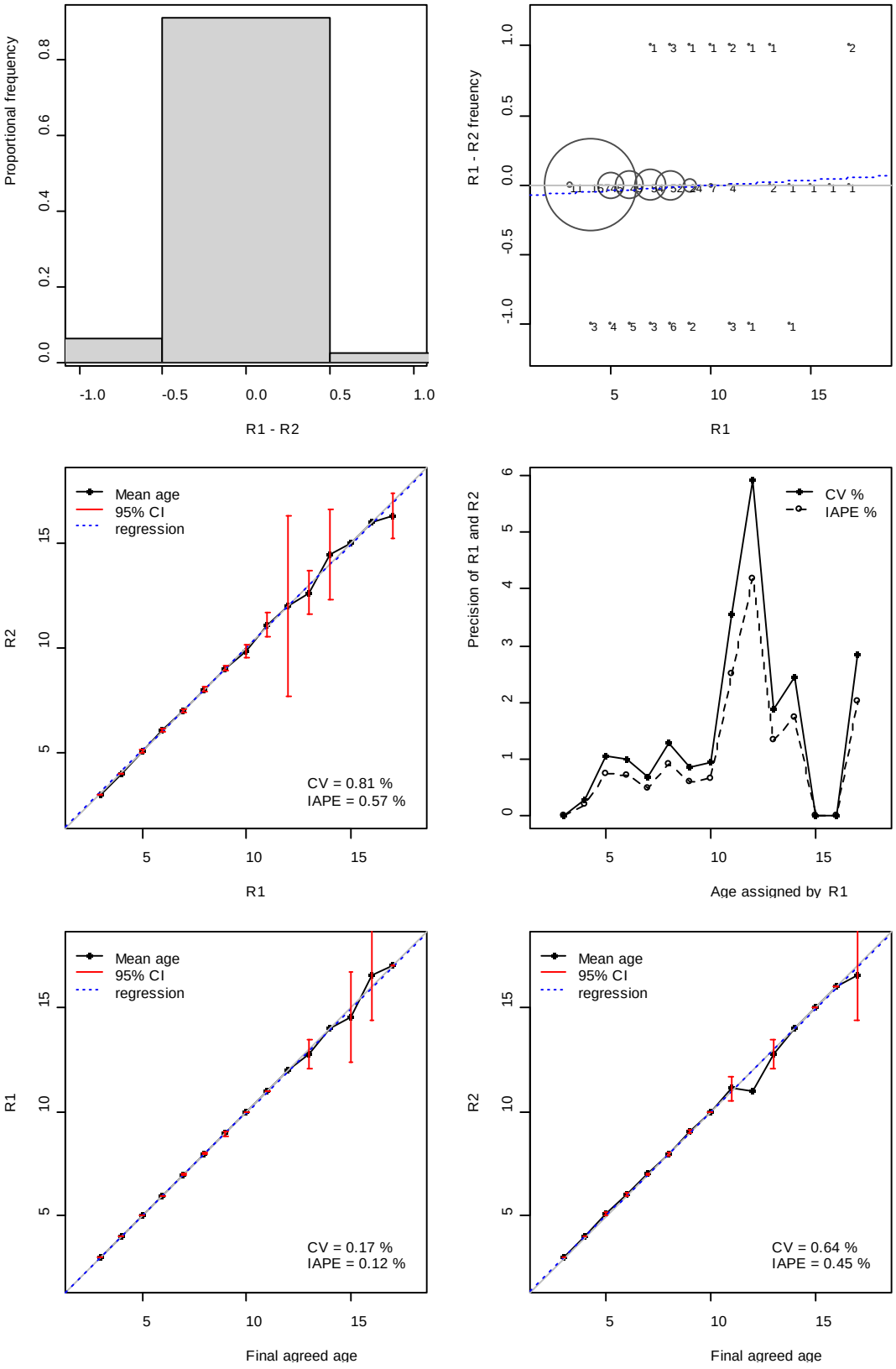
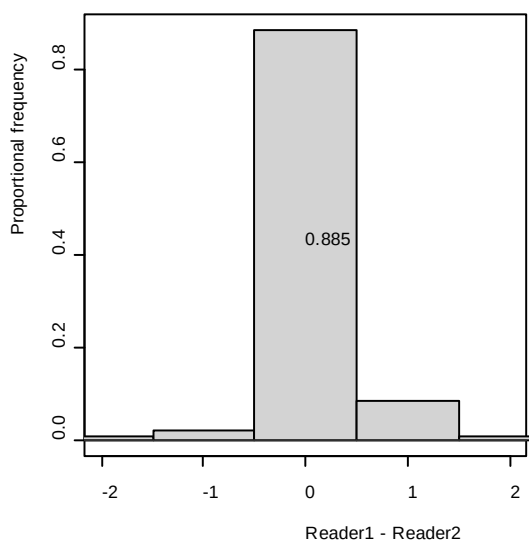
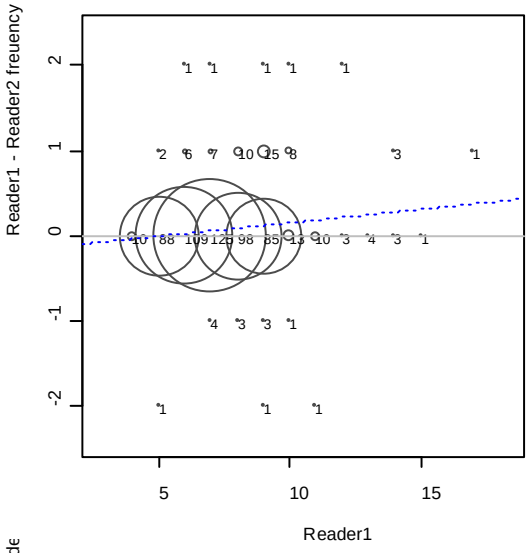
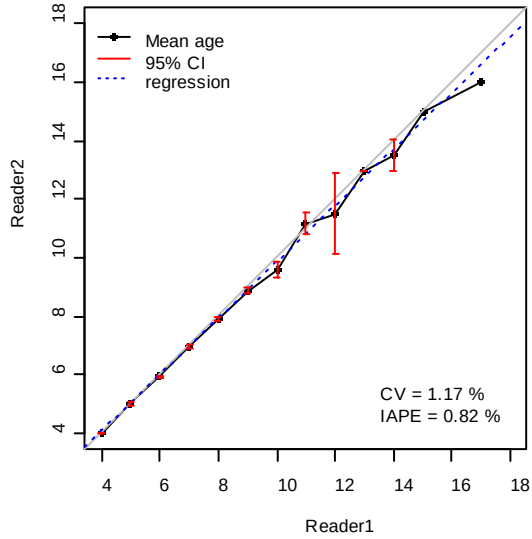
APPENDIX 1: age bias diagnostic plots for kahawai sampled from the Bay of Plenty purse seine fishery in 2011 (n = 449).

