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Data for the 2014 stock assessment of red rock lobsters (*Jasus edwardsii*) in CRA 3

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EXECUTIVE SUMMARY

This document presents data for use in the 2014 stock assessments and management procedure evaluations for rock lobsters in CRA 3. Data sets described in this report include catch estimates for all sectors of this fishery, standardised CPUE indices, length frequency distributions, tag-recapture data and puerulus settlement data.

Catch estimates are provided for the commercial, recreational, customary and illegal fisheries, collated by year to 1978 and then by season (spring-summer and autumn-winter), and by size-limited and non-size-limited fisheries. Recreational catch estimates were available from telephone/diary surveys in 1992, 1996 and from a recent large scale multi-species survey conducted using a population-based survey methodology. It was assumed that recreational catch has been proportional to spring-summer CPUE, and the method used in recent assessments was used to estimate recreational catches from 1979.

CPUE was standardised for the spring-summer and autumn-winter seasons. The F2 algorithm, which uses a truncated distribution of "vessel correction factors" to adjust estimated catches to final catch, was used to prepare the catch and effort data. The destination codes "X" (discarded at sea) and "F" (Section 111 recreational catches) were added to the destination code "L" (landed to an LFR) to obtain the final catch total for scaling the estimated catches.

Length frequency data were available from both observer catch sampling and voluntary logbook programmes. These were collated by data source and by season, and the document describes how the various records were weighted. Tag-recapture data provide strong information on growth rates for each sex. The document describes the data set and exploratory fits. The time series of puerulus settlement data was standardised for exploration by the stock assessment model.

This work was conducted by a stock assessment team contracted by the New Zealand Rock Lobster Industry Council Ltd.

1. INTRODUCTION

This work addressed parts of Objective 4 of the Ministry for Primary Industries (MPI) contract CRA2012-01B. This three-year contract, which began in April 2013, was awarded to New Zealand Rock Lobster Industry Council Ltd. (NZ RLIC Ltd.), who sub-contract Objective 4 to the authors of this report.

Objective 4 - Stock assessment: To estimate biomass and sustainable yields for rock lobster stocks

The National Rock Lobster Management Group (NRLMG) determined that both CRA 1 and CRA 3 should be assessed in 2014. Data were compiled for both stocks by a team comprising Paul Starr, D'Arcy Webber and Paul Breen. CRA 1 was then assessed by Paul Starr and D'Arcy Webber, and CRA 3 was assessed by Vivian Haist, Paul Breen and Charles Edwards, with close communication and discussion between the two teams. New graphic routines were developed by D'Arcy Webber and Charles Edwards. This document is limited to the data for CRA 3 and describes catches – including catches commercial, recreational, customary and illegal – CPUE, length frequencies, tag-recapture data and puerulus settlement data.

The previous stock assessment of CRA 3 was in 2008 (Breen et al. 2009a). Operational management procedures (MPs) were developed for CRA 3 in 2009 (Breen et al. 2009b) in a procedure that was essentially a fresh stock assessment.

Decisions on data and modelling choices were discussed and approved by the Rock Lobster Fishery Assessment Working Group (RLFAWG). For definitions of technical terms used here see the Glossary in the CRA 3 assessment description (Haist et al. 2015).

The CRA 3 fishery extends from East Cape south to the Wairoa River (see Figure 1). The current 389.95 t TAC comprises allowances of 20 t for recreational catch, 20 t for customary harvest, 89 t for illegal removals and a TACC of 260.95 t distributed among 43 quota share owners. In 2013–14 25 vessels reported CRA 3 landings. There is significant Iwi involvement in quota share ownership and fishing and rock lobsters have great cultural significance to local Maori. The commercial harvest has an approximate landed value of $18.3 million based on average port price. There are two processing plants in Gisborne and product is also shipped to Wellington, Tauranga and Auckland for processing and export.

2. CATCH ESTIMATES

For commercial catches, the fishing year and calendar year were the same before 1979. From 1979 onwards, the fishing year has been April through March (Breen et al. 2001). Reported annual commercial catches from 1945 through 1978, summarised by calendar year, were obtained from sources described in Bentley et al. (2005). From 1 January 1979 through 31 March 1986, catches were taken from monthly data summarised by fishing year from the Fisheries Statistics Unit (FSU), a version of which is now held by MPI. The three months of catch from January through March 1979 were added to the 1978 annual total to ensure that no catch was lost when switching from calendar year to fishing year.

For 1 April 1986 through 30 March 1988, monthly reported catch totals from all of New Zealand were obtained from Quota Management Returns (QMRs), maintained by MPI. Because catch estimates for individual QMAs were not available for this period, these total New Zealand catches were divided into QMA catches based on the proportional landings reported on FSU forms. From 1 April 1988 through 30 September 2001, catches were summarised from monthly QMRs from each QMA. The QMRs were replaced by Monthly Harvest Returns (MHRs) on 1 October 2001, but the same information is available from these newer forms.

There is uncertainty in the quality of the catch estimates in the years before the FSU system began in 1979, but catches in the 1980s were collected when the FSU system was operating and there is confidence in the quality of these estimates. Catch estimates generated from the FSU data available to the stock assessment team are consistent with published historical catch estimates from the FSU system.

Annual commercial catches in CRA 3 averaged 119 t before 1979, with a short period in the late 1960s when catches exceeded 250 t/year (Figure 2). CRA 3 commercial catches were higher in the period leading up to the introduction of rock lobster into the QMS (1979–1987), with catches peaking at 763 t in 1983–84 and averaging 575 t during that decade. Commercial catches in CRA 3 were less than the TACC until 1993 (Figure 3), when a suite of new management measures was introduced, including a greatly reduced TACC. Catches also were less than the TACC in the early 2000s, partly because of shelving by fishers before the TACC was reduced.

2.1 CRA 3 Recreational catch

Five annual recreational catch estimates are available for CRA 3 (Table 1). The estimates from the two Kingett Mitchell National Surveys in 2000 and 2001 (Boyd & Reilly 2004; Boyd et al. 2004) have never been accepted by the RLFAWG. because they were thought to be biased (unpublished minutes: Recreational Technical Working Group [Auckland NIWA, 10–11 June 2004]).

The recreational catch vectors prepared for this assessment assume that recreational catch is proportional to the SS abundance as reflected by SS CPUE. The standardised SS CPUE vector was calculated based on the F2 algorithm (see Starr 2013) using combined "L", "F" and "X" destination codes. This was then scaled to the mean catch from the 1992, 1996 and 2011 recreational surveys.

A recently completed national recreational survey (Wynne-Jones et al. 2014) provided an estimate of the CRA 3 recreational catch for 1 October 2011 through 30 September 2012. Most of the recreational catch is taken during the spring-summer season (SS, October through March), so this estimate was assigned to the 2011–12 fishing year. The RLFAWG has the most confidence in this estimate among the five available recreational catch estimates.

MPI were asked to provide estimates of current and historical recreational catches and an appreciation of their uncertainty (see Appendix A); MPI were unable to provide these estimates (see Appendix B).

The recreational catch vectors prepared for this assessment assume that recreational catch is proportional to the SS abundance as reflected by SS CPUE. The standardised SS CPUE vector was calculated based on the F2-LFX algorithm (see Starr 2013), then scaled to the mean catch from the 1992, 1996 and 2011 recreational surveys (Figure 4) by calculating the ratio of the survey catch estimate in each year to the respective SS CPUE. The mean of these ratios was then applied to the SS CPUE for all years from 1979–2013. Catch in 1945 was assumed to be 20% of that estimated for 1979 and was scaled proportionally for 1946 through 1978. This procedure is analogous to that used in recent assessments.

The resulting base case recreational catch vector is shown in Figure 4 after adding to each year the maximum reported recreational landings (2.94 t) from commercial vessels under Section 111 of the Fisheries Act. Recreational catch was split between seasons with 90% assumed taken in the SS and the remainder in AW. The mean annual recreational catch for the period 1979–2013 from this vector was 11.7 t. For sensitivity trials, an alternative recreational vector was created with twice the base case values.

2.2 CRA 3 Customary catch

MPI were asked to provide estimates of current and historical customary catches, and an appreciation of their uncertainty (see Appendix A). The information was very incomplete (see Appendix B). MPI advised that a constant customary catch of 20 t should be assumed. This was split between seasons with 90% assumed taken in the SS.

2.3 CRA 3 Illegal catch

MPI were asked to provide estimates of current and historical illegal catches, and an appreciation of their uncertainty (see Appendix A). MPI were also asked to provide an estimate of the proportion of illegal catch that was eventually reported as legal catch.

MPI suggested that 89.5 t should be assumed from 2004 onwards. Accordingly, a constant illegal catch of 89.5 t/year was used to fill in the missing years (Table 2) from 2004 to 2013. Missing years between 1990 and 2003 were filled in by interpolation. The MPI Compliance estimates for illegal catch were sometimes provided in two categories per QMA by year (Table 2). Missing categories were treated as zeroes by MPI Compliance and we have continued this practice. The category of "commercial illegal reported" or "reported" is assumed to represent illegal commercial catch that is eventually reported to the QMS as legitimate catch; this catch is subtracted from the reported commercial catch to avoid double-counting. A constant value of 4.48% (the mean of the years with reported and unreported estimates) was applied to the total illegal catch estimate in the years with missing illegal estimates to estimate the proportion that is eventually reported to the QMS.

The following procedure was used to estimate illegal catch:
- Starting with the estimates of export discrepancies for all of New Zealand for 1974–80 (McKoy, unpublished data), the CRA 3 illegal catches for each of these seven years were estimated from the ratio of the reported commercial catch in CRA 3 relative to the total New Zealand reported commercial catch for the same years.
- The average ratio of the export discrepancy catch to the reported commercial catch was calculated for the period 1974–80. This ratio was used to generate an illegal catch estimate for all years with no data (1945 through 1973 and 1981 through 1989) by multiplying the reported catch by the average ratio. This approach was agreed by the RLFAWG on 15 Aug 2002.
- Beginning with 1990, the first year for which estimates were provided by QMA, illegal catch was based on MPI Compliance estimates (Table 2). For years without Compliance estimates, the level of illegal catch was interpolated between estimates.
- Estimates for "commercial illegal reported" (shown as "reported" in Table 2) are used to split the illegal catch into the "SL illegal" and "NSL illegal" categories (see the next section).
- We assumed that both the reported and unreported annual illegal catches were distributed between seasons in the same proportion as the commercial catch for each year.

The illegal catch estimates are shown in Figure 5.

2.4 Size-limited and non-size-limited catch by season

The size-limited (SL) catch is taken under the MLS regulations and the restriction on landing berried females; it is the sum of the commercial and recreational catches minus the reported illegal catches. The non-size-limited (NSL) catch is taken without regard to those restrictions; it is the sum of reported and unreported illegal catches and the customary catches. Annual commercial catches were divided into seasons from 1979 onwards based on the FSU and QMR/MHR data. Illegal catches were divided in the same proportions as commercial. It was assumed that 90% of the customary and recreational catches were taken in SS. These catches are shown in Figure 6 and Table 3.

3. CATCH RATES

Catch and effort data were obtained from MPI in September 2014 (replogs 9650 and 9742), loaded into the CRACE database and processed using standard error checks (Bentley et al. 2005). Data spanned the period 1 April 1979 through 31 March 2014 and originated from the FSU and CELR.

Data preparation used the "F2" algorithm, which corrects the monthly estimated catch taken by a vessel in a statistical area using a truncated distribution of "vessel correction factors" (VCF: ratio of landed catch to estimated catch for one vessel in a year) (Starr 2013). The F2 algorithm used 0.8 and 1.2 as lower and upper bounds for the observed VCF distribution, discarding data from vessels outside these bounds in each year. The F2 algorithm scales the estimated catches from each vessel to the combined "L" (LFR) landings, the "X" (discarded to sea) and "F" (Section 111 recreational catch) destination codes using the annual VCF for that vessel.

These analyses estimated separate [month] effects in each half-year period by using as the reference month the month in each period with the lowest standard error (Starr 2014).

The CPUE standardisation procedure used sequential six-month periods as the time-dependent explanatory variable. Three other explanatory variables were available for this analysis: [month] of capture, [statistical_area] of capture and [vessel]. The first two variables were offered as categorical explanatory factors, but [vessel] was not used, although Starr (2012) showed that [vessel] was potentially an important factor. Vessel codes have not been consistently maintained between the FSU and CELR data systems, so using vessel would require estimating separate CPUE series unless the vessel codes could be reconciled. Using [month] and [statistical_area] as explanatory variables is consistent with analyses done for all previous rock lobster stock assessments.

3.1 CRA 3 Seasonal standardised CPUE

The number of records available by year for this analysis shows a considerable drop over the 35 years since 1979, particularly in the SS season in the late 1990s when the AW catch rates were very high (Table 4). The final model explained 51% of the deviance, with most of the explanatory power lying in the sequential period variable, followed by month and statistical area (Table 5).

CRA 3 CPUE indices are shown in Figure 7 and Table 6. The standardised CPUE had generally the same trends as the arithmetic CPUE (annual catch divided by annual effort) and the unstandardised CPUE (geometric mean of the monthly records), particularly in the AW season. Residual diagnostics are shown in Figure 8 and the month and area effects in Figure 9. CPUE peaked in 1998, fell to much lower values in the mid-2000s and then recovered to late 1990s values.

3.2 Historical catch rate (CR)

Monthly catch and effort (days fishing) data from 1963 through 1973 were summarised by Annala & King (1983) and used to calculate unstandardised catch per day for each calendar year from 1963 to 1973 (Figure 10).

4. LENGTH FREQUENCY DISTRIBUTIONS (LFs)

Data were extracted in September 2014; they comprised both observer and voluntary logbook catch sampling from 1986 through 2013.

4.1 LF records and record weighting

Each data record compiled for input to the model was from either voluntary logbook or observer catch sampling, and contained all the data from either the AW or SS season in one year. After elimination of logbook records from fewer than three participants and records with fewer than 100 fish measured, there were 59 records, mostly (50) from the observer program.

Record fields were:
- QMA (all CRA 3)
- fishing year
- season (coded 1 for autumn winter AW, April through September, 2 for spring summer SS)
- source (in these data: coded 1 for logbooks and 2 for observers; there were no data from market sampling or other old codes)
- a relative weight field for the record (w), described below
- the total number of lobsters measured
- 31 fields, representing the relative proportion (see below) of males measured by sex class, where the first size class is 30–31.9 mm tail width (TW), the next is 32–33.9 mm, etc.
- 31 fields for immature female numbers measured
- 31 fields for mature female numbers measured.

