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Review of stock monitoring options for kingfish (*Seriola lalandi lalandi*) based on an analysis of the commercial and recreational fisheries up to 2006

New Zealand Fisheries Assessment Report 2014/38

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ISSN 1179-5352 (online)
ISBN 978-0-478-43718-8 (online)

August 2014

New Zealand Government

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EXECUTIVE SUMMARY

McKenzie, J.R.; Smith, M.; Hartill, B. (2014). Review of stock monitoring options for kingfish (*Seriola lalandi lalandi*) based on an analysis of the commercial and recreational fisheries up to 2006.

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The stock assessment and monitoring utility of commercial and recreational kingfish data collected prior to 2006 was evaluated.

The low volume and by-catch nature of kingfish fisheries makes the monitoring of stock abundance using commercial catch and effort data difficult. Changes in targeting rules since 1989, the introduction of catch quotas, minimum legal size changes, and varying economic incentives, have influenced the continuity of fishing effort since 1989 in all kingfish stocks. The effect of this is that it will be difficult to discern true abundance trends in historical commercial catch and effort data, consequently these data have limited utility for kingfish stock monitoring.

Because recreational kingfish fishers capture a wide range of age classes, changes and patterns in CPUE (abundance) and age structure (total mortality) in the recreational fisheries are more likely to reflect those of the underlying stock than commercial setnet and trawl data. However the numbers of kingfish measured in recreational harvest surveys since 1991 have been both low and highly variable. Low sample sizes mean these programmes have limited stock monitoring utility.

Relatively precise kingfish age and catch-effort data was obtained from sampling the eastern Bay of Plenty recreational charter-boat fishery in 2002. The success of the 2002 kingfish charter-boat sampling programme suggests that dedicated age sampling and logbook programmes implemented on recreational charter boats are likely to be a viable stock monitoring option for kingfish. Catch optimisation analysis using the 2002 charter boat data indicate MWCV scores of 0.2 could be achieved from age collections of between 400 and 450 otoliths and length samples of between 150 and 200 trips. Consultations with KIN 1, 2 & 8 recreational charter boat operators indicate that the implementation of a 3–5 year charter boat based monitoring programme would be highly feasible in KIN 1, with a strong likelihood of success in the other QMAs. All programmes would require additional age data from the commercial fishery, which again is a feasible proposition.

The spatial extent of New Zealand kingfish stocks has yet to be definitively determined. Recreational tagging has potential utility for determining stock boundaries but obtaining information on spatial recreational effort may be problematic. In the future recreational effort information could be collected as part of a charter boat catch sampling programme. Parasite data may also have stock separation utility and three species have been identified as suitable for this purpose. It may be possible to persuade recreational and commercial fisheries to maintain logbooks of parasite observations.

1 INTRODUCTION

Kingfish became a quota species under the QMS in October 2003. TACCs were established relative to seven administration areas, known as QMAs (Figure 1). Although this report refers to these areas as "stocks" biological kingfish stock boundaries have yet to be established (Walsh et al. 2003; Smith et al. 2004). Prior to 2003 kingfish catches were reported relative to ten administrative boundaries (Walsh et al. 2003), and the new quota areas are an amalgamation of these. Readers should note that catch data presented in this report is summarised relative to the revised quota areas only.

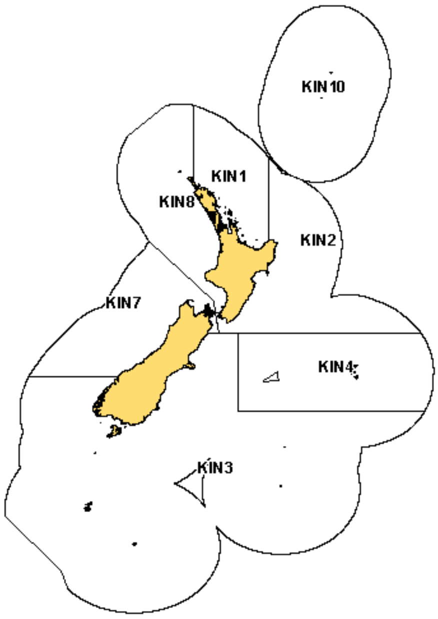

Figure 1: Kingfish Quota management areas as of October 2003.

Significant numbers of kingfish are taken only in KIN 1, KIN 2 and KIN 8 (Figure 1), the other four QMAs being irrelevant from a fisheries management perspective.

The status of kingfish stocks is poorly understood; the main areas of uncertainty being the biological stock boundaries, estimates of stock biomass and the non-commercial catch history. Kingfish catch and effort information has been collected from the commercial sector since the early 1980s, however the utility of this information series as an abundance measure has not been investigated. With the exception of isolated surveys (Poortenarr et al. 2001; Walshe & Ackroyd 1999), as of 2006, there had been no commercial catch sampling programmes implemented on kingfish. A length composition time series of recreational catches is available from various boat ramp surveys conducted between 1990 and 2002 (Walsh et al. 2003), but the age composition of these catches is unknown.

Modelling options for obtaining sustainable yield estimates for kingfish stocks range from simple biomass dynamic models to fully age and length structured models with multiple gear-specific fishing mortalities. Catch monitoring information is fundamental to all these approaches, the minimum being a reliable time series of abundance (e.g. CPUE).

This report is one of a series of five kingfish assessment and management reports produced for the then Ministry of Fisheries between 2000 and 2006. An outline of the content and scope of each report in chronological order of writing is as follows:

1. *Information available for the management of New Zealand kingfish stocks.* (Walsh et al. 2003)

This report summarises what was known about kingfish biological and life history of New Zealand as well as providing a summary of New Zealand kingfish management and monitoring up to 2000. A range of assessment and monitoring options are also discussed and evaluated.

2. *Kingfish stock structure* (Smith et al. 2004)

This report provides an evaluation of information available to spatially delineate different New Zealand kingfish stocks. The report also contains results from a pilot study to assess the utility of meristic and parasite markers in kingfish stock delineation.

3. *Age, growth, maturity and natural mortality of New Zealand kingfish* (McKenzie et al. 2014)

A range of growth estimates (von Bertalanffy) for kingfish derived using age and length data collected from the eastern Bay of Plenty charter-boat fishery, and growth increment data derived from tagging, are presented. The charter-boat data is also used to derive a total mortality (Z) estimate for the eastern Bay of Plenty and a revised estimate of natural mortality (M). The report also includes a review of kingfish ageing methods and a reanalysis of the available maturity at-age data.

4. *Review of productivity parameters and stock assessment options for kingfish* (McKenzie 2014)

Results of yield per recruit and spawning stock biomass per recruit (YPR/SSBR) analyses are presented and discussed. Also included are evaluations of different stock assessment approaches for kingfish.

5. *Review of stock monitoring options for kingfish* (this report)

The feasibility of monitoring kingfish stocks using recreational and commercial catch data is examined. Specifically considered are the collection of catch and effort data, age and length data, tag recovery information, and parasite identification.

2 COMMERCIAL FISHERY PROFILE 1983–84 TO 2003–04

Relative to other fisheries, the annual commercial catch of kingfish in 2003–04 was low, being in the order of 250–350 tonnes per annum (Sullivan et al. 2005). However, kingfish has a high value per kilogram, and the indications are the market demand for kingfish still greatly exceeds its 2003–04 catch levels.

Kingfish was only introduced into the Quota Management System (QMS) in October 2003; Total Allowable Commercial Catch (TACC) limits were set significantly below the historical averages (Figure 2). Between October 1988 and kingfish's QMS introduction it was Ministry policy not to grant kingfish targeting rights on new fishing permits. Only fishers who had obtained dispensation to target kingfish prior to October 1988 could directly target kingfish and there were relatively few dispensations issued.

Prior to its QMS introduction kingfish were taken mostly as by-catch in snapper, trevally, and tarakihi fisheries (Appendix 1; Appendix 2). Setnet was the only method reporting significant levels of kingfish targeting (Appendix 1; Appendix 2). The pattern of kingfish catches from other target fisheries (e.g. pilchard, warehou and trevally) suggests that that undeclared targeting may have occurred (Appendix 1; Appendix 2).

Other management changes that may have affected the commercial take of kingfish between 1988 and 2003 include the introduction of a 65 cm MLS for trawl in December 2000 and the introduction of a 65 cm minimum legal size (MLS) for all methods except trawl in October 1993.