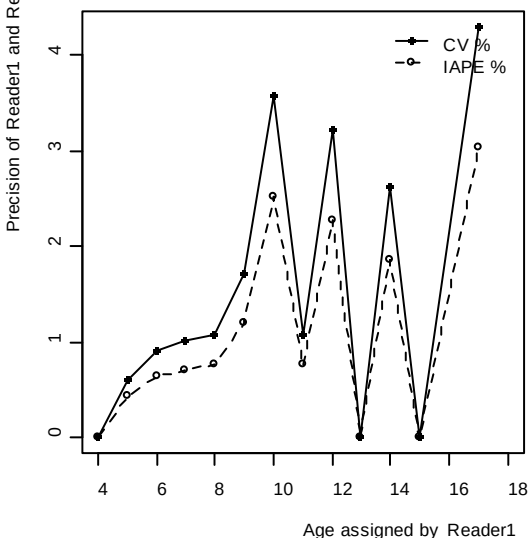


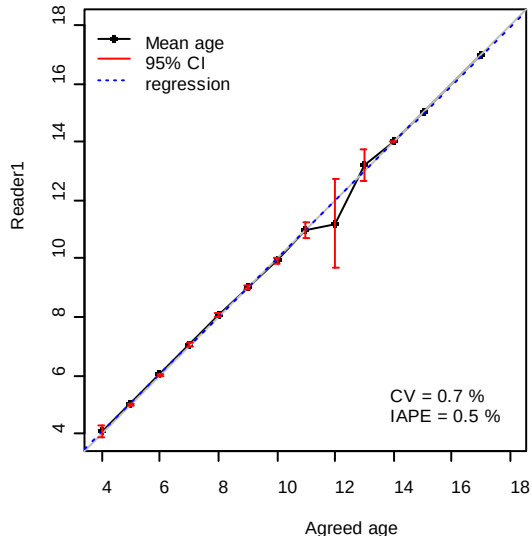
APPENDIX 2: Age bias diagnostic plots for kahawai sampled from the Bay of Plenty purse seine fishery in 2012 (n = 619).

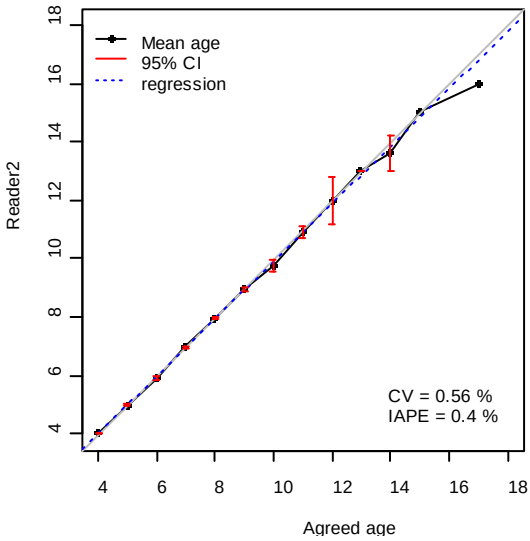












APPENDIX 3: Age-length key for kahawai sampled from the Bay of Plenty purse seine fishery in 2011.

