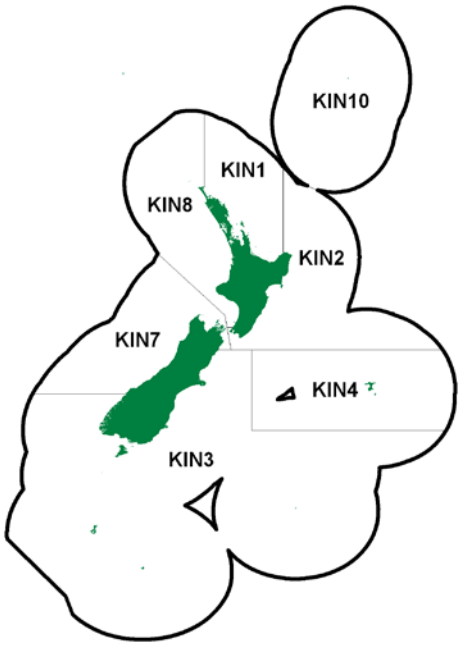
KINGFISH (KIN)

(*Seriola lalandi*)
Haku



1. FISHERY SUMMARY

Kingfish were introduced into the QMS on 1 October 2003, with allowances, TACCs and TACs in Table 1. The TACC for KIN 8 was increased from 36 to 45t in October 2012.

Table 1: Recreational and customary non-commercial allowances, TACCs and TACs by Fishstock.

Fishstock	Recreational Allowance	Customary non-commercial Allowance	Other sources of fishing related mortality	TACC	TAC
KIN 1	459	76	47	91	673
KIN 2	65	18	24	63	170
KIN 3	1	1	0	1	3
KIN 4	1	1	0	1	3
KIN 7	10	2	2	7	21
KIN 8	31	9	7	45	92
KIN 10	1	0	0	1	2

An increased minimum legal size (MLS) to 75 cm (from 65 cm) for recreationally caught kingfish was introduced on 15 January 2004. Kingfish were added to the 6th Schedule in October 2005 for all fishing methods except setnet and in all areas. A special reporting code for 6th Schedule releases has also been introduced on 1 October 2006 to allow monitoring of releases. Kingfish released in accordance with 6th Schedule conditions and reported against this code is not counted against ACE.

