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Estimation of fin ratios and dressed weight conversion factors for selected shark species

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M.P. Francis

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The New Zealand Government has announced that a shark finning ban will be introduced for all shark species by 1 October 2014. For seven Quota Management System (QMS) species (rig, school shark, mako shark, porbeagle shark, elephantfish, dark ghost shark and pale ghost shark) fishers will be able to land fins separately from the body of the shark but only in accordance with a gazetted fin to whole weight ratio. The remaining two QMS species (blue shark and spiny dogfish) and non-QMS species will need to be landed with their fins naturally or artificially attached. Implementation of the ban therefore requires accurate knowledge of the ratio of the weight of a shark’s fins to its whole weight. This study estimates wet fin ratios for all QMS shark species for which there are suitable data. It also reviews dressed weight conversion factors for dark and pale ghost shark using historical and new data collected by MPI observers aboard commercial fishing vessels.

Data collected by Ministry for Primary Industries observers on fin weight, dressed weight and whole weight were extracted from the observer database, or obtained from specially designed forms completed by observers at sea. Shark fin ratios (fin weight as a percentage of whole weight) and conversion factors (CFs, whole weight divided by dressed weight), were plotted against trip, vessel, fishing year, method/nationality, fin code (an index of which fins were retained), Fisheries Management Area, month, test type (whether random or non-random) and mean weight, and compared with the current legislated fin ratio. Dressed weight CFs for dark and pale ghost shark were estimated using a linear mixed effect model.

Shark fin weight data suffered from some serious limitations and potential biases and errors, making it difficult to draw strong conclusions. A major issue for fishers is the apparent confusion over whether shark fin sets should include the entire tail or just the lower lobe. For pelagic sharks (blue, porbeagle and mako sharks), this is an important consideration, because Japanese chartered Surface Longline (SLL) vessels typically included the whole tail, whereas the New Zealand domestic SLL vessels typically retained only the lower lobe. Unfortunately few tests were carried out aboard the domestic fleet, making it difficult to estimate an appropriate fin ratio for them. No observer data were available for estimating fin ratios for rig and elephantfish.

CF analyses for dressed dark and pale ghost shark were based on large numbers of tests and of sharks caught mainly on deepwater trawlers. The estimated CF for dark ghost shark (3.21) was slightly and significantly lower than the gazetted value of 3.40. The estimated CF for pale ghost shark (3.50) was higher, but not significantly so, than the gazetted value of 3.40. I recommend that the CF for dressed dark ghost shark be adjusted downwards to a rounded value of 3.20, and that the CF for dressed pale ghost shark be retained at the present level of 3.40. Further investigation is required to determine whether different processed states are warranted for inshore and offshore vessels.

The data presented here can be used to support the development of official fin ratios for monitoring compliance with the ban on shark finning to be introduced on 1 October 2014, and for providing improved estimates of dressed weight CFs for dark and pale ghost shark.

1. INTRODUCTION

In 2014, the New Zealand Government released its second National Plan of Action for the Conservation and Management of Sharks (NPOA Sharks) (Ministry for Primary Industries 2014a). In the NPOA Sharks, the Government announced its intention to ban shark finning (the removal and retention of a shark's fins with the remainder of the shark being discarded at sea) by 1 October 2015 for all shark species except blue shark, and by 1 October 2016 (at the latest) for blue shark.

Progress on this issue has been rapid, with the Government announcing on 20 August 2014 that a finning ban would be introduced for all shark species by 1 October 2014, thus bringing the date of introduction forward by one year for many species and by two years for blue shark (Ministry for Primary Industries 2014b, c, d). For all non-Quota Management System (QMS) sharks and two QMS species (spiny dogfish and blue shark), the ban requires all shark fins to be landed attached to the body of the shark, either naturally or artificially (blue shark only). For seven QMS species (rig, school shark, mako shark, porbeagle shark, elephantfish, dark ghost shark and pale ghost shark) fishers will be able to land shark fins separately from the body of the shark but only in accordance with a gazetted fin to whole weight ratio (Ministry for Primary Industries 2014d). Implementation of the shark finning ban therefore requires accurate knowledge of the ratio of the weight of a shark's fins to its whole weight for seven of the nine QMS species. Conversion factors for converting fin weights to whole weights (CFs) are already available, and are being used routinely in some fisheries (Table 1). The inverse of each CF, expressed as a percentage, is the corresponding shark fin ratio required for monitoring compliance with the shark finning ban. However, many shark species currently have nominal CFs of 30 (fin ratio = 3.33%), and the few species-specific CFs were all based on minimal data (see Section 2). There is therefore a need to review and estimate shark fin CFs and fin ratios for New Zealand sharks.

The carcasses of dark and pale ghost sharks are usually processed at sea into a 'dressed' form (see below for definition), and then filleted for human consumption after being landed ashore. The current gazetted conversion factor for dressed ghost sharks of 3.40 was based on CF tests by MPI observers mainly aboard large deepwater trawlers. Anecdotal evidence suggests that smaller inshore trawlers use a different processing cut, and CF tests indicate that a lower CF of 2.65−2.70 may be more appropriate for dark ghost shark processed by that fleet (Blackwell 2001, 2003). A review of the dressed CFs for dark and pale ghost shark is therefore warranted, with emphasis on inclusion of any recent data in the analyses.

This study estimates wet fin ratios for nine QMS shark species, and dressed CFs for dark and pale ghost shark using historical and new data collected by MPI observers aboard commercial fishing vessels. Dried fins are not considered here because shark fins are very rarely landed in that state, and because no data were available to estimate dried fin ratios. The objectives of the study were:

1. To recommend appropriate fin:greenweight ratios for nine QMS shark species (school shark, rig, spiny dogfish, pale ghost shark, dark ghost shark, elephantfish, blue shark, mako shark, porbeagle shark) based on all available data
2. To review the conversion factor for dressed dark and pale ghost sharks

Note: Following clarification of the final shark finning regulations (Ministry for Primary Industries 2014d), fin:greenweight ratios are not required for spiny dogfish, because they will be landed with fins naturally attached. However, fin weight information is required to assist in the calculation of a shark fins attached CF.

2. Background to current conversion factors

The current CFs for the species and processed states of interest in this study are shown in Table 1. The sources of information and reports underpinning the wet fin and dressed CFs are summarised briefly below.

2.1 Wet fins conversion factors

Blue shark
The CF of 48 was based on unspecified North Atlantic data (Ministry of Fisheries 2004).

Mako shark
The CF of 59 was based on a sample of 23 mako sharks caught and landed in recreational fishing competitions around North Island in 2003 (C. Duffy, Department of Conservation, unpubl. data; Ministry of Fisheries 2004).

Porbeagle shark
The CF of 45 apparently came from data on North Atlantic porbeagles (Ministry of Fisheries 2004).

Rig, school shark and spiny dogfish
Data for the wet fins CF for these three species were reported by Johnston (1994). A CF of 28.6 was obtained for 117 rig sampled from QMA 8; a mean CF of 27.8 was obtained for 338 school shark from QMAs 1 and 7; and a CF of 33.7 was obtained for 102 spiny dogfish sampled from Tasman Bay (QMA 7). The mean CF across all three species was 30.0 and this was adopted as the official CF for each of the three species (Ministry of Fisheries 2004).

Dark and pale ghost shark, elephantfish
No species-specific data were available, so the CFs for these three species were based on the mean CF of 30.0 estimated for rig, school shark and spiny dogfish as described above (Ministry of Fisheries 2004).

Table 1: Current shark wet fin conversion factors for nine QMS shark species, and dressed state conversion factors for two QMS shark species (Source: Fisheries (Conversion Factors) Notice 2011 (No. F607), New Zealand Gazette 157, 14 October 2011.) Also shown are shark fin ratios (the inverse of the CFs, expressed as percentages), and the year of first use of the current CF.

Species	Scientific name	Code	State	Conversion factor	Fin ratio (%)	CF first used
Blue shark	*Prionace glauca*	BWS	Fins	48	2.08	2004
Mako shark	*Isurus oxyrinchus*	MAK	Fins	59	1.69	2004
Porbeagle shark	*Lamna nasus*	POS	Fins	45	2.22	2004
Rig	*Mustelus lenticulatus*	SPO	Fins	30	3.33	1993
School shark	*Galeorhinus galeus*	SCH	Fins	30	3.33	1993
Spiny dogfish	*Squalus acanthias*	SPD	Fins	30	3.33	1993
Dark ghost shark	*Hydrolagus novaezealandiae*	GSH	Fins	30	3.33	1993
Pale ghost shark	*Hydrolagus bemisi*	GSP	Fins	30	3.33	1993
Elephantfish	*Callorhinchus milii*	ELE	Fins	30	3.33	1993
Dark ghost shark	*Hydrolagus novaezealandiae*	GSH	Dressed	3.4		1998
Pale ghost shark	*Hydrolagus bemisi*	GSP	Dressed	3.4		2000

2.2 Dressed state conversion factors

Dark ghost shark

The CF for dressed dark ghost shark was first set at 2.0 in 1986, then increased to 2.3 in 1992, and further increased to 3.4 in 1998 (Blackwell & Anderson 2008) where it has remained ever since. Two reports that analysed dark ghost shark samples collected from the east coast South Island during trawl surveys in 1992 and 1993 recommended a CF of 2.85 based on undefined ‘standard cuts’ (Johnston 1993, 1994). The 1998 increase was based on an analysis of 52 observer tests carried out aboard large offshore trawlers targeting mainly hoki in Fisheries Management Areas (FMAs) 3 and 4 in 1996−98 (Johnston 2000; Blackwell 2003).

Pale ghost shark

The CF for pale ghost shark was set at the same level as that for dark ghost shark in 2000, one year after it entered the QMS.

3. METHODS

3.1 Definitions

Current definitions of shark fin and dressed weight states are provided in both Conversion Factors and Reporting regulations as follows (emphasis added):

Fisheries (Conversion Factors) Notice 2011 (No. F607), New Zealand Gazette 157, 14 October 2011

“Dressed … means in relation to all species of sharks and ghost sharks (including elephant fish), the body of a fish from which the head, gut, and fins have been removed with:
(i) the anterior cut being a straight line passing immediately behind the posterior insertions of both pectoral fins; and
(ii) the forward angle of the anterior cut not less than 90 degrees in relation to the longitudinal axis of the fish; and
(iii) no part of the tail cut forward of the posterior base of the anal fin, or in ghost sharks, elephant fish and those species without an anal fin, forward of the posterior base of the second dorsal fin; and
(iv) the belly-flap may be removed by a cut, no part of which is dorsal to the cartilaginous backbone”

“Fins, with respect to the species of shark referred to in (a) to (d), means the state where the head, body and internal organs may be discarded, but the fins must be retained as follows:
(a) in relation to all spiny dogfish species, the pectoral fins and **the caudal (tail) fin must be retained**:
(b) in relation to school shark, the pectoral fins and dorsal fins and **either the caudal (tail) fin or the dorsal lobe of the caudal (tail) fin must be retained**:
(c) in relation to rig, ghost shark, sixgill shark, sevengill shark, and elephant fish, the pectoral fins and anterior dorsal fin must be retained:
(d) in relation to black shark, blue shark, whaler sharks, hammerhead shark, mako shark, porbeagle shark and all other species of shark, the pectoral fins, dorsal fin(s) and **caudal (tail) fin must be retained**”

“Wet fins, in relation to blue, mako and porbeagle shark, means the state in which:
(a) the head, body and all internal organs have been discarded, and
(b) the pectoral fins, dorsal fin and **caudal fin have been retained**, and
(c) the pectoral fins, dorsal fin and caudal fin have not undergone any drying and their moisture content is equal to or greater than 18%”

Fisheries (Reporting) Regulations 2001

"Shark fins, in the case of fish **landed in more than 1 state**, means,
(a) in relation to all spiny dogfish species, the state in which the pectoral fins and caudal (tail) fin have been landed:
(b) in relation to school shark, the state in which the pectoral fins and dorsal fins and **either the caudal (tail) fin or the bottom lobe of the caudal (tail) fin** have been landed:
(c) in relation to rig, ghost shark, sixgill shark, sevengill shark, and elephant fish, the state in which the pectoral fins and anterior dorsal fins have been landed:
(d) in relation to black shark, blue shark, whaler shark, mako shark, porbeagle shark, and basking shark, the state in which the pectoral fins, dorsal fins, and **caudal (tail) fins** have been landed"

"Wet fins in relation to blue shark, mako shark, or porbeagle shark, means the state in which
(a) the head, body, and all internal organs, except the pectoral fins, dorsal fin, and **lower lobe of the caudal fin**, have been removed; and
(b) no drying or other processing of the pectoral fins, dorsal fin, or lower lobe of the caudal fin has occurred"

Note that the definition of "shark fins" in the Reporting Regulations applies to sharks for which another body part (typically the trunk) has also been landed and the fins are therefore a secondary landed state. However, the "wet fins" definition is for a primary landed state.