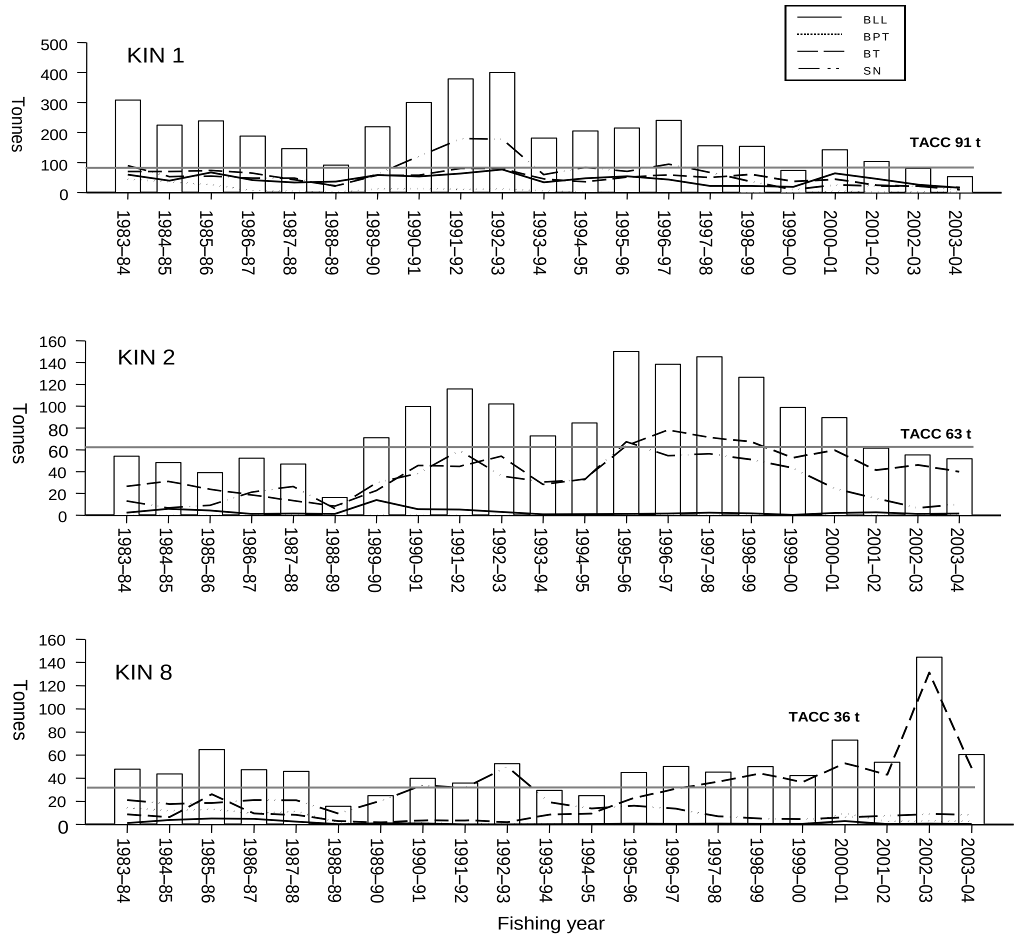

Figure 2: Kingfish annual commercial catches between fishing years 1983–84 and 2003–04 by method.

Despite the 1988 targeting moratorium, catches in each of the three stocks fluctuated greatly between 1983–84 and 2003–04 (Figure 2). On the east coast (KIN 1) setnet, single trawl and longline were the main fishing methods. A significant increase in KIN 1 catches in the early 1990s can be attributed to the setnet method; the abrupt decline in setnet catches after 1993 corresponds with the introduction of the 65 cm MLS (Figure 2). The fishery in KIN 2 was predominately trawl and setnet. The reason for the significant decline in KIN 2 setnet catches after 1999 is not clear (Figure 2). Trawl and setnet were also the main fishing methods on the west coast, KIN 8 (Figure 2). Setnet, the major KIN 8 method in the early 1990s, abruptly declined in importance after 1993, when the 65 cm MLS was introduced. In contrast, KIN 8 trawl catches steadily increased after 1993 (Figure 2).

3 RECREATIONAL FISHERY PROFILE PRE 2006

Kingfish is an important recreational game-fish species; predominantly caught by hook and line. Significant numbers of kingfish are taken each year by charter boats (James et al. 1997).

In January 2004, the recreational kingfish MLS was increased from 65 cm to 75 cm. The effect of the change is evident in the cumulative length frequency of kingfish sampled at boat ramps between 1994 and 2005 (Figure 3). The 2004 MLS change is likely to have decreased recreational landings of kingfish in the years immediately following its introduction.

Recreational KIN 1 catch estimates from telephone/diary surveys conducted in 1994 and 2000 range from 383 to 800 tonnes (Boyd et al. 2004). These telephone diary estimates are considered to be unreliable and it is likely that the actual harvest tonnage was at the lower end of the estimated range (Walsh et al. 2003). A further harvest estimate became available after 2006 from an aerial access survey conducted between 1 December 2004 and 30 November 2005. However, as these surveys were optimised for estimating snapper harvests the kingfish harvest estimates may not be truly representative. The aerial access approach focuses on landings at boat ramps, which differ from those made from charter boats and allowance for charter boat harvests may be problematic. Catch sampling of the Bay of Plenty charter-boat fishery in 2002 (McKenzie et al. 2014) indicates that a higher proportion of larger kingfish are taken on charter vessels (Figure 3).

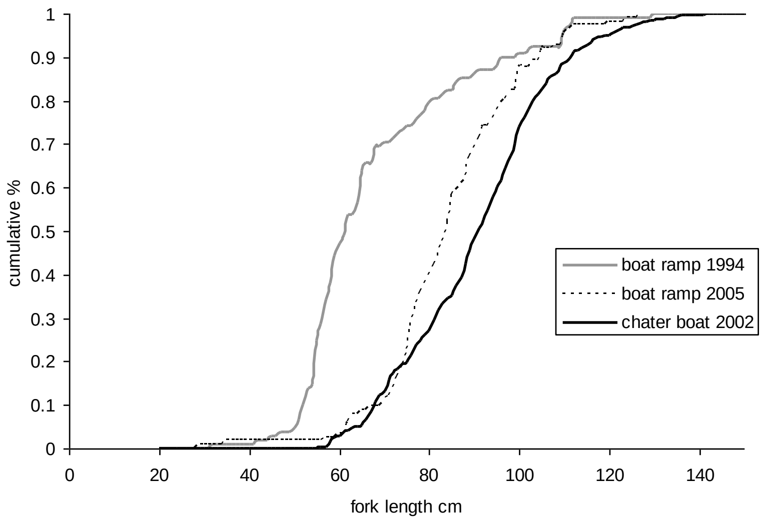

Figure 3: Cumulative length frequency of kingfish caught in the Bay of Plenty by trailer and charter boat fishers, 1994 n = 108; 2002 n = 929; 2005 n = 113.

4 ABUNDANCE MONITORING

4.1 Commercial CPUE

Walsh et al. (2003) found that the utility of kingfish catch and effort data for fishery characterisation in many cases was limited by the fact that for many sets or shots kingfish was not one of the top five species caught and therefore not required to be recorded. Walsh et al. also found that significant quantities of catch relating to other species such as southern kingfish or gemfish (SKI) had been incorrectly coded as kingfish (KIN).

A plot of kingfish estimated against landed catch weights for all recorded single trawl trips between 1989–90 and 2003–04 shows poor correspondence (R^2 = 0.31; Figure 4). For most trips the estimated catch was less than the actual landed weight with 68% of trips having no estimated catch records. Points above the 1:1 line represent estimated catches higher than landed weight; some of these extreme positive differences were likely to have been due to the miscoding of other species. Given that kingfish single trawl, set or shot information is either missing or severely decoupled from the landed catch it has very little utility to track kingfish stock abundance.

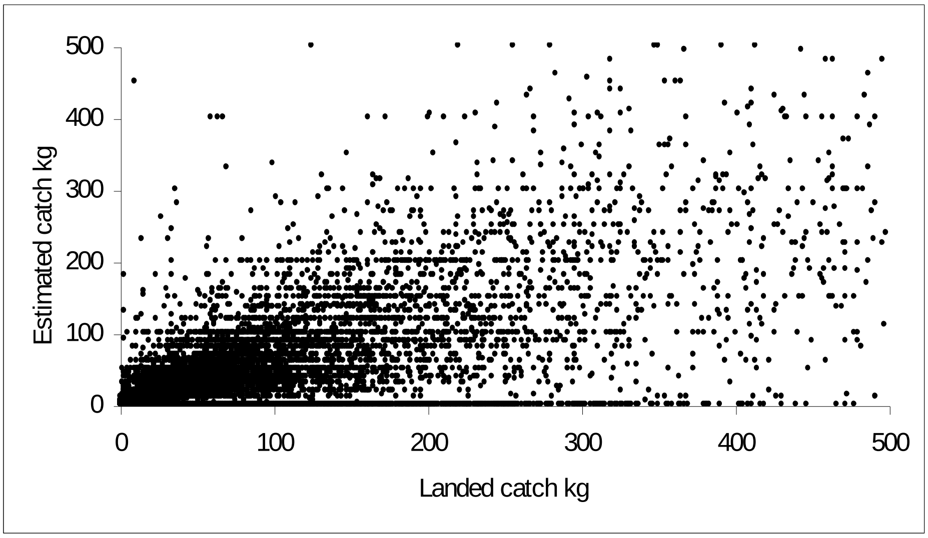

Figure 4: Estimated catch versus landed catch taken in single trawl trips in KIN 1,2 or 8 between 1989–90 and 2003–04 (23 000 trips).