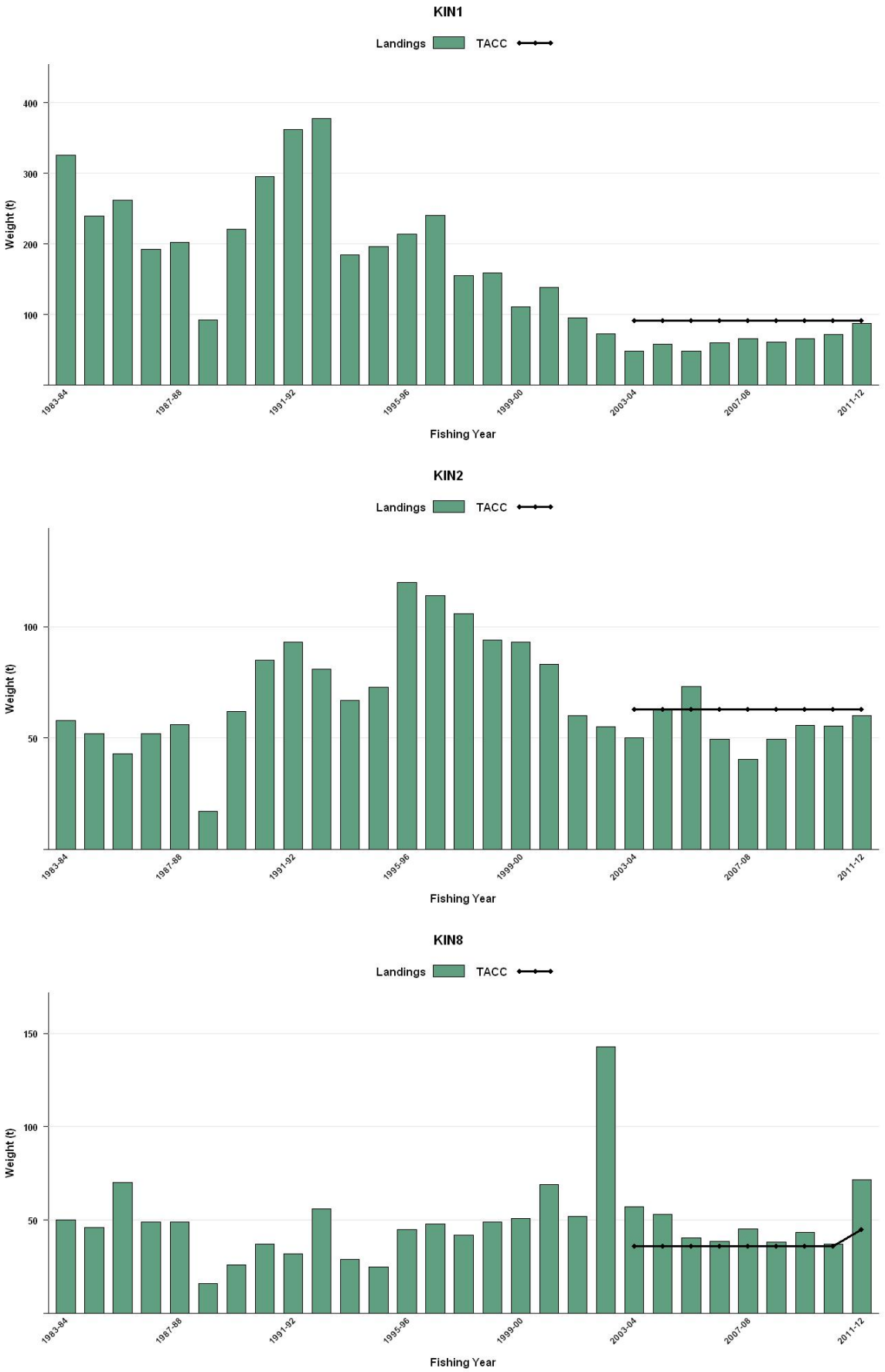


Figure 1: Historical landings and TACC for the three largest KIN stocks. From top left: KIN1 (Auckland East), KIN2 (Central East) and KIN8 (Central Egmont).

1.1 Commercial fisheries

Kingfish commercial landings are reported largely as non-target catch of inshore setnet, trawl and longline fisheries. From 1991 to late 2003, targeting of kingfish (as a non-QMS species) was prohibited unless the species was identified on a fishers permit. A few permit holders were authorized to target kingfish and most of their catch was taken using setnets.

Commercially, kingfish is a moderately high value species and is usually sold as fillets or whole chilled. In recent years about one quarter of the commercial catch has been exported, the main markets being the United States and Australia.

The main fishing areas for kingfish are the east (KIN 1 and KIN 2) and west coast (KIN 8) of the North Island of New Zealand (Table 2). The largest commercial catches generally come from KIN 1. Landings were relatively large in 1983-84, especially in KIN 1, and were probably due to the greater number of vessels in the fishery prior to the introduction of the QMS in 1986. In addition, there was increased effort and better reporting as fishers sought to establish a catch history for the main species in anticipation of the introduction of the QMS. By 1988-89, catches of kingfish had reduced to their lowest levels across most areas. This was most likely due to the under-reporting of less common species in the catch (which includes kingfish) and the introduction of non-QMS restrictions. An increase in kingfish landings in FMA 1 between 1988-89 and 1992-93 and in FMA 2 between 1988-89 and 1991-92 may be due to a number of factors. These include: better reporting of catches; changes in fishing patterns with increased catch by setnet; increased numbers of vessels reporting kingfish catch; and, increased targeting of kingfish.

The total reported catch across all FMAs peaked in 1992-93 at 532 t, with 73% of the catch from KIN 1. By 1993-94, the reported catch of kingfish over all QMAs decreased considerably, mainly because of the reduced catch from KIN 1. Possible reasons for this decrease include: the effect of the October 1993 introduction of a MLS of 65 cm on all methods other than trawl; changes in fishing patterns in the snapper and trevally target setnet, trawl, and bottom longline fisheries (that were responsible for most of the non-target catch of kingfish); decreased target fishing for kingfish; and, setnet area closures in FMA 1 from October 1993. The trawl exemption with respect to MLS was removed in December 2000.

The annual catch of kingfish from KIN 1 fluctuated between 100 and 250 t from 1993-94 through 2000-01 and has remained below 100 t since 2001-02. The kingfish annual catch from KIN 2 declined from the high of 120 t in 1995-96 to 50 t in 2003-04, and has mostly been below 60t since then. Landings from KIN 8 have averaged approximately 35 t for the last 19 years, with catches ranging from 19-70 t. In 2002-03 landings nearly triple the 2001-02 level were reported in KIN 8, the highest ever landing in this area. Landings returned to near average in 2003-04 and 2004-05, but still above the TACC. Annual catches in KIN8 have remained below 50t since 2005-06, but were often above the 36t TACC Although the TACC was increased to 45 t in October 2011 to accommodate previous levels of by-catch, the 2011-12 commercial catch increased substantially to 92 t. In addition to annual catches reported for kingfish QMAs, about 5 t of kingfish has been taken by New Zealand flagged vessels fishing outside NZ fishing waters.

