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Tini a Tangaroa

Mean weight estimates for recreational fisheries in 2017–18

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N. Davey,
B. Hartill,
M. Carter

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EXECUTIVE SUMMARY

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This report provides mean weight estimates for species commonly landed by recreational fishers from New Zealand stocks during the 2017–18 fishing year. Mean weight estimates are required by the concurrent national panel survey to convert numbers of fish harvested by recreational fishers into harvest tonnage estimates. This survey repeats the similar survey conducted in 2011–12.

Potential sources of catch data were identified at an early stage in the research planning. A dedicated creel survey was required to collect data for Fishery Management Areas (FMAs) 2, 3, 5, 7, 8, and 9, to provide coverage of recreational fisheries that were not surveyed by other programmes in the 2017–18 fishing year. Species specific length frequency data were available from other concurrent, NIWA surveys of recreational fishers in FMAs 1, 2, 7, 8, and 9. These included an aerial-access survey of the boat-based recreational fishery in FMA 1 during the 2017–18 fishing year, and an ongoing creel survey of recreational fishers returning to key ramps overlooked by web cameras in FMAs 1, 7, 8, and 9.

The collation of data from all sources provided a data set of 85 425 lengths for 79 species measured throughout New Zealand. Most of these measurements were from snapper, but there were also large numbers of measurements for kahawai, blue cod, gurnard, tarakihi and trevally. Published length weight relationships were used to convert fish lengths into fish weights for the quota species for which at least 50 measurements were available, plus albacore and skipjack tuna. These estimates were used to generate mean fish weights by Quota Management Area (QMA). Mean weight estimates were also calculated by region for snapper in FMA 1 and FMA 8.

Previous programmes have found evidence of seasonal differences in the mean weights for some species commonly landed recreationally. Seasonal mean weights were therefore calculated for the main fish stocks and then compared using t tests. Statistically significant seasonal differences were found for most of the species caught in the large recreational fisheries, and in some cases these were substantially different. These results suggest that seasonal mean weights should be used when converting estimates of numbers of fish landed into tonnage estimates.

1. INTRODUCTION

New Zealand's marine fisheries are primarily managed based on harvest weight rather than the number of fish landed. Recreational fishers are not required to report their catch whereas commercial fishers must report the tonnage of fish that they harvest from each fish stock. As the recreational harvest from some fish stocks can be substantial, survey methods are required to provide estimates of the recreational harvest tonnage.

Offsite survey methods such as national panel surveys offer the only viable and cost-effective means of estimating the recreational harvest taken from New Zealand's varied and diverse inshore fisheries, as onsite methods such as creel surveys are not cost effective at a national scale. Survey panellists are asked to report the number of fish that they caught rather than the weight of their catch. During a telephone diary survey in 1992–93, diarists were asked to report both the number of fish that they caught and to estimate the weight of each fish, but a comparison of weights reported by diarists with weights derived from an onsite creel survey has shown that diarists overestimate the size and hence weight of the fish they retain (Ryan & Kilner 1994). Offsite surveys since then have relied on concurrent creel surveys to provide mean weight estimates which are used to convert offsite survey estimates of numbers of fish caught into recreational harvest tonnage estimates (Boyd & Gowing 2004, Hartill et al. 1998, Hartill & Davey 2015). As average fish weights of individual species can vary between fish stocks it is necessary to conduct onsite creel surveys throughout New Zealand.

The most recent national survey of recreational fishers in New Zealand was a National Panel Survey (NPS) conducted in 2011–12, which provided recreational catch estimates for the 27 most commonly caught fish (Wynne-Jones et al. 2014). A second NPS survey was conducted during the 2017–18 fishing year, and the survey discussed here provides concurrent mean weight estimates that can be used to convert estimates of numbers of fish caught by recreational fishers into harvest tonnage estimates that are more appropriate for fisheries management. Comparisons between the two surveys were also made.

The overall objective of this report for Ministry for Primary Industries Research Project MAF2016-03 was to continue the implementation of an integrated amateur harvest estimation system by providing estimates of absolute total harvest on a stock basis to inform fisheries management. The specific objectives of this research project were: 1) to collate and collect length data describing amateur fisheries catch of key species throughout New Zealand; 2) to convert length data to weight data to inform estimation of the harvest of amateur fisheries; and 3) to collaborate with concurrent onsite and offsite survey projects to provide information to corroborate and if possible calibrate harvest estimates.

2. METHODS

Recreational harvest fish length measurements for commonly caught species were obtained from two sources (Figure 1):

- Concurrent creel surveys already scheduled for other purposes during the 2017–18 fishing year, in Fishery Management Areas (FMAs) 1, 2, 7, 8, and 9.
- A creel survey of fishers returning to other boat ramps during the 2017–18 fishing year, that was conducted as part of this study, to provide further coverage of recreational fisheries in FMAs 2, 3, 5, 7, 8, and 9.

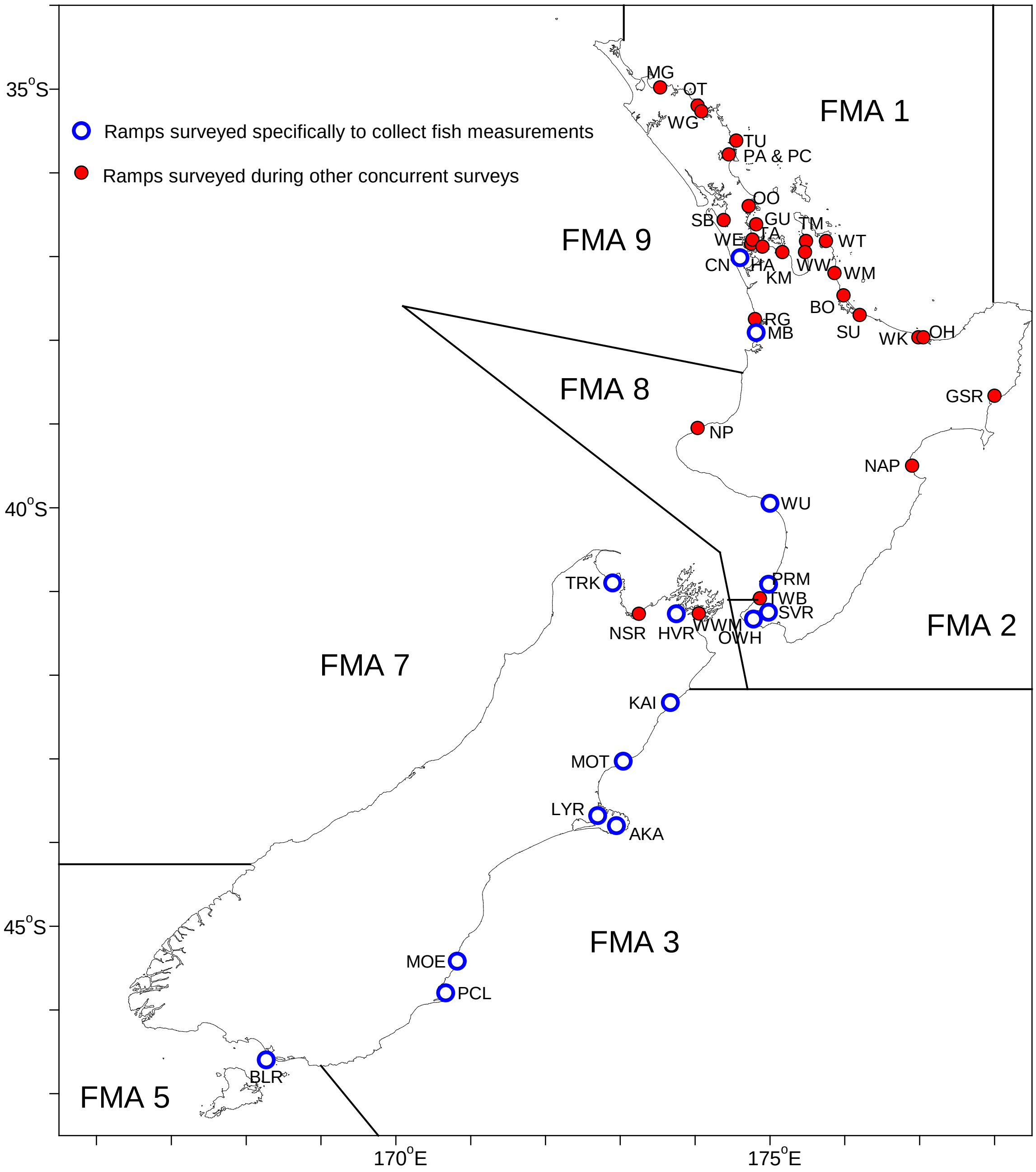

Figure 1: Location of boat ramps where landed recreational catches were measured 2017–18.

2.1 Dedicated creel survey of recreational fishers in FMAs 2, 3, 5, 7, 8, and 9.

A dedicated creel survey was required to collect catch composition data for FMAs 2, 3, 5, 7, 8, and 9, to provide additional coverage of recreational fisheries that were not going to be surveyed by other programmes scheduled for the 2017–18 fishing year. This augmented survey approach follows the methods used in 2011–12 (Hartill & Davey 2015).

The sampling methods used were designed to maximise the number of measurements obtained per interview hour, and sampling effort was therefore non-randomly allocated in space and time. Interviews were only conducted at the busiest ramps in each region (denoted by open circles in Figure 1). The selection of these ramps was based on both historical boat ramp interview data (which was limited in some areas) and conversations with others who had worked in these areas, such as Fisheries Officers. Interviews were conducted at boat ramps as these provide choke points through which relatively high volumes of traffic pass.

Interviews were conducted throughout the fishing year, because seasonal differences in length frequency composition were found for some species in a similar survey in 1996 and in 2011–12 (Hartill et al. 1998, Hartill & Davey 2015). The season definitions used in the analysis of all data collected and collated as part of this programme are summer (1 October to 30 April) and winter (1 May to 30 September).

Interviewers were required to work on weekends and public holidays only, to maximise the likely potential number of fishers encountered. The decision to avoid midweek interviewing is unlikely to cause biased estimates of mean fish weight, as species specific comparisons of weekday and weekend length frequency data in 1996 found little apparent difference in mean size with respect to day type (Hartill et al. 1998). Three days were surveyed per month during the busiest part of the summer season (November to February) and two days were surveyed during the other months. Four hour interview shifts were conducted on each survey day, with no two days falling in the same weekend. Interviewers were asked to reschedule their survey to another weekend day in the same month if the weather forecast was unfavourable for fishing. When possible, we encouraged interviewers to reschedule their survey day when they found that no empty boat trailers were parked at their assigned ramp.

The format of interviews conducted as part of this project and other concurrent recreational creel surveys undertaken by NIWA followed that used in previous surveys over the last 20 years. As many fishing parties as possible were approached during each four hour interview session and the interviewer was asked to select the next boat at random when there were too many boats to interview at any given time. Fishing parties were asked where they fished, for how long and by what methods, and who caught which fish. Individual fish were counted and then measured if time permitted. Finfish were measured to the nearest centimetre on a measuring board, but interviewers were also given a smaller measuring board to measure rock lobster tail widths (tail lengths for packhorse lobster) to the nearest millimetre.

2.2 Concurrent creel surveys of recreational fishers in FMAs 1, 2, 7, 8, and 9.

Species specific length frequency data were also available from concurrent NIWA surveys of recreational fishers conducted in FMAs 1, 2, 7, 8, and 9, for related purposes. These survey programmes were:

- An aerial-access survey of the boat based recreational fishery in FMA 1 during the 2017–18 fishing year (MAF201602). Although this survey provided harvest estimates for snapper, kahawai, red gurnard, trevally and tarakihi, all species were measured when possible.
- An ongoing creel survey of recreational fishers returning to a small number of key ramps overlooked by web cameras in FMAs 1, 7, 8, and 9 (MAF201404). As part of this ongoing programme, digital camera systems are used to monitor changes in levels of recreational boating effort, alongside a creel survey that provides data used to estimate the proportion of boats that have been used for fishing, and the average catch per fishing boat.

The format of the interviews conducted during these NIWA surveys were identical to that used in the dedicated survey discussed in Section 2.1.

2.3 Deriving fish stock specific mean weight estimates from creel survey data

All catch data were assigned to species specific Quota Management Areas (QMAs) which for some fish stocks are comprised of more than one FMA. For example, SNA 1 is a QMA for snapper which has fish stock boundaries corresponding to FMA 1, whereas GUR 1 is the QMA definition for red gurnard caught in FMAs 1 and 9 combined. Some other QMAs are subsets of FMAs (e.g., those for PAU 5A, PAU 5B, etc) or have boundaries that are not coincident with those of FMAs (e.g., those for rock lobster stocks CRA 1 to CRA 9). Each fish has been assigned to a QMA based on the area fished, and not the location of the ramp surveyed (some ramps are close to QMA boundaries). Some species such as albacore and skipjack tuna are highly migratory and not currently part of the Quota Management System (QMS) and are therefore treated as a single stock.