The alternative approach would be to quantify effort using some amalgamated measure from each trip in which kingfish was landed. Patterns are evident in the seasonal total-catch/total-trips ratios in each stock area (Figure 5) indicating that there may be some utility in this approach. To investigate this further would require removing erroneous trips or trips not confined to local spatial areas or a few target species and then conducting a standardised log-linear analysis on the data; i.e. a full CPUE analysis.

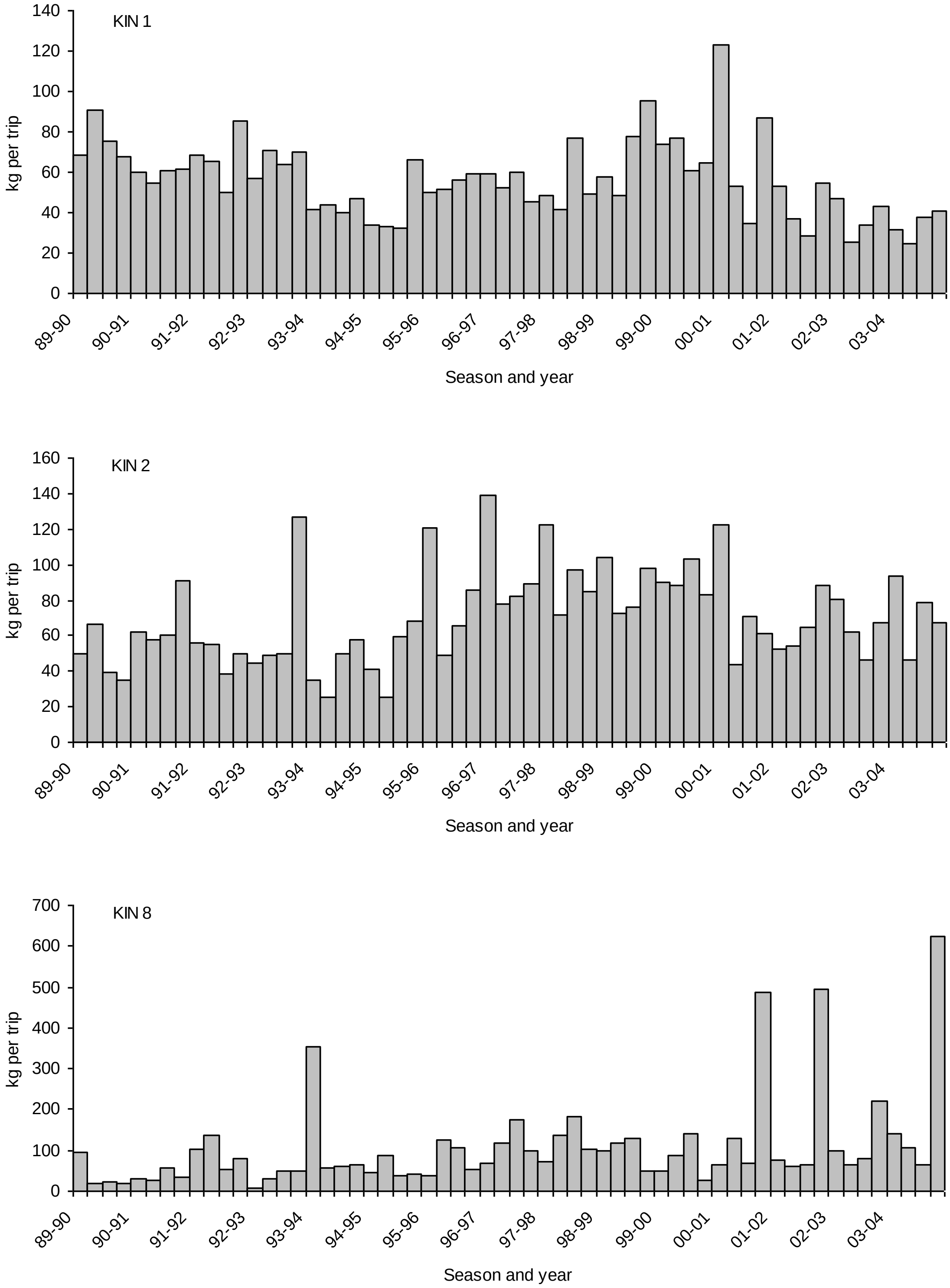

Figure 5: Total kingfish catch (kg) per single trawl trip for trips in which kingfish was caught, by season and year.

Longline was also a significant method catching KIN 1 between 1989–90 and 2003–04 (Figure 2). Although there is better correspondence between estimated and landed catch weights (R^2 0.61;Figure 6) than in the trawl fishery, the proportion of landings with landed catch but no estimated catch was 23.5%, the median landed weight was only 12 kg and the proportion of landings where kingfish was a designated target species was never greater than 0.2 % in any year. On the basis of these findings, in our opinion longline CPUE is of questionable utility for tracking KIN 1 stock abundance.

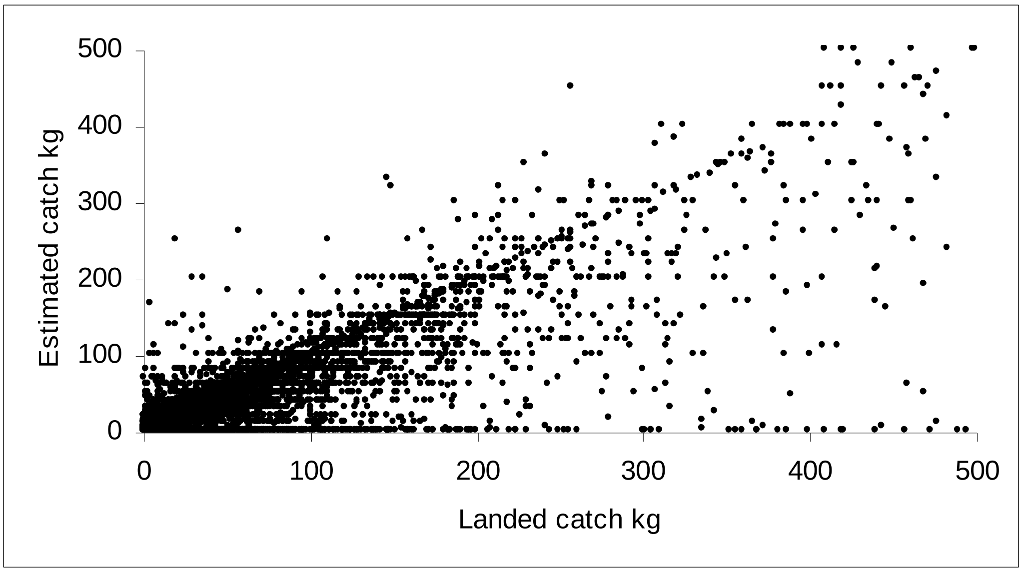

Figure 6: Estimated catch versus landed catch in KIN 1 in longline trips between 1989–90 and 2003–04 (22 000 trips).

Setnet was an important fishing method in all three kingfish QMAs during the 1990s, however the proportion of kingfish taken by this method markedly declined and by 2003–04 the method accounted for less than 20% of the total commercial kingfish catch over all QMAs (Figure 2). Setnet is the only method historically reporting significant levels of kingfish targeting (Figure 7). However targeting by setnet had virtually ceased in all kingfish QMAs by 2003–04 (Figure 7).