For wet shark fins, there are some important differences among species, and some inconsistencies between the gazetted state and the reporting requirements, in how the tail (caudal) fin is treated. The gazetted state requires retention of the *whole tail* for spiny dogfish, blue shark, mako shark and porbeagle shark (among others); *no tail* for rig, elephantfish and ghost shark (species not specified) (among others); and *whole tail or dorsal tail lobe* for school shark. The dorsal lobe of the tail mentioned for school shark has no cartilaginous fin needles and is not used in making shark fin soup; this appears to be a drafting error and the definition should instead refer to the ventral (lower) lobe of the tail. Furthermore, the school shark definition includes two allowed tail processing states (whole or dorsal lobe only) which would lead to substantially different fin ratios.

The reporting requirements for school shark correctly specify that the *lower* [i.e. ventral] *lobe of the caudal fin* is to be retained. The reporting requirements for blue, mako and porbeagle sharks specify retention of the whole tail under the 'shark fins' definition but only the *lower lobe of the caudal fin* under the 'wet fins' definition. The fin ratio for the latter would differ substantially from the gazetted state that includes the whole tail fin. This confusion over how to treat the tail fin has translated into the surface longline fleet, where chartered Japanese vessels routinely retain the whole tail, whereas New Zealand domestic vessels retain only the lower lobe of the tail (Francis 2013).

In this study, shark fin sets weighed by MPI observers comprised a variety of different fins. These were classified into nine different fin composition codes, plus an 'unknown' category (Table 2).

The MPI Observer Programme uses the term 'test' to refer to a dataset containing whole and processed weights collected for the purpose of calculating conversion factors. I follow that usage here, but note that in this report, a test may consist of multiple individual tests that have been aggregated as described in Section 3.3.

Fishing years (1 October to 30 September) are used throughout this report, and are labelled after the second year of the pair (e.g. the 2013−14 fishing year is labelled 2014).

Table 2: Shark fin composition codes assigned to shark fin sets comprising different fins, as identified by observers. Fin code U indicates that the fin set composition is unknown.

Code	Pectoral (x2)	First dorsal	Second dorsal	Tail (whole)	Tail (lower lobe)	Pelvic (x2)	Anal
A	Y	Y	–	Y	–	–	–
B	Y	Y	Y	Y	–	–	–
D	Y	Y	–	–	Y	–	–
E	Y	Y	–	–	–	–	–
J	Y	Y	Y	Y	–	Y	–
K	Y	Y	Y	Y	–	Y	Y
L	Y	Y	Y	Y	–	–	Y
M	Y	Y	–	Y	–	Y	–
N	Y	Y	–	–	–	Y	–
U	?	?	?	?	?	?	?

3.2 Data sources

For the species of interest, we extracted all available observer data on fin weights, dressed weights, and their associated whole weights and numbers of individuals, from the MPI observer database *COD* on 21 August 2014. Weights were measured at sea on spring balances, platform scales, or electronic motion-compensated scales, or estimated by the observer, so they are subject to variable levels of inaccuracy, and potentially also measurement or estimation bias. Ancillary information on vessel identity (as an anonymous numeric key), vessel nationality, FMA, fishing method, date, CF test validity (Y/N), and CF test type (Random, Non-random) were also extracted. Random CF tests occurred where processed weight was measured on a different sample of the same number of fish than was used to measure whole weight; Non-random tests used the same sample for both measurements. Random tests were only available for dressed dark and pale ghost shark. For shark fin measurements on all species, CF tests were always Non-random. The test type field was not used before about the middle of 2001, and I assumed that tests with this field blank were Non-random (see also Anderson 2012). Examination of the data for fish used in CF tests showed that some pairs of Random and Non-random tests from the same tow had the same fish whole weights and the same fish numbers, indicating that the two tests were carried out on the same sample of fish. Such paired tests are not independent so one of each pair was randomly removed from the dataset, after Anderson (2012). This resulted in the removal of seven dark ghost shark and 17 pale ghost shark CF tests.

Additional data were collected by observers for this study and a previous one (Francis 2013) using a targeted approach. Observers focussed on SLL vessels for blue, porbeagle and mako shark fin weights between 2011 and 2014, and on trawl (TWL) vessels for dark and pale ghost shark dressed weights, and school shark, mako shark and porbeagle shark fin weights, in 2014. Data were collected on specially designed sheets that allowed observers to record which fins comprised each fin set (Appendices 1 and 2).

During tests, sharks were often at least partially processed by observers rather than the crew, because the crew were not retaining fins for sale on a number of the trips (especially TWL trips). However, experienced crew members usually instructed observers in their normal commercial processing methods prior to observer processing of sharks.

3.3 Data processing and analysis

A few CF tests were reported by the observer to be ‘invalid’ and they were removed from the *COD* dataset. *COD* fin state codes FIN and FIW are believed to represent the same state, and they were combined. Shark fin composition codes (Table 2) were assigned to all *COD* and additional observer records based on observer descriptions of which fins were included in each set. For both *COD* and the additional observer data, whole and processed weights and numbers were aggregated by species, fin composition code and trip. *COD* and additional data were then merged into a single data file. Aggregated shark fin data used in this study are shown in Appendix 3.

The following derived variables were calculated for each aggregated record:
mean weight = (whole weight)/(number of sharks)
CF = (whole weight)/(dressed weight)
fin ratio = 100 * (fin weight)/(whole weight)

For shark fins, the distribution of the fin ratios for each species was inspected by plotting them against trip, vessel, fishing year, method/nationality (treated as a combined variable), fin code and mean weight, and compared with the current legislated fin ratio. For dressed sharks, the distribution of the CFs for each species was inspected by plotting them against trip, vessel, fishing year, method/ nationality, FMA, month, test type and mean weight, and compared with the current legislated CF. Month was not considered an influential variable for shark fins because most of the data were collected over only a few months of the year (typically April−June) by the surface longline (SLL) fleet. FMA was not considered for shark fins as it was confounded with vessel nationality for SLL vessels (most data from Japanese chartered vessels came from FMAs 5 and 7, whereas most data from domestic vessels came from FMAs 1, 2 and 9).

Dressed weight CFs for dark and pale ghost shark were estimated using a linear mixed effect model (LME) following the methods of Middleton (2008) and Anderson (2012). *Vessel* and *trip* were treated as random variables, with *trip* nested within *vessel*. The following fixed factors were supplied as potential predictors: *year*, *fleet* (a combination of method and nationality), *FMA*, *month*, *test type*, and *mean weight*. Stepwise model selection was carried out using the Akaike Information Criterion (AIC) and approximate 95% confidence intervals for parameters were obtained using a normal approximation to the distribution of the maximum likelihood estimators (Middleton 2008).

4. RESULTS

4.1 Shark fin ratios – species subject to ratio approach

Mako shark

Data were available from 18 observer trips, 13 of them on chartered Japanese SLL vessels; only three tests were available from domestic SLL vessels and two from domestic trawlers (Figure 1). The number of sharks analysed was small (N = 119). Calculated fin ratios were highly variable ranging from 1.33% to 4.84%.

The three domestic SLL vessels retained only the lower lobe of the caudal fin (fin code D) and had significantly lower fin ratios (1.33−2.47%, median 2.39% based on 18−22 sharks per test) than Japanese SLL vessels and two domestic trawlers which retained the whole caudal fin (fin code A, range 2.85−4.84%, median 3.52%, N = 15 tests). The two domestic trawlers had higher fin ratios (range 4.05−4.37%) than most of the Japanese SLL vessels. The domestic SLL vessel fin ratios straddled the current gazetted fin ratio of 1.69%, while the Japanese SLL and domestic TWL ratios were well above it.

Porbeagle shark

Data were available from 19 observer trips, 13 of them on chartered Japanese SLL vessels; only one test was available from a domestic SLL vessel, and five from trawlers of three nationalities (Figure 2). The number of sharks analysed was small (N = 146). Calculated fin ratios were highly variable ranging from 2.50% to 5.07%.

The single domestic SLL vessel retained only the lower lobe of the caudal fin (fin code D) and had the lowest observed fin ratio (2.50%), but this was based on only one porbeagle shark. Japanese SLL vessels retained the whole caudal fin (fin code A) and had variable but higher fin ratios (range 3.49−5.07%, median 4.01%, N = 13 tests). The five trawler samples had similar fin ratios to the Japanese SLL vessels (range 3.00−4.42%, median 4.24%). The single domestic SLL vessel fin ratio was near the current gazetted fin ratio of 2.22%, while the Japanese SLL and TWL ratios were well above it.

Rig

No observer data were available for fin ratio analysis, but a previously published fin ratio estimate is available (see Section 5.1).

School shark

Data were available from 14 observer trips, all of them on TWL vessels (Figure 3). The number of sharks analysed was small (N = 166). Calculated fin ratios were highly variable ranging from 1.94% to 5.95%. However the lowest value was an outlier, based on only four fish having a high mean weight of 14.9 kg; the next lowest was 3.68%. There appeared to be a decline in fin ratio with increasing mean weight.

All tests except the outlier mentioned above fell above the current gazetted fin ratio of 3.33%, many of them by a substantial amount. This is at least partly attributable to the fact that all of the fin codes represented in the tests included the whole tail.

Dark ghost shark

Data were available from only four observer trips, all of them on TWL vessels, and the number of sharks involved was small (N = 193) (Figure 4). Calculated fin ratios covered a wide range between 4.79% and 10.36%, but one of the tests (from a Ukraine trawler) was a high outlier with the next highest ratio being 6.96%. The fin ratios were all substantially higher than the gazetted value of 3.33%. Fin code N, used by an observer on one vessel, includes the pelvic fins as well as the pectoral and dorsal fins, and may not reflect typical commercial practice. Surprisingly, the fin ratio for that trip fell within the range of ratios obtained on other vessels for fin code E which excludes the pelvic fins.

Pale ghost shark

Data were available from only three observer trips, all of them on TWL vessels, and the number of sharks involved was small (N = 218) (Figure 5). Calculated fin ratios covered a small range between 4.77% and 6.24%. The fin ratios were all substantially higher than the gazetted value of 3.33%.

Elephantfish

No observer data were available for fin ratio analysis, but see Section 5.1 for further discussion.

4.2 Shark fin ratios – species not subject to ratio approach

Blue shark

Data were available from 22 observer trips, most of them on chartered Japanese SLL vessels; only two tests were available from domestic SLL vessels (Figure 6). The number of sharks analysed was high (N = 4037). Calculated fin ratios were highly variable ranging from 2.02% to 9.32%. However the maximum value was extreme (the next largest being 6.88%), and resulted from a sample of only five sharks that had the smallest recorded mean weight of 8.8 kg, suggesting either a data error, or that small sharks have markedly higher fin ratios than larger sharks.

Three of the four tests with unknown fin code came from Japanese SLL vessels, and so were probably fin code A; the fourth was from a Ukraine trawler.

The two domestic vessels retained only the lower lobe of the caudal fin (fin code D) and had significantly lower fin ratios (2.02% based on 883 sharks, and 3.54% based on 136 sharks) than Japanese vessels which retained the whole caudal fin (fin code A, range 4.1−6.8%, median 4.7%, N = 14 tests). The domestic SLL vessel fin ratios were near or above the current gazetted fin ratio of 2.08%, and the Japanese SLL ratios were well above the current ratio.

