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The New Zealand Bluenose Fishery and CPUE Standardisations, 1989–90 to 2009–10

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EXECUTIVE SUMMARY

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The New Zealand fisheries taking bluenose (*Hyperoglyphe antarctica*) are described from 1989–90 to 2009–10, based on the compulsory reported commercial catch and effort data held by the Ministry for Primary Industries (MPI, formerly the Ministry of Fisheries). Eight commercial fisheries which take this species are described, defined by location and method of capture, spanning five Quota Management Areas which comprise all of the New Zealand Exclusive Economic Zone (EEZ).

Commercial Catch Per Unit Effort (CPUE) analyses, also based on the compulsory reported commercial catch and effort data, were used to estimate changes in abundance for this species. These analyses provided input to a bluenose stock assessment covering the entire NZ EEZ (Cordue & Pomarède 2012). These analyses treat bluenose as a single NZ-wide stock, based on stock structure evidence presented in Cordue & Pomarède (2012) and by agreement in the MPI Northern Inshore Fishery Assessment Working Group.

1. INTRODUCTION

There are five actively fished bluenose (*Hyperoglyphe antarctica*) QMAs in the NZ EEZ and one QMA (BNS 10) which is currently closed to commercial fishing (Figure 1, Figure 2; see Appendix A for definitions of abbreviations and terms used in this report). Bluenose were brought into the QMS at its inception in 1986 and every bluenose QMA (apart from BNS 10) has been part of the experimental fishing programme instituted in 1991 known as the AMP (Adaptive Management Programme). The history of TACC changes to the five actively fished BNS QMAs is given in the following text table:

Fishstock	Year TACC raised	TACC prior to change	AMP TACC	2008–09 TACC	% drop in 2008–09	2011–12 TACC	% drop in 2011–12
BNS 1	1996–97	705	1 000	786	-21%	571	-27%
BNS 2	2004–05	873	1 048	902	-14%	629	-30%
BNS 3	1992–93 & 2001–02	175	350 & 925[1]	505	-45%	248	-51%
BNS 7	1994–95	97	150	89	-41%	89	0%
BNS 8	1994–95	22	100	43	-57%	43	0%
Total		1 872	3 223	2 325	-28%	1580	-32%

[1] +250 t ACE under provisions of s369G of the 1996 Fisheries Act (for 2 years)

The TACCs for all the BNS QMAs were dropped by varying amounts in 2008–09 (see above) in response to information which indicated that bluenose in the NZ EEZ were declining precipitously (Minister of Fisheries 2008). The Minister of Fisheries implemented further reductions in TACC for BNS 1, BNS 2 and BNS 3 for 1 October 2011, resulting in a total drop in TACC of 745 t or -47% (see above) (Minister of Fisheries and Aquaculture 2011). This TACC reduction is the first of three stepped changes designed to rebuild the stock in 20–25 years. The deemed value for this species was also increased in all QMAs to discourage overcatch.

Fishery characterisations and CPUE standardisations covering the period 1989–90 to 2009–10 are available for each of the five individual bluenose QMAs (Starr & Kendrick 2011a, 2011b, 2011c and 2011d). This report summarises those characterisations over the entire NZ EEZ, as well as presenting CPUE standardisations based on bottom longline and trawl data for the entire NZ EEZ.

2. METHODS

2.1 Data

Data extracts were obtained from the MPI Warehou database (Ministry of Fisheries 2010). One extract consisted of the complete data (all fishing event information along with all bluenose landing information) from every trip which recorded landing bluenose from any QMA, starting from 1 October 1989 and extending to 30 September 2010. Two further extracts were obtained: one consisting of all trips which used the methods BT, BPT (bottom pair trawl), MW or MWPT (midwater pair trawl) and did not target ORH (orange roughy), OEO (oreo) or CDL (cardinalfish) in the NZ EEZ. Once these trips were identified, all fishing event data and bluenose landing data from the entire trip, regardless of method of capture, were obtained. The final extract consisted of all trips which used the methods BLL, DL (Dahn line) or TL (trot line) in the NZ EEZ, without reference to target species. These data extracts (MPI replog 7992) were received 11 January 2011. The first data extract was used to characterise and understand the fisheries taking bluenose. These characterisations are reported in Sections 3.2 and 3.3. The remaining two extracts were used to calculate CPUE standardisations (Section 3.4 and Appendix A).

Data were prepared by linking the effort (“fishing event”) section of each trip to the landing section, based on trip identification numbers supplied in the database. Effort and landing data were groomed to remove large outliers. This procedure is documented in Starr (2007) and in Starr & Kendrick (2011a, 2011b, 2011c, and 2011d).

The original level of time stratification for a trip is either by tow, line set, or day of fishing, depending on the type of form used to report the trip information. These data were amalgamated into a common level of stratification known as a “trip stratum” (see table of definitions: Appendix A). Depending on how frequently an operator changed areas, method of capture or target species, a trip could consist of one or more “trip strata”. This amalgamation was required so that these data could be analysed at a common level of stratification across all reporting form types. Landed catches of bluenose by trip were then allocated to the “trip strata” in proportion to the estimated bluenose catches in each “trip stratum”. In situations when trips recorded landings of bluenose without any associated estimates of catch in any of the “trip strata” (operators were only required to report the top five species in any fishing event for the CELR and TCEPR form types, although this number has been increased to 8 species with the implementation of new form types), the bluenose landings were allocated proportionally to effort (tows for trawl data and number of sets for line data) in each “trip stratum”.

The catch totals (Table 1; Figure 3) resulting from this procedure may not be the same as those reported to the QMS system (Table 2) because the QMS is a separate reporting system from the MPI catch/effort reporting system. The data obtained from the MPI extracts were further modified during the preparation procedure described in Starr (2007), including dropping trips which had large landings of bluenose without sufficient effort to corroborate the large landing. The most important source of data loss in this procedure resulted from dropping trips which fished in ambiguous “straddling” statistical areas (the statistical area boundaries do not coincide with the QMA boundaries: Figure 2) and which reported multiple bluenose QMAs in the landing data (Table 1).

The annual totals at different stages of the data preparation procedure are presented in Table 1 and Figure 3. Total landings in the data set are similar to the landings in the QMR/MHR system, except for a 25% shortfall in landings in the first year of data (1989–90), which was a change-over year to a new system of data reporting. Landings by year in the subsequent fishing years vary from –4% to +9% relative to the QMR/MHR annual totals (Table 1). The shortfall between landed and estimated catch by trip varies from –21% to –7% by fishing year and may be diminishing in recent years (Table 1). A scatter plot of the estimated and landed catch by trip shows that relatively few trips overestimate the landing total for the trip (Figure 4 [left panel]). The distribution of the ratios of the landed relative to estimated catch shows a skewed distribution with many ratios greater than 1.0 and with a mode at 1.0 (Figure 4 [right panel]).

The 5% to 95% quantiles (excluding trips where there was no estimated catch) for the ratio of landed to estimated catch range from 0.60 to 2.44 for the dataset, with the median and mean ratios showing the landed catch 6% and 39% higher respectively than the estimated catch (Table 3). On average, 21% of trips estimated no catch of bluenose but then reported BNS (from any QMA) in the landings (Table 3). These landings represented only 2% of the total BNS landings for a total of 1 079 tonnes over all years (Table 3). There is a decreasing trend in these observations, with the proportion and the number of trips with unreported estimated bluenose declining.

Catch totals in the fishery characterisation tables have been scaled to the QMR/MHR totals in each QMA in Table 2 by calculating the ratio of these catches with the total annual landed catch in the analysis dataset and scaling all the landed catch observations (*i*) within a trip using this ratio:

Eq. 1
$$L'_{i,q,y} = L_{i,q,y} \frac{\mathbf{QMR}_{q,y}}{\sum_{i=1}^{i=N_{q,y}} L_{i,q,y}}$$

where $L_{i,q,y}$ = landed catch for QMA *q* in trip stratum *i* during fishing year *y*;

$N_{q,y}$ = total number of trip strata in QMA *q* during fishing year *y*

$\mathbf{QMR}_{q,y}$ = total QMR/MHR catch for QMA *q* during fishing year *y*;

2.2 Standardised CPUE analyses

2.2.1 Data preparation for standardisation

The second and third data extracts described in Section 2.1 were used to create indices of relative catching success for bluenose over the period of 1 October 1989 to 30 September 2010. The criteria used to obtain these extracts were designed to capture effort data from all fishing events which could have taken bluenose, including effort from trips which reported no landings of bluenose. The second extract was directed at trawl fishing methods, while the third extract was directed at line fishing methods.

The line fishing extract was constrained to bottom longline effort and landings for the standardisation analysis once the data were amalgamated into “trip strata”. The trawl method extract was similarly constrained to bottom and midwater trawl effort and landings for the standardisation analysis, but two data sets were prepared from these data. The first data set used the definition of “trip stratum” to allocate landings to effort and included data from all vessels fishing bluenose that were greater than 6 m in length. The other data set allocated the landings using the tow-by-tow stratification available in the more detailed TCEPR and TCER data forms. This level of detail was available for vessels greater than 28 m in length prior to October 2007 (and some smaller vessels that voluntarily used this form type). After October 2007, all vessels larger than 6 m using the trawl method reported their data on a tow-by-tow basis. However, because a reasonably large proportion of the bluenose trawl fishery reported their catch on the more detailed TCEPR form type in the early years of the fishery, this allowed the opportunity to proceed with a tow-by-tow analysis from 1989 onward.

Extreme values in the effort data were identified as outliers by examining the distribution for each field by vessel and for the whole fleet. All CELR records for a trip with missing or bad effort data were removed. This was not done for trips reporting tow-by-tow data on TCEPR or TCER forms. Instead, the median value for the vessel was substituted for data that were deemed to be out of range on these form types. This was done because it was found that dropping the entire trip resulted in losing too much data due to the long trips undertaken by the larger vessels using the TCEPR form. Missing values for statistical area or target species within a trip were substituted with the predominant (most frequent) value for that field over all records for that trip, regardless of form type.

Data used for these analyses were selected from fisheries defined on the basis of specified criteria of target species, method of capture and statistical areas fished, without regard to whether they captured bluenose. Records with no catch of bluenose were assigned a catch of zero. Unfortunately, because of the manner that CELR data were collected (summed over a full day of fishing), it was possible for daily records to contain unsuccessful effort because it would be combined with the successful effort before prior to filling in the form.

2.2.2 Analytical methods for standardisation

Arithmetic CPUE $\left(\hat{A}_y\right)$ in year *y* was calculated as the total catch for the year divided by the total effort in the year:

Eq. 2 $$\hat{A}_y = \frac{\sum_{i=1}^{n_y} C_{i,y}}{\sum_{i=1}^{n_y} E_{i,y}}$$

where $C_{i,y}$ is the [*catch*] and $E_{i,y} = T_{i,y}$ ([*tows*]) or $E_{i,y} = H_{i,y}$ ([*hours_fished*] or $E_{i,y} = K_{i,y}$ ([*number_hooks*]) for record *i* in year *y*, and n_y is the number of records in year *y*.

Unstandardised CPUE $\left(\hat{G}_y\right)$ in year *y* is the geometric mean of the ratio of catch to effort for each record *i* in year *y*:

Eq. 3 $$\hat{G}_y = \exp\left[\frac{\sum_{i=1}^{n_y} \ln\left(C_{i,y} \big/ E_{i,y} \right)}{n_y}\right]$$

where C_i, $E_{i,y}$ and n_y are as defined for Eq. 2. Unstandardised CPUE makes the same log-normal distributional assumption as the standardised CPUE, but does not take into account changes in the fishery. This index is the same as the "year index" calculated by the standardisation procedure, when not using additional explanatory variables and using the same definition for $E_{i,y}$. Presenting the arithmetic and unstandardised CPUE indices in this report provide measures of how much the standardisation procedure has modified the series from these two sets of indices.

A standardised abundance index (Eq. 4) was calculated from a generalised linear model (GLM) (Quinn & Deriso 1999) using a range of explanatory variables including [*year*], [*month*], [*vessel*] and other available factors by assuming a lognormal error distribution:

Eq. 4 $$\ln(I_i) = B + Y_{y_i} + \alpha_{a_i} + \beta_{b_i} + ... + f\left(\chi_i\right) + f\left(\delta_i\right).... + \varepsilon_i$$

where $I_i = C_i$ for the *i*th record, Y_{y_i} is the year coefficient for the year corresponding to the *i*th record, α_{a_i} and β_{b_i} are the coefficients for factorial variables *a* and *b* corresponding to the *i*th record, and $f\left(\chi_i\right)$ and $f\left(\delta_i\right)$ are polynomial functions (to the 3rd order) of the continuous variables χ_i and δ_i corresponding to the *i*th record, *B* is the intercept and ε_i is an error term.

The actual number of factorial and continuous explanatory variables in each model depends on the model selection criteria. A stepwise multiple regression procedure was followed which selected explanatory variables for inclusion in the model until the improvement in model R^2 (deviance) was less than 0.01 with the addition of another variable. The order of the variables in the selection process was based on the variable with the lowest AIC, so that the degrees of freedom were minimised. Datasets were restricted to core fleets of vessels, defined by their activity in the fishery, thus selecting only the most active vessels without unduly constraining the amount of catch and effort available for analysis.

Canonical coefficients and standard errors were calculated for each categorical variable (Francis 1999). Standardised analyses typically set one of the coefficients to 1.0 without an error term and estimate the remaining coefficients and the associated error relative to the fixed coefficient. This is required because of parameter confounding. The Francis (1999) procedure rescales all coefficients so that the geometric mean of the coefficients is equal to 1.0 and calculates a standard error for each coefficient, including the fixed coefficient.

The procedure described by Eq. 4 is necessarily confined to the positive catch observations in the data set because the logarithm of zero is undefined. Observations with zero catch were modelled by fitting a linear regression model based on a binomial distribution and using the presence/absence of bluenose as the dependent variable (where 1 is substituted for $\ln(I_i)$ in Eq. 4 if it is a successful catch record and 0 if it is not successful), using the same data set. Explanatory factors were estimated in the model in the same manner as described for Eq. 4. Such a model provides an alternative series of standardised coefficients of relative annual changes that is analogous to the equivalent series estimated from the lognormal regression.

A combined model, which integrates the lognormal and binomial annual coefficients, was estimated using the delta distribution, which allows zero and positive observations (Vignaux 1994):

Eq. 5
$$^{C}Y_y = \frac{^{L}Y_y}{\left(1 - P_0\left[1 - \frac{1}{^{B}Y_y}\right]\right)}$$

where $^{C}Y_y$ = combined index for year *y*

$^{L}Y_y$ = lognormal index for year *i*

$^{B}Y_y$ = binomial index for year *i*

P_0 = proportion zero for base year *0*

Confidence bounds, while straightforward to calculate for the binomial and lognormal models, were not calculated for the combined model because a bootstrap procedure (recommended by Francis 2001) had not yet been implemented in the available software. The lognormal model almost always represents the major portion of the signal in the combined model and there is concern that the information added by the binomial model may be an artefact of the data amalgamation procedure and not always interpretable as a biomass index. The binomial model is therefore presented here for information and to contrast with the lognormal model.

The following steps were followed for each standardised analysis:

1. The fishery definition was based on fishing activity and target species, thus allowing for the possibility of zero catches of bluenose, which could be then be incorporated into the analysis.
2. No trips were dropped for fishing in ambiguous statistical areas. All data were used without reference to the QMA of capture.
3. Catches were based on landed rather than estimated catch.
4. A method for selecting “core” vessels was used.
5. The dependent variable for the lognormal standardised analysis was ln(catch) and was presence/absence of bluenose (coded as 1/0) for the binomial standardised analysis. The model was allowed to select the effort variable which had the greatest explanatory power for each analysis (number of sets or hooks for bottom longline and number of tows or duration of fishing for trawl). The following potential explanatory variables were offered to the lognormal and binomial models: fishing year (forced as the first variable), statistical area and method of capture (trawl analyses only), bottom depth (tow-by-tow trawl model only), target species, month, and vessel. Number of sets, duration, number of hooks, number of tows and bottom depth were introduced as continuous variables modelled as a 3^{rd} order polynomial. The remaining variables were treated as categorical.

3. RESULTS

3.1 Landed catch and TACC

The BNS 1 fishery initially developed as a bycatch of the hapuku/bass longline fishery. During the early 1980s, increased fishing effort was targeted at bluenose and catches steadily increased from around 200 t in the early 1980s to 696 t in 1990–91 (Figure 5; Table 2). During this period, most of the increase in catch was taken from the developing target longline fishery in the Bay of Plenty. An important target fishery for bluenose also subsequently developed in east Northland in the late 1980s. During the 1990–91 to 1995–96 period, the total catch from BNS 1 remained relatively stable at around the level of the TACC of 705 tonnes. In 1996–97, the total reported landings from BNS 1 increased with the increase in the TACC to 1 000 t under the AMP. Catches remained at this level for the 1997–98 fishing year, but declined between 1998–99 and 2000–01 to less than 900 t/year. Landings rose to the level of the BNS 1 TACC for the next three fishing years but declined to below 900 t in 2004–05, reaching a low of below 600 t in 2007–08 (Table 2). Catches since the TACC reduction have been below the new TACC of 786 t by 159 t and 121 t in 2008–09 and 2009–10 respectively.

BNS 2, located entirely on the east coast of the North Island (Figure 1), is the most important BNS QMA in terms of accumulated catch and has the longest catch history in New Zealand, with the fishery beginning to be important in the early 1980s (Figure 5; Table 2). The BNS 2 TACC was exceeded in every year from 1991–92 to 2005–06, often by several hundred tonnes (e.g. by 439 t in 1993–94, by 264 t in 1999–2000, and by 114 t in 2004–05, the year of the AMP increase) (Figure 5; Table 2). Landings dropped to below the TACC for the first time in 15 years in 2006–07 and have stayed below the reduced TACC in both 2008–09 and 2009–10.

BNS 3, which includes FMAs 3, 4, 5, and 6 (Figure 1), is the largest BNS QMA in terms of area. The BNS 3 TACC was routinely exceeded from 1994–95 to 2000–01 (Figure 5; Table 2). Following the implementation of the higher BNS 3 TACC in 2001–02, landings in 2001–02 and 2002–03 never reached the effective commercial catch limit of 1 175 t, although the 2003–04 landings of 915 t were close to the TACC. Landings dropped to below 900 t in 2004–05 and were just above 500 t in both 2005–06 and 2006–07 (Table 2). The amount of BNS 3 landed under the provisions of s369G of the 1996 Fisheries Act was 113.3 t in 2001–02 and 107.6 t in 2002–03 (W. Lowther, FishServe, *pers. comm.*). Landings exceeded 600 t in 2007–08 but dropped to below 500 t after the implementation of the reduced TACC in 2008–09 (Table 2).

BNS 7 has a relatively small TACC with most of the catch being targeted using bottom longline or taken as by-catch in the west coast, South Island, hoki fishery. Historically, landings appear to have fluctuated independently of the TACC, with the exception of the drop in TACC for the 2008–09 fishing year (Figure 5; Table 2). Landings in BNS 7 have been mainly below the TACC in every year since the introduction of this Fishstock into the AMP, coming near to the TACC (landings of 145 t) in 1996–97 and above the TACC in 2006–07 (Table 2). Landings dropped to below 80 t/year in the early 2000s, but rose to above or near the TACC in 2006–07 and 2007–08. Landings dropped in 2008–09 to the new TACC level and have stayed there in 2009–10, making this QMA the only BNS QMA which has been constrained by the recent TACC reductions. It is not known why the TACC in this Fishstock has been generally undercaught for so many years, but the small amount of quota and the requirement to reserve quota to cover bycatch may contribute to the low annual catches.

Prior to the raising of the TACC in 1994–95, BNS 8 catches were very low due to the small amount of available quota which made the Fishstock uneconomical to fish. Landings in BNS 8 have always been less than the TACC (often well below the TACC level) since its introduction into the AMP, except for 2003–04, when landings were only 4 t below the TACC (Table 2). Reasons for this failure to catch the TACC are likely to have been economic (e.g., failure to lease quota when catches would be economical or insufficient longline fishermen available to catch the quota) rather than due to difficulties in catching the available quota.

Combined bluenose landings for the entire NZ EEZ exceeded the combined TACC in every year from 1991–92 to 2000–01 (Figure 5; Table 2), with an average overage of 10% per year calculated over these ten years and totalling over 2 000 t. This overage occurred primarily because of overcatch in BNS 2 by the trawl fleet. Since 2000–01, the combined TACC has only been exceeded in one year (2003–04, by 1%), averaging –14% in the nine years beginning from 2001–02.

3.2 Description of BNS landing information

Landing data for bluenose were provided for all trips which landed bluenose in any of the BNS QMAs (BNS 1, BNS 2, BNS 3, BNS 7, BNS 8) at least once. Each landing record contained a reported green weight (in kilograms), a code indicating the processed state of the landing, along with other auxiliary information such as the conversion factor used, the number of containers involved and the average weight of the containers. Every landing record also contained a "destination code" (Table 4), which indicated the category under which the landing occurred. The majority of the landings were made using destination code "L" (landed to a LFR; Table 4). However, other codes (e.g., A, O and C; Table 4) also potentially described valid landings and were included in this analysis. A number of other codes (notably R, Q and T; Table 4) were not included because these codes are used for intermediate unloading destinations, with the expectation that the fish would be reported at a later date under the "L" destination category. Note that proportionately there are very few landings using this destination code with respect to bluenose landings. Two other codes (D and NULL) represented errors which could not be reconciled without making unwarranted assumptions.

Most of the valid bluenose landing data were reported using state codes HGU and GRE with lesser amounts of landings reported using the state code DRE (Table 5). The conversion factors associated with the major state codes have been reported consistently over the data period (Table 6), with the exception of FIL (fillets) which have been adjusted (but which represent a very minor proportion of landings).

Eighteen trips, representing 1 250 t of landings, were dropped from the total landings dataset for all BNS QMAs (from a total of 52 800 trips), when preparing the data for this report (Figure 6). Eleven of these trips were from BNS 1, representing 1 061 t of landings, with two of the dropped BNS 1 trips reporting 671 t and 189 t of landings respectively (accounting for the majority of the dropped tonnage). Four trips were dropped from BNS 2 (representing about 110 t) and three trips representing about 80 t were dropped from BNS 3. All 18 trips were dropped because the nominal CPUE associated with these trips was much higher than expected (based on an analysis of nominal CPUE restricted to trips with good correspondence between landings and estimated catch), given the amount of effort declared for the trip. Dropping these trips moved the sum of the landings to a value very close to the QMR total for 1996–97 and moved it about halfway to the QMR total for 1994–95 (Figure 6). In all, there are nine fishing years where the sum of the landings exceed the total reported to the QMR/MHR, representing 450 t of landings. Conversely, there are 11 fishing years (excluding 1989–90) where the sum of the landings is 480 t lower (in aggregate) than the QMR/MHR totals. The landings total for the first data year (1989–90) is so much less than the QMR total (the shortfall is nearly 400 t) that it is likely this is a function of start-up issues in this initial year of the data collection system.

Total landings available in the complete data set are primarily for BNS 1 and BNS 2, with lesser amounts reported for BNS 3, BNS 7 and BNS 8 (Table 7). For the New Zealand EEZ as a whole, bluenose landings in the early years were reported on CELR forms (about 75% by weight) while the balance were reported on CLR forms (Table 8). These latter forms were mainly used for landings from the trawl fisheries which reported tow-by-tow data on the more comprehensive TCEPR forms. The percentage of landings reported on CELR forms gradually dropped to 60–65% by the mid-2000s and then dropped to less than 5%, beginning in 2007–08 with the introduction of the TCER and LTCER forms, which replaced the older daily CELR forms (see the caption of Table 8 for the full names of the forms). The newer forms all use the CLR forms to report landings, with the exception of the NCELR form which only applies to setnetting. The introduction of these new forms is apparent in the effort data as well, with the CELR forms dropping from 40–50% of the days fishing to less than 10%, while the LTCER forms (used by the smaller longliners) account for nearly 30% of the day fishing (Table 8).

3.3 Description of the BNS fishery

Distributions by statistical area, major fishing method and target species in this section are provided by summarised methods and target species, with the codes associated with each summarisation described in Table 9. Summary distributions are provided for each of the BNS QMAs as well as for all of the New Zealand EEZ.

The BNS 1 fishery is taken primarily by the bottom longline method, with relatively small amounts of catch using a range of other methods including Dahn line, bottom trawl and midwater trawl (Table 10; Figure 7). Over 90% of the landings have been taken by either bottom longline or Dahn line over the 21 years of available data, with another 5% taken by either the bottom trawl or midwater trawl fisheries. Other methods (setnet, trot line, surface longline) account for about 3% of the total BNS 1 landings. There has been no trend in the proportion of the total annual catch taken by bottom longline in BNS 1, ranging between 80 and 90% in almost every year since 1990–91 (Table 10).

The BNS 2 fishery is primarily taken by the bottom longline, midwater trawl and bottom trawl methods, with additional catches coming from the setnet and Dahn line methods (Table 10; Figure 7). The bottom longline and midwater trawl methods each account for about 40% of the total landings over the 21 years of available data. Bottom trawl has taken about 15% of the total landings while Dahn line and setnet methods only account for about 1% of the total landings. There has been a decreasing trend in the proportion of bluenose taken by bottom or midwater trawl, dropping from over 60% of the total bluenose landings in BNS 2 as late as 2002–03 to less than 25% in 2009–10 (Table 10).

The BNS 3 fishery is primarily taken by the bottom longline and bottom trawl methods, with reasonably large catches coming from the midwater trawl, setnet and Dahn line methods (Table 10; Figure 7). The bottom longline and bottom trawl methods each account for about 40% of the total landings over the 21 years of available data. Setnet has taken just under 10% of the total landings while midwater trawl and Dahn line divide the remaining landings approximately evenly. As in BNS 2, there has been a decreasing trend in recent years in the amount of bluenose taken by trawl gear, although not as marked as in BNS 2 (Table 10).

The BNS 7 fishery is primarily taken by the bottom longline method, with some large catches coming from the midwater trawl method, especially before 2000–01 (Table 10; Figure 7). The BNS 8 fishery is almost entirely taken by the bottom longline method, with only minor landings coming from other methods (Table 10; Figure 7). The bottom longline method accounts for 65% of the total landings in BNS 7 and 95% of the BNS 8 landings over the 21 years of available data. The midwater and bottom trawl methods have landed about 30% of the total BNS 7 landings but account for less than 0.5% of the BNS 8 landings. The setnet fishery for bluenose in BNS 7 was never very large and had largely disappeared by the end of the 1990s (Figure 7).

Bluenose in the New Zealand EEZ are taken primarily by bottom longline, rising from 50–60% of the total landings during the 1990s to near 80% in the late 2000s (Table 10). When summarised over the 21 years of data, about 60% of all BNS landings in the New Zealand EEZ have been made by bottom longline and another 30% by the combined midwater and bottom trawl methods. Dahn line and setnet each account for about 3% of the total BNS landings in the New Zealand EEZ.

The location of bluenose catches (at the statistical area level; see Figure 2) varies by method of capture. Area 014, located on the northern Wairarapa coast, is the most important statistical area for BLL in terms of total overall landings, accounting for over 3 200 t of bluenose BLL landings when summed over 21 years and with an increasing trend in landings in the latter half of the 2000s (Table 11A; Figure 8). Area 010, in the eastern Bay of Plenty, has logged just over 3 000 t of landings, but there is decreasing trend for this statistical area, with landings being less than 100 t/y since 2004–05. Eleven of the top 12 statistical areas (in terms of total catch over 21 years) for BLL landings are in either BNS 1 or located off the east coast of the North Island, with only one area from the Chatham Rise reporting BLL catch totals greater than 1 000 t (Area 051; Table 11A). The importance of Dahn line fishing has been split between one statistical area in east Northland (BNS 1) and one in Fiordland, although there has been a definite drop in the importance of this method since the mid-2000s, particularly in the Fiordland Area 032 fishery (Table 11B; Figure 8).

Midwater trawl fishing for bluenose has been almost exclusively off the east coast North Island Wairarapa coast, with much smaller totals taken from the Bay of Plenty, off Mahia (near Gisborne) and the Chatham Rise (Table 12A; Figure 9). Bottom trawl fishing has been mainly on the Chatham Rise and the Wairarapa coast (Table 12B; Figure 9). The majority of the setnet fishing for bluenose have been from the east of the South Island, mainly in Kaikoura (Area 018) and between Timaru and Otago (Area 024) (Table 13; Figure 10).

Bottom longline landings of bluenose have been evenly spaced throughout the fishing year, without showing a strong tendency towards a specific time period (Table 14). This pattern of relatively even distribution of landings across the entire fishing year seems to hold for each of the BNS QMAs (Figure 11). Midwater trawl tends to be concentrated in the first 5–6 months of the fishing year in BNS 2 while it only occurs in the last three months of the fishing year in BNS 7, in conjunction with the west coast South Island hoki target fishery (Table 14; Figure 12). A similar pattern (a concentration in the first 5–6 months in both BNS 2 and BNS 3 and in the final three months in BNS 7) holds for the seasonal distribution of bottom trawl landings (Table 14; Figure 13).

Bottom longline landings of bluenose are almost exclusively from fishing targeted at bluenose, in all five BNS QMAs and in the total New Zealand EEZ (Table 15; Figure 14). The predominance of target fishing for BNS has been increasing in the BLL landings, with a switch away from bycatch of bluenose in the ling and hapuku/bass target fisheries, which accounted for about 30% of the annual landings in earlier years to less than 10% in recent years. Most of this switch has occurred in the BNS 3 BLL fishery, where both target species have nearly disappeared in terms of relative importance over the last seven or eight fishing years (Figure 14). Midwater trawl catches of bluenose have been primarily from fishing targeted at alfonsino in both BNS 2 and BNS 3, with some targeting of bluenose as well in the early to mid-2000s, especially in BNS 1 (Table 16; Figure 15). A similar pattern emerges for the bycatch of bluenose in the bottom trawl fishery, with most of the effort targeted at alfonsino (Table 17; Figure 16). The only exception to this pattern for both midwater and bottom trawl is BNS 7, where almost all the bycatch of bluenose is taken while targeting hoki during the west coast South Island winter hoki fishery.

Bottom depth information is now available for bottom longline fishing as well as the two trawl methods, with the introduction of the new fishing event-based form types developed for the line fishing methods. Depth information is also available from the older TCEPR form and the new TCER form (Ministry of Fisheries 2010). Bottom longline fishing is done at similar depths in all five BNS QMAs when targeting BNS and LIN, although there is a suggestion that bluenose BLL fishing uses slightly deeper depths in BNS 1 than in the other QMAs (between 400–500 m; Figure 17). Midwater and bottom trawling when targeting for bluenose or alfonsino takes place at deeper depths in BNS 1 than in either BNS 2 or BNS 3 (Figure 17). The median bottom depth for bluenose captures is near 400 m for all three methods of capture over the main target species over all five QMAs.

3.4 Standardised CPUE analyses

Catch Per Unit Effort (CPUE) analyses, based on the compulsory reported commercial catch and effort data described in Section 2.2.1, were used to estimate changes in abundance for this species. These analyses provided input to a bluenose stock assessment (Cordue & Pomarède 2012) covering the entire NZ EEZ (Figure 1). Cordue & Pomarède (2012) present the stock structure information available for this species, and, after a review of this information, the Northern Inshore Assessment Working Group (NINSWG) agreed that the stock assessment should treat bluenose as a single NZ-wide stock. Consequently, the CPUE analyses in this report combine the available data for each method of capture across all QMAs. Separate QMA-specific CPUE analyses are available for BNS 1 (two analyses: bottom longline in East Northland and Bay of Plenty; Starr & Kendrick 2011a), for BNS 2 (two fisheries: bottom longline and mixed bottom and midwater trawl; Starr & Kendrick

2011b), for BNS 3 (two fisheries: Chatham Rise mixed trawl and bottom longline; Starr & Kendrick 2011c), and combined BNS 7 and BNS 8 (one fishery: bottom longline; Starr & Kendrick 2011d).

Standardised CPUE analyses were performed on data from two NZ-wide BNS fisheries, which are described in detail in Appendix B and Appendix C and summarised below.

1. BNS trawl: Two analyses were performed based on records which targeted bluenose or alfonsino using either midwater or bottom trawl methods: one (T_NZ–OR) used the original tow-by-tow record level but was limited to data collected at this level of detail. The other (T_NZ–TS) trawl analysis was done at the "trip-stratum" level, which included a wider selection of vessels but lost the detail available in the tow-by-tow analysis. These two data sets contained data mainly from BNS 2 and BNS 3, along with a limited amount of data from BNS 1 and BNS 7.

2. BNS longline: This analysis (BLL_NZ) was based on vessels targeting bluenose, ling, and hapuku/bass using the bottom longline method. This analysis was performed at the level of a trip-stratum, with the new fishing event-level forms, introduced in October 2007, amalgamated to a "trip-stratum" level of aggregation to match the stratification level available from the older daily fishing event forms. This analysis contained data from each bluenose QMA: BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8.

The two trawl series estimated by the lognormal model, using positive catch records only, showed an overall declining trend which levelled out in the most recent three years (top row, Figure 18). The standardisation procedure appears to have had relatively little impact on either series (T_NZ–OR or T_NZ–TS), with little difference between either of the unstandardised series compared to the equivalent standardised series. Each of the two trawl analyses show generally similar trends, with the T_NZ–OR series lying slightly below the T_NZ–TS series since 2005–06 (Figure 19). The similarity of the two analyses is not surprising, given that there is considerable overlap in the data. A comparison of the NZ-wide series with series estimated for BNS 2 and BNS 3 shows good correspondence between all three series (the comparison is based on the equivalent tow-by-tow analyses) (Figure 20), indicating that the signal obtained from the trawl data is similar for both BNS 2 and BNS 3 and is retained when combined into a single data set.

Although there are some departures between the standardised and the two unstandardised series for the BLL_NZ data set, particularly in the early years and in the relative steepness of the drop in the early 2000s, there is reasonable agreement between the standardised and unstandardised BLL_NZ series (bottom row; Figure 18). A comparison of the BLL_NZ series with the bottom longline series derived for each individual QMA demonstrates that the total NZ series lies within the range of the five available bottom longline series, effectively averaging the individual QMA series as well as smoothing some of the annual deviations (Figure 21). The BNS 2 series showed the greatest relative decline while the combined BNS 7&8 series had the least decline among the six available series.

It appears that, while there is likely to be an area or 'zone' effect which roughly corresponds to the BNS QMAs defined by MPI (Figure 1), this effect is relatively small compared to the strong downward trend in the data observed in all six zones (Appendix D):

1. When statistical area was offered to the bottom longline model using the same core vessel data set, the resulting standardised index series was indistinguishable from the original series, even though statistical area entered the model as the final explanatory variable, raising the explained deviance by 1.7% (Table D.1; Figure D.1).

2. When 'zone' was offered as an explanatory variable describing one of the five available bottom longline fisheries, the resulting model did not accept 'zone' under the 1% acceptance rule (Table D.2). When 'zone' was forced into the model, the patterns in the individual QMAs closely resembled the overall series pattern, showing a steep decline from the early 2000s (Figure D.2).

3. When a ‘fishing year: zone’ interaction term was offered to the model in place of the ‘fishing year’ term, the model accepted the ‘fishing year: zone’ interaction term, but this term explained only a small amount (1.3%) of the overall deviance (Table D.3). The resulting fishing year:zone indices still showed the same declines which characterised all previous depictions of these data series (Figure D.3).

Figure E.1 indicates that the number of hooks set over time has been increasing in both BNS 1 and BNS 2, leading to a concern that this trend could be confounded with the fishing year effect in the standardised analyses presented in Appendix B and possibly lead to spurious conclusions. When the vessels which had been identified as having an increasing trend in number of hooks set were removed from the standardised analysis, the resultant comparative plots show that the general pattern of decline in the early 2000s persists (Appendix E).

4. CONCLUSIONS

The CPUE plots presented in Section 3.4 demonstrate a consistency between areas and between the two capture methods investigated. Although CPUE is generally considered a relatively poor indicator of changes in biomass, the concurrence amongst these five areas and two capture methods gives some comfort that these indices may be tracking an underlying process which has caused these simultaneous declines in bluenose indices, beginning in the early 2000s. In the absence of other explanations, the NINSWG has accepted that this decline was caused by an overall drop in the abundance of bluenose in the NZ EEZ.

5. ACKNOWLEDGMENTS

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Table 1. Comparison of the total QMR/MHR catch (t), reported by fishing year, with the sum of the corrected landed catch totals (bottom part of the MPI CELR form), the total catch after matching effort with landing data (‘Analysis’ data set) and the sum of the estimated catches from the Analysis data set, all representing the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 QMAs.

Fishing Year	QMR/MHR (t)	Total landed catch (t)	% landed/ QMR/MHR	Total Analysis catch (t)	% Analysis /Landed	Total Estimated Catch (t)	% Estimated /Analysis
89/90	1 541	1 154	75	1 123	97	998	89
90/91	1 781	1 855	104	1 779	96	1 526	86
91/92	2 031	2 033	100	1 958	96	1 745	89
92/93	2 335	2 254	97	2 215	98	1 979	89
93/94	2 323	2 369	102	2 329	98	2 068	89
94/95	2 285	2 496	109	2 371	95	1 872	79
95/96	2 351	2 270	97	2 110	93	1 833	87
96/97	2 846	2 742	96	2 540	93	2 199	87
97/98	2 613	2 547	97	2 409	95	2 144	89
98/99	2 775	2 729	98	2 618	96	2 320	89
99/00	2 731	2 755	101	2 551	93	2 291	90
00/01	2 721	2 778	102	2 616	94	2 335	89
01/02	2 784	2 754	99	2 640	96	2 262	86
02/03	3 002	3 035	101	2 888	95	2 443	85
03/04	3 091	3 093	100	2 948	95	2 642	90
04/05	3 012	3 009	100	2 854	95	2 585	91
05/06	2 475	2 456	99	2 365	96	2 138	90
06/07	2 425	2 421	100	2 350	97	2 168	92
07/08	2 498	2 465	99	2 307	94	2 144	93
08/09	2 046	2 049	100	1 940	95	1 792	92
09/10	2 059	2 046	99	1 950	95	1 747	90

Table 2: Reported landings (t) of bluenose by Fishstock from 1981 to 2009–10 and TACCs (t) from 1986-87 to 2009–10 (Data sources: QMR [1986–87 to 2000–01]; MHR [2001–02 to 2009–10]).