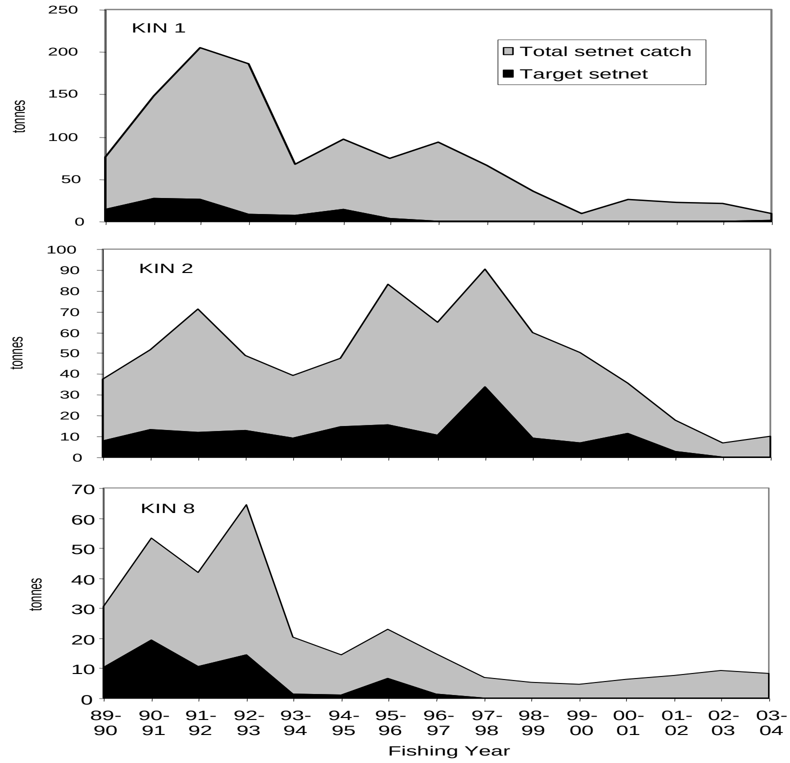

Figure 7: Kingfish setnet catch since 1989–90 showing proportion of targeting.

There was reasonable correspondence between estimated catch and landed trip catch weights in the setnet fishery in KIN 1 between 1989–90 and 2003–04 (R^2 0.80; Figure 8); the proportion of zero effort landings was 26.4% and the median landing weight was 22 kg.

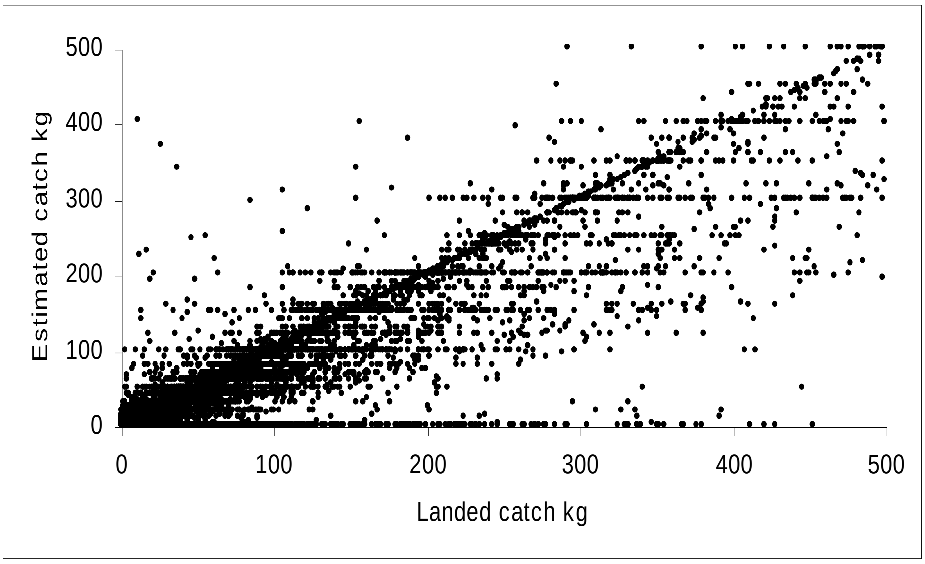

Figure 8: Estimated catch versus landed catch weights in KIN 1 in setnet trips between 1989–90 and 2003–04 (22 000 trips).

Given the reasonable level of kingfish targeting by setnet during the 1990s it is possible that setnet CPUE does have some utility to track kingfish stock abundance through this period, however, the introduction of a 65 cm MLS in 1993, which possibly resulted in a reduction in setnet catches in KIN 1 and 8 (Figure 2), may also have resulted in a lack of continuity in the CPUE data series, i.e. there is a possible catchability change after 1993. Also, if setnet was used to target young kingfish it is also likely to have limited utility for monitoring the relative abundance of the entire population.

4.2 Recreational CPUE

Catch rate information is available from the various recreational fishing surveys conducted between 1991 and 2000 (Boyd et al. 2004). Recreational CPUE may have some utility to monitor kingfish abundance, however the numbers of kingfish encountered by the survey interviewers on a daily basis was low; typically less than one fish per day (Table 1).

Table 1: Number of kingfish encountered by boat-ramp interviewers during recreational fishing surveys.

5	6	7	8			
Region	Year	Months	Ramps	Interview Days	KIN landed	kingfish per day
East Northland	1991	Jan to Dec	9	108	123	1.14
	1994	Jan to Dec	5	86	150	1.74
	1996	Jan to Dec	9	88	213	2.42
	2000	Jan to Nov	5	99	152	1.54
	2001	Jan to Apr	9	188	114	0.61
	2002	Jan to Apr	8	185	81	0.44
	2003	Jan to Apr	8	177	76	0.43
	2004	Jan to Apr	8	183	131	0.72
Hauraki Gulf	1991	Jan to Dec	17	157	116	0.74
	1994	Jan to Dec	25	405	135	0.33
	1996	Jan to Dec	18	77	45	0.58
	2000	Jan to Nov	12	123	514	4.18
	2001	Jan to Apr	11	196	81	0.41
	2002	Jan to May	10	198	52	0.26
	2003	Jan to Apr	12	330	76	0.23
	2004	Jan to Apr	13	426	83	0.19
Bay of Plenty	1991	Jan to Jul	14	169	379	2.24
	1994	Jan to Dec	9	135	127	0.94
	1996	Jan to Dec	12	119	133	1.12
	2000	Jan to Nov	10	145	115	0.79
	2001	Jan to Apr	9	53	32	0.60
	2002	Jan to May	9	79	56	0.71
	2003	Jan to Apr	9	77	46	0.60
	2004	Jan to Apr	9	72	52	0.72

In 2002 a kingfish sampling programme was initiated on charter boats operating in the eastern Bay of Plenty. The purpose of the survey was to derive estimates of kingfish growth and maximum age (McKenzie et al. 2014). This was largely a voluntary programme with charter operators recording length information on a trip by trip basis into logbooks. The programme logged data from 135 charter fishing days; a total of 1376 kingfish were measured.

The average number of fish caught on eastern Bay of Plenty charter vessels per day was six (Figure 9). With a higher average encounter rate and the ability to obtain more detailed effort information such as number of hooks, fisher experience and location, logbook data collected on kingfish charter boats may have better utility to monitor kingfish abundance than recreational boat-ramp data.

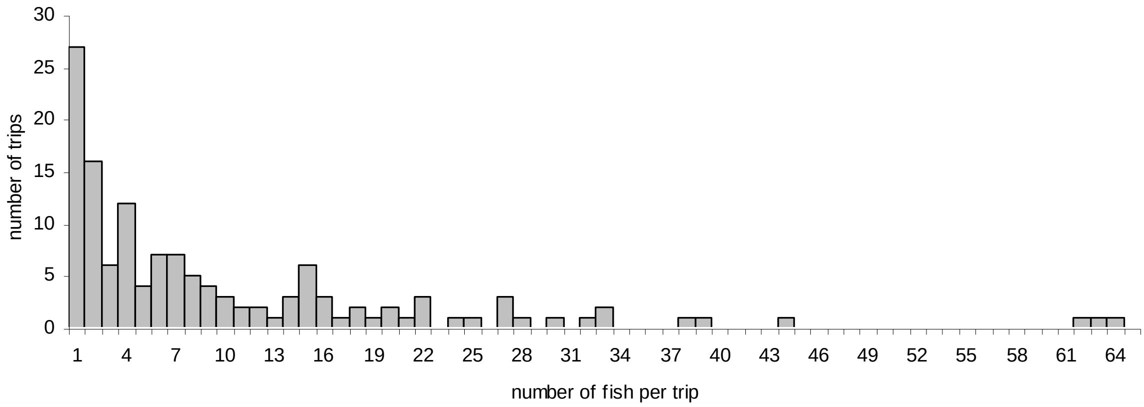

Figure 9: Frequency of numbers of kingfish per trip for charter boats operating in the eastern Bay of Plenty in 2002 [mean = 6; median = 10].