Fisheries in FMA 1 are commonly regarded as three separate regions: East Northland (north of a line going from Cape Rodney to Cape Colville), the Hauraki Gulf (south of this line), and the Bay of Plenty (Cape Colville to Cape Runaway). The species mix and catch size distributions in these regions can differ markedly. Mean weight estimates for snapper, kahawai, red gurnard, tarakihi and trevally were calculated separately for these three regions. Mean weight estimates for snapper in SNA 8 were also calculated separately for harbours (Manukau and Kaipara), north, and south coasts.

2.4 Length-weight relationships used to derive mean weight estimates

Interviewers measured but did not weigh fish, because weighing fish increases the duration of an interview and length measurements have a greater general utility. Standard length-weight relationships (Table 1) were used to convert individual measurements in fish weights, which were then averaged.

Table 1: Length-weight relationships used to convert fish measurements into weight estimates.

Stock	Species		*a*	*b*	Reference
BAR	Barracota	*Thyrstites atun*	0.0075	2.900	Hurst & Bagley (1994)
BCO	Blue cod	*Parapercis colias*	5E-06	3.197	Beentjes (Unpub. Data)
BNS	Bluenose	*Hyperoglyphe antarctica*	0.0096	3.173	Horn (1988)
BUT	Butterfish	*Odax pullus*	6E-06	3.239	Paul et al. (2000)
EMA	Blue mackerel	*Scomber australasicus*	0.0088	3.110	Shaun-ror (1970)
FLA	Flatfish	*Rhombosolea* spp.	0.0380	2.660	McGregor (Unpub. Data)
GMU	Grey mullet	*Mugil cephalus*	0.0424	2.826	Breen & McKenzie (unpublished)
GUR 1	Red gurnard	*Chelidonichthys kumu*	0.0100	2.990	Elder (1976)
GUR 2	Red gurnard	*Chelidonichthys kumu*	0.0053	3.190	Stevenson (2000)
HAP 1	Hapuku/Bass	*Polyprion oxygeneios & P. americanus*	0.0142	3.003	Johnston (1993)
HAP 2	Hapuku/Bass	*Polyprion oxygeneios & P. americanus*	0.0242	2.867	Johnston (1993)
HAP 7,8	Hapuku/Bass	*Polyprion oxygeneios & P. americanus*	0.0142	2.998	Johnston (1993)
JDO	John dory	*Zeus faber*	0.0480	2.700	MFish (2010a)
JMA	Jack mackerel	*Trachurus spp.*	0.0255	2.840	Horn (1991)
KAH	Kahawai	*Arripis trutta*	0.0236	2.890	Hartill & Walsh (2005)
KIN	Kingfish	*Seriola lalandi*	0.0365	2.762	Walsh et al. (2003)
MOK	Blue moki	*Latridopsis ciliaris*	0.0550	2.713	Francis (1979)
PAU	Paua	*Haliotis iris*	3E-08	3.303	Schiel & Breen (1991)
POR	Porae	*Nemadactylus douglasi*	0.0057	3.175	Taylor & Willis (1998)
RCO	Red cod	*Pseudophycis bachus*	0.0092	3.001	Beentjes (1992)
SCA	Scallop	*Pecten novaezelandiae*	0.0004	2.690	Cryer & Parkinson (2006)
SNA	Snapper	*Pagrus auratus*	0.0447	2.793	Paul (1976)
SPD	Spiny dogfish	*Squalus acanthias*	0.0021	3.150	Hanchet (1986)
SPE	Sea perch	*Helicolenus spp.*	0.0078	3.219	Schofield & Livingston (1996)
SPO	Rig	*Mustelus lenticulatus*	0.0010	3.320	Francis (Unpub. Data)
TAR	Tarakihi	*Nemadactylus macropterus*	0.0141	3.087	Tong & Vooren (1972)
TRE	Trevally	*Pseudocaranx dentex*	0.0160	3.064	James (1984)
TRU	Trumpeter	*Latris lineata*	0.0116	3.090	Beentjes et al. (2010)
YEM	Yellow eyed mullet	*Aldrichetta forsteri*	0.0068	3.200	Gorman (1962)

weight = *a* length^b greenweights in g for all species except blue cod and butterfish (kg) all lengths in cm except for **scallops and paua (mm)**

Stock	Species	*b0*	*b1*	Source
ALB	Albacore tuna	-10.29	2.9	MFish (2010)
SKJ	Skipjack tuna	-11.7	3.16	Habib et al. (1981)

In(weight) = $b0 + b1$ * In(fork length) greenweights in kg, fork lengths in cm

Stock	Males		Females		Source
	a	*b*	*a*	*b*	
CRA 1,2,3,4,5	0.00000416	2.935	0.000013	2.545	MFish (2010)
CRA 6,7,8,9	0.000003394	2.967	0.00001037	2.632	MFish (2010)

weight = a length ^{b} greenweights in kg, lengths in mm

3. RESULTS

3.1 Collection and collation of fish length data

The most intensive sampling of recreational catches in 2017–18 took place in FMA 1 as part of a concurrent aerial access survey (Table 2). Interviews of recreational fishers were conducted at the busiest ramps in each region, and interviews were conducted throughout the day, on both weekend and midweek days regardless of the weather. Consequently, the average rate of interviewing at many ramps was less than one boat per hour, especially outside of the Hauraki Gulf, as poor weather suppressed fishing effort, which is also usually less intense during the working week. However, the overall level of sampling effort in FMA 1 was high, with 14 687 boats interviewed during the 12 376 hours that interviewers were present at FMA 1 ramps.

The level of sampling effort and numbers of boats interviewed in other parts of New Zealand was far lower than in FMA 1 (Table 3). The sole purpose of surveying at 15 of these ramps was to provide fish measurements which were not available as a by-product of other surveys conducted for other purposes in 2017–18. All interviewers completed their required minimum number of hours interviewing (112 hours) with extra hours worked at Bluff to increase the number of fish measured. The remaining 7 ramps were part of the webcam programme and interview hours were between 184 and 248, depending on the site.

The total number of fish measurements available from all data sources for commonly caught species by QMA, and for some species by region of FMA 1, are given in Table 4. A small number of species accounted for most of the measured fish during the survey.

Table 2: The number of hours that interviewers were present at boat ramps and the number of fishing boats that they fully interviewed by region of FMA 1, by ramp, by season.

			Hours worked			Fishing boats interviewed	
Region	Ramp	Summer	Winter	Full year	Summer	Winter	Full year
FMA 1	Mangonui	399	174	573	530	144	674
East Northland	Opito Bay	393	173	566	470	123	593
	Parua Bay (public)	399	173	572	385	88	473
	Parua Bay (club)	462	184	646	465	126	591
	Tutukaka	403	171	574	458	140	598
	Waitangi	445	184	628	802	208	1 010
	Total	2 501	1 058	3 559	3 110	829	3 939
FMA 1	Gulf Harbour	392	175	567	438	171	609
Hauraki Gulf	Half Moon Bay	710	179	889	645	155	800
	Kawakawa (public)	379	172	551	392	128	520
	Omaha	388	172	560	576	189	765
	Takapuna	443	178	621	554	133	687
	Te Kouma	402	174	575	503	113	616
	Westhaven	395	173	568	406	97	503
	Waikawau	408	176	584	750	291	1 041
	Total	3 517	1 398	4 916	4 264	1 277	5 541
FMA 1	Bowentown	397	172	569	610	170	780
Bay of Plenty	Ohope	360	165	525	222	101	323
	Sulphur Point	787	311	1 098	1 488	502	1 990
	Whakatane	402	172	574	479	197	676
	Whangamata	386	176	562	648	196	844
	Whitianga	397	176	573	464	130	594
	Total	2 729	1 171	3 901	3 911	1 296	5 207

Table 3: The number of hours that interviewers were present at boat ramps and the number of fishing boats that they fully interviewed by region of FMA 2, 3, 5, 7, 8 and 9, by ramp, by season.

		Hours worked			Fishing boats interviewed		
Region	Ramp	Summer	Winter	Full year	Summer	Winter	Full year
FMA 2	Gisborne	152	57	209	125	35	160
	Napier	176	60	236	285	19	304
	Owhiro Bay	73	40	113	37	2	39
	Seaview	72	40	112	110	36	146
	Total	473	197	670	557	92	649
FMA 3	Akaroa	72	40	112	33	15	48
	Kaikoura	73	39	112	186	80	266
	Lyttelton	72	40	112	60	13	73
	Moeraki	72	40	112	89	29	118
	Motunau	72	40	112	120	16	136
	Port Chalmers	72	40	112	59	18	77
	Total	433	239	672	547	171	718
FMA 5	Bluff	77	52	129	89	45	134
FMA 7	Havelock	72	40	112	144	20	164
	Nelson	172	76	248	329	73	402
	Tarakohe	72	40	112	59	40	99
	Waikawa	172	76	248	172	24	196
	Total	488	232	720	704	157	861
FMA 8	New Plymouth	165	64	229	226	58	284
	Paraparaumu	72	40	112	151	21	172
	Twin Bridges	120	64	184	119	22	141
	Whanganui	72	40	112	87	15	102
	Total	429	208	637	583	116	699
FMA 9	Cornwallis	76	41	117	149	43	192
	Raglan	107	65	172	123	39	162
	Shelley Beach	172	64	236	197	67	264
	Total	355	170	525	469	149	618

Table 4: Number of measurements by species by Quota Management Area from all available data sources.

		QMA 1					QMA 2	QMA 3	QMA 4	QMA 5	QMA 7	QMA 8	QMA 9	Unassigned	Total
Species	Species	ENLD	HAGU	BPLE	unspecified region	All									
SNA	Snapper	9 291	28 144	15 993	–	53 428	318	–	–	–	580	2 219	–	–	56 545
KAH	Kahawai	1 664	3 431	3 984	–	9 079	416	120	–	–	–	684	–	–	10 299
BCO	Blue cod	–	1	–	293	294	343	1 303	–	236	981	456	–	–	3 613
GUR	Gurnard	230	489	1 250	192	2 161	388	6	–	–	297	303	–	–	3 155
TAR	Tarakihi	238	3	1 543	–	1 784	274	40	–	–	182	416	–	–	2 696
TRE	Trevally	470	352	1 272	–	2 094	59	5	–	–	100	–	–	–	2 258
CRA	Rock lobster	–	–	–	233	233	297	20	112	707	25	–	57	–	1 451
KIN	Kingfish	–	3	3	893	899	24	3	–	–	8	47	–	–	981
SPE	Sea perch	–	1	–	15	16	24	183	–	–	326	19	–	–	568
SKJ	Skipjack tuna	–	–	1	468	469	–	–	–	–	–	–	–	–	469
PAU	Paua	–	–	–	–	–	199	44	–	80	75	–	–	–	398
SCA	Scallops	–	–	–	383	383	–	–	–	–	–	–	–	–	383
BUT	Butterfish	–	–	–	197	197	30	48	–	12	87	–	–	–	374
JDO	John Dory	–	4	–	335	339	19	–	–	–	4	1	–	–	363
HPB	Hapuka/Bass	–	–	–	57	57	15	49	–	–	36	85	–	–	242
JMA	Jack Mackerel	–	3	–	143	146	–	–	–	–	48	–	–	–	194
BNS	Bluenose	–	–	11	152	163	2	12	–	–	–	–	–	–	177
BMA	Blue maomao	–	–	–	–	–	–	–	–	–	–	–	–	140	140
RSN	Red snapper	–	–	–	–	–	–	–	–	–	–	–	–	124	124
ALB	Albacore tune	–	–	–	121	121	–	–	–	–	–	–	–	–	121
MOK	Blue moki	–	–	–	86	86	–	–	–	–	–	–	–	–	86
RPI	Red pigfish	–	–	–	–	–	–	–	–	–	–	–	–	85	85
EMA	Blue mackerel	–	–	–	51	51	3	–	–	–	11	11	–	–	76
WSE	Wrasse spp.	–	–	–	–	–	–	–	–	–	–	–	–	70	70
FLA	Flatfish	–	–	–	64	64	–	–	–	–	–	–	–	–	64
STY	Spotty	–	–	–	–	–	–	–	–	–	–	–	–	62	62
RCO	Red cod	–	–	–	11	11	30	14	–	–	5	–	–	–	60
POR	Porae	–	–	–	48	48	1	–	–	–	–	–	–	–	49
BAR	Barracouta	–	–	–	39	39	–	–	–	–	5	–	–	–	44
PAR	Parorae	–	–	–	–	–	–	–	–	–	–	–	–	39	39
PMA	Pink maomao	–	–	–	–	–	–	–	–	–	–	–	–	36	36
SPO	Rig	–	–	–	7	7	2	9	–	–	3	12	–	–	33
PHC	Packhouse crayfish	–	–	–	–	–	–	–	–	–	–	–	–	28	28
TRU	Trumpeter	–	–	–	–	–	1	17	–	7	–	–	–	–	25
KOH	Koheru	–	–	–	–	–	–	–	–	–	–	–	–	22	22
RMO	Red moki	–	–	–	–	–	–	–	–	–	–	–	–	22	22
YEM	Yellow eyed mullet	–	–	–	21	21	–	–	–	–	–	–	–	–	21
LEA	Leatherjacket	–	–	–	–	–	–	–	–	–	–	–	–	21	21
RRC	Granddaddy hapuka	–	–	–	–	–	–	–	–	–	–	–	–	21	21
SPD	Spiny dogfish	–	–	–	5	5	–	1	–	–	1	–	–	–	7
GMU	Grey Mullet	–	–	–	3	3	–	–	–	–	–	–	–	–	3
37 other spp		–	–	–	–	–	–	–	–	–	–	–	–	140	140
Total		11 893	32 431	24 057	3 817	72 198	2 445	1 874	112	1 042	2 774	4 253	57	670	85 425

3.2 Mean weight estimates

Length-weight relationships given in Table 1 were used to convert measurements of the 25 most commonly caught QMS species and for albacore and skipjack tuna also. The resulting individual fish weights were then averaged for each QMA, and by region of QMA 1 for some commonly caught species (Table 5). Mean weight estimates were calculated by season (summer – October to April and winter – May to September) and for all of 2017–18, and t tests were used to determine whether seasonal or annual mean weight estimates should be used for each fish stock. Only seasonal estimates that were statistically different from each other ($p < 0.05$) were used in preference to annually averaged mean weights. The standard errors calculated for estimates with low sample sizes are likely to be underestimates, as distribution of the underlying data will be potentially poorly defined and highly influenced by a small number of individual measurements.