	BNS 1		BNS 2		BNS 3		BNS 7		BNS 8		BNS 10		Total NZ	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings[1]	TACC	Landings	TACC
1981*	146	–	101	–	36	–	12	–	–	–	0	–	295	–
1982*	246	–	170	–	46	–	22	–	–	–	0	–	484	–
1983†	250	–	352	–	51	–	47	–	1	–	0	–	701	–
1984†	464	–	810	–	81	–	30	–	1	–	0	–	1 386	–
1985†	432	–	745	–	73	–	26	–	1	–	0	–	1 277	–
1986†	440	–	1 009	–	33	–	53	–	1	–	0	–	1 536	–
1986–87	286	450	953	660	93	150	71	60	1	20	7	10	1 411	1 350
1987–88	405	528	653	661	101	166	104	62	1	22	10	10	1 274	1 449
1988–89	480	530	692	768	90	167	135	69	13	22	10	10	1 420	1 566
1989–90	535	632	766	833	132	174	105	94	3	22	0	10	1 541	1 765
1990–91	696	705	812	833	184	175	72	96	5	22	12	10	1 781	1 831
1991–92	765	705	919	839	240	175	62	96	5	22	40	10	2 031	1 837
1992–93	787	705	1 151	842	224	350	120	97	24	22	29	10	2 335	2 016
1993–94	615	705	1 288	849	311	350	79	97	27	22	3	10	2 323	2 023
1994–95	706	705	1 028	849	389	357	83	150	79	100	0	10	2 285	2 161
1995–96	675	705	953	849	513	357	140	150	70	100	0	10	2 351	2 161
1996–97	966	1 000	1 100	873	540	357	145	150	86	100	9	10	2 846	2 480
1997–98	1 020	1 000	929	873	444	357	123	150	67	100	30	10	2 613	2 480
1998–99	868	1 000	1 002	873	729	357	128	150	46	100	2	10	2 775	2 480
1999–00	860	1 000	1 136	873	566	357	114	150	55	100	0	10	2 731	2 480
2000–01	890	1 000	1 097	873	633	357	87	150	14	100	0	10	2 721	2 480
2001–02	954	1 000	1 010	873	733	925[2]	70	150	17	100	0	10	2 784	3 048
2002–03	1 051	1 000	933	873	876	925[2]	76	150	66	100	0	10	3 002	3 058
2003–04	1 030	1 000	933	873	915	925	117	150	96	100	0	10	3 091	3 058
2004–05	870	1 000	1 162	1 048	844	925	94	150	42	100	0	10	3 012	3 233
2005–06	699	1 000	1 136	1 048	536	925	84	150	20	100	0	10	2 475	3 233
2006–07	742	1 000	957	1 048	511	925	164	150	50	100	0	10	2 425	3 233
2007–08	585	1 000	1 055	1 048	660	925	145	150	53	100	0	10	2 498	3 233
2008–09	627	786	864	902	444	505	80	89	31	43	0	10	2 046	2 335
2009–10	665	786	845	902	419	505	94	89	36	43	0	10	2 059	2 335

* MPI data, † FSU data, [1] BNS 10 landings in some years include exploratory catches taken under permit [2]An additional transitional 250 t of ACE was provided to Chatham Islands fishers in 2001–02 and 2002–03, resulting in an effective commercial catch limit of 1 175 t .

Table 3: Summary statistics for trips which report no estimated catches and for the ratio of landings divided by estimated catches by trip. All statistics apply to the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 QMAs in the analysis dataset.

	Trips with landed catch but which report no estimated catch			Statistics (excluding 0s) for the ratio of landed/estimated catch by trip			
Fishing year	Trips: % relative to total trips	Landings: % relative to total landings	Landings (t)	5% quantile	Median	Mean	95% quantile
89/90	28	5	80	0.64	1.04	1.42	1.85
90/91	22	2	30	0.60	1.04	1.30	2.25
91/92	23	2	48	0.60	1.05	1.33	2.32
92/93	23	2	47	0.58	1.03	1.31	2.33
93/94	19	1	33	0.59	1.05	1.32	2.27
94/95	20	2	55	0.54	1.03	1.45	2.27
95/96	21	4	96	0.59	1.04	1.33	2.34
96/97	23	6	167	0.54	1.03	1.30	2.45
97/98	24	3	81	0.53	1.07	1.34	2.27
98/99	23	3	82	0.63	1.08	1.48	2.52
99/00	23	2	62	0.61	1.08	1.38	2.30
00/01	24	2	48	0.64	1.09	1.58	2.47
01/02	22	1	33	0.65	1.13	1.61	3.08
02/03	22	1	45	0.65	1.09	1.47	2.87
03/04	21	1	44	0.63	1.11	1.38	2.51
04/05	18	1	24	0.66	1.08	1.37	2.34
05/06	20	1	24	0.65	1.10	1.39	2.40
06/07	15	1	25	0.63	1.05	1.32	2.15
07/08	12	1	15	0.62	1.04	1.26	2.25
08/09	15	1	14	0.60	1.07	1.45	2.70
09/10	19	1	24	0.62	1.07	1.39	2.50
Total	21	2	1 079	0.60	1.06	1.39	2.44

Table 4: Destination codes present in the unedited landing data received for the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 QMAs analysis (descriptions taken from table on page 76, Ministry of Fisheries 2010). The destination "type" is T: terminal (final); U: unknown; I: intermediate, with "intermediate" codes eventually moving to a "terminal" code. Only "T" destination codes were used in the analysis.

Destination code	Number of events	Total green weight (t)	Description	Type of destination
L	60 834	54 566.6	Landed in NZ (to LFR)	T
O	109	137.6	Conveyed outside NZ	T
E	3 525	136.1	Eaten	T
C	236	111.4	Disposed to Crown	T
F	1 759	35.0	Section 111 Recreational Catch	T
A	115	30.6	Accidental loss	T
W	219	3.4	Sold at wharf	T
S	3	1.4	Seized by Crown	T
U	97	1.3	Bait used on board	T
H	1	0.0	Loss from holding pot	T
R	947	554.1	Retained on board	I
T	366	260.3	Transferred to another vessel	I
Q	344	35.8	Holding receptacle on land	I
NULL	49	27.1	Nothing	U
D	51	3.1	Discarded (non-ITQ)	U
B	109	0.3	Bait stored for later use	U
P	3	0.0	Holding receptacle in water	I

Table 5: Total greenweight reported and number of events by state code in the unedited landing file used to process the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 characterisation data.

State code	Number of events	Total reported green weight (t)	Description
GRE	31 830	35 212.1	Green (or whole)
HGU	27 883	13 744.9	Headed and gutted
DRE	3 129	2 880.2	Dressed
SKF	462	390.1	Fillets: skin-off
GUT	717	223.4	Gutted
FIL	758	209.9	Fillets: skin-on
FIN	124	50.7	Fins
UTF	21	47.8	Fillets: skin-on untrimmed
NULL	31	29.1	Unknown
HGT	49	15.0	Headed, gutted, and tailed
MEA	276	14.0	Fish meal
GGO	85	11.8	Gilled and gutted tail-on
HDS	385	5.9	Heads
ROE	99	2.0	Roe
DVC	11	1.0	Unknown
TSK	13	0.5	Fillets: skin-off trimmed
DSC	2	0.3	Dressed-straight cut (stargazer)
HGF	1	0.2	Unknown
MEB	1	0.1	Fish meal by-product
TEN	1	0.0	Tentacles
OIL	1	0.0	Oil
TRF	1	0.0	Fillets: skin-on trimmed
WIN	1	0.0	Squid wings
WSB	1	0.0	0
LUG	66	0.0	Lugs or collars

Table 6: Mean conversion factor for the major state codes reported in Table 5 and the total reported greenweight by fishing year in the unedited landing file used to process the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 characterisation data. Landings associated with state code FIL were adjusted to a constant conversion factor of 2.25.

Fishing									Landed state code
year	GRE	HGU	DRE	SKF	GUT	FIL	FIN	UTF	NULL	OTH
Mean conversion factor										
89/90	1.0	1.4	–	–	1.1	3.00	–	–	–	1.4
90/91	1.0	1.4	1.7	–	1.1	2.30	–	–	–	0.0
91/92	1.0	1.4	1.7	–	1.1	2.25	–	–	–	0.0
92/93	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	2.8
93/94	1.0	1.4	1.7	–	1.1	2.25	–	–	–	5.6
94/95	1.0	1.4	1.7	2.3	1.1	2.25	–	–	–	5.6
95/96	1.0	1.4	1.7	2.5	1.1	2.25	–	–	–	0.0
96/97	1.0	1.4	1.7	2.8	1.1	2.25	1.0	–	–	0.0
97/98	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
98/99	1.0	1.4	1.7	2.8	1.1	2.25	–	–	1.0	5.6
99/00	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
00/01	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
01/02	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
02/03	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
03/04	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
04/05	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
05/06	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
06/07	1.0	1.4	1.7	2.8	1.1	2.25	–	–	1.0	5.6
07/08	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
08/09	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6
09/10	1.0	1.4	1.7	2.8	1.1	2.25	–	–	–	5.6

Table 6 (cont.)

Fishing year	GRE	HGU	DRE	SKF	GUT	FIL	FIN	UTF	NULL	OTH
										Landed state code
Total reported green weight (t)										
89/90	652.0	469.7	–	–	0.0	21.0	–	–	–	13.6
90/91	858.6	982.8	27.3	–	6.0	11.7	–	–	0.7	1.3
91/92	639.5	1275.5	101.9	–	5.6	16.2	–	–	–	0.2
92/93	934.6	1160.8	151.1	0.7	7.1	8.6	–	–	–	0.3
93/94	1304.3	1000.6	40.9	–	3.1	20.8	–	–	–	0.7
94/95	1574.4	785.4	139.8	0.1	2.6	6.2	–	–	0.0	0.4
95/96	1511.1	629.7	73.4	1.5	4.9	5.6	5.0	47.7	4.9	5.1
96/97	1877.9	756.4	62.8	10.0	10.1	33.6	0.1	–	20.9	2.7
97/98	1799.3	607.8	122.3	8.1	0.9	23.7	1.3	–	0.9	5.9
98/99	1998.4	585.8	72.8	53.5	0.3	10.8	5.3	–	0.3	3.0
99/00	2057.9	573.4	57.1	39.4	2.5	16.5	5.2	–	0.0	3.0
00/01	2134.4	504.3	51.7	61.0	9.1	8.8	9.6	–	–	3.7
01/02	2040.0	288.5	354.4	59.4	0.6	3.4	3.9	0.0	–	4.7
02/03	2184.0	313.4	504.3	16.2	8.8	1.9	6.5	–	–	0.7
03/04	2069.8	644.4	281.2	65.9	20.1	5.0	9.9	–	1.4	2.1
04/05	2188.1	547.8	227.7	42.7	1.2	2.8	4.1	–	–	1.4
05/06	1836.0	431.0	183.0	11.7	2.9	2.7	–	0.0	0.0	1.4
06/07	1830.4	362.8	138.9	3.6	84.7	2.3	–	–	0.0	0.5
07/08	1960.7	359.8	134.5	8.7	43.8	0.5	–	–	–	0.3
08/09	1809.9	206.5	38.3	6.0	1.4	0.4	–	–	–	0.2
09/10	1810.0	164.4	107.0	1.4	7.8	0.1	–	–	–	0.2
Total	35071.0	12651.0	2870.1	390.1	223.4	202.7	50.7	47.8	29.1	51.3

Table 7: Distribution of total landings (t) by bluenose Fishstock and by fishing year for the set of trips that recorded at least one landing in any of BNS 1, BNS 2, BNS 3, BNS 7 or BNS 8.

Fishing year	BNS 1	BNS2	BNS3	BNS7	BNS8	Total
89/90	266	695	107	84	2	1 154
90/91	695	865	222	67	6	1 855
91/92	766	980	225	56	6	2 033
92/93	759	1 150	214	94	38	2 254
93/94	622	1 337	283	100	27	2 369
94/95	685	1 223	412	88	87	2 496
95/96	635	930	509	125	71	2 270
96/97	895	1 084	540	134	89	2 742
97/98	1 010	895	459	113	70	2 547
98/99	866	981	730	117	36	2 729
99/00	865	1 146	570	119	54	2 755
00/01	894	1 124	662	84	13	2 778
01/02	967	986	711	74	17	2 754
02/03	1 048	1 029	820	74	64	3 035
03/04	979	978	917	123	96	3 093
04/05	853	1 156	858	99	43	3 009
05/06	699	1 116	537	83	20	2 456
06/07	737	955	512	166	50	2 421
07/08	573	1 021	672	147	52	2 465
08/09	663	836	440	80	31	2 049
09/10	660	838	430	82	36	2 046
Total	16 137	21 329	10 828	2 107	907	51 308

Table 8: Distribution by form type for landed catch by weight for each fishing year in the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 data set. Also provided is the number of days fishing and the associated distribution of days fishing by form type for the effort data from the same combined data set. CELR: Catch, effort, landing return; CLR: catch landing return; NCELR: netting catch effort landing return; TCEPR: trawl catch effort processing return; TCER: trawl catch effort return; LTCER: lining trip catch effort return; TLCER: tuna longlining catch effort return. Forms other than CELR and NCELR report their landings on CLR forms.

Fishing	Landings[1]			Days Fishing (%)[2]							Days Fishing							
Year	CELR	CLR	NCELR	CELR	TCEPR	TCER	LCER	LTCER	TLCER	NCELR	CELR	TCEPR	TCER	LCER	LTCER	TLCER	NCELR	Total
89/90	75.0	25.0	0.0	45.0	55.0	–	–		–	–	3 553	4 334	–	–	–	–	–	7 887
90/91	77.1	22.9	0.0	51.0	49.0	–	–	–	–	–	5 352	5 134	–	–	–	–	–	10 486
91/92	78.8	21.2	0.0	50.2	49.6	–	–	–	0.2	–	5 505	5 444	–	–	–	20	–	10 969
92/93	75.3	24.7	0.0	51.6	47.8	–	–	–	0.6	–	6 477	6 001	–	–	–	79	–	12 557
93/94	65.3	34.7	0.0	48.2	51.4	–	–	–	0.5	–	5 512	5 877	–	–	–	53	–	11 442
94/95	60.0	40.0	0.0	48.9	50.6	–	–	–	0.5	–	5 554	5 738	–	–	–	57	–	11 349
95/96	64.6	35.4	0.0	46.6	53.0	–	–	–	0.4	–	5 605	6 372	–	–	–	52	–	12 029
96/97	62.5	37.5	0.0	45.9	54.0	–	–	–	0.2	–	6 696	7 875	–	–	–	22	–	14 593
97/98	68.0	32.1	0.0	41.9	57.9	–	–	–	0.2	–	6 240	8 619	–	–	–	29	–	14 888
98/99	73.1	26.9	0.0	37.6	61.5	–	–	–	0.8	–	5 950	9 730	–	–	–	131	–	15 811
99/00	66.1	33.9	0.0	33.9	65.4	–	–	–	0.6	–	5 326	10 271	–	–	–	96	–	15 693
00/01	66.0	34.0	0.0	32.9	66.4	–	–	–	0.7	–	5 278	10 643	–	–	–	108	–	16 029
01/02	62.4	37.6	0.0	32.6	66.7	–	–	–	0.7	–	4 700	9 601	–	–	–	96	–	14 397
02/03	60.1	39.9	0.0	36.2	62.6	–	–	–	1.2	–	5 376	9 305	–	–	–	182	–	14 863
03/04	65.1	34.9	0.0	35.3	60.4	–	3.6	–	0.7	–	4 977	8 521	–	504	–	94	–	14 096
04/05	58.2	41.9	0.0	36.8	56.1	–	6.3	–	0.8	–	5 021	7 659	–	853	–	112	–	13 645
05/06	62.1	37.9	0.0	38.5	54.2	–	6.3	–	1.0	–	4 642	6 528	–	762	–	121	–	12 053
06/07	69.1	30.4	0.6	36.4	52.0	–	8.7	–	0.6	2.4	4 526	6 475	–	1 078	–	69	303	12 451
07/08	4.4	94.8	0.8	8.9	44.5	3.9	10.2	29.1	0.3	3.1	1 058	5 304	465	1 222	3 469	31	374	11 923
08/09	4.4	94.3	1.3	9.3	44.4	3.7	10.0	27.9	0.5	4.2	1 002	4 800	396	1 085	3 018	50	453	10 804
09/10	3.2	96.5	0.3	7.6	47.1	4.5	8.0	28.7	0.4	3.6	841	5 226	504	892	3 187	44	403	11 097
Total	58.3	41.6	0.1	36.9	55.5	0.5	2.4	3.6	0.5	0.6	99 191	149 457	1 365	6 396	9 674	1 446	1 533	269 062

[1] Percentages of landed greenweight

[2] Percentages of number of days fishing

Table 9: Definitions of major method codes and target species codes used in the distribution tables and plots in this report.

Method code[2]	Method definition	Number of events[1]	Number of records
BLL	Bottom longline	101 298	31 419
MW	Mid-water trawl	106 413	13 371
BT	Bottom trawl	330 007	44 923
DL	Dahn line	8 349	5 640
SN	Setnet	16 500	13 551
OTH	Other [in ranked descending order down to two tonnes: Trot line (TL), Surface longline (SLL), Handline (HL) rock lobster potting (RLP), Troll(T)]	9 431	5 295

Target species code[2,3]	Target species definition	Number of events[1]	Number of records
BNS	Bluenose	37 299	14 264
LIN	Ling	45 565	8 570
HPB	Hapuku and Bass	13 569	6 249
SKI	Gemfish	339	270
OTH	All other species (in ranked descending order down to one tonne: School Shark, Alfonsino, Ribaldo, Snapper, Trumpeter, Blue Cod, Rig, Cardinalfish)	4 526	2 066

Target species code[2,4]	Target species definition	Number of events[1]	Number of records
BYX	Alfonsino	7 866	2 092
BNS	Bluenose	1 047	446
HOK	Hoki	79 643	8 257
RBY	Rubyfish	1 067	427
SKI	Gemfish	1 101	355
OTH	All other species (in ranked descending order down to one tonne: Cardinalfish, Hake, Jack Mackerel, Silver Warehou, Squid, Southern Blue Whiting, Barracouta, Orange Roughy, White Warehou)	15 689	1 794

Target species code[2,5]	Target species definition	Number of events[1]	Number of records
BYX	Alfonsino	8 769	1 533
HOK	Hoki	154 467	14 190
BNS	Bluenose	1 841	462
SKI	Gemfish	11 243	3 177
CDL	Cardinalfish	9 304	2 301
ORH	Orange roughy	34 614	5 270
OTH	All other species (in ranked descending order down to two tonnes: White Warehou, Scampi, Red Cod, Ling, Barracouta, Rubyfish, Silver Warehou, Tarakihi, Squid, Hake, Oreo, Jack Mackerel, Snapper, Sea Perch, Blue Warehou, Stargazer, Red Gurnard, Spiny Dogfish, Trevally)	109 769	17 990

[1] Number of effort events (day of fishing or tow)
[2] In descending ranked order of total NZ EEZ BNS landings
[3] Bottom longline method
[4] Midwater trawl method
[5] Bottom trawl method

Table 10: Distribution of landings by tonne (scaled to the QMR landings using Eq. 1) and by percentage for each method and fishing year in BNS QMA: BNS 1, BNS 2 and BNS 3. '–': no landings in the indicated year/method cell.

Fishing						BNS 1						BNS 2						BNS 3
Year	BLL	MW	BT	DL	SN	OTH	BLL	MW	BT	DL	SN	OTH	BLL	MW	BT	DL	SN	OTH
	Distribution (t)																	
89/90	361.5	–	13.9	74.6	36.6	48.1	81.7	605.3	54.2	5.3	18.5	0.7	42.8	5.0	11.3	14.9	53.3	4.3
90/91	554.0	–	16.7	45.3	57.9	22.1	323.2	297.9	145.9	3.4	32.6	9.0	15.8	1.8	95.0	4.1	35.5	31.6
91/92	627.9	0.1	13.5	55.2	60.2	17.0	421.7	370.1	62.8	3.3	19.6	0.1	94.8	5.0	85.3	0.1	43.0	16.8
92/93	663.6	1.2	10.2	50.2	37.3	25.0	443.3	461.6	204.6	24.1	17.2	1.1	145.6	0.5	30.8	0.0	44.3	2.2
93/94	509.3	–	4.9	51.6	29.6	19.4	439.9	605.4	215.2	18.6	8.3	0.3	206.5	7.8	17.6	3.5	71.5	4.1
94/95	613.9	0.0	10.6	59.1	4.2	18.5	275.4	408.1	321.4	18.0	3.5	1.8	96.3	76.3	125.2	23.0	54.3	14.2
95/96	569.0	2.5	6.3	55.7	3.3	19.5	275.6	416.3	243.5	8.5	0.0	1.6	255.4	44.8	81.3	33.9	79.5	10.8
96/97	854.7	30.5	12.2	33.4	10.7	24.2	289.3	428.6	365.3	6.8	0.5	0.4	285.3	17.2	159.4	10.3	58.5	6.5
97/98	919.4	0.2	27.8	40.5	12.8	13.2	357.3	363.2	189.3	5.3	1.4	0.0	165.5	52.1	92.6	20.4	63.5	0.1
98/99	795.7	5.2	14.3	31.5	9.7	11.8	382.6	460.3	152.1	7.1	0.0	1.5	394.9	24.7	202.7	54.9	50.6	0.9
99/00	790.3	26.7	11.8	26.7	0.3	5.9	382.3	573.3	172.3	5.8	0.1	3.2	258.7	1.7	202.9	40.0	60.7	1.5
00/01	800.5	35.2	11.0	37.7	0.3	5.1	457.2	489.4	138.2	5.6	1.4	4.9	169.0	5.1	378.7	35.1	45.0	0.0
01/02	764.7	155.2	13.6	14.3	0.4	9.8	329.5	596.7	70.4	10.9	1.6	0.3	150.4	29.4	449.9	65.4	38.1	0.0
02/03	914.6	61.5	34.6	33.5	0.1	6.2	313.1	462.1	131.8	20.5	2.6	3.1	172.8	30.8	596.2	39.2	36.8	0.0
03/04	933.0	12.1	65.9	14.1	0.0	4.6	512.6	306.8	68.8	10.8	0.2	33.8	336.8	83.0	395.3	50.7	29.0	19.7
04/05	744.5	31.8	83.5	7.2	–	3.1	594.7	397.9	156.3	8.8	1.5	3.2	364.3	71.0	358.0	35.5	15.1	0.5
05/06	605.0	22.0	36.2	32.2	0.0	3.3	753.2	240.2	137.5	3.6	0.6	1.0	235.6	18.0	230.4	40.8	10.4	0.4
06/07	676.7	26.4	8.7	26.4	0.0	4.1	693.8	122.5	138.6	1.6	0.2	0.7	387.5	11.9	83.9	12.4	15.5	0.3
07/08	522.8	6.5	11.6	41.5	0.0	3.0	828.6	163.7	39.6	9.3	13.3	0.1	483.1	36.1	124.6	7.8	8.6	0.2
08/09	579.4	7.0	13.5	26.3	0.0	0.8	685.6	94.7	63.6	2.6	16.6	0.9	310.4	12.2	105.0	9.8	6.9	0.4
09/10	598.8	2.1	34.9	24.0	0.0	5.4	646.8	84.0	107.5	2.6	3.6	0.5	221.4	93.6	80.7	14.3	7.6	0.9
Total	14 399.2	426.2	455.8	781.2	263.4	270.0	9 487.4	7 947.7	3 178.9	182.4	143.4	68.2	4 792.8	627.9	3 906.9	516.1	827.8	115.6
	Distribution (%)																	
89/90	67.6	–	2.6	13.9	6.9	9.0	10.7	79.1	7.1	0.7	2.4	0.1	32.5	3.8	8.6	11.3	40.5	3.3
90/91	79.6	–	2.4	6.5	8.3	3.2	39.8	36.7	18.0	0.4	4.0	1.1	8.6	1.0	51.7	2.2	19.3	17.2
91/92	81.1	0.0	1.7	7.1	7.8	2.2	48.1	42.2	7.2	0.4	2.2	0.0	38.7	2.0	34.8	0.1	17.6	6.9
92/93	84.3	0.1	1.3	6.4	4.7	3.2	38.5	40.1	17.8	2.1	1.5	0.1	65.1	0.2	13.8	0.0	19.8	1.0
93/94	82.8	–	0.8	8.4	4.8	3.1	34.2	47.0	16.7	1.4	0.6	0.0	66.4	2.5	5.7	1.1	23.0	1.3
94/95	86.9	0.0	1.5	8.4	0.6	2.6	26.8	39.7	31.3	1.8	0.3	0.2	24.7	19.6	32.2	5.9	13.9	3.7
95/96	86.7	0.4	1.0	8.5	0.5	3.0	29.1	44.0	25.8	0.9	0.0	0.2	50.5	8.9	16.1	6.7	15.7	2.1
96/97	88.5	3.2	1.3	3.5	1.1	2.5	26.5	39.3	33.5	0.6	0.0	0.0	53.1	3.2	29.7	1.9	10.9	1.2
97/98	90.7	0.0	2.7	4.0	1.3	1.3	39.0	39.6	20.6	0.6	0.2	0.0	42.0	13.2	23.5	5.2	16.1	0.0
98/99	91.6	0.6	1.6	3.6	1.1	1.4	38.1	45.9	15.2	0.7	0.0	0.2	54.2	3.4	27.8	7.5	6.9	0.1
99/00	91.7	3.1	1.4	3.1	0.0	0.7	33.6	50.4	15.2	0.5	0.0	0.3	45.7	0.3	35.9	7.1	10.7	0.3
00/01	90.0	4.0	1.2	4.2	0.0	0.6	41.7	44.6	12.6	0.5	0.1	0.4	26.7	0.8	59.8	5.6	7.1	0.0
01/02	79.8	16.2	1.4	1.5	0.0	1.0	32.6	59.1	7.0	1.1	0.2	0.0	20.5	4.0	61.4	8.9	5.2	0.0
02/03	87.1	5.9	3.3	3.2	0.0	0.6	33.5	49.5	14.1	2.2	0.3	0.3	19.7	3.5	68.1	4.5	4.2	0.0
03/04	90.6	1.2	6.4	1.4	0.0	0.4	54.9	32.9	7.4	1.2	0.0	3.6	36.8	9.1	43.2	5.5	3.2	2.2
04/05	85.6	3.7	9.6	0.8	–	0.4	51.2	34.2	13.4	0.8	0.1	0.3	43.1	8.4	42.4	4.2	1.8	0.1
05/06	86.6	3.2	5.2	4.6	0.0	0.5	66.3	21.1	12.1	0.3	0.0	0.1	44.0	3.4	43.0	7.6	1.9	0.1
06/07	91.2	3.6	1.2	3.6	0.0	0.5	72.5	12.8	14.5	0.2	0.0	0.1	75.8	2.3	16.4	2.4	3.0	0.1
07/08	89.3	1.1	2.0	7.1	0.0	0.5	78.6	15.5	3.8	0.9	1.3	0.0	73.2	5.5	18.9	1.2	1.3	0.0
08/09	92.4	1.1	2.1	4.2	0.0	0.1	79.4	11.0	7.4	0.3	1.9	0.1	69.8	2.7	23.6	2.2	1.5	0.1
09/10	90.0	0.3	5.3	3.6	0.0	0.8	76.6	9.9	12.7	0.3	0.4	0.1	52.9	22.4	19.3	3.4	1.8	0.2
Total	86.8	2.6	2.7	4.7	1.6	1.6	45.2	37.8	15.1	0.9	0.7	0.3	44.4	5.8	36.2	4.8	7.7	1.1

Table 10 (cont.) Distribution of landings by tonne (scaled to the QMR landings using Eq. 1) and by percentage for each method and fishing year in BNS 7, BNS 8 and NZ EEZ BNS. '–': no landings in the indicated year/method cell.

Fishing	BNS 7						BNS 8						Total BNS					
Year	BLL	MW	BT	DL	SN	OTH	BLL	MW	BT	DL	SN	OTH	BLL	MW	BT	DL	SN	OTH
	Distribution (t)																	
89/90	15.1	70.0	3.8	1.1	8.6	6.1	0.1	–	–	–	1.9	1.3	501.2	680.3	83.2	95.8	119.0	60.6
90/91	39.5	15.0	4.9	2.6	6.0	3.8	0.1	–	–	–	2.9	2.5	932.6	314.7	262.5	55.4	134.8	69.1
91/92	45.0	6.5	6.2	0.8	1.6	1.8	4.6	–	–	–	0.0	0.9	1 194.0	381.6	167.8	59.4	124.4	36.6
92/93	93.1	14.8	9.6	0.0	0.4	2.2	22.9	–	0.0	–	0.5	0.3	1 368.5	478.0	255.2	74.4	99.8	30.8
93/94	63.9	8.3	1.2	0.3	0.9	4.6	26.1	–	–	0.9	0.0	0.0	1 245.6	621.5	238.9	74.9	110.2	28.3
94/95	49.3	17.9	4.1	8.5	1.9	1.5	55.0	3.7	–	18.2	0.0	2.0	1 089.9	505.9	461.3	126.8	63.9	38.0
95/96	72.0	31.0	4.5	25.3	5.8	0.1	66.5	–	0.2	–	0.6	0.1	1 238.5	494.5	335.8	123.3	89.2	32.3
96/97	74.7	43.1	7.1	7.1	11.8	1.5	85.2	–	0.0	–	0.0	0.9	1 589.2	519.4	544.0	57.5	81.6	33.3
97/98	59.7	55.2	7.7	5.9	0.5	0.4	51.4	–	0.0	1.0	0.1	0.0	1 553.3	470.7	317.4	73.2	78.3	13.8
98/99	77.3	28.2	16.2	6.1	0.2	0.0	43.6	–	–	2.4	0.1	0.0	1 694.1	518.4	385.3	102.0	60.5	14.3
99/00	63.1	32.0	13.6	2.2	3.3	0.2	54.9	–	–	–	–	0.0	1 549.4	633.8	400.7	74.8	64.5	10.8
00/01	59.6	16.3	8.2	2.6	0.2	0.0	13.3	0.0	–	0.2	0.1	0.0	1 499.6	545.9	536.1	81.2	47.0	10.0
01/02	46.1	16.6	6.6	0.0	0.9	0.0	14.7	0.0	–	1.7	0.0	0.0	1 305.4	797.9	540.6	92.2	41.1	10.2
02/03	61.6	4.6	6.4	1.0	1.5	1.0	65.9	–	–	0.3	–	0.0	1 528.0	559.0	769.1	94.3	41.1	10.3
03/04	87.2	13.0	12.3	3.6	0.6	0.0	95.7	–	–	0.2	0.0	0.1	1 965.4	414.9	542.4	79.3	29.8	58.2
04/05	71.1	13.6	7.2	2.2	–	0.0	41.9	–	–	0.0	0.0	0.6	1 816.5	514.2	605.0	53.6	16.5	7.4
05/06	58.5	15.1	10.1	0.7	0.0	0.0	20.0	–	–	0.1	–	0.0	1 672.3	295.4	414.2	77.3	11.0	4.7
06/07	130.7	27.8	5.1	0.1	0.2	0.1	50.1	–	–	0.1	0.0	0.1	1 938.7	188.5	236.3	40.6	15.9	5.2
07/08	132.3	2.9	9.4	0.5	0.0	0.0	53.3	–	–	0.1	0.0	0.0	2 020.1	209.1	185.2	59.2	21.9	3.4
08/09	52.5	21.4	5.7	0.4	0.2	0.0	30.4	–	0.0	–	0.0	0.3	1 658.4	135.3	187.8	39.0	23.6	2.4
09/10	62.3	29.7	1.7	0.6	0.0	0.0	35.8	–	0.2	0.1	0.0	0.0	1 565.2	209.3	225.1	41.6	11.2	6.7
Total	1 414.9	482.8	151.5	71.3	44.7	23.4	831.4	3.8	0.5	25.1	6.2	9.1	30 925.7	9 488.4	7 693.6	1 576.1	1 285.5	486.3
	Distribution (%)																	
89/90	14.4	66.8	3.6	1.0	8.2	5.9	4.0	–	–	–	56.7	39.3	32.5	44.2	5.4	6.2	7.7	3.9
90/91	55.0	20.9	6.8	3.6	8.3	5.4	1.5	–	–	–	52.2	46.2	52.7	17.8	14.8	3.1	7.6	3.9
91/92	72.8	10.4	10.1	1.3	2.6	2.9	84.1	–	–	–	0.4	15.5	60.8	19.4	8.5	3.0	6.3	1.9
92/93	77.5	12.3	8.0	0.0	0.4	1.9	96.5	–	0.0	–	2.2	1.3	59.3	20.7	11.1	3.2	4.3	1.3
93/94	80.6	10.5	1.5	0.4	1.1	5.8	96.5	–	–	3.4	0.1	0.0	53.7	26.8	10.3	3.2	4.8	1.2
94/95	59.3	21.5	4.9	10.2	2.2	1.8	69.7	4.7	–	23.1	0.1	2.5	47.7	22.1	20.2	5.5	2.8	1.7
95/96	51.9	22.4	3.2	18.2	4.2	0.1	98.6	–	0.3	–	0.9	0.2	53.5	21.4	14.5	5.3	3.9	1.4
96/97	51.4	29.7	4.9	4.9	8.1	1.0	99.0	–	0.0	–	0.0	1.0	56.3	18.4	19.3	2.0	2.9	1.2
97/98	46.1	42.6	6.0	4.6	0.4	0.3	98.0	–	0.1	1.9	0.1	0.0	62.0	18.8	12.7	2.9	3.1	0.5
98/99	60.4	22.1	12.6	4.7	0.1	0.0	94.7	–	–	5.2	0.1	0.0	61.1	18.7	13.9	3.7	2.2	0.5
99/00	55.2	28.0	11.9	1.9	2.9	0.1	100.0	–	–	–	–	0.0	56.7	23.2	14.7	2.7	2.4	0.4
00/01	68.6	18.7	9.4	3.0	0.2	0.0	98.3	0.2	–	1.1	0.4	0.0	55.1	20.1	19.7	3.0	1.7	0.4
01/02	65.7	23.6	9.4	0.0	1.3	0.0	89.3	0.3	–	10.1	0.1	0.2	46.8	28.6	19.4	3.3	1.5	0.4
02/03	81.0	6.0	8.5	1.3	2.0	1.3	99.6	–	–	0.4	–	0.0	50.9	18.6	25.6	3.1	1.4	0.3
03/04	74.7	11.1	10.5	3.1	0.5	0.0	99.7	–	–	0.2	0.0	0.1	63.6	13.4	17.6	2.6	1.0	1.9
04/05	75.7	14.4	7.6	2.3	–	0.0	98.5	–	–	0.1	0.0	1.4	60.3	17.1	20.1	1.8	0.5	0.2
05/06	69.3	17.9	12.0	0.8	0.0	0.0	99.5	–	–	0.5	–	0.0	67.6	11.9	16.7	3.1	0.4	0.2
06/07	79.7	17.0	3.1	0.1	0.1	0.0	99.7	–	–	0.1	0.0	0.1	79.9	7.8	9.7	1.7	0.7	0.2
07/08	91.2	2.0	6.5	0.4	0.0	0.0	99.9	–	–	0.1	0.0	0.0	80.8	8.4	7.4	2.4	0.9	0.1
08/09	65.5	26.7	7.1	0.5	0.2	0.0	99.0	–	0.0	–	0.0	1.0	81.0	6.6	9.2	1.9	1.2	0.1
09/10	66.1	31.5	1.8	0.6	0.0	0.0	99.2	–	0.5	0.3	0.0	0.0	76.0	10.2	10.9	2.0	0.5	0.3
Total	64.6	22.1	6.9	3.3	2.0	1.1	94.9	0.4	0.1	2.9	0.7	1.0	60.1	18.4	15.0	3.1	2.5	0.9

Table 11A: Annual landings (in tonnes, scaled to the QMR landings using Eq. 1) by MPI finfish statistical area (see Figure 2) for the bottom longline method (Figure 8). Statistical areas have been ranked in descending order of total catch over the 21 years of catch history. The 'Oth' category serves as an accumulator for all remaining statistical areas. '–': no data for the indicated statistical area/fishing year combination.

Fishing	MPI Finfish Statistical Area																							
Year	014	010	002	013	004	009	012	051	003	008	001	204	050	041	011	049	047	033	052	034	046	032	015	Oth
89/90	50.6	123.3	5.1	16.8	–	179.9	1.8	–	0.6	12.4	40.1	–	–	–	10.7	0.9	–	9.4	–	3.1	–	8.8	1.1	36.4
90/91	136.3	120.2	20.4	134.3	37.9	179.1	27.4	1.6	3.1	42.4	144.1	–	0.4	–	24.9	0.0	–	24.2	0.0	12.1	–	1.3	–	22.8
91/92	168.6	136.2	161.3	150.7	182.7	80.8	41.2	7.5	3.4	49.8	8.4	–	–	0.1	34.8	2.4	0.1	12.3	48.8	27.5	–	1.9	23.2	52.7
92/93	156.6	123.4	171.0	164.4	120.5	80.4	46.9	36.0	22.6	51.4	85.2	–	30.3	3.4	33.5	2.3	8.5	46.4	16.3	37.9	0.1	4.2	29.2	97.8
93/94	172.2	164.6	104.1	141.5	73.4	51.0	74.6	60.5	34.3	43.6	37.9	–	34.3	3.3	23.5	15.3	0.1	14.9	22.0	31.1	0.3	12.9	22.4	107.8
94/95	92.0	199.7	115.5	111.2	22.8	53.0	44.9	6.5	33.5	59.0	80.9	–	7.0	40.0	2.0	4.1	27.4	7.3	15.6	13.8	9.5	17.7	19.1	107.1
95/96	22.9	107.0	93.8	130.7	53.8	68.6	57.6	8.2	9.9	40.1	80.8	–	7.3	66.1	59.6	138.8	71.0	21.7	8.2	23.4	16.3	30.6	4.2	117.9
96/97	3.3	193.3	193.4	127.0	74.4	101.5	116.8	56.5	68.0	41.9	49.7	–	48.3	79.5	32.3	41.1	59.9	36.7	72.8	12.5	44.0	20.1	8.7	107.3
97/98	59.8	194.9	181.4	72.3	72.7	85.5	167.5	60.8	160.0	39.8	68.1	7.1	39.1	41.5	34.1	2.5	76.5	6.3	36.0	24.4	10.0	6.2	15.6	91.2
98/99	159.2	232.1	131.8	38.5	45.9	50.4	117.7	123.4	143.8	40.5	97.6	15.5	58.3	33.6	30.3	55.5	17.8	31.5	87.8	30.1	29.5	33.6	9.2	80.6
99/00	133.2	227.5	120.1	101.5	79.5	67.9	80.9	93.5	101.5	44.2	74.0	17.8	87.7	47.5	38.9	28.2	35.9	26.6	18.0	19.6	22.8	6.5	6.7	69.6
00/01	178.0	286.0	110.2	58.2	48.5	166.2	92.4	58.2	49.5	25.6	54.0	28.9	23.1	4.2	78.5	41.6	32.2	25.1	4.4	20.4	12.5	17.6	18.1	66.2
01/02	90.7	118.8	146.5	40.8	99.1	179.4	118.0	36.4	97.2	67.9	21.8	42.9	54.3	9.7	26.1	27.0	19.7	16.2	6.9	20.5	0.0	19.2	7.3	39.0
02/03	26.9	173.8	147.5	118.9	210.0	99.9	114.3	81.2	151.9	44.6	29.1	0.9	22.8	58.8	36.0	45.7	44.1	32.2	9.3	14.3	9.5	11.6	5.7	38.9
03/04	60.6	236.3	189.5	182.7	208.2	111.5	174.8	207.3	21.3	68.3	1.8	44.9	44.3	76.7	37.5	17.8	45.3	26.2	3.2	33.2	42.8	19.1	8.7	103.0
04/05	224.6	99.5	124.2	123.8	157.0	121.2	145.0	130.8	38.8	74.3	16.2	47.6	26.1	32.8	35.3	38.3	66.7	16.7	2.4	18.7	32.5	37.1	10.4	196.7
05/06	442.7	63.8	150.1	160.9	125.3	64.8	96.3	66.9	40.7	54.5	5.9	2.4	23.5	19.5	31.9	71.7	40.5	31.0	3.4	18.6	9.9	24.3	3.3	120.6
06/07	279.7	45.0	118.2	230.2	168.2	68.0	73.8	106.4	13.1	74.9	65.2	–	37.5	49.6	23.6	35.4	46.8	67.7	9.5	19.3	30.6	35.5	60.9	279.8
07/08	291.3	53.8	77.0	89.9	97.9	90.5	90.4	153.4	7.5	48.3	0.1	246.2	55.0	39.4	15.9	34.7	12.3	58.1	56.2	28.3	11.3	26.8	76.5	359.5
08/09	210.9	61.5	80.1	108.6	102.0	113.6	104.7	48.8	15.7	44.1	–	201.0	95.6	18.5	26.1	13.5	12.4	19.7	28.5	13.3	53.2	32.4	23.5	230.4
09/10	273.1	39.7	137.6	85.2	125.3	71.5	70.1	66.7	16.3	32.7	0.2	152.4	42.9	32.2	14.1	23.4	13.6	35.8	13.9	8.4	68.2	26.0	36.0	179.9
Total	3 233.1	3 000.5	2 579.0	2 387.9	2 105.2	2 084.7	1 857.1	1 410.7	1 032.6	1 000.2	961.1	807.5	737.9	656.4	649.8	640.4	630.8	566.2	463.1	430.5	403.0	393.2	389.9	2 505.1

Table 11B: Annual landings (in tonnes, scaled to the QMR landings using Eq. 1) by MPI finfish statistical area (see Figure 2) for the Dahn line method (Figure 8). Statistical areas have been ranked in descending order of total catch over the 21 years of catch history. The 'Oth' category serves as an accumulator for all remaining statistical areas. '–': no data for the indicated statistical area/fishing year combination.