Records contained from 159 to 26 724 fish measured and averaged 8662 fish. The proportion of males ranged from 30% to 96% and averaged 75%, immature females from 0% to 6%, averaging 1%, and mature females from 4% to 70%, averaging 24%.

Each record comprised measurements taken from various months within the period and from various statistical areas within the QMA. For each month/area cell, the numbers-at-length were summed for each sex, and the proportion-at-sex was calculated as:

$$p^g_{m,a,s} = \frac{N^g_{m,a,s}}{\sum_g \sum_s N^g_{m,a,s}}$$

where g indexes sex, s indexes size group, m indexes month, a indexes statistical area and $N^g_{m,a,s}$ represents the number-at-length for each sex in the month/area cell.

Proportions-at-length from the month/area cells were combined to form a record, and their "representativeness" was used, i.e. using the catch in the month/area cell ($C_{m,a}$) compared with the total catch for the season:

$$P^g_s = \frac{\sum_m \sum_a \left(C_{m,a} p^g_{m,a,s}\right)}{\sum_m \sum_a \sum_s \sum_g \left(C_{m,a} p^g_{m,a,s}\right)}$$

where P^g_s is the relative proportion-at-length for each sex in the record. The model re-normalises these to sum to 1 across the record or across each sex, depending on the choice of fitting procedure (see Starr et al. 2014).

As well as the relative weight assigned to the overall LF dataset, a relative weight (w) was assigned to each data record within the dataset which combined the representativeness of each month/area cell, the cube root of the number of fish measured ($N_{m,a}$) and the cube root of the number of days sampled ($D_{m,a}$):

$$w = \sum_m \sum_a \frac{C_{m,a} \sqrt[3]{N_{m,a}} \sqrt[3]{D_{m,a}}}{\sum_m \sum_a C_{m,a}}$$

The individual weights given to records ranged from 0.25 to 150.2 and averaged 18.1. These weights were constrained to be lie between 1 and 10 when used in the model.

4.2 Proportion by sex

Sex proportions were calculated from the normalised data records. Immature females were in low proportion (Figure 11). In most records, males were a much higher proportion than were mature females, but mature females were a high proportion in the earliest few records and in the SS near 2000.

4.3 Mean length

Mean length was also calculated from the data records (Figure 12). Mean length of AW males showed a clear increase to a peak of about 61 mm TW in 1999 or 2000, followed by a decline of about 5 mm. Males in SS do not show a clear pattern.

4.4 Binning

Although the model contains size bins from 30 to 92 mm TW, few fish as small as 30 mm are measured, and very few large fish are measured, especially immature females, leading to many cells with zero observations. For sex/size bins with few observations, the model would be comparing many zero observations with very small predictions, resulting in a large population of very small residuals that distort the diagnostics, as well as taking up computing time.

Bins at both ends of the range for each sex were therefore combined into "plus" and "minus" bins. The model was therefore given the length range of bins for each sex that contained a reasonable number of observations. These bins were determined arbitrarily by inspecting the proportion of cells in each sex/size bin that contained a minimum proportion of normalised observations. The threshold was set at 0.001, but the procedure was not very sensitive to the chosen value. Figure 13 shows the cumulative distribution of sex/size bins: 40% were zero.

Figure 14 suggested the appropriate binning: males should be fitted for 32–77 mm TW, mature females for 34–77 mm TW and immature females for 36–63 mm. For each sex, smaller and larger bins were combined to form plus and minus bins.

4.5 Length frequency (LF) distributions

The distributions of the LF data by sex are shown for each data record included in the stock assessment, where a "data record" represents the summarised frequency in a sequential six-month season by data source (logbook or observer) (Figure 15).

5. TAG-RECAPTURE DATA

Tag release and re-capture data for CRA 3 were extracted in September 2013 and processed with purpose-built software developed by Nokome Bentley (Trophia, unpublished). This software matches recaptures to releases, treating re-recaptures as having been released from the previous recapture. It calculates TW from CL where necessary, using relations developed in the Breen et al. (1988)

morphometrics program. It discards records with missing tail widths at release or recapture, records with inappropriate sex codes or apparent sex changes, discards records with apparent shrinkage greater than 10 mm or with an increment greater than 40 mm and records with time at liberty less than 31 days.

The screened MPI tag-recapture data extract for CRA 3 comprised 4188 records: 3059 males and 1129 females. There were also 139 recaptures from fish tagged outside the marine reserve, supplied by Debbie Freeman of DoC: 132 males and 7 females. An additional 924 DoC tags released inside the marine reserve were not used because the high density inside the reserve is likely to have reduced growth in these fish despite a positive marine reserve effect on growth (Freeman et al. 2012).

Sizes at release by sex from the combined data set are shown in Figure 16. The records peak near the SS MLS (54 mm TW) for males while there are a substantial number of female releases above the MLS (60 mm TW).

Releases were made in 1975–81 with western rock lobster tags and 2001–13 with HallPrint tags (Table 7). The early releases had size recorded in carapace length and the later releases used tail width. Roughly two-thirds of the tags were released in area 910 (Table 8) and nearly all tags remained in the area of release (Table 9).

Times at liberty varied from 31 days to 2840 days (8 years), but the median was 195 days and 79% were at liberty for less than one year and 97% less than two years. One fish was re-released four times (Table 10), but 96% of records were from fish that were not re-released. Condition codes were nearly all zero or missing.

Increments (size at recapture minus size at release) ranged from -9.6 to 23.3. For exploration only (not for use by the model), increments were "annualised" based on days at large:

$$\Delta l_i^{ann} = \frac{365\left(l_i^{rec} - l_i^{rel}\right)}{d_i}$$

where Δl_i^{ann} is annualised increment for the ith record, l_i^{rel} and l_i^{rec} are the sizes at release and recapture and d_i is the number of days at liberty. Annualised increments ranged from -68 to 105, and are shown for males and females in Figure 17.

6. PUERULUS SETTLEMENT DATA

The puerulus settlement program, conducted by NIWA, is described in annual reports (e.g. Forman et al. 2013). For CRA 3, the only site used is Gisborne itself. Since 1978, 10 groups of collectors have been used, but no group has been used continuously. Group 002 has been sampled from 1991 through the present; group 003 from 1993 through 2006 and group 004 from 1994 through the present. These three groups have been used by NIWA to calculate a series of annual settlement indices using a GLM standardisation procedure. Group 001, which was sampled from 1987 through 2003, had been discarded by NIWA because the settlement was thought to be "anomalously high compared to other groups" (Forman et al. 2013). However, the RLFAWG agreed that this group should be included in the standardisation because it extended the series back from 1991 to 1987. The RLFAWG agreed that other groups were of too short duration to be useful.

Puerulus settlement data were organised by fishing year. Only the months May through September were used because of low settlement outside that period. Year, month and collector group were used as explanatory variables, and standardisation used negative-binomial likelihood (Andy McKenzie, NIWA, pers. comm.).

Results are shown in Figure 18. Standardisation reduced the early indices because they were based on group 001 only, which was higher than the other groups when they overlapped. Diagnostics from the standardisation are shown in Figure 19 and Figure 20.

7. ACKNOWLEDGEMENTS

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Table 1: CRA 3 recreational survey estimates.

Year	Number	Mean weight	Weight (kg)
1992	8 000	0.534	4 272
1996	27 000	0.534	14 418
2000	270 000	0.543	146 610
2001	215 000	0.543	116 745
2011	13 912	0.580	8 069

Table 2: Available estimates of illegal catches (t) by QMA from 1990, as provided by MPI (formerly MFish) Compliance over a number of years. R (reported): illegal catch that will eventually be processed though the legal catch/effort system; NR (not reported): illegal catch outside of the catch/effort system. Cells without data or missing rows have been left blank.

Year	CRA 1 R	CRA 1 NR	CRA 2 R	CRA 2 NR	CRA 3 R	CRA 3 NR	CRA 4 R	CRA 4 NR	CRA 5 R	CRA 5 NR	CRA 6 R	CRA 6 NR	CRA 7 R	CRA 7 NR	CRA 8 R	CRA 8 NR	CRA 9 R	CRA 9 NR
1990		38		70		288.2		160.1		178		85	34	9.6	25	5		12.8
1992		11		37		250		30		180		70	34	5	60	5		31
1994		15		70	5	37		70		70		70		25		65		18
1995		15		60	0	63		64		70		70		15		45		12
1996	0	72	5	83	20	71	0	75	0	37	70	0	15	5	30	28	0	12
1997					4	60												
1998					4	86.5												
1999					0	136								23.5		54.5		
2000					3	75		64										
2001		72		88	0	75												
2002					0	75	9	51		40		10		1		18		1
2003					0	89.5			5	47								
2004							10	30										
2005																		
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2011														1		3		
2012																		
2013																		

Table 3: Estimated CRA 3 catches (commercial, recreational including s. 111, illegal and customary) by season. Note that the model does not use two seasons until 1979. Annual estimates are provided in the AW column before 1979.

Year	Commercial AW	Commercial SS	Recreational AW	Recreational SS	Illegal AW	Illegal SS	Customary AW	Customary SS	Total AW	Total SS
1945	43.1	–	4.3	–	6.9	–	20.0	–	74.3	–
1946	38.8	–	4.4	–	6.2	–	20.0	–	69.4	–
1947	55.1	–	4.6	–	8.9	–	20.0	–	88.5	–
1948	57.0	–	4.7	–	9.2	–	20.0	–	90.9	–
1949	32.1	–	4.9	–	5.2	–	20.0	–	62.1	–
1950	41.5	–	5.1	–	6.7	–	20.0	–	73.2	–
1951	54.3	–	5.2	–	8.7	–	20.0	–	88.3	–
1952	36.5	–	5.4	–	5.9	–	20.0	–	67.8	–
1953	35.2	–	5.5	–	5.7	–	20.0	–	66.3	–
1954	20.8	–	5.7	–	3.4	–	20.0	–	49.9	–
1955	15.8	–	5.8	–	2.5	–	20.0	–	44.2	–
1956	13.4	–	6.0	–	2.2	–	20.0	–	41.5	–
1957	22.5	–	6.2	–	3.6	–	20.0	–	52.2	–
1958	27.1	–	6.3	–	4.4	–	20.0	–	57.7	–
1959	29.1	–	6.5	–	4.7	–	20.0	–	60.3	–
1960	34.8	–	6.6	–	5.6	–	20.0	–	67.0	–
1961	57.2	–	6.8	–	9.2	–	20.0	–	93.1	–
1962	64.0	–	6.9	–	10.3	–	20.0	–	101.3	–
1963	117.1	–	7.1	–	18.8	–	20.0	–	163.0	–
1964	212.2	–	7.3	–	34.1	–	20.0	–	273.6	–
1965	186.7	–	7.4	–	30.0	–	20.0	–	244.1	–
1966	236.8	–	7.6	–	38.1	–	20.0	–	302.5	–

	Commercial		Recreational		Illegal		Customary		Total	
Year	AW	SS	AW	SS	AW	SS	AW	SS	AW	SS
1967	349.4	–	7.7	–	56.2	–	20.0	–	433.4	–
1968	363.0	–	7.9	–	58.4	–	20.0	–	449.3	–
1969	260.8	–	8.0	–	42.0	–	20.0	–	330.9	–
1970	206.1	–	8.2	–	33.2	–	20.0	–	267.5	–
1971	146.9	–	8.4	–	23.6	–	20.0	–	198.9	–
1972	131.7	–	8.5	–	21.2	–	20.0	–	181.4	–
1973	103.0	–	8.7	–	16.6	–	20.0	–	148.2	–
1974	183.0	–	8.8	–	23.4	–	20.0	–	235.2	–
1975	162.0	–	9.0	–	39.2	–	20.0	–	230.2	–
1976	198.0	–	9.1	–	38.5	–	20.0	–	265.6	–
1977	220.0	–	9.3	–	56.5	–	20.0	–	305.8	–
1978	305.4	–	9.4	–	78.3	–	20.0	–	413.2	–
1979	106.2	374.0	1.0	8.6	9.2	32.5	2.0	18.0	118.4	433.2
1980	155.6	450.8	1.0	9.1	17.7	51.4	2.0	18.0	176.3	529.3
1981	153.9	420.2	1.0	9.2	24.8	67.6	2.0	18.0	181.6	515.0
1982	184.8	549.1	1.0	9.4	29.7	88.4	2.0	18.0	217.6	664.8
1983	246.9	516.8	1.0	8.8	39.7	83.2	2.0	18.0	289.6	626.8
1984	194.6	514.3	0.9	7.9	31.3	82.8	2.0	18.0	228.8	623.0
1985	152.7	501.4	0.9	8.0	24.6	80.7	2.0	18.0	180.1	608.0
1986	100.6	469.4	0.8	7.3	16.2	75.5	2.0	18.0	119.6	570.1
1987	85.2	270.2	0.6	5.7	13.7	43.5	2.0	18.0	101.6	337.4
1988	54.1	227.7	0.7	6.0	8.7	36.6	2.0	18.0	65.4	288.4
1989	81.0	304.9	0.7	6.4	13.0	49.1	2.0	18.0	96.8	378.3
1990	81.5	242.6	0.7	6.0	72.5	215.7	2.0	18.0	156.7	482.3
1991	63.3	205.5	0.6	5.0	63.4	205.7	2.0	18.0	129.2	434.2
1992	41.6	150.0	0.5	4.8	54.2	195.8	2.0	18.0	98.3	368.5
1993	120.5	59.0	1.0	8.9	98.0	48.0	2.0	18.0	221.5	133.9
1994	146.2	14.5	1.4	12.6	38.2	3.8	2.0	18.0	187.8	48.9
1995	150.4	6.4	2.1	19.3	60.4	2.6	2.0	18.0	215.0	46.3
1996	201.0	2.6	2.5	22.7	89.9	1.1	2.0	18.0	295.4	44.4
1997	222.1	1.3	1.8	16.3	63.6	0.4	2.0	18.0	289.6	36.0
1998	292.3	33.4	2.6	23.7	81.2	9.3	2.0	18.0	378.1	84.5
1999	286.9	39.2	2.0	17.9	119.7	16.3	2.0	18.0	410.6	91.4
2000	258.5	69.5	1.6	14.0	61.5	16.5	2.0	18.0	323.6	118.1
2001	182.2	107.7	1.3	11.3	47.1	27.9	2.0	18.0	232.6	164.9
2002	164.0	127.3	0.8	7.5	42.2	32.8	2.0	18.0	209.1	185.6
2003	120.6	95.3	0.7	6.5	50.0	39.5	2.0	18.0	173.4	159.2
2004	86.9	75.2	0.7	6.0	48.0	41.5	2.0	18.0	137.6	140.7
2005	91.2	78.9	0.7	6.6	48.0	41.5	2.0	18.0	141.9	145.1
2006	87.7	91.0	0.7	6.7	43.9	45.6	2.0	18.0	134.4	161.2
2007	91.2	81.2	0.8	6.8	47.3	42.2	2.0	18.0	141.3	148.2
2008	112.4	77.4	0.8	7.6	53.0	36.5	2.0	18.0	168.3	139.4
2009	106.7	57.3	1.0	8.9	58.2	31.3	2.0	18.0	167.9	115.5
2010	137.3	26.4	1.3	12.1	75.1	14.4	2.0	18.0	215.7	71.0
2011	148.7	15.2	1.7	15.2	81.2	8.3	2.0	18.0	233.5	56.8
2012	143.9	49.4	2.1	18.7	66.6	22.9	2.0	18.0	214.6	108.9
2013	175.0	49.2	2.0	18.4	69.9	19.6	2.0	18.0	248.9	105.2

Table 4: Number of vessel/statistical area records by fishing year and season in the dataset used to calculate the CRA 3 seasonal CPUE time series. '–': no data.