Snapper

Snapper was the most commonly encountered species in all three regions of FMA 1 (53 428 measured). Snapper was the second most commonly caught species in FMA 7 (580 measured) (Table 5, Figures 2 and 3). Snapper were also measured in SNA 2 (318), and SNA 8 (2 219). Snapper landed from the SNA 1 region Hauraki Gulf were on average significantly heavier in winter than in summer (Table 5). This same seasonal difference was present for the SNA 1 region Bay of Plenty. Significant seasonal differences were also detected for SNA 8 landed fish from Manukau and Kaipara harbours, where heavier fish were landed in winter than in summer, whereas snapper caught on the southern coast of SNA 8 were significantly heavier during summer.

Kahawai

Kahawai was the second most frequently encountered species in all regions of FMA 1 (9 079). This species was the most commonly encountered fish in FMAs 8 and 9 (which collectively make up KAH 8 (684) (Table 5, Figures 4 and 5). There was a significant seasonal difference in the average weight of kahawai landed in the Bay of Plenty region of KAH 1: the winter landed fish were heavier than the summer landed fish. Kahawai landed in KAH 8 were conversely significantly heavier in the summer than in the winter.

Blue cod

Blue cod was another species commonly landed by interviewed fishers in 2017–18, especially from BCO 7 and BCO 3. It was also landed in BCO 5, and was hence the most common finfish caught in the South Island (Table 5, Figure 6). Significant seasonal differences were detected in BCO 5 and BCO 7 with fish landed in the summer being on average heavier than those landed in the winter.

Red gurnard

Red gurnard was commonly encountered in most areas (Table 5, Figures 7 and 8). The GUR 1 management area spans the east and west coasts at the top of the North Island and the size composition differs between these areas. Gurnard landed from the west coast are on average heavier than those landed on the east coast of GUR 1. There was a significant seasonal difference for red gurnard landed in the region Bay of Plenty of GUR 1, with fish landed in winter being on average heavier than those landed in summer (Table 5). There was also a seasonal difference in mean weights in GUR 8, with fish landed in summer weighing more on average than fish landed in winter.

Tarakihi

Tarakihi was landed in most surveyed areas, with most measured fish coming from TAR 1 and TAR 8 (Table 5, Figures 9, 10). In the Bay of Plenty region of TAR 1, there was a significant seasonal difference, where weights of those landed in summer were on average heavier than those landed in winter. This was the only seasonal difference in all tarakihi fish stocks.

Trevally

Many measurements of trevally were taken from fish landed in TRE 1 (2 094 measured) and seasonal differences in weights detected from all the regional areas of FMA 1 (Table 5, Figure 11). East Northland and Hauraki Gulf landed trevally were on average significantly heavier in summer than in winter, whereas Bay of Plenty trevally weighed less on average in summer than in winter.

Other species

Mean weights were calculated for all other finfish species but, for most of these, relatively few measurements were available so all data were combined to provide an ‘all region mean weight’ estimate (Table 5).

Shellfish

A small number of scallops and paua were measured during the 2017–18 fishing year (Table 6). The only significant seasonal difference was detected in PAU 2, where summer caught paua were on average heavier than those caught in winter.

Rock lobster

Weights of rock lobster harvested by recreational fishers varied considerably by QMA, sex and fishing method (Table 7). Only sexed rock lobster measurements were used when estimating mean weights because of minimum size limits and morphology differences by sex in all areas. Fishing method (diving and potting) specific mean weights were calculated for all CRA stocks where possible, as divers tend to land larger fish than those caught by fishers using pots. Only a small number of rock lobster were encountered by creel survey interviewers in most areas, and additional commercial logbook and observer data based measurements made in 2017–18 were therefore used to augment the limited data available for these stocks (See Appendix 1 for a description of this data source and summary statistics by CRA stock).

Annual mean weights are recommended for all rock lobster stocks except for CRA 5, where there was a significant seasonal difference, with the winter caught fish being on average heavier than the summer fish.

Table 5: Mean weight estimates (g) for finfish species commonly caught by recreational fishers by QMA, by season and for both seasons combined. Asterisks denote where t tests have detected a significant difference between seasonal mean weight estimates. Best estimates are boxed.

		Summer			Winter			All year			Seasonal	Best
Fishstock	Region	Estimate (g)	SE	n	Estimate (g)	SE	n	Estimate (g)	SE	n	difference	estimate
ALB		4 553	270.1	121	–	–	–	4 553	270.1	121	–	all ALB
BAR 1		2 479	273.4	28	2 380	273.8	11	2 451	209.1	39	–	too few
BAR 7		2 126	387.7	4	1 357	–	1	1 972	337.4	5	–	too few
		2 435	243.3	32	2 295	264.1	12	2 397	189.7	44	–	all BAR
BCO 1		440	15.5	188	471	18.6	106	451	12.0	294	–	Annual
BCO 2		590	19.4	285	550	35.6	58	583	17.2	343	–	Annual
BCO 3		480	8.1	1 010	505	13.9	293	486	7.0	1 303	–	Annual
BCO 5		444	14.6	87	579	10.6	149	529	9.6	236	***	Seasonal
BCO 7		484	5.5	753	494	10.5	228	486	4.8	981	–	Annual
BCO 8		477	8.7	321	570	20.8	135	504	8.9	456	***	Seasonal
		489	4.4	2 644	522	6.7	969	498	3.7	3 613	***	not used
BNS 1		4 271	310.9	56	5 099	442.9	107	4 814	310.6	163	–	Annual
BNS 2		6 581	–	1	2 522	–	1	4 552	2 029	2	–	too few
BNS 3		2 522	–	1	3 451	1 299	11	3 374	1 188	12	–	too few
		4 280	304.3	58	4 925	417.2	119	4 714	298.0	177	–	for BNS 2, 3
BUT 1		1 050	22.1	169	1 070	63.6	28	1 053	20.9	197	–	Annual
BUT 2		2 267	178.0	27	1 553	93.8	3	2 195	164.9	30	**	too few
BUT 3		1 659	112.2	43	614	168.7	5	1 550	111.8	48	***	too few
BUT 5		1 219	128.5	12	–	–	–	1 219	128.5	12	–	too few
BUT 7		1 256	108.2	86	1 189	–	1	1 255	107.0	87	–	Annual
		1 284	40.8	337	1 051	63.8	37	1 261	37.4	374	**	for BUT 2,3,5
EMA 1		1 150	101.9	43	1 140	181.7	8	1 148	89.9	51	–	Annual
EMA 2		679	193.4	3	–	–	–	679	193.4	3	–	too few
EMA 7		205	13.0	10	221	–	1	207	11.9	11	–	too few
EMA 8		1 481	221.8	8	1 911	–	1	1 529	201.3	9	–	too few
		1 021	87.9	64	1 125	191.1	10	1 035	80.0	74	–	for EMA 2, 7, 8
FLA 1		401	19.6	52	438	32.1	12	408	17.0	64	–	all FLA
GUR 1		438	4.8	1 229	453	6.1	932	444	3.8	2 161	*	Seasonal
	ENLD	465	11.1	153	450	14.6	77	460	8.8	230	–	Annual
	HAGU	363	7.7	280	355	9.1	209	360	5.9	489	–	Annual
	BPLE	441	6.6	695	466	8.0	555	452	5.1	1 250	*	Seasonal
	GUR 1 east	425	4.9	1 128	437	6.1	841	430	3.8	1 969	–	Annual
	GUR 1 west	581	16.7	101	601	19.1	91	591	12.6	192	–	Annual
GUR 2		536	9.9	359	635	61.5	29	544	10.3	388	–	Annual
GUR 3		770	92.5	5	489	–	1	723	89.0	6	–	too few
GUR 7		636	19.5	229	560	31.0	68	619	16.7	297	*	Annual
GUR 8		564	11.3	374	479	15.0	71	550	9.9	445 3	***	Seasonal
		497	4.5	2 196	466	5.9	1 101	487	3.6	3 297	***	for GUR 3
GMU 1		784	181.0	3	–	–	–	784	181.0	3	–	Annual

Table 5: -continued: Mean weight estimates (g) for finfish.

		Summer			Winter			All year			Seasonal	Best
Fishstock	Region	Estimate (g)	SE	n	Estimate (g)	SE	n	Estimate (g)	SE	n	difference	estimate
HPB 1		6 092	774.0	43	5 567	1213.9	14	5 963	651.1	57	–	Annual
HPB 2		9 212	1460.9	10	2 429	1532.2	5	6 951	1367.0	15	**	too few
HPB 3		4 524	1056.0	7	5 583	344.8	42	5 431	331.4	49	–	too few
HPB 7		5 718	484.3	33	7 101	1282.3	3	5 833	456.7	36	–	too few
HPB 8		6 094	862.8	10	6 427	–	1	6 125	781.0	11	–	too few
		6 168	408.6	103	5 420	375.1	65	5 879	290.1	168	–	for HPB 2, 3, 7, 8
JDO 1		1 161	28.7	180	1 163	31.7	159	1 162	21.2	339	–	Annual
JDO 2		1 494	170.8	16	1 832	358.3	3	1 547	153.5	19	–	too few
JDO 7		1 541	469.6	3	1 757	–	1	1 595	336.4	4	–	too few
JDO 8		317	–	1	–	–	–	317	–	1	–	too few
		1 189	30.7	200	1 179	32.3	163	1 185	22.3	363	–	for JDO 2, 3, 7, 8
JMA 1		291	14.6	140	424	36.1	6	297	14.2	146	*	Annual
JMA 7		338	39.5	32	393	21.3	16	356	27.4	48	–	too few
		300	14.0	172	401	18.1	22	311	12.8	194	***	for JMA 7
KAH 1		1 704	8.4	6936	1 733	12.6	2143	1 711	7.1	9 079	–	by region
	ENLD	1 713	17.4	1417	1 739	38.3	247	1 717	15.9	1 664	–	Annual
	HAGU	1 702	15.7	2465	1 794	20.3	966	1 728	12.7	3 431	***	Seasonal
	BPLE	1 701	11.6	3054	1 667	16.9	930	1 693	9.8	3 984	–	Annual
KAH 2		1 685	40.4	343	1 757	69.2	73	1 698	35.5	416	–	Annual
KAH 3		1 086	90.6	102	892	132.1	18	1 056	79.6	120	–	Annual
KAH 8		1 872	32.0	485	1 505	42.9	199	1 765	26.7	684	***	Seasonal
		1 705	8.0	7 866	1 708	12.0	2 433	1 706	6.7	10 299	–	not used
KIN 1		8 135	114.7	738	8 591	240.6	161	8 217	103.6	899	–	Annual
KIN 2		9 666	727.5	23	6 588	–	1	9 538	708.2	24	–	too few
KIN 3		6 901	978.8	3	–	–	–	6 901	978.8	3	–	too few
KIN 7		8 482	1692.1	8	–	–	–	8 482	1692.1	8	–	too few
KIN 8		8 485	494.6	42	6 332	254.3	5	8 256	452.8	47	***	too few
		8 195	110.4	814	8 512	234.2	167	8 249	100.0	981	–	for KIN 2,3,7,8
MOK 1		1 923	112.3	84	3 627	1946.2	2	1 962	117.6	86	–	all MOK
POR 1		1 232	96.0	34	1 174	160.0	14	1 215	81.6	48	–	too few
POR 2		2 142	–	1	–	–	–	2 142	–	1	–	too few
		1 258	96.8	35	1 174	160.0	14	1 234	82.2	49	–	all POR
RCO 1		870	184.7	7	677	93.4	4	799	121.8	11	–	too few
RCO 2		1 058	123.0	18	1 317	213.8	12	1 162	113.2	30	–	too few
RCO 3		992	128.1	11	1 153	164.0	3	1 027	105.5	14	–	too few
RCO 7		1 215	501.3	3	791	0.0	2	1 045	293.5	5	–	too few
		1 018	80.8	39	1 121	136.0	21	1 054	70.5	60	–	all RCO
SKJ		1 800	31.0	468	1 704	–	1	1 800	31.0	469	–	all SKJ

Table 5: -continued: Mean weight estimates (g) for finfish.