Fishing	MPI Finfish Statistical Area													
Year	032	001	002	031	016	008	003	048	047	009	018	010	004	Oth
89/90	12.8	51.2	5.6	1.8	5.2	7.3	5.0	–	–	5.2	0.2	–	0.1	1.3
90/91	0.4	24.5	9.7	3.7	2.9	3.8	2.0	–	1.0	0.2	0.3	–	0.1	6.8
91/92	0.1	5.6	16.2	0.0	2.7	0.1	0.1	–	0.0	8.0	0.0	4.6	12.4	9.7
92/93	–	4.0	15.4	–	5.4	8.9	3.4	0.0	0.1	0.4	0.0	7.7	10.0	19.0
93/94	2.9	13.7	16.7	–	9.8	8.1	1.9	–	0.2	6.6	0.4	3.0	0.6	11.0
94/95	7.4	1.6	19.7	7.7	11.5	5.2	1.5	–	–	8.5	0.1	22.6	–	41.0
95/96	2.5	13.9	11.0	12.0	6.7	10.8	5.1	0.0	0.1	13.4	1.7	–	1.4	44.8
96/97	8.8	5.0	4.9	–	4.4	2.2	14.4	0.0	1.4	4.2	1.5	–	0.9	9.7
97/98	19.3	21.5	3.0	–	4.4	5.1	7.9	0.0	0.8	0.0	1.0	0.7	0.5	8.8
98/99	53.8	11.1	2.6	0.2	7.1	3.2	10.0	–	0.8	–	1.5	–	0.3	11.5
99/00	21.0	4.4	0.7	18.8	5.9	1.8	1.8	–	3.7	0.7	0.2	2.0	1.7	12.2
00/01	25.6	1.1	2.0	7.9	4.7	4.9	8.4	–	0.3	4.6	0.2	–	2.5	18.9
01/02	48.6	0.0	1.5	16.6	1.7	3.3	3.0	–	0.2	1.3	0.3	0.2	1.2	14.5
02/03	27.2	16.1	2.8	11.6	15.7	2.7	1.3	0.6	1.0	0.1	0.2	0.3	2.4	12.4
03/04	37.1	4.9	1.2	13.6	10.6	1.7	2.6	–	0.1	0.3	0.0	0.3	–	6.9
04/05	21.6	–	0.6	12.4	8.7	2.0	0.2	0.1	1.9	0.4	1.5	–	0.7	3.6
05/06	29.9	–	1.3	10.1	3.3	2.1	1.5	–	23.4	0.3	0.7	0.0	0.0	4.8
06/07	4.4	–	2.4	1.2	1.3	2.9	1.0	0.5	16.1	0.1	2.0	–	1.4	7.2
07/08	–	–	0.7	–	2.0	6.0	1.0	30.4	2.5	–	7.6	–	0.5	8.7
08/09	0.2	–	1.2	0.6	1.4	3.6	0.4	20.1	0.0	–	8.8	–	0.0	2.8
09/10	–	–	5.5	–	2.0	2.2	0.1	12.9	2.1	0.5	14.0	–	0.1	2.2
Total	323.5	178.8	124.7	118.4	117.3	87.5	72.6	64.7	55.7	54.7	42.3	41.3	36.7	257.8

Table 12A: Annual landings (in tonnes, scaled to the QMR landings using Eq. 1) by MPI finfish statistical area (see Figure 2) for the midwater trawl method (Figure 9). Statistical areas have been ranked in descending order of total catch over the 21 years of catch history. The 'Oth' category serves as an accumulator for all remaining statistical areas. '–': no data for the indicated statistical area/fishing year combination.

Fishing	MPI Finfish Statistical Area										
Year	014	204	015	013	034	010	012	051	018	016	Oth
89/90	326.4	148.0	118.6	10.0	53.6	–	–	–	0.1	4.7	18.9
90/91	138.0	111.3	30.6	9.8	3.9	–	–	–	0.1	13.2	7.8
91/92	91.5	139.5	67.6	61.7	2.6	0.1	–	–	10.4	5.3	2.8
92/93	127.9	167.2	106.4	48.9	9.3	–	–	–	5.2	5.0	8.1
93/94	215.6	184.5	91.8	99.6	5.2	–	0.0	–	1.6	2.2	21.0
94/95	106.6	175.0	29.9	31.9	12.6	0.0	43.1	5.1	4.1	4.0	93.6
95/96	137.7	160.2	25.7	45.2	27.6	0.1	20.0	43.5	1.7	12.5	20.5
96/97	193.0	41.7	101.5	27.0	32.8	0.3	29.5	1.4	29.4	6.8	56.0
97/98	167.7	90.0	69.8	18.6	45.1	0.1	0.8	16.4	13.2	10.4	38.6
98/99	64.1	89.3	66.6	165.1	23.2	3.9	35.1	6.3	34.8	4.8	25.3
99/00	151.1	132.0	156.6	87.1	28.2	15.8	24.8	0.0	6.3	6.3	25.7
00/01	168.3	68.0	117.2	73.6	14.7	29.1	45.5	0.1	11.8	5.3	12.3
01/02	245.2	117.6	93.6	80.5	14.7	144.9	48.9	6.3	0.6	9.8	35.8
02/03	140.2	215.9	20.1	62.3	2.5	61.2	7.6	2.6	4.3	7.6	34.7
03/04	79.6	106.7	69.2	41.0	12.0	11.5	3.3	78.1	3.6	3.6	6.2
04/05	62.5	161.9	79.3	65.9	12.8	31.5	14.4	49.8	10.5	3.2	22.5
05/06	35.1	92.4	8.4	80.1	14.3	18.8	8.6	7.9	1.9	0.9	27.0
06/07	38.2	48.5	11.5	14.1	25.9	25.5	2.0	0.0	0.3	2.6	19.9
07/08	47.3	26.2	55.7	17.9	2.4	3.4	6.9	6.3	3.1	2.6	37.3
08/09	32.7	2.9	15.1	19.3	20.7	6.8	0.3	5.8	3.4	3.8	24.4
09/10	47.4	16.0	7.0	7.2	20.9	1.0	1.6	0.6	0.1	0.4	107.0
Total	2 616.3	2 294.7	1 342.2	1 066.6	385.0	354.1	292.4	230.1	146.5	115.1	645.4

Table 12B: Annual landings (in tonnes, scaled to the QMR landings using Eq. 1) by MPI finfish statistical area (see Figure 2) for the bottom trawl method (Figure 9). Statistical areas have been ranked in descending order of total catch over the 21 years of catch history. The ‘Oth’ category serves as an accumulator for all remaining statistical areas. ‘–’: no data for the indicated statistical area/fishing year combination.

Fishing	MPI Finfish Statistical Area														
Year	051	015	014	404	204	013	030	412	012	106	018	052	050	011	Oth
89/90	0.0	4.2	44.6	0.3	0.4	4.4	3.8	–	0.0	0.3	0.3	0.0	0.0	0.0	24.9
90/91	–	9.3	125.0	0.5	1.6	8.7	13.5	–	0.1	0.0	1.9	0.0	0.1	0.0	101.7
91/92	0.0	12.8	33.6	0.2	0.3	12.7	17.4	–	0.3	–	1.9	0.0	3.8	0.3	84.7
92/93	0.0	74.9	96.3	0.5	1.5	27.9	0.2	0.0	0.3	0.0	1.5	0.0	1.8	0.7	49.5
93/94	0.7	97.3	92.4	0.0	4.8	12.5	0.1	1.0	2.2	–	11.7	0.1	0.0	5.2	10.7
94/95	0.2	206.1	48.7	2.1	13.7	4.2	0.1	0.8	30.3	0.1	20.9	94.6	0.2	6.8	32.6
95/96	53.5	93.6	44.5	1.9	24.1	21.2	1.5	9.1	13.1	0.2	41.0	0.2	0.0	11.1	20.9
96/97	135.2	170.9	73.1	0.2	13.9	34.2	0.1	3.3	35.6	0.0	15.0	2.3	0.0	11.1	49.2
97/98	47.4	48.3	79.7	0.0	21.3	8.2	0.0	2.7	5.7	0.1	7.6	0.1	0.2	21.6	74.4
98/99	90.4	58.9	22.8	6.3	38.8	13.4	2.2	23.8	5.5	0.3	21.5	0.1	34.2	8.1	59.0
99/00	62.6	23.5	45.2	69.5	26.3	31.8	11.7	2.7	6.0	0.2	16.0	0.1	4.6	4.6	95.9
00/01	264.5	36.0	43.0	57.5	17.2	27.0	3.7	3.8	7.8	0.4	6.6	0.6	11.3	1.5	55.2
01/02	209.8	33.0	8.7	192.7	15.0	8.8	7.6	10.4	4.0	0.3	0.2	2.9	2.4	0.1	44.8
02/03	288.0	32.1	27.5	133.1	53.7	10.3	7.3	93.5	1.4	0.1	2.5	0.1	33.9	5.7	79.5
03/04	268.8	23.6	20.2	50.4	4.1	15.8	32.8	6.5	0.1	31.7	1.2	0.1	1.5	3.0	82.4
04/05	193.5	14.5	15.0	34.6	105.3	14.2	35.0	8.9	0.3	68.6	3.5	0.3	0.8	2.2	108.4
05/06	88.0	21.8	7.7	56.7	54.8	45.2	21.6	11.3	3.2	28.9	2.4	0.2	5.4	4.6	62.5
06/07	24.5	37.3	22.6	3.4	63.5	12.4	21.5	0.3	0.1	0.7	0.2	0.1	0.1	2.4	47.3
07/08	54.7	10.2	11.8	1.5	10.8	1.6	54.5	0.3	2.1	5.5	2.5	0.1	0.3	2.0	27.3
08/09	67.8	8.6	4.3	4.4	24.9	1.7	16.1	0.0	20.4	4.8	1.8	0.0	0.0	2.5	30.5
09/10	43.1	12.0	29.6	2.7	22.4	5.0	18.5	0.2	32.8	23.1	0.0	0.1	0.0	5.4	30.2
Total	1 892.7	1 028.9	896.3	618.5	518.2	321.0	269.2	178.7	171.6	165.2	160.0	102.0	100.7	98.9	1 171.8

Table 13: Annual landings (in tonnes, scaled to the QMR landings using Eq. 1) by MPI finfish statistical area (see Figure 2) for the setnet method (Figure 10). Statistical areas have been ranked in descending order of total catch over the 21 years of catch history. The ‘Oth’ category serves as an accumulator for all remaining statistical areas. ‘–’: no data for the indicated statistical area/fishing year combination.

Fishing	MPI Finfish Statistical Area						
Year	018	024	010	014	015	001	Oth
89/90	38.6	12.9	36.5	16.9	1.0	–	13.1
90/91	19.0	16.2	57.4	21.7	10.6	–	9.8
91/92	22.1	20.8	59.1	12.3	1.4	–	8.7
92/93	26.3	15.3	3.4	3.9	0.2	30.2	20.6
93/94	32.6	37.1	27.1	0.3	2.0	–	11.1
94/95	22.4	29.0	2.2	0.0	3.5	–	6.8
95/96	30.4	44.9	2.3	0.0	0.0	–	11.6
96/97	28.3	27.7	4.8	0.4	–	–	20.5
97/98	32.7	30.4	2.7	1.4	0.0	0.1	11.1
98/99	34.0	16.5	2.2	0.0	0.0	–	7.9
99/00	48.7	12.2	–	–	0.1	0.2	3.3
00/01	37.3	7.2	–	0.0	1.3	–	1.2
01/02	29.6	9.0	–	–	1.0	–	1.4
02/03	20.8	16.0	0.0	–	2.4	–	1.8
03/04	18.1	10.8	–	0.0	0.2	–	0.7
04/05	9.5	3.8	–	0.0	0.9	–	2.4
05/06	6.6	3.7	–	0.1	0.5	–	0.1
06/07	6.7	8.9	–	–	0.0	–	0.3
07/08	6.2	2.3	–	0.9	2.3	–	10.2
08/09	6.8	0.0	–	6.2	0.6	–	10.0
09/10	7.2	0.3	–	0.0	3.3	–	0.3
Total	483.9	325.1	197.7	64.2	31.5	30.5	152.7

Table 14: Percent distribution of landings by month and total annual landings (t) in the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 data set from 1989−90 to 2009–10 for the three major methods which take bluenose in the NZ EEZ. Annual landings (t) by method have been scaled to the QMR totals using Eq. 1 and the percentages by row sum to 100.

Fishing												Month	Total
year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	(t)
Bottom longline (%)													
89/90	2	5	4	4	11	9	4	8	12	9	7	24	501
90/91	7	9	9	6	10	6	9	11	5	6	8	14	933
91/92	11	9	10	8	6	6	8	7	12	7	5	10	1 194
92/93	9	13	8	8	8	8	5	8	6	9	7	11	1 368
93/94	8	11	10	7	7	6	11	5	5	7	13	10	1 246
94/95	8	12	8	4	8	7	6	8	4	4	12	19	1 090
95/96	9	9	8	7	9	11	10	4	7	6	9	11	1 238
96/97	8	7	8	7	9	11	11	13	5	7	6	8	1 589
97/98	9	9	11	10	11	12	8	5	8	6	6	8	1 553
98/99	6	9	8	10	10	12	8	10	5	4	10	9	1 694
99/00	5	9	10	8	14	12	8	6	5	6	8	9	1 549
00/01	4	7	11	12	10	12	9	4	10	6	7	8	1 500
01/02	7	8	7	11	9	11	9	5	5	10	9	10	1 305
02/03	4	12	11	11	13	9	12	9	4	5	6	6	1 528
03/04	7	10	12	13	7	15	10	5	7	3	5	6	1 965
04/05	8	13	5	12	7	7	8	11	6	6	9	8	1 816
05/06	10	9	9	10	11	7	8	6	8	6	8	8	1 672
06/07	4	8	9	12	8	11	12	10	7	8	6	6	1 939
07/08	4	12	10	9	10	10	9	9	6	7	6	9	2 020
08/09	6	9	9	11	11	10	7	5	8	8	7	8	1 658
09/10	9	8	10	11	10	8	8	7	6	7	8	7	1 565
Mean	7	10	9	10	9	10	9	7	7	6	8	9	30 926[1]
Midwater trawl (%)													
89/90	6	18	13	9	9	4	3	6	5	7	8	13	680
90/91	8	11	6	31	4	5	2	4	6	8	4	10	315
91/92	9	14	7	3	7	3	2	8	10	13	16	8	382
92/93	4	22	6	4	8	10	5	9	1	3	17	13	478
93/94	12	16	14	12	6	4	5	5	5	2	13	5	622
94/95	15	23	10	15	5	11	1	0	1	4	10	4	506
95/96	10	37	12	8	8	2	1	3	4	6	4	5	495
96/97	7	30	11	8	12	4	3	3	2	4	8	7	519
97/98	28	10	15	4	12	6	2	0	4	12	4	5	471
98/99	4	9	19	13	20	6	5	3	3	4	6	7	518
99/00	8	5	5	27	11	7	7	6	2	11	7	5	634
00/01	7	18	8	16	10	5	4	8	6	5	3	10	546
01/02	8	5	2	19	11	12	3	12	4	13	4	7	798
02/03	26	23	9	4	8	4	3	3	5	2	2	10	559
03/04	11	5	4	21	8	14	5	12	13	3	2	2	415
04/05	4	20	10	12	11	13	14	1	2	5	3	4	514
05/06	14	20	25	6	3	1	3	0	5	12	6	6	295
06/07	7	5	24	2	1	6	7	3	3	8	19	17	189
07/08	8	14	14	2	1	11	20	7	0	4	5	15	209
08/09	8	11	6	17	11	5	5	2	0	13	15	6	135
09/10	1	7	4	33	10	2	9	2	0	7	16	9	209
Mean	10	16	10	13	9	7	5	5	4	7	7	8	9 488[1]

Table 14. (cont.)

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Month Sep	Total (t)
Bottom trawl (%)													
89/90	4	20	6	4	5	8	8	7	11	3	8	15	83
90/91	6	9	11	3	3	9	37	3	2	3	2	12	262
91/92	3	5	3	6	8	26	8	4	8	3	4	21	168
92/93	6	10	11	18	14	7	6	9	5	2	8	4	255
93/94	3	7	23	11	23	9	6	10	4	1	1	2	239
94/95	4	3	6	8	24	8	4	36	1	2	1	2	461
95/96	8	19	11	4	13	23	8	4	2	2	1	6	336
96/97	4	9	14	13	21	25	2	5	2	2	0	3	544
97/98	10	9	9	18	10	5	12	15	5	3	1	2	317
98/99	2	5	22	17	8	18	5	5	5	3	3	7	385
99/00	5	20	13	6	5	15	6	5	6	2	1	16	401
00/01	14	4	4	26	5	15	11	2	3	9	0	7	536
01/02	19	18	17	6	3	7	1	9	1	5	6	7	541
02/03	5	6	12	19	13	14	14	11	1	4	2	1	769
03/04	8	12	21	5	9	5	16	12	2	1	2	7	542
04/05	7	17	10	14	11	8	8	9	2	3	3	9	605
05/06	7	15	7	14	11	6	3	18	2	4	3	12	414
06/07	7	14	10	18	3	14	7	12	2	3	8	2	236
07/08	3	5	6	13	14	7	5	23	1	2	13	7	185
08/09	5	14	10	18	11	7	12	5	6	5	2	6	188
09/10	3	9	11	17	7	26	9	3	2	5	1	9	225
Mean	7	11	12	13	11	12	9	10	3	3	3	7	7 694[1]

[1] Total catch (t): 1989–90 to 2009–10

Table 15: Distribution in tonnes and percent for BNS by target species taken in the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 data set from 1989–90 to 2009–10 by the bottom longline method. Annual landings (t) by method have been scaled to the QMR totals using Eq. 1 and the row percentages sum to 100. Annual totals by method of capture can be found in Table 14.

Fishing Year	Target Species BNS	LIN	HPB	SKI	OTH	Target Species BNS	LIN	HPB	SKI	OTH
	Distribution (t)					Distribution (%)				
89/90	402.1	85.4	11.4	–	2.4	80	17	2	–	0
90/91	818.5	63.0	47.7	1.1	2.3	88	7	5	0	0
91/92	943.4	162.3	52.2	14.1	22.0	79	14	4	1	2
92/93	981.9	227.4	146.3	10.7	2.2	72	17	11	1	0
93/94	863.2	233.4	113.3	26.7	9.1	69	19	9	2	1
94/95	914.3	92.7	69.8	2.8	10.4	84	9	6	0	1
95/96	905.9	209.8	99.2	9.6	13.9	73	17	8	1	1
96/97	1 231.2	287.7	60.0	4.8	5.4	77	18	4	0	0
97/98	1 144.6	206.1	186.0	15.1	1.6	74	13	12	1	0
98/99	1 209.5	268.0	212.3	2.4	1.9	71	16	13	0	0
99/00	1 140.2	211.6	191.7	2.1	3.8	74	14	12	0	0
00/01	1 154.3	197.0	142.8	0.7	4.7	77	13	10	0	0
01/02	1 033.6	131.3	134.0	1.5	4.9	79	10	10	0	0
02/03	1 235.5	111.8	172.6	0.6	7.4	81	7	11	0	0
03/04	1 647.7	72.2	238.1	0.0	7.5	84	4	12	0	0
04/05	1 596.4	96.4	111.6	0.0	12.0	88	5	6	0	1
05/06	1 538.8	58.4	64.4	–	10.7	92	3	4	–	1
06/07	1 790.2	72.8	66.9	0.3	8.5	92	4	3	0	0
07/08	1 832.8	110.9	56.5	0.1	19.8	91	5	3	0	1
08/09	1 503.6	81.3	66.2	0.0	7.3	91	5	4	0	0
09/10	1 437.6	62.4	60.5	0.0	4.6	92	4	4	0	0
Total	25 325.1	3 041.9	2 303.6	92.6	162.5	82	10	7	0	1

Table 16: Distribution in tonnes and percent for BNS by target species taken in the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 data set from 1989–90 to 2009–10 by the midwater trawl method. Annual landings (t) by method have been scaled to the QMR totals using Eq. 1 and the row percentages sum to 100. Annual totals by method of capture can be found in Table 14.

Fishing	Target Species						Target Species					
Year	BYX	BNS	HOK	RBY	SKI	OTH	BYX	BNS	HOK	RBY	SKI	OTH
	Distribution (t)						Distribution (%)					
89/90	484.4	114.6	71.8	3.9	–	5.5	71	17	11	1	–	1
90/91	156.3	107.7	30.4	15.8	0.0	4.4	50	34	10	5	0	1
91/92	280.8	60.5	26.6	9.2	2.9	1.6	74	16	7	2	1	0
92/93	399.6	5.2	30.9	31.8	10.0	0.6	84	1	6	7	2	0
93/94	532.6	0.2	33.1	7.3	33.2	15.1	86	0	5	1	5	2
94/95	399.3	6.8	57.5	4.9	21.0	16.4	79	1	11	1	4	3
95/96	412.9	0.9	50.7	4.2	20.0	5.8	84	0	10	1	4	1
96/97	257.3	28.8	168.7	15.4	38.2	10.9	50	6	32	3	7	2
97/98	277.4	28.6	153.2	0.2	7.5	3.7	59	6	33	0	2	1
98/99	391.8	8.6	110.4	1.7	0.6	5.3	76	2	21	0	0	1
99/00	485.2	38.8	85.8	2.1	0.9	21.0	77	6	14	0	0	3
00/01	397.7	46.6	82.7	2.0	9.4	7.5	73	9	15	0	2	1
01/02	421.3	310.2	41.2	8.6	9.2	7.5	53	39	5	1	1	1
02/03	266.2	239.0	43.0	2.8	6.1	1.8	48	43	8	1	1	0
03/04	143.4	197.5	63.2	3.0	7.0	0.8	35	48	15	1	2	0
04/05	256.1	192.9	51.6	4.8	0.1	8.8	50	38	10	1	0	2
05/06	217.5	32.5	22.4	21.7	0.0	1.2	74	11	8	7	0	0
06/07	108.9	19.6	32.2	26.2	–	1.6	58	10	17	14	–	1
07/08	125.8	53.0	9.8	17.2	–	3.2	60	25	5	8	–	2
08/09	55.6	22.9	31.7	24.6	–	0.5	41	17	23	18	–	0
09/10	51.5	143.8	4.3	8.2	0.0	1.6	25	69	2	4	0	1
Total	6 121.7	1 658.8	1 201.3	215.8	166.1	124.8	65	17	13	2	2	1

Table 17: Distribution in tonnes and percent for BNS by target species taken in the combined BNS 1, BNS 2, BNS 3, BNS 7 and BNS 8 data set from 1989–90 to 2009–10 by the bottom trawl method. Annual landings (t) by method have been scaled to the QMR totals using Eq. 1 and the row percentages sum to 100. Annual totals by method of capture can be found in Table 14.

Fishing	Target Species							Target Species						
Year	BYX	HOK	BNS	SKI	CDL	ORH	OTH	BYX	HOK	BNS	SKI	CDL	ORH	OTH
	Distribution (t)							Distribution (%)						
89/90	7.2	5.2	6.9	32.3	1.1	2.4	28.0	9	6	8	39	1	3	34
90/91	34.7	25.5	60.1	15.0	7.0	1.4	118.8	13	10	23	6	3	1	45
91/92	1.2	30.0	13.7	32.4	0.8	4.1	85.6	1	18	8	19	1	2	51
92/93	14.1	23.3	44.4	110.9	2.1	3.2	57.1	6	9	17	43	1	1	22
93/94	16.2	25.0	0.0	150.2	14.6	18.1	14.8	7	10	0	63	6	8	6
94/95	15.7	285.6	4.5	61.5	26.1	36.7	31.3	3	62	1	13	6	8	7
95/96	99.2	69.1	5.5	70.0	38.9	35.9	17.2	30	21	2	21	12	11	5
96/97	183.1	120.5	12.3	145.3	20.6	34.5	27.6	34	22	2	27	4	6	5
97/98	85.9	124.7	17.7	32.6	27.4	14.6	14.6	27	39	6	10	9	5	5
98/99	158.6	81.3	30.2	19.5	46.4	29.1	20.2	41	21	8	5	12	8	5
99/00	170.1	80.5	8.2	27.7	62.0	20.2	31.9	42	20	2	7	15	5	8
00/01	287.8	68.5	74.3	48.5	21.5	8.8	26.7	54	13	14	9	4	2	5
01/02	168.3	22.9	283.7	9.6	15.8	6.8	33.4	31	4	52	2	3	1	6
02/03	448.6	41.7	193.3	15.5	29.6	8.5	31.8	58	5	25	2	4	1	4
03/04	233.2	41.6	176.8	21.1	8.7	10.5	50.6	43	8	33	4	2	2	9
04/05	402.9	29.7	61.3	6.3	19.5	13.8	71.4	67	5	10	1	3	2	12
05/06	248.1	25.4	72.7	0.7	21.6	2.4	43.3	60	6	18	0	5	1	10
06/07	100.2	24.3	7.7	11.0	35.4	1.3	56.3	42	10	3	5	15	1	24
07/08	72.7	12.4	10.4	1.4	10.3	2.9	75.3	39	7	6	1	6	2	41
08/09	113.6	13.4	15.9	1.8	8.9	6.4	27.8	60	7	8	1	5	3	15
09/10	135.0	5.5	22.3	0.0	22.6	11.3	28.5	60	2	10	0	10	5	13
Total	2 996.5	1 156.1	1 121.8	813.3	441.1	272.7	892.2	39	15	15	11	6	4	12

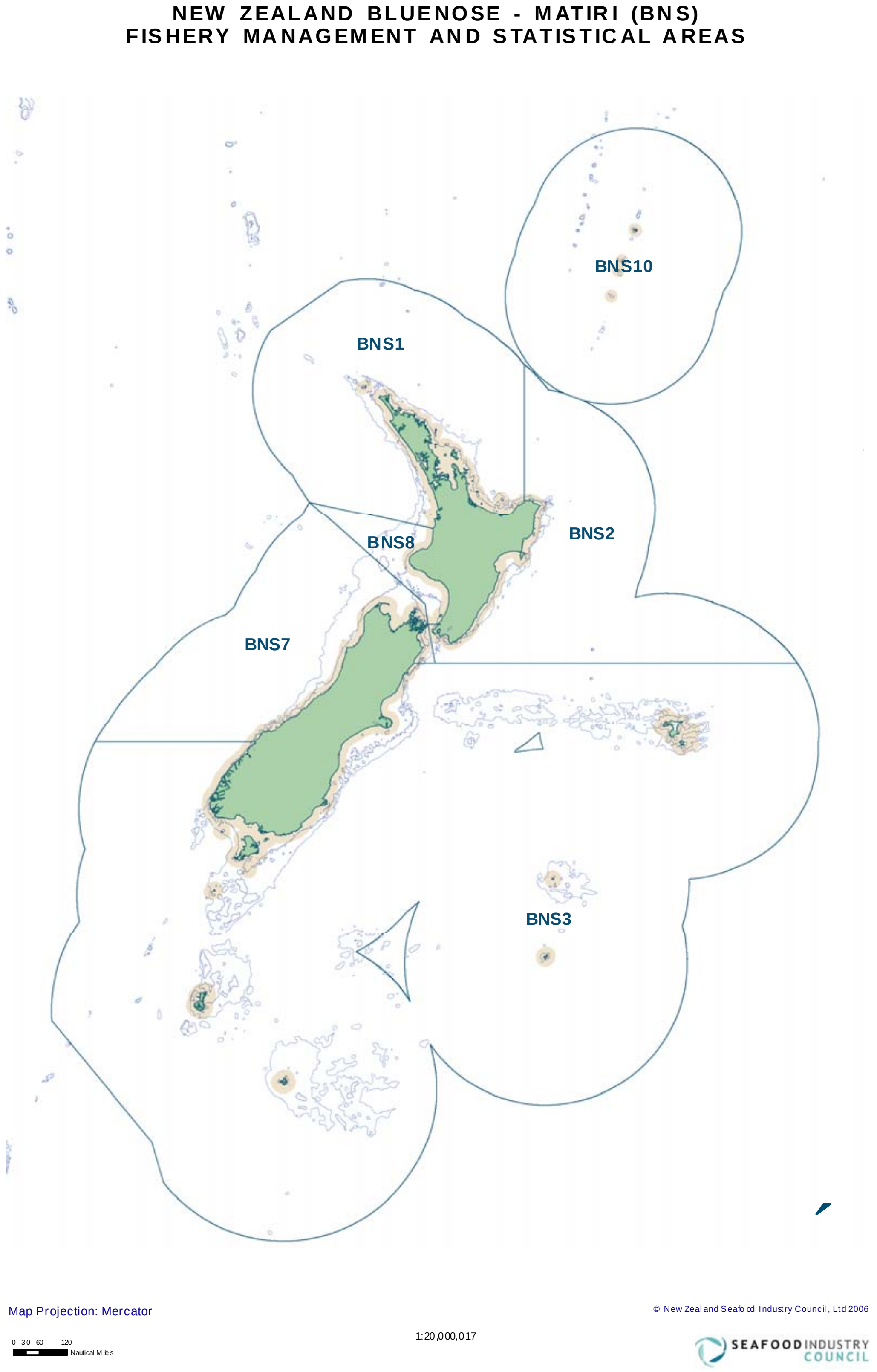

Figure 1: Map of bluenose (BNS) Quota Management Areas, showing the 100 m and 400 m depth contours.

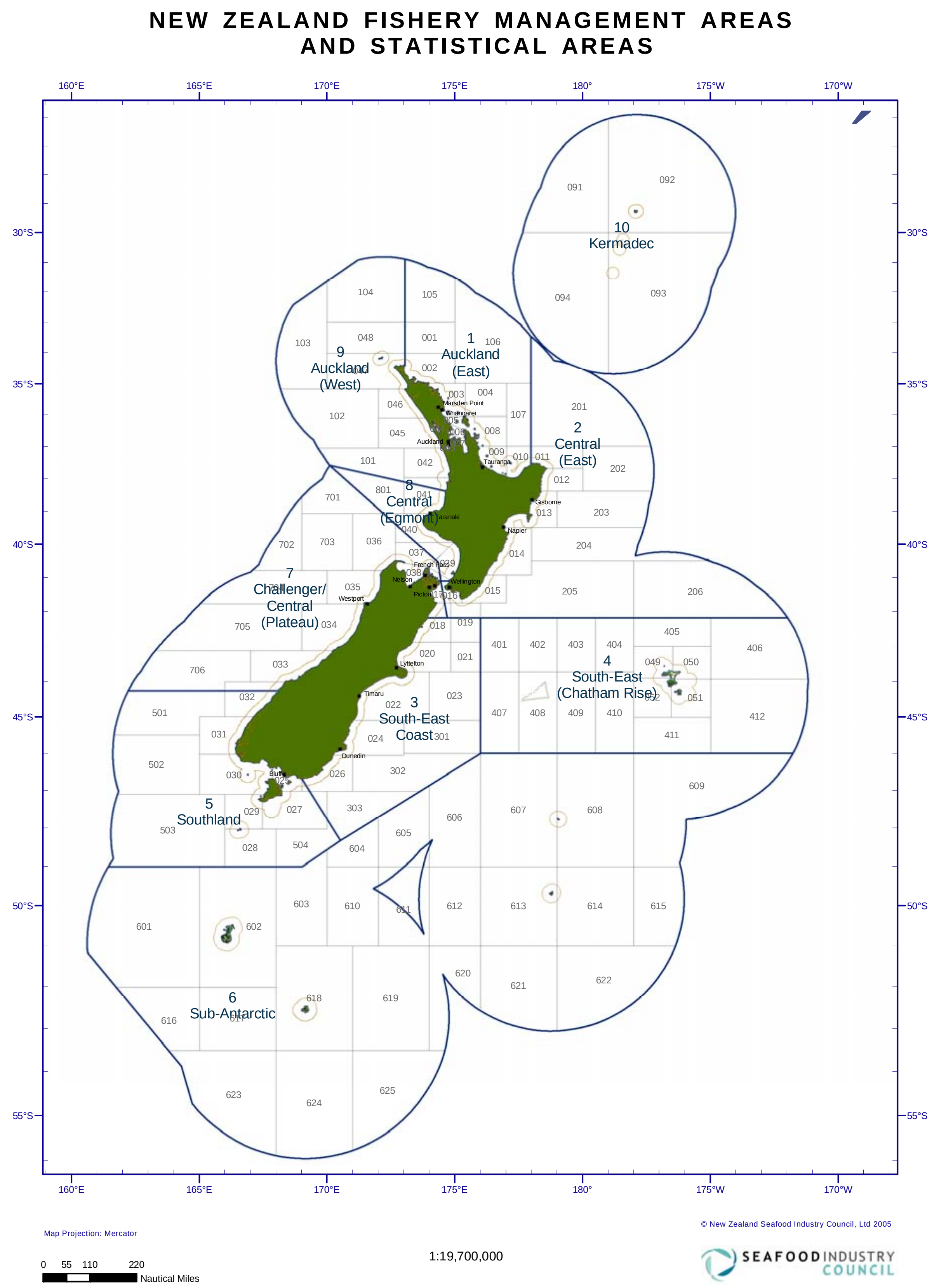

Figure 2: Map of MPI statistical areas and Fishery Management Area (FMA) boundaries, showing locations where FMA boundaries are not contiguous with the statistical area boundaries.

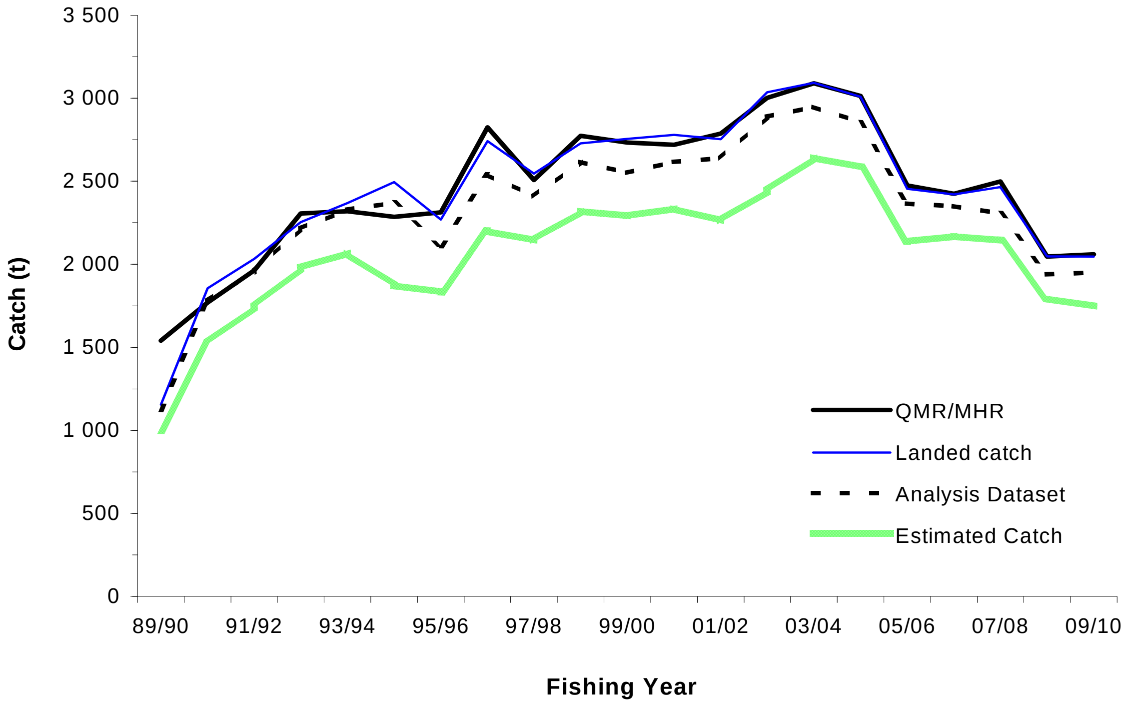

Figure 3: Plot of catch datasets presented in Table 1. The estimated catch total is the sum of the estimated catch in the analysis dataset.