	Autumn-winter season				Spring-summer season			
Year	909	910	911	Total	909	910	911	Total
79/80	25	117	83	225	46	223	151	420
80/81	29	138	94	261	50	228	169	447
81/82	40	124	98	262	54	209	150	413
82/83	47	150	102	299	81	216	138	435
83/84	40	176	107	323	53	232	162	447
84/85	44	173	129	346	69	223	166	458
85/86	47	157	121	325	66	201	149	416
86/87	31	121	94	246	49	204	147	400
87/88	40	155	97	292	58	189	125	372
88/89	26	88	71	185	47	141	114	302
89/90	17	143	65	225	35	208	115	358
90/91	16	120	80	216	19	142	131	292
91/92	22	113	106	241	40	143	154	337
92/93	18	101	128	247	27	117	151	295
93/94	21	86	91	198	9	29	21	59
94/95	11	58	48	117	–	7	9	16
95/96	8	52	43	103	–	1	10	11
96/97	11	44	34	89	–	2	4	6
97/98	11	46	33	90	–	2	4	6
98/99	15	60	25	100	1	9	2	12
99/00	8	53	31	92	–	19	5	24
00/01	7	74	40	121	2	27	6	35
01/02	9	57	39	105	8	27	18	53
02/03	12	73	38	123	8	68	43	119
03/04	13	55	47	115	11	38	70	119
04/05	11	54	54	119	9	27	64	100
05/06	10	49	47	106	8	46	57	111
06/07	6	56	48	110	6	58	68	132
07/08	9	47	36	92	7	41	54	102
08/09	8	38	34	80	7	17	49	73
09/10	8	37	29	74	5	19	41	65
10/11	9	42	34	85	3	11	29	43
11/12	9	47	37	93	3	8	15	26
12/13	5	42	19	66	1	22	20	43
13/14	8	39	21	68	2	24	17	43

Table 5: Total deviance (R^2) explained by each variable in the CRA 3 standardised seasonal CPUE model. The number of categories in each explanatory variable is given in parentheses.

Variable	1	2	3
Period (70)	0.4396		
Month (12)	0.0762	0.4935	
Statistical Area (3)	0.0138	0.4584	0.5131
Additional deviance explained	0.0000	0.0540	0.0195

Table 6: Seasonal standardised indices with associated standard error and the corresponding arithmetic CPUE (kg/potlift) for CRA 3 from AW and SS 1979–80 to 2013–14. This table generated from data prepared using the F2 algorithm scaled to combined "LFX" destination codes.

Fishing year	AW season			SS season		
	Arithmetic	Standardised	s.e.	Arithmetic	Standardised	s.e.
79/80	0.754	0.728	0.0369	0.973	0.792	0.0282
80/81	0.848	0.845	0.0346	0.960	0.854	0.0274
81/82	0.835	0.807	0.0345	0.969	0.859	0.0283
82/83	0.868	0.924	0.0327	0.996	0.891	0.0278
83/84	0.794	0.836	0.0317	0.900	0.817	0.0275
84/85	0.651	0.632	0.0307	0.803	0.695	0.0273
85/86	0.581	0.563	0.0315	0.792	0.701	0.0283
86/87	0.471	0.482	0.0355	0.745	0.609	0.0287
87/88	0.357	0.372	0.0330	0.472	0.409	0.0297
88/89	0.343	0.359	0.0404	0.487	0.440	0.0324
89/90	0.343	0.362	0.0371	0.576	0.500	0.0301
90/91	0.326	0.383	0.0378	0.525	0.445	0.0328
91/92	0.236	0.248	0.0359	0.373	0.308	0.0309
92/93	0.182	0.188	0.0355	0.321	0.286	0.0327
93/94	0.424	0.396	0.0393	0.667	0.830	0.0697
94/95	0.898	0.866	0.0497	1.063	1.310	0.1310
95/96	1.331	1.380	0.0527	2.981	2.202	0.1577
96/97	1.763	1.757	0.0565	2.396	2.648	0.2128
97/98	2.137	2.319	0.0562	1.124	1.806	0.2132
98/99	1.679	1.854	0.0535	2.023	2.784	0.1510
99/00	1.690	1.793	0.0556	1.365	2.013	0.1074
00/01	1.168	1.222	0.0490	1.019	1.500	0.0893
01/02	0.885	0.914	0.0523	1.005	1.148	0.0732
02/03	0.740	0.677	0.0486	0.642	0.647	0.0492
03/04	0.724	0.588	0.0500	0.546	0.507	0.0492
04/05	0.573	0.425	0.0493	0.442	0.446	0.0534
05/06	0.638	0.558	0.0520	0.563	0.525	0.0509
06/07	0.584	0.571	0.0511	0.562	0.531	0.0469
07/08	0.651	0.593	0.0556	0.555	0.546	0.0530
08/09	0.765	0.641	0.0594	0.667	0.655	0.0620
09/10	0.850	0.875	0.0617	0.908	0.828	0.0655
10/11	1.088	1.101	0.0577	1.140	1.248	0.0801
11/12	1.533	1.634	0.0553	1.688	1.660	0.1025
12/13	2.111	2.472	0.0652	1.925	2.114	0.0801
13/14	1.954	2.211	0.0643	1.700	2.078	0.0801

Table 7: CRA 3 tag recaptures by release year and sex.

Year	Male	Female	Total
1975	174	30	204
1976	464	227	691
1977	613	155	768
1978	128	79	207
1979	269	309	578
1980	231	173	404
1981	3	1	4
1995	50	6	56
1996	122	20	142
1997	25	2	27
1999	1		1
2001	200	32	232
2002	8	1	9
2003	39	4	43
2004	243	23	266
2005	184	35	219
2006	44	3	47
2007	2	1	3
2008	86	17	103
2009	65	5	70
2010	86	9	95
2011	73		73
2012	77	4	81
2013	4		4
Total	3191	1136	4327

Table 8: CRA 3 tag releases by area and sex.

Area	Male	Female
909	464	10
910	2128	647
911	589	479

Table 9: CRA 3 tag recapture areas compared to release areas.

Release area	Recapture area		
	909	910	911
909	474		
910	4	2586	1
911	1	5	1062

Table 10: CRA 3 numbers of re-releases by sex.