Fishstock	Region	Summer Estimate (g)	Summer SE	Summer n	Winter Estimate (g)	Winter SE	Winter n	All year Estimate (g)	All year SE	All year n	Seasonal difference	Best estimate
SNA 1		1 186	4.0	39 819	1 212	6.2	13 609	1 193	3.4	53 428	***	by region
	ENLD	1 361	13.5	7 396	1 312	25.5	1 895	1 351	11.9	9 291	–	Annual
	HAGU	1 162	5.0	21 461	1 189	8.1	6 683	1 168	4.3	28 144	**	Seasonal
	BPLE	1 116	5.7	10 962	1 205	8.8	5 031	1 144	4.8	15 993	***	Seasonal
SNA 2		1 072	51.4	307	2 367	614.2	11	1 117	55.3	318	–	Annual
SNA 7		1 510	54.1	535	1 436	292.1	45	1 505	54.7	580	–	Annual
SNA 8		1 347	22.8	1 861	1 428	69.7	358	1 360	22.2	2 219	–	by region
	Harbours	932	22.1	637	1 439	140.6	79	988	25.7	716	***	Seasonal
	N coast	1 186	69.3	198	1 512	163.1	44	1 246	64.3	242	–	Annual
	S coast	1 637	34.0	1 025	1 409	90.3	235	1 595	32.5	1 260	*	Seasonal
		1 196	4.0	42 522	1 219	6.4	14 023	1 202	3.4	56 545	**	not used
SPD 1		1 994	–	1	1 540	57.4	4	1 631	101.1	5	–	too few
SPD 3		–	–	–	1 079	–	1	1 079	–	1	–	too few
SPD 7		1 489	–	1	–	–	–	1 489	–	1	–	too few
		1 741	252.7	2	1 448	102.5	5	1 532	104.7	7	–	all SPD
SPE 1		554	69.0	9	808	149.9	7	665	80.1	16	–	too few
SPE 2		541	53.1	19	399	27.9	5	512	43.8	24	*	too few
SPE 3		583	18.5	143	656	40.8	40	599	17.1	183	–	Annual
SPE 7		396	12.5	289	348	17.1	37	391	11.2	326	*	Seasonal
SPE 8		554	67.3	9	339	57.0	10	441	49.5	19	*	too few
		465	10.7	469	507	26.9	99	472	10.0	568	–	for SPE 1,2,5,8,9
SPO 1		2 574	966.2	5	756	580.0	2	2 054	756.9	7	–	too few
SPO 2		2 574	1 238	2	–	–	–	2 574	1 238	2	–	too few
SPO 3		1 443	400.7	5	898	70.3	4	1 201	233.6	9	–	too few
SPO 7		854	378.9	3	–	–	–	854	378.9	3	–	too few
SPO 8		2 081	–	1	–	–	–	2 081	–	1	–	too few
		1 867	372.6	16	851	159.1	6	1 590	289.0	22	*	all SPO
TAR 1		840	8.9	1 074	863	10.7	710	849	6.8	1 784	–	for HAGU
	ENLD	902	25.5	151	872	41.7	87	891	22.2	238	–	Annual
	HAGU	1 266	288.5	2	1 150	–	1	1 227	171.0	3	–	too few
	BPLE	829	9.4	921	861	10.7	622	842	7.1	1 543	*	Seasonal
	TAR 1 east	840	8.9	1074	863	10.7	710	849	6.8	1 784	–	Annual
TAR 2		751	22.7	235	700	40.5	39	744	20.3	274	–	Annual
TAR 3		715	62.9	35	1 018	168.1	5	753	60.3	40	–	too few
TAR 7		581	30.8	156	1 059	102.6	26	649	32.5	182	***	Annual
TAR 8		595	18.6	299	564	26.3	117	586	15.3	416	–	Annual
		763	7.8	1 799	823	10.4	897	783	6.3	2 696	***	for TAR 3, 5
TRE 1		1 328	19.6	1 649	1 233	32.2	445	1 308	16.9	2 094	*	by region
	ENLD	1 411	48.6	367	917	60.3	103	1 303	41.2	470	***	Seasonal
	HAGU	1 142	50.5	260	909	54.3	92	1 081	40.2	352	**	Seasonal
	BPLE	1 345	22.9	1 022	1 483	41.4	250	1 372	20.2	1 272	**	Seasonal
TRE 2		1 561	94.0	54	1 371	312.0	5	1 545	89.5	59	–	Annual
TRE 3		645	112.0	5	–	–	–	645	112.0	5	–	too few
TRE 7		2 179	106.2	86	1 924	210.5	14	2 143	96.0	100	–	Annual
		1 373	19.5	1 794	1 256	32.1	464	1 349	16.8	2 258	**	for TRE 3

Table 5: -continued: Mean weight estimates (g) for finfish.

		Summer			Winter			All year			Seasonal	Best
Fishstock	Region	Estimate (g)	SE	n	Estimate (g)	SE	n	Estimate (g)	SE	n	difference	estimate
TRU 2		4 216	–	1	–	–	–	4 216	–	1	–	too few
TRU 3		3 385	635.7	14	2 534	709.0	3	3 235	536.7	17	–	too few
TRU 5		829	47.2	7	–	–	–	829	47.2	7	–	too few
		2 609	480.8	22	2 534	709.0	3	2 600	427.9	25	–	All TRU
YEM 1		301	25.8	20	99	–	1	291	26.3	21	–	too few
		301	25.8	20	99	–	1	291	26.3	21	–	All YEM

Table 6: Mean weight estimates (g) for shellfish species other than rock lobster, which are commonly caught by recreational fishers by QMA, by season and for both seasons combined. Asterisks denote where t tests have detected a significant difference between seasonal mean weight estimates. Best estimates are boxed.

	Summer			Winter			All year			Seasonal	Best
	Estimate (g)	SE	n	Estimate (g)	SE	n	Estimate (g)	SE	n	difference	estimate
PAU 2	295	42.3	97	281	30.2	102	288	37.2	199	–	Seasonal
PAU 3	329	49.0	13	264	92.5	31	283	86.8	44	–	too few
PAU 5B	641	144.1	6	–	–	–	641	144.1	6	–	too few
PAU 5D	350	71.9	74	–	–	–	350	71.9	74	–	Annual
PAU 7	286	64.7	69	288	32.7	6	286	62.6	75	–	Annual
	318	83.3	259	277	51.2	139	304	76.2	398	–	for PAU 1,3,5B,6
SCA(CS)	10	–	1	95	2.5	27	92	3.9	28	–	too few
SCA 1	112	0.8	288 0	111	2.1	60 0	112	0.8	348	–	Seasonal
SCA 9	100	5.2	7 0	–	–	– 0	100	5.2	7	–	too few
	111	0.9	296 0	106	1.8	87 0	110	0.8	383	**	for SCA CS, 9

Table 7: Mean weight estimates (g) for rock lobster by QMA, by diver and by pot caught fish. Best estimates are boxed.

	Summer			Winter			All year			Seasonal	Best
	Estimate (g)	SE	n	Estimate (g)	SE	n	Estimate (g)	SE	n	difference	estimate
CRA 1 (diver)	851	34.0	162	755	36.2	70	822	26.3	232	–	Annual
CRA 2 (diver)	747	20.3	229	795	35.9	44	754	18.0	273	–	Annual
CRA 3 (diver)	563	13.6	50	597	29.8	12	570	97.5	62	–	Annual ##
CRA 4 (diver)	961	71.9	70	1 169	354.0	6	977	71.3	76	–	Annual
CRA 5 (diver)	945	24.1	344	1 203	66.1	39	971.0	23.0	383	***	Seasonal
CRA 7 (diver)	1125	107.9	25	–	–	–	1 125	107.9	25	–	Annual
CRA 8 (diver)	No creel data available						654	–	6 921	–	Annual #
CRA 9 (diver)	791	55.9	29	1 478	251.1	9	852	–	268	*	Annual #
CRA 1 (pot)	–	–	–	871	–	1	817	–	2 091	–	Annual #
CRA 2 (pot)	704	49.4	18	662	59.8	6	588	–	2 285	–	Annual #
CRA 3 (pot)	553	33.4	18	–	–	–	531	–	2 716	–	Annual #
CRA 4 (pot)	614	34.6	34	1 116	427.7	2	502	–	8 858	–	Annual #
CRA 5 (pot)	595	10.6	241	678	24.8	83	616	10.3	324	**	Seasonal
CRA 7 (pot)	No creel data available			–	–	–	657	–	1 471	–	Annual #
CRA 8 (pot)	No creel data available						654	–	6 921	–	Annual #
CRA 9 (pot)	758	65.8	13	951	34.0	6	852	–	268	*	Annual #

\# based on commercial observer and logbook data - see Appendix 1

\## data from 2016–17 and 2017–18 combined

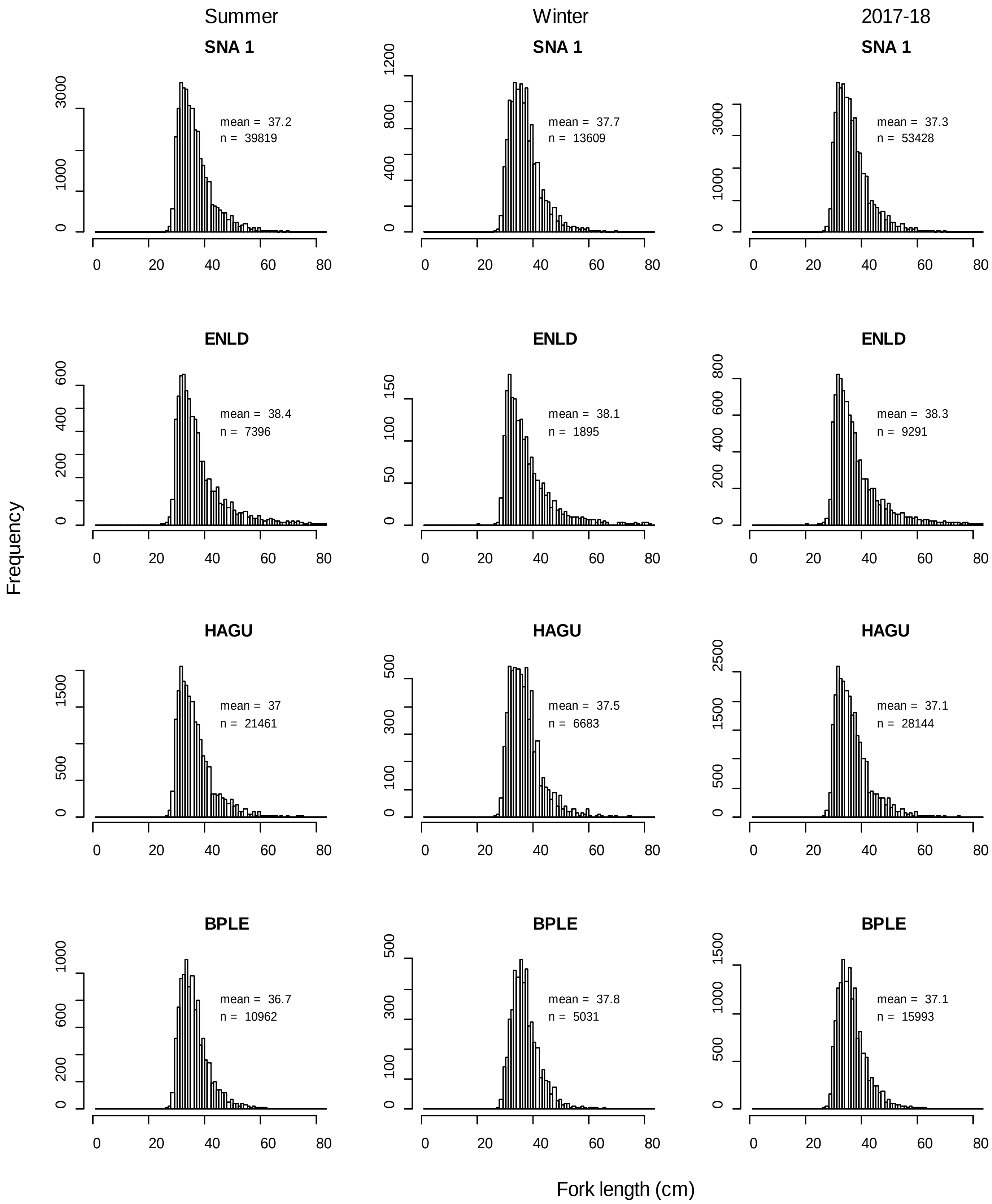

Figure 2: Length frequency distributions for snapper measured in SNA 1 by region and season.