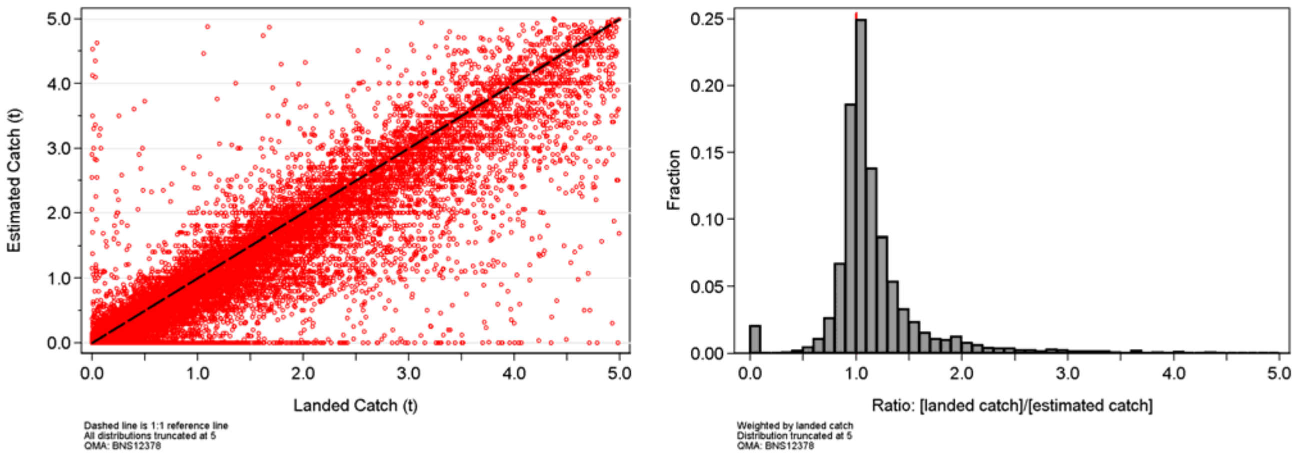

Figure 4: [left panel]: Scatter plot of the sum of landed and estimated bluenose catch for each trip in the combined BNS analysis dataset. [right panel]: Distribution (weighted by the landed catch) of the ratio of landed to estimated catch per trip. Trips where the estimated catch is zero have been assigned a ratio of zero.

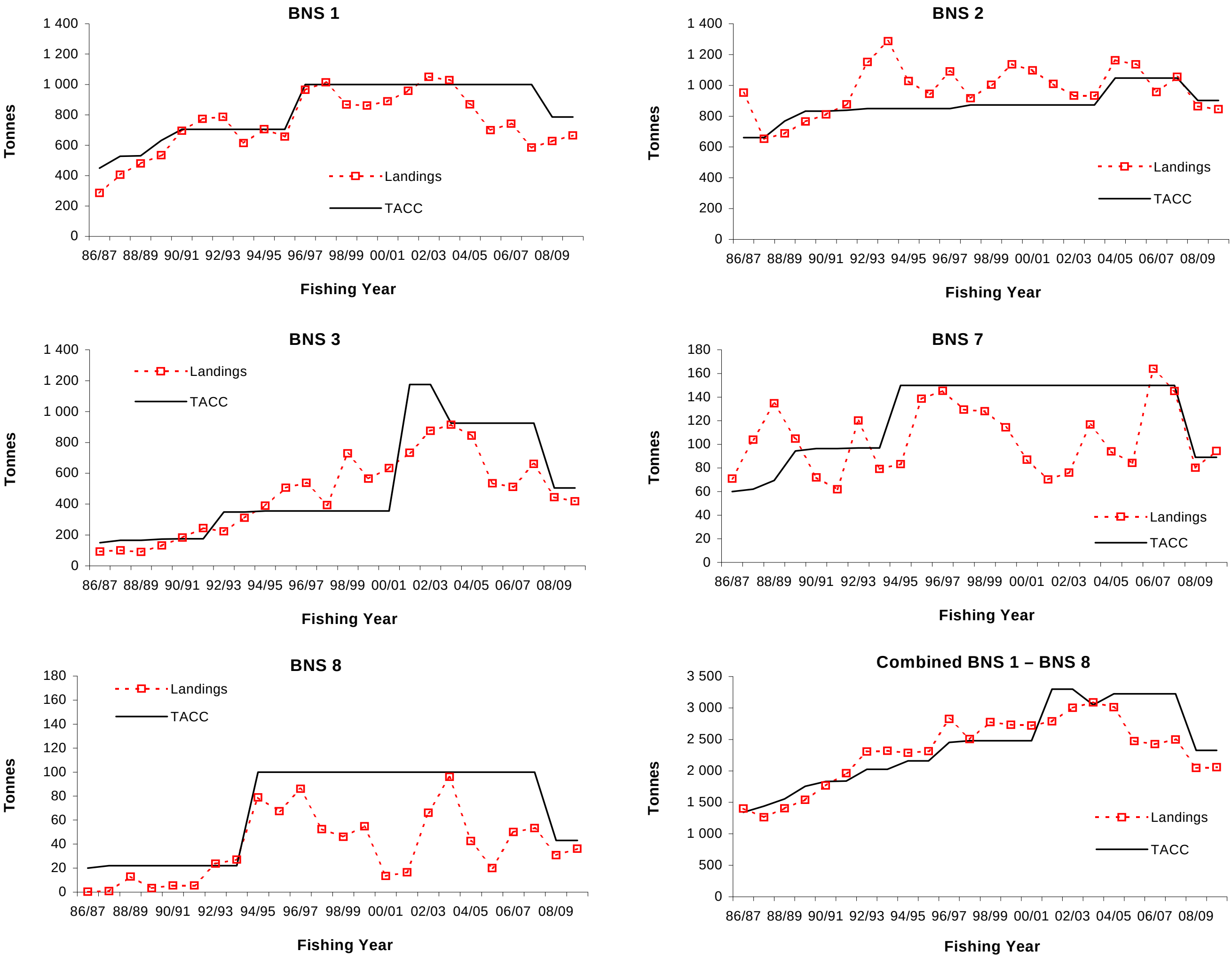

Figure 5: Catch history and TACC (t) for the five BNS QMAs, as well as for the combined NZ EEZ, from 1986–87 to the 2009–10 fishing years.

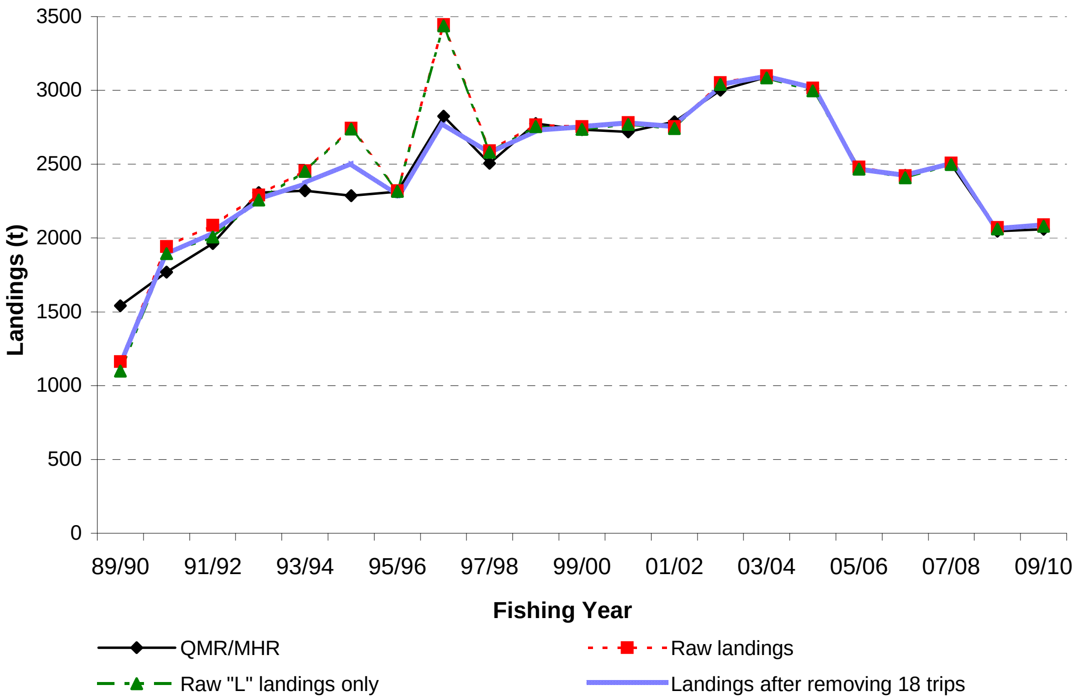

Figure 6: Landing totals for BNS 1 by year from three sources, compared with the QMR/MHR annual totals (Table 2).

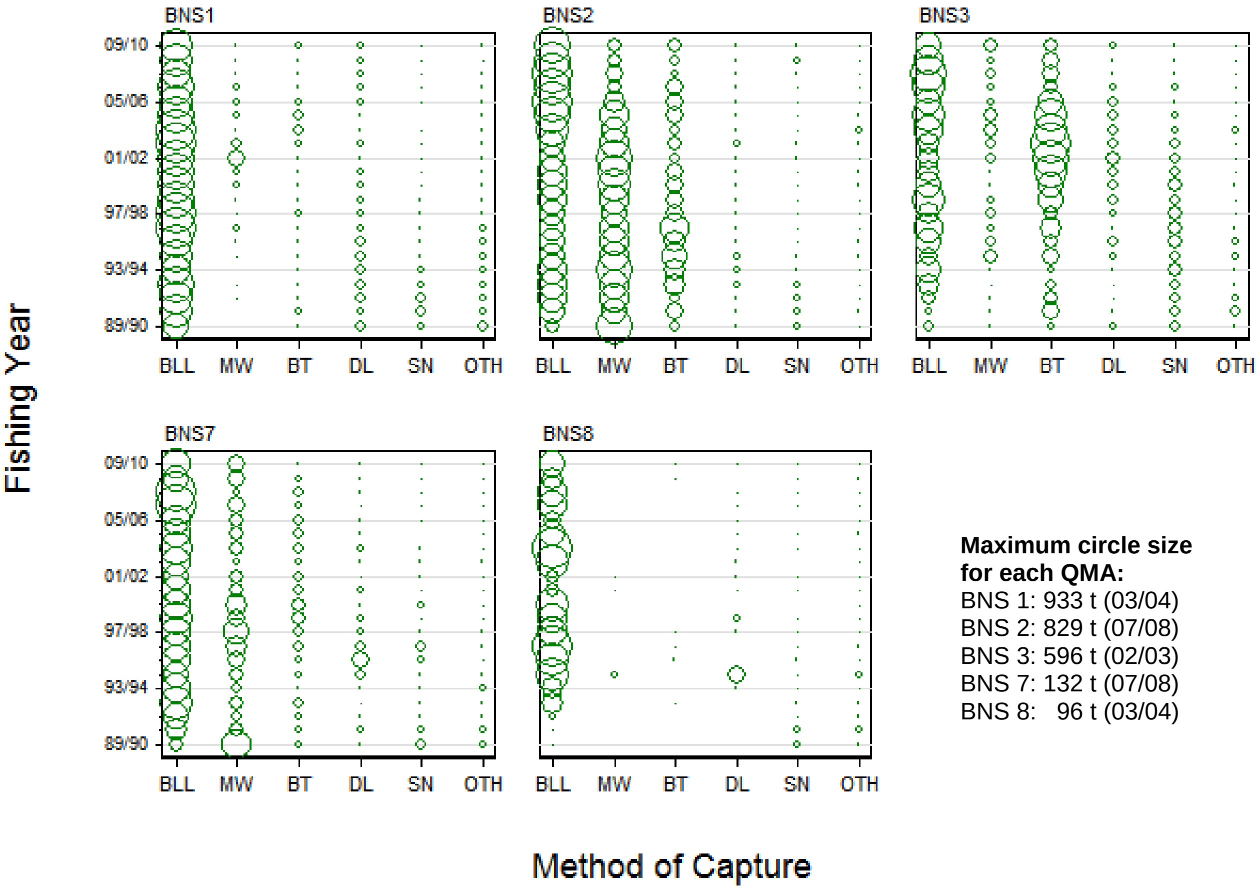

Figure 7: Distribution of landings by method of capture and fishing year for each BNS QMA.

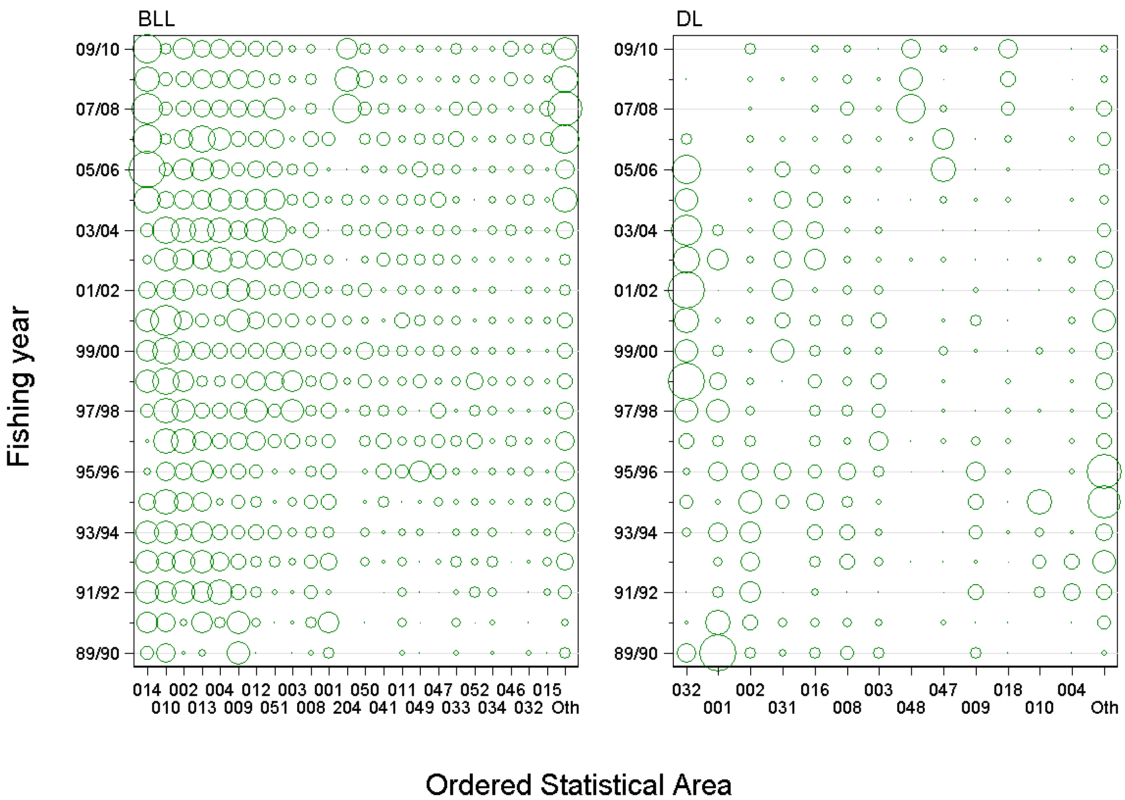

Figure 8: Distribution of landings for the top statistical areas (presented in descending order of total landings over 21 years) in the BNS EEZ for the two line methods of capture. Maximum circle size: BLL=443 t (05/06 for 014); DL=54 t (98/99 for 032).

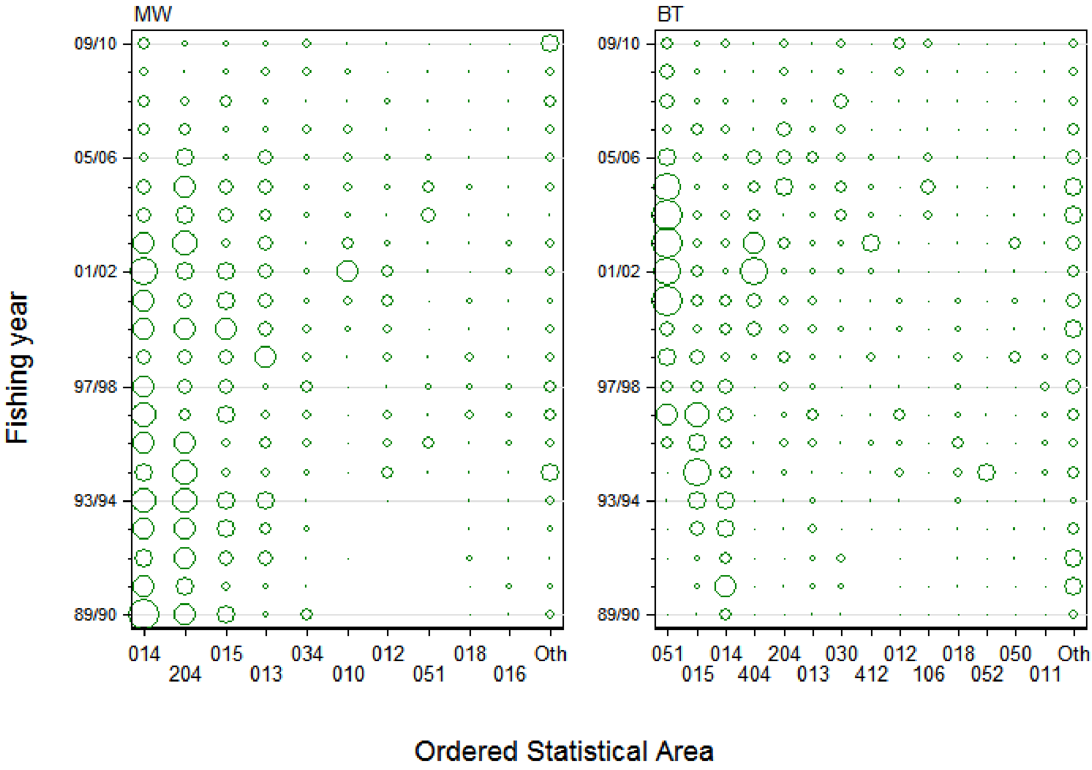

Figure 9: **Distribution of landings for the top statistical areas (presented in descending order of total landings over 21 years) in the BNS EEZ for the two trawl methods of capture. Maximum circle size: MW=326 t (89/90 for 014); BT=288 t (02/03 for 051).**

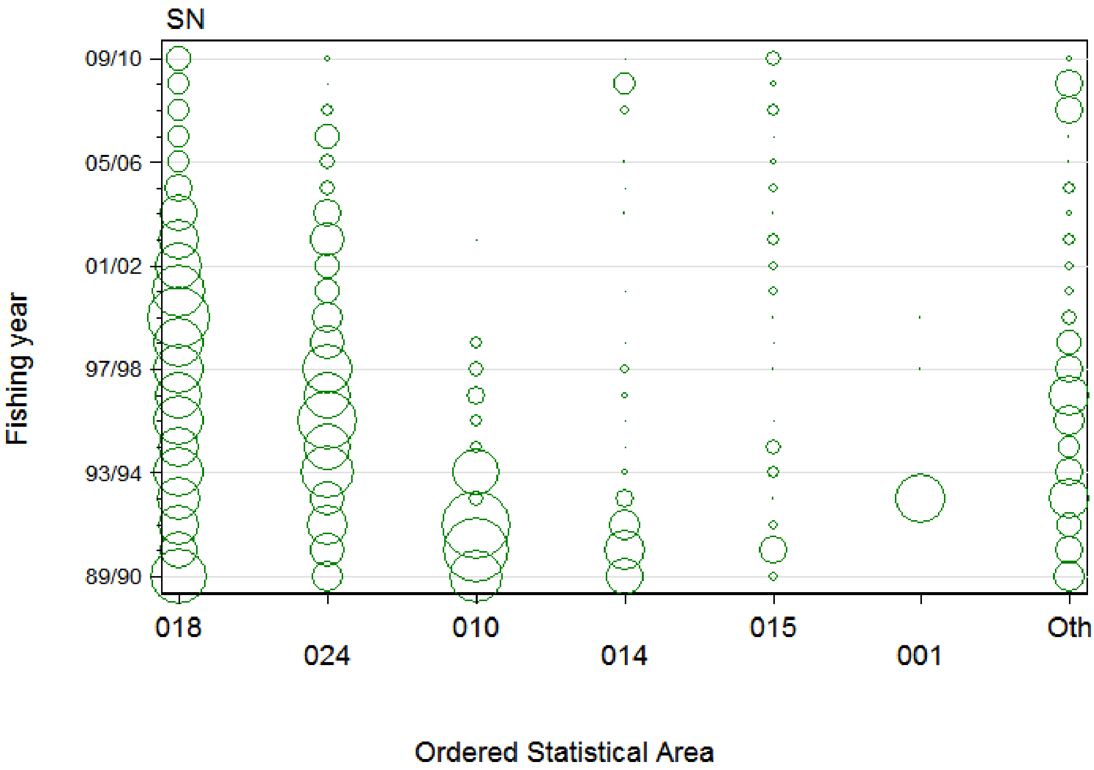

Figure 10: **Distribution of landings for the top statistical areas (presented in descending order of total landings over 21 years) in the BNS EEZ for the setnet method of capture. Maximum circle size: 59 t (91/92 for 010).**

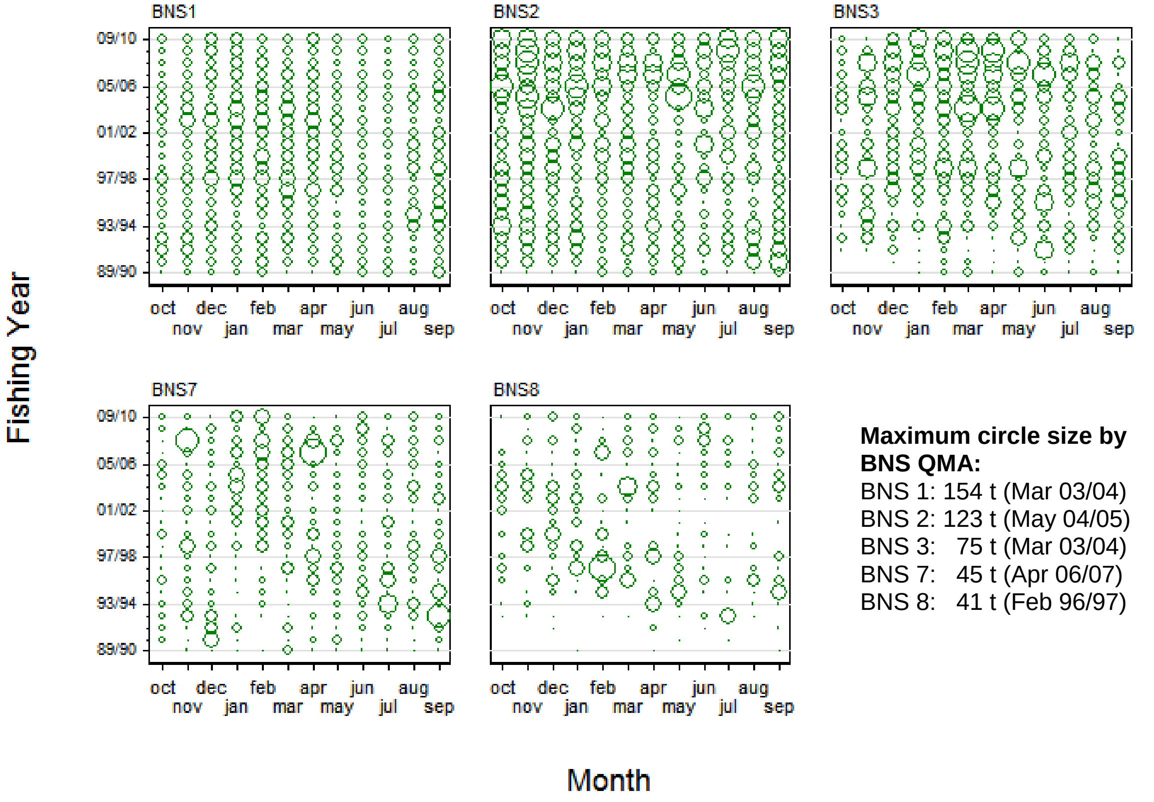

Figure 11: Distribution of landings for the bottom longline method by month and fishing year for each of the BNS QMAs.

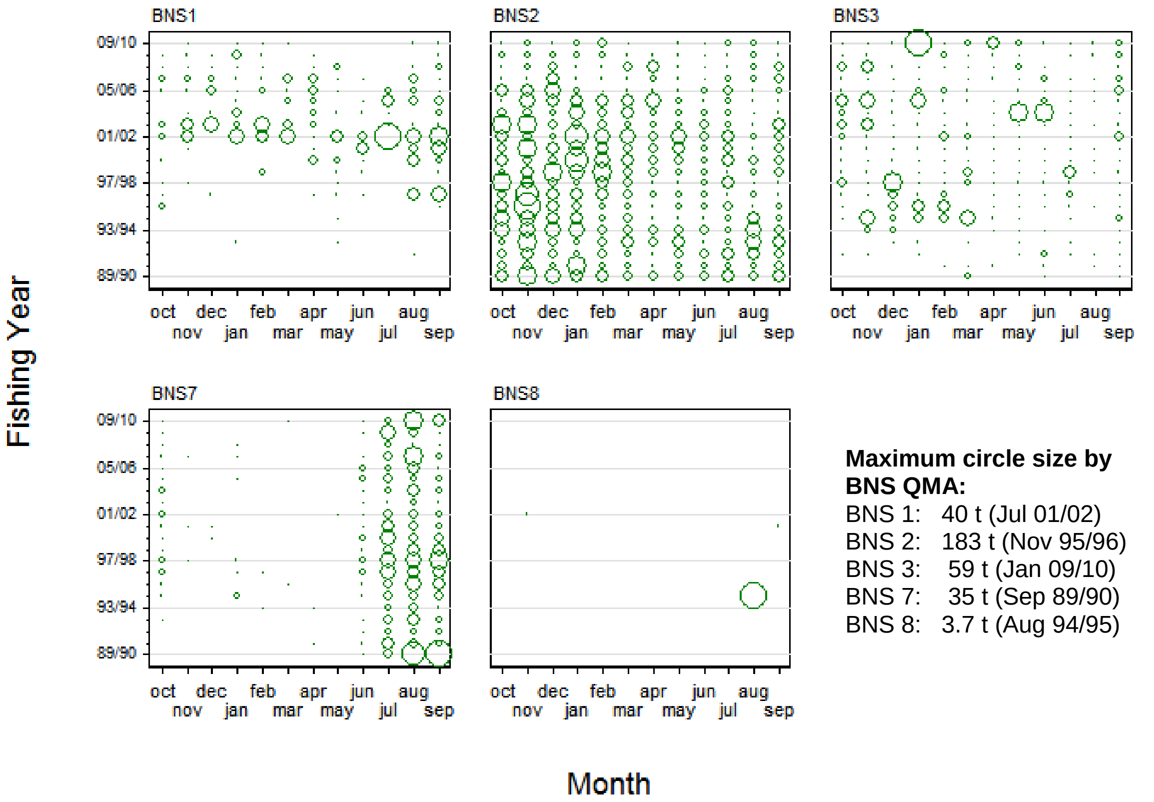

Figure 12: Distribution of landings for the midwater trawl method by month and fishing year for each of the BNS QMAs.

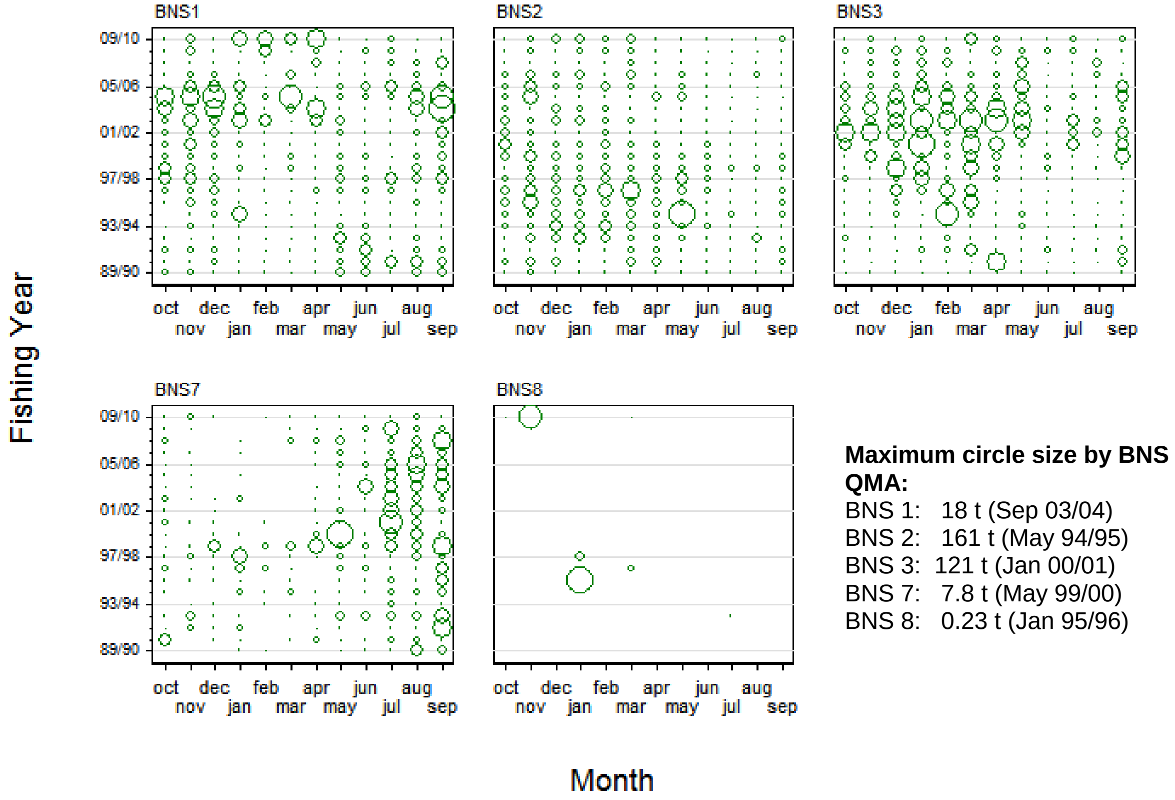

Figure 13: Distribution of landings for the bottom trawl method by month and fishing year for each of the BNS QMAs.

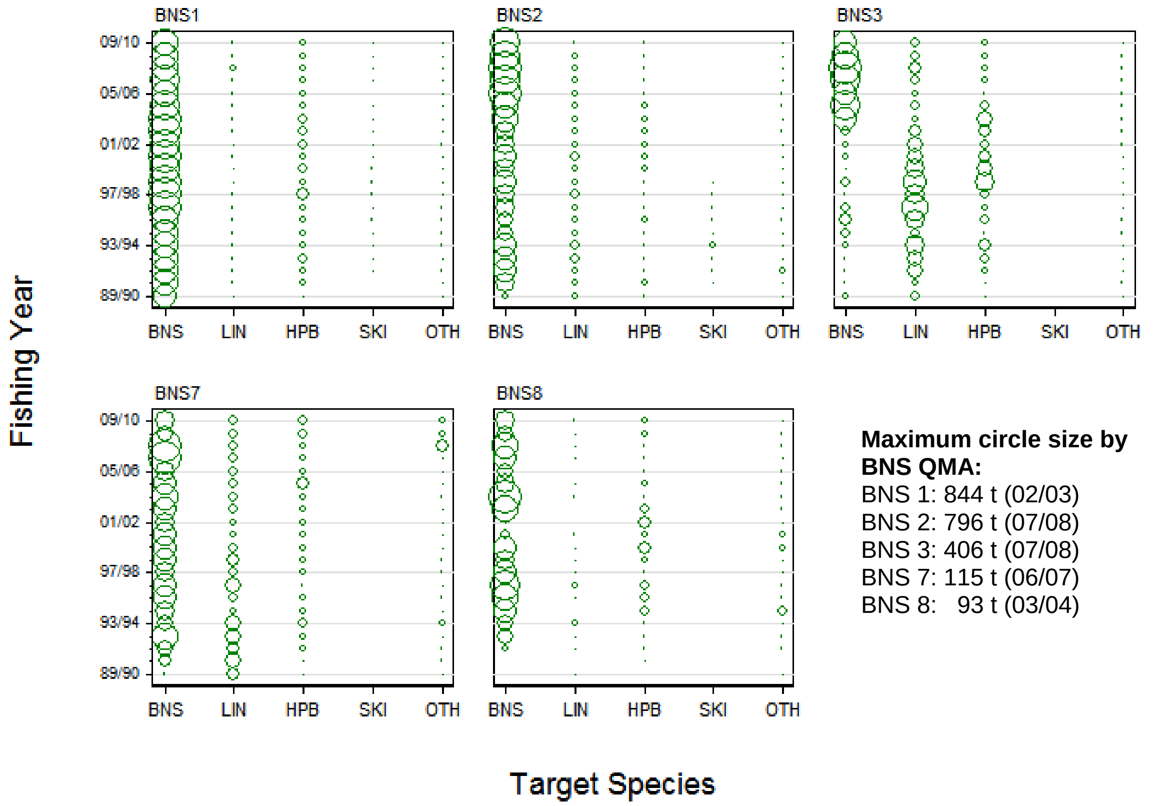

Figure 14: Distribution of landings for the bottom longline method by target species and fishing year for each of the BNS QMAs.

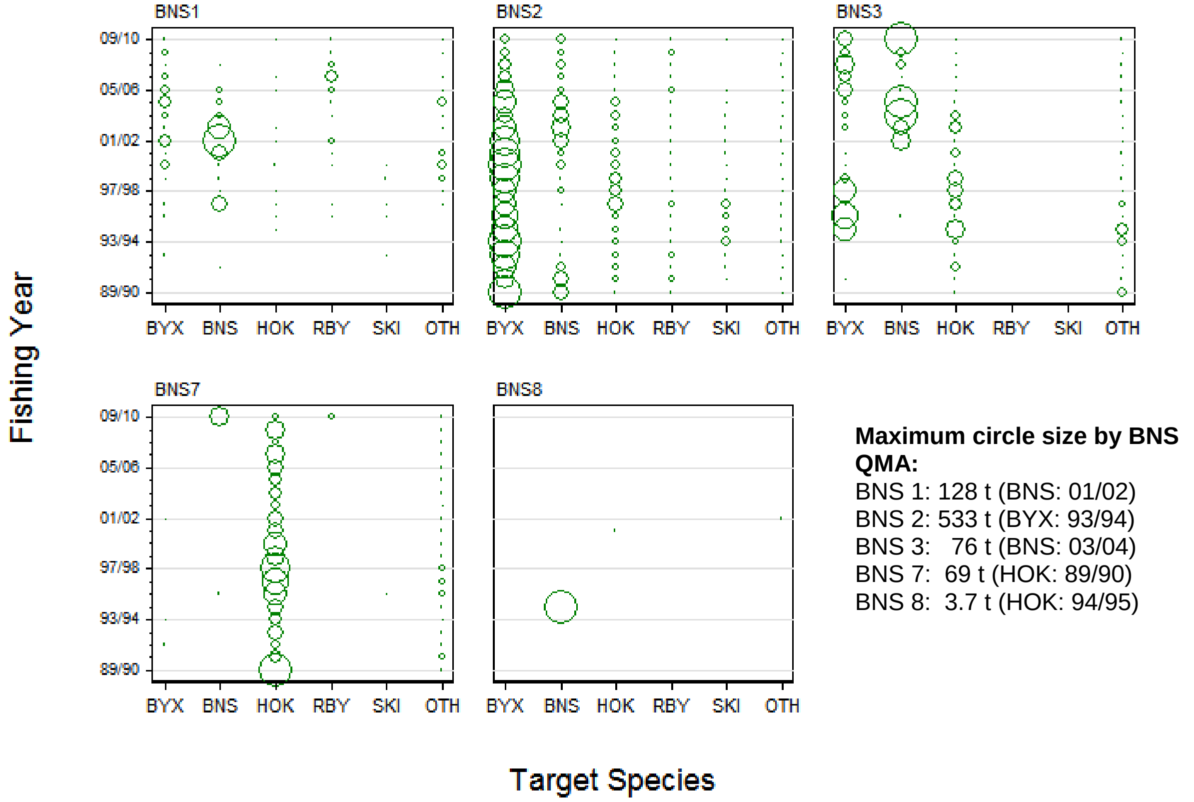

Figure 15: Distribution of landings for the midwater trawl method by target species and fishing year for each of the BNS QMAs.

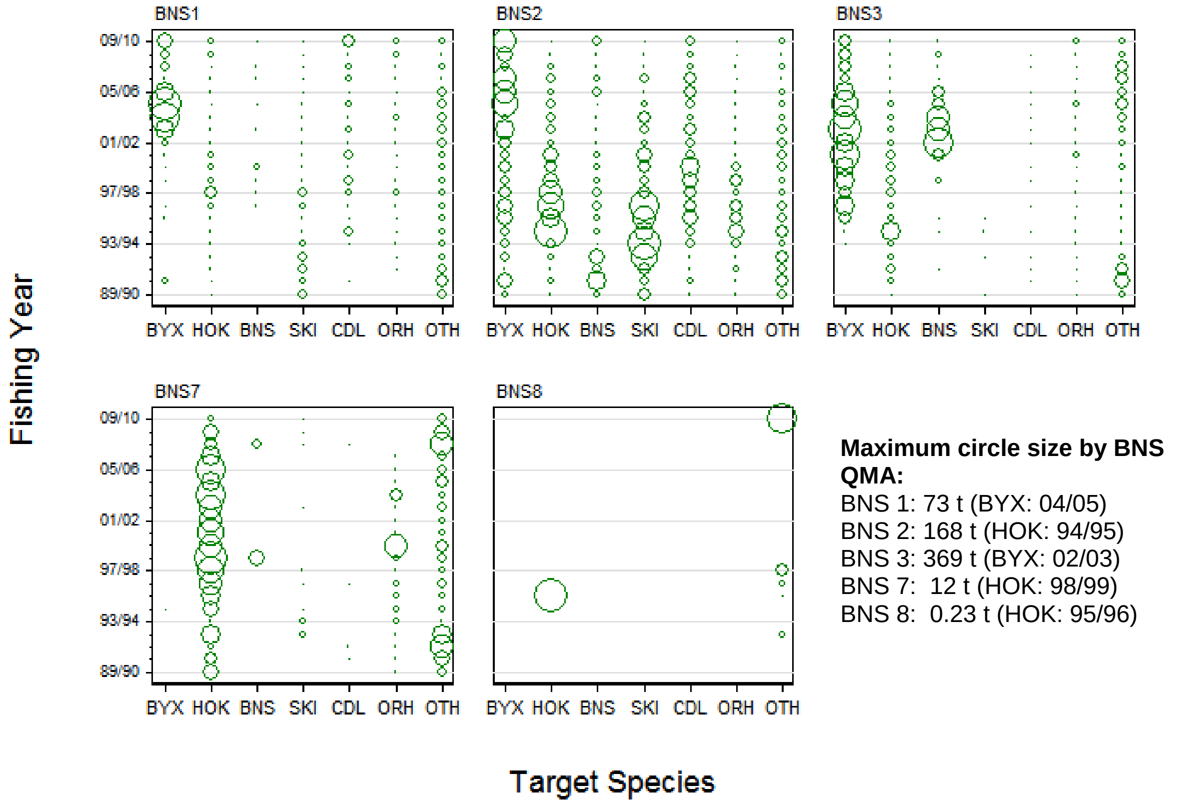

Figure 16: Distribution of landings for the bottom trawl method by target species and fishing year for each of the BNS QMAs.