Re-releases	Males	Females	Total
0	2866	1077	3943
1	158	48	206
2	28	4	32
3	6		6
4	1		1
Total	3059	1129	4188
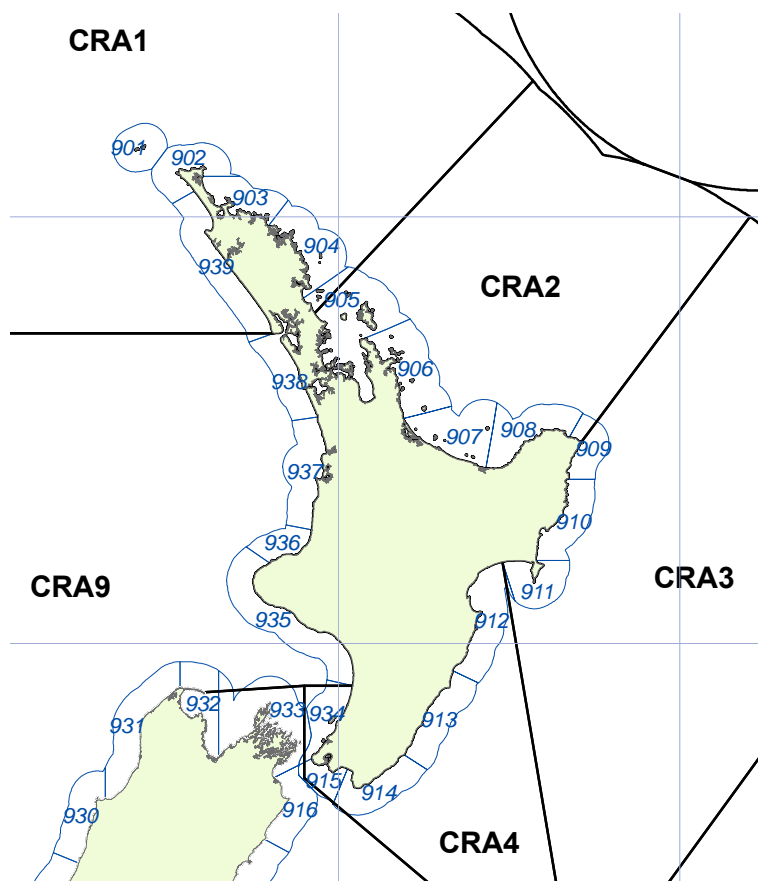
Figure 1: The CRA 3 stock area on the east coast of the North Island, and its statistical areas (light blue).
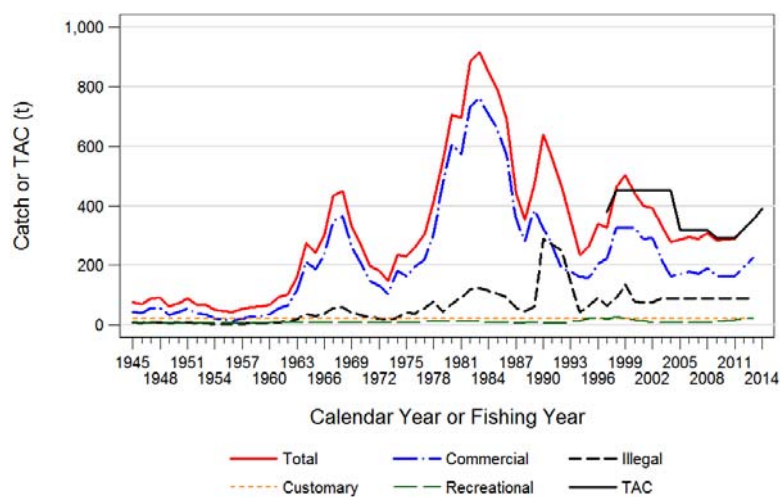
Figure 2: All CRA 3 catches by source, 1945–2013.
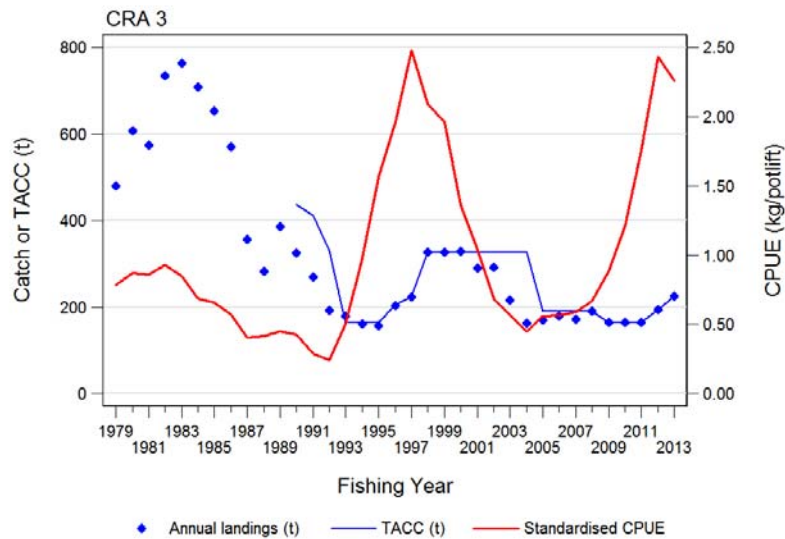
Figure 3: CRA 3 commercial catch, TACC and CPUE, 1979–2013.
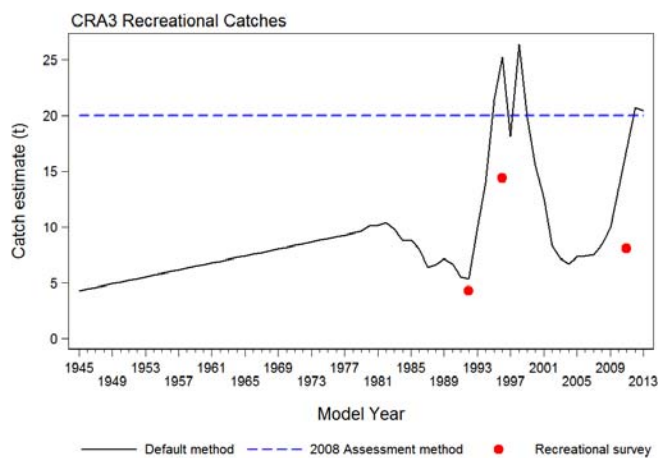
Figure 4: Estimated CRA 3 recreational catch (black line) and survey estimates (red dots) compared with the estimates used in 2008 (dashed blue line).
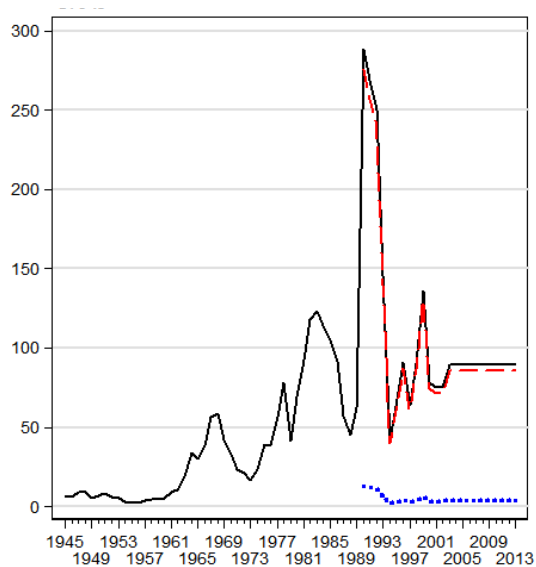
Figure 5: Estimated CRA 3 total illegal catches (solid black line); the blue dashed line is reported illegal catch and the red dashed line is unreported.
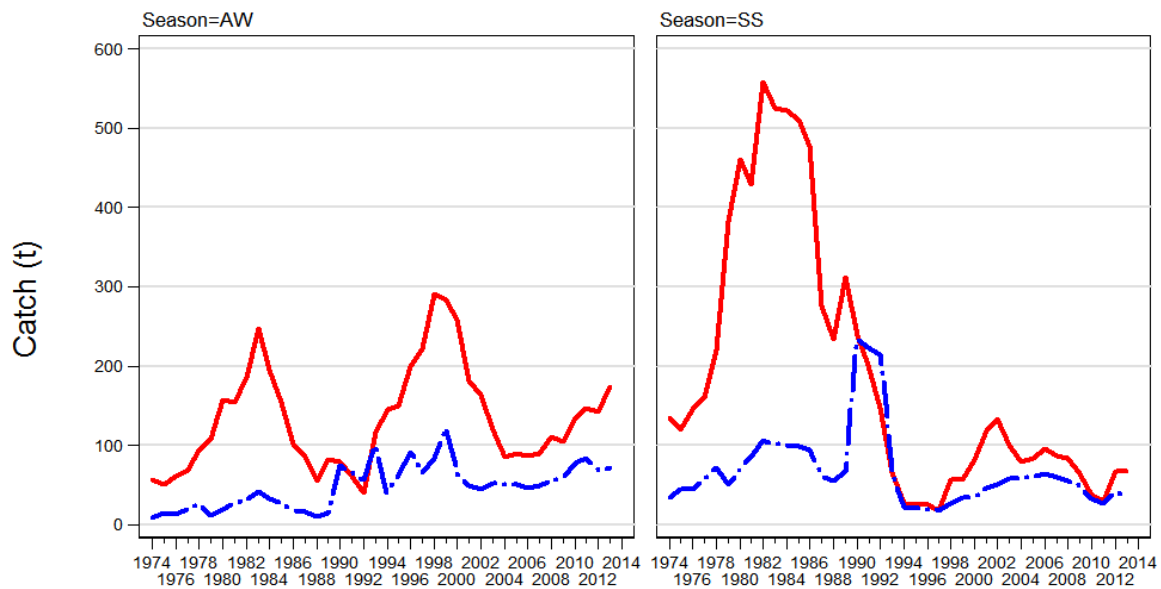
Figure 6: CRA 3 seasonal Size Limited (SL, solid red line) and Non-Size Limited (NSL, dashed blue line) catches (t).
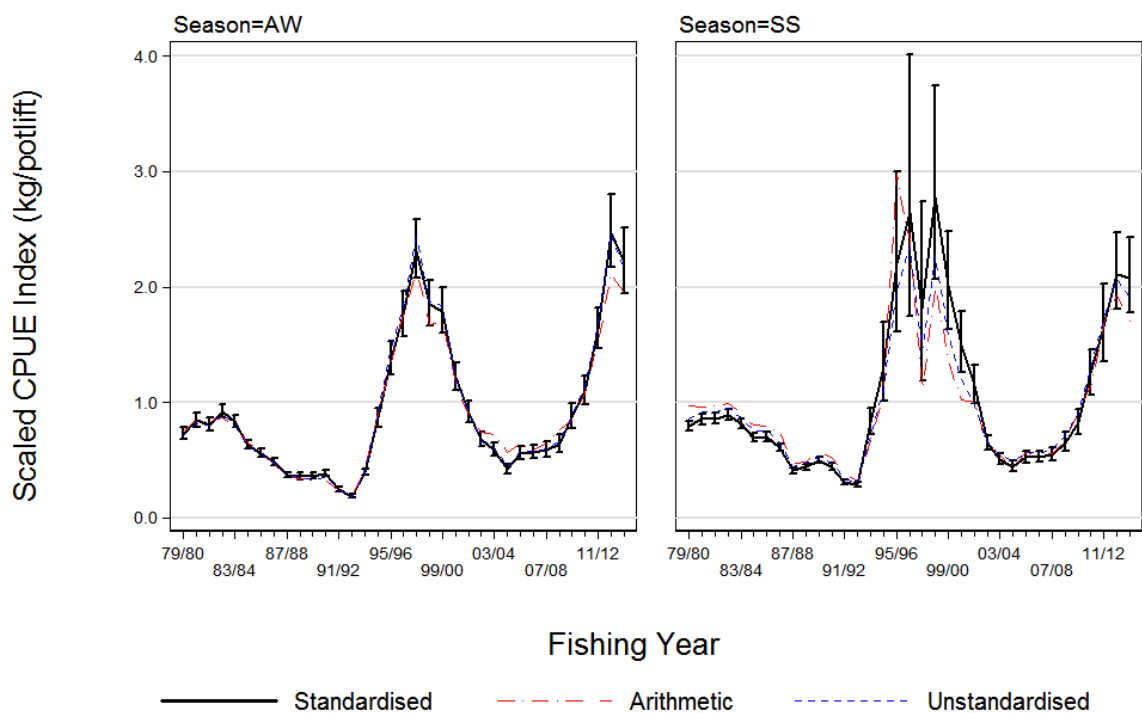
Figure 7: CRA 3 relative seasonal CPUE indices; error bars show the 95% confidence intervals.
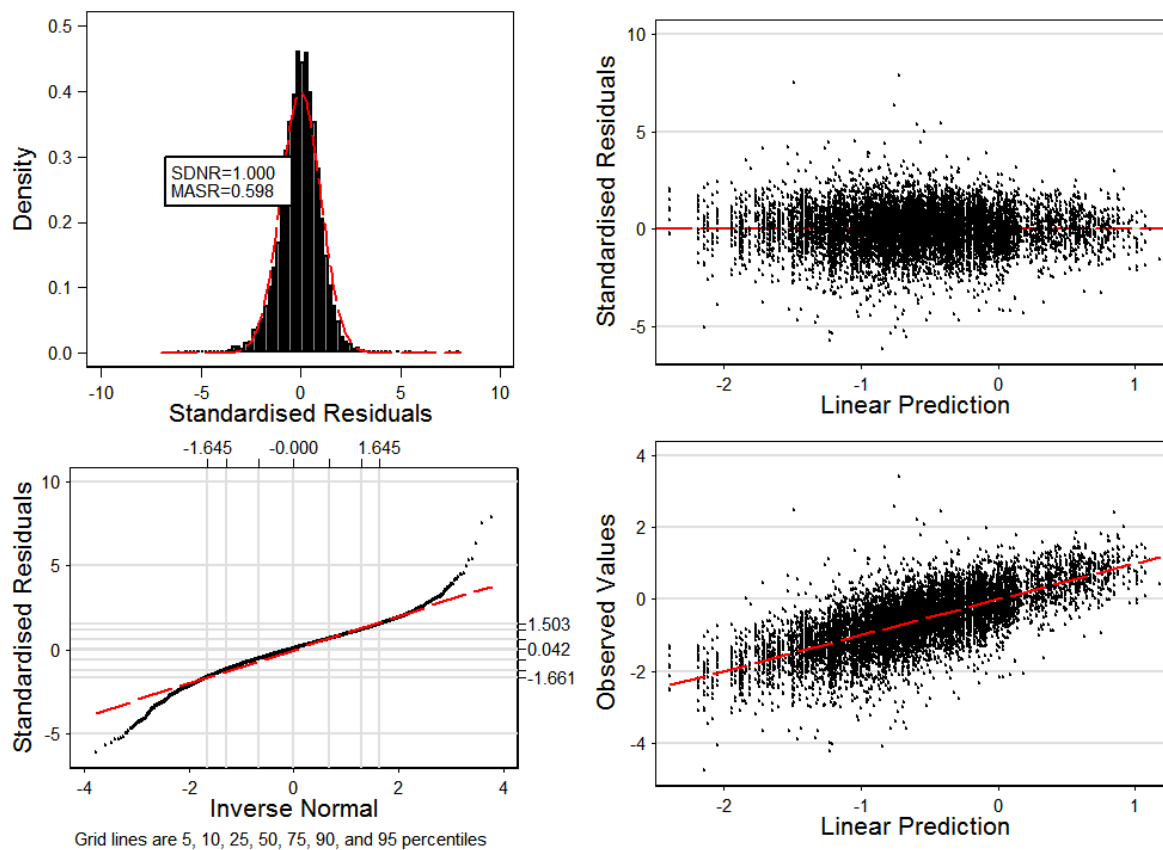
Figure 8: Residual diagnostics for the CRA 3 seasonal CPUE standardisation.
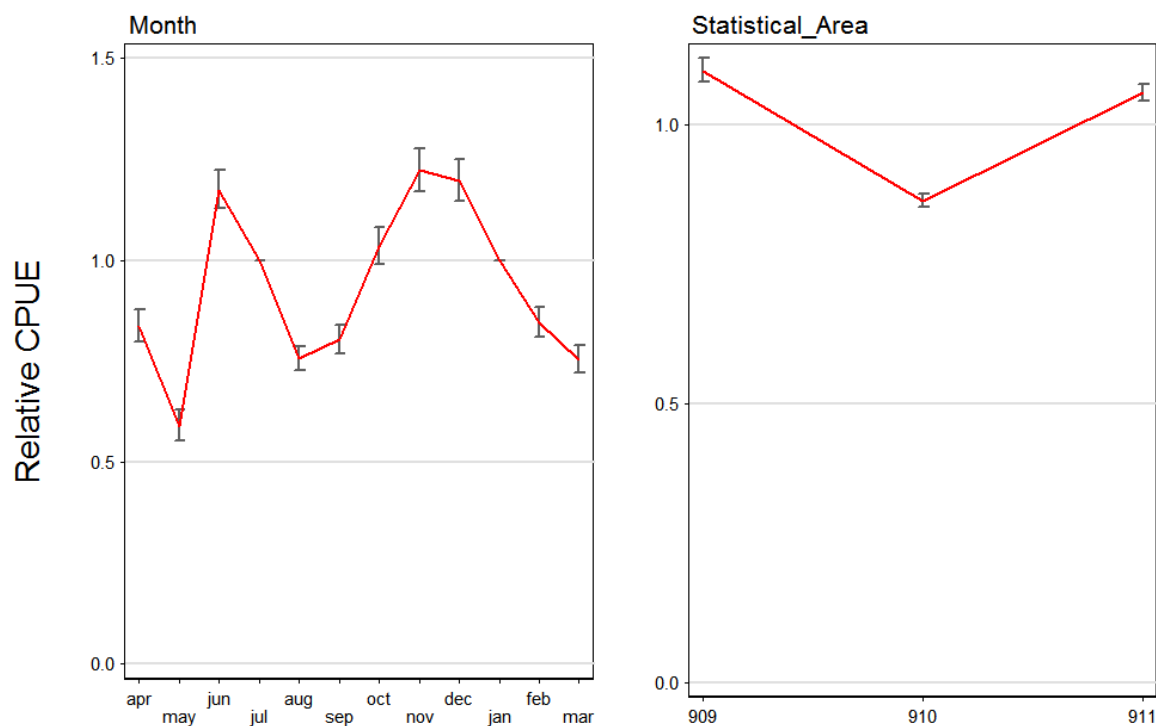
Figure 9: Month and area effects showing 95% confidence intervals from the seasonal CRA 3 CPUE standardisation.
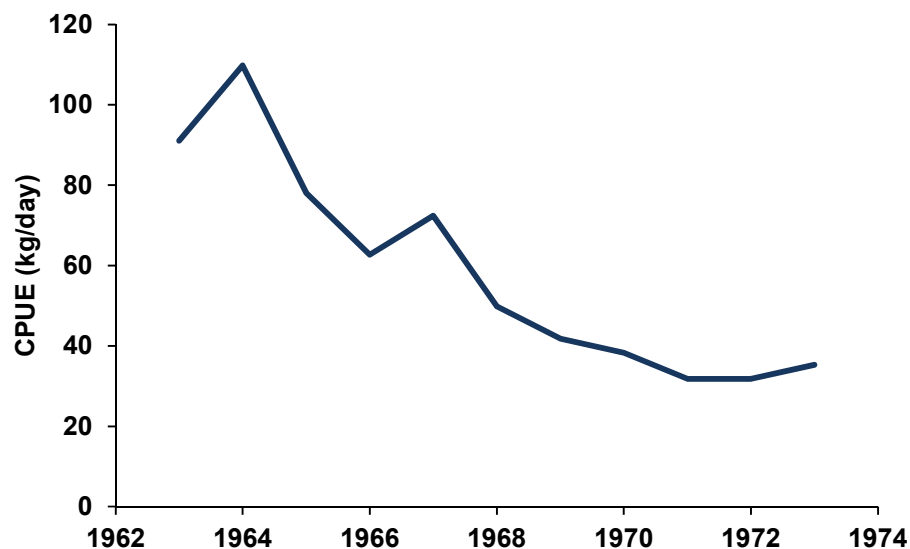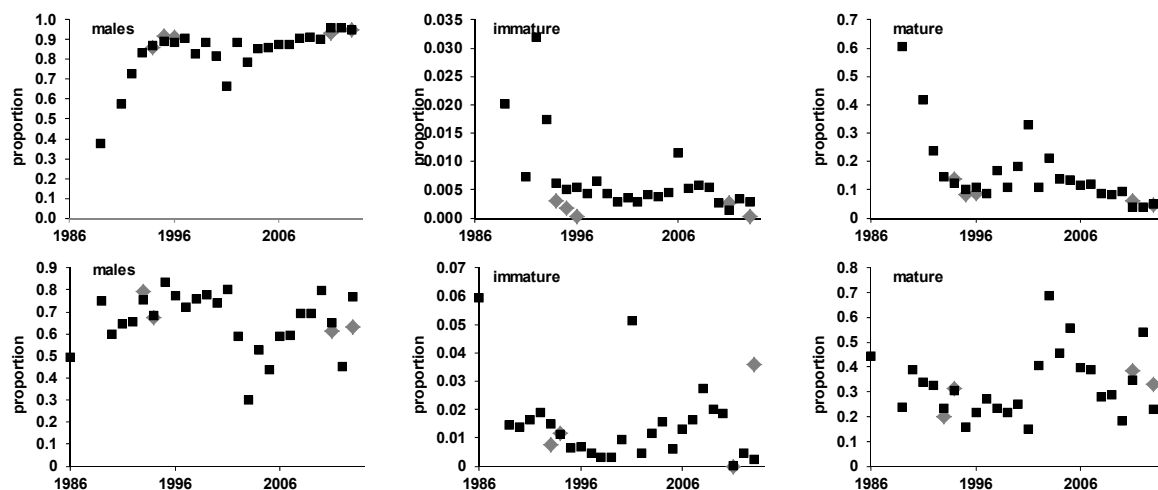
Figure 10: Arithmetic CRA 3 catch per day from Annala & King (1983).