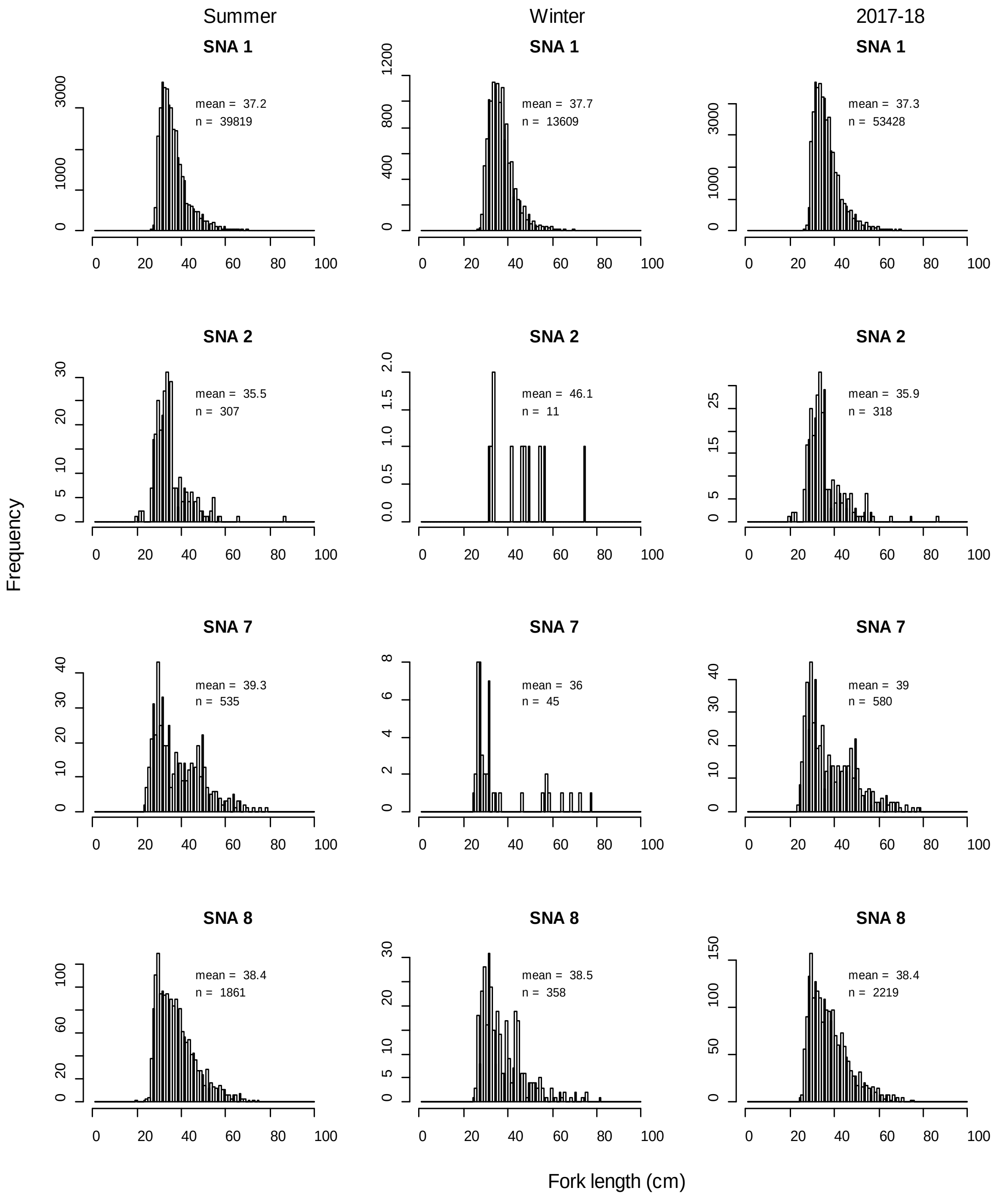

Figure 3: Length frequency distributions for snapper by QMA and season.

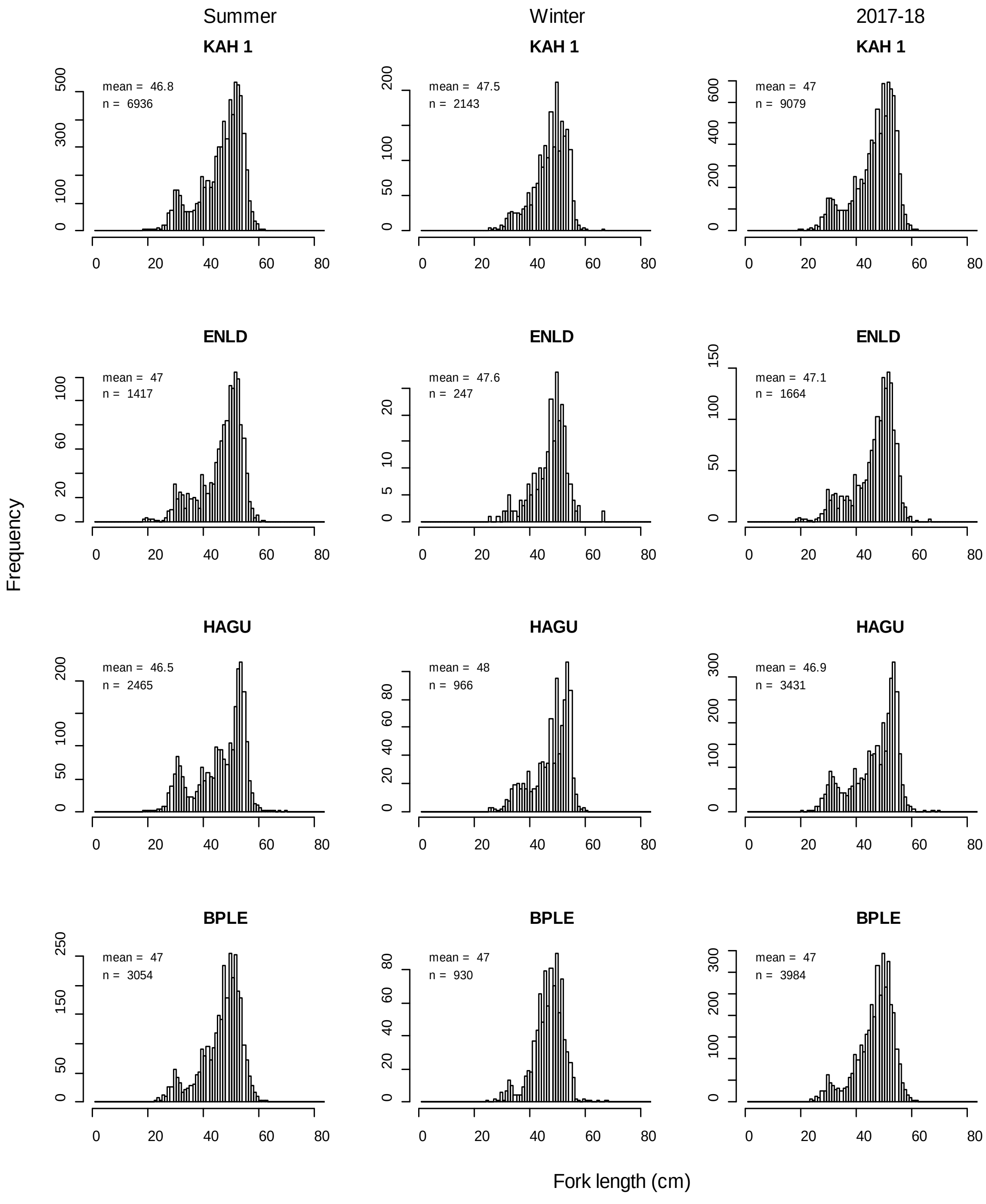

Figure 4: Length frequency distributions for kahawai measured in KAH 1 by region and season.

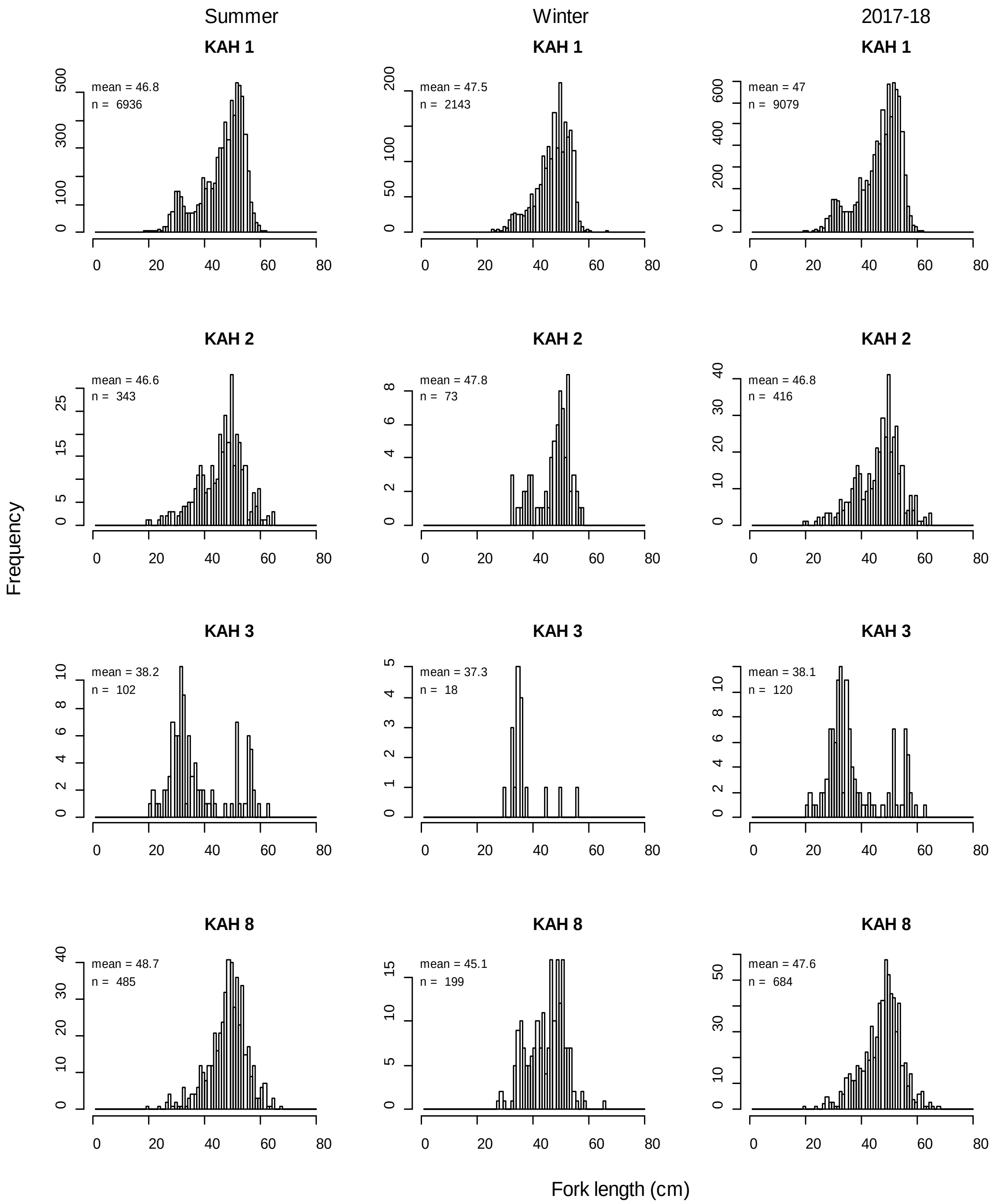

Figure 5: Length frequency distributions for kahawai by QMA and season.