Assuming kingfish targeting effectively ceased during the mid 1990s, catches since the early 2000s possibly reflect ‘true’ bycatch levels.

Table 2: Reported landings (t) of kingfish by area (QMA) from 1983-84 to 2011-12. From 1986-87 to 2000-01, total landings are from LFRRs and landings by QMA are from CLRs prorated to the LFRR total. Totals include landings not attributed to the listed QMAs. MHR data from 2001-present.

Year	KIN 1		KIN 2		KIN 3		KIN 4	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983-84*	326	-	58	-	11	-	0	-
1984-85*	239	-	52	-	8	-	0	-
1985-86*	262	-	43	-	4	-	0	-
1986-87	192	-	52	-	9	-	0	-
1987-88	202	-	56	-	9	-	0	-
1988-89	92	-	17	-	4	-	0	-
1989-90	221	-	62	-	2	-	0	-
1990-91	295	-	85	-	6	-	< 1	-
1991-92	362	-	93	-	4	-	< 1	-
1992-93	378	-	81	-	4	-	0	-
1993-94	184	-	67	-	2	-	< 1	-
1994-95	196	-	73	-	2	-	0	-
1995-96	214	-	120	-	2	-	< 1	-
1996-97	240	-	114	-	7	-	< 1	-
1997-98	155	-	106	-	2	-	< 1	-
1998-99	159	-	94	-	3	-	< 1	-
1999-00	111	-	93	-	4	-	< 1	-
2000-01	138	-	83	-	4	-	< 1	-
2001-02	95	-	60	-	2	-	< 1	-
2002-03	73	-	55	-	1	-	0	-
2003-04	49	91	50	63	1	1	< 1	1
2004-05	58	91	63	63	1	1	0	1
2005-06	48	91	73	63	< 1	1	0	1
2006-07	60	91	50	63	1	1	0	1
2007-08	66	91	40	63	< 1	1	< 1	1
2008-09	61	91	50	63	< 1	1	< 1	1
2009-10	66	91	56	63	< 1	1	< 1	1
2010-11	71	91	55	63	< 1	1	< 1	1
2011-12	87	91	60	63	< 1	1	< 1	1

Year	KIN 7		KIN 8		KIN 10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983-84*	3	-	50	-	0	-	448	-
1984-85*	< 1	-	46	-	0	-	345	-
1985-86*	1	-	70	-	0	-	380	-
1986-87	1	-	49	-	0	-	356	-
1987-88	1	-	49	-	0	-	373	-
1988-89	< 1	-	16	-	0	-	460	-
1989-90	3	-	§26	-	< 1	-	428	-
1990-91	2	-	§37	-	< 1	-	448	-
1991-92	2	-	§32	-	9	-	512	-
1992-93	1	-	§56	-	< 1	-	532	-
1993-94	4	-	29	-	< 1	-	288	-
1994-95	6	-	25	-	< 1	-	302	-
1995-96	7	-	45	-	< 1	-	380	-
1996-97	11	-	48	-	6	-	427	-
1997-98	7	-	42	-	1	-	326	-
1998-99	16	-	49	-	< 1	-	323	-
1999-00	10	-	51	-	0	-	270	-
2000-01	11	-	69	-	< 1	-	304	-
2001-02	22	-	52	-	0	-	231	-
2002-03	20	-	143	-	0	-	292	-
2003-04	3	7	57	36	0	1	160	200
2004-05	19	7	53	36	0	1	195	200
2005-06	7	7	40	36	< 1	1	169	200
2006-07	13	7	39	36	0	1	161	200
2007-08	5	7	45	36	0	1	157	200
2008-09	5	7	38	36	0	1	154	200
2009-10	7	7	43	36	0	1	172	200
2010-11	6	7	37	36	0	1	171	200
2011-12	15	7	72	45	0	1	235	209

* FSU data (Area unknown data prorated in proportion to recorded catch).
§ Some data included in FMA 1.