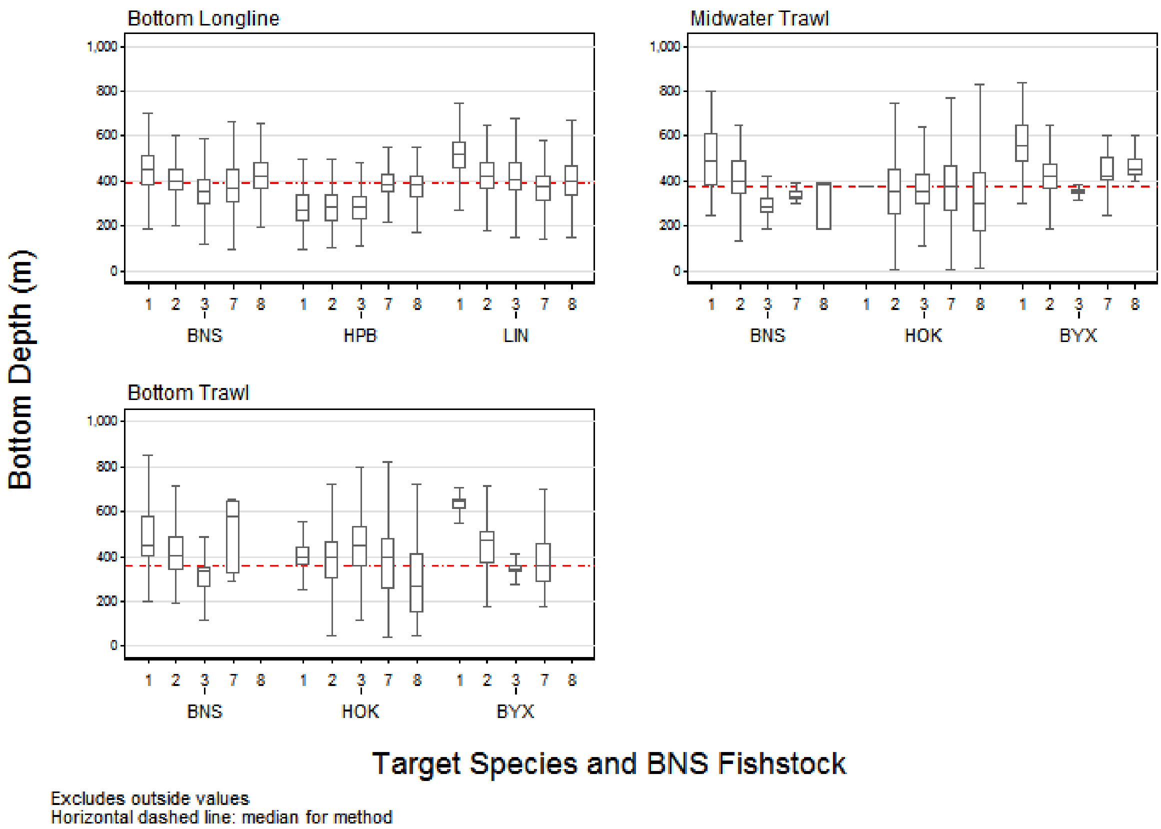

Figure 17: Distribution of bottom depth for the three major methods of bluenose capture, ordered by BNS QMA for each of the top three target species by method (in terms of total landings), summed across all available data.

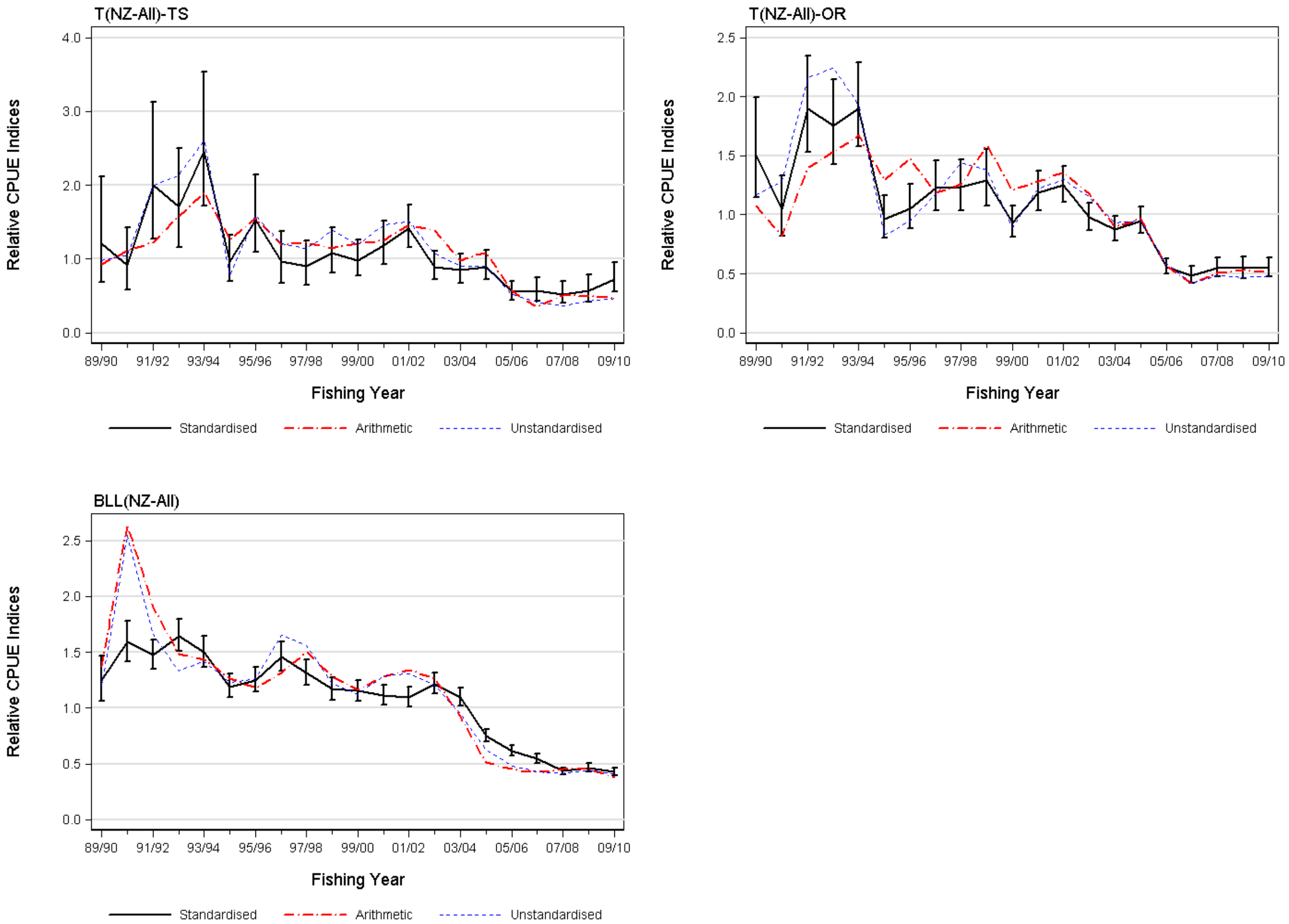

Figure 18: Standardised lognormal CPUE models (Eq. 4) for three total NZ EEZ fisheries. Top row: data sets based on a fishery defined from bottom or midwater trawl sets targeting bluenose or alfonsino: [top left panel] using amalgamated trip-strata; [top right panel] original tow-by-tow stratification. Bottom row: data set based on a fishery defined from bottom longline sets targeting bluenose, ling or hapuku/bass. Error bars are plus or minus two standard errors. Also shown are two unstandardised CPUE series based on the same data: a) Arithmetic (Eq. 2); b) Geometric or 'Unstandardised' (Eq. 3).

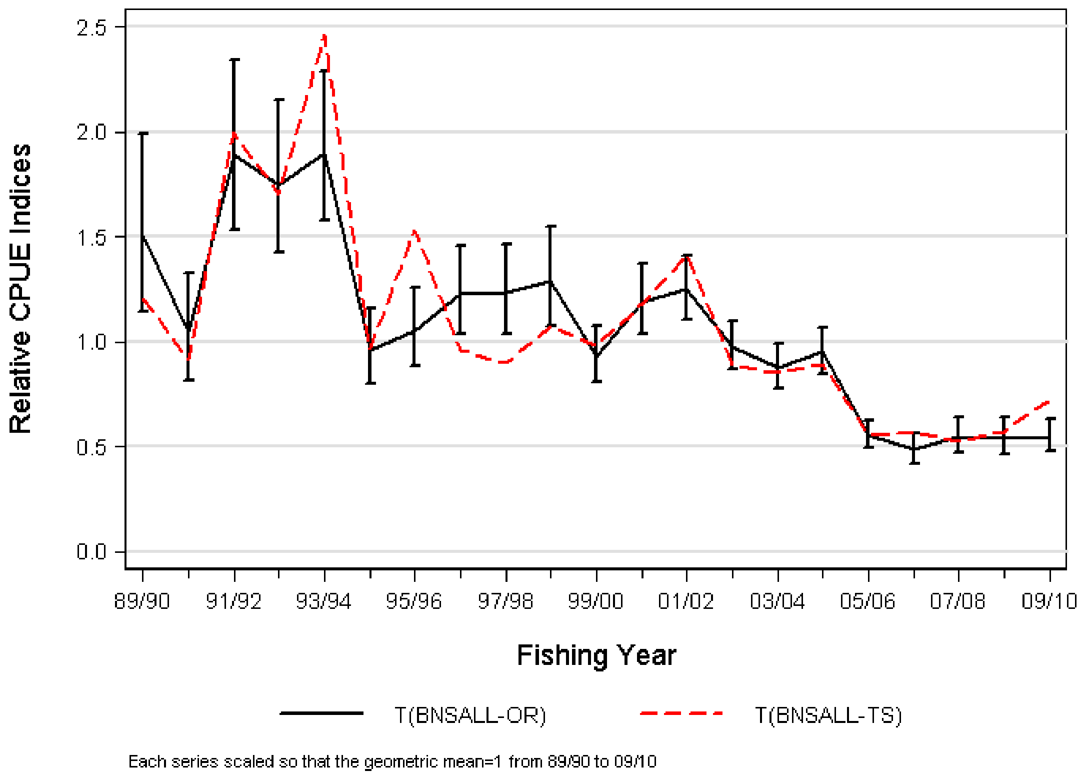

Figure 19: Plot comparing total NZ EEZ mixed method trawl series based on original tow-by-tow records with total NZ EEZ mixed method trawl series based on amalgamated trip-stratum records.

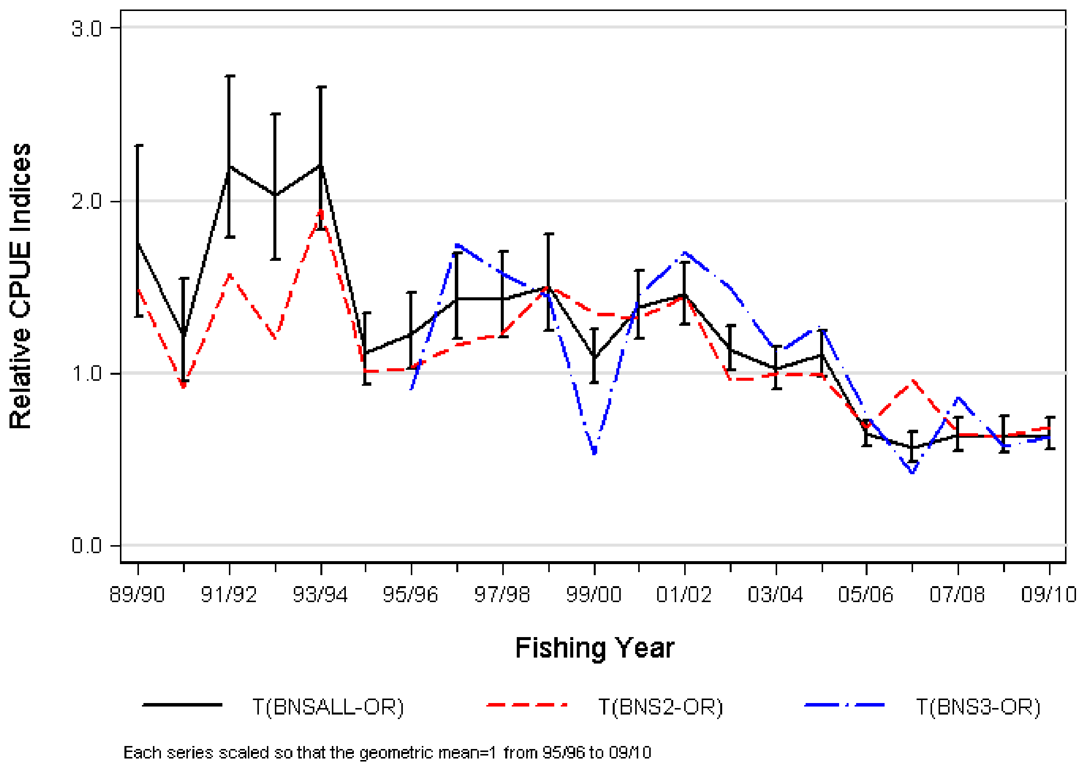

Figure 20: Plot comparing total NZ EEZ mixed method trawl series (original tow-by-tow records) with equivalent trawl series estimated for BNS 2 (Starr & Kendrick 2011b) and for BNS 3 (Starr & Kendrick 2011c).

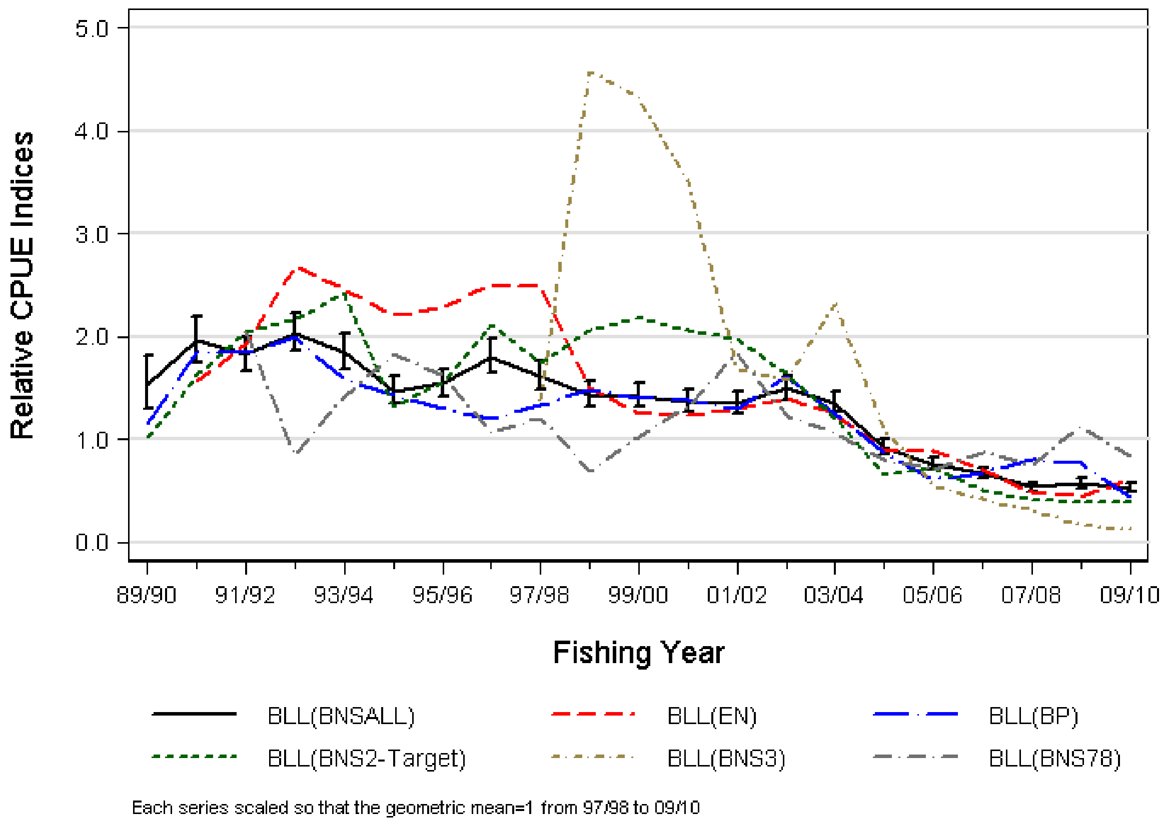

Figure 21: Plot comparing total NZ EEZ bottom longline series with bottom longline series estimated for East Northland (BNS 1; Starr & Kendrick 2011a); for the Bay of Plenty (BNS 1; Starr & Kendrick 2011a); for BNS 2 (Starr & Kendrick 2011b); for BNS 3 (Starr & Kendrick 2011c), and for combined BNS 7&8 (Starr & Kendrick 2011d).

Appendix A. TABLE OF ABBREVIATIONS AND DEFINITIONS OF TERMS

Term/Abbreviation	Definition
ACE	Allowable Catch Entitlement: derived from quota and used to offset catch of a QMS species
AMP	Adaptive Management Programme
analysis dataset	data set available after completion of grooming procedure (Starr 2007)
arithmetic CPUE	Sum of catch/sum of effort, usually summed over a year within the stratum of interest
BLL	method code for bottom longline
BLL_NZ	designator for the NZ EEZ bluenose CPUE analysis based on bottom longline data
BNS	species code for bluenose
BT	method code for bottom trawl
CELR	Catch/Effort Landing Return (Ministry of Fisheries 2010): active since July 1989 for all vessels less than 28 m. Fishing events are reported on a daily basis on this form
CLR	Catch Landing Return (Ministry of Fisheries 2010): active since July 1989 for all vessels not using the CELR or NCELR forms to report landings
CPUE	Catch Per Unit Effort
destination code	code indicating how each landing was directed after leaving vessel (see Table 4)
EEZ	Exclusive Economic Zone: marine waters under control of New Zealand
estimated catch	an estimate made by the operator of the vessel of the weight of bluenose captured, which is then recorded as part of the “fishing event”. Only the top five species are required for any fishing event in the CELR and TCEPR data (increased to eight for the TCER, NCELR and LTCER form types)
fishing event	a “fishing event” is a record of activity in trip. It is a day of fishing within a single statistical area, using one method of capture and one declared target species (CELR data) or a unit of fishing effort (usually a tow or a line set) for fishing methods using other reporting forms
fishing year	1 October – 30 September for bluenose
FSU	Fisheries Statistics Unit: format used to report catches, January 1979 to June 1989
landing event	weight of bluenose off-loaded from a vessel at the end of a trip. Every landing has an associated destination code and there can be multiple landing events with the same destination code for a trip
LCER	Lining Catch Effort Return (Ministry of Fisheries 2010): active since October 2003 for lining vessels larger than 28 m and reports set-by-set fishing events
LFR	Licensed Fish Receiver: processors legally allowed to receive commercially caught species
LTCER	Lining Trip Catch Effort Return (Ministry of Fisheries 2010): active since October 2007 for lining vessels between 6 and 28 m and reports individual set-by-set fishing events
MHR	Monthly Harvest Return: monthly returns used after 1 October 2001. Replaced QMRs but have same definition and utility
MPI	New Zealand Ministry for Primary Industries (formerly Ministry of Fisheries)
MW	method code for midwater trawl
NCELR	Netting Catch Effort Landing Return (Ministry of Fisheries 2010): active since October 2006 for inshore vessels using setnet gear between 6 and 28 m and reports individual fishing events
NINSWG	Northern Inshore Fishery Assessment Working Group: stakeholder science peer review group organised and chaired by MPI
NZ EEZ	New Zealand Exclusive Economic Zone
QMA	Quota Management Area: legally defined unit area used for bluenose management (see Figure 1)
QMR	Quota Management Report: monthly harvest reports submitted by commercial fishermen to MPI. Considered to be best estimates of commercial harvest. In use from 1986 to 2001.
QMS	Quota Management System: name of the management system used in New Zealand to control commercial and non-commercial catches
replog	data extract identifier issued by MPI data unit

Term/Abbreviation	Definition
residual implied coefficient plots	plots which mimic interaction effects between the year coefficients and a categorical variable by adding the mean of the categorical variable residuals in each fishing year to the year coefficient, creating a plot of the “year effect” for each value of the categorical variable
rollup	a term describing the average number of records per “trip-stratum”
standardised CPUE	procedure used to remove the effects of explanatory variables such as vessel, statistical area and month of capture from a data set of catch/effort data for a species; annual abundance is usually modelled as an explanatory variable representing the year of capture and, after removing the effects of the other explanatory variables, the resulting year coefficients represent the relative change in species abundance
statistical area	sub-areas (Figure 2) within a bluenose QMA which are identified in catch/effort returns. The boundaries for these statistical areas do not always coincide with the QMA boundaries, leading to ambiguity in the assignment of effort to a QMA.
T_NZ–OR	designator for the NZ EEZ bluenose CPUE analysis based on bottom and midwater trawl data using the original tow-by-tow stratification
T_NZ–TS	designator for the NZ EEZ bluenose CPUE analysis based on bottom and midwater trawl data using the “trip-stratum” stratification
TACC	Total Allowable Commercial Catch: catch limit set by the Minister for Primary Industries for a QMA that applies to commercial fishing
TCEPR	Trawl Catch Effort Processing Return (Ministry of Fisheries 2010): active since July 1989 for deepwater vessels larger than 28 m and reports tow-by-tow fishing events
TCER	Trawl Catch Effort Return (Ministry of Fisheries 2010): active since October 2007 for inshore vessels between 6 and 28 m and reports tow-by-tow fishing events
trip	a unit of fishing activity by a vessel consisting of “fishing events” and “landing events”, which are activities assigned to the trip. MPI generates a unique database code to identify each trip, using the trip start and end dates and the vessel code (Ministry of Fisheries 2010)
trip-stratum	summarisation within a trip by fishing method used, the statistical area of occupancy and the declared target species
unstandardised CPUE	geometric mean of all individual CPUE observations, usually summarised over a year within the stratum of interest

Appendix B. BLUENOSE: STANDARDISED CPUE ANALYSIS FOR ALL NZ

B.1 GENERAL OVERVIEW

This appendix provides detailed information in support of analyses which estimate indices of relative CPUE for bluenose in NZ-wide trawl and bottom longline fisheries. These indices have been estimated from a catch and effort dataset that has been described in Section 2.1. The justification for combining these data into a single NZ EEZ analysis has been presented in Section 3.4. The NZ wide analyses may include some data not included in individual QMA analyses presented elsewhere (Starr & Kendrick 2011a–d). Specifically, the NZ-wide trawl fishery analysis included some observations of trawl fishing in BNS 1 and in BNS 7 which obviously could not be used in the QMA analyses for BNS 2 and BNS 3. As well, some data were kept in for these analyses that were previously dropped because they came from multiple BNS QMA trips which fished in straddling statistical areas.

The series estimated through the standardisation procedure moderated the decline in the trawl fishery relative to the arithmetic series, but had the opposite effect in the bottom longline fishery, with the standardised series steeper than the equivalent arithmetic series. These shifts are the result of changes in fishing practice that appear to have occurred in these fisheries as evidenced by the available data. The general pattern appears to be that the trawl fishery has slowly moved away from targeting bluenose while the bottom longline fishery has increased its targeting behaviour towards this species.

B.2 FISHERY DEFINITIONS FOR CPUE ANALYSIS

Two fisheries (coded: T_NZ, and BLL_NZ) are defined for this CPUE analysis. They both have large components targeted at bluenose, but also include trawl effort targeted at alfonsino (T_NZ), and bottom longline effort targeted at hapuku/bass and ling (BLL_NZ). This expansion of the fisheries definition to include a wider selection of target species was made because the fishing strategies are reasonably similar, and because these fisheries have traditionally landed a considerable bycatch of bluenose. Two alternative analyses of T_NZ were made, one based on the amalgamated “trip-strata” and the other using the original tow-by-tow stratification. The original resolution datasets used only TCEPR/TCER data. See Section 2.2 for more explanation of the differences between these analyses.

T_NZ (trawl methods): This fishery definition used bottom or midwater trawl fishing events which fished in any NZ statistical area and targeted bluenose or alfonsino. This definition allowed the use of total effort and not just successful effort in the analysis of catch rates. Due to the existence of small amounts of trawl fishing in some statistical areas, observations from BNS 1 were combined into a single ‘zone’ (designated as ‘1’), and those from BNS 7 & 8 were combined into a zone (coded as ‘78’). The “trip-stratum” analysis is coded with the suffix –TS, while the “original resolution” analysis is coded with the suffix –OR.

BLL_NZ (bottom longline only): This fishery definition uses bottom longline fishing events only, fishing in any NZ statistical areas, and targeting bluenose, ling, or hapuku/bass. This definition allowed the use of total effort and not just successful effort in the analysis of catch rates.

B.3 UNSTANDARDISED CPUE

B.3.1 T_NZ (TRAWL METHODS)

Effort in the T_NZ–TS fishery has varied between 75 and 180 trips per year, with a period of lower activity in the mid 1990s and with the highest level of activity in 2002–03. Effort has since declined and is currently between 90 and 120 trips per year (Figure B.1). The number of trips and participating vessels in the T_NZ–OR data set was lower than in the T_NZ–TS data set, particularly in the first few years, because the T_NZ-OR data set included only events reported in tow-by-tow format (usually larger vessels using the TCEPR form type) and excluded data reported on the CELR form type, which was used by smaller vessels.

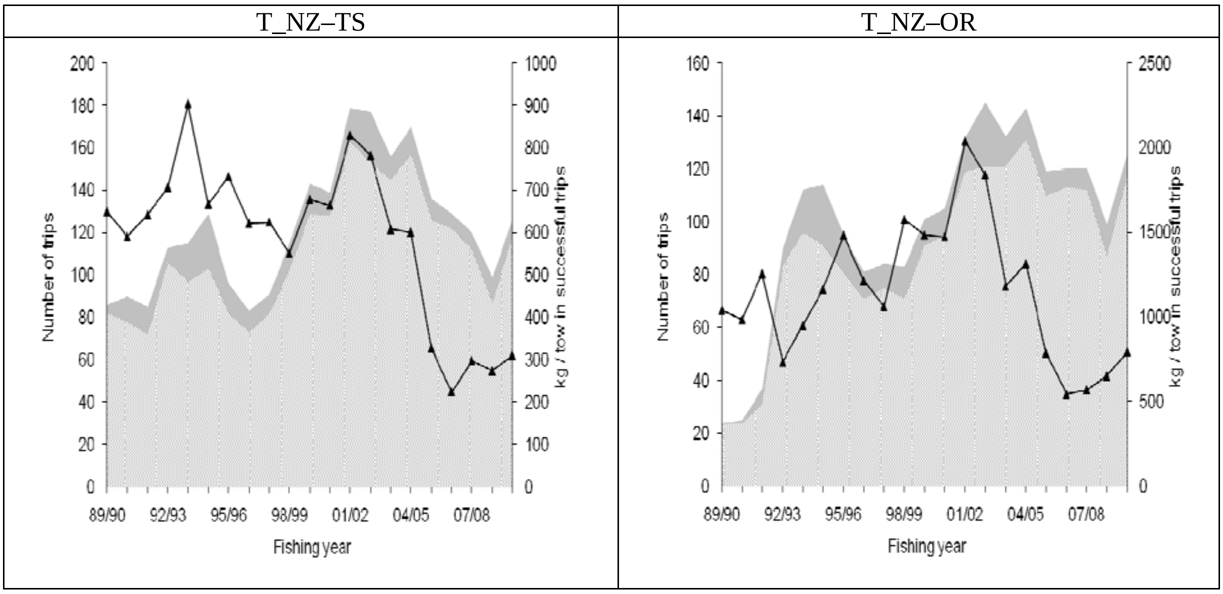

Figure B.1: Number of trips (dark area), the number of those trips that landed BNS (light area) and the simple catch rate (kg/tow) of BNS NZ in successful trip-strata, by fishing year for T_NZ–TS [left] and in successful tows for T_NZ–OR [right].

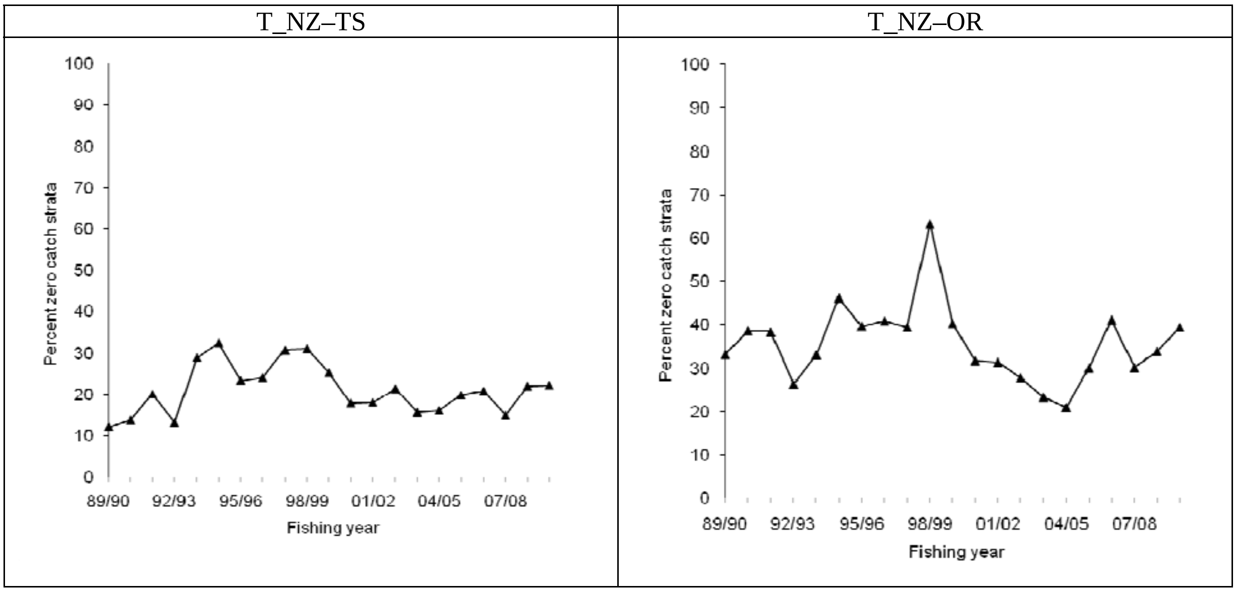

Figure B.2: The proportion of qualifying records that included zero BNS, by fishing year for T_NZ–TS [left] and for T_NZ–OR [right].

Catch rates in successful trip-strata varied without trend in the T_NZ–TS data set (there is a possibly increasing trend in catch rates for the T_NZ–OR data set) up to about 2004–05 and then dropped over two consecutive years to a new low level that is only about 25% of the peak earlier in the decade. The annual average unstandardised catch rate then remains close to that level for the most recent four years. The data preparation to trip stratum yields lower catch rates because the “trip-stratum” data will include some unsuccessful tows, but the trend is similar to that seen in the original resolution dataset (Figure B.1).

The proportion of zero catch records at the "trip-stratum" level has fluctuated between 10 and 35% annually with no overall trend up or down. Much of the zero catch information is incorporated into the catch rate at trip-stratum resolution (T_NZ–TS), while a higher proportion (25–65%) of the records in each year are identified as unsuccessful in the original resolution dataset (T_NZ–OR; Figure B.2). Rolling up the data to "trip-stratum" level of amalgamation has resulted in 3 to 7 sets per record (Figure B.3) with no trend up or down.

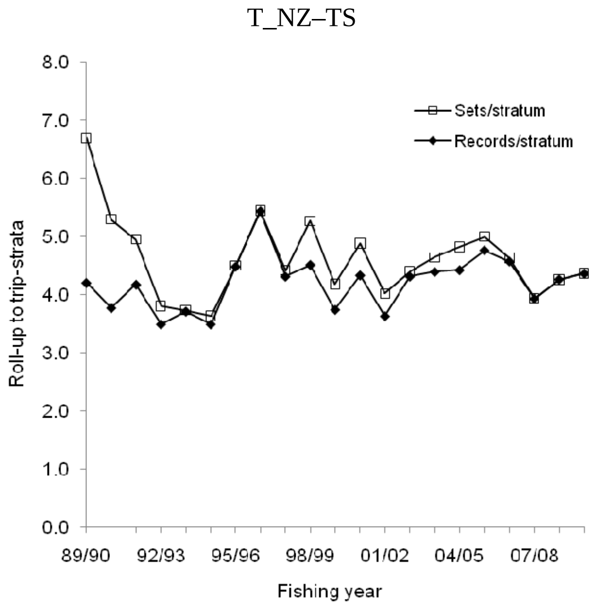

Figure B.3: The effect of data amalgamation for T_NZ–TS. The number of original records per trip-stratum and the resultant number of sets per trip-stratum.

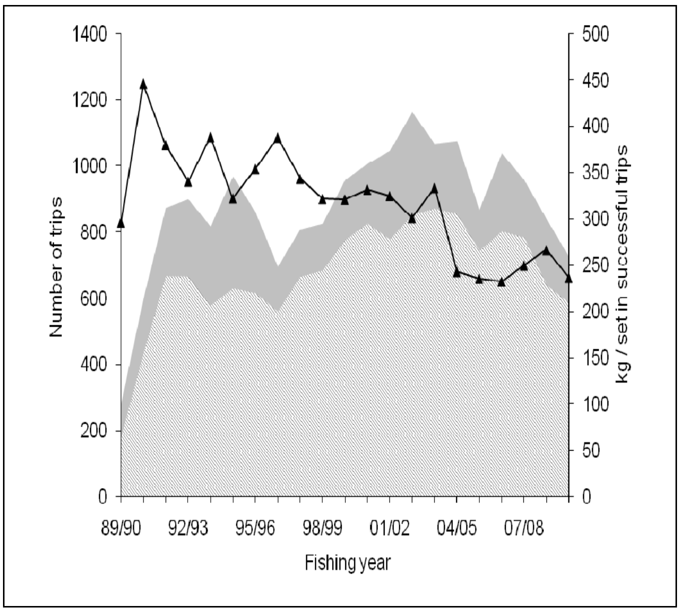

Figure B.4: Number of trips in BLL_NZ (dark area), the number of those trips that landed BNS (light area) and the simple catch rate (kg/set) of BNS NZ in successful trip-strata, by fishing year.

B.3.2 BLL_NZ (BOTTOM LONGLINE)

Effort (as measured by number of trips) in this fishery was at its lowest level of about 300 trips per year in 1989–90 (this may be an artefact of the first year of data capture) but increased rapidly over the following two years to a level of about 900 trips/year and then continued to increase slowly over the following decade to a peak of about 1200 trips in 2002–03. Effort has since declined to fewer than 700 trips in 2009–10. The arithmetic catch rate in successful trips has generally declined from a peak of about 450 kg per set in 1990–91 and currently averages less than 250 kg per set (Figure B.4). The proportion of zero catches at the level of a “trip-stratum” has varied without any overall trend up or down between 20 and 40%. The “rollup” to trip-stratum has trended upwards over the series, effectively doubling the number of original records (from 2.0 to 4.5) and the number of sets per stratum (from 3 to 5) between 1989–90 and 2009–10. This has some potential to mask a signal in the proportion of zero catches by increasingly subsuming that information into the apparent catch rate.

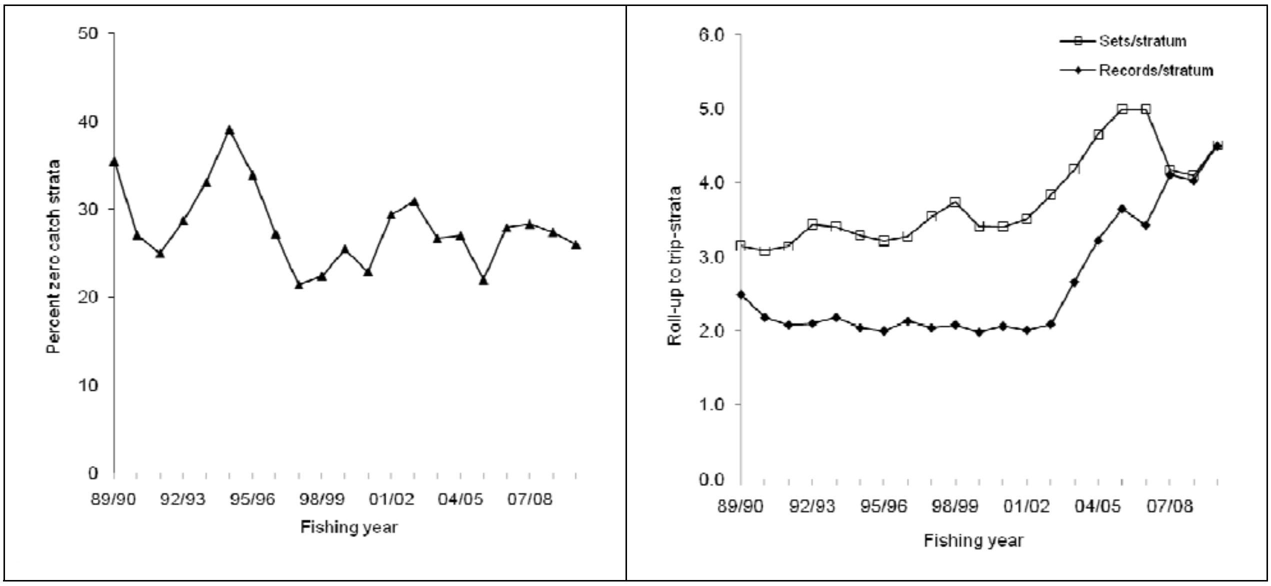

Figure B.5: The proportion of qualifying trip-strata targeted on bluenose, hapuku/bass, or ling in BLL_NZ the BNS NZ bottom longline fishery, that landed zero BNS NZ (left), and the effect of amalgamation to trip-strata on the ratio of original records per trip strata and the number of tows per trip-strata, by fishing year.

B.3.3 CORE FLEET DEFINITIONS

The data sets used for the standardised CPUE analysis were restricted to those vessels that participated consistently in each fishery. Core vessels were selected by specifying two variables; the number of trips that determined a qualifying year, and the number of qualifying years, given the specified number of trips per year, that were required to qualify a vessel in the analysis. The effect of these two variables on the amount of landed bluenose retained in the dataset and on the number of core vessels is shown for the T_NZ–TS data set in Figure C.1, the T_NZ–OR data set in Figure C.2, and the BLL_NZ data set in Figure C.3. The core fleet was selected by choosing variable values that resulted in the fewest vessels while maintaining the largest catch of bluenose, usually resulting in dropping the number of vessels in the dataset by about 70% while reducing the amount of landed bluenose by about 20%. The length of participation by the core vessels and the overlap across years in each fishery is shown in Figure C.1, Figure C.2, and Figure C.3. Data sets for the final core vessels are summarised in Table C.1 and Table C.2.