Figure 11: CRA 3: proportions by sex in the LF data for AW (upper) and SS seasons, from logbooks (grey diamonds) and observer catch sampling (black squares).
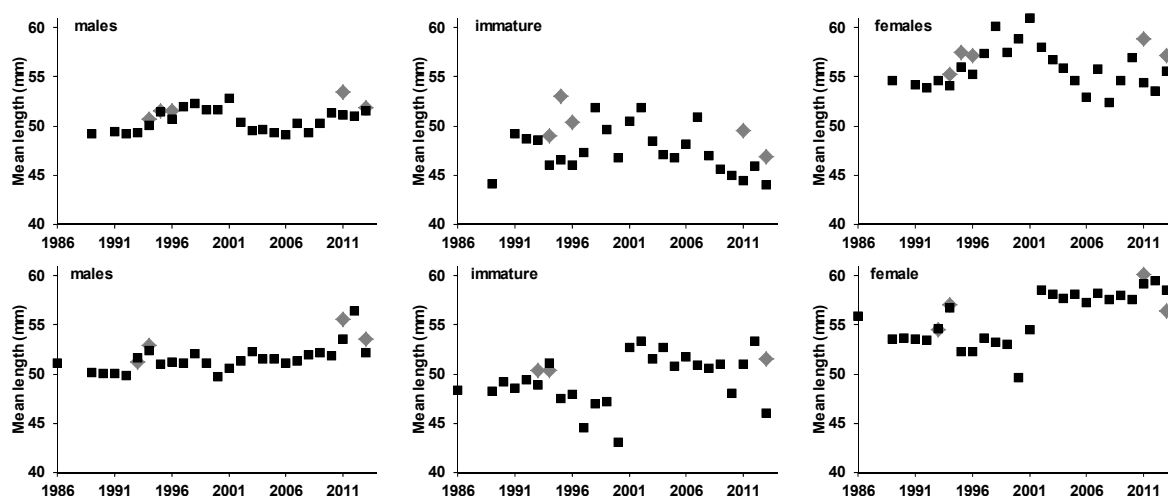

Figure 12: CRA 3: Mean lengths by sex for AW (upper) and SS seasons, from logbooks (grey diamonds) and observer catch sampling (black squares).
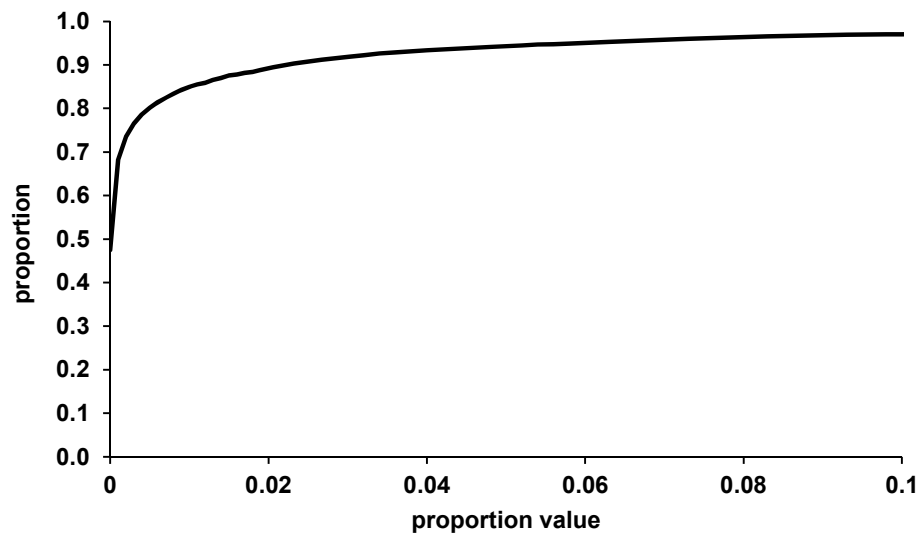
Figure 13: CRA 3: Cumulative frequency distribution of records with increasing proportion of lobsters measured in a sex/length bin.
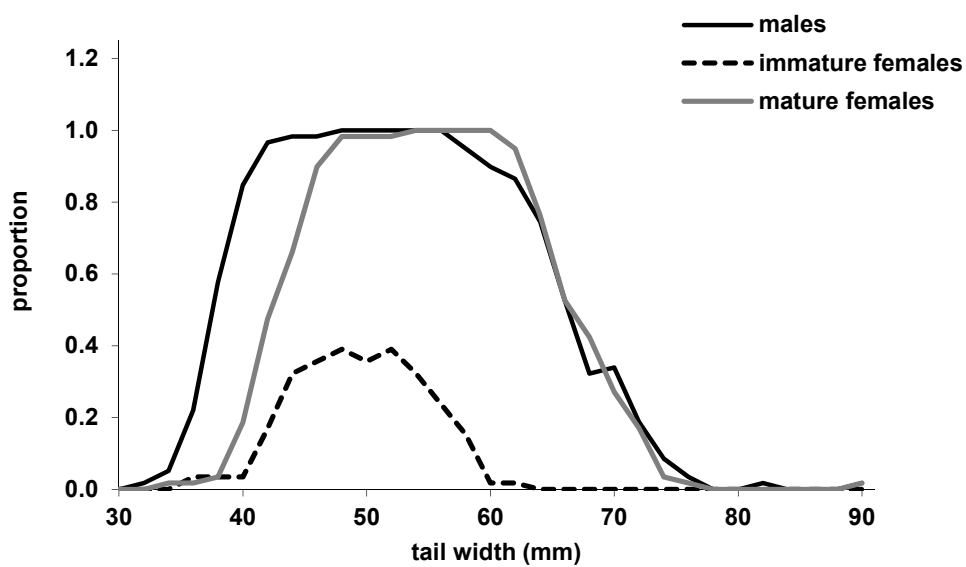