1.2 Recreational fisheries

Kingfish is highly regarded by recreational fishers in New Zealand for its sporting attributes and large size. Kingfish are most often caught by recreational fishers from private boats and from charter boats, but are also a prized catch for spearfishers and shore based game fishers. Kingfish are recognized internationally as a sport fish, and kingfish caught in New Zealand waters hold 20 of the 22 International Gamefish Association World Records.

Recreational fishers have voiced concerns over a perceived marked decline in the size of kingfish available to them in recent years. Many clubs, competitions and charter boats have implemented a voluntary one kingfish per person per day limit in response. A number of gamefish clubs have also adopted a minimum size limit of 100 cm for kingfish.

Recreational harvest estimates by fish stock have been obtained from national telephone diary surveys undertaken in 1996 and 2000, with a follow up survey in 2001. Regional telephone diary surveys were undertaken in 1991-92 in the South Region, 1992-93 in the Central Region and in 1993-94 in the North Region. There is some uncertainty with all recreational harvest estimates for kingfish as presented in Table 3.

Table 3: Estimated number of kingfish harvested by recreational fishers by Fishstock. (Source: Tierney *et al.* 1997, Bradford 1997, Bradford 1998, Boyd & Reilly 2002, Boyd *et al.* 2004).

	KIN 1				KIN 2			
Survey Year	Number	CV (%)	Range	Estimated Harvest (t)	Number	CV (%)	Range	Estimated Harvest (t)
1992	186 000	-	240-280	260	68 000	-	65-120	92.5
1994	180 000	9	-	228#	62 000	18	-	78.5
1996	194 000	7	215-255	234	67 000	11	60-80	70
2000	127 000	18	590.9-764	800	25 000	38	58.8-102.6	138
2001	449 000	19	-	434.2	107 000	21	-	124.3

	KIN 7				KIN 8			
Survey Year	Number	CV (%)	Range	Estimated Harvest (t)	Number	CV (%)	Range	Estimated Harvest (t)
1992	10 000	-	15-25	20	6 000	-	-	7.6#
1994	-	-	-	-	-	-	-	-
1996	9 000	19	10-15	13	2 000	-	-	2.5#
2000	2 000	55	63.2-256.6	11	1 000	63	5.6-14.8	7
2001	32 000	23	-	33.9	2 000	46	-	1.7

#No harvest estimate available in the survey report, estimate presented is calculated as average fish weight for all years and areas by the number of fish estimated caught.

A telephone diary or personal interview diary survey (2000 and 2001) has three main components: i) the population that fishes recreationally, the group eligible to complete diaries; ii) a diary survey which generates the mean catch in the eligible population; and iii) the mean weight of the catch, usually estimated from boat ramp surveys. The Recreational Technical Working Group (RTWG) concluded that the methodological framework used for telephone interviews produced low eligibility figures for the 1996 and previous surveys. Consequently the harvest estimates derived from these surveys are unreliable.

Comparisons between boat ramp and diary estimates of snapper catch per fisher-trip indicate that there are inconsistencies between the observational and diary information. These inconsistencies, suggest to the RTWG that the diary methodology used in these surveys produces unreliable estimates of total catch. Relative comparisons may be possible between stocks within these surveys.
Mean weight, the third component of the diary survey, introduces uncertainty in the estimates of total weight of recreational catch. However, it is possible to bypass this problem by using the estimated catch in numbers.

The RTWG recommends that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a

methodological error; and c) the 2000 and 2001 estimates are implausibly high for many important fisheries.

All indications are that the recreational catch is in the range of 500-700 t in KIN 1. Recreational surveys also indicate 85% of the recreational kingfish catch is taken in the northern QMAs (1 & 8).

It was assumed that the introduction of the higher MLS of 75 cm on 15 January 2004 for kingfish would reduce recreational catches.

In 2004-05 a recreational harvest estimate for KIN 1 was requested as part of the combined aerial / boat ramp survey targeted primarily at snapper and kahawai. The PELWG indicated that this estimate should be considered with considerable caution due to the limited overlap between this methods sampling technique and the fisheries for kingfish, e.g., the target fisheries for kingfish are usually in offshore areas from launches which were not sampled by the boat ramp survey. For this reason the results from this survey have not been accepted or included in the working group report at this time.

1.3 Customary non-commercial fisheries

Kingfish is an important traditional food fish for Maori, but no quantitative information on the level of Maori customary non-commercial catch is available. The extent of the traditional fisheries for kingfish in the past is described by the Muriwhenua Fishing Report (Waitangi Tribunal 1988). Because of the coastal distribution of the species and its inclination to strike lures, it is likely that historically Maori caught considerable numbers of kingfish.