Spiny dogfish

Data were available from only 4 observer trips − one on a bottom longline (BLL) vessel and the rest on TWL vessels (Figure 7). Nevertheless, the number of sharks analysed was moderate (N = 1151). Calculated fin ratios had a medium range between 2.61% to 3.89%, but the fin code was not known for any of the trips. The fin ratios straddled the gazetted value of 3.33%.

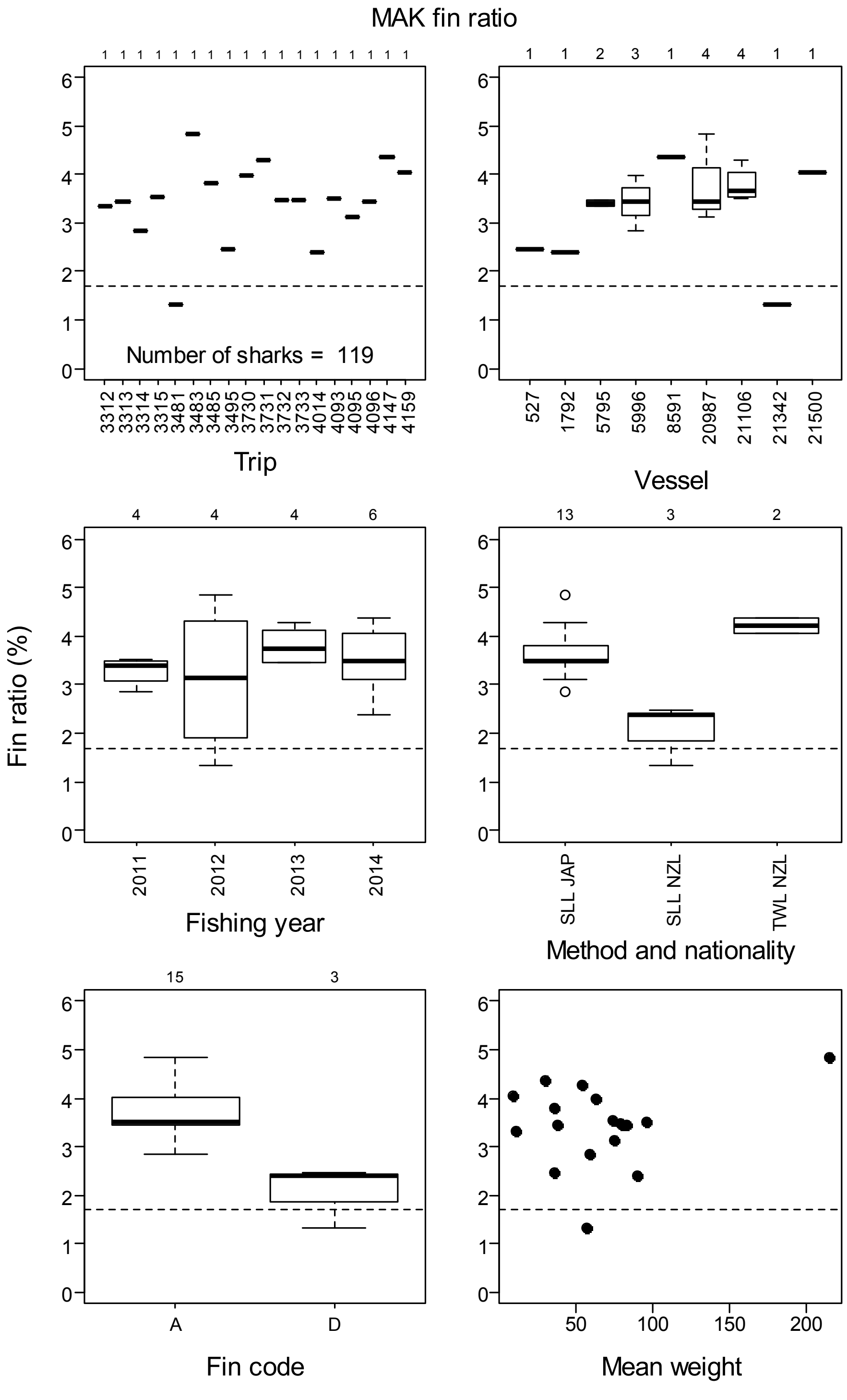

Figure 1: Mako shark fin ratios relative to selected variables. Medians are indicated by bold horizontal lines, interquartile ranges by the boxes, the most extreme data points which are no more than 1.5 times the interquartile range from the box by the whiskers, and outliers by circles. The number of strata (trip/fin code) contributing to each factor level is shown above the plot, and the overall number of sharks in the dataset is shown in the top left plot. The horizontal dashed line is the current fin ratio (inverse of the conversion factor). Fin codes are defined in Table 2.

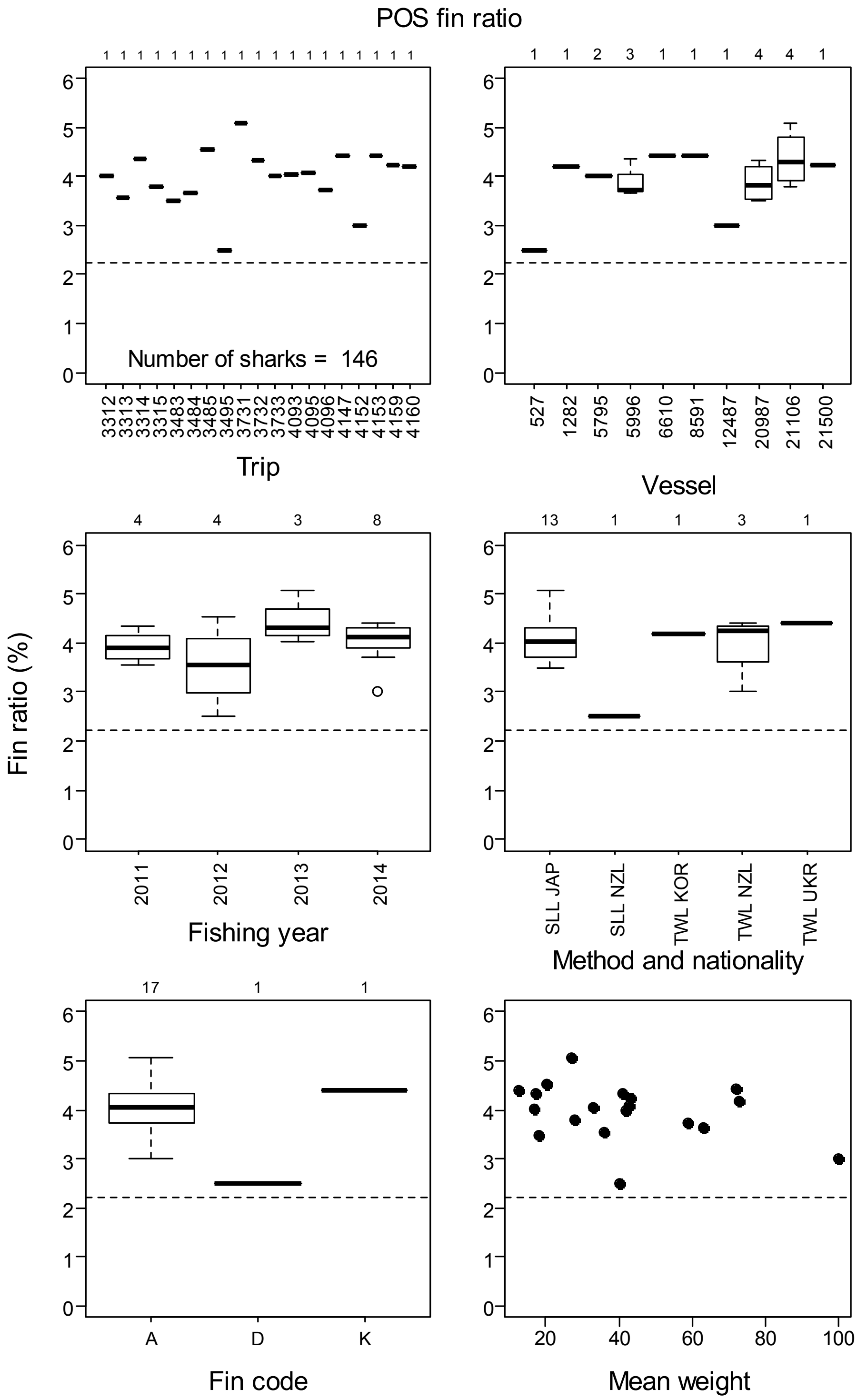

Figure 2: Porbeagle shark fin ratios relative to selected variables. See Figure 1 caption for further explanation.

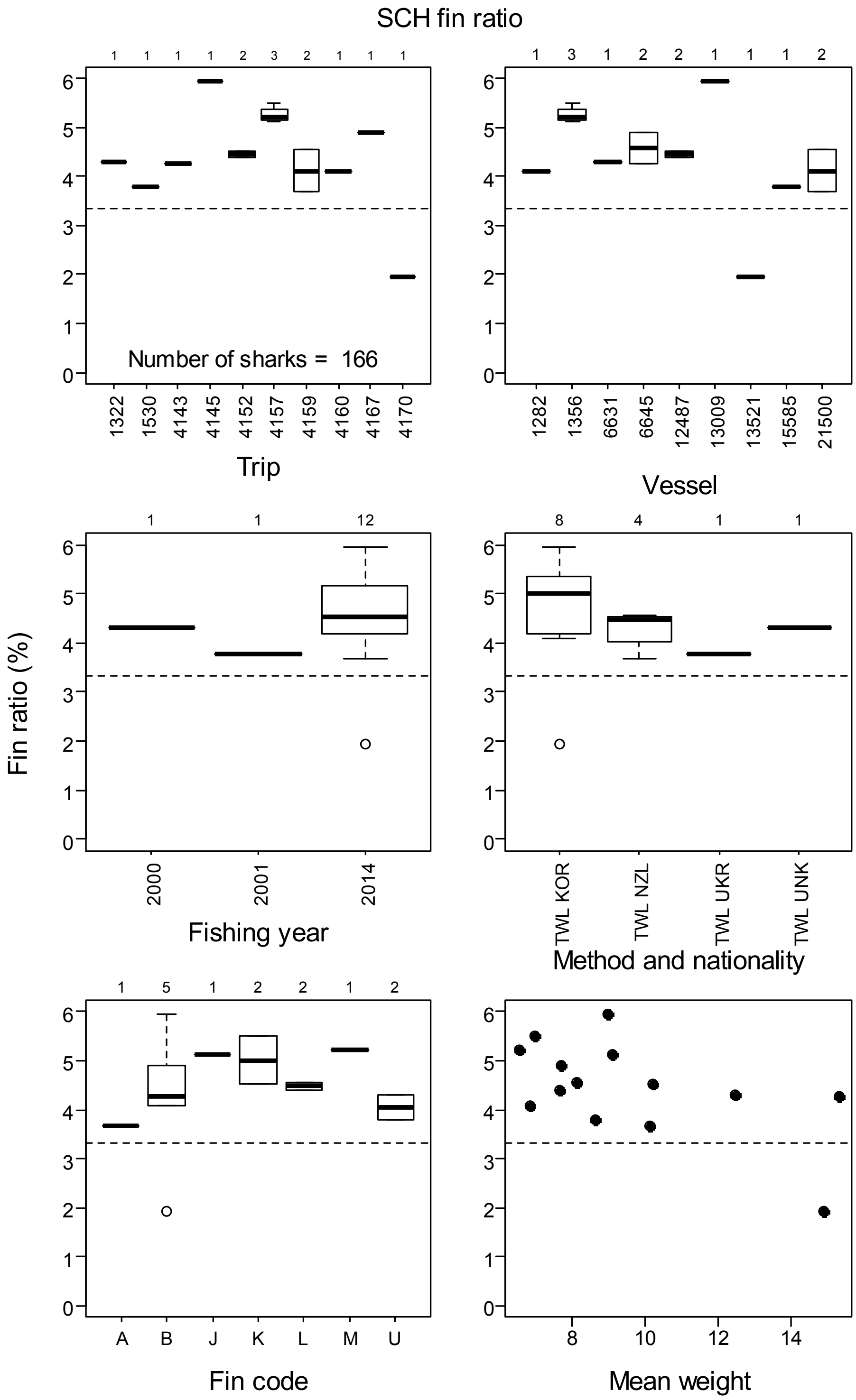

Figure 3: School shark fin ratios relative to selected variables. See Figure 1 caption for further explanation.