9 AGE LENGTH CHARACTERISATION

9.1 Introduction

The establishment of a catch-at-age time series for each kingfish stock areas would have high assessment utility. Stock assessment models usually require a mean weighted CV over the main age classes to be better than 0.3 in order to achieve informative results (Megrey 1989). There are logistic problems sampling kingfish commercial catches: typically average landing weights are small and landings are numerous (Table 2), with the result that many landings would need to be sampled in order to obtain length or age estimates of suitable precision. A comparison of the length composition of kingfish taken by the Bay of Plenty single trawl fishery with that from the Bay of Plenty recreational charter boat fishery suggests that the single trawl method selects mainly smaller (primarily immature) fish (Figure 10). The adult kingfish stock does not appear to be well described by single trawl landings.

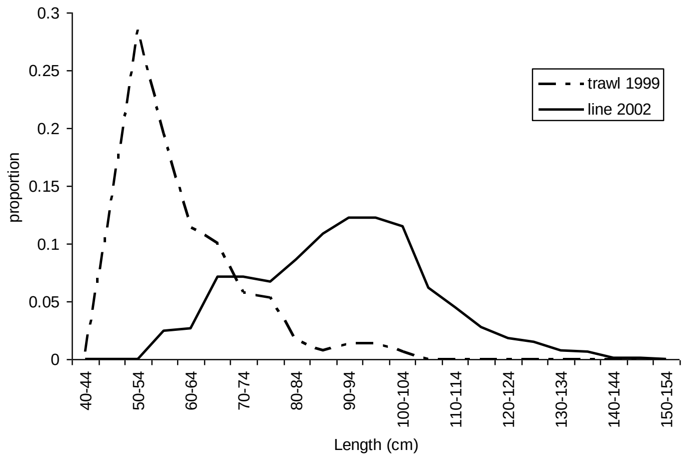

Figure 10: Length frequency distributions of kingfish taken in the Bay of Plenty by single trawl (1999; Walshe & Akroyd 1999) and recreational hook and line (charter boat data 2002; McKenzie et al. 2014).

No catch sample information is unavailable for the longline method, however, given that the method probably has a similar selectivity pattern to recreational lining, there may be utility in sampling this fishery to derive estimates of total mortality (Z).

Likewise there is no comparable length data available for setnet. The selectivity characteristics of the method are typically domed (Hovgård & Lassen 2000), and the reduction in catches with the increase in MLS suggests that this method selected young fish. It is therefore unlikely that setnet catches would provide a good representation of the adult length/age structure.

Table 2: Average annual kingfish landing weights and numbers of trips by method between 1999–00 and 2003–04.

Stock	Method	Annual trips	Average catch (kg)
KIN1	Long line	1000	30
KIN1	Bottom Trawl	550	50
KIN1	Setnet	250	70
KIN2	Bottom Trawl	650	70
KIN2	Setnet	225	90
KIN8	Bottom Trawl	320	200
KIN8	Setnet	170	50

The unpredictable nature of kingfish landings makes catch sampling by fishery independent samplers difficult. The most cost effective sampling option would be for individual fishing companies to do the sampling. However, NIWA's experience during the 2002 West coast snapper tagging programme has shown that most of the smaller fishing companies cannot be relied upon to sampling their own catches. And without the smaller fishing companies it may not be possible to sample a sufficient number of setnet and longline landings. Experience suggests that trawl catches could be adequately sampled in house by the larger fishing companies, however the method does not appear suitable for monitoring the adult size-range. Age and length sampling is usually undertaken on commercial fisheries due to the large number of measurements required, however, any method that captures a wide range of length and age classes from the population would be suitable for stock monitoring purposes. The recreational charter boat fishery data indicates this method capture a broader range of the mature kingfish age classes than single trawl therefore this method-fishery is likely to have better utility for population age monitoring (Figure 10). Our recommended strategy would be to monitor the kingfish stocks largely through recreational charter-boat catches.

9.2 Catch-sampling optimisations for age and length

During the summer of 2003 a large sample of kingfish age and length information was collected from the Whakatane Charterboat fleet, specifically to revise growth estimates (McKenzie et al. 2014). A series of catch sampling optimisations were undertaken using these data.

9.2.1 Methods

Simulations were done pursuant to a fixed proportion age length key and random sampling for length. Length information for use in the simulations was available from 134 kingfish charter trips conducted in the eastern Bay of Plenty during the summer of 2002. The number of kingfish measured per trip ranged from 1 to 64, the average being 9 per trip (Figure 9).

A total of 1374 kingfish were measured over a fork-length range between 55 and 150 cm (Figure 11).

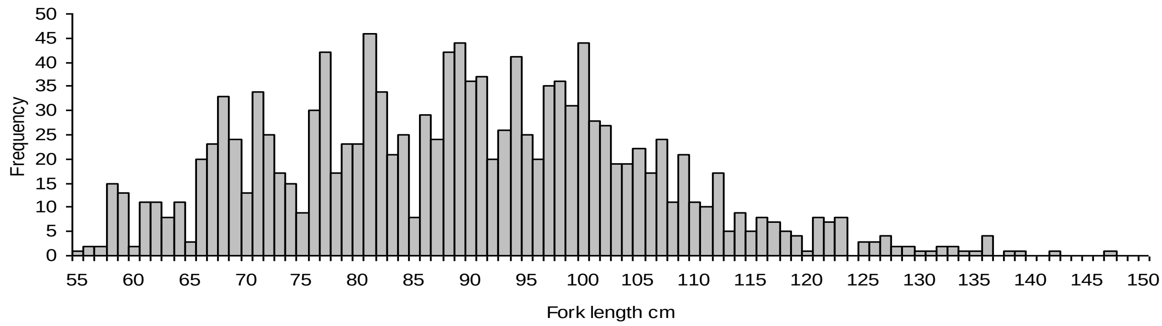

Figure 11: Combined length frequency of kingfish measured during the 2002 Whakatane programme.

Age data for simulating the age length key came from the 2002 Whakatane programme and comprised of 187 aged kingfish (Figure 12). Because there were 27 length classes for which no corresponding age data existed in the key (Figure 12) the age data were pooled across 19 length divisions for use in the sample simulations (55–69; 70–74; 75–79; 80–84; 85–89; 90–91; 92–93; 94–95; 96–97; 98–99; 100–101; 102–103; 104–105; 106–107; 108–109; 110–111; 112–114; 115–119; 120+) (Figure 13).

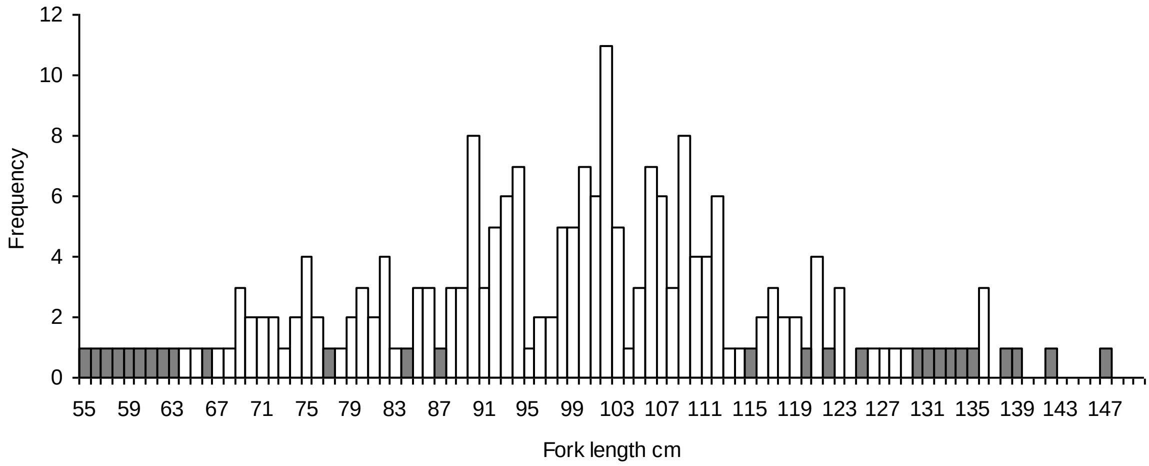

Figure 12: Age data collected by length class (shaded bars represent observed length frequency classes for which there were no age data).

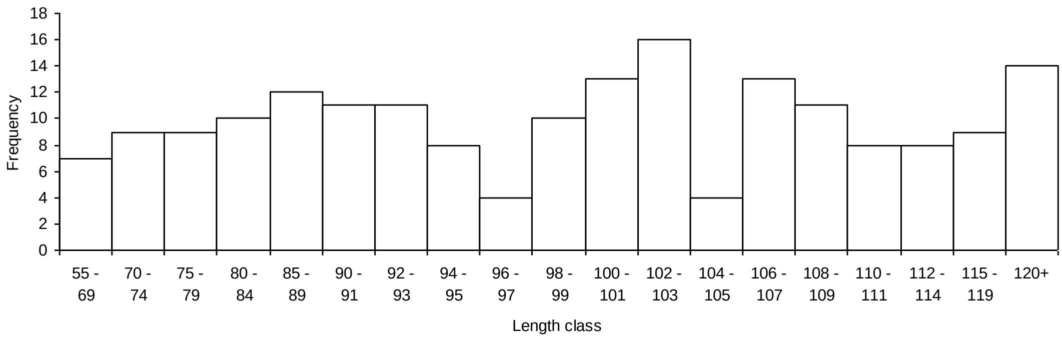

Figure 13: Frequency of kingfish age data by 5 cm length bins.