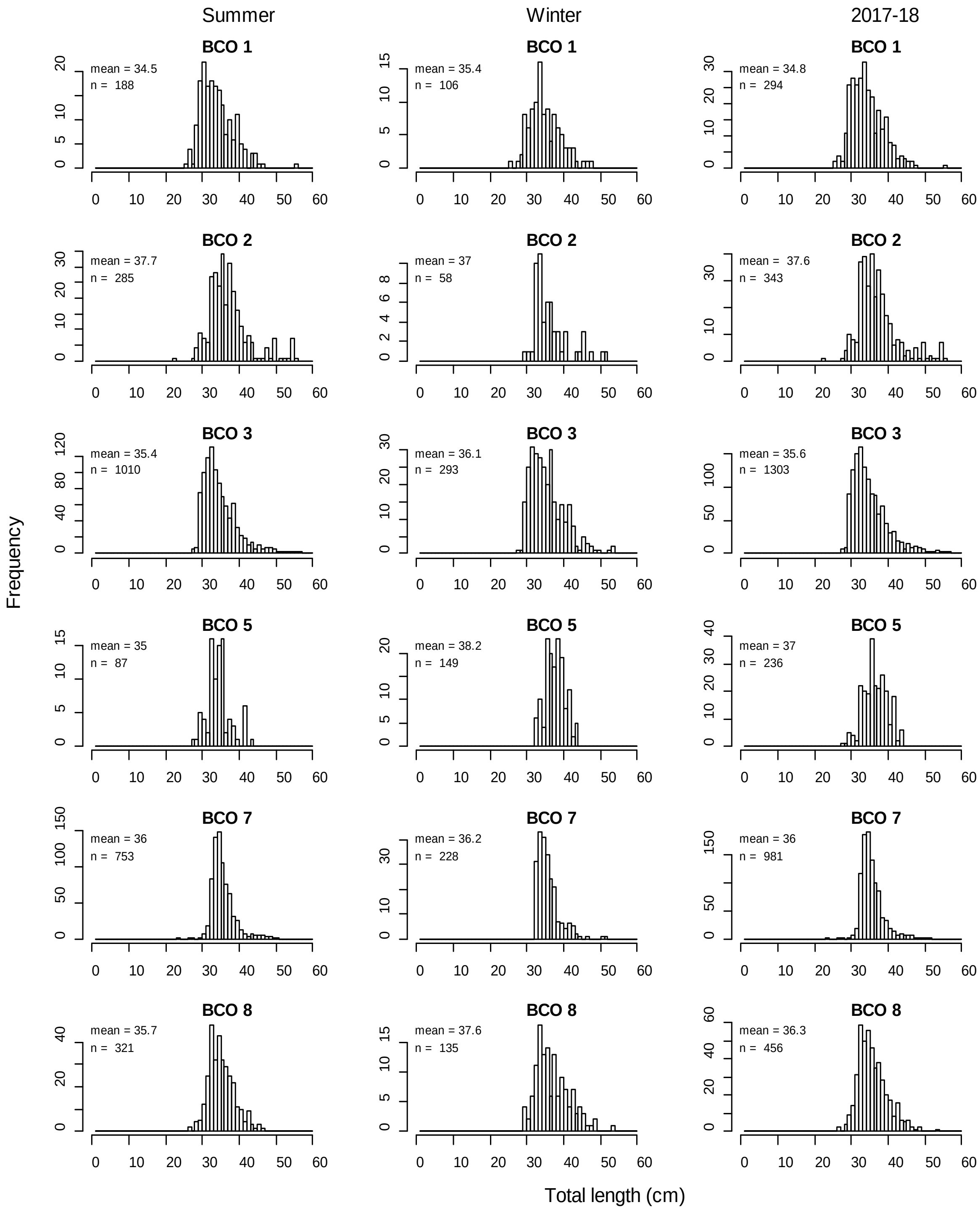

Figure 6: Length frequency distributions for blue cod by QMA and season.

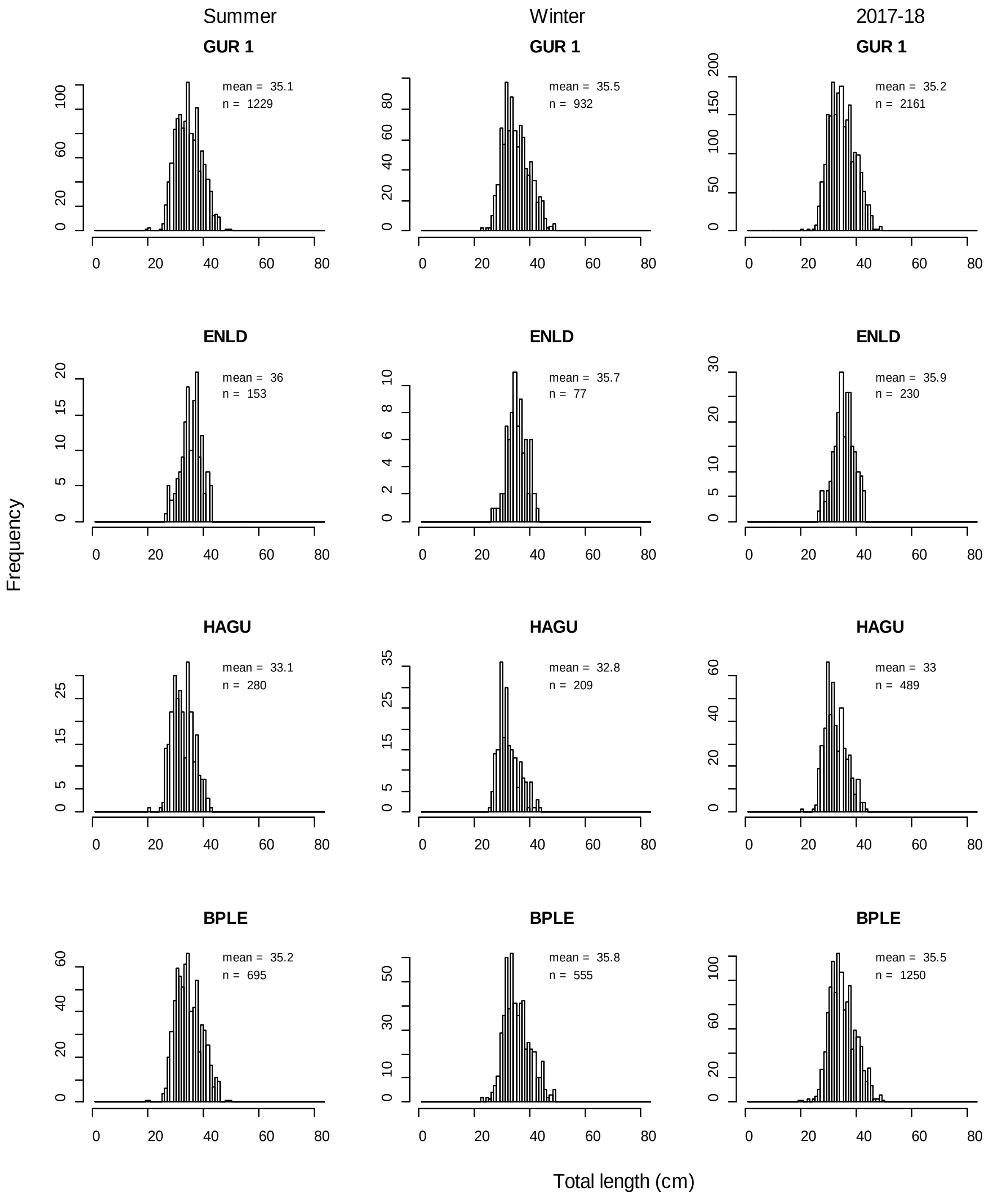

Figure 7: Length frequency distributions for red gurnard measured in GUR 1 by region and season.

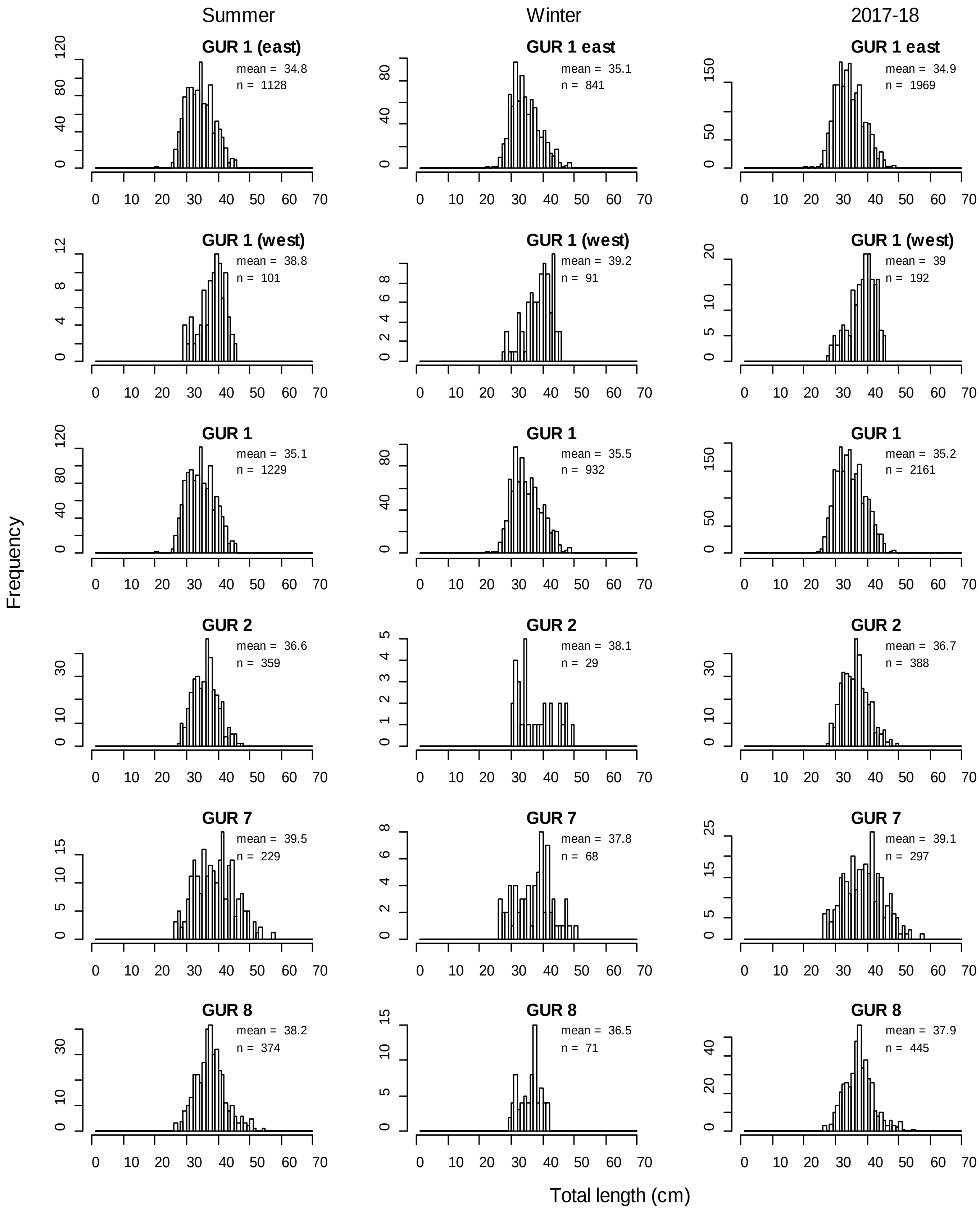

Figure 8: Length frequency distributions for red gurnard by QMA, location, and season.

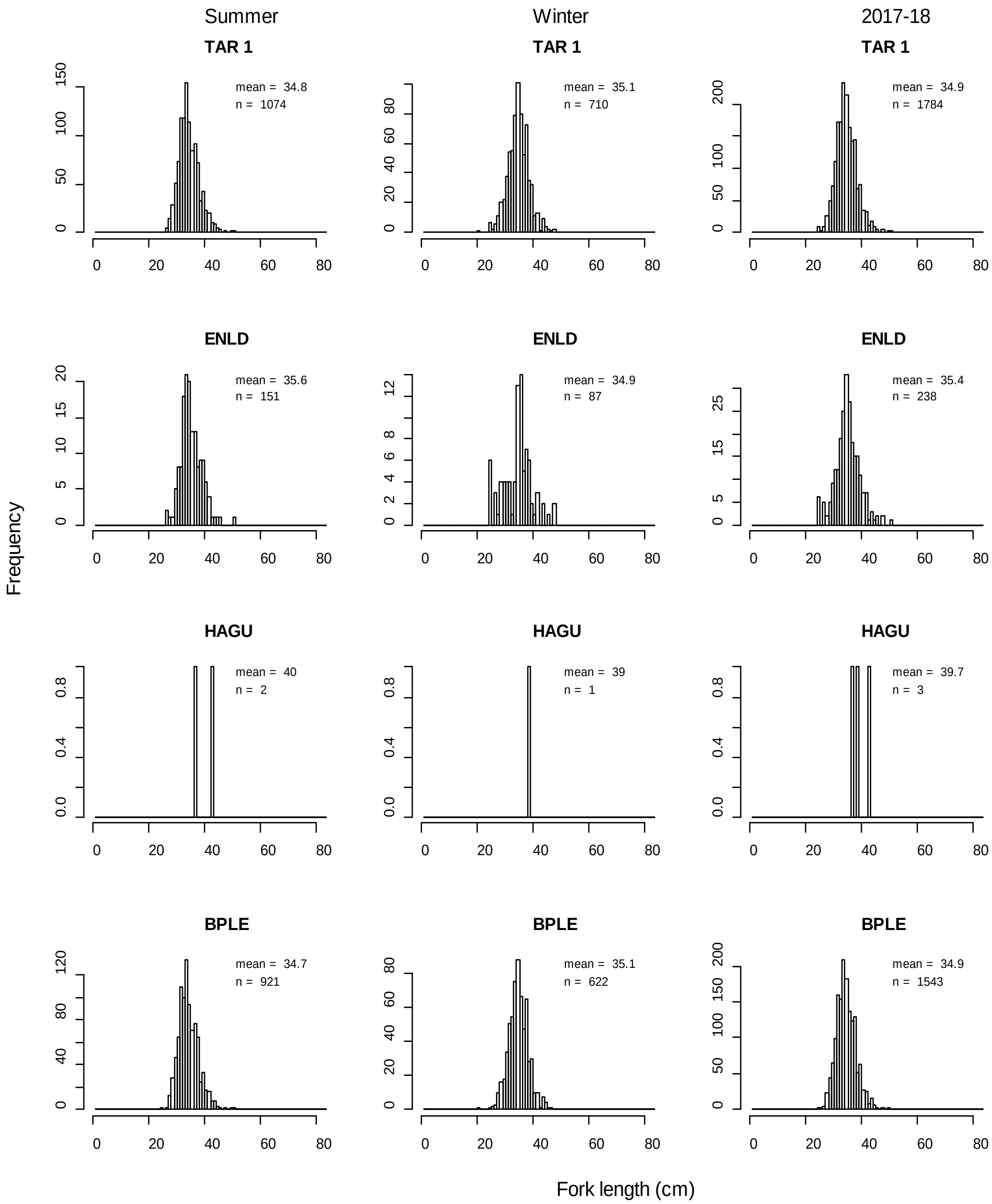

Figure 9: Length frequency distributions for tarakihi measured in TAR 1 by region and season.