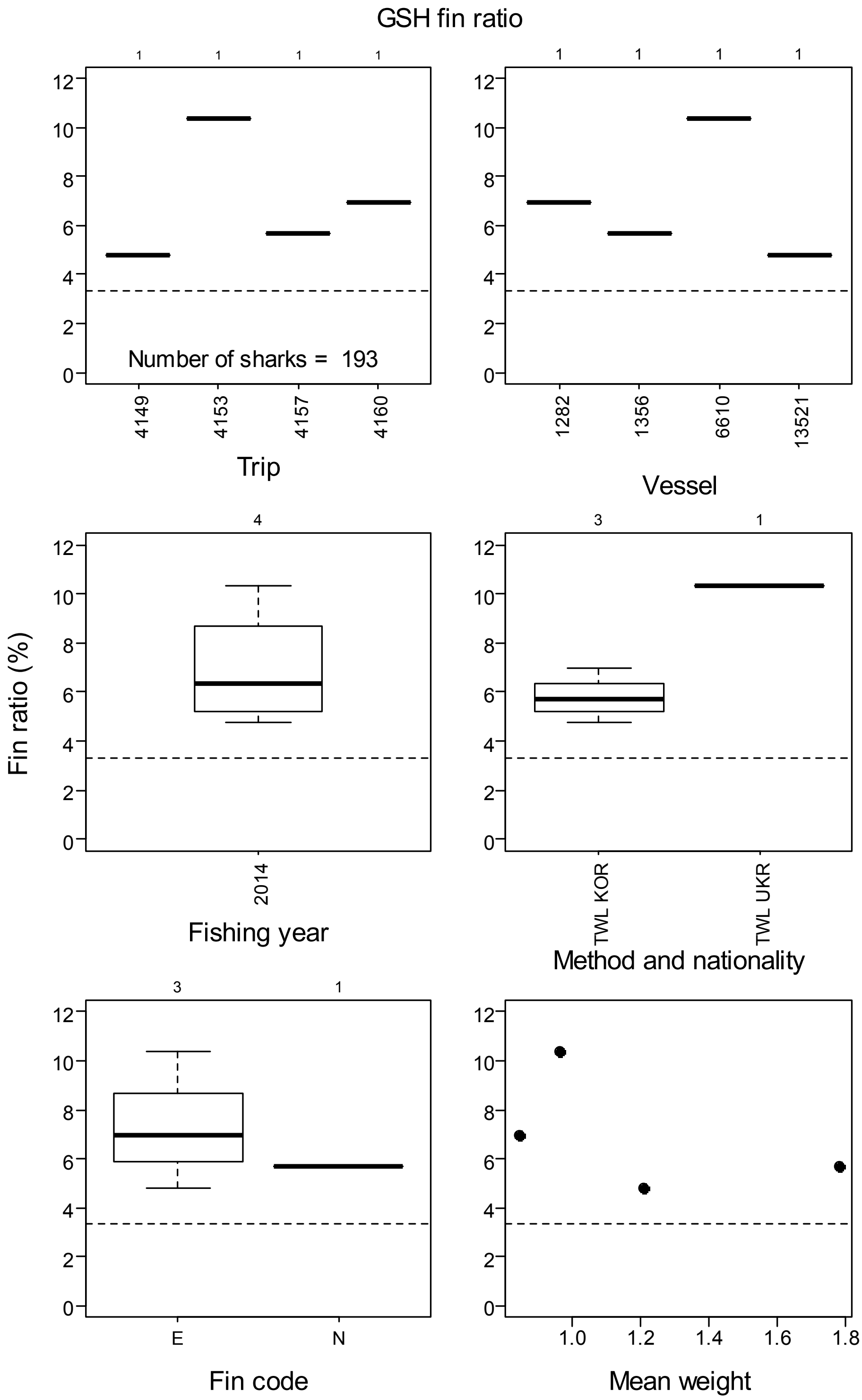

Figure 4: Dark ghost shark fin ratios relative to selected variables. See Figure 1 caption for further explanation.

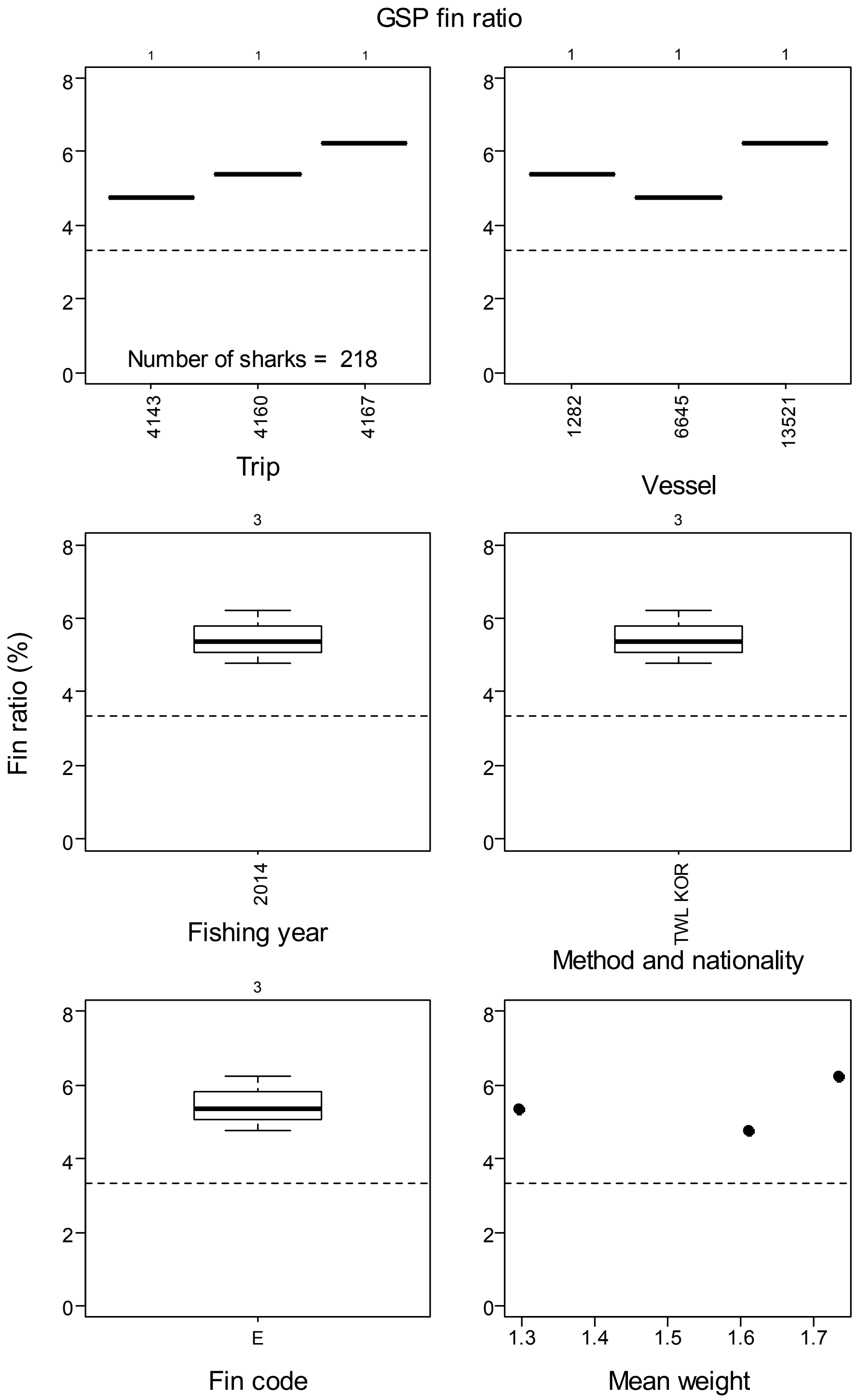

Figure 5: Pale ghost shark fin ratios relative to selected variables. See Figure 1 caption for further explanation.

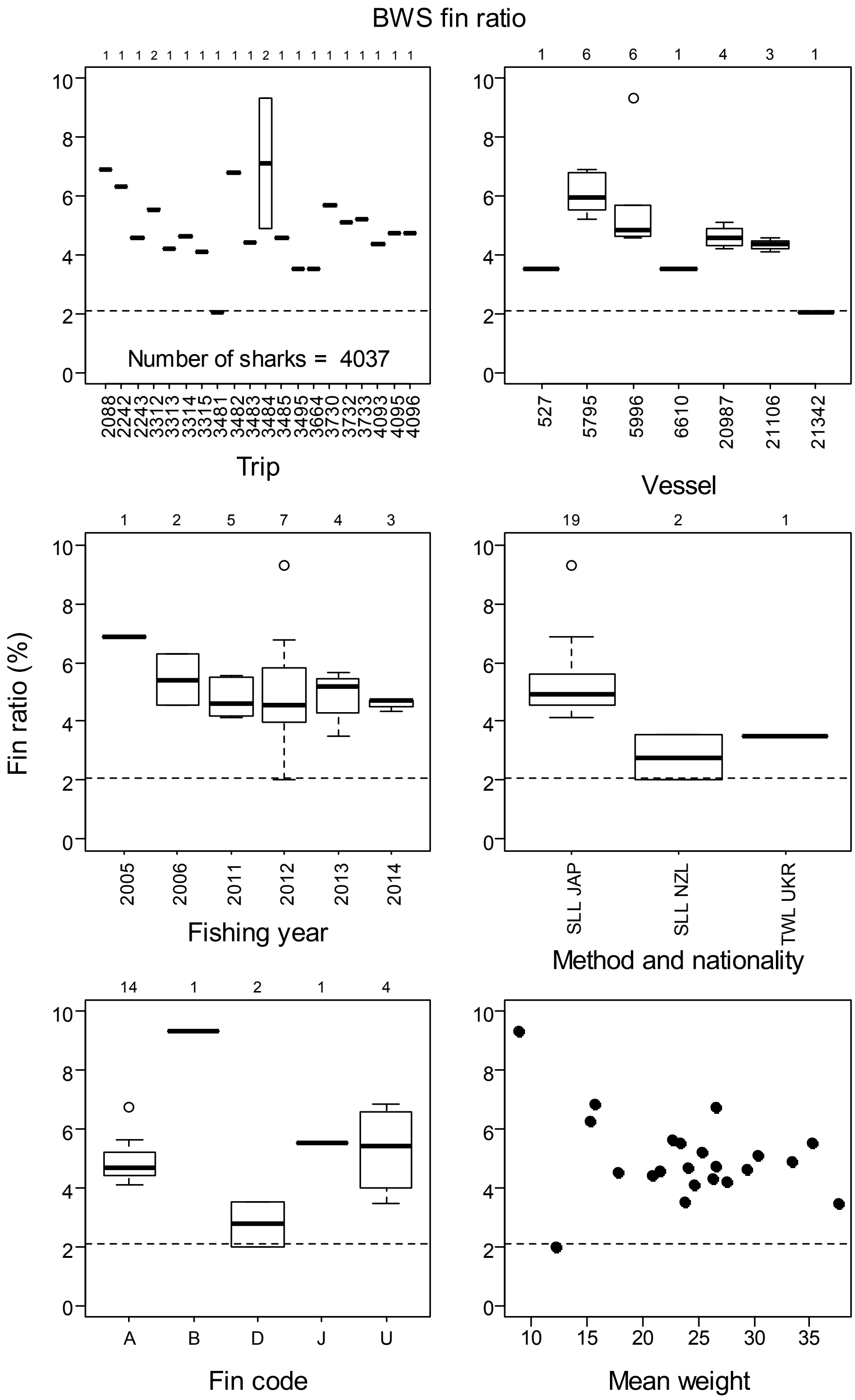

Figure 6: Blue shark fin ratios relative to selected variables. See Figure 1 caption for further explanation.