Figure 14: CRA 3: Proportion of cells, across all records at each tail width, with at least 0.001 of the fish measured.
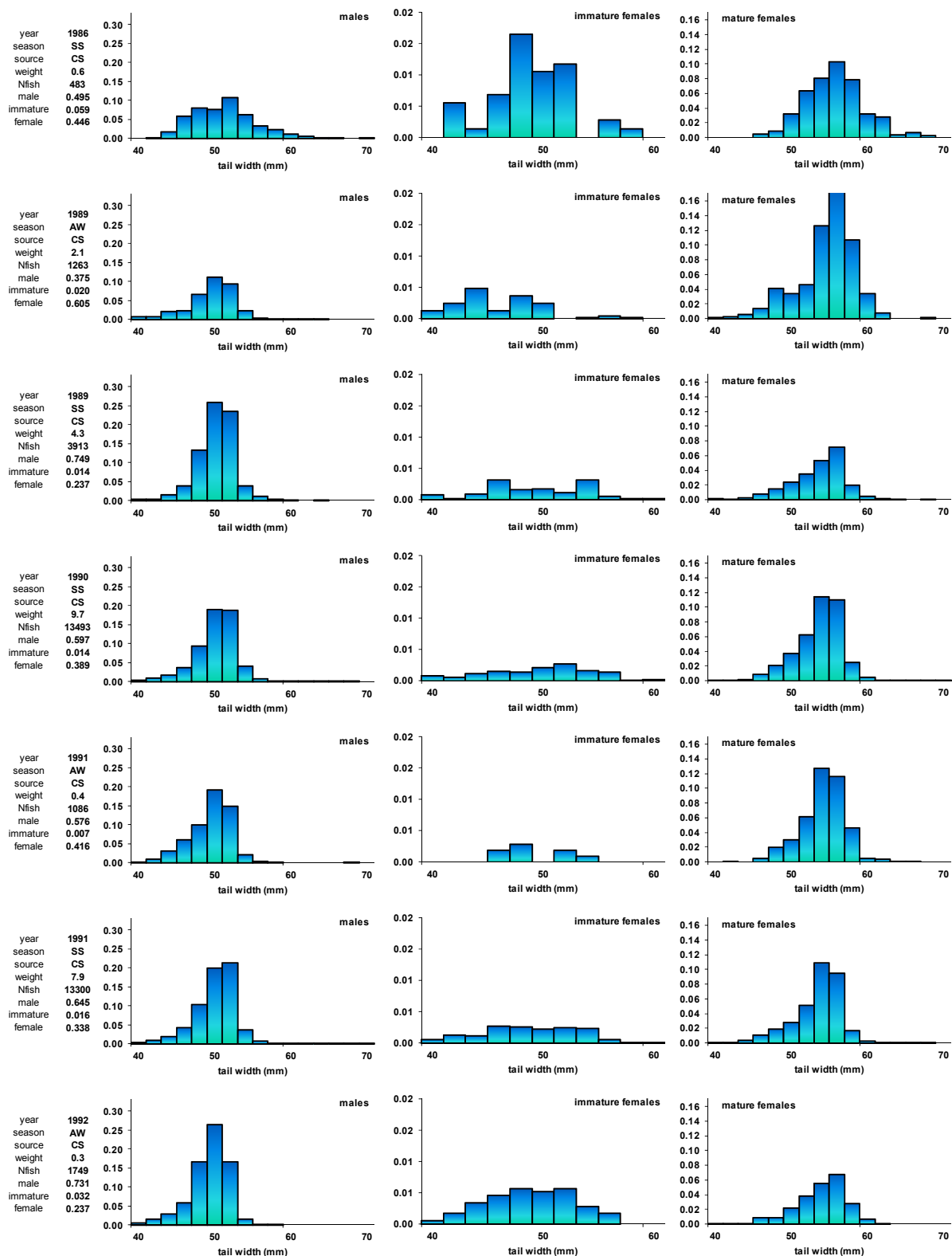
Figure 15: CRA 3 LF records, showing proportion for each sex; note that there are different scales for each sex but that scales are constant throughout the figure.
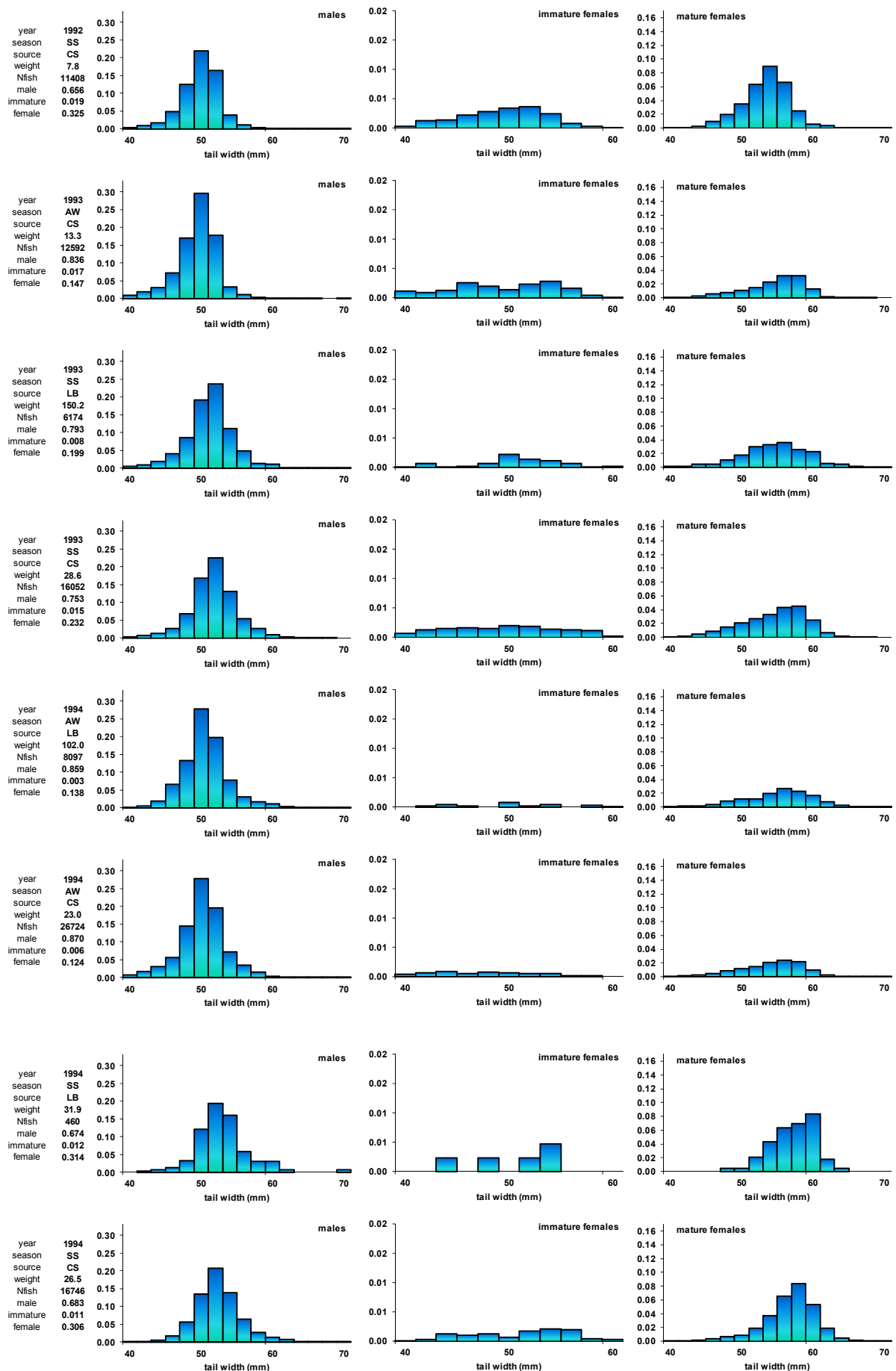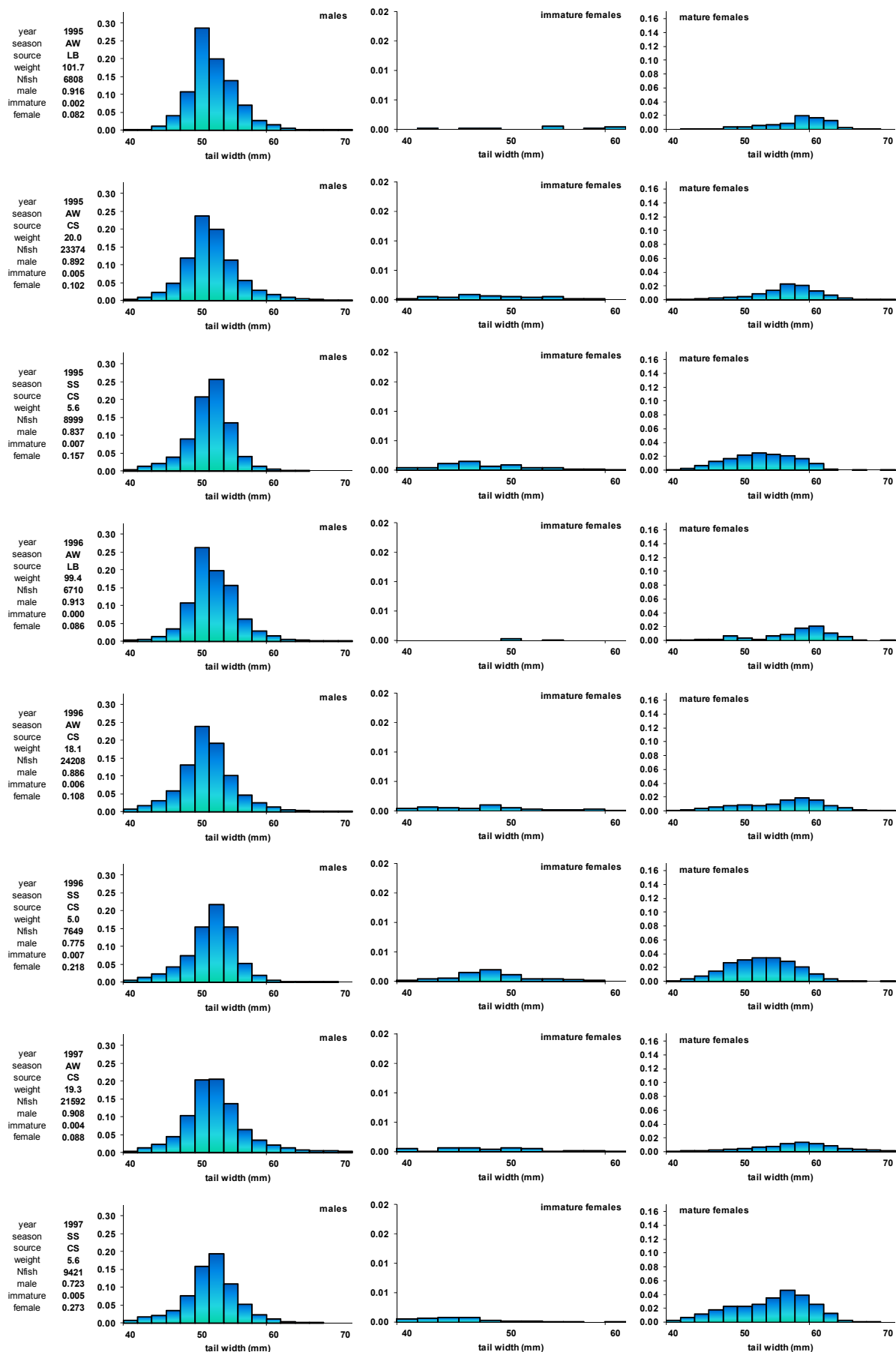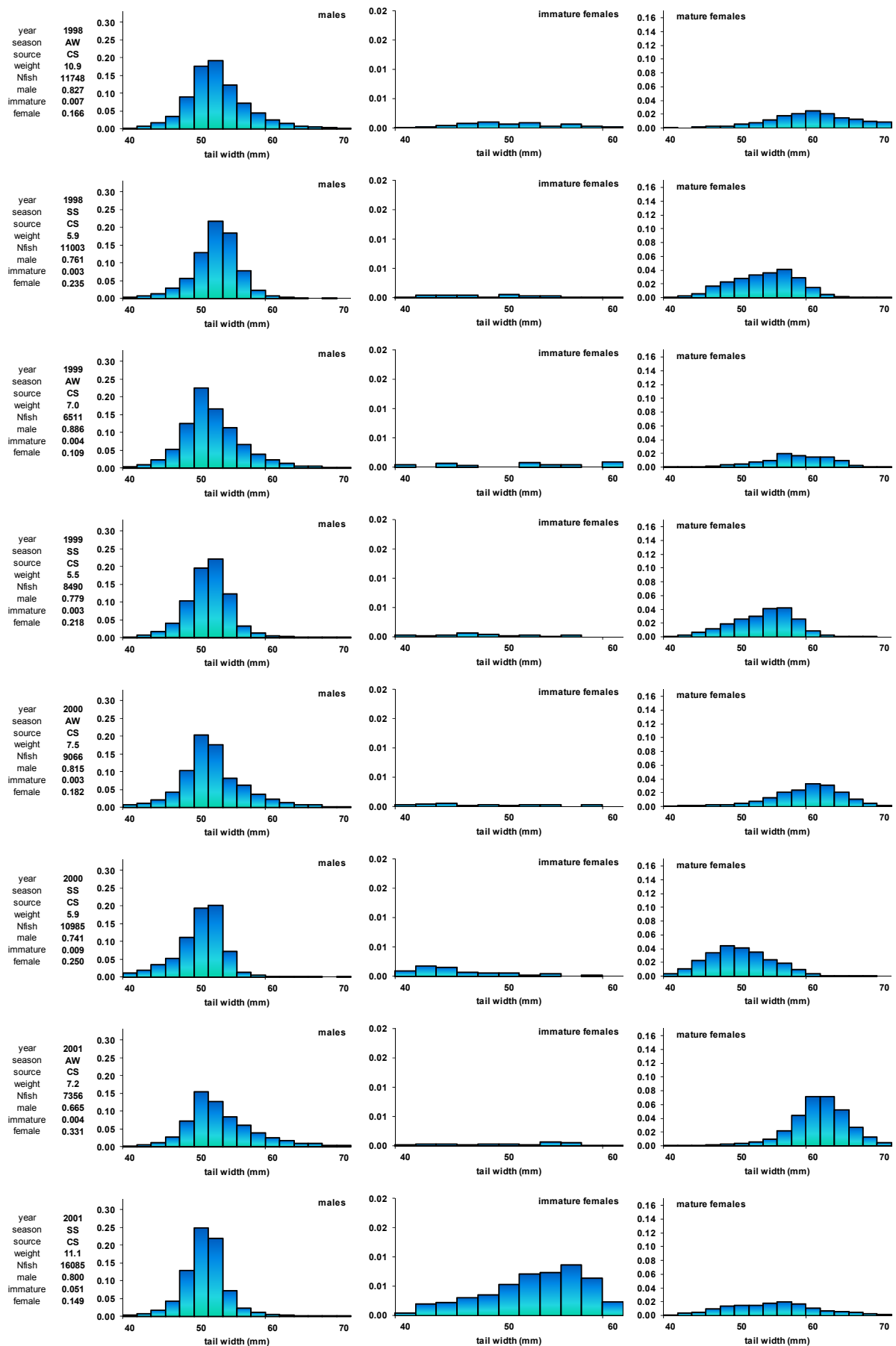
Figure 15 continued.
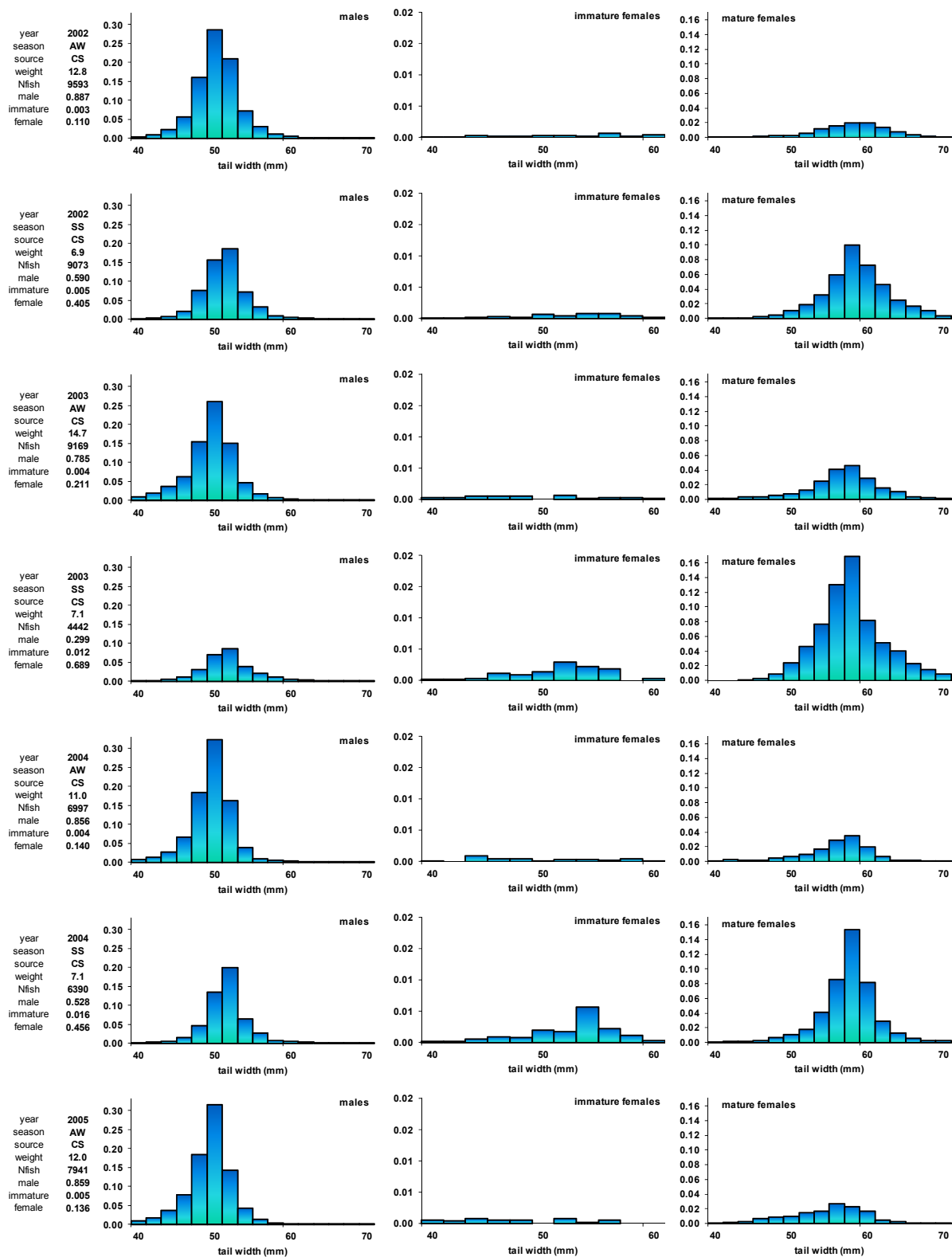
Figure 15 continued.
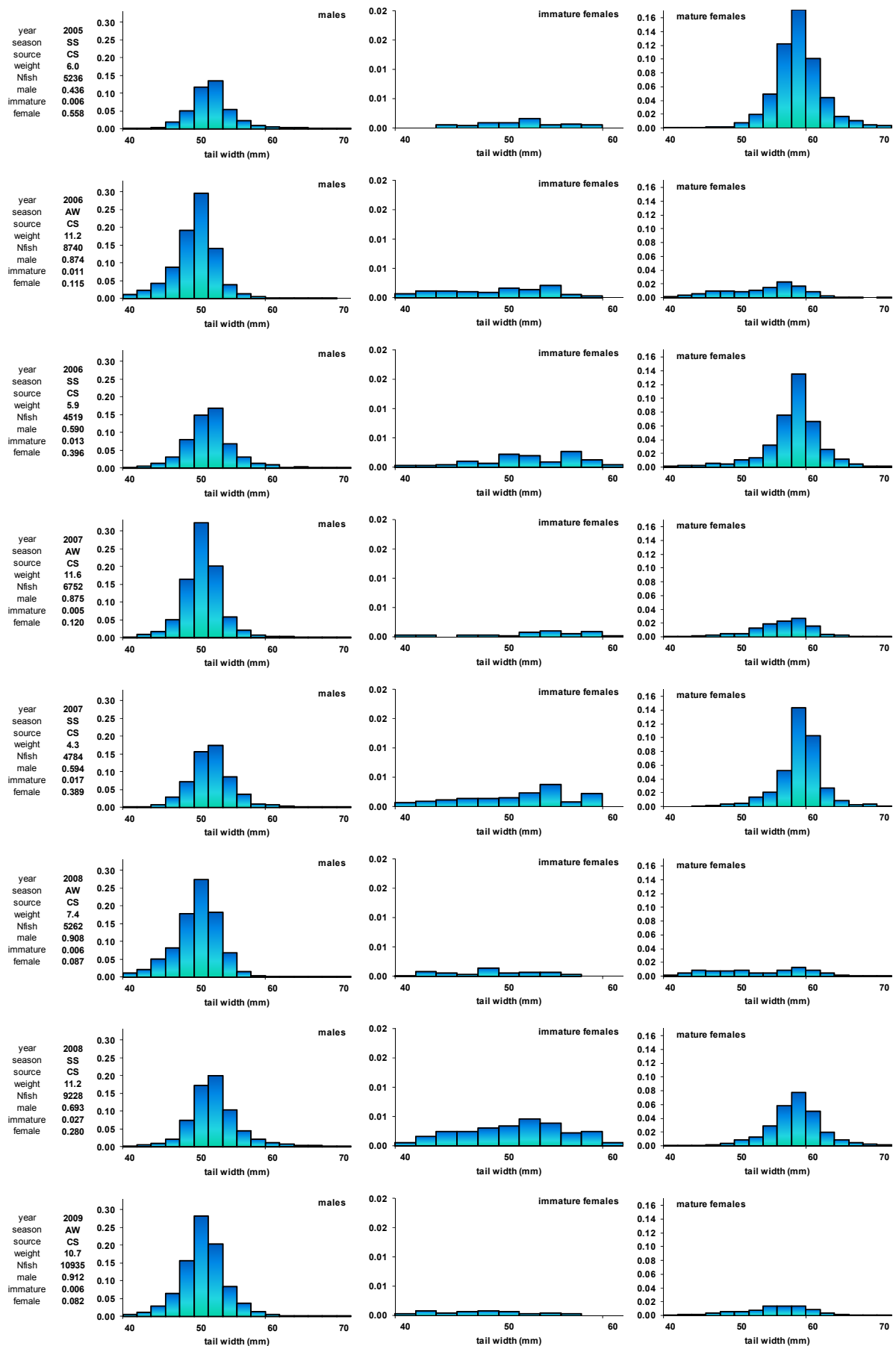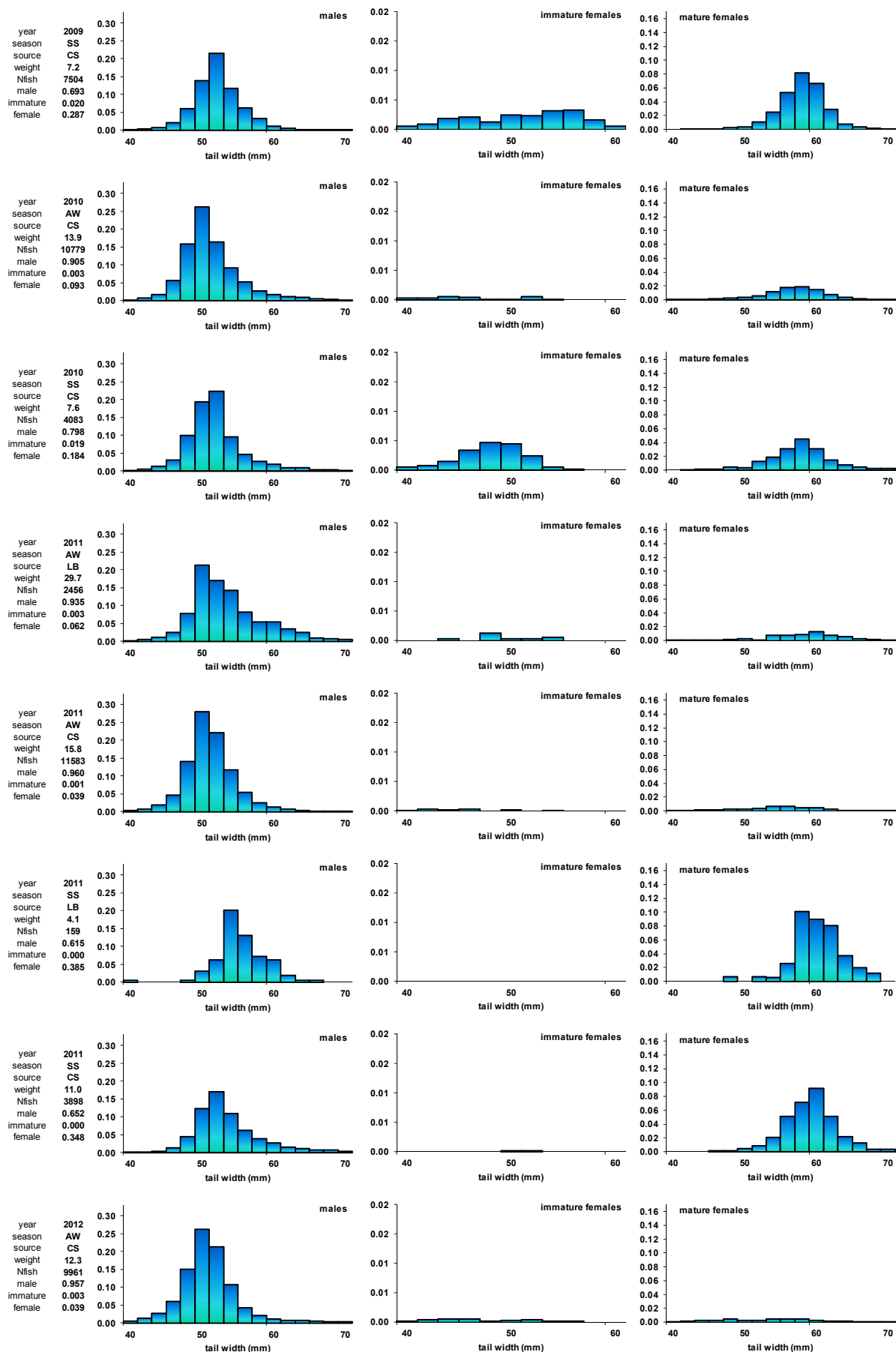
Figure 15 continued.