The definition used to determine core vessels in the two T_NZ fishery data sets was that the vessel needed to have completed at least five trips per year over a minimum of five years. The selection of a core fleet reduced the number of vessels in the T_NZ–TS dataset from 81 to 13 and the amount of landed bluenose from 11 610 t to 9 759 t. The selection of a core fleet in the somewhat smaller T_NZ-OR dataset reduced the number of vessels from 59 to 12, and the amount of landed bluenose from 9 718 t to 8 679 t. The definition used to determine core vessels in BLL_NZ was that a selected vessel needed to have completed at least five trips per year over a minimum of five years. This selection reduced the number of vessels in the BLL_NZ dataset from 464 to 100, and the amount of landed bluenose from 27 509 t to 23 101 t.

B.3.4 MODEL SELECTION

The T_NZ–TS lognormal model explained over 44% of the variance in log(catch), largely by adjusting for a declining trend in the number of tows from the peak in 1991–92 (Table B.1; Figure C.7). There is a positive relationship predicted between catch and the number of tows over the range of the data, although with a slight downturn in expected catch at extreme high values of number of tows (this is possibly an artefact of the polynomial shape imposed on the data). The overall influence of this trend on observed CPUE is shown to have been negative (Figure C.7). The inclusion of log(tows) into the model dropped some earlier points and raised the most recent points, moderating the steepness of the observed decline in CPUE (Figure B.6).

Fishing year was forced as the first variable in T_NZ–TS to ensure the estimation of the year effects, and explained about 7% of the variance (Table B.1). Vessel entered the model as the third most important variable, raising the indices in recent years to adjust for the loss from the fishery of the four best performing vessels (Figure C.8). Statistical area entered the model, adjusting for a shift away from areas in BNS 7&8 and for the development of a recent fishery in BNS 3. This variable had an overall negative influence on observed CPUE in this model (Figure C.9). A steady trend away from midwater towards more bottom trawl tows (Figure C.10) dropped the observed CPUE overall and acceptance of that variable into the model further raised the most recent two points to compensate for the shift (Figure B.6). Month entered the model, adjusting for a trend towards fishing in the first half of the fishing year that has elevated CPUEs in the last half of the time series, but without further modifying the annual indices greatly (Figure C.11). Target species did not have significant explanatory power, supporting the inclusion of alfonsino tows in the dataset. The logistic model explained about 25% of variance in success rate and also included log(tows) statistical area, vessel, and method as explanatory variables (Table B.1).

The R^2 values for the T_NZ–OR lognormal model (Table B.2) were much lower than those for the trip-stratum lognormal model of the same fishery and reflect a fundamental difference between the analyses; while catch per trip-stratum is largely a function of the number of tows in a record, that explanatory power is subsumed into the dependent variable (catch per tow) when the analysis is done at original resolution. Because each record represented one tow, each catch field implicitly includes this effort level. The bluenose/alfonsino target fishery tends to use short tows, so duration of the tow had little contrast or explanatory power (Table B.2). Otherwise, the variables selected for the T_NZ-OR model resembled the model selected using the trip-stratum resolution dataset except that method of capture was not included in the logistic model for T_NZ–OR.

The lognormal model of BLL_NZ explained about 55% of the variance in catch rate by adjusting for a shift towards greater targeting of bluenose in the second half of the time series (Table B.3; Figure C.14), an increasing trend to the number of hooks set (Figure C.15), and also for changes in the core fleet (Figure C.16). The relationship between catch and the number of hooks is positive with a downturn at extremely high numbers of hooks (which is likely to be an artefact of the imposed 3^{rd}-order polynomial). The model raises the early annual indices and drops the more recent index points because of the shift towards targeting bluenose and an increasing number of hooks set per line. These adjustments make the apparent decline steeper than for the unstandardised CPUE (Figure B.8). The inclusion of vessel into the lognormal model did not change the annual indices very much. The main effect of this variable was to drop some points in the mid 1990s, resulting in a series which showed less year-to-year variation, thus smoothing the series (Figure B.8; Figure C.16).

Table B.1: Order of acceptance of variables into the lognormal model of successful catches and the logistic model of catches (successful or unsuccessful) in the T_NZ–TS fishery for all qualifying vessels (based on at least five trips per year in at least five years). The amount of explained deviance (R^2) is shown for each variable and variables accepted into the model are marked with an *, with the final R^2 of the selected model in bold. Fishing year was forced as the first variable.

	DF	Deviance	AIC	R^2	Final
Lognormal model					
None	0	13 793	13 259	0.000	
fyear	21	12 820	13 076	0.071	*
poly(log(num) 3)	24	9 101	12 037	0.340	*
vessel	39	8 500	11 859	0.384	*
zone	51	8 045	11 715	0.417	*
method	52	7 853	11 643	0.431	*
month	63	7 688	11 600	**0.443**	*
target	64	7 606	11 570	0.449	
Binomial model					
None	0	3 713	3 715	0.000	
fyear	21	3 666	3 708	0.013	*
poly(log(num) 3)	24	3 037	3 085	0.182	*
zone	39	2 838	2 916	0.236	*
vessel	51	2 752	2 854	0.259	*
target	52	2 736	2 840	**0.263**	
method	53	2 729	2 835	0.265	

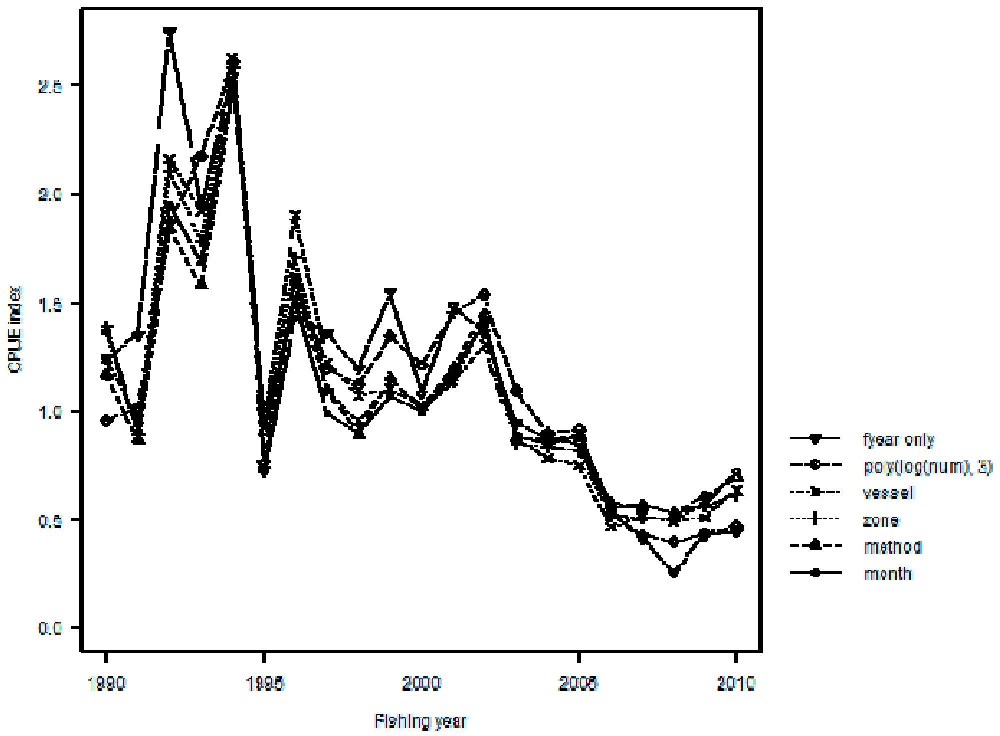

Figure B.6: Annual indices from the lognormal model of T_NZ–TS at each step in the variable selection process.

Table B.2: Order of acceptance of variables into the lognormal model of successful catches and the logistic model of catches (successful or unsuccessful) in the T_NZ–OR fishery for all qualifying vessels (based on at least five trips per year in at least five years), with the amount of explained deviance (R^2) for each variable. Variables accepted into the model are marked with a *, and the final R^2 of the selected model is in bold. Fishing year was forced as the first variable.

	DF	Deviance	AIC	R^2	Final
Lognormal model					
None	0	36 147	44 748	0.000	
fyear	21	33 901	44 073	0.062	*
vessel	32	32 120	43 494	0.111	*
zone	47	31 192	43 197	**0.137**	*
method	48	30 895	43 093	0.145	
month	59	30 605	43 009	0.153	
poly(log(bottom) 3)	62	30 539	42 991	0.155	
target	63	30 499	42 979	0.156	
poly(log(duration) 3)	66	30 473	42 975	0.157	
Binomial model					
None	0	20 198	20 200	0.000	
fyear	21	19 784	19 826	0.021	*
vessel	32	19 206	19 270	0.049	*
zone	47	18 832	18 926	**0.068**	*
month	58	18 783	18 899	0.070	
poly(log(duration) 3)	61	18 770	18 892	0.071	
method	62	18 764	18 888	0.071	
target	63	18 761	18 887	0.071	

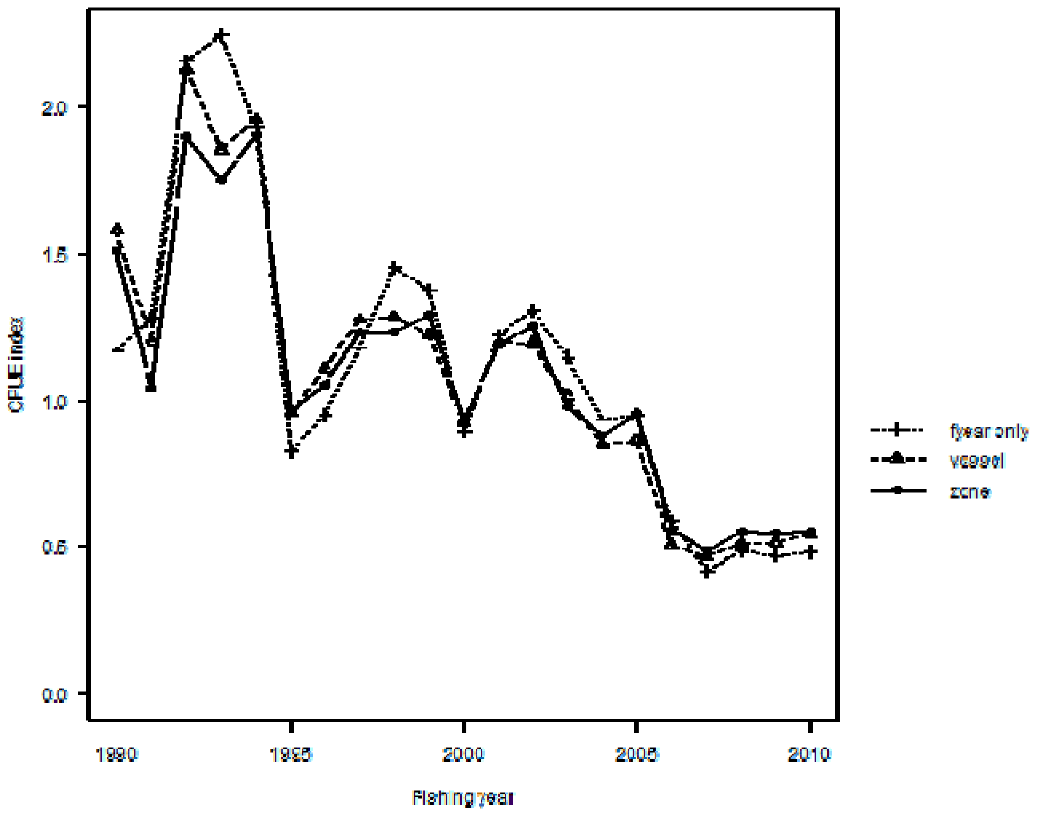

Figure B.7: Annual indices from the lognormal model of T_NZ–OR at each step in the variable selection process.

Table B.3: **Order of acceptance of variables into the lognormal model of successful catches of BNS NZ for all qualifying vessels (based on at least five trips per year in at least five years) in the BLL_NZ fishery, with the amount of explained deviance (R^2) for each variable. Variables accepted into the model are marked with an *, and the final R^2 of the selected model is in bold. Fishing year was forced as the first variable.**

	DF	Deviance	AIC	R2	Final
Lognormal model					
None	0	60 333	75 292	0.0000	
fyear	21	59 635	75 113	0.0116	*
target	23	40 849	68 002	0.3229	*
poly(log(hooks) 3)	26	32 742	63 849	0.4573	*
vessel	123	26 997	60 414	**0.5525**	*
poly(log(num) 3)	126	26 672	60 193	0.5579	
month	137	26 445	60 054	0.5617	
Binomial model					
None	0	30 710	30 712	0.00000	
fyear	21	30 495	30 537	0.00702	*
target	23	21 278	21 324	0.30713	*
vessel	122	18 683	18 927	0.39162	*
poly(log(num) 3)	125	17 907	18 157	**0.41690**	*
poly(log(hooks) 3)	128	17 790	18 046	0.42070	
month	139	17 738	18 016	0.42240	

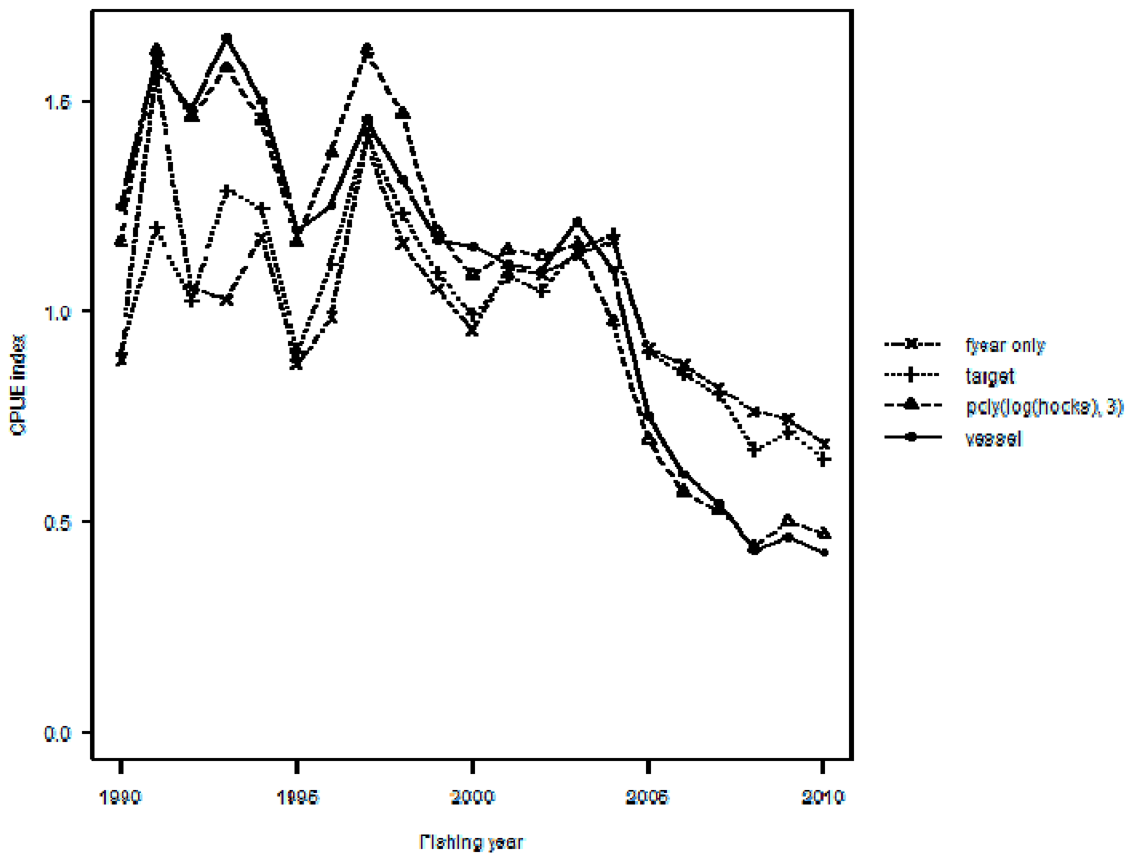

Figure B.8: **Annual indices from the lognormal model of BLL_NZ at each step in the variable selection process.**

Diagnostic residual plots are presented for each lognormal model in Figure C.4 (T_NZ–TS), Figure C.5 (T_NZ–OR) and Figure C.6 (BLL_NZ). The fit of the data to the log normal assumption for both T_NZ models is reasonable, with less departure from the lognormal assumption for the T_NZ–OR data set. The analysis based on trip-strata has noticeably fewer data points than that based on original resolution data. The fit of the BLL_NZ data to the lognormal assumption is poorer than for the two T_NZ models, with some pattern in the residuals and considerable departure from the lognormal assumption at the lower end of the residual distribution (Figure C.6).

B.3.5 TRENDS IN MODEL YEAR EFFECTS

B.3.6 T_NZ (TRAWL METHODS)

The indices of catch rate for the two T_NZ data sets decline steadily from 2001–02, with a levelling out in the most recent three years. The early indices in the T_NZ–TS series have very wide error bars but the patterns are similar to those from T_NZ–OR. Both analyses show a similar downward trend over the same period (Figure B.9). The effect of standardisation was to smooth both series by removing peaks in the early 2000s, and to lift recent points in the T_NZ–TS series. The T_NZ–OR series was less changed in recent years. Adding the binomial series of success rate to either analysis had little effect, given the lack of contrast in this series (Figure B.9).

T_NZ–TS	**T_NZ–OR**

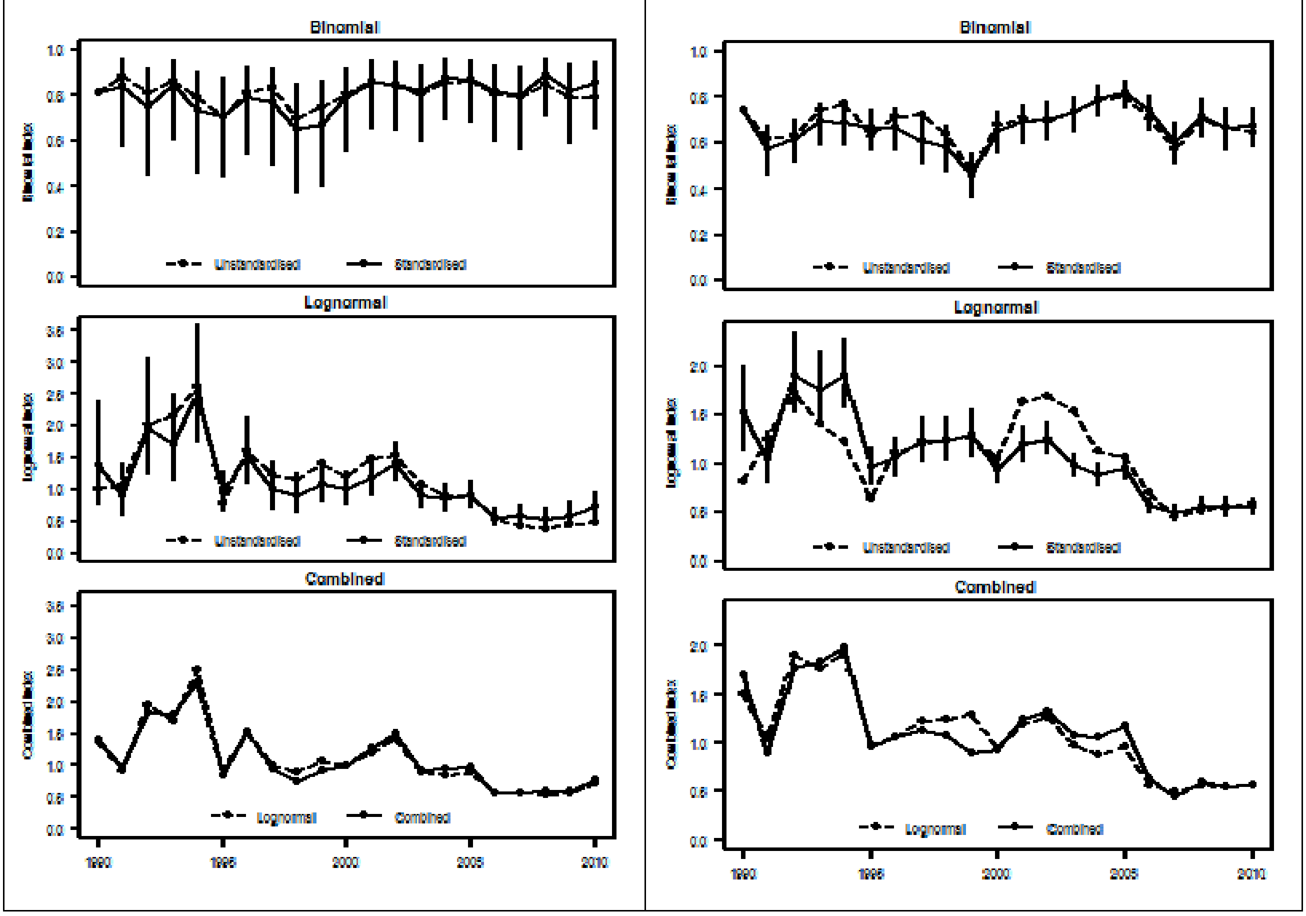

Figure B.9: The effect of standardisation on the arithmetic CPUE in the T_NZ fishery. Top: Binomial index of probability of capture. Middle: Lognormal index of magnitude of catch. Broken line is the arithmetic CPUE (kg/tow), the solid line is the standardised CPUE indices with plus or minus two standard bars. Bottom: The lognormal index compared with the combined lognormal/binomial index. [left panel]: T_NZ–TS model; [right panel]: T_NZ–OR model.

B.3.7 BLL_NZ (BOTTOM LONGLINE)

The fishing year indices of catch rate in the BLL_NZ model show an overall declining trend, which appears to get steeper since 2000–01 (Figure B.9). The current (2009–10) index is the lowest of the series. The effect of standardisation on CPUE relative to the arithmetic series raises the indices in the first half of the series and lowers the 2007–08 point, largely as a correction for an decline in targeting of hapuku/bass in that year, making the apparent decline even steeper. Otherwise, there is relatively little effect from standardisation procedure in the last ten years, with the standardised and arithmetic series being very similar. The pattern of standardised indices from the logistic model of success rates is similar to that of the lognormal model, including corroborating the small drop in 2007–08. The effect of combining the lognormal and binomial series is to emphasise the peaks and lows in the early years (up to 2000–01), but has no effect since then.

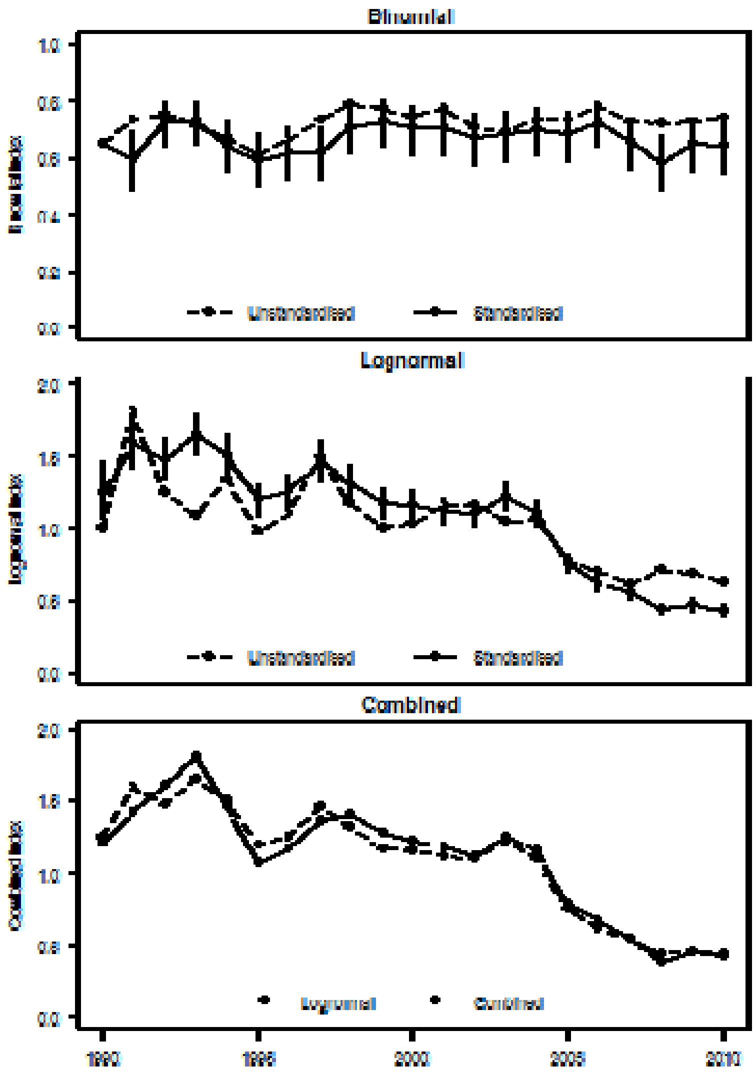

Figure B.10: The effect of standardisation on the arithmetic CPUE in the BLL_NZ fishery. Top: Binomial index of probability of capture. Middle: Lognormal index of magnitude of catch. Broken line is the arithmetic CPUE (kg / set), the solid line is the standardised CPUE indices with plus or minus two standard error bars. Bottom: The lognormal index compared with the combined lognormal/binomial index.

Appendix C. Detailed diagnostics for BNS NZ CPUE standardisations

C.1 Core vessel selection

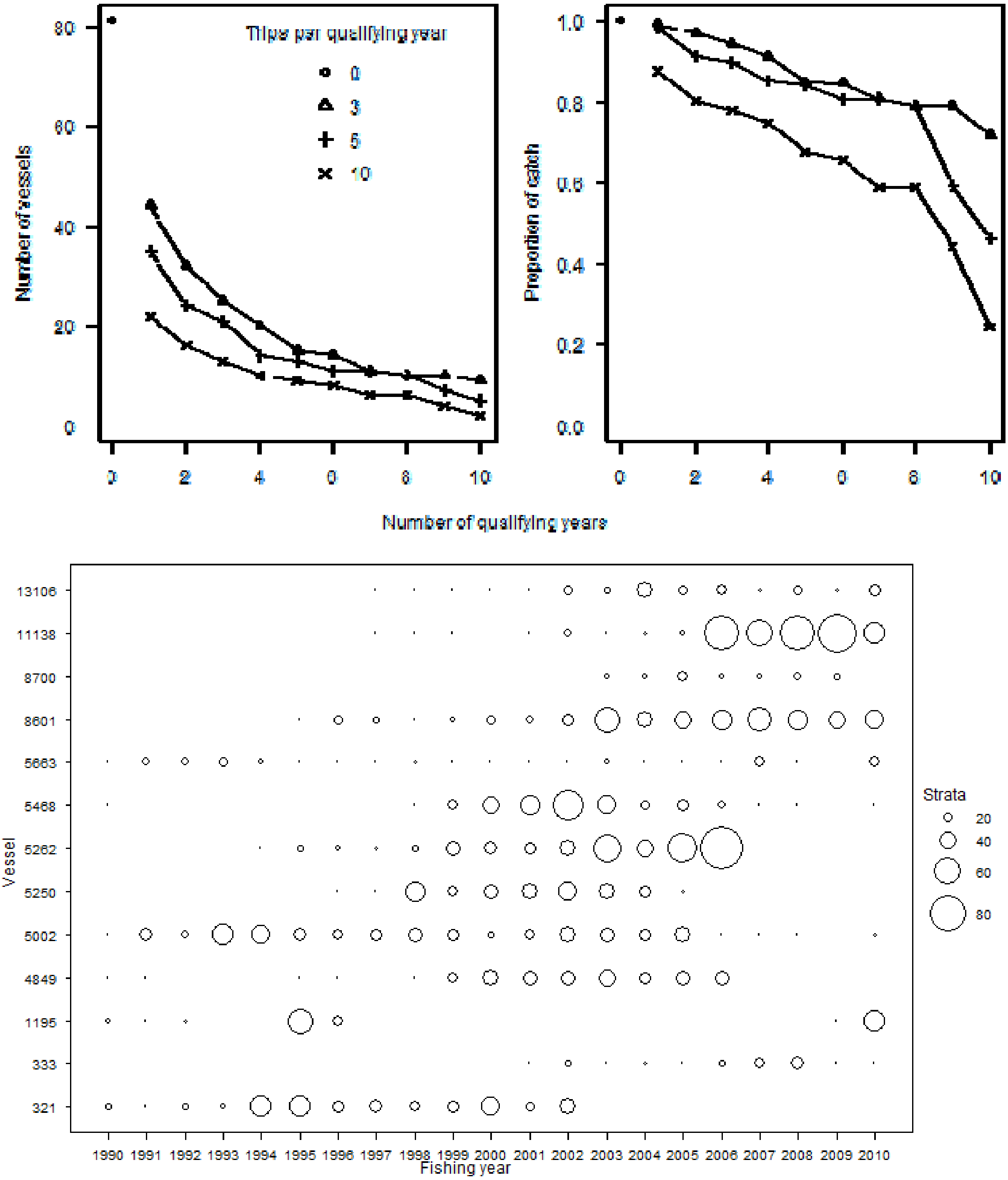

Figure C.1: The total landed BNS NZ [top left] and the number of vessels [top right] retained in the T_NZ–TS datasets depending on the minimum number of qualifying years used to define core vessels. The number of qualifying years (minimum number of trips per year) for each series is indicated in the legend. The participation of selected core vessels (based on at least five trips per year in at least five years); number of records for each vessel key in each fishing year [bottom panel].

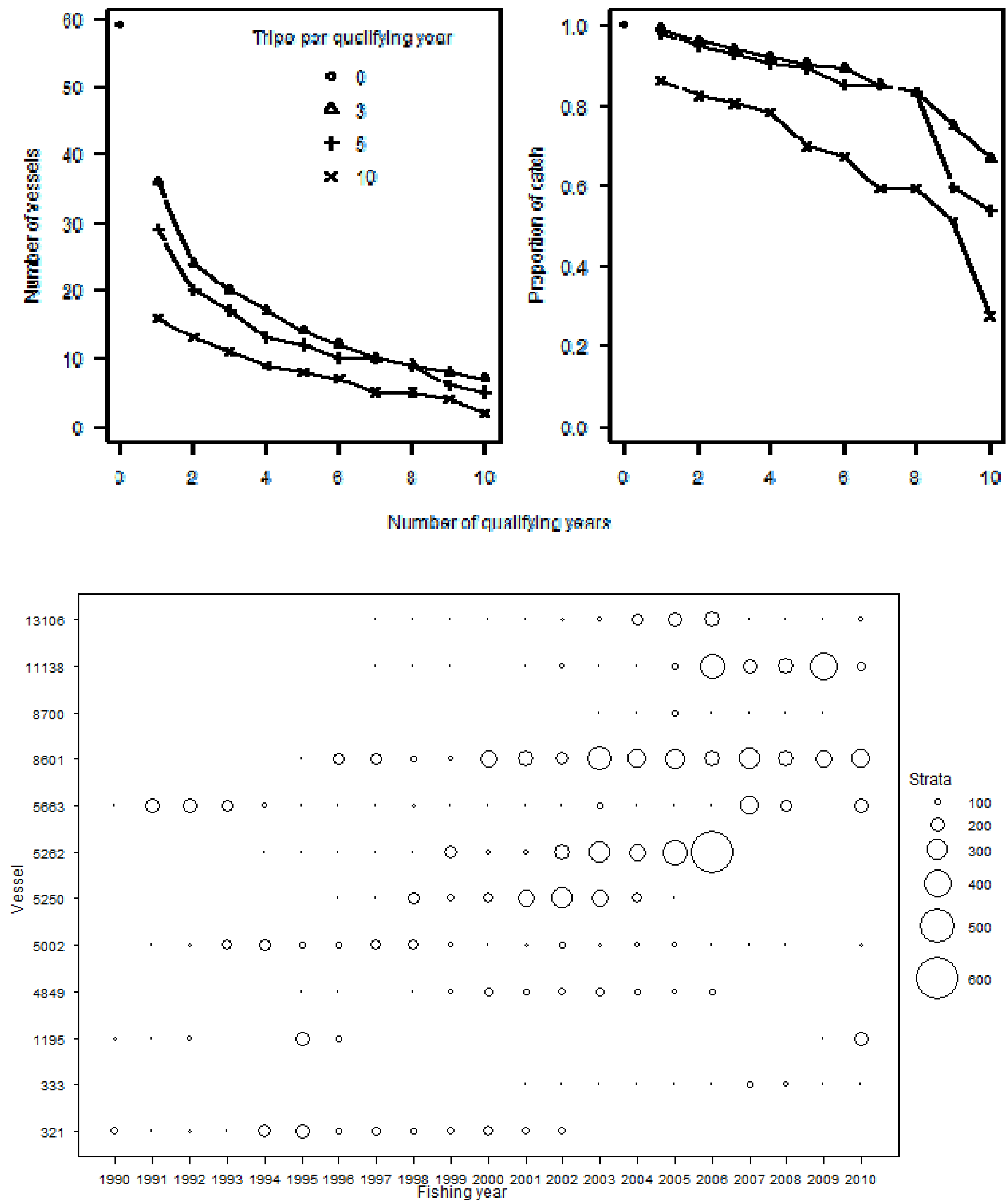

Figure C.2: The total landed BNS NZ [top left] and the number of vessels [top right] retained in the T_NZ–OR datasets depending on the minimum number of qualifying years used to define core vessels. The number of qualifying years (minimum number of trips per year) for each series is indicated in the legend. The participation of selected core vessels (based on at least five trips per year in at least five years); number of records for each vessel key in each fishing year [bottom panel].

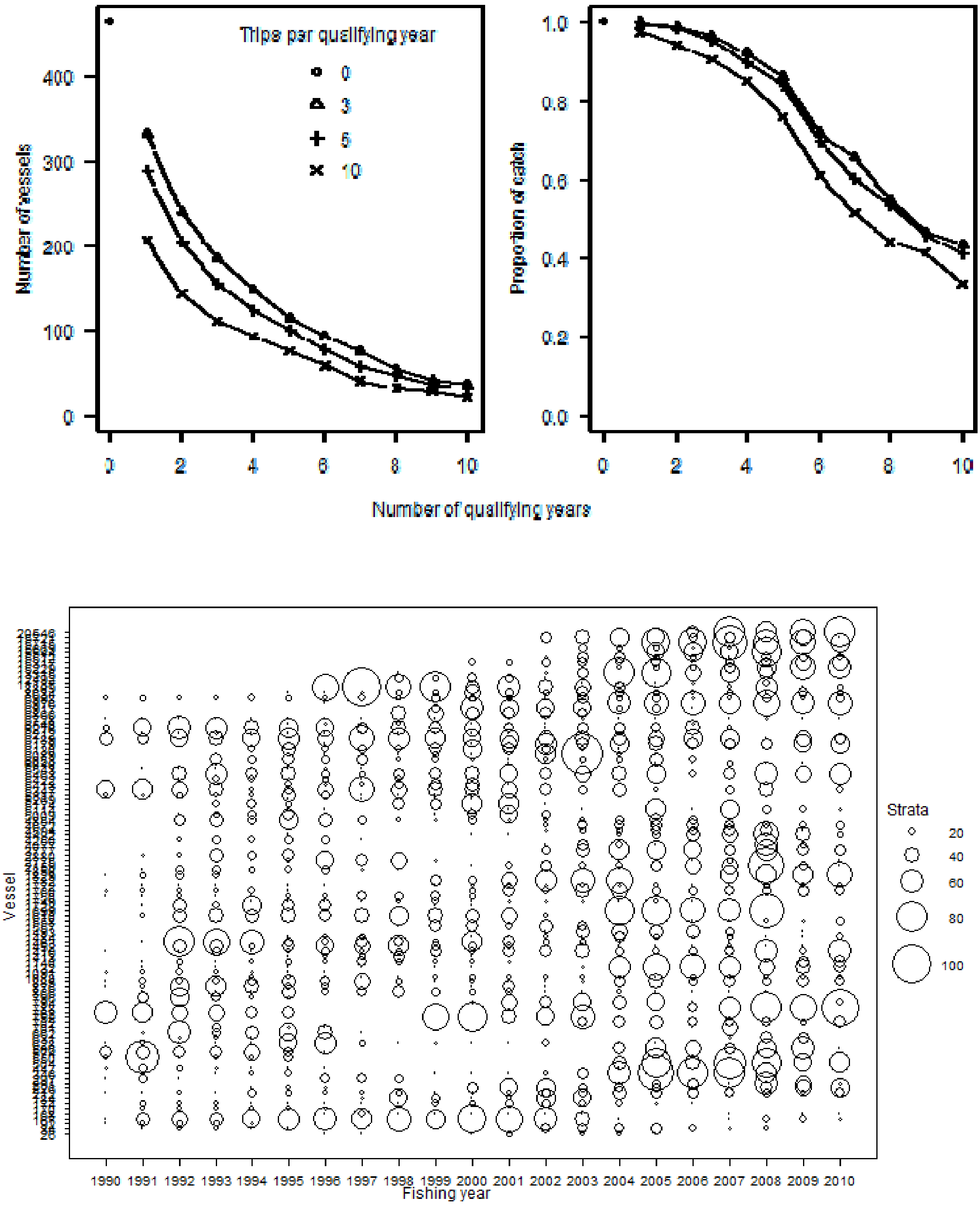

Figure C.3: The total landed BNS NZ [top left] and the number of vessels [top right] retained in the BLL_NZ dataset depending on the minimum number of qualifying years used to define core vessels. The number of qualifying years (minimum number of trips per year) for each series is indicated in the legend. The participation of selected core vessels (based on at least five trips per year in at least five years); number of records for each vessel key in each fishing year [bottom panel].

C.2 DATA SUMMARIES

Table C.1: Number of trips, percentage of zero catch records, number of core vessels, total hours fished, landed BNS NZ (t), and simple overall catch rate of BNS NZ for core vessels (based on a minimum of five trips per year in at least five years) in the bottom trawl fishery by fishing year.

	T_NZ–TS						T_NZ–OR					
Fishing year	Trips	% zero strata	Vessels	Duration (hrs)	Catch (t)	CPUE kg/h	Trips	% zero strata	Vessels	Duration (hrs)	Catch (t)	CPUE kg/h
1989/90	19	20	6	288	131	455	11	27	3	177	122	689
1990/91	39	12	5	407	253	622	25	39	4	172	118	686
1991/92	31	19	4	407	275	676	31	37	4	336	275	818
1992/93	51	14	3	371	323	871	51	26	3	404	323	800
1993/94	61	21	4	446	442	991	61	23	4	449	442	984
1994/95	79	30	7	574	358	624	79	37	7	478	358	749
1995/96	65	19	8	492	398	809	65	29	8	311	398	1 280
1996/97	59	17	8	524	344	656	59	28	8	361	344	953
1997/98	78	31	10	604	371	614	77	37	9	483	371	768
1998/99	93	26	10	895	513	573	69	53	9	442	395	894
1999/00	113	20	9	1 003	629	627	80	33	8	458	515	1 124
2000/01	115	14	11	1 067	744	697	83	30	10	416	595	1 430
2001/02	163	17	11	1 389	1 111	800	121	31	10	579	849	1 466
2002/03	156	20	11	1 387	1 022	737	124	27	10	632	871	1 378
2003/04	144	15	11	1 185	641	541	124	22	10	611	604	989
2004/05	154	14	11	1 353	820	606	131	20	10	712	755	1 060
2005/06	122	20	10	1 698	525	309	108	30	9	943	503	533
2006/07	96	22	8	987	187	189	89	43	7	624	177	284
2007/08	95	16	8	811	220	271	94	30	7	574	220	383
2008/09	60	21	6	755	205	272	60	34	6	490	205	418
2009/10	81	22	8	965	248	257	78	36	7	563	240	426

Table C.2: Number of trips, percentage of zero catch records, number of core vessels, number of sets, landed BNS NZ (t), and simple overall catch rate of BNS NZ for core vessels (based on a minimum of five trips per year in at least five years) in the BLL_NZ by fishing year.