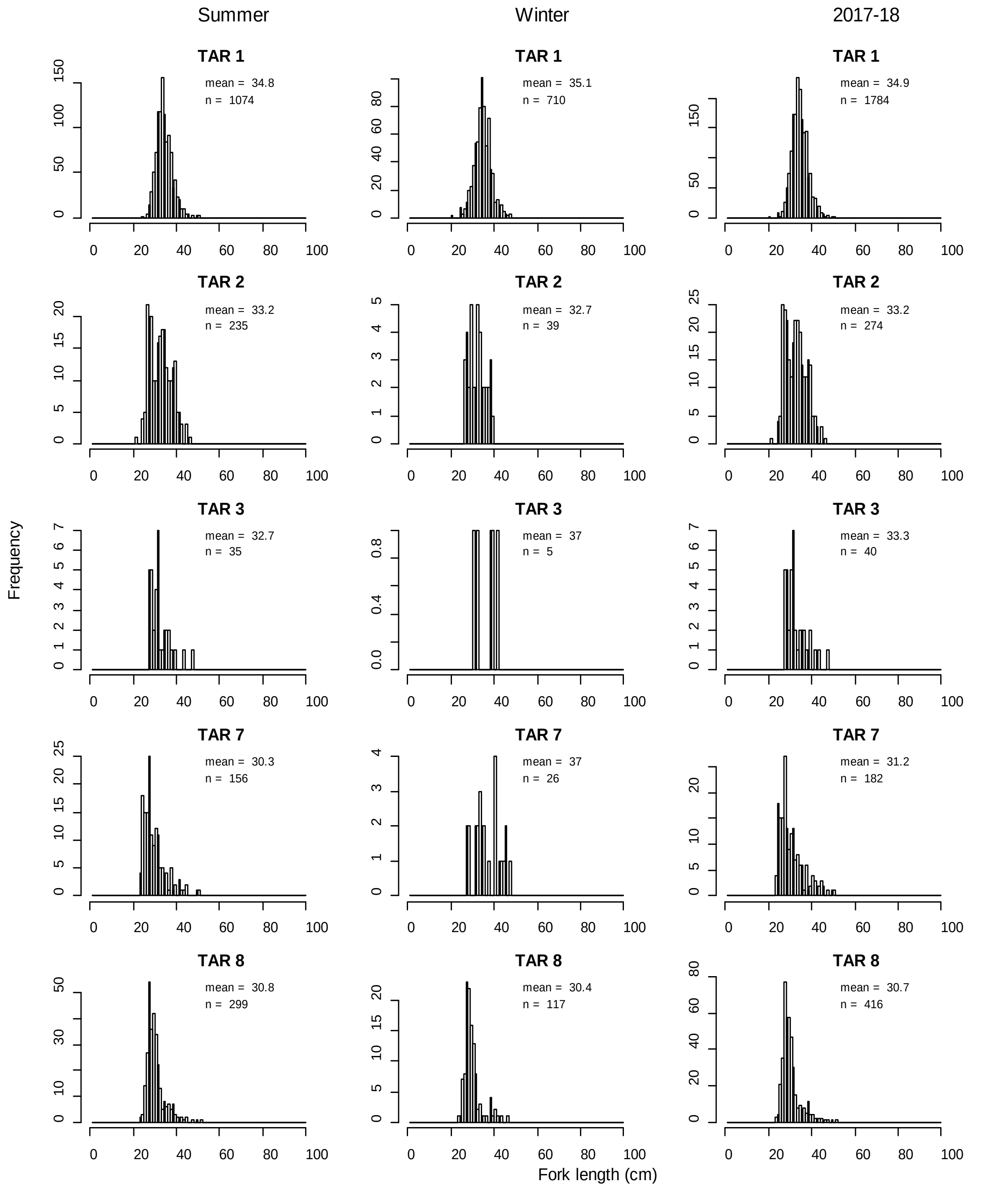

Figure 10: Length frequency distributions for tarakihi by QMA and season.

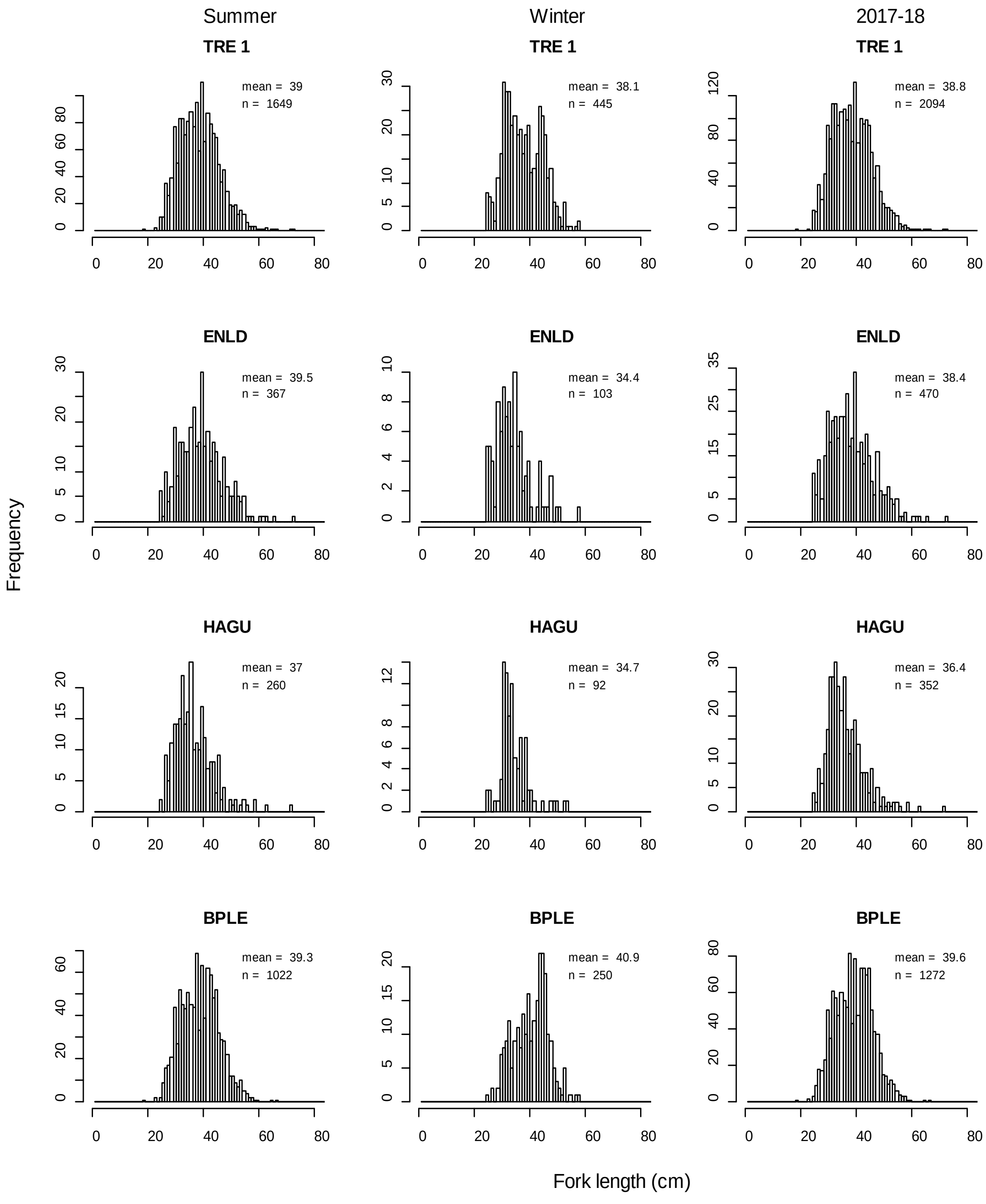

Figure 11: Length frequency distributions for trevally in TRE 1 by region and season.

4. DISCUSSION

Recreational fishers are not required to provide any information on their harvest despite accounting for a significant proportion of the overall take from many of New Zealand's fish stocks. The 2011–12 National Panel Survey (NPS) provided estimates of the number of recreationally caught fish, which were then combined with fish stock mean fish weight estimates provided by a concurrent creel survey (Hartill & Davey 2015) to provide estimates in tonnage of the recreational harvest, by QMA, of the 27 most commonly caught and landed fish throughout the country (Wynne-Jones et al. 2014). A second NPS has been conducted during the 2017–18 fishing year and the mean weight estimates presented here will be used to translate the estimates of numbers into a more useful harvest tonnage estimate. Additionally, we can compare the means weights and seasonality of the two surveys.

The fish length data presented in this research come from a variety of concurrent surveys which ran in the 2017–18 fishing year. The overall objectives of each of these concurrent surveys differed, but the methodology used to collect the fish length data was similar between all surveys. The most intensive sampling occurred in FMA 1 and the large amount of data gathered allowed us to calculate mean weights by region. Additional sampling for the rest of the country was generally targeted to surveying fishers at ramps for the sole purpose of providing fish lengths.

Creel surveys did not provide enough rock lobster measurements for robust mean weight estimates to be calculated for both fishing methods (potting and diving). A large number of additional measurements provided by commercial fisher logbooks and observers were therefore used to produce more informed mean weight estimates for the rock lobster stocks. These additional data sources are for pot caught fish only, however, and past work has shown that divers tend to take larger rock lobsters than those taken by recreational potting fishers. Further measurements of diver-caught fish are required to provide reasonably accurate estimates for areas where snorkelling and diving is predominantly used to take rock lobster.

Almost all the data used here has been collected from fishers fishing from boats, and although it is possible that shore-based fishers tend to catch larger or smaller fish of a given species, by far the majority of fishing overall is by boat based fishers. Also, almost all the data collected outside of FMA 1 has been collected on weekends and public holidays and during an afternoon time slot where expectations of encountering fishers were at their highest. In some instances, some interviewers conducted interviews during the week or earlier in the day, given prevailing weather forecasts and local knowledge (e.g. could see ramp from home). All the surveys and data collections ran throughout the year as the size structure and species composition of recreational landings from any area can potentially change throughout a year. As the main objective of most of the surveys outside FMA 1 were to get fish measurements we encouraged workers to utilise busy times on the ramp. Hartill et al. (1998) compared mean weights estimates for fish landed during weekends and during the week and found little differences between day type in either summer or winter.

The number of snapper measured in SNA 1 during the 2011–12 mean weight survey (Hartill & Davey 2015) was comparable to the number measured in this 2017–18 survey (69 698 in 2011–12; 53 428 in 2017–18), reflecting similar levels of sampling effort in both years. Overall the mean weight of snapper landed from SNA 1 in 2017–18 was notably higher than in 2011–12. This could be due to the increase in size limit from 27 cm to 30 cm in 2014.

A substantial number of snapper were also measured on the west coast of the North Island (SNA 8) in both surveys, with markedly different mean weights calculated in all three regions. Seasonal differences in mean weight estimates were more evident in 2017–18, when the winter mean weight estimates for the harbour and southern coast regions were significantly higher than the summer estimates. The mean weight estimates for snapper caught in harbours and on the north coast were higher in 2017–18 than in the 2011–12 survey whereas the south coast mean weight was slightly lower. Mean weights of SNA 2 and SNA 7 in 2017–18 were similar to the 2011–12 survey estimates, with no seasonal differences detected in either of the fishing years.