A non-parametric bootstrap procedure was used to re-generate the pooled age-length key and trip length frequency data by drawing randomly with replacement from the observational data (Davies & Walsh 2003). Data were combined to produce an expected age frequency distribution with associated CVs. Mean weighted CVs (MWCV) were calculated for each simulation run of 1000 bootstraps. Sampling options were explored stepping across 200–1000 otoliths and 100–600 trips.

9.2.2 Results

MWCV's generated by the bootstrap simulations ranged from 0.3 – 0.12 (Appendix 3). MWCV values were more influenced by the number of otoliths than by the number of trips (Figure 14). The simulations indicate that MWCV scores of 0.2 could be achieved from age collections of between 400 and 450 otoliths and length samples of between 150 and 200 trips (Appendix 3).

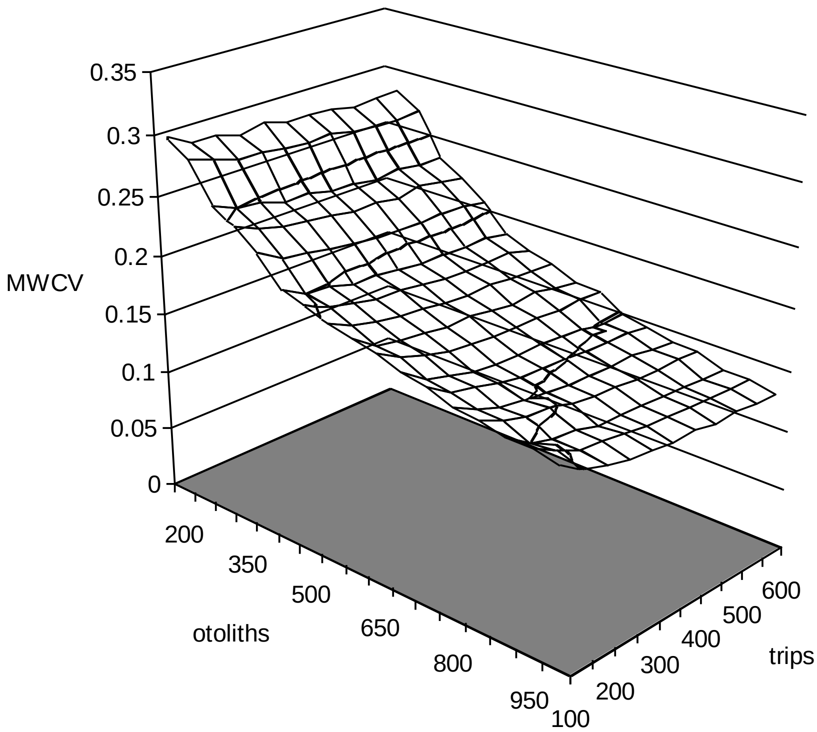

Figure 14: Bootstrap MWCV scores by number of otoliths and number of trips.

9.3 Charter boat catch sampling programme feasibility

The 2003 Whakatane charter boat kingfish sampling programme demonstrated that it is possible to achieve reasonable length and age data from charter boat caught kingfish. The feasibility of implementing five year monitoring programmes across KIN1, KIN 2 and KIN 8 using charter boats was investigated.

9.3.1 Methods

KIN 1, KIN 2 and KIN 8 charter boat operators who specifically target kingfish or have a history of targeting kingfish were identified. Individual operators were contacted and the framework of likely sampling requirements was outlined to them which included: a log book system for recording effort information; obtaining length measurements of all kingfish caught; removal of kingfish heads for otolith extraction. The consultation process identified a number of charter boat operators who could potentially meet the sampling criteria and were willing to maintain the collection process for three to five years.

9.3.2 Results

KIN 1

The Whakatane Charter Boat Association in the Eastern Bay of Plenty was willing to take part in a future kingfish stock monitoring programme. The Whakatane fleet (approximately 12 vessels) predominately operates in three areas: the inshore waters around Whakatane, White Island, and Ranfurly Bank (KIN 2). Logistics for obtaining length and age information were established during the 2003 programme.

Rick Pollock, skipper of ‘Pursuit’ was a key participant in the 2003 programme. In Rick’s opinion the 200 trip target per year is achievable but the fleet would be unlikely to supply more than 200 otoliths. Although data collected during the 2003 programme came from predominantly 3 vessels, indications are that more skippers would cooperate in a future programme particularly if it was sub-contracted to the association to run and/or financial inducement was provided on an otolith or trip basis.

Wider spatial coverage could be achieved by sampling charter boats operating out of the Bay of Islands, Tutakaka, Whangaroa and Maunganui. The kingfish charter operation out of Paihia comprises three 8-metre vessels and 10–15 larger vessels. The majority of kingfish are caught by the smaller vessel operators who run one to two trips daily over most of the year. These operators catch up to 4–6 kingfish per trip. The larger Pahia boats typically do longer duration trips (3–5 days) usually encompassing cape Kari Kari, the Cavalli Islands, Three Kings Islands (KIN 8) and Cape Brett in winter. These vessels target a variety of species including marlin, hapuku and kingfish. Five Pahia charter boat operators have expressed interest in participating in a stock monitoring programme: Geoff Stone ‘Major Tom’, Steve Butler ‘Earl Grey’, Pete Saul ‘Lady Jess’, Chris Britain ‘Maraqueta’ and Blue Sea fishing who run three larger vessels. These operators believe they could provide 200–300 trips per summer period and 100 otoliths.

It is likely that other members of the Northland fleet would be agreeable to collect length and otolith data, although requests for a logbook programme for striped marlin in FMA 1 have been met with some obstacles (Steve Butler, pers. comm.). Around 60 charter boats operate from Tutakaka (John Holdsworth, pers. comm.), although closure of the Poor Knights reserve to line fishing has limited the number of vessels likely to catch kingfish.

Indications are that adequate sampling for length from Bay of Plenty and East Northland charter boat fishers is achievable. However, experience from the 2003 Whakatane programme indicates that the collection of 450 otoliths may prove difficult. The solution in the 2003 Whakatane programme was to make up the otolith shortfall from the commercial fishery. Licensed Fish Receivers in Auckland and Tauranga were therefore canvassed. Indications are that the KIN 1 commercial fishing industry could contribute up to 200 otoliths annually for stock monitoring, and would be willing to co-operate.

KIN 2

Although there are numerous boating and fishing clubs in Tolaga Bay, Waipiro Bay, Tokomaru Bay, Mahia and Gisborne there is no charter boat cluster in operation in KIN 2 comparable to those in KIN 1. Only a small number of charter-boats operating in specialised in kingfish fishing.

Bert Lee, skipper of 'Osprey' in Tolaga Bay could be a key participant, and has previous experience collecting data for NIWA and with tag and release of kingfish. Mike Richmond skippers 'Pacific Invader' from Gisborne Marina and targets kingfish year round. Both cover grounds from Cape Runaway, Ranfurly Bank to Mahia Peninsula. Experience with the Whakatane charter boat operators has shown that a small number of boats can still return sufficient data if the catch rates per vessel are high. Whakatane charter-boats fishing Ranfurly Bank could also contribute KIN 2 stock monitoring data.

Based on our consultations we estimate that 150–250 trips and 150+ otoliths per season could potentially come from charter boat operators in KIN 2. Licensed Fish Receivers in Napier have previous catch sampling experience for blue moki and indicate a willingness to supply kingfish otolith samples to make up for a shortfall from charter boats.

KIN 8

As with KIN 2 there is no charter boat cluster to help coordinate a stock monitoring programme for KIN 8. Sheryl and Richard Hart of the Raglan Sport Fishing Club are potential key participants in a stock monitoring programme. They have considerable experience tagging kingfish; in excess of 300 fish per season in 2004 and 2005 (Sheryl Hart, pers.comm.). Kawhia has 2–3 boats with potential to catch reasonable kingfish numbers, and these could share logistics with the Raglan boats. There is one charter-boat in the Manukau and 3–4 dedicated kingfish boats operating from the Manukau Sport Fishing club. The Taranaki area has a possible charter boat operator, and there is further potential with members of the New Plymouth Sports Fishing & Underwater Club. Hokianga may provide some kingfish data, but this has yet to be determined. Further north, charter boats operating from the Bay of Islands/Northland and fishing in the Three Kings Island area could contribute to KIN 8 data.