1.4 Illegal catch

There is no known illegal catch of kingfish.

1.5 Other sources of mortality

The extent of any other sources of mortality is unknown, however, handling mortality for sub-MLS size fish is likely to occur in both the recreational (sub 75 cm) and commercial (sub 65 cm) fisheries.

2. BIOLOGY

In New Zealand, kingfish are predominantly found in the northern half of the North Island but also occur from 29° to 46° S, Kermadec Islands to Foveaux Strait (Francis 1988) and to depths of 200 m. Kingfish are large predatory fish with adults exceeding one and a half metres in length. They usually occur in schools ranging from a few fish to well over a hundred fish. Kingfish tend to occupy a semi-pelagic existence and occur mainly in open coastal waters, preferring areas of high current and or tidal flow adjacent to rocky outcrops, reefs and pinnacles. However, kingfish are not restricted to these habitats and are sometimes caught or observed in open sandy bottom areas and within shallow enclosed bays.

Estimates of age have been derived from opaque-zone counts in sagittal otolith thin sections. Estimates of kingfish von Bertalanffy growth parameters were also derived from recreational tagging data and otoliths collected from the eastern Bay of Plenty. Estimates of K and L_∞ were similar being 0.128 and 130 cm from the otolith age data and 0.130 and 142 cm from the tagging increment data respectively (Table 4). The hard-structure ageing techniques have yet to be validated for New Zealand kingfish, although the position of the first annulus has been validated using regular samples of 0+ year old fish from a fish aggregating device (Holdsworth *et al.* 2013; Francis *et al.* 2005).

A Bayesian analysis of length and maturity data suggests that the length of 50% maturity is 97 cm in females and 83 cm in males.

The recent research has provided estimates of M ranging from 0.20-0.25, however, these estimates are thought to represent an upper bound as the samples were taken from an exploited population.

Available biological parameters relevant to stock assessment are shown in Table 4.

Table 4: Estimates of biological parameters.

Fishstock	Estimate		Source
2. Weight = a(length)^b (Weight in g, length in cm fork length).			
	Both Sexes		
	a	B	
KIN 1	0.03651	2.762	Walsh *et al.* (2003)

3. von Bertalanffy growth parameters

Females				Males				Combined			
L_∞	k	t_0		L_∞	k	t_0		L_∞	k	t_0	
Bay of Plenty (2002?)											
135.79	0.119	-0.976		123.81	0.137	-0.911		130.14	0.128	-0.919	McKenzie *et al.* (in press)
East Northland (2010)											
124.48	0.232	-0.890		113.69	0.279	-0.790					Holdsworth *et al.* (in press)
Bay of Plenty (2010)											
125.63	0.211	-0.987		119.32	0.226	-0.976					Holdsworth *et al.* (in press)

3. STOCKS AND AREAS

A study based on meristic characters and parasite loads suggests two stocks of kingfish off the west and east coasts. These stocks are contained within the Tasman current on the west coast and the east Auckland current and east Cape current on the east coast, with little mixing between them. The east coast stock may be further subdivided into northeast and Hawkes Bay stocks based on limited exchange from tagging studies and parasite marker prevalence.

Tagging results suggest that most adult kingfish do not move outside local areas, with many tag returns close to the release site. However, some tagged kingfish have been found to move very long distances; there are validated reports of New Zealand tagged kingfish being caught in Australian waters and Australian tagged kingfish being recaptured in New Zealand waters.

4. STOCK ASSESSMENT

4.1 Estimates of fishery parameters and abundance

Total mortality (Z) was estimated for kingfish stocks in East Northland and in the Bay of Plenty based on the age structure of the recreational catches in 2010 (Holdsworth *et al.* 2010). In the Bay of Plenty estimates of Z for offshore (i.e., White Island) and inshore samples were 0.3 and 0.38, respectively; assuming an age of full recruitment of 5yrs. Assuming an instantaneous rate of natural mortality (M) of 0.2, the target reference point of $F_{40\%}$ for kingfish in KIN1 was calculated to be 0.1. This suggests that overfishing of kingfish in the Bay of Plenty is not occurring.

Total mortality for East Northland was estimated to be 0.77. However, fishing pressure is expected to be lower in East Northland than in the Bay of Plenty and since no samples were obtained from offshore areas known to be inhabited by large kingfish – i.e. Three Kings Islands and Ranfurly Bank – the Northern Inshore Working Group concluded that the recreational catch sampled in 2010 was unlikely to reflect the age structure of the entire East Northland population. As the 2010 estimate of Z for East Northland may well have been biased (high) by emigration to offshore areas, this estimate is considered to be unreliable.