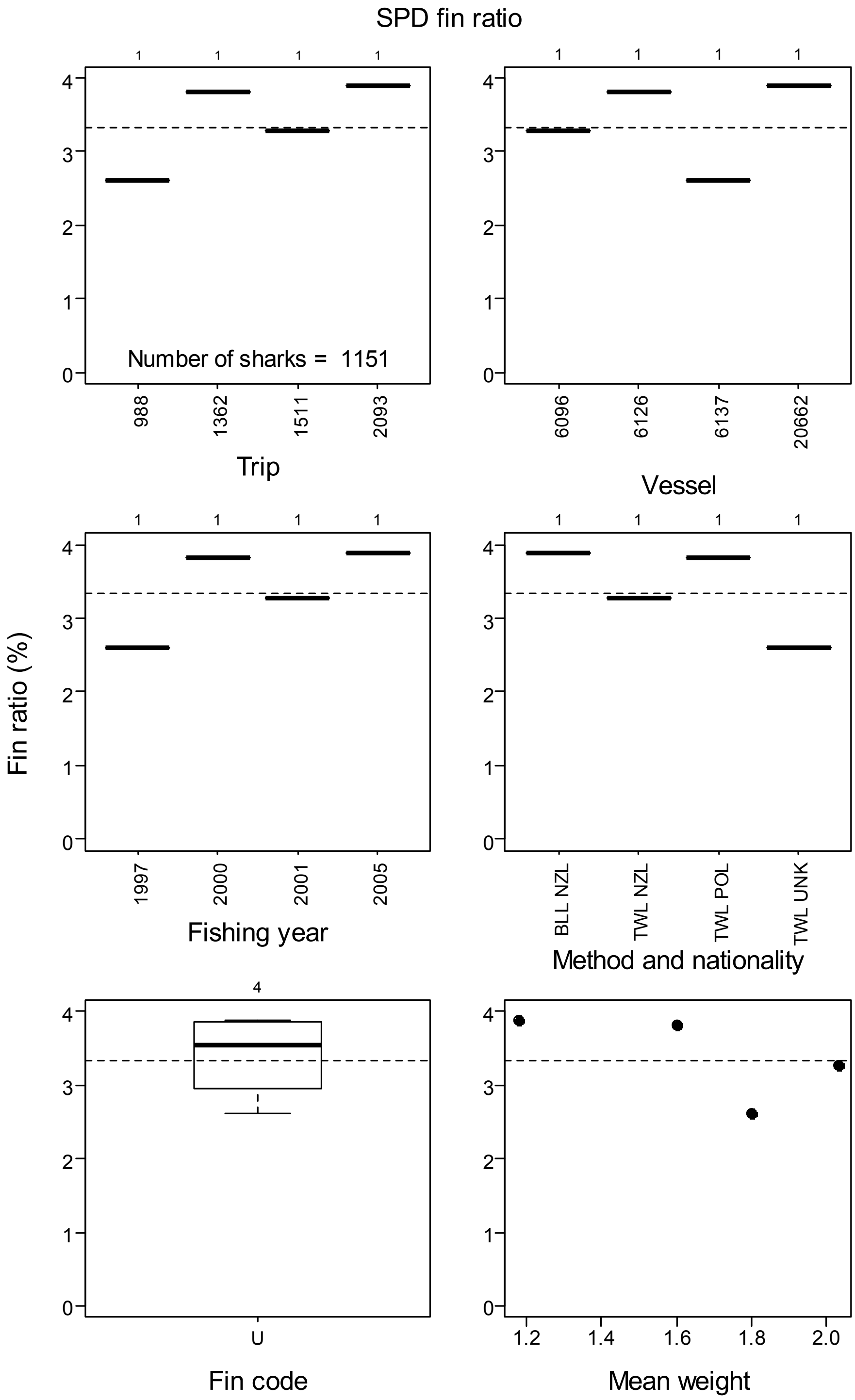

Figure 7: Spiny dogfish fin ratios relative to selected variables. See Figure 1 caption for further explanation.

4.3 Dressed weight conversion factors

Dark ghost shark

A large number of dressed weight CF tests were available (N = 150) comprising many sharks (N = 11 920). They spanned most years between 1989 and 2014, and there was no obvious annual pattern in the CFs; however, in most years the median CF fell below the gazetted value of 3.40 (Figure 8). Most of the data came from trawlers, but five tests came from BLL vessels (Figure 9). Nearly all of the tests came from FMAs 3−7. There appeared to be a seasonal pattern in the data, with low values in June−August, but sample sizes were small in those months. Non-random tests predominated.

A stepwise LME model included only one explanatory variable – *FMA*. However, only FMA 2 differed significantly from the reference FMA (= FMA 1), and then only marginally (p = 0.045). Furthermore the significant FMA 2 coefficient was based on only a single test, and FMA 2 landings of GSH are minor (2.5−4.1% of the national total over the period 2009−2013). I therefore regard the significant *FMA* effect as spurious and unimportant, and removed it from the model. Consequently the best model was very simple, having only an intercept term (in addition to the random variables *vessel* and *trip*). The model intercept therefore provides the best estimate of the CF for these data: 3.21 ± 0.04 (estimate ± standard error). This is slightly but significantly lower than the current gazetted value of 3.40.

For species having many available CF tests, an alternative approach is to model the individual test results, rather than aggregating them across trips (Middleton 2008; Anderson 2012). I tested the effect of this for dark ghost shark by re-fitting the LME model to non-aggregated data. The result was essentially identical with only FMA being selected as an explanatory variable, and after removing FMA (for the same reasons discussed above) the CF estimate was 3.22 ± 0.04.

Pale ghost shark

A large number of dressed weight CF tests were available (N = 133) comprising many sharks (N = 11 628). They spanned many years between 1989 and 2013, though few tests were made before 1999; there was no obvious annual pattern in the CFs (Figure 10). Most of the data came from trawlers, but eight tests came from BLL vessels (Figure 11). Nearly all of the tests came from FMAs 3−6. There was a hint of a seasonal pattern in the data, with low values in August−September, but sample sizes were small in those months. Non-random tests predominated over Random tests by 117:16.

A stepwise LME model fitted to the whole dataset failed to produce a positive-definite variance-covariance matrix, which is necessary for estimation of confidence intervals. This probably resulted from the small sample size in some years, and was resolved by dropping the two 1989 tests from the dataset. The re-fitted stepwise model included two explanatory variables – *test-type* and *FMA*. However, none of the individual FMAs differed significantly from the reference FMA (= FMA 1) (Figure 12). I therefore removed *FMA* from the model and refitted it with *test-type* as the only explanatory variable. The estimated CF for Random tests was 3.47. Random tests are regarded as superior to Non-random tests, because they avoid any possible bias associated with crew changing their processing practices when they know a test is being conducted (Middleton 2008; Anderson 2012). To estimate the confidence intervals for Random tests, all Non-random tests were excluded and the model re-fitted on the considerably reduced data set (16 tests compared with 133). The intercept estimate from an LME model on Random data only with no explanatory variables was 3.50 with a standard error of 0.09, which is not significantly different from the current gazetted value of 3.40.

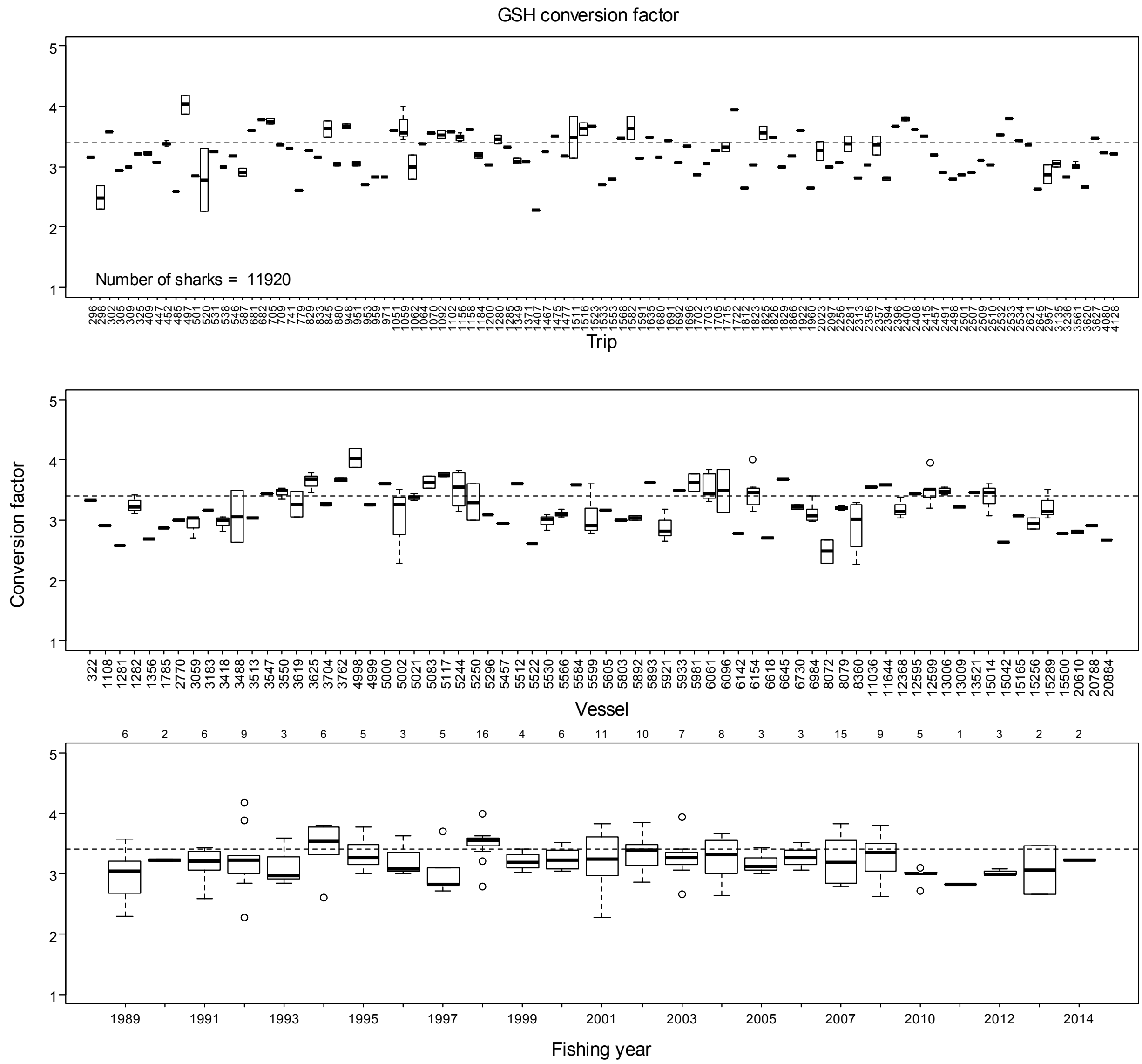

Figure 8: Dark ghost shark dressed weight conversion factors relative to selected variables. Medians are indicated by bold horizontal lines, interquartile ranges by the boxes, the most extreme data points which are no more than 1.5 times the interquartile range from the box by the whiskers, and outliers by circles. The number of strata (trip/fin code) contributing to each factor level is shown above the plot, and the overall number of sharks in the dataset is shown in the top left plot. The horizontal dashed line is the current conversion factor.