Indications are that the collecting 150 trips may be possible but it is likely that the number of otoliths charter fishers could provide annually would be less than 100. Licensed Fish Receivers in Auckland and Taranaki have indicated a willingness to supply otoliths from commercially caught kingfish to supplement those provided through charter boats.

9.3.3 Conclusions

Implementation of a three to five year catch sampling programme in each kingfish stock using charter boat caught kingfish is plausible. There are sufficient numbers of charter operators in KIN 1 to meet sampling requirements and systems are largely in place for this to be initiated in the near future. The implementation of monitoring programmes in KIN 2 and KIN 8 is more problematic.

The biggest issue in setting up kingfish monitoring programmes would be the collection of sufficient numbers of otoliths to produce a viable age length-key. Previous studies with recreationally caught kahawai and kingfish highlight the reluctance of fishers to cut 'trophy' fish. However, incentive prizes have been trialled successfully to overcome fisher reservations. Access to commercially caught kingfish from the corresponding QMA could be used to supplement the otolith collections.

Some charter boat operators have expressed reluctance to do paperwork and fill out log books. Although paper work is unavoidable if worthwhile data is to be collected, data collection needs to be streamlined and minimal. Provision for payment to charter boat skippers or deckhands on a trip, otolith, length or contract basis may ensure support for the programme is maintained, and may go some way to overcoming paperwork reluctance.

A staged implementation across KIN 1, KIN 2 and KIN 8 is recommended, pending successful reviews. In our opinion, a charter boat based stock monitoring programme in KIN 8 would be the most difficult to implement.

10 STOCK DELINEATION OPTIONS

The number of biological stocks and stock boundaries are not well understood for New Zealand kingfish. Movement of tagged fish suggest that adult kingfish remain in the same general area of release, with only 3% of fish recovered greater than 100 kilometres from the release point, regardless of time at liberty (Holdsworth & Saul 2005). However, due to the lack of spatial information on recreational angler effort, the tagging information is difficult to interpret. The study by Smith et al. (2004) using a combination of parasite and meristic techniques found evidence for separating east and west coast kingfish populations. The parasite data also suggested a possible stock boundary between the Bay of Plenty and the Wairarapa coast. Due to the limited number of samples collected, the Smith et al. findings do not constitute definitive proof of stock separation. The authors however believe the techniques do have stock separation utility for kingfish and that more data should be collected.

10.1 Tagging

Recreational anglers have been tagging and releasing kingfish as part of a Ministry funded programme since 1985, and due to a strong commitment by recreational anglers and the Ministry for Primary Industries the programme is likely to continue for the foreseeable future. This tagging information could be used to derive movement patterns if spatial estimates of angler fishing effort were known and it may be possible to infer this from the spatial distribution of the tagged fish. A charter boat log book system like the one proposed under Section 5.3 could also provide the necessary effort data.

10.2 Parasite markers

Smith et al. (2004) identified three crustacean ectoparasites as candidate biological markers for delineating kingfish stock boundaries. *Neobrachiella sp.*, *Lernanthropus sp.* and *Caligus aesopus* (Appendix 4). These parasites are found on the gills of kingfish and can be observed by the naked eye. It may be possible for recreational and commercial fishers to ascertain parasite presence/absence on kingfish gills. However the observer would need suitable training and the kingfish would need to be intrusively examined. Parasite presence/absence data would best be collected as part of a formal catch sampling programme and again a charter boat logbook programme might be a vehicle for this.

10.3 Otolith spectrographic chemical analysis

Chemical profiling of fish otoliths using laser and other spectrographic techniques is a potential way to separate stocks spatially (Kalish 1990; Campana et al. 1997). This method has been applied with varying levels of success since the mid 1990s (Rieman et al. 1994; Patterson et al. 1998; Thorrold & Shuttleworth 2000; Milton & Chenery 2001; Veinott & Porter 2005) with many authors reporting poor or weak spatial associations with otolith chemistry. This method generally works when water from different nursery grounds have different chemical signatures. Given the pelagic and mobile nature of young kingfish it is unlikely to work for this species. Trace element analysis seems to work best when young fish are confined to harbours or bays with unique chemical traces.

11 DISCUSSION AND RECOMMENDATIONS

The by-catch nature of kingfish fisheries makes the monitoring of stock abundance using commercial catch and effort data difficult. Since 1989 the majority of the annual kingfish catch has been taken by single trawl. As kingfish usually accounts for a very small proportion of trawl catches it is often not reported in the trawl fishing effort records. This fact reduces the utility of trawl catch per unit information significantly as effort can only be reliably determined at the amalgamated trip level. The resolution of kingfish catch and effort data from longline and setnet landings was found to be more acceptable, so these methods may be preferable to trawl for describing historical trends in kingfish stock abundance. Overall, however, changes in targeting rules, the introduction of catch quotas, minimum legal size changes, and varying economic incentives, have influenced the continuity of fishing effort since 1989 in all kingfish stocks. Therefore it will be difficult to discern true abundance trends in historical commercial catch and effort data from any method.

The number of kingfish recorded during recreational boat ramp surveys is low. It is unlikely that the series which begins in 1991 in KIN 1 has stock monitoring utility. Consultations with recreational charter boat skippers in KIN 1 have indicated a willingness on the part of some operators to maintain catch logbooks and to measure catches. A charter boat based logbook programme could have utility for tracking changes in future stock abundance, at least in KIN 1.

A method that catches a wide range of adult kingfish age classes would be preferable for stock monitoring purposes, as changes and patterns in CPUE (abundance) and age structure (total mortality) would be more likely to be reflective of the underlying stock. Because their selectivity characteristics are likely to be relatively flat, recreational line and commercial longline would therefore be the preferred choices for stock monitoring. Consultations with KIN 1, 2 and 8 recreational charter boat operators indicate that the implementation of a 3–5 year charter boat based monitoring programme for CPUE and catch-at-age would be highly feasible in KIN 1, with a strong likelihood of success in the other QMAs. All programmes would probably require the supplementation of age data from the commercial fishery which again is a feasible proposition.

The spatial extent of New Zealand kingfish stocks has yet to be definitively determined. Recreational tagging has potential utility for determining stock boundaries but obtaining information on spatial recreational effort may be problematic. In future this information could be collected as part of a charter boat catch sampling programme. Parasite data may also have stock separation utility and three species have been identified as suitable for this purpose. It may be possible to persuade recreational and commercial fisheries to maintain logbooks of parasite observations.

12 ACKNOWLEDGMENTS

Funding for this project, KIN2004/01 objective 1, was provided by the Ministry of Fisheries.