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
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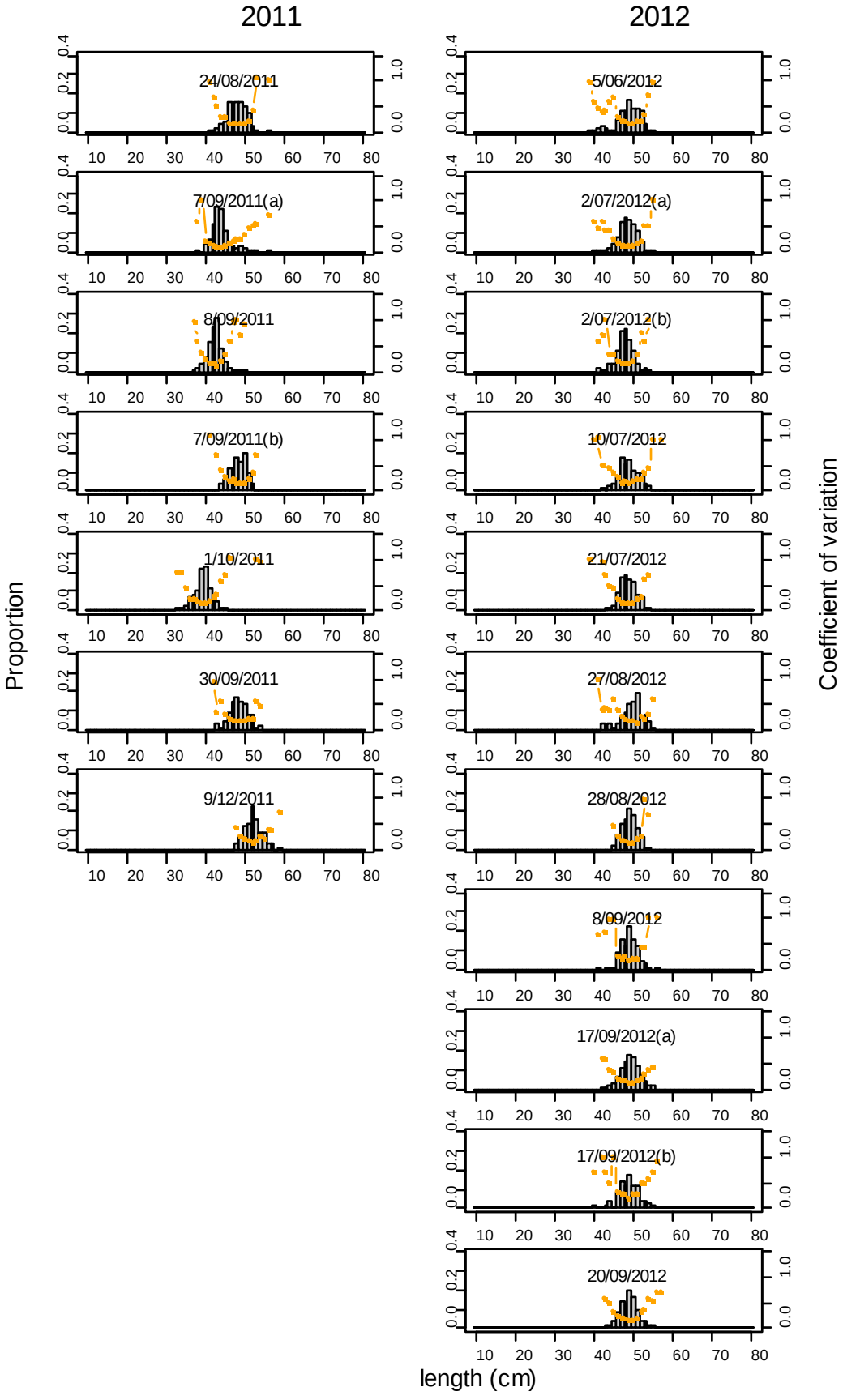
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
36	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
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	0.29	0.71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
39	0	0	0.06	0.94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
40	0	0	0.10	0.86	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
41	0	0	0.06	0.94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
42	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
43	0	0	0	0.95	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
44	0	0	0	0.80	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
45	0	0	0	0.62	0.29	0.05	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	21
46	0	0	0	0.11	0.52	0.30	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	27
47	0	0	0	0	0.34	0.48	0.14	0.03	0	0	0	0	0	0	0	0	0	0	0	0	29
48	0	0	0	0.02	0.10	0.38	0.38	0.06	0.06	0	0	0	0	0	0	0	0	0	0	0	48
49	0	0	0	0	0.07	0.14	0.38	0.38	0.03	0	0	0	0	0	0	0	0	0	0	0	29
50	0	0	0	0	0.04	0.11	0.34	0.40	0.11	0	0	0	0	0	0	0	0	0	0	0	47
51	0	0	0	0	0	0.08	0.12	0.46	0.23	0.08	0.04	0	0	0	0	0	0	0	0	0	26
52	0	0	0	0	0.04	0.04	0.13	0.35	0.26	0.09	0	0	0.04	0.04	0	0	0	0	0	0	23
53	0	0	0	0	0	0	0	0.25	0.31	0.06	0.13	0.06	0.19	0	0	0	0	0	0	0	16
54	0	0	0	0	0	0	0	0.67	0	0	0	0	0	0	0.33	0	0	0	0	0	3
55	0	0	0	0	0	0	0	0	0.30	0.20	0.30	0	0	0	0.10	0	0.10	0	0	0	10
56	0	0	0	0	0	0	0	0	0.33	0	0.33	0	0	0	0	0.33	0	0	0	0	3
57	0	0	0	0	0	0	0	0	0	0	0.67	0	0	0	0	0	0.33	0	0	0	3
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	1
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
Total																					449