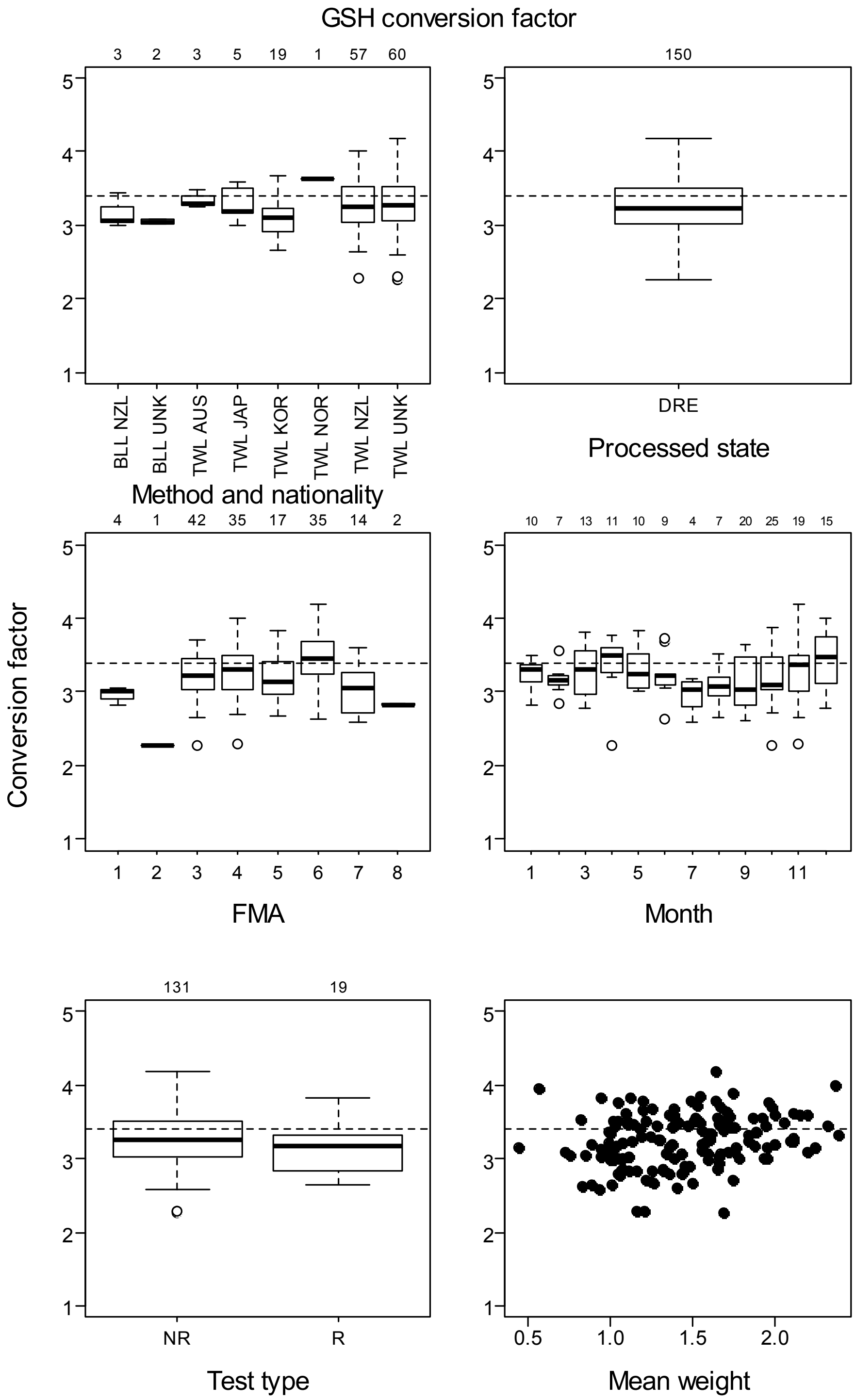

Figure 9: Dark ghost shark dressed weight conversion factors relative to selected variables. See Figure 8 caption for further explanation.

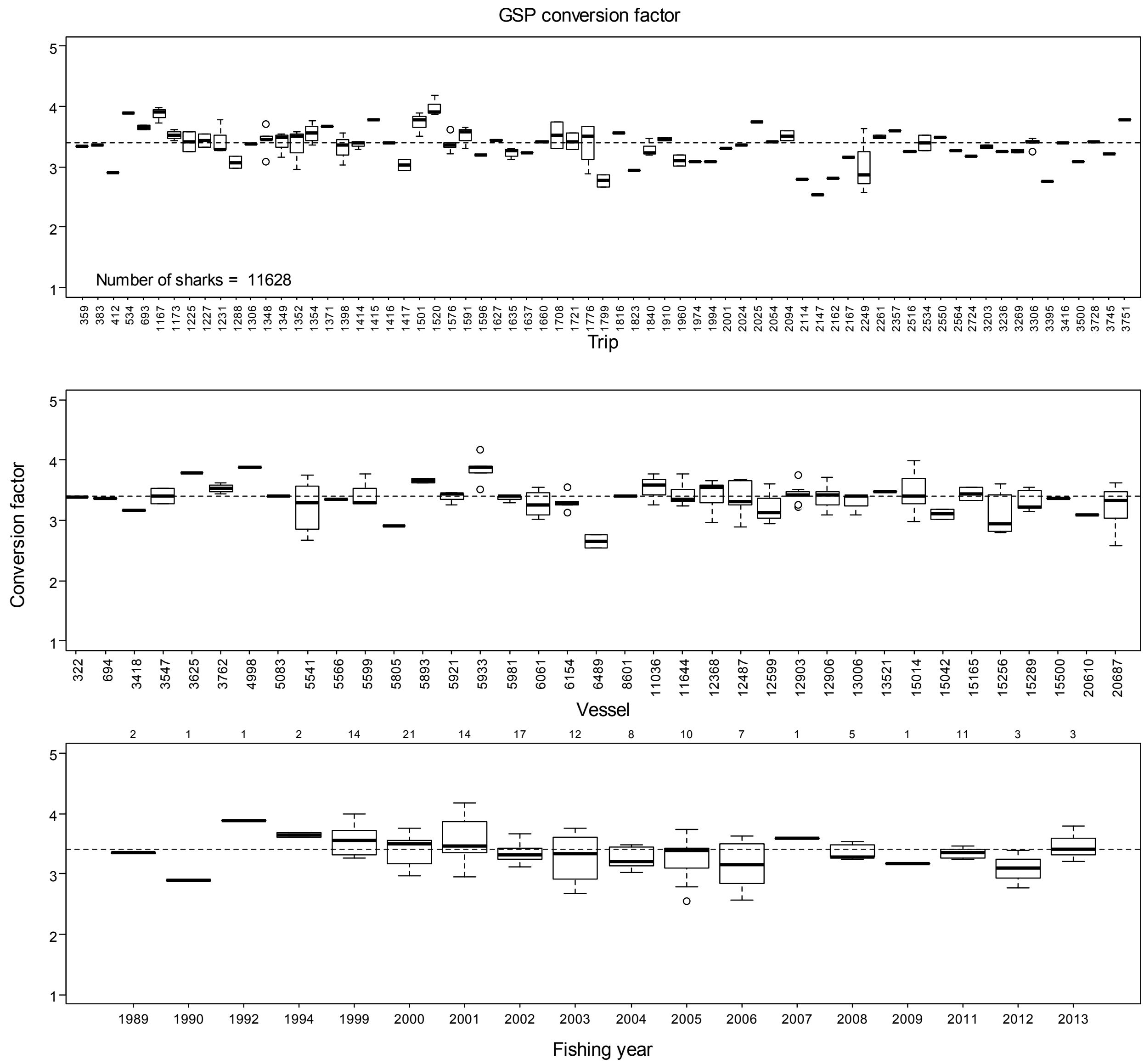

Figure 10: Pale ghost shark dressed weight conversion factors relative to selected variables. See Figure 8 caption for further explanation.

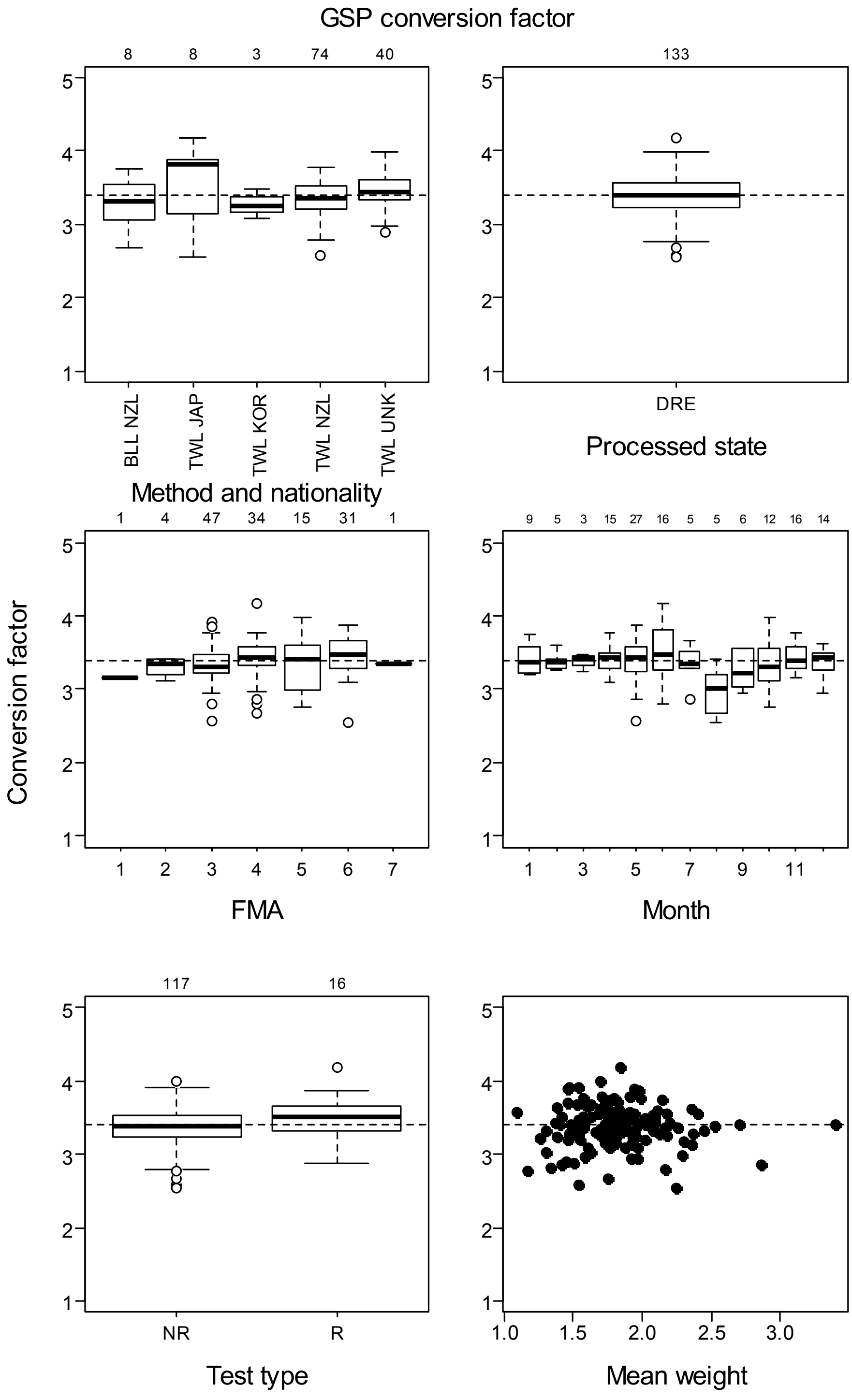

Figure 11: Pale ghost shark dressed weight conversion factors relative to selected variables. See Figure 8 caption for further explanation.

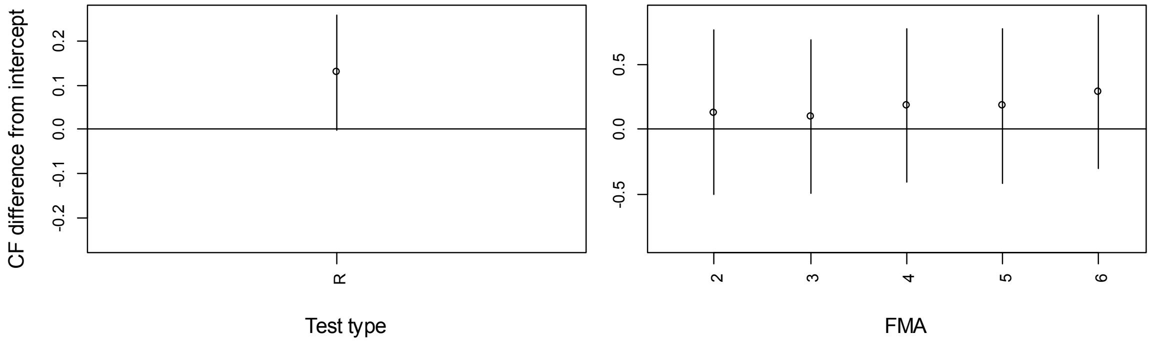

Figure 12: Linear mixed model effects and their 95% confidence intervals for pale ghost shark.