Fishing year	Trips	% zero strata	Vessels	Number of sets	Catch (t)	CPUE kg / set
1989/90	281	36	23	1 063	208	196
1990/91	598	27	37	2 147	734	342
1991/92	873	25	44	3 357	970	289
1992/93	899	29	49	3 927	1 002	255
1993/94	817	33	50	3 443	903	262
1994/95	968	39	58	4 072	844	207
1995/96	860	34	54	3 550	857	241
1996/97	695	27	43	3 161	974	308
1997/98	808	21	43	3 639	1 014	279
1998/99	825	22	47	3 955	1 026	259
1999/00	957	25	56	4 301	1 074	250
2000/01	1 006	23	51	4 380	1 178	269
2001/02	1 045	29	56	4 543	1 064	234
2002/03	1 162	31	54	5 825	1 328	228
2003/04	1 067	27	61	6 728	1 731	257
2004/05	1 075	27	56	8 054	1 488	185
2005/06	867	22	54	7 011	1 362	194
2006/07	1 038	28	55	8 331	1 580	190
2007/08	957	28	50	8 017	1 555	194
2008/09	839	27	44	5 612	1 147	204
2009/10	725	26	41	5 826	1 063	182

C.3 RESIDUAL PLOTS

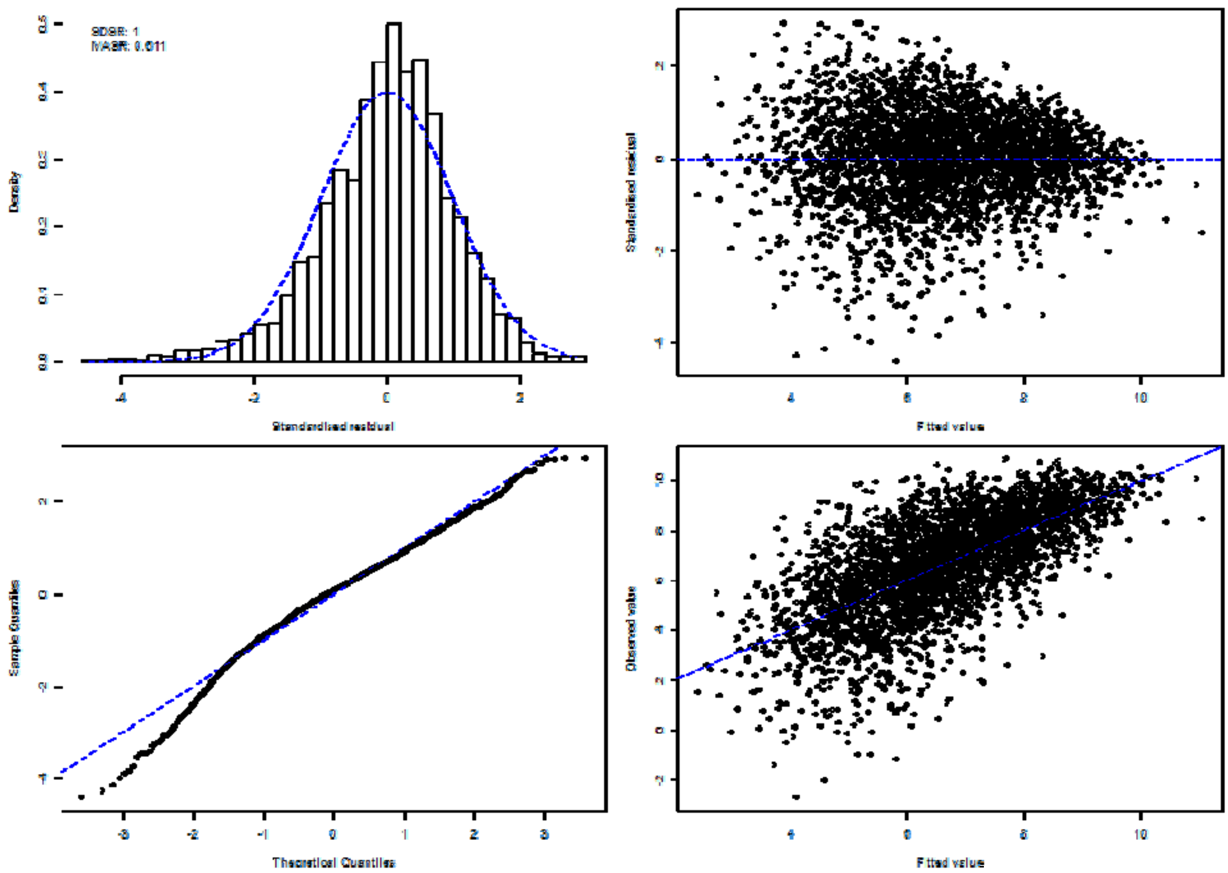

Figure C.4: Plots of the fit of the standardised CPUE model to successful catches of BNS NZ for T_NZ-TS. [Upper left] histogram of the standardised residuals compared to a lognormal distribution (SDSR: standard deviation of standardised residuals, MASR: median of absolute standardised residuals); [Upper right] Standardised residuals plotted against the predicted model catch per trip; [Lower left] Q-Q plot of the standardised residuals; [Lower right] Observed catch per record plotted against the predicted catch per record.

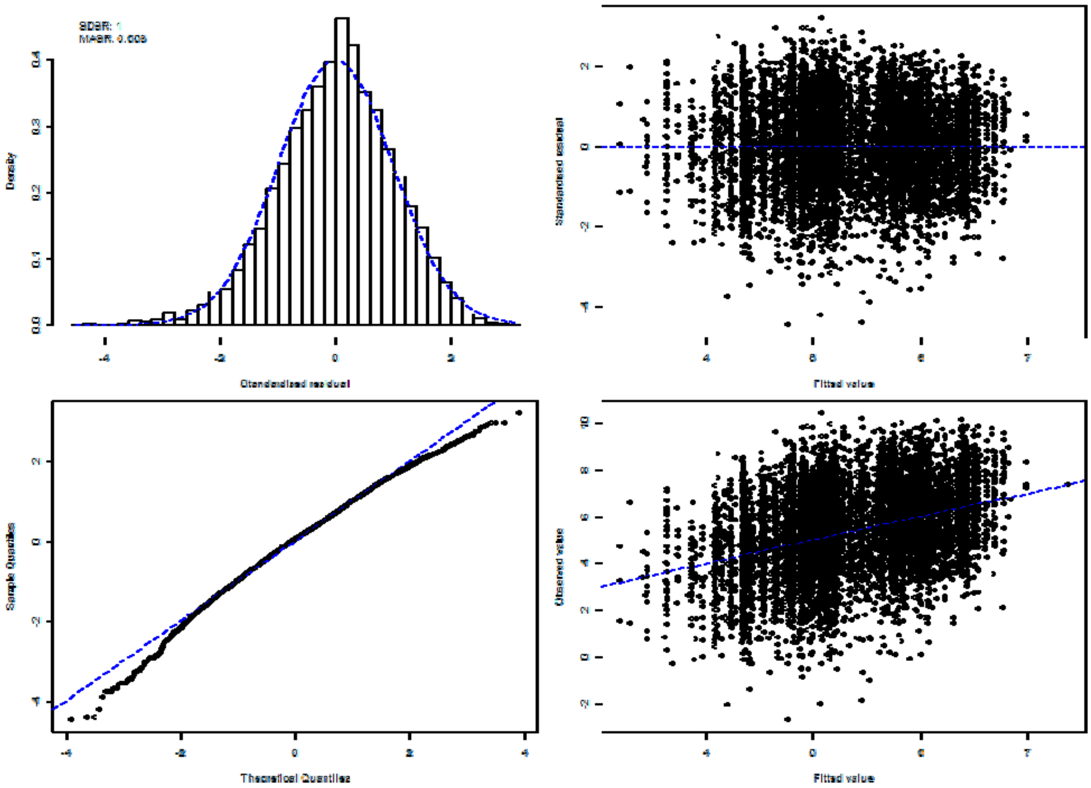

Figure C.5: Plots of the fit of the standardised CPUE model to successful catches of BNS NZ for T_NZ–OR. See caption of Figure C.4 for details.

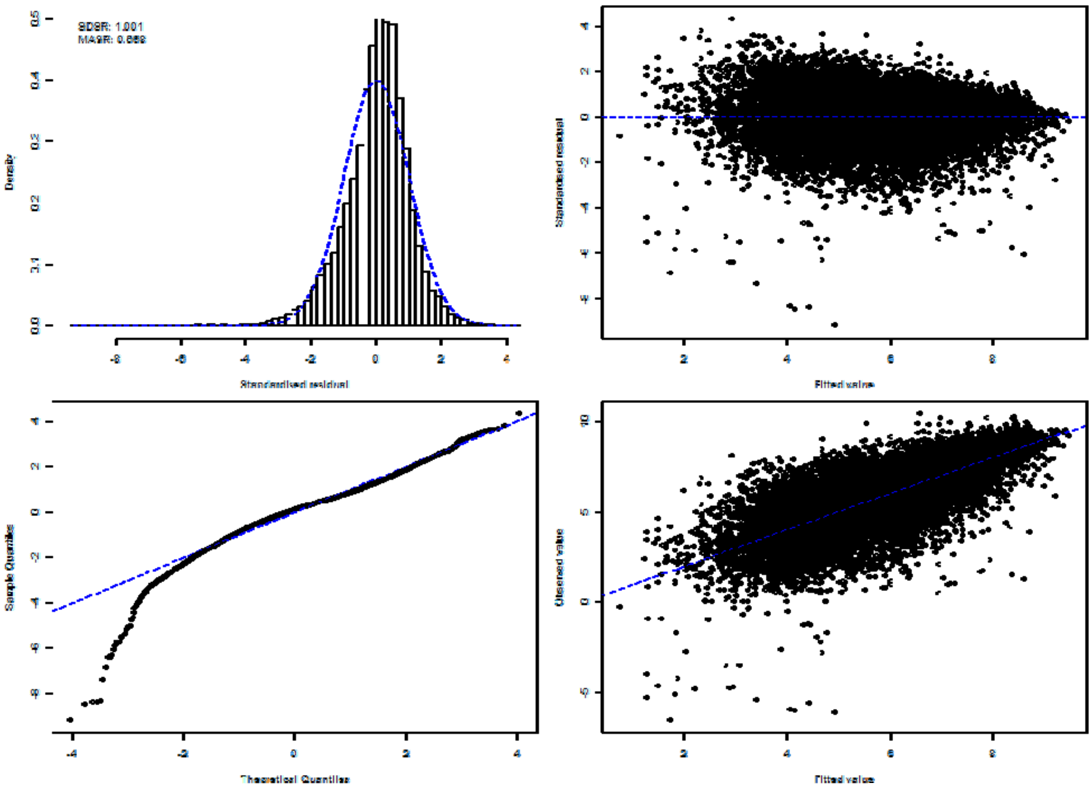

Figure C.6: Plots of the fit of the standardised CPUE model to successful catches of BNS NZ for BLL_NZ. See caption of Figure C.4 for details.

C.4 MODEL COEFFICIENTS

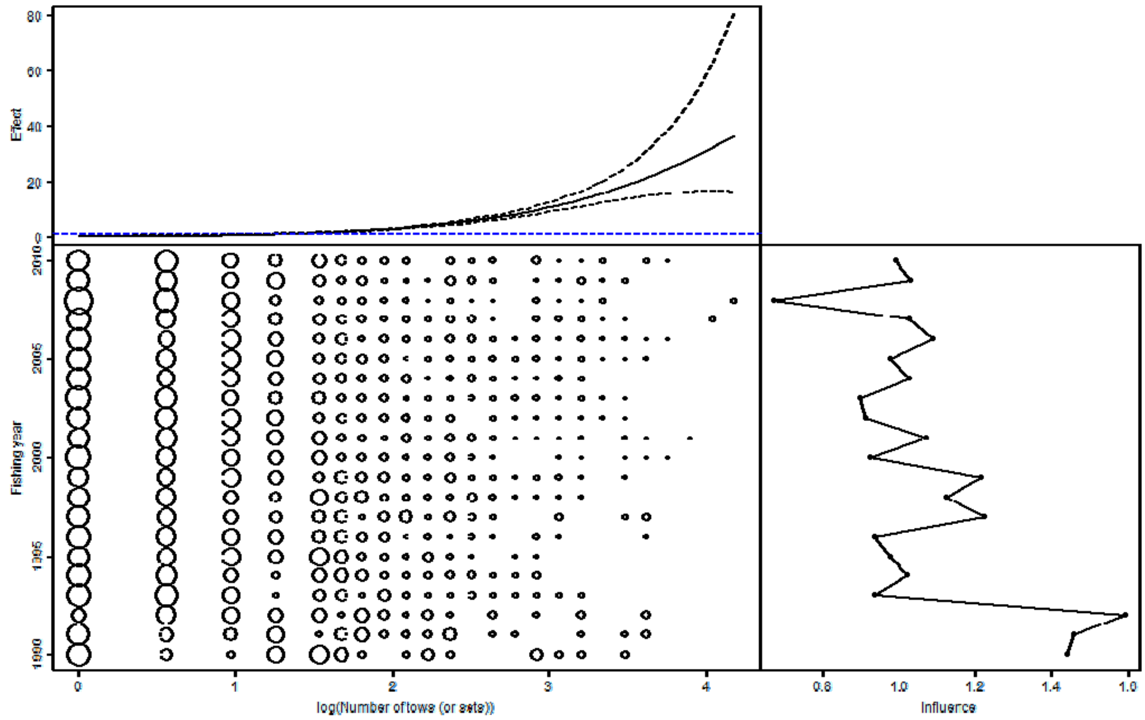

Figure C.7: Effect of log(tows) in the lognormal model for the BNS NZ T_NZ–TS fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

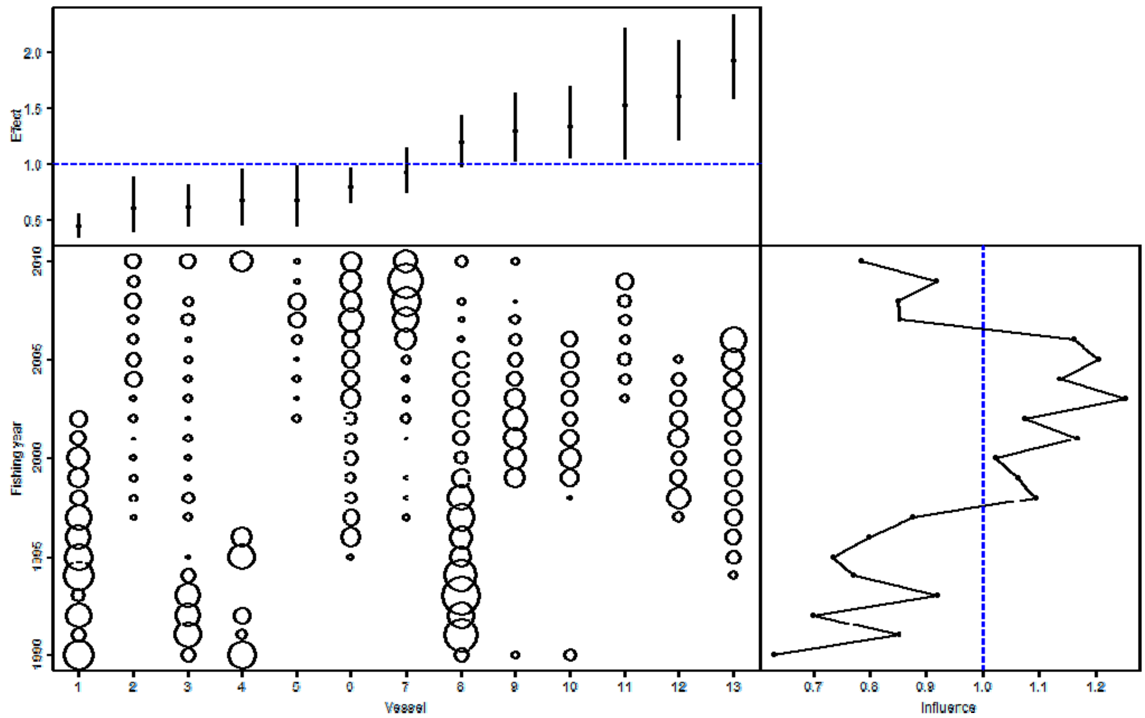

Figure C.8: Effect of vessel in the lognormal model for the BNS NZ T_NZ–TS fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

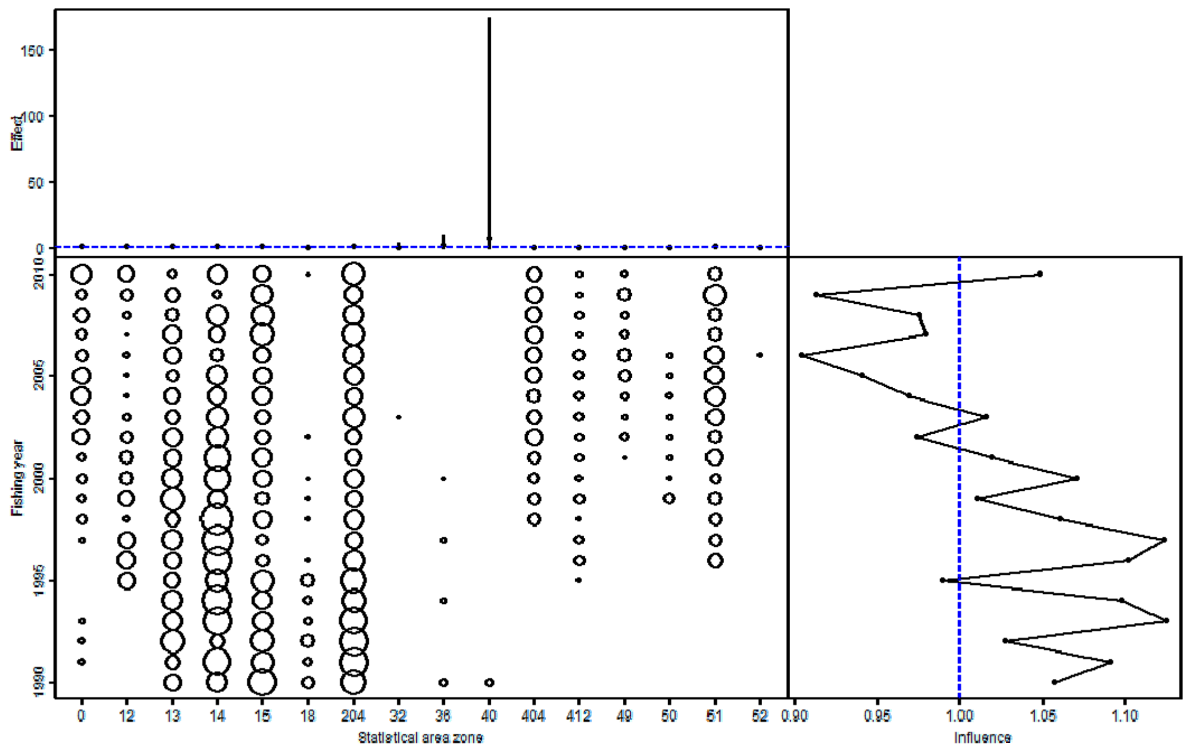

Figure C.9: Effect of statistical area in the lognormal model for the BNS NZ T_NZ–TS fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

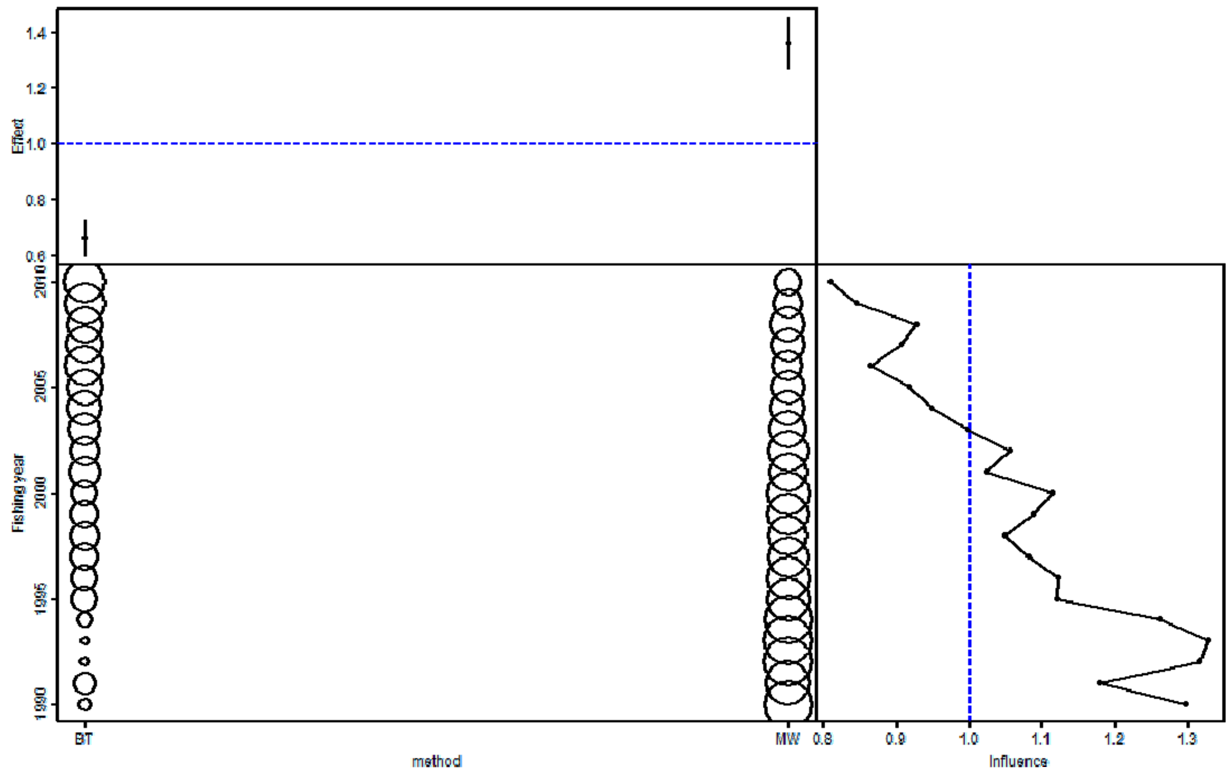

Figure C.10: Effect of method in the lognormal model for the BNS NZ T_NZ–TS fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

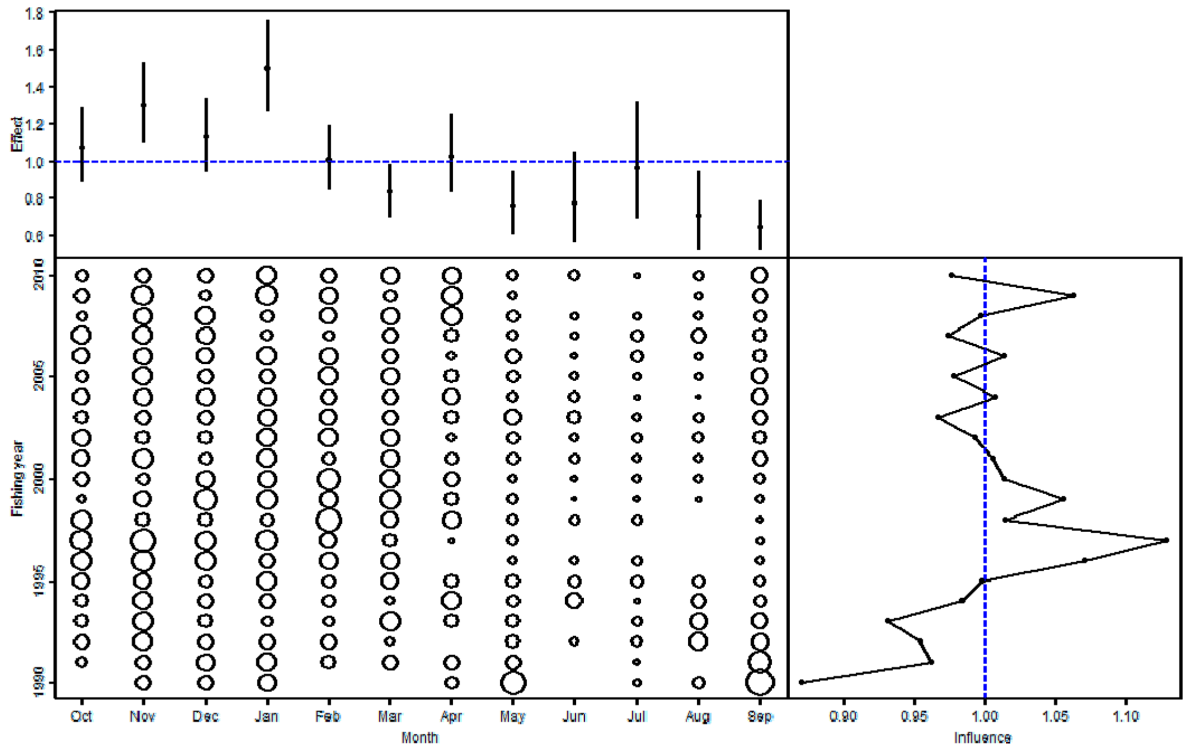

Figure C.11: Effect of month in the lognormal model for the BNS NZ T_NZ–TS fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

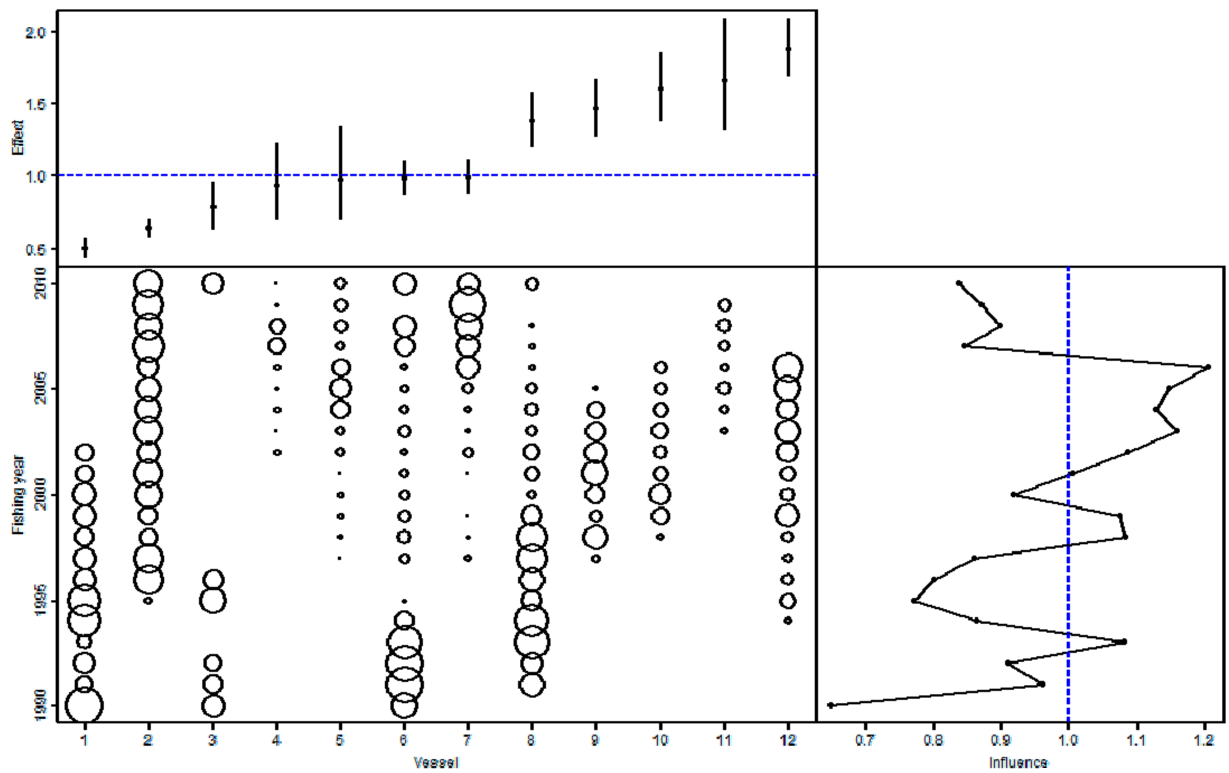

Figure C.12: Effect of vessel in the lognormal model for the BNS NZ T_NZ–OR fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

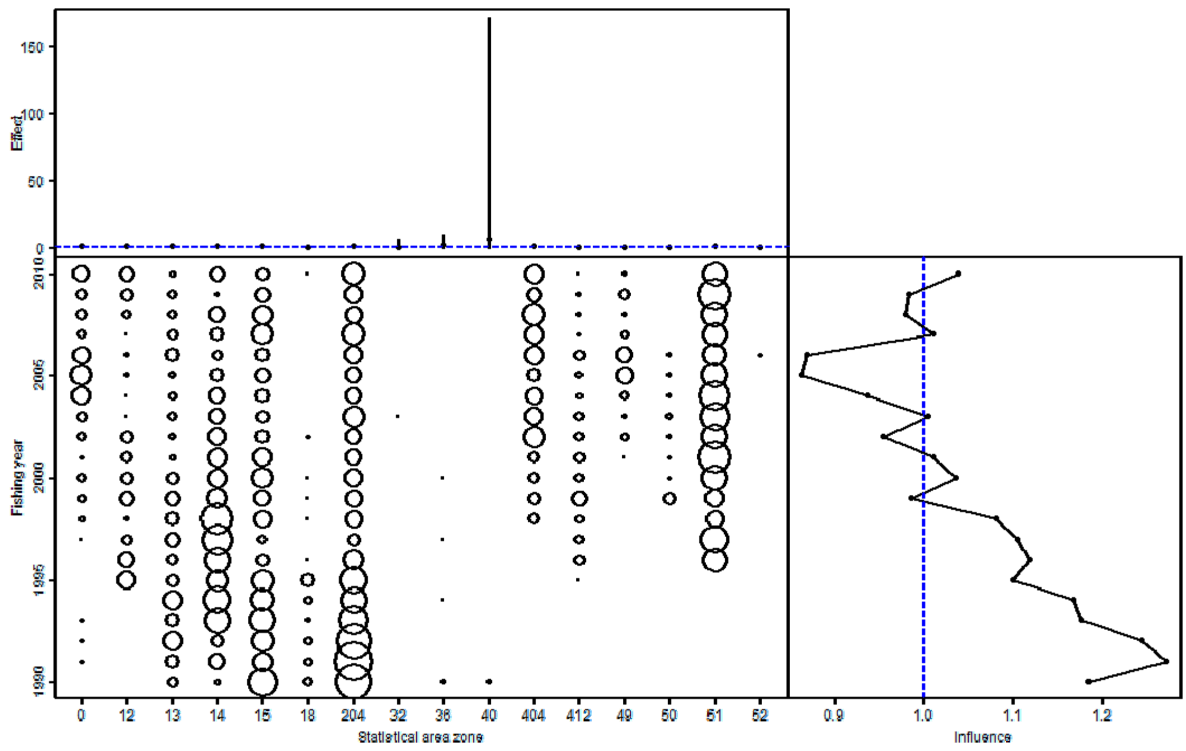

Figure C.13: Effect of statistical area in the lognormal model for the BNS NZ T_NZ–OR fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

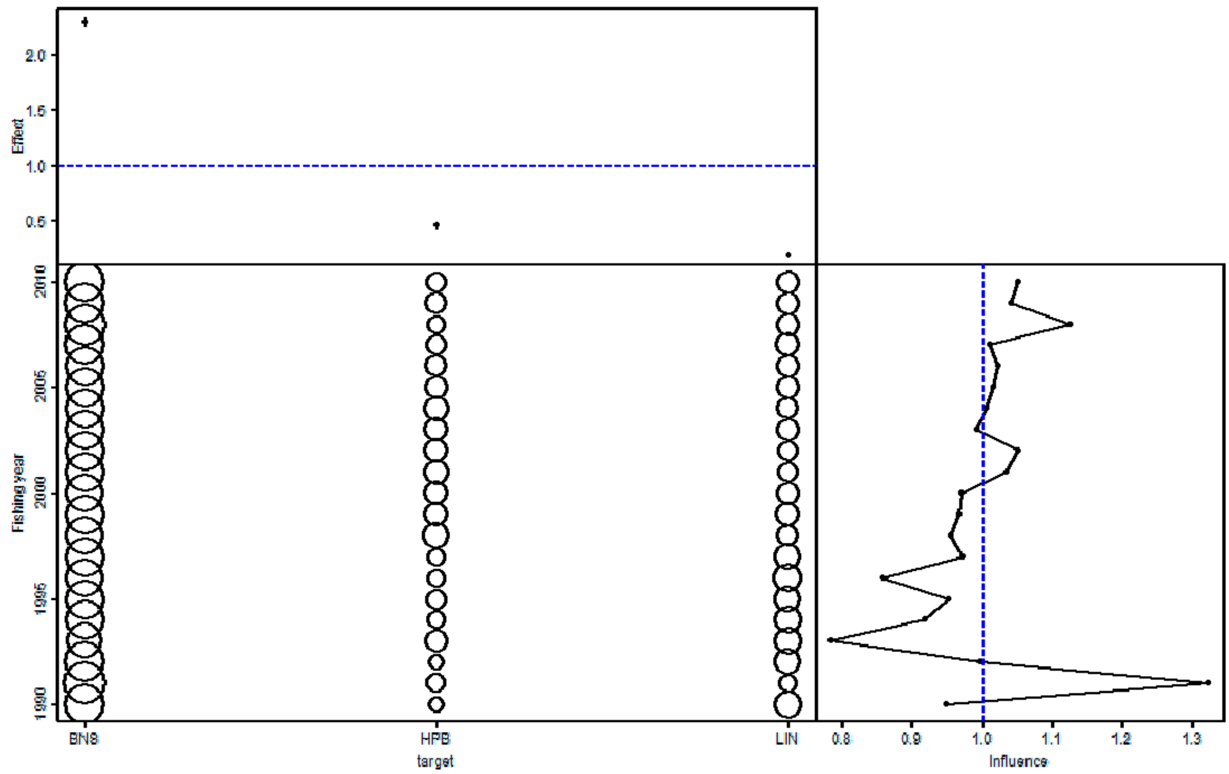

Figure C.14: Effect of target in the lognormal model for the BNS NZ BLL_NZ fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

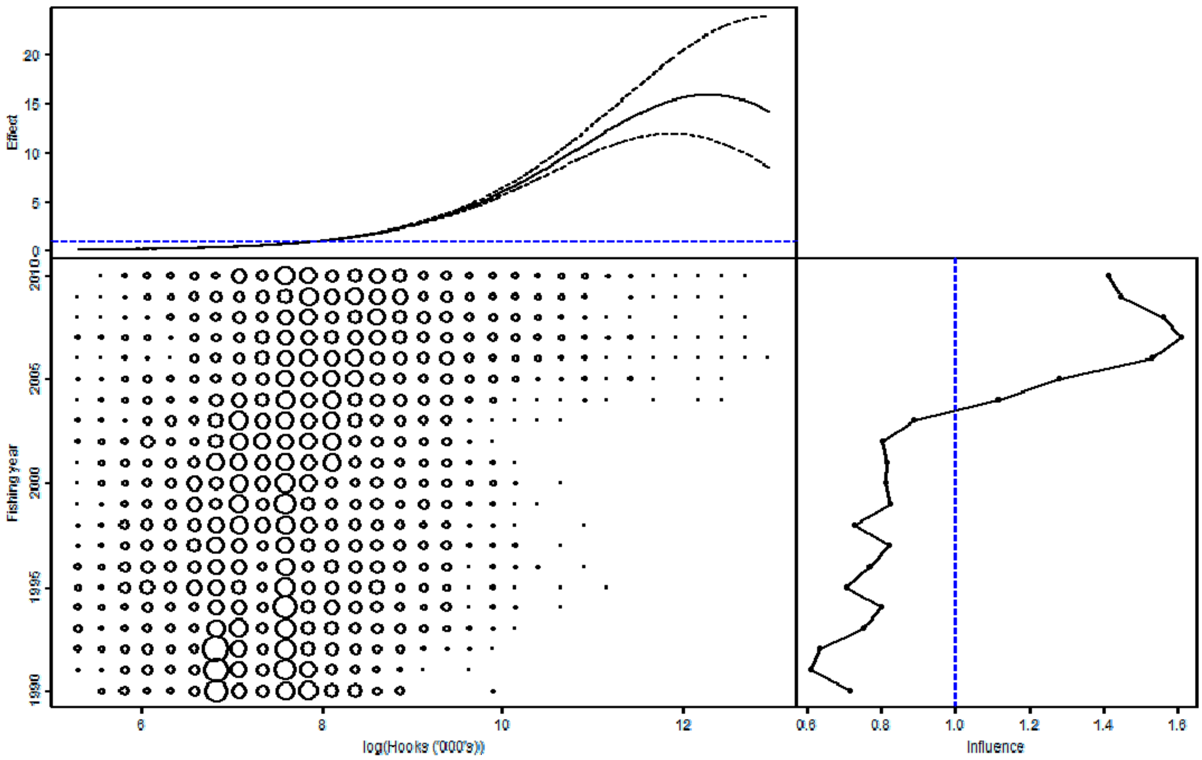

Figure C.15: Effect of log(hooks) in the lognormal model for the BNS NZ BLL_NZ fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

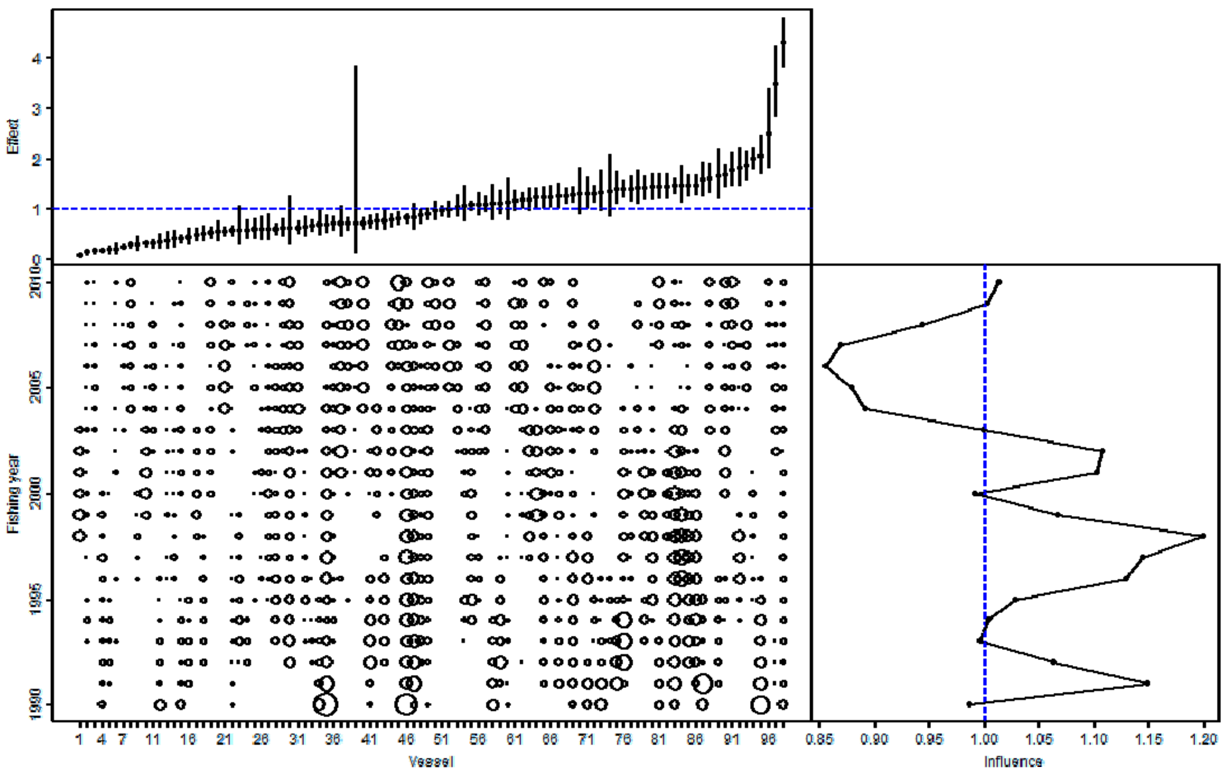

Figure C.16: Effect of vessel in the lognormal model for the BNS NZ BLL_NZ fishery. Top: effect by level of variable. Bottom-left: distribution of variable by fishing year. Bottom-right: cumulative effect of variable by fishing year.