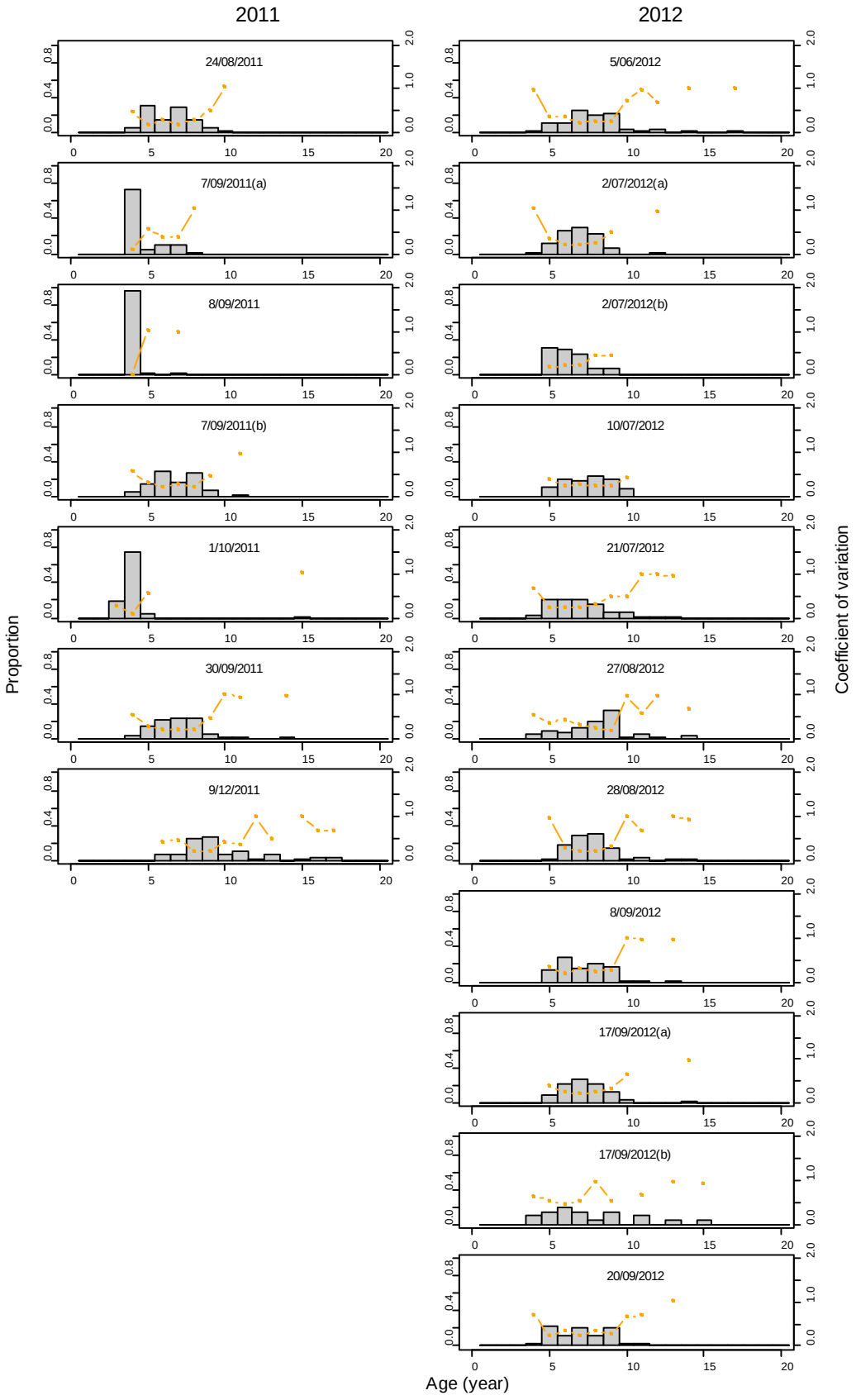
APPENDIX 4: Age-length key for kahawai sampled from the Bay of Plenty purse seine fishery in 2012.

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
40	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
41	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
42	0	0	0	0.29	0.71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
43	0	0	0	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
44	0	0	0	0.10	0.80	0	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	10
45	0	0	0	0.04	0.50	0.17	0.17	0.13	0	0	0	0	0	0	0	0	0	0	0	0	24
46	0	0	0	0	0.24	0.39	0.29	0.08	0	0	0	0	0	0	0	0	0	0	0	0	49
47	0	0	0	0	0.24	0.33	0.28	0.13	0	0.01	0	0	0	0	0	0	0	0	0	0	90
48	0	0	0	0	0.14	0.35	0.28	0.16	0.05	0.01	0	0	0	0	0	0	0	0	0	0	85
49	0	0	0	0	0.12	0.25	0.24	0.27	0.09	0.02	0	0.01	0	0	0	0	0	0	0	0	97
50	0	0	0	0	0.01	0.09	0.28	0.23	0.31	0.06	0.02	0	0	0	0	0	0	0	0	0	87
51	0	0	0	0	0	0.07	0.14	0.30	0.37	0.04	0.04	0.03	0	0	0	0.01	0	0	0	0	71
52	0	0	0	0	0	0.02	0.23	0.28	0.42	0	0.02	0	0	0.02	0	0	0	0	0	0	43
53	0	0	0	0	0	0	0.09	0.17	0.43	0.13	0.04	0.04	0.04	0.04	0	0	0	0	0	0	23
54	0	0	0	0	0	0	0	0	0.38	0.08	0.15	0	0.15	0.15	0.08	0	0	0	0	0	13
55	0	0	0	0	0	0	0	0	0	0.20	0.40	0.20	0	0.20	0	0	0	0	0	0	5
56	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	2
57	0	0	0	0	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	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	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
Total																					619

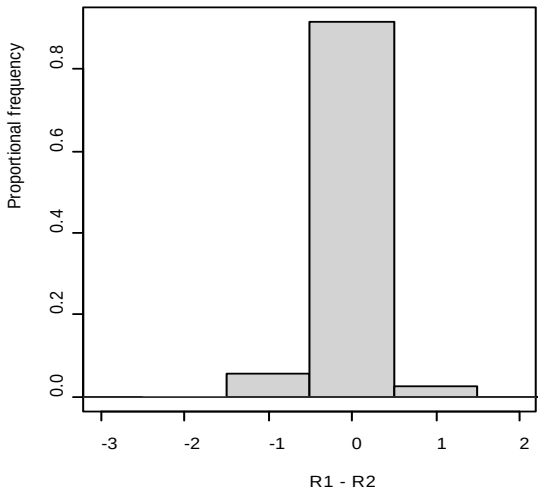
APPENDIX 5: Length distributions of Bay of Plenty purse seine landings sampled in 2011 (left panels) and in 2012 (right panels).