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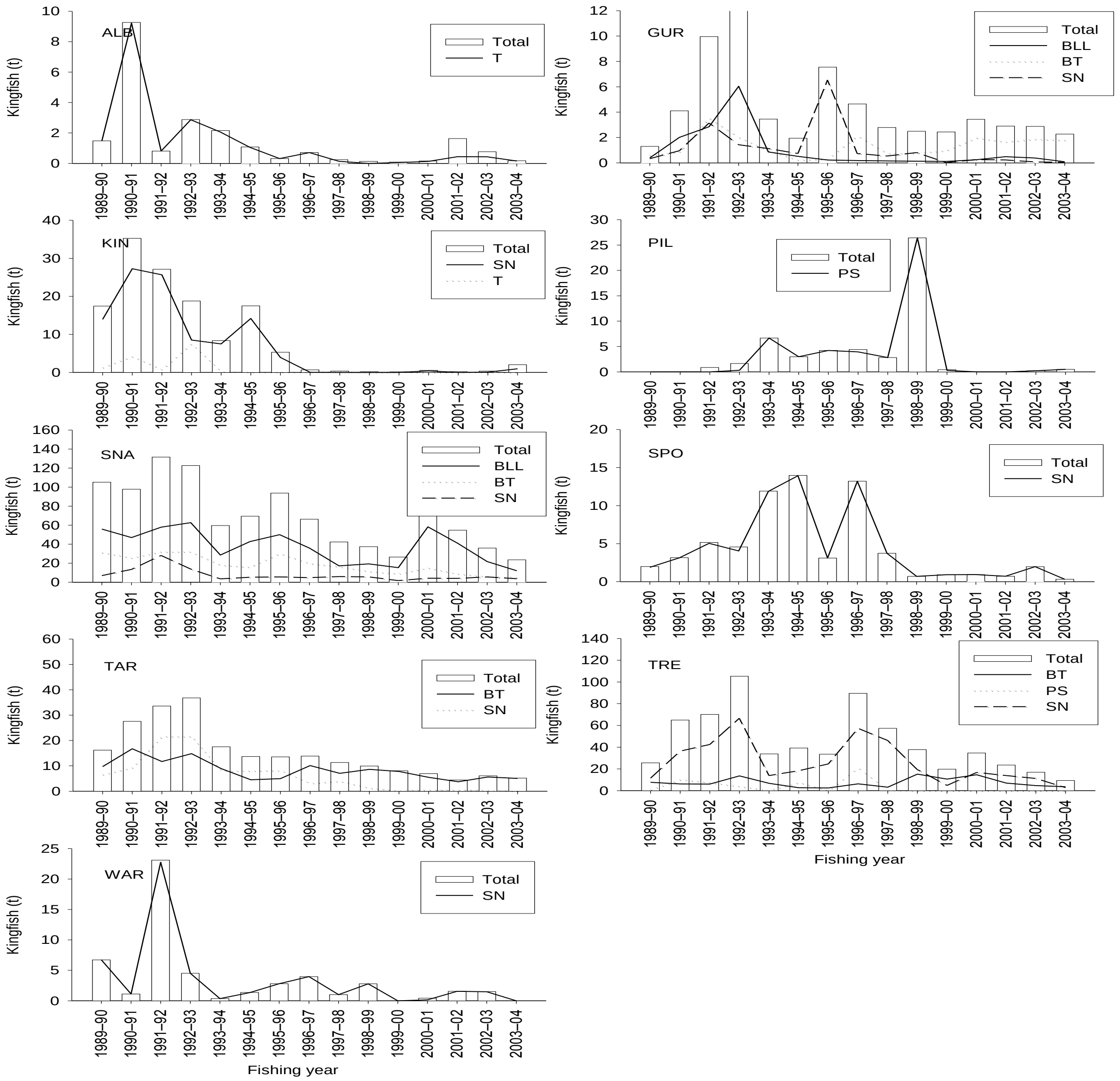
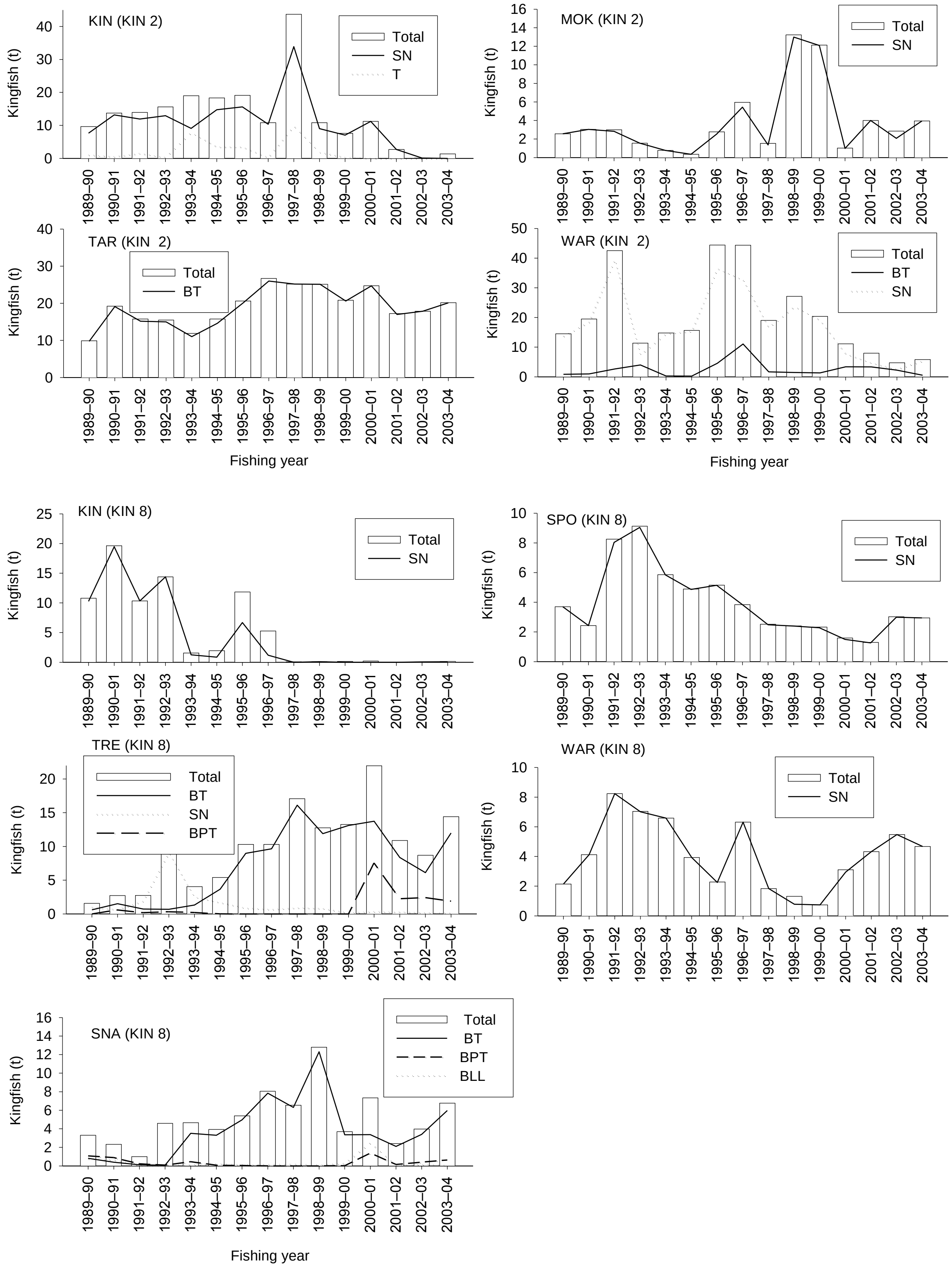
APPENDICES

Appendix 1: Total catch (t) of kingfish by target species and main commercial methods for KIN 1 from 1989–90 to 2003–2004 (BLL, bottom longline; BT, bottom trawl; PS, purse-seine; SN, setnet; T, troll).



Appendix 2: Total catch (t) of kingfish by target species and main commercial method for KIN 2 and 8 from 1989–90 to 2003–2004 (BT, bottom trawl; SN, setnet; T, troll).



Appendix 3: Mean weighted CVs from bootstrap simulations.

		Otoliths																
		200	**250**	**300**	**350**	**400**	**450**	**500**	**550**	**600**	**650**	**700**	**750**	**800**	**850**	**900**	**950**	**1000**
	100	0.301	0.289	0.257	0.247	0.233	0.21	0.205	0.198	0.193	0.189	0.182	0.178	0.17	0.169	0.164	0.164	0.16
	150	0.291	0.283	0.25	0.239	0.222	0.2	0.196	0.189	0.179	0.178	0.168	0.165	0.16	0.16	0.151	0.153	0.148
	200	0.291	0.277	0.247	0.234	0.218	0.199	0.191	0.184	0.175	0.171	0.163	0.161	0.154	0.154	0.145	0.144	0.141
	250	0.284	0.275	0.241	0.231	0.215	0.192	0.187	0.18	0.174	0.166	0.158	0.157	0.151	0.152	0.142	0.142	0.136
Trips	**300**	0.289	0.273	0.241	0.228	0.212	0.193	0.187	0.178	0.17	0.164	0.155	0.152	0.148	0.146	0.137	0.139	0.134
	350	0.283	0.271	0.236	0.225	0.209	0.189	0.184	0.175	0.172	0.162	0.155	0.152	0.145	0.145	0.138	0.136	0.131
	400	0.283	0.273	0.236	0.227	0.208	0.187	0.181	0.174	0.169	0.163	0.156	0.15	0.145	0.144	0.135	0.135	0.132
	450	0.282	0.268	0.234	0.223	0.209	0.188	0.18	0.176	0.166	0.163	0.153	0.149	0.144	0.142	0.135	0.134	0.128
	500	0.279	0.267	0.236	0.227	0.21	0.187	0.181	0.174	0.169	0.161	0.152	0.148	0.145	0.14	0.134	0.133	0.13
	550	0.28	0.267	0.233	0.224	0.209	0.188	0.181	0.172	0.165	0.162	0.148	0.148	0.142	0.141	0.132	0.132	0.127
	600	0.28	0.269	0.233	0.222	0.206	0.184	0.177	0.172	0.163	0.161	0.149	0.145	0.14	0.14	0.131	0.131	0.126

Appendix 4: The three species of parasitic crustaceans found on the gills of kingfish, from left, *Neobrachiella sp.*, *Caligus aesopus*, and *Lernanthropus sp.* Scale in millimetres (reproduced from Smith et al. 2004).