Figure 15 continued.

Figure 15 continued.

Figure 15 continued.

		males	immature females	mature females
year	2012			
season	SS			
source	CS			
weight	7.2			
Nfish	3789			
male	0.453			
immature	0.004			
female	0.543			

		males	immature females	mature females
year	2013			
season	AW			
source	LB			
weight	47.2			
Nfish	3846			
male	0.952			
immature	0.000			
female	0.048			

		males	immature females	mature females
year	2013			
season	AW			
source	CS			
weight	14.9			
Nfish	13812			
male	0.948			
immature	0.003			
female	0.049			

		males	immature females	mature females
year	2013			
season	SS			
source	LB			
weight	6.8			
Nfish	1707			
male	0.633			
immature	0.036			
female	0.331			

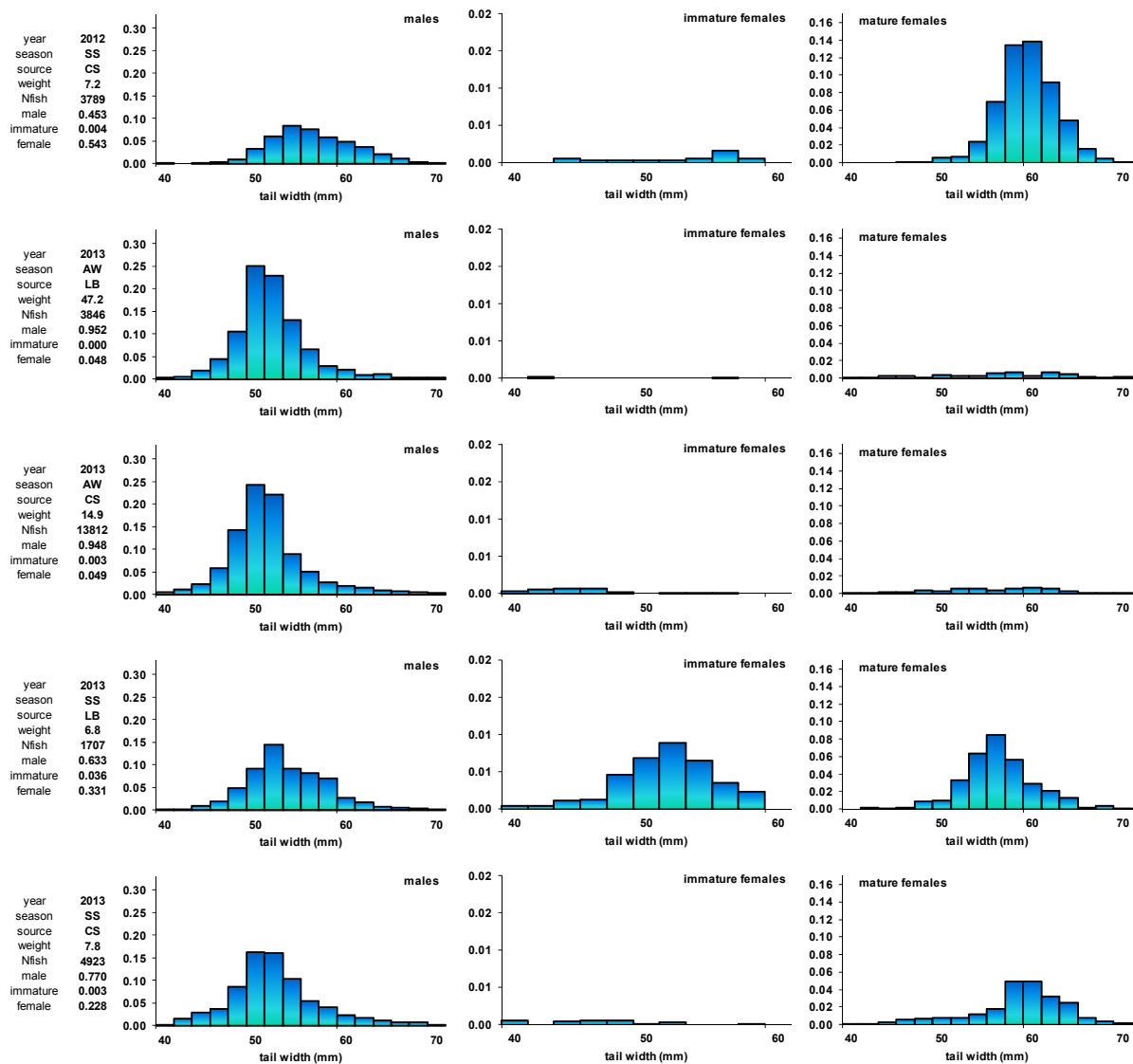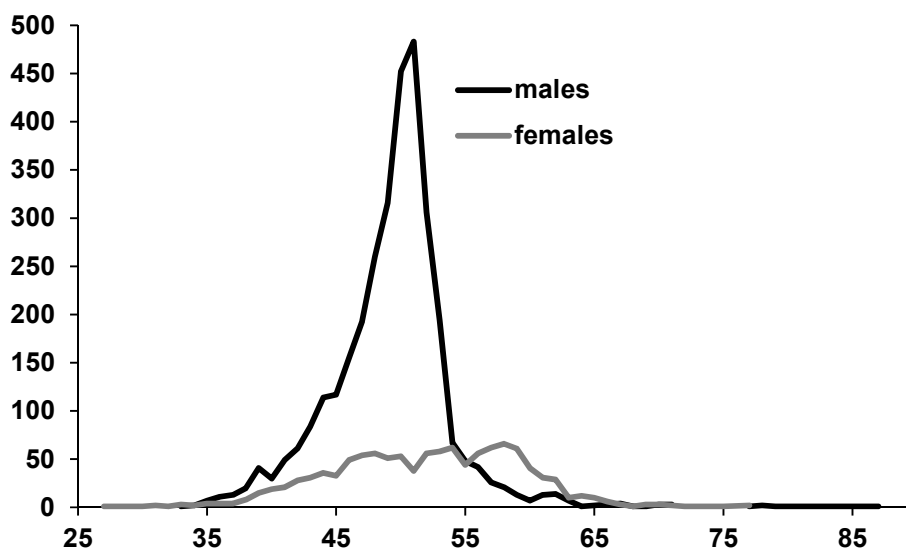|		males	immature females	mature females
year	2013			
season	SS			
source	CS			
weight	7.8			
Nfish	4923			
male	0.770			
immature	0.003			
female	0.228			

Figure 15 concluded.

Figure 16: CRA 3: Sizes at release of recaptured tagged lobsters by sex.
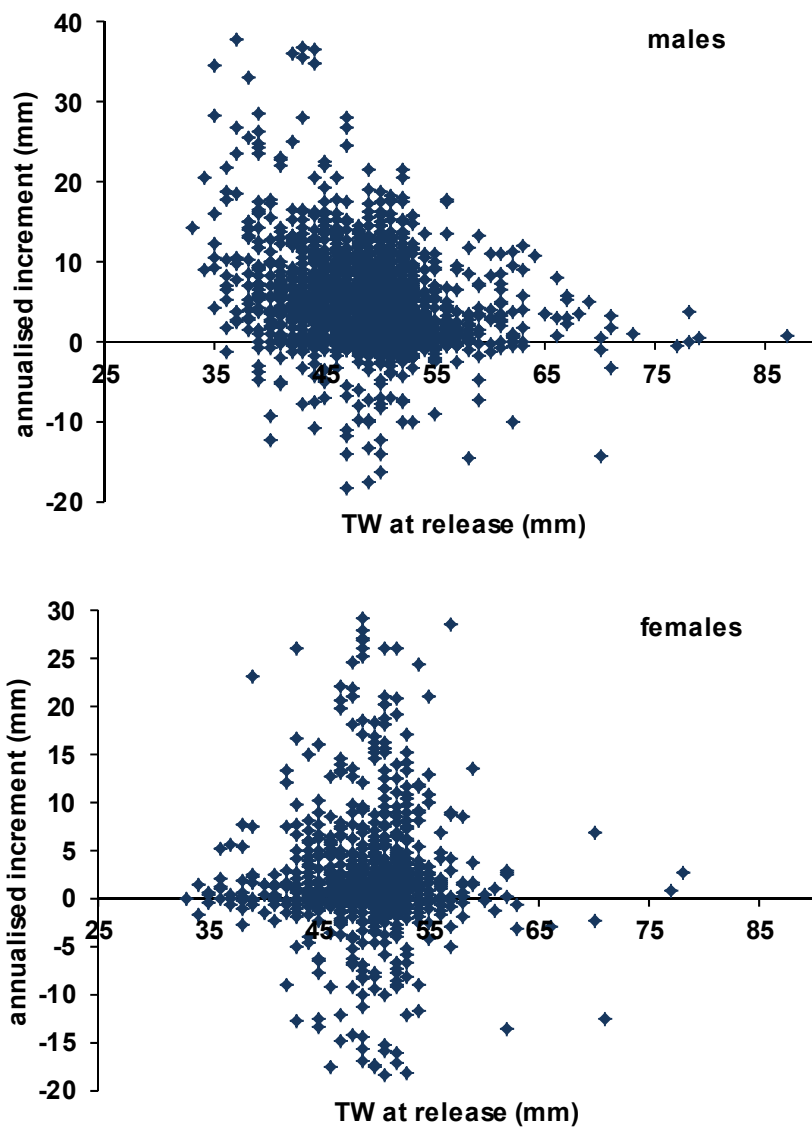
Figure 17: CRA 3: Annualised increments versus size at release by sex; the y-axes have been truncated to exclude the extreme outliers.
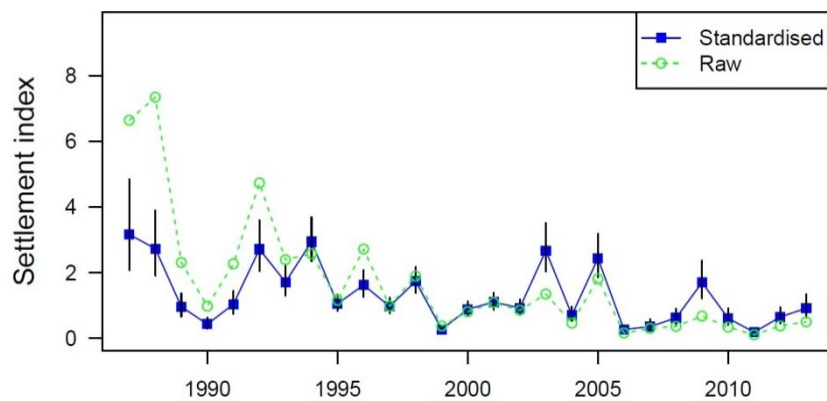