5. DISCUSSION

5.1 Shark fin ratios

The shark fin weight data that were available for analysis in this study suffered from some serious limitations and potential biases and errors:

1. Data were usually sparse and probably unrepresentative of the fishery. The numbers of trips and/or sharks sampled were small for all species except blue shark. No data were available for rig or elephantfish.
2. Shark fin processing was not always done by the crew, so some processing may have differed from normal commercial practice.
3. Shark fin ratios were usually highly variable. This is partly attributable to the diversity of fins retained, and whether or not the whole tail was included in the fin set. However, fin ratios sometimes varied considerably within fin codes, and some notable outliers could not be explained on the basis of their reported fin codes.
4. Many tests were conducted without the use of motion-compensated scales, potentially leading to large errors in at-sea measurements. In some tests, the observer estimated rather than weighed whole weight. These factors undoubtedly contributed to the large variability, but would have been ameliorated somewhat, providing there was no overall bias, by the aggregation of data by trip.
5. All shark fin tests were Non-random, potentially leading to biased measurements through altered processing techniques.

It is therefore difficult to draw strong conclusions from the analyses presented here. A major issue for fishers has been the apparent confusion over whether shark fins sets should include the entire tail or just the lower lobe. For pelagic sharks (blue, porbeagle and mako sharks), this is an important consideration, because Japanese chartered SLL vessels typically included the whole tail, whereas the New Zealand domestic SLL vessels typically retained only the lower lobe (Francis 2013). Unfortunately few tests were carried out aboard the domestic fleet, making it difficult to estimate an appropriate fin ratio for them. Similarly, the definition of fins for school sharks allows the inclusion of just the lower lobe or inclusion of the whole tail (see Section 3.1). The school shark tests available for this study all included the whole tail, but it is not known if this represents the usual practice across the commercial fishery.

Summary statistics for the fin ratio estimates made during this study are shown in Table 3. As well as the median, I provide reference points that may be useful for managers when making decisions about appropriate fin ratios. These are the median and minimum across all fin codes, and the 25th, 50th (= median), 75th and 95th percentiles for fin codes A, B, D and E (where relevant and available). Caution is required, however, when using these reference points, as some of the species/fin code combinations were based on very few tests. In some cases the analyses in this study incorporated no or few tests in which only the lower lobe of the tail was retained (fin code D). The reference points in Table 3 may therefore be poorly estimated or inappropriate for fin code D. In particular, no fin code D data were available for school shark or spiny dogfish (fin state was unknown for all spiny dogfish tests).

Table 3: Summary statistics for shark fin ratio estimates (as percentages) and dressed weight conversion factors (CF). Also shown in bold are the current gazetted values.

State	Statistic	BWS	GSH	GSH*	GSP	MAK	POS	SCH	SPD
Wet fins	No. tests	22	4	3	3	18	19	14	4
Wet fins	Median (all fin codes)	4.72	6.33	5.69	5.37	3.47	4.05	4.46	3.55
Wet fins	Minimum (all fin codes)	2.02	4.79	4.79	4.77	1.33	2.50	1.94	2.61
Wet fins	25th percentile fin code A	4.47	–	–	–	3.45	3.73	3.68	–
Wet fins	50th percentile fin code A	4.72	–	–	–	3.52	4.05	3.68	–
Wet fins	75th percentile fin code A	5.19	–	–	–	4.02	4.33	3.68	–
Wet fins	95th percentile fin code A	6.05	–	–	–	4.51	4.64	3.68	–
Wet fins	25th percentile fin code B	9.32	–	–	–	–	–	4.10	–
Wet fins	50th percentile fin code B	9.32	–	–	–	–	–	4.27	–
Wet fins	75th percentile fin code B	9.32	–	–	–	–	–	4.89	–
Wet fins	95th percentile fin code B	9.32	–	–	–	–	–	5.74	–
Wet fins	25th percentile fin code D	2.40	–	–	–	1.86	2.50	–	–
Wet fins	50th percentile fin code D	2.78	–	–	–	2.39	2.50	–	–
Wet fins	75th percentile fin code D	3.16	–	–	–	2.43	2.50	–	–
Wet fins	95th percentile fin code D	3.46	–	–	–	2.46	2.50	–	–
Wet fins	25th percentile fin code E	–	5.87	5.33	5.07	–	–	–	–
Wet fins	50th percentile fin code E	–	6.96	5.87	5.37	–	–	–	–
Wet fins	75th percentile fin code E	–	8.66	6.42	5.80	–	–	–	–
Wet fins	95th percentile fin code E	–	10.02	6.85	6.15	–	–	–	–
Wet fins	**Current fin ratio**	**2.08**	**3.33**	**3.33**	**3.33**	**1.69**	**2.22**	**3.33**	**3.33**
Dressed	No. tests	–	150	–	133	–	–	–	–
Dressed	Median	–	3.23	–	3.40	–	–	–	–
Dressed	Model estimate	–	3.21	–	3.50**	–	–	–	–
Dressed	**Current CF**	–	**3.40**	–	**3.40**	–	–	–	–

* Excluding one high outlier (trip 4153; see Figure 4)

** Intercept from model fitted to Random tests with no explanatory variables; N = 16 tests

Typically, no part of the tail is retained for dark and pale ghost shark fin sets, so this issue is not relevant for them. Ghost shark fin sets are thought to consist normally of the pectoral and first dorsal fins (fin code E). Fin code E could be used as the standard for ghost shark fin processing, but this should be confirmed with the fishing industry. For dark and pale ghost sharks, the observed fin ratios for fin code E were all substantially above the current gazetted values.

Results presented here extend and supersede those presented by Francis (2013) for blue, mako and porbeagle sharks using a subset of the present SLL observer data, all of which were fin code A. Francis (2013) also reported a small mako shark fin dataset collected onshore at recreational fishing competitions using accurate scales, and those fins included first dorsal, pectoral and lower caudal fins after removal of excess meat (C. Duffy, pers. comm.). That sample therefore approximated fin code D used by New Zealand domestic SLL vessels. Fin weights in the recreational data set showed clear evidence of variation with mako shark size: the fin ratio increased from a mean of 1.43% in sharks shorter than 150 cm to a mean of 2.22% for sharks 250 cm or longer. The overall mean ratio for all mako sharks was 1.71%, which is somewhat lower than the median of 2.39% for fin code D observed in the present study (Table 3), presumably because of more careful trimming of flesh from the base of the fins in the recreational fishing sample.

Comparison of the data in Figures 1−7 and the statistics in Table 3 with the current gazetted fin ratios leads to the following observations (acknowledging the caveats discussed at the beginning of this section):

1. Observed fin ratios for fin code D are near or slightly below the current gazetted fin ratios for blue, mako and porbeagle sharks.
2. No data are available for fin code D for school shark, which may have a fin ratio below the current gazetted value. An earlier study that estimated the CF for school shark fins as 27.8 (fin ratio = 3.60%) did not report the condition of the tail (Johnston 1994).
3. The fin code for spiny dogfish analysed in the present study was unknown. One of the fin ratio tests was considerably below the current gazetted value. In an earlier study, the reported wet fins CF of 33.7 (fin ratio = 2.97%) was based on a small sample of spiny dogfish (N = 102) from one location (Tasman Bay, FMA 7) (Johnston 1994) and it may not be representative. Furthermore, the composition of the fin sets was not stated, but they potentially contained no dorsal fins as the definition of spiny dogfish fins excludes the dorsals (see Section 3.1).

Current regulations exclude the dorsal fins of spiny dogfish, and the tail of rig. The latter may be because the lower caudal lobe is small and may not be desirable for shark fin soup. The reason for excluding spiny dogfish dorsal fins is unknown but possibly relates to the presence of a strong spine on the anterior edge of each. Therefore it will be important to consult with industry about which fins should comprise a fin set for these species.

The second dorsal fin and the anal fin are very small in porbeagle and mako sharks, and are rarely kept by fishers, although one observer test included these fins for porbeagle sharks (see fin code K in Figure 3). These fins can probably be omitted from the gazetted definition for these species, although they are small enough that it makes little difference whether they are included or excluded. These fins are substantially larger in other shark species (e.g. blue, school and rig sharks) and may be an important component of their fin sets (fin codes B, J, K and L, Figures 1 and 4). Spiny dogfish and their relatives (Order Squaliformes) lack an anal fin, so that fin should be excluded from their fin set definitions.

The absence of observer data for estimating a fin ratio for rig is problematic, and priority should be given to collecting such data from commercial fisheries. In an earlier study, the reported wet fins CF of 28.6 (fin ratio = 3.50%) was based on a small sample of rig (N = 117) from one location (FMA 8) and it may not be representative. Furthermore, the composition of the fin sets was not stated (Johnston 1994), but they probably contained no part of the tail, given that the definition of rig fins excludes the tail (see Section 3.1; R. Blackwell, MPI, pers. comm.). Nevertheless, the fin ratio estimate of 3.50% is the best available for rig. Some support for that ratio is provided by data for a closely related species, the smooth dogfish (*Mustelus canis*), from the north-eastern United States: a sample of 77 sharks produced a mean fin ratio of 3.58% and a 95^{th} percentile (calculated across measurements for individual sharks in one test) of 4.37, for a fin set comprising the first dorsal and pectoral fins (calculated from data in Hawk et al. 2014).

No fin weight data are available for elephantfish, so this is another high priority for observer data collection. Based on the similarity of fin sizes and body proportions of elephantfish and ghost sharks, I recommend that, as an interim measure, the fin ratio for elephantfish be set using the data provided here for dark ghost shark.

5.2 Dressed weight conversion factors

CF analyses for dressed dark and pale ghost shark in the present study were based on large numbers of tests and of sharks caught mainly on deepwater trawlers. The estimated CF for dark ghost shark (3.21) was slightly and significantly lower than the gazetted value of 3.40. The estimated CF for pale ghost shark (3.50) was higher, but not significantly so, than the gazetted value of 3.40. Furthermore, the estimate of 3.50 was based on only 16 Random tests, and may not be representative of the whole pale ghost shark fishery. Based on these data, I recommend that the CF for dressed dark ghost shark be adjusted downwards to a rounded value of 3.20, and that the CF for dressed pale ghost shark be retained at the present level of 3.40.

Two samples of dark ghost shark processed to the dressed state during research trawl surveys off the east coast of South Island in 1992 and 1993 resulted in recommended CFs of 2.85 (Johnston 1993, 1994). The size of both samples combined was only 114 sharks, and although the fish were said to be processed using 'standard cuts', they were not processed under commercial operating conditions. The indicated CF of 2.85 falls below most of the test values analysed in the present study (see Figures 8 and 9).

Two other dressed CF tests used 941 and 956 dark ghost sharks respectively that were caught in Cook Strait (QMA 7) and processed by crew either ashore or at-sea (Blackwell 2001, 2003). Overall CFs for these samples were 2.69 and 2.66 respectively. These values fall below nearly all of the observer data analysed in this study, and were based on large samples. The reason for the differences is unknown but the differences are large enough to suggest that different processing techniques were used by the inshore and offshore trawl vessels. Further investigation is required to determine whether different processed states are warranted for inshore and offshore vessels, or whether re-wording of the dressed state definition would be sufficient to ensure correct interpretation of the existing definition.

6. MANAGEMENT IMPLICATIONS

The data presented here can be used to support the development of official fin ratios for monitoring compliance with the ban on shark finning to be introduced on 1 October 2014, and for providing improved estimates of dressed weight CFs for dark and pale ghost shark. Associated with the ban on finning, a new set of landed state definitions have also been developed by MPI to reflect the new requirements for processing and reporting of shark fins and trunks. All shark fin primary state codes have been removed from both the reporting regulations and the conversion factors notice and replaced by the following definitions (Fisheries (Reporting) Amendment Regulations 2014):

1. A single definition for shark fins as a secondary landed state: "**shark fins**, in relation to any species of shark, means all primary fins* associated with that shark".
2. **A primary landed state code of "shark fins attached,"** which means:

(a) in relation to blue shark, the state in which the trunk is processed to the dressed state and the fins are artificially attached:

(b) in relation to any other species of shark, the state in which the trunk is processed to the headed and gutted state and the fins are naturally attached".