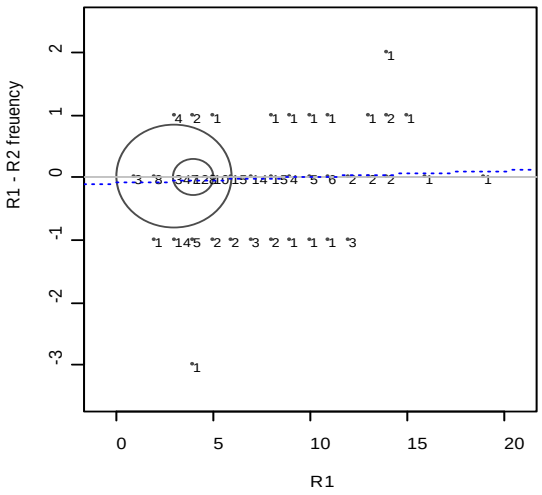


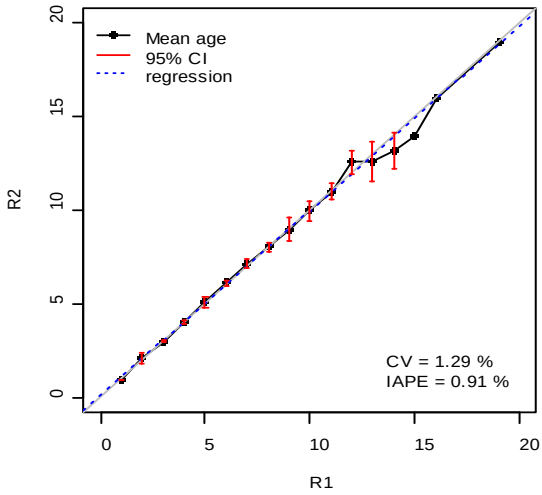
APPENDIX 6: Age distributions of Bay of Plenty purse seine landings sampled in 2011 (left panels) and in 2012 (right panels).

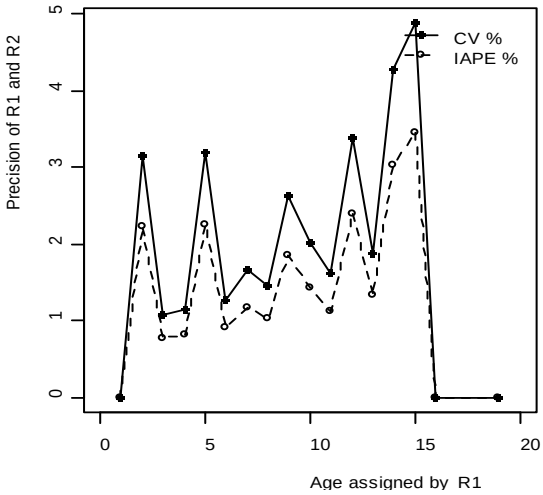


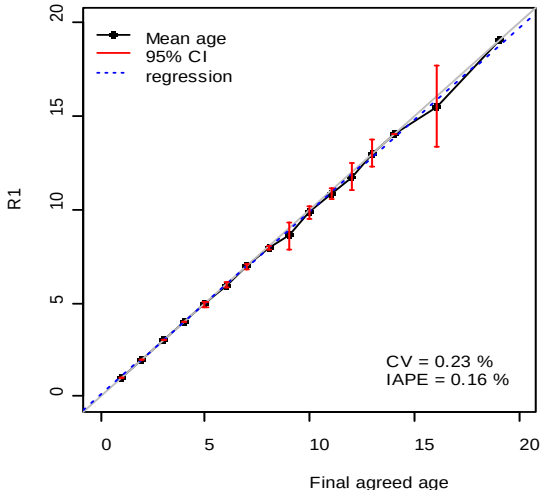
APPENDIX 7: Age bias diagnostic plots for kahawai sampled from the Hauraki Gulf set net/ring net fishery in 2011 (n = 615).