4.2 Biomass estimates

Few kingfish are encountered in trawl surveys, suggesting that trawling is not a suitable method for monitoring changes in kingfish abundance. Kingfish are amenable to mark-recapture studies. However, up to now, tagging studies have been conducted solely to describe kingfish movement patterns and to estimate growth. Data from these programmes is inadequate to estimate stock biomass.

4.5 Yield estimates and projections

No information is available.

4.6 Other factors

Kingfish in New Zealand can be regarded as a high value species from customary, commercial and recreational perspectives. Although fluctuating, catches of kingfish have shown very little trend over the last 20 years and there is no direct evidence to suggest that the current catch levels are not sustainable. However, recreational fishers are concerned about a perceived decline in the quality of the fishery.

5. STATUS OF THE STOCKS

Stock Structure Assumptions

The movement of New Zealand kingfish has been extensively studied through mark-recapture programmes. Although some kingfish moved considerable distances (e.g., from New Zealand to Australia) most kingfish were recaptured close to the site of release, regardless of time at liberty. It is therefore assumed that New Zealand kingfish are comprised of several biological stocks. In addition to the results from tagging studies, the age structure of recreational catches suggests that kingfish off East Northland and in the Bay of Plenty in KIN1 comprise separate stocks.

- **KIN1 – Bay of Plenty**

Stock Status	
Year of Most Recent Assessment	2013
Assessment Runs Presented	Base case model only
Reference Points	Target: $F_{40\%}$ Soft Limit: 20%B_0 Hard Limit: 10%B_0 Overfishing threshold: $F_{40\%B0}$
Status in relation to Target	*F* is About as Likely as Not (40-60%) to be at or below the target
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown Overfishing is Unlikely (< 40%) to be occurring
Historical Stock Status Trajectory and Current Status -	

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	-
Recent Trend in Fishing Mortality or Proxy	Low estimates of fishing mortality for 2010 and low and stable catches over the previous 10 years, suggest that fishing mortality has been low for a decade.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Catch curve analysis from recent catch sampling (2010) indicates that total mortality is low, with fishing mortality below natural mortality and close to the target. Given the low TACC for KIN 1, inclusion on Schedule 6, increased MLS, and practice of catch and release by recreational anglers, stock size is unlikely to decline in the medium-term.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown Overfishing: Unlikely (< 40%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative stock assessment	
Assessment Method	Estimates of total mortality using Chapman-Robson estimator	
Assessment dates	Latest assessment: 2013	Next assessment: 2017
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	-Age structure of recreational catch in 2010 -Instantaneous rate of natural mortality (*M*) of 0.20 based on a maximum age of 23 years. - Age at 50% maturity (6yrs) -Age at MLS (4yrs) -Growth rate	1 – High Quality 1 – High Quality 1 – High Quality 1 – High Quality 1 – High Quality
Data not used (rank)	-	-
Assessment dates	Latest assessment: 2013	Next assessment: 2017
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	Uncertainty in the estimate of *M*	

Qualifying Comments
-
Fishery Interactions
Commercial kingfish catch is almost all bycatch in fisheries for other species.

Research Needs
Future kingfish catch at age sampling in KIN1 needs to include samples from offshore fishing grounds. CPUE based on charterboat catch and effort forms should be investigated once there are sufficient data.

- **KIN1 – East Northland**

A status of the stock summary table is not included for the East Northland substock as the 2010 estimates of mortality (Z) for this area are not reliable.

Yields, TACCs and reported landings for the 2011-12 fishing year are summarised in Table 6.

Table 6: Summary of yields (t) from the commercial fishery, and reported commercial landings (t) for the most recent fishing year.

Fishstock		QMA	*MCY*	2011-12 Actual TACC	2011-12 Reported landings
KIN 1	Auckland (East)	1	195	91	87
KIN 2	Central	2	40	63	60
KIN 3	South-east (Coast), Southland, Sub-Antarctic	3, 5 & 6	-	1	< 1
KIN 4	South-east (Chatham)	4	-	1	< 1
KIN 7	Challenger	7	-	7	15
KIN 8	Central (West) and Auckland (West)	8 & 9	20	45	72
KIN 10	Kermadec	10	-	1	0
Total			260*	209	235

*5 ton *MCY* estimate for FMAs 3,4,5,6 & 7 combined included in total.

6. FOR FURTHER INFORMATION

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