Kahawai was the second most commonly landed and measured fish in 2011–12 and 2017–18, with over 10 000 fish measured in both surveys. In 2017–18, substantial numbers of kahawai were landed and measured in all three regions of KAH 1, where the only significant seasonal difference in mean weight was in the Hauraki Gulf. In 2011–12 there were seasonal differences in mean weight in all three regions of KAH 1, and all FMA areas. Overall the 2017–18 weights were slightly higher than 2011–12.

The number of blue cod measurements taken in 2011–12 was higher than our current survey. This is in part due to data being available from two additional surveys in 2011–12, in FMA 3 (Kendrick et al. 2009) and in FMA 5 (Davey & Hartill 2011), as well as changes to the fishing rules for BCO 7. There were still a sufficient number of measurements obtained in 2017–18 to detect seasonal patterns in mean weights. Mean weight estimates in both survey years were similar, ranging from 430–610 g. In 2011–12 seasonal significance was detected in BCO 1, 5 and 7 whereas in 2017–18 seasonally statistically significant differences were detected for BCO 3 and 8. In BCO 7 there is a closed blue cod fishing season in the Marlborough Sounds for the period 1 September until 20 December, which has been in place since 2015. This means that there are almost 4 months during which blue cod were not landed from part of a key BCO stock, limiting the number of measurements available to inform summer and winter seasons in this area.

Over 2000 measurements are available for the GUR 1 stock with region GUR east accounting for over half of these in both survey years. There were seasonally different mean weight estimates in all three regions of GUR 1 in 2011–12. Mean weight estimates for red gurnard in GUR 1 tended to be higher during winter, which was again the case in 2017–18. There were no major differences in mean weights between survey years.

Bradford (1996) suggested that at least 1000 measurements are required to detect a 100 g weight difference over time. Apart from snapper, the only species for which at least 1000 measurements were available were tarakihi and trevally. Obtaining this many measurements for most other recreationally caught species would be prohibitively expensive. Our boat ramp interviewers are required to measure all species that are landed, not just the species associated with a specific objective, so we have as much data as is able to be collected.

Additional individual fish measurement data are also available for rock lobster from commercial fishers using pots with similar escapement sizes. Separate mean weight estimates were calculated for rock lobster caught by divers and by fishers using pots, as an analysis of data collected during the 2011–12 mean weight survey highlighted the fact that divers tend to take larger rock lobster on average than those taken by pot fishers. The mean weight estimates for diver caught fish in 2017–18 were once again larger than those caught by fishers using pots. Possible explanations for this are that divers can potentially target larger fish because more fish are encountered, and because pot caught fishers are more likely to carefully measure and take fish when they are close to the minimum legal size limit.

Interviewers measure individual fish rather than weighing them, because this approach is quicker and length frequency data have many other additional purposes such informing size limits and bag limit allocations. Here we have used existing published length-weight relationships for all the quota species for which 50 length measurements were available, and for albacore and skipjack tuna. Hartill & Davey (2015), prompted by reviewers of this research in 2011–12, carried out an additional review of the merits of non-linear and linear regressions of length-weight relationships. Data were available for comparisons for three species (kahawai, blue cod and scallops) and the choice of regression method had very little influence on the accuracy of mean weight estimates. We therefore continue to use the same length-weight relationships as were used for the 2011–12 survey (Hartill & Davey, 2015). Reviewers did recommend that up to date length and weight data should be collected in a seasonally and spatially representative manner as important changes in fish populations may have occurred in recent years, but this recommendation fell outside of the objectives set for this survey.

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APPENDIX 1: Commercial logbook and observer mean weight data and estimates which were used for some rock lobster stocks.

1. Paul Starr used the following procedure:

    a. All LF data are organised in 2 mm bins of tail width (TW). The file I am working with has been processed for the stock assessment, which means that the LF data have been rolled up by data source, season and sex, with weights based on catch, number of samples and number of length observations. The weighting procedure is described in Section 4 of Starr & Webber (2018).

I calculated the weight associated with each TW length bin using fixed sex-specific length-weight parameters which are in regular use in all the CRA stock assessments

(Table 1). These parameters were generated from data collected in the late 1980s/1990s and have not been updated since then.

Eq. 1 $$W_l^s = A^s T_l^{B^s}$$

where T_l is the mid-point of length bin *l*.

    b. The mean weight is the sum of the weight associated with each TW length bin multiplied by the sample weight associated with that bin, divided by the summed sample weight. This calculation is done by sex at or above the recreational minimum legal size (MLS) for males (54 mm) and females (60 mm):

Eq. 2 $$\bar{W} = \frac{\sum_{s=1}^{2} \sum_{l=\mathrm{MLS}_s}^{l_{\max}} \sum_{c=1}^{2} v_{c,l}^s W_l^s}{\sum_{s=1}^{2} \sum_{l=\mathrm{MLS}_s}^{l_{\max}} \sum_{c=1}^{2} v_{c,l}^s}$$

Note that I am combining the two data sources (subscript *c*) at this point (logbook and observer catch sampling) where they co-exist. I did this to reduce the complexity of the calculations and to make up for situations when the data from one or other of the sources are poor (see Table 2)

    c. I have left out the step where I combine the immature and mature females into a single sex.

2. Table 2 shows, for period 146, the sample weight associated with each 2 mm TW length bin, summed across sexes but separated out by CRA QMA and sample source. Period 146 is for the SS (spring-summer) season in 2017–18, which runs from 1 October 2017 to 31 March 2018, coinciding with the summer season of the LSMS survey. I am providing this level of detail to show what data are available and how much is associated with each data source.

3. Table 3 provides the calculated mean weights and number of length observations above the MLS for each CRA QMA in period 146.

Table 1: Length-weight parameter values used in the rock lobster stock assessments by CRA QMA. Converts to kg. The CRA 9 parameters are assumed as this QMA has never had a formal length-based stock assessment. The CRA 6 parameters are from the 2018 stock assessment but are based on samples collected in 1996 and 1997.

	Males		Females	
	A	B	A	B
CRA 1	0.00000416	2.9354	0.0000130	2.5452
CRA 2	0.00000416	2.9354	0.0000130	2.5452
CRA 3	0.00000416	2.9354	0.0000130	2.5452
CRA 4	0.00000416	2.9354	0.0000130	2.5452
CRA 5	0.00000416	2.9354	0.0000130	2.5452
CRA 6	0.000000678	3.3613	0.00000989	2.6199
CRA 7	0.00000339	2.9665	0.0000104	2.6323
CRA 8	0.00000339	2.9665	0.0000104	2.6323
CRA 9	0.00000339	2.9665	0.0000104	2.6323

Table 2: Sample weights by TW length bin combined across sexes for sampling period 146 (SS 2017–18), separated by sampling source and CRA QMA. LB: logbook samples; CS: observer catch sampling samples

	CRA 1		CRA 2		CRA 3		CRA 4		CRA 5		CRA 6		CRA 7		CRA 8		CRA 9	
TWC	LB	CS	LB	CS	LB	CS	LB	CS	LB	CS	LB	CS	LB	CS	LB	CS	LB	CS
30	–	–	0.002	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
32	–	–	–	–	–	–	–	–	–	–	0.059	–	–	–	0.001	–	–	–
34	0.005	–	–	–	–	0.005	0.013	0.000	0.004	–	–	–	–	0.001	–	–	–	–
36	–	–	–	–	–	0.006	–	0.001	–	–	–	–	–	–	–	–	–	–
38	0.007	0.002	0.019	–	0.012	0.022	0.011	0.004	0.010	–	–	–	–	0.008	0.002	–	–	–
40	0.041	0.002	0.010	–	–	0.059	0.032	0.004	0.005	–	–	–	–	0.049	0.004	–	–	–
42	0.045	0.007	0.007	–	0.115	0.141	0.022	0.029	0.004	–	–	–	–	0.134	0.005	–	–	–
44	0.111	0.002	0.024	–	0.270	0.246	0.049	0.051	0.026	–	0.002	–	–	0.329	0.025	–	–	–
46	0.110	0.015	0.041	0.008	0.613	0.484	0.097	0.117	0.050	–	–	–	–	0.709	0.085	–	–	–
48	0.176	0.020	0.175	0.019	1.661	0.958	0.269	0.277	0.100	–	0.021	–	–	1.024	0.199	–	–	–
50	0.304	0.037	0.636	0.072	2.567	1.646	1.447	1.016	0.244	–	0.098	–	–	1.222	0.812	–	0.006	–
52	0.424	0.062	1.959	0.129	4.463	1.493	7.517	2.130	1.439	–	0.174	–	–	1.379	2.026	–	0.004	–
54	0.325	0.094	1.910	0.124	2.224	0.880	4.285	1.522	1.104	–	0.216	–	–	1.118	2.251	–	–	–
56	0.404	0.139	2.339	0.168	1.577	0.499	2.834	1.517	1.420	–	0.206	–	–	0.735	2.753	–	–	–
58	0.493	0.215	2.993	0.196	1.083	0.335	4.432	2.156	1.868	–	0.283	–	–	0.498	2.373	–	0.002	–
60	0.467	0.164	1.831	0.181	0.636	0.228	1.880	1.311	1.500	–	0.471	–	–	0.304	2.161	–	0.026	–
62	0.445	0.173	1.550	0.125	0.419	0.109	0.851	0.429	2.237	–	0.328	–	–	0.126	1.610	–	0.027	–
64	0.588	0.184	1.058	0.135	0.263	0.090	0.324	0.159	1.756	–	0.384	–	–	0.100	1.182	–	0.056	–
66	0.354	0.157	0.585	0.097	0.146	0.051	0.115	0.070	1.348	–	0.265	–	–	0.066	0.976	–	0.085	–
68	0.374	0.149	0.630	0.056	0.051	0.024	0.096	0.052	1.018	–	0.256	–	–	0.050	0.699	–	0.098	–
70	0.627	0.133	0.477	0.074	0.039	0.019	0.075	0.037	0.829	–	0.417	–	–	0.042	0.608	–	0.092	–
72	0.268	0.096	0.277	0.032	0.019	0.010	0.090	0.026	0.777	–	0.154	–	–	0.030	0.463	–	0.037	–
74	0.659	0.070	0.264	0.028	0.017	–	0.088	0.017	0.708	–	0.271	–	–	0.050	0.489	–	0.157	–
76	0.308	0.057	0.138	0.022	0.012	0.000	0.023	0.013	0.574	–	0.083	–	–	0.051	0.397	–	0.069	–
78	0.337	0.029	0.182	0.009	0.006	–	0.018	0.007	0.564	–	0.031	–	–	0.051	0.323	–	0.036	–
80	0.534	0.012	0.087	0.011	–	0.004	0.010	0.004	0.484	–	0.135	–	–	0.049	0.263	–	0.078	–
82	0.084	0.012	0.036	0.010	–	–	0.008	0.006	0.381	–	0.050	–	–	0.036	0.139	–	0.009	–
84	0.181	0.009	0.032	0.004	–	–	0.002	0.007	0.320	–	0.123	–	–	0.041	0.114	–	0.004	–
86	0.040	–	0.002	–	–	–	0.002	0.003	0.126	–	0.152	–	–	0.028	0.047	–	0.003	–
88	0.020	0.004	0.002	0.002	–	–	–	–	0.112	–	0.037	–	–	0.021	0.038	–	–	–
90	0.145	–	0.015	0.000	–	–	0.005	0.000	0.094	–	0.016	–	–	0.025	0.008	–	–	–
92	0.008	–	–	–	–	–	–	–	0.058	–	0.032	–	–	0.017	0.007	–	–	–
94	0.089	–	–	–	–	–	–	–	0.018	–	0.047	–	–	0.009	0.008	–	–	–
96	0.023	–	–	–	–	–	–	–	0.009	–	0.043	–	–	0.012	0.003	–	–	–
98	0.023	–	–	–	–	–	–	–	0.010	–	0.016	–	–	0.006	0.011	–	–	–
100	0.005	–	–	–	–	–	–	–	–	–	–	–	–	0.009	–	–	–	–
102	–	–	–	–	–	–	–	–	–	–	0.013	–	–	0.004	–	–	–	–
Total	8.025	1.842	17.280	1.502	16.192	7.307	24.597	10.969	19.198	.	4.382	.	.	8.334	20.080	–	0.790	–

Table 3: Calculated mean weight (kg) by CRA QMA for period 146 (SS 2017–18) using Eq. 2, with T_l the mid-point of length bin *l* in Eq. 1. Also shown are the number of length observations above the sex-specific MLS for each mean weight estimate.

QMA	$\bar{W}_q$	N_q
CRA 1	0.817	2 091
CRA 2	0.588	2 285
CRA 3	0.531	2 716
CRA 4	0.502	8 858
CRA 5	0.625	4 190
CRA 6	0.830	564
CRA 7	0.657	1 471
CRA 8	0.654	6 921
CRA 9	0.852	268

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