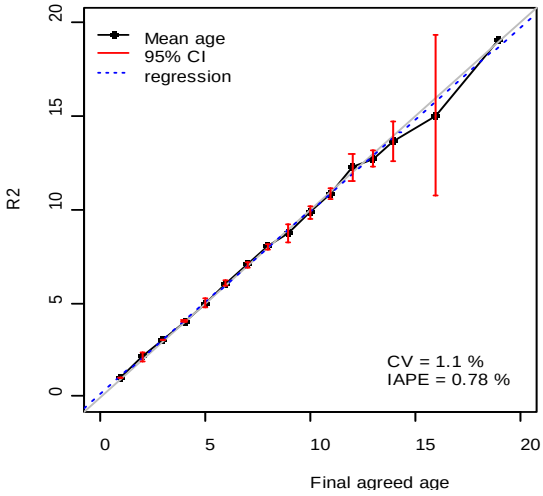




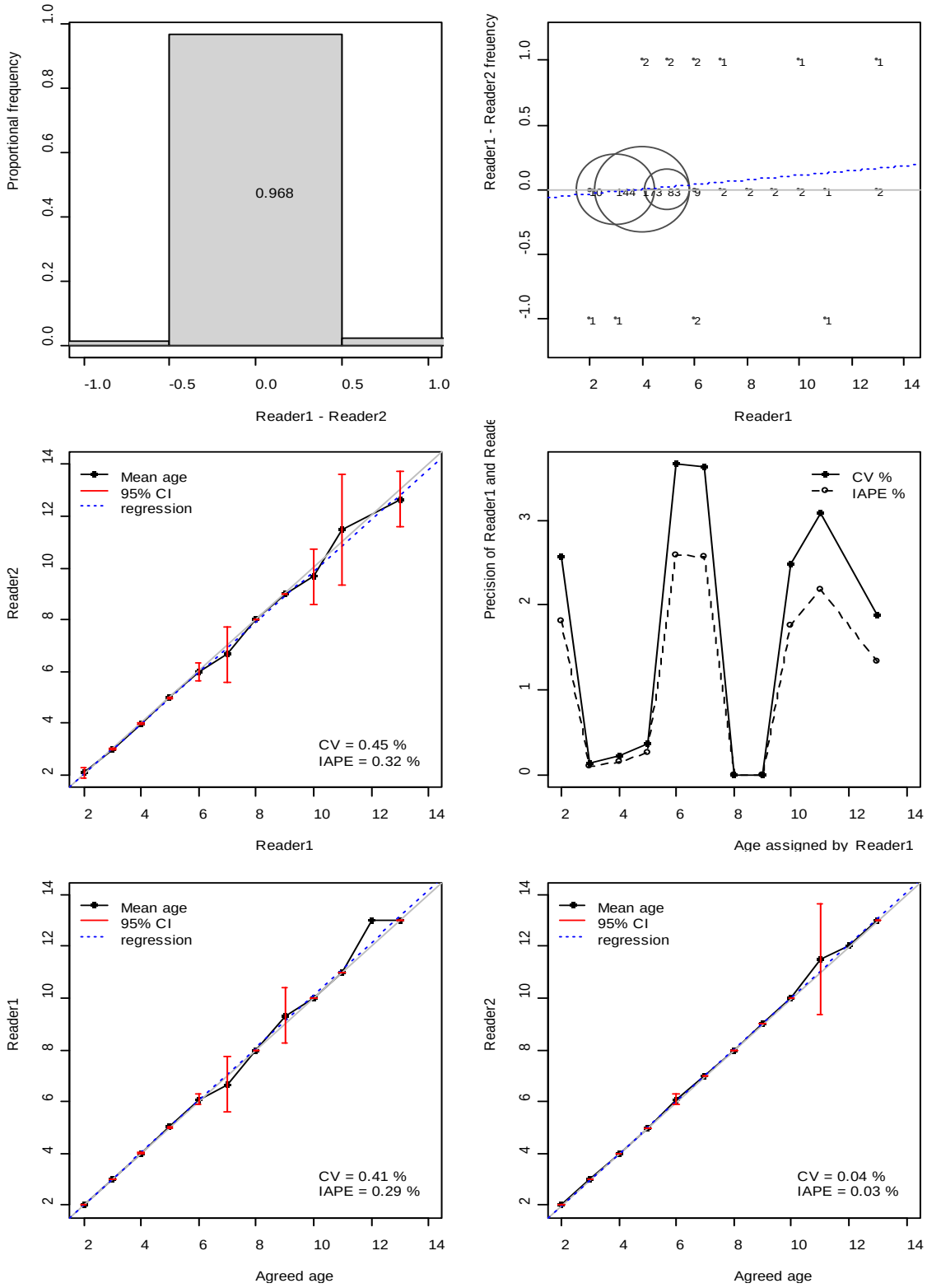








APPENDIX 8: Age bias diagnostic plots for kahawai sampled from the Hauraki Gulf set net/ring net fishery in 2012 (n = 444).



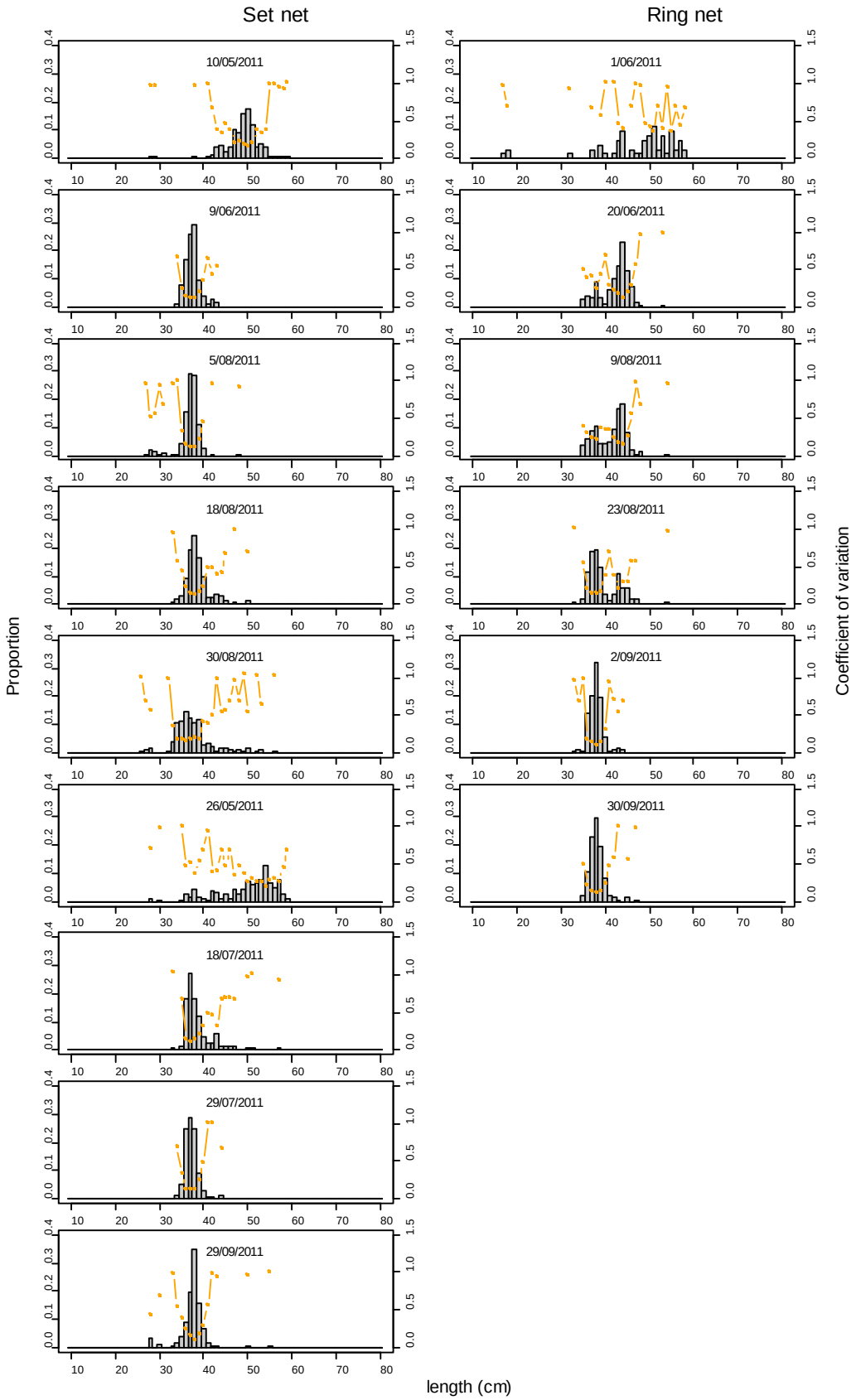
APPENDIX 9: Age-length key for kahawai sampled from the Hauraki Gulf set net/ring net fishery in 2011.