C.5 CPUE INDICES

Table C.3: Relative year effects and 95% confidence intervals (in parentheses) for the models fitted to T_NZ–TS trawl fishery data set.

Fishing year	Arithmetic mean	Geometric mean	Lognormal standardisation	Binomial standardisation	Combined standardisation
1989/90	0.9	0.983	1.205 (0.686-2.116)	0.805	1.147
1990/91	1.1	1.053	0.916 (0.589-1.424)	0.887 (0.673-0.968)	0.961
1991/92	1.2	1.989	1.997 (1.278-3.120)	0.812 (0.553-0.938)	1.918
1992/93	1.5	2.137	1.704 (1.161-2.502)	0.893 (0.704-0.967)	1.799
1993/94	1.8	2.612	2.465 (1.720-3.532)	0.788 (0.544-0.921)	2.298
1994/95	1.2	0.771	0.966 (0.703-1.327)	0.783 (0.556-0.912)	0.894
1995/96	1.5	1.587	1.534 (1.099-2.142)	0.846 (0.643-0.944)	1.536
1996/97	1.1	1.212	0.963 (0.672-1.382)	0.812 (0.572-0.933)	0.925
1997/98	1.2	1.141	0.898 (0.649-1.243)	0.725 (0.471-0.887)	0.770
1998/99	1.1	1.387	1.079 (0.816-1.426)	0.744 (0.498-0.895)	0.949
1999/00	1.2	1.193	0.986 (0.770-1.261)	0.840 (0.644-0.939)	0.979
2000/01	1.2	1.461	1.181 (0.923-1.511)	0.898 (0.746-0.963)	1.254
2001/02	1.4	1.515	1.414 (1.154-1.733)	0.889 (0.737-0.958)	1.487
2002/03	1.3	1.069	0.894 (0.722-1.108)	0.867 (0.694-0.949)	0.917
2003/04	0.9	0.900	0.852 (0.678-1.070)	0.909 (0.772-0.967)	0.915
2004/05	1.0	0.903	0.895 (0.719-1.115)	0.903 (0.762-0.965)	0.956
2005/06	0.5	0.522	0.558 (0.449-0.694)	0.865 (0.690-0.949)	0.571
2006/07	0.3	0.420	0.568 (0.430-0.751)	0.849 (0.654-0.944)	0.570
2007/08	0.5	0.366	0.527 (0.400-0.694)	0.917 (0.786-0.971)	0.571
2008/09	0.5	0.433	0.574 (0.418-0.789)	0.868 (0.683-0.953)	0.589
2009/10	0.4	0.467	0.726 (0.555-0.949)	0.894 (0.743-0.961)	0.767

Table C.4: Relative year effects and 95% confidence intervals (in parentheses) for the models fitted to the T_NZ–OR trawl fishery data set.

Fishing year	Arithmetic mean	Geometric mean	Lognormal standardisation	Binomial standardisation	Combined standardisation
1989/90	0.878	0.804	1.510 (1.145-1.992)	0.735	1.682
1990/91	0.829	1.248	1.043 (0.817-1.330)	0.568 (0.464-0.666)	0.897
1991/92	1.118	1.710	1.894 (1.533-2.341)	0.609 (0.512-0.698)	1.748
1992/93	0.929	1.393	1.751 (1.427-2.149)	0.686 (0.589-0.769)	1.819
1993/94	1.068	1.223	1.900 (1.579-2.286)	0.685 (0.592-0.766)	1.972
1994/95	1.034	0.632	0.964 (0.801-1.160)	0.657 (0.567-0.737)	0.960
1995/96	1.650	1.110	1.053 (0.882-1.257)	0.660 (0.566-0.743)	1.053
1996/97	1.144	1.200	1.228 (1.036-1.457)	0.603 (0.505-0.693)	1.122
1997/98	0.992	1.251	1.233 (1.038-1.464)	0.575 (0.478-0.666)	1.073
1998/99	1.518	1.273	1.290 (1.073-1.551)	0.454 (0.362-0.549)	0.887
1999/00	1.468	1.038	0.934 (0.808-1.079)	0.647 (0.556-0.728)	0.915
2000/01	1.774	1.622	1.191 (1.035-1.370)	0.686 (0.599-0.762)	1.238
2001/02	1.863	1.685	1.249 (1.105-1.412)	0.699 (0.615-0.771)	1.322
2002/03	1.689	1.524	0.978 (0.871-1.097)	0.729 (0.649-0.796)	1.079
2003/04	1.064	1.132	0.879 (0.779-0.991)	0.787 (0.716-0.844)	1.047
2004/05	1.145	1.068	0.951 (0.846-1.070)	0.814 (0.749-0.865)	1.173
2005/06	0.682	0.692	0.558 (0.498-0.625)	0.735 (0.657-0.801)	0.621
2006/07	0.427	0.449	0.485 (0.417-0.563)	0.598 (0.505-0.685)	0.440
2007/08	0.441	0.508	0.551 (0.474-0.641)	0.711 (0.625-0.784)	0.594
2008/09	0.560	0.530	0.545 (0.463-0.643)	0.661 (0.567-0.743)	0.546
2009/10	0.587	0.583	0.551 (0.477-0.635)	0.669 (0.582-0.746)	0.558

Table C.5: Relative year effects and 95% confidence intervals (in parentheses) for the models fitted to the BLL_NZ fishery data set.

Fishing year	Arithmetic mean	Geometric mean	Lognormal standardisation	Binomial standardisation	Combined standardisation
1989/90	0.950	1.003	1.247 (1.061-1.467)	0.645	1.214
1990/91	1.430	1.803	1.591 (1.421-1.782)	0.589 (0.485-0.685)	1.413
1991/92	1.218	1.246	1.478 (1.352-1.615)	0.724 (0.639-0.795)	1.614
1992/93	1.092	1.095	1.650 (1.513-1.799)	0.726 (0.644-0.795)	1.807
1993/94	1.246	1.335	1.500 (1.367-1.647)	0.642 (0.549-0.726)	1.454
1994/95	1.034	0.980	1.193 (1.092-1.303)	0.591 (0.497-0.680)	1.064
1995/96	1.135	1.096	1.251 (1.143-1.368)	0.615 (0.520-0.703)	1.161
1996/97	1.244	1.495	1.457 (1.330-1.597)	0.616 (0.518-0.706)	1.355
1997/98	1.101	1.172	1.314 (1.205-1.433)	0.706 (0.616-0.783)	1.400
1998/99	1.032	1.010	1.168 (1.073-1.273)	0.726 (0.639-0.798)	1.279
1999/00	1.029	1.033	1.152 (1.063-1.249)	0.701 (0.613-0.777)	1.219
2000/01	1.064	1.164	1.113 (1.030-1.203)	0.700 (0.612-0.776)	1.176
2001/02	1.042	1.153	1.098 (1.013-1.190)	0.669 (0.577-0.750)	1.109
2002/03	0.965	1.052	1.217 (1.127-1.313)	0.679 (0.588-0.758)	1.245
2003/04	1.070	1.059	1.100 (1.022-1.184)	0.697 (0.610-0.773)	1.157
2004/05	0.779	0.773	0.753 (0.700-0.811)	0.682 (0.593-0.760)	0.776
2005/06	0.755	0.696	0.615 (0.569-0.664)	0.723 (0.636-0.795)	0.670
2006/07	0.746	0.620	0.545 (0.506-0.587)	0.654 (0.561-0.736)	0.537
2007/08	0.801	0.712	0.435 (0.404-0.467)	0.584 (0.487-0.674)	0.383
2008/09	0.854	0.685	0.465 (0.428-0.504)	0.646 (0.551-0.731)	0.453
2009/10	0.758	0.635	0.429 (0.395-0.466)	0.638 (0.542-0.724)	0.413

Appendix D. AREA SENSITIVITY ANALYSES IN THE BLL_NZ SERIES

D.1 ADDITION OF STATISTICAL AREA TO THE MODEL

Statistical area was inadvertently not offered as an explanatory variable in the bottom longline model described in Table B.3 and Table C.5. This could have been a problem because, by the time that this determination was made, the BNS stock assessment was well underway, using the lognormal indices provided in Table C.5. The model was refitted to the same data, based on the same core vessel selection and adding statistical area as an explanatory variable (Table D.1). This variable entered the model last, increasing the R^2 by 1.7%. The resulting standardised series showed almost no difference with the original series, indicating that the stock assessment did not need to be repeated with the new series (Figure D.1).

Table D.1: Order of acceptance of variables into the lognormal model of successful catches in the BLL_NZ fishery for qualifying vessels (based on at least five trips per year in at least five years). This model differs from the one presented in Table B.3 by the addition of 'area' (statistical area) as an explanatory variable (grey highlight). The amount of explained deviance (R^2) is shown for each variable and variables accepted into the model are marked with an *, with the final R^2 of the selected model in bold. Fishing year was forced as the first variable.

Lognormal Model	DF	Deviance	AIC	R^2	Final
None	0	60 333	75 292	0.000	
fyear	21	59 635	75 113	0.012	*
target	23	40 849	68 002	0.323	*
poly(log(hooks), 3)	26	32 742	63 849	0.457	*
vessel	123	26 997	60 414	0.553	*
area	198	25 951	59 821	**0.570**	*
poly(log(sets), 3)	201	25 668	59 621	0.575	
month	212	25 430	59 467	0.579	

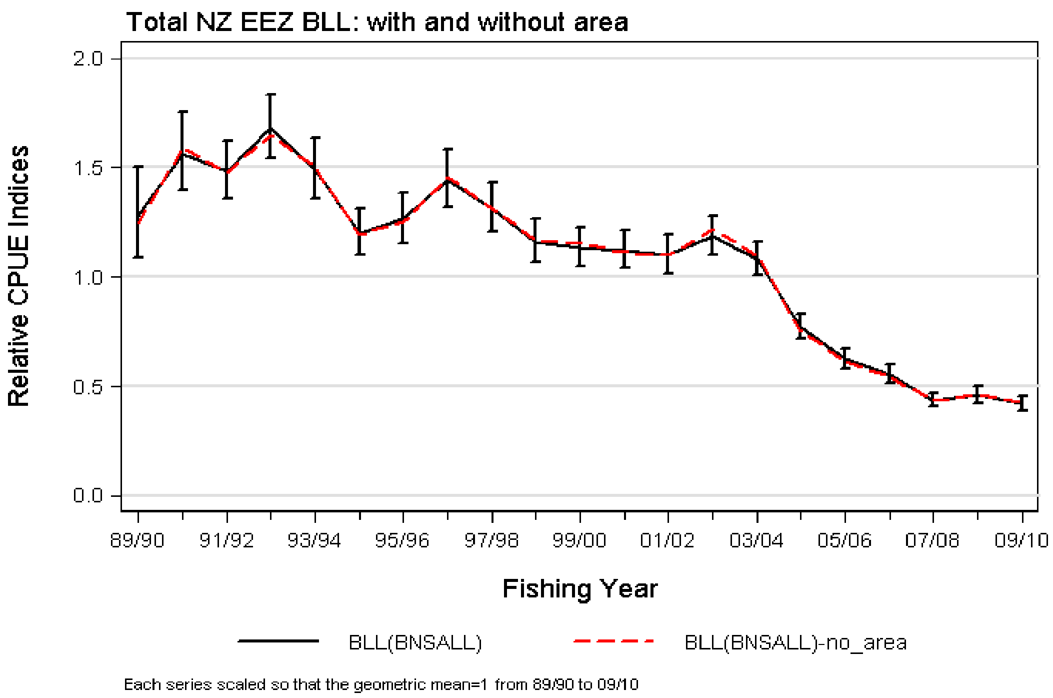

Figure D.1. Plot showing the correspondence between the BLL(NZ-All) series calculated with and without using statistical area as an explanatory variable.

D.2 ADDITION OF QMA TO THE MODEL

A further sensitivity to the inclusion of area/QMA as an explanatory variable in the bottom longline model was made by using the statistical area codes to approximate the BNS QMA of capture. The model was refitted to the data based on the same core vessel selection and adding ‘zone’ as an explanatory variable instead of statistical area (Table D.2). In this instance, ‘zone’ defined the QMA of capture (in the case of BNS 2, BNS 3, BNS 7 and BNS 8) or a BNS 1 sub-area (East Northland or Bay of Plenty). This variable did not enter the model under the 1% acceptance rule (Table D.2). A plot of the implied coefficients for each ‘zone’ when this variable was forced into the model showed that catch rates in all six zones declined in the early 2000s, with some variation from zone to zone, but in a manner consistent with the overall BLL_NZ model (Figure D.2).

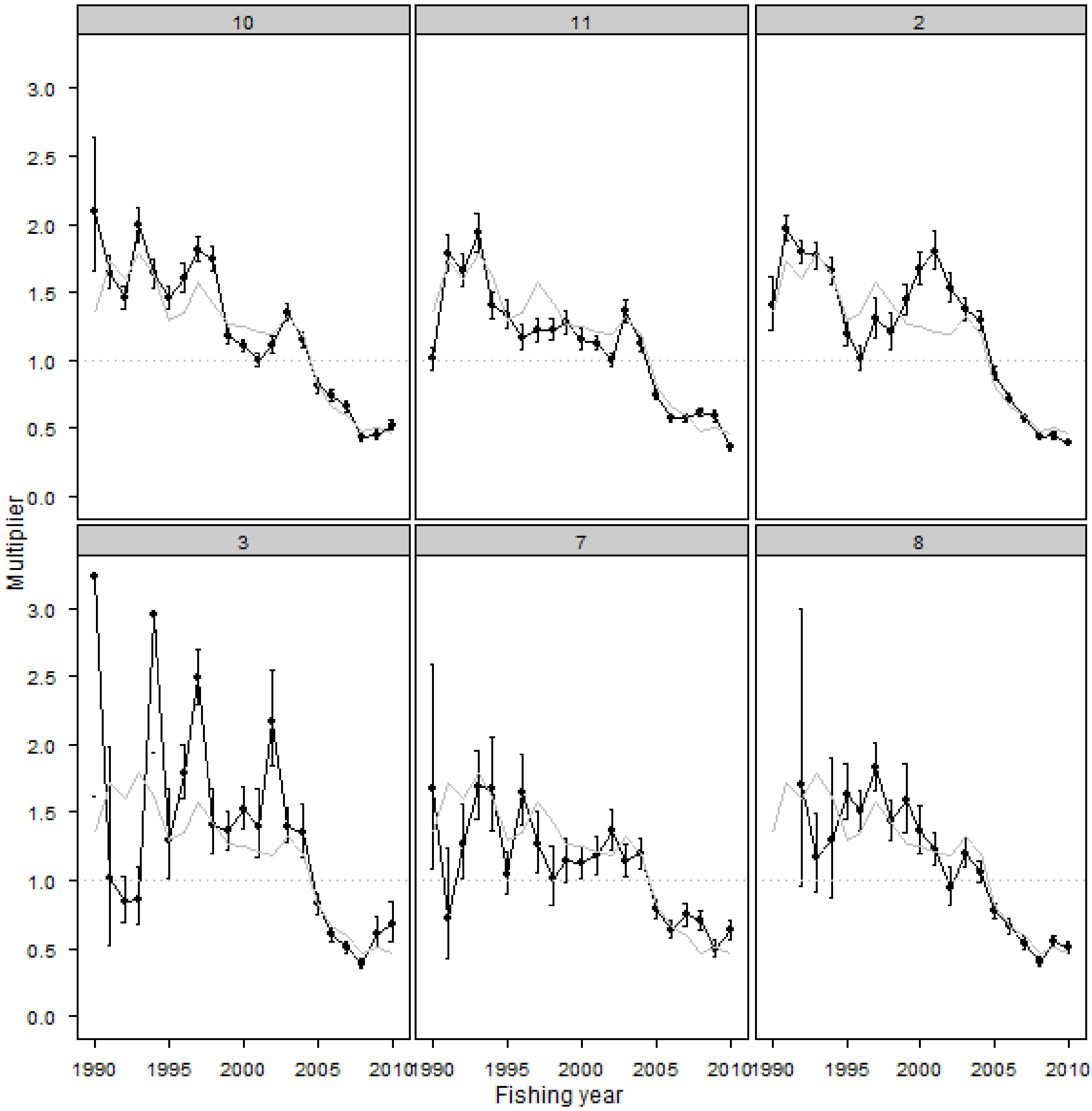

Figure D.2. Residual implied coefficients from the BLL_NZ model for each zone in each fishing year. Implied coefficients are calculated as the sum of the fishing year coefficient plus the mean of the residuals in each fishing year in each zone. The error bars indicate one standard error of residuals. The grey line indicates the model's overall fishing year coefficients. Explanation of codes: 10 = East Northland, 11= Bay of Plenty, 2, 3, 7 & 8 are FMAs except that the few BLL events from BNS1W (northland west coast) have been included with 8 because there are relatively few BNS longline sets on the west coast, North Island.

Table D.2: Order of acceptance of variables into the lognormal model of successful catches in the BLL_NZ-All fishery for all qualifying vessels (based on at least five trips per year in at least five years). The statistics for this model are the same as the one presented in Table B.3, except that 'zone' was offered to this model but did not exceed the 1% threshold for acceptance (grey highlight). 'Zone' describes the five large areas used for independent bottom longline CPUE analyses (Starr & Kendrick 2011a–d). The amount of explained deviance (R^2) is shown for each variable and variables accepted into the model are marked with an *, with the final R^2 of the selected model in bold. Fishing year was forced as the first variable.

Lognormal Model	DF	Deviance	AIC	R^2	Final
None	0	60 333	75 292	0.000	
fyear	21	59 635	75 113	0.012	*
target	23	40 849	68 002	0.323	*
poly(log(hooks), 3)	26	32 742	63 849	0.457	*
vessel	123	26 997	60 414	**0.553**	*
poly(log(sets), 3)	126	26 672	60 193	0.558	
month	137	26 445	60 054	0.562	
zone	142	26 397	60 030	0.562	

D.3 INVESTIGATION OF FISHING YEAR:ZONE INTERACTIONS

A model which did not force fishing year as the first explanatory variable was fitted to the core vessel data set, along with offering the model all possible 'fishing year:zone' interaction terms as explanatory variables (Table D.3). 'Zone' is defined as in Section D.2. Although the interaction term entered the model, it entered last and explained only 1.3% of the total deviance (Table D.3). A plot of the implied coefficients for each 'zone' from this model again showed that catch rates in all six zones declined in the early 2000s, with more variation between zones than observed in Figure D.2 (see Figure D.3).

Table D.3: Order of acceptance of variables into the lognormal model of successful catches in an alternative BLL_NZ-All fishery model for all qualifying vessels (based on at least five trips per year in at least five years). This model differs from the one presented in Table D.1 and Table D.2 by not forcing year as an explanatory variable and offering a 'fishing year:zone' interaction term (grey highlight); Df: degrees of freedom

Lognormal Model	DF	Deviance	Residual Df	Residual Deviance	Final
NULL	–	–	18 804	60 333	
target	2	18 582	18 802	41 751	*
vessel	97	7 090	18 705	34 661	*
poly(log(hooks),3)	3	5 769	18 702	28 892	*
fyear	20	1 894	18 682	26 997	*
poly(log(sets),3)	3	325	18 679	26 672	*
month	11	227	18 668	26 445	*
zone	5	45	18 663	26 400	*
fyear:zone	98	791	18 565	**25 609**	*

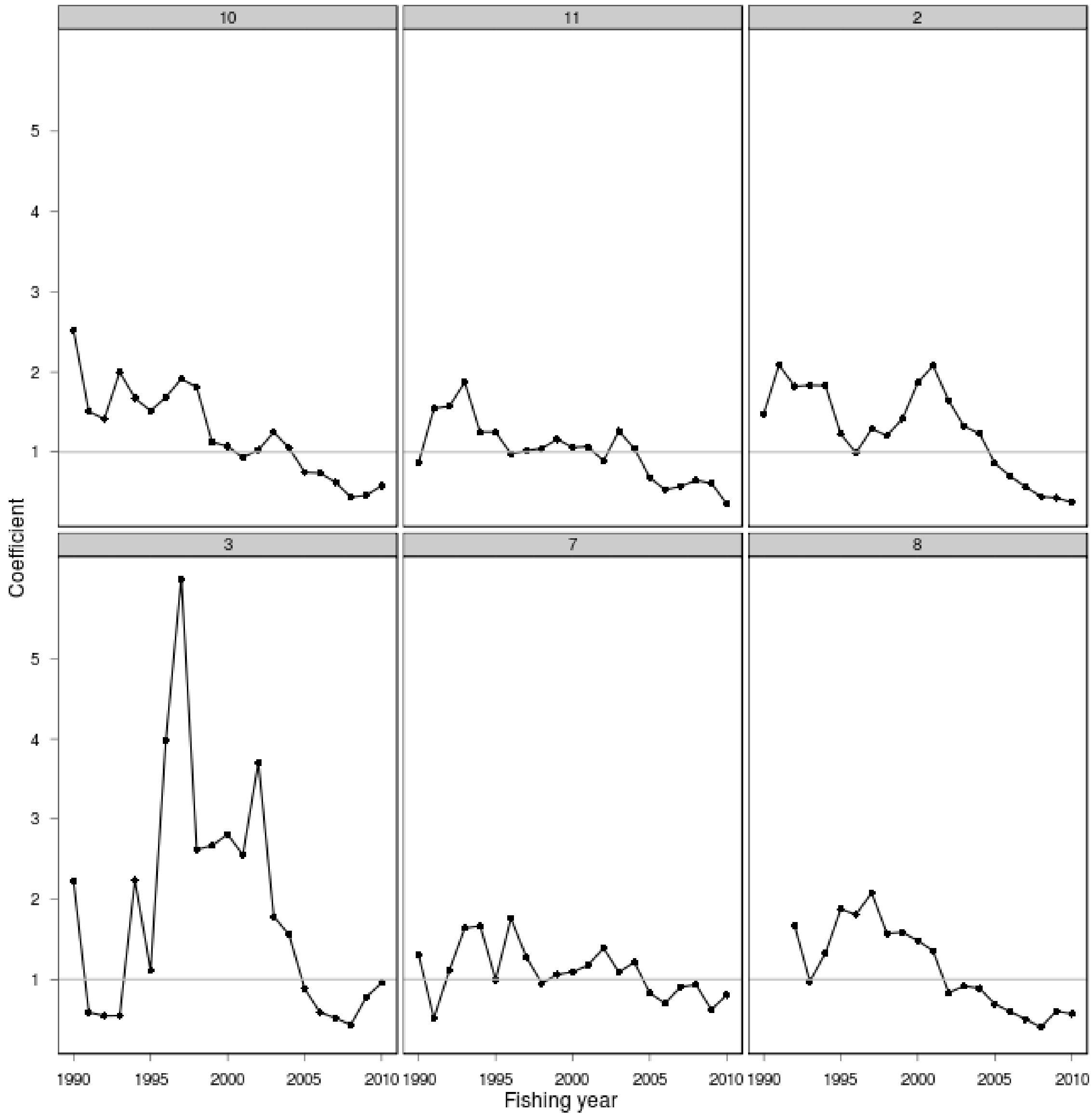

Figure D.3. Residual implied coefficients for each zone by fishing year from the alternative BLL_NZ model using a fishing_year:zone term (described in Table D.3). Zone codes and 'residual implied coefficients' are defined in the Figure D.2 caption.

Appendix E. ANALYSIS OF EFFECT OF INCREASING NUMBER OF HOOKS

E.1 DESCRIPTION OF PROBLEM

The bottom longline fisheries in both BNS 1 and BNS 2 showed a pattern of an increasing number of hooks set per year over the 21-year history of the fishery (Figure E.1). The pattern in BNS 3 was confounded with the large number of hooks set by the auto-longliners fishing for ling and did not seem to be increasing. Although the BLL_NZ CPUE analysis presented in Appendix A showed a strong decline in the catch weight per hook set in the early 2000s (as did all of the BNS QMA analyses: Figure 21), there was concern that this decline may be influenced by an interaction with the increasing number of hooks and a corresponding decrease in the success per hook. Simply put, the drop in catch per hook may be an artefact of the increase in the number of hooks set. This hypothesis was tested by identifying those vessels responsible for the increasing trend in number of hooks, removing these vessels and then refitting the standardised lognormal model to see if the declining trend remained. This was done separately for each BNS QMA to see if there were different effects in each QMA.

Vessels contributing to the increasing trend of hooks shown in Figure E.1 were identified by summarising the average number of hooks per set by each vessel in each year and then fitting a simple regression through these points. Those vessels with a positive "significant" ($p<0.05$) increasing slope were considered to be vessels which might fool the standardisation procedure, given that their behaviour was changing over time and that this might become confounded with the year effect rather than the vessel effect. Conversely it was reasoned that vessels with "non-significant" slopes would be appropriately handled by the estimated vessel coefficient. Figure E.2 to Figure E.5 plot the mean number of hooks per set for the 38 vessel/QMA combinations with positive slopes that were identified using this method in each of the four BLL QMA analyses (Table E.1).

E.2 RESULTS

When the vessels with an increasing number of hooks per set were removed and the standardised analyses were repeated with the reduced data set, the correspondence with the original analysis was very strong, especially for BLL(EN) (Figure E.6), BLL(BNS 2) (Figure E.8) and BLL(BNS 7&8) (Figure E.9). The correspondence is not as good for the BLL(BP) model (Figure E.7); however, there is general agreement with the pattern of the decline between these two Bay of Plenty models, and lack of close correspondence can be attributed to the loss of over one third of the vessels in the data set. An equivalent analysis was not done for BLL(BNS 3) because no vessels were identified as being potentially removable by this method, as well as there being only five eligible vessels in BLL(BNS 3). The conclusion from this analysis is that the pattern of steep decline observed in the early 2000s is probably not an artefact of the increasing number of hooks per line set because it also can be seen in those vessels that did not show significant change in their fishing behaviour as determined through this method.

Table E.1: Table showing the number of vessels that were kept and dropped in each of four BLL standardised CPUE analyses. Vessels were dropped if slope of a line fitted to the average number hooks/set in a fishing was positive with $p<0.05$. The BLL(EN): BNS 1 East Northland and BLL(BP): BNS 1 Bay of Plenty.

Model	Figure reference	Keep	Drop	Total	Reference
BLL(EN)	Figure E.2	23	12	35	Starr & Kendrick 2011a
BLL(BP)	Figure E.3	24	13	37	Starr & Kendrick 2011a
BLL(BNS2)	Figure E.4	27	8	35	Starr & Kendrick 2011b
BLL(BNS78)	Figure E.5	8	5	13	Starr & Kendrick 2011d
Total		82	38	120	

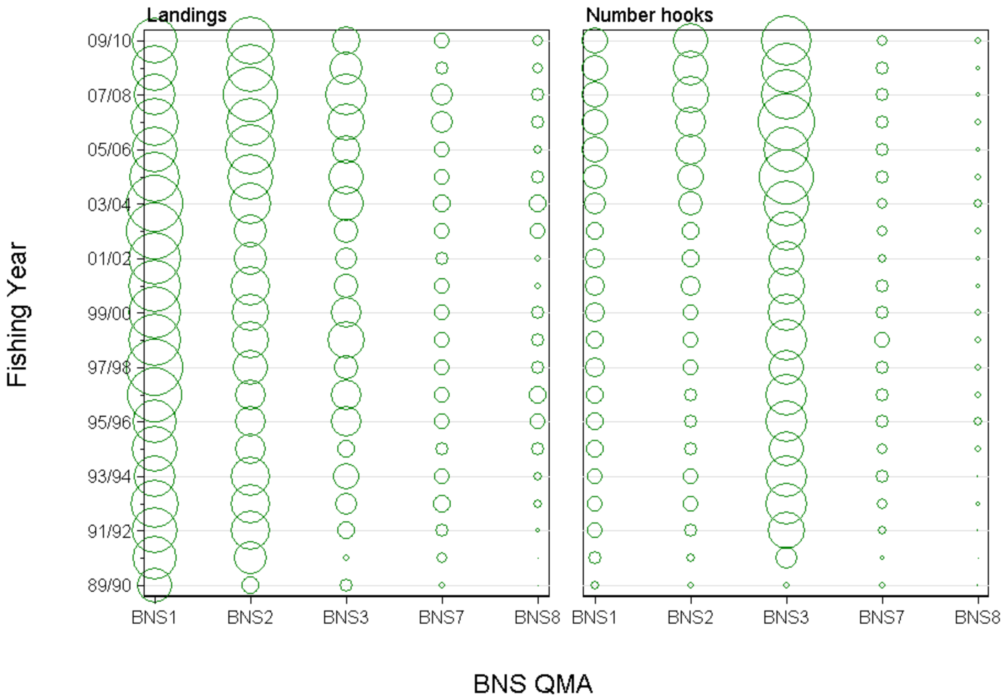

Figure E.1. Distribution of landings and number of hooks for bottom longline by BNS QMA and fishing year. Circles are proportional within each panel: [landings] largest circle=933 t in 03/04 for BNS1 ; [number hooks] largest circle=15.600 × 10^6 hooks in 2006–07 for BNS3.

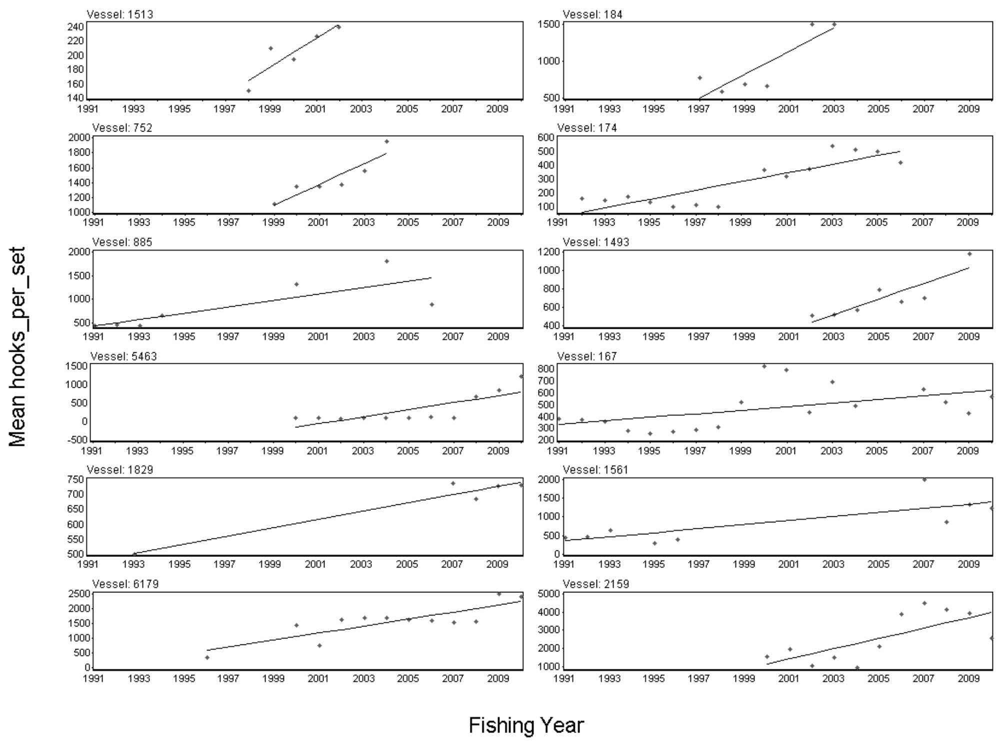

Figure E.2: Plots of the mean number of hooks/set for the 12 vessels with significant positive slopes (Table E.1) from the core vessel set in the BLL(EN) CPUE analysis.

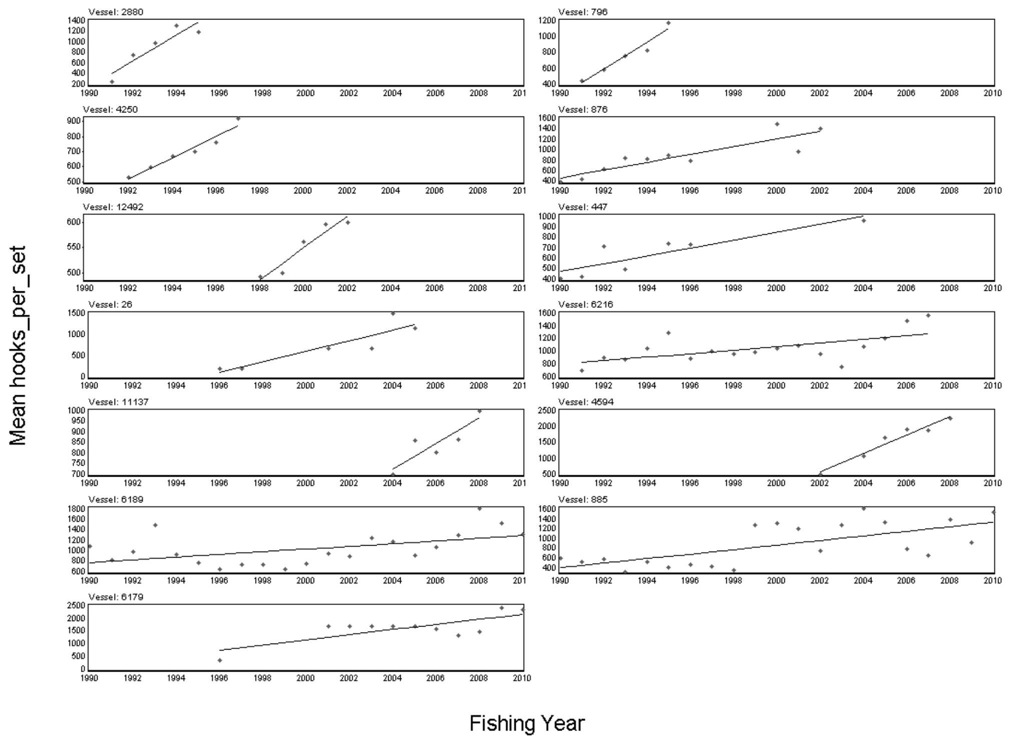

Figure E.3: Plots of the mean number of hooks/set for the 13 vessels with significant positive slopes (Table E.1) from the core vessel set in the BLL(BP) CPUE analysis.

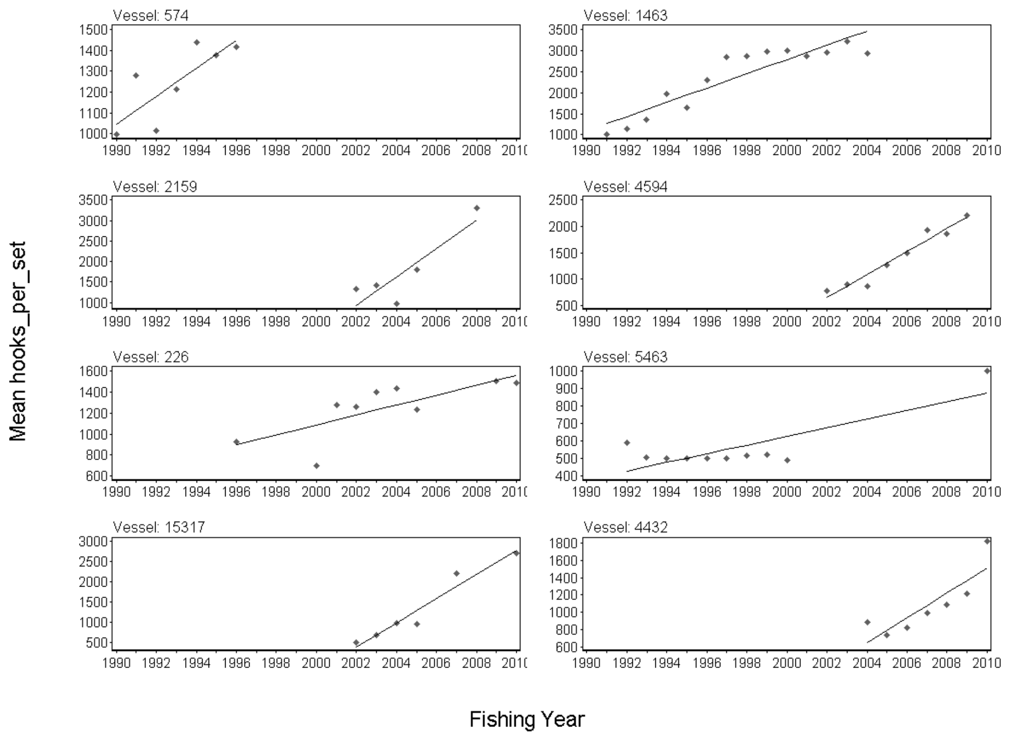

Figure E.4: Plots of the mean number of hooks/set for the 8 vessels with significant positive slopes (Table E.1) from the core vessel set in the BLL(BNS 2) CPUE analysis.