* The primary fin sets for each shark subject to the ratio approach will be defined in the Circular that sets out the applicable ratios.

7. ACKNOWLEDGMENTS

Special thanks go to MPI observers for collecting the data presented here at sea under frequently difficult conditions. David Fisher extracted data from the MPI observer (*COD*) database, and James Andrew provided additional observer data. Warrick Lyon assisted with data punching and collation, and error checking. John Moriarty and Graeme McGregor advised on MPI legislation and processed state definitions. David Middleton and Owen Anderson helped with analytical methods. Owen also provided historical information on CF studies, and along with Tiffany Bock and Stephanie Hills, useful comments on this report. This study was completed under MPI project SEA201403.

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APPENDIX 1: Data sheets used by observers aboard SLL vessels to collect fin weight data (and reproductive data) from individual sharks (top) and aggregated sharks (bottom, truncated).

Trip number: ________ **Individual shark sampling record sheet - BWS, POS, MAK** Page ____ of ____

Shark details										Wet fin weight (tick retained fins)									
Set no	Sample no (from deck log)	Species	Fork length	Green weight	Sex	Maturity stage	Spermatophores (Y/N)*	Uterine width**	Vertebral sample (Y/N)	Left pectoral	Right pectoral	First dorsal	Second dorsal	Tail whole	Tail lower lobe	Pelvic fins	Anal fin	Weight of fin set	Comments

* Record spermatophore presence/absence for BWS and MAK > 150 cm fork length and POS > 120 cm FL

**Record uterine width for MAK >250 cm FL and POS >150 cm FL

Comments:

Aggregated shark sampling record sheet - BWS, POS, MAK

Trip number: ________

Shark details				Wet fin weight (kg to one decimal place)		
Set no	Species	Number of sharks	Green weight	Total fin weight	Total fin weight - frozen	Comments

APPENDIX 2: Data sheets used by observers aboard trawl vessels to collect fin weight and dressed weight data.

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MPI PROJECT

Ministry for Primary Industries
Manatū Ahu Matua

SCH/MAK/POS FIN WEIGHT AND CONVERSION FACTOR DATA

Trip Code		Vessel	
Species		State	

Side view of cut, include gills, gill covers etc.	Written Description of cut

									Tick the retained / weighed fins														
FMA	Tow / Set No.	Fish No.	Sex M or F	Fork length (cm)	Total length (cm)	Green weight (kg)	Scales Used G	P	Left pectoral	Right pectoral	First dorsal	Second dorsal	Tail whole	Tail lower lobe	Pelvic fins	Anal fin	Fin weight (kg)	Processed weight (kg)	Tail cut (mm)	Crew (C) or Obs (O) Processed?	Process Equip.	CF (final product)	Obs Initial

COMMENTS: (Write comment for each test)

MPI PROJECT

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Ministry for Primary Industries
Manatū Ahu Matua

GSH/GSP FIN WEIGHT DATA

Trip Code		Vessel	
Species			

Side view of cut, include gills, gill covers etc.	Written description of cuts made

FMA	Tow / Set No.	Length Range (cm) Min	Max	No. of Fish	Greenweight (kg)	Scales Used G	P	Fin weight (kg)	Crew (C) or Obs (O) Processed?	CF	Obs Initial

COMMENTS: (Write comment for each test)

APPENDIX 3: Observer shark fin weight data aggregated by species, fin code and trip.

Species	Year	Trip	Vessel	Fleet	Fin code	Whole weight	Fin weight	Number of fish	Mean weight	CF
BWS	2005	2088	5795	SLL JAP	U	2638.0	181.5	169	15.61	6.88
BWS	2006	2242	5795	SLL JAP	U	1861.0	117.0	122	15.25	6.29
BWS	2006	2243	5996	SLL JAP	U	1417.0	64.5	80	17.71	4.55
BWS	2011	3312	5795	SLL JAP	A	10402.0	574.5	446	23.32	5.52
BWS	2011	3312	5795	SLL JAP	J	387.0	21.5	11	35.18	5.56
BWS	2011	3313	20987	SLL JAP	A	2395.0	100.5	87	27.53	4.20
BWS	2011	3314	5996	SLL JAP	A	6915.0	319.2	236	29.30	4.62
BWS	2011	3315	21106	SLL JAP	A	3645.0	149.6	148	24.63	4.10
BWS	2012	3481	21342	SLL NZL	D	10779.0	217.5	883	12.21	2.02
BWS	2012	3482	5795	SLL JAP	A	6352.0	429.6	239	26.58	6.76
BWS	2012	3483	20987	SLL JAP	A	3365.0	149.2	161	20.90	4.43
BWS	2012	3484	5996	SLL JAP	B	44.0	4.1	5	8.80	9.32
BWS	2012	3484	5996	SLL JAP	A	167.0	8.2	5	33.40	4.91
BWS	2012	3485	21106	SLL JAP	A	2736.0	125.2	127	21.54	4.58
BWS	2012	3495	527	SLL NZL	D	3228.0	114.3	136	23.74	3.54
BWS	2013	3664	6610	TWL UKR	U	188.2	6.6	5	37.65	3.50
BWS	2013	3730	5996	SLL JAP	A	13663.0	773.5	603	22.66	5.66
BWS	2013	3732	20987	SLL JAP	A	2857.0	146.2	94	30.39	5.12
BWS	2013	3733	5795	SLL JAP	A	2232.0	116.4	88	25.36	5.22
BWS	2014	4093	21106	SLL JAP	A	2942.7	127.6	112	26.27	4.34
BWS	2014	4095	20987	SLL JAP	A	1849.0	87.0	77	24.01	4.71
BWS	2014	4096	5996	SLL JAP	A	5408.0	255.7	203	26.64	4.73
MAK	2011	3312	5795	SLL JAP	A	21.0	0.7	2	10.50	3.33
MAK	2011	3313	20987	SLL JAP	A	238.0	8.2	3	79.33	3.45
MAK	2011	3314	5996	SLL JAP	A	295.0	8.4	5	59.00	2.85
MAK	2011	3315	21106	SLL JAP	A	147.0	5.2	2	73.50	3.54
MAK	2012	3481	21342	SLL NZL	D	1018.0	13.5	18	56.56	1.33
MAK	2012	3483	20987	SLL JAP	A	215.0	10.4	1	215.00	4.84
MAK	2012	3485	21106	SLL JAP	A	252.0	9.6	7	36.00	3.81
MAK	2012	3495	527	SLL NZL	D	760.0	18.8	21	36.19	2.47
MAK	2013	3730	5996	SLL JAP	A	188.0	7.5	3	62.67	3.99
MAK	2013	3731	21106	SLL JAP	A	161.0	6.9	3	53.67	4.29
MAK	2013	3732	20987	SLL JAP	A	165.0	5.7	2	82.50	3.45
MAK	2013	3733	5795	SLL JAP	A	784.0	27.3	10	78.40	3.48
MAK	2014	4014	1792	SLL NZL	D	1975.0	47.2	22	89.77	2.39
MAK	2014	4093	21106	SLL JAP	A	479.5	16.9	5	95.90	3.52
MAK	2014	4095	20987	SLL JAP	A	374.0	11.7	5	74.80	3.12
MAK	2014	4096	5996	SLL JAP	A	76.0	2.6	2	38.00	3.45
MAK	2014	4147	8591	TWL NZL	A	30.0	1.3	1	30.00	4.37
MAK	2014	4159	21500	TWL NZL	A	59.7	2.4	7	8.53	4.05

APPENDIX 3 (continued)

Species	Year	Trip	Vessel	Fleet	Fin code	Whole weight	Fin weight	Number of fish	Mean weight	CF
POS	2011	3312	5795	SLL JAP	A	500.0	20.0	12	41.67	4.00
POS	2011	3313	20987	SLL JAP	A	253.0	9.0	7	36.14	3.56
POS	2011	3314	5996	SLL JAP	A	205.0	8.9	5	41.00	4.34
POS	2011	3315	21106	SLL JAP	A	616.0	23.4	22	28.00	3.80
POS	2012	3483	20987	SLL JAP	A	109.0	3.8	6	18.17	3.49
POS	2012	3484	5996	SLL JAP	A	63.0	2.3	1	63.00	3.65
POS	2012	3485	21106	SLL JAP	A	245.0	11.1	12	20.42	4.53
POS	2012	3495	527	SLL NZL	D	40.0	1.0	1	40.00	2.50
POS	2013	3731	21106	SLL JAP	A	215.0	10.9	8	26.88	5.07
POS	2013	3732	20987	SLL JAP	A	52.0	2.3	3	17.33	4.33
POS	2013	3733	5795	SLL JAP	A	136.0	5.5	8	17.00	4.01
POS	2014	4093	21106	SLL JAP	A	726.5	29.4	22	33.02	4.05
POS	2014	4095	20987	SLL JAP	A	858.0	35.0	20	42.90	4.08
POS	2014	4096	5996	SLL JAP	A	176.0	6.6	3	58.67	3.73
POS	2014	4147	8591	TWL NZL	A	575.0	25.4	8	71.88	4.42
POS	2014	4152	12487	TWL NZL	A	100.0	3.0	1	100.00	3.00
POS	2014	4153	6610	TWL UKR	K	37.7	1.7	3	12.55	4.41
POS	2014	4159	21500	TWL NZL	A	129.2	5.5	3	43.05	4.24
POS	2014	4160	1282	TWL KOR	A	73.0	3.1	1	73.00	4.19
SCH	2000	1322	6631	TWL UNK	U	37.4	1.6	3	12.47	4.30
SCH	2001	1530	15585	TWL UKR	U	198.2	7.5	23	8.62	3.78
SCH	2014	4143	6645	TWL KOR	B	30.7	1.3	2	15.35	4.27
SCH	2014	4145	13009	TWL KOR	B	107.9	6.4	12	8.99	5.95
SCH	2014	4152	12487	TWL NZL	K	51.0	2.3	5	10.20	4.51
SCH	2014	4152	12487	TWL NZL	L	168.1	7.4	22	7.64	4.40
SCH	2014	4157	1356	TWL KOR	J	82.0	4.2	9	9.12	5.12
SCH	2014	4157	1356	TWL KOR	K	34.9	1.9	5	6.97	5.51
SCH	2014	4157	1356	TWL KOR	M	6.5	0.3	1	6.53	5.21
SCH	2014	4159	21500	TWL NZL	A	40.5	1.5	4	10.13	3.68
SCH	2014	4159	21500	TWL NZL	L	32.5	1.5	4	8.13	4.55
SCH	2014	4160	1282	TWL KOR	B	328.1	13.4	48	6.83	4.10
SCH	2014	4167	6645	TWL KOR	B	184.3	9.0	24	7.68	4.89
SCH	2014	4170	13521	TWL KOR	B	59.7	1.2	4	14.92	1.94
SPD	1997	988	6137	TWL UNK	U	36.0	0.9	20	1.80	2.61
SPD	2000	1362	6126	TWL POL	U	813.5	31.1	508	1.60	3.82
SPD	2001	1511	6096	TWL NZL	U	30.5	1.0	15	2.03	3.28
SPD	2005	2093	20662	BLL NZL	U	716.8	27.9	608	1.18	3.89
GSH	2014	4160	1282	TWL KOR	E	82.7	5.8	98	0.84	6.96
GSH	2014	4157	1356	TWL KOR	N	35.7	2.0	20	1.78	5.69
GSH	2014	4153	6610	TWL UKR	E	1.9	0.2	2	0.97	10.36
GSH	2014	4149	13521	TWL KOR	E	88.2	4.2	73	1.21	4.79
GSP	2014	4160	1282	TWL KOR	E	57.0	3.1	44	1.30	5.37
GSP	2014	4143	6645	TWL KOR	E	193.3	9.2	120	1.61	4.77
GSP	2014	4167	13521	TWL KOR	E	93.6	5.8	54	1.73	6.24