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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
18	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
29	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
33	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
34	0	0.10	0.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
35	0	0	0.91	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
36	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58
37	0	0	0.99	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94
38	0	0	0.98	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107
39	0	0	0.87	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61
40	0	0	0.63	0.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
41	0	0	0.19	0.81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
42	0	0	0.08	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
43	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
44	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
45	0	0	0	0.79	0.17	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
46	0	0	0	0.50	0.17	0.17	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	6
47	0	0	0	0.11	0.33	0.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
48	0	0	0	0	0.57	0.29	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	7
49	0	0	0	0	0	0.14	0.57	0	0.14	0.14	0	0	0	0	0	0	0	0	0	0	7
50	0	0	0	0	0.08	0.38	0.38	0.15	0	0	0	0	0	0	0	0	0	0	0	0	13
51	0	0	0	0	0	0.13	0.25	0.38	0.13	0	0.13	0	0	0	0	0	0	0	0	0	16
52	0	0	0	0	0	0	0.17	0.50	0.17	0	0	0	0.17	0	0	0	0	0	0	0	6
53	0	0	0	0	0	0	0.20	0.20	0.20	0	0	0.20	0.20	0	0	0	0	0	0	0	5
54	0	0	0	0	0	0	0	0.20	0.10	0.20	0.20	0.10	0.10	0.10	0	0	0	0	0	0	10
55	0	0	0	0	0	0	0	0.25	0.13	0	0.13	0	0.25	0.13	0	0.13	0	0	0	0	8
56	0	0	0	0	0	0	0	0	0	0.20	0.40	0.20	0	0	0	0	0	0	0.20	0	5
57	0	0	0	0	0	0	0	0.13	0	0.38	0.13	0	0.13	0.13	0	0.13	0	0	0	0	8
58	0	0	0	0	0	0	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	0	2
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
Total																					615

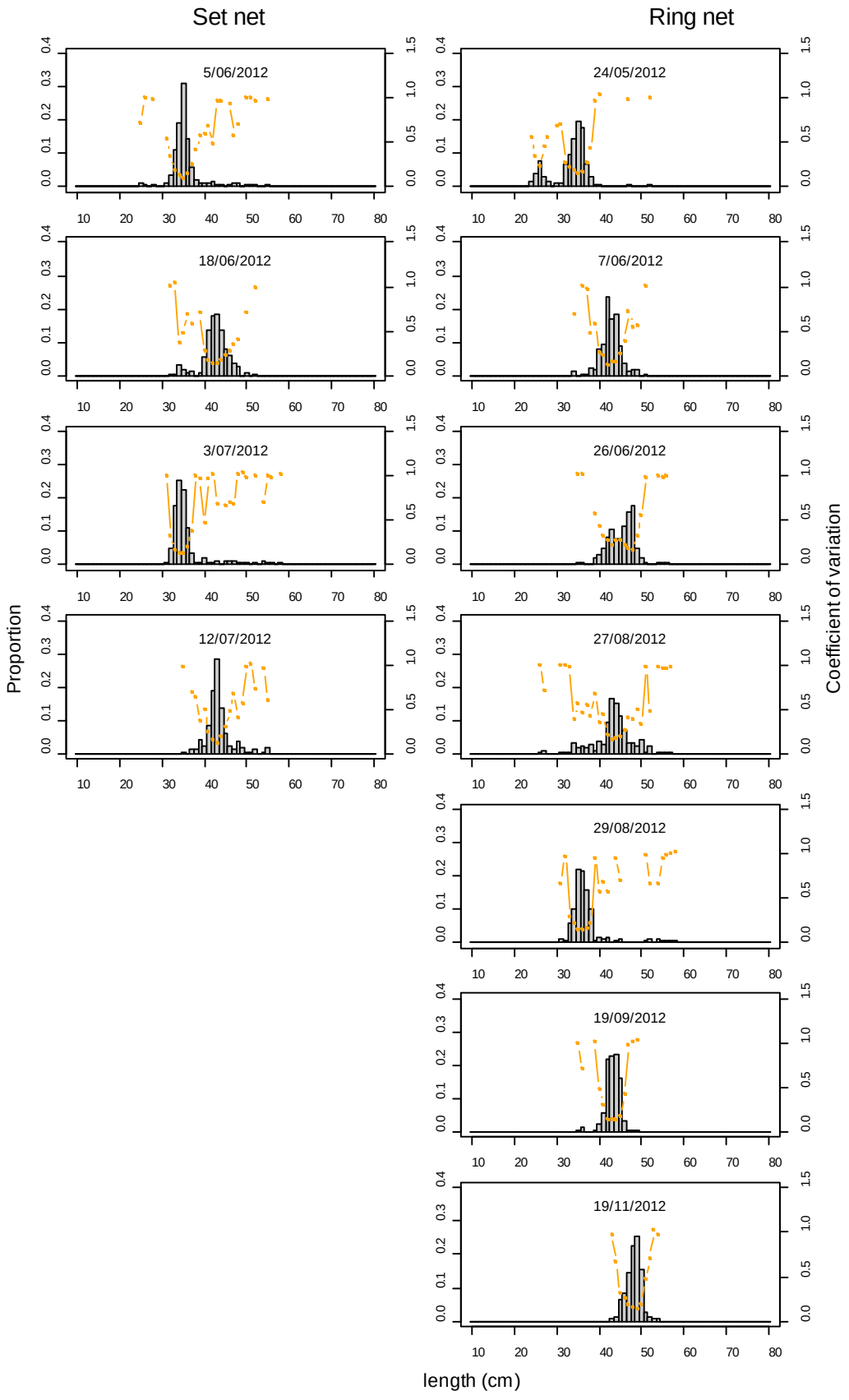
APPENDIX 10: Age-length key for kahawai sampled from the Hauraki Gulf set net/ring net fishery in 2012.