Figure 18: CRA 3 standardised and raw puerulus settlement indices (Andy McKenzie, NIWA, unpublished).
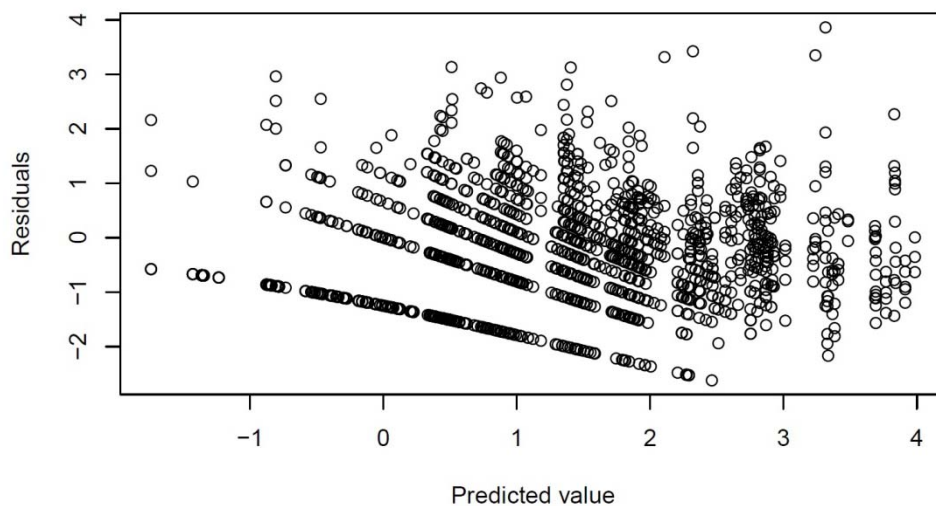
Figure 19: CRA 3 puerulus settlement standardisation: residuals versus predicted (Andy McKenzie, NIWA, unpublished).
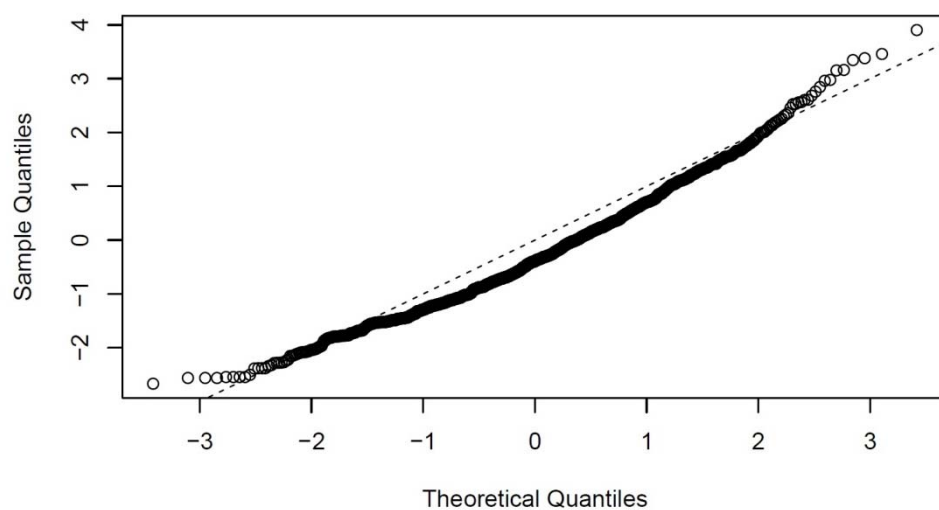

Figure 20: CRA 3 puerulus settlement standardisation: quantile-quantile plot (Andy McKenzie, NIWA, unpublished).

NZ ROCK LOBSTER INDUSTRY COUNCIL

Ka whakapai te kai o te moana

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May 24th 2014

Alicia McKinnon, Ministry of Fisheries
by email: Alicia.McKinnon@mpi.govt.nz

cc Kevin Sullivan, Chair, RLFAWG
by email: Kevin.Sullivan@fish.govt.nz

Dear Alicia:

DATA REQUEST – CRA 1 Stock Assessment and Management Procedure

Under Objectives 4 and 5 of MPI contract CRA 2012/01B, the stock assessment team will be conducting a CRA 3 stock assessment and reviewing CRA 3 management procedure in September and October of this year.

The stock assessment team has access to good data on current and historical commercial catches. However, there are limited data on the non-commercial catch components, which are customary, illegal and recreational catches.

The team has no access to customary catch information.

In the past, MFish provided estimates of illegal catches, but these were highly uncertain and since 2004 there have been no estimates except for advice in response to requests about the stock(s) being assessed each year.

Recreational catch has been estimated by the large-scale multi-species national survey (LSMS), which ended in September 2012. Previous estimates of recreational catch in CRA 3 were available from surveys in 1994-96 and 2000-01. We are content to obtain estimates from the Marine Amateur Fisheries WG when the recent estimates become available.

The stock assessment cannot ignore the current and historical customary and illegal catches: that would cause stock productivity to be greatly underestimated. In the absence of information, only MPI can solve the problem of what to assume for these components; it is up to MPI to specify the customary and illegal catch assumptions that MPI wishes to be used in the stock assessment. It is likely that the RLFAWG will request sensitivity analyses on catch series that are alternatives to the base case non-commercial catch vectors, but the base case non-commercial mortalities must be provided by MPI.

For illegal catches, the assessment team needs to know the MPI estimates of current CRA 3 illegal catch and its historical trend. To assign illegal catch to the appropriate catch components in the stock assessment model, the stock assessment team needs to know the proportions by year of the estimated illegal catches that were reported to the QMS. Otherwise, if commercial fishermen report to an MHR

scrubbed females or other illegal fish that are already part of the illegal catch estimate, then that catch will have been double-counted.

The assessment team also requests an appreciation of the uncertainty in the MPI illegal catch estimates.

For customary catch, the requirements are similar: the assessment team requires MPI to provide estimates of the current customary catch in CRA 3 and its historical trend. The assessment team also request an appreciation of the uncertainty in the MPI customary catch estimates.

Without these estimates from MPI, it will not be possible to produce a credible CRA 3 stock assessment.

The input data, including these estimates, are scheduled to be discussed at a RLFAWG meeting on 26 September. These MPI estimates of illegal and customary catches are thus required by 1 September 2014.

Can you please confirm your understanding of this written request and also advise likely delivery dates for these catch estimates? To assist the task, I will be happy to answer any queries you may have.

Sincerely,

Daryl Sykes
Research Programme Manager
NZ Rock Lobster Industry Council

APPENDIX B: MPI RESPONSE TO NON-COMMERCIAL DATA REQUEST

[MPI letterhead]

29 August 2014

Daryl Sykes
NZ Rock Lobster Industry Council
lobster@seafood.co.nz

Dear Daryl

Data request for CRA 1 and CRA 3 Stock Assessments

This letter provides a response to your request for non-commercial catch data for this year's CRA 1 and CRA 3 stock assessments and management procedure evaluations.

1. CRA 1 and CRA 3 illegal catch estimates
Historical estimates of CRA 1 and CRA 3 illegal catches have been supplied to the Rock Lobster Fisheries Assessment Working Group (RLFAWG) on several occasions from 1990 to 2003. Some of these estimates include a breakdown of the proportion of estimated illegal catches that were reported to the QMS or not. The historical estimates of CRA 1 and CRA 3 illegal catch are available in the November 2013 Rock Lobster Fishery Assessment Plenary Report.

The last illegal catch estimates that MPI supplied for CRA 1 was for 72 tonnes in 2001 and for 89.5 tonnes for CRA 3 in 2003. MPI acknowledges that it has been some time since this estimate was updated. However, as discussed at the recent National Rock Lobster Management Group, there is currently no robust and defensible methodology that MPI can use to accurately estimate illegal catches from these or any other rock lobster fishery.

Anecdotal information from MPI's Compliance team suggests there are moderate levels of illegal activity in parts of the CRA 1 fishery at this time which seems to be highly seasonal and is associated with rock lobsters moving close to shore. In relation to CRA 3, it considered that there are moderate to high levels of illegal activity in the fishery, but it is considered that targeted and varied enforcement efforts in recent years is helping to reduce illegal activities.

Taking into account the uncertainty in the available information on illegal take, MPI suggests that a 72 tonne illegal catch estimate continues to be used in the CRA 1 stock assessment and 89.5 tonnes is used in the CRA 3 stock assessment. It is also suggested that the RLFAWG considers carrying out sensitivity analyses with lower levels of illegal take (i.e. half of the last supplied estimates).

2. CRA 1 and CRA 3 customary catch estimates
Summaries of the information MPI holds on CRA 1 and CRA 3 customary harvest since the 2003/04 April fishing year is provided at the end of this letter (Tables 1 to 4). MPI notes that some harvest information is yet to be entered into the customary database; therefore, the information provided is considered incomplete.

CRA 1 and CRA 3 customary harvest information is collected under two types of regulations: the Fisheries (Kaimoana) Regulations 1998, and Regulation 50 of the Fisheries (Amateur Fishing) Regulations 2013 (previously Regulation 27A of the Fisheries (Amateur Fishing) Regulations 1986).

Under the Kaimoana Regulations, Tangata kaitiaki are responsible for providing quarterly reports of their harvest authorisations to MPI. In areas not covered by the Kaimoana Regulations, customary harvest can be authorised for the purpose of hui or tangi under the Amateur Regulations. There is no mandatory requirement for permit issuers under the Amateur Regulations to provide MPI with details of customary fishing authorisations.

Based on the information supplied on CRA 1 and CRA 3 customary harvest, noting its incompleteness and uncertainty, MPI considers it appropriate to continue to use a 10 tonne customary catch estimate for CRA 1 and a 20 tonne estimate for CRA 3. MPI suggests that the RLFAWG considers carrying out sensitivity analyses for higher levels of CRA 3 customary catch (i.e. of 40 tonnes).

2. CRA 1 and CRA 3 amateur charter catch
Information MPI holds on CRA 1 and CRA 3 rock lobsters reported under the charter boat reporting scheme from the 2010/11 April fishing year is provided in Table 5. Charter vessel operators were required to report CRA 1 catches from October 2011 and CRA 3 catches from 1 October 2012; however, many operators also voluntarily provided catch information ahead of the requirements.

If you would like to clarify any of the details supplied in this letter please do not hesitate to contact me.

Kind regards

Alicia McKinnon
Senior Fisheries Analyst

Table 1: Summary of CRA 1 customary harvest information collected under the Kaimoana Regulations from 2007-08 to 2012-13 (noting no information is available in the customary database for CRA 1 from 2003-04 to 2006-07 and for 2013-14).

April fishing year	Unit Type	Sum of Quantity Approved	Sum of Actual Quantity Harvested
2007/08	NO.	207	207
2008/09	BIN	1	
	NO.	40	20
	(blank)	70	70
2009/10	KG	8	8
	(blank)	25	25
2011/12	NO.	72	58
2012/13	NO.	12	10

Table 2: Summary of CRA 1 customary harvest information collected under the Amateur Regulations from 2003-04 to 2013-14 (noting no information is available in the customary database for CRA 1 from 2003-04 to 2007-08 and for 2013-14).

April fishing year	Unit Type	Sum of Quantity Approved	Sum of Actual Quantity Harvested
2008/09	(blank)		50
2009/10	BIN	4	2
	(blank)	354	215
2010/11	BIN	8	18
	KG	45	9
	(blank)	569	210
2011/12	BIN	7	20
	KG	235	36
	(blank)	1342	212
2012/13	BIN	10	3
	KG	66	0
	(blank)	632	55

Table 3: Summary of CRA 3 customary harvest information collected under the Kaimoana Regulations from 2003-04 to 2013-14.

April fishing year	Unit Type	Sum of Quantity Approved	Sum of Actual Quantity Harvested
2003/04	(blank)	495	138
2004/05	(blank)	290	200
2006/07	KG	225	177
	NO.	1665	456
	(blank)	273	273
2007/08	NO.	17377	10100
	(blank)	1555	1480
2008/09	NO.	8911	6015
	(blank)	1410	1025
2009/10	NO.	1030	663
	(blank)	2985	340
2010/11	NO.	12624	8647
	(blank)	5666	5463
2011/12	NO.	24863	19091
	(blank)	690	484
2012/13	NO.	26927	20901
	(blank)	691	327
2013/14	NO.	13423	10664
	(blank)	18835	15612

Table 4: Summary of CRA 3 customary harvest information collected under the Amateur Regulations from 2003-04 to 2013-14 (noting no information is available in the customary database for CRA 3 for 2013-14).

April fishing year	Unit Type	Sum of Quantity Approved	Sum of Actual Quantity Harvested
2003/04	BIN	15	
	KG	50	
	NO.	275	30
	(blank)	7275	664
2004/05	NO.	1260	
	(blank)	3642	908
2005/06	NO.	2082	477
	(blank)	6072	590
2006/07	KG	390	340
	NO.	8631	4954
	(blank)	4350	2875
2007/08	BIN	4	
	KG	30	30
	NO.	100	
2008/09	(blank)	2626	1730
2009/10	NO.	530	
	(blank)	6371	920
2010/11	NO.	80	
	(blank)	2640	244
2011/12	(blank)	1750	836
2012/13	(blank)	630	119

Table 5: Summary of CRA 1 and CRA 3 amateur charter vessel activity reporting information from 2010-11 to 2013-14.

	Sum of Number Caught	*Sum of Number Retained*
CRA 1		
2010/11	208	123
2011/12	192	127
2012/13	344	172
2013/14	125	67
CRA 3		
2010/11	26	13
2011/12	70	18
2012/13	*Nil*	*Nil*
2013/14	*Nil*	*Nil*