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	2
26	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
27	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
28	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
30	0	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	15
32	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
33	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39
34	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
35	0	0	0.96	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
36	0	0	0.88	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
37	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
38	0	0	0	0.89	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
39	0	0	0.05	0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
40	0	0	0	0.95	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
41	0	0	0	0.93	0.04	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46
42	0	0	0	0.91	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
43	0	0	0	0.89	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
44	0	0	0	0.11	0.68	0.16	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	19
45	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
46	0	0	0	0.04	0.85	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
47	0	0	0	0	0.81	0.13	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	16
48	0	0	0	0	0.70	0.20	0	0.10	0	0	0	0	0	0	0	0	0	0	0	0	10
49	0	0	0	0	0.50	0	0.25	0	0.25	0	0	0	0	0	0	0	0	0	0	0	4
50	0	0	0	0	0	0	0	0	0.33	0.33	0	0	0.33	0	0	0	0	0	0	0	3
51	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	1
52	0	0	0	0	0	0	0	0	0.33	0	0	0.33	0.33	0	0	0	0	0	0	0	3
53	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	2
54	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	1
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	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
Total																					444

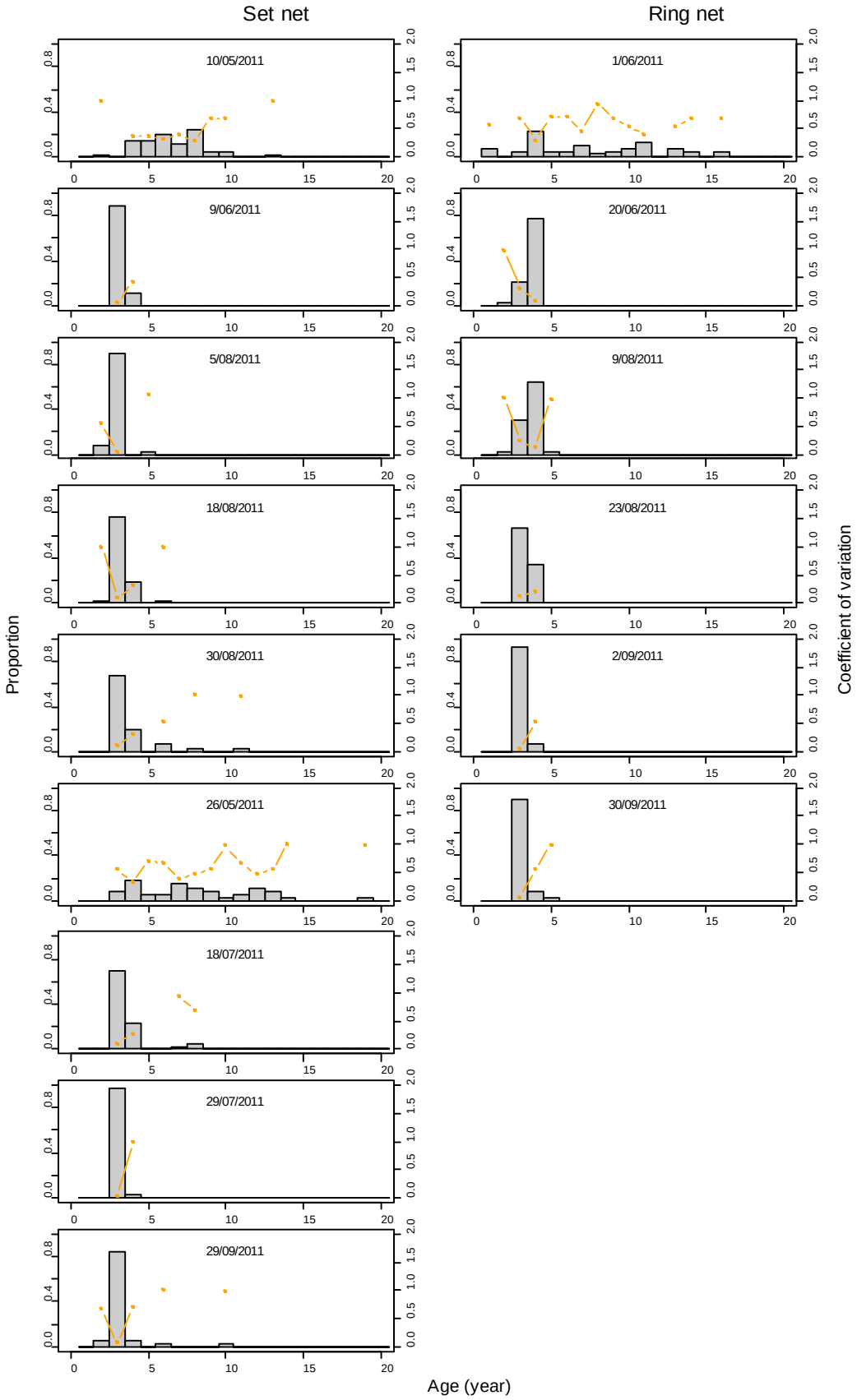
APPENDIX 11: Length distributions for each of the Hauraki Gulf set net/ring net landings of kahawai sampled in 2011. The method definitions used here are those reported by fishers on their CELRs.



APPENDIX 12: Length distributions for each of the Hauraki Gulf set net/ring net landings of kahawai sampled in 2012. The method definitions used here are those reported by fishers on their CELRs.



APPENDIX 13: Age distributions for each of the Hauraki Gulf set net/ring net landings of kahawai sampled in 2011. The method definitions used here are those reported by fishers on their CELRs.



APPENDIX 14: Age distributions for each of the Hauraki Gulf set net/ring net landings of kahawai sampled in 2012. The method definitions used here are those reported by fishers on their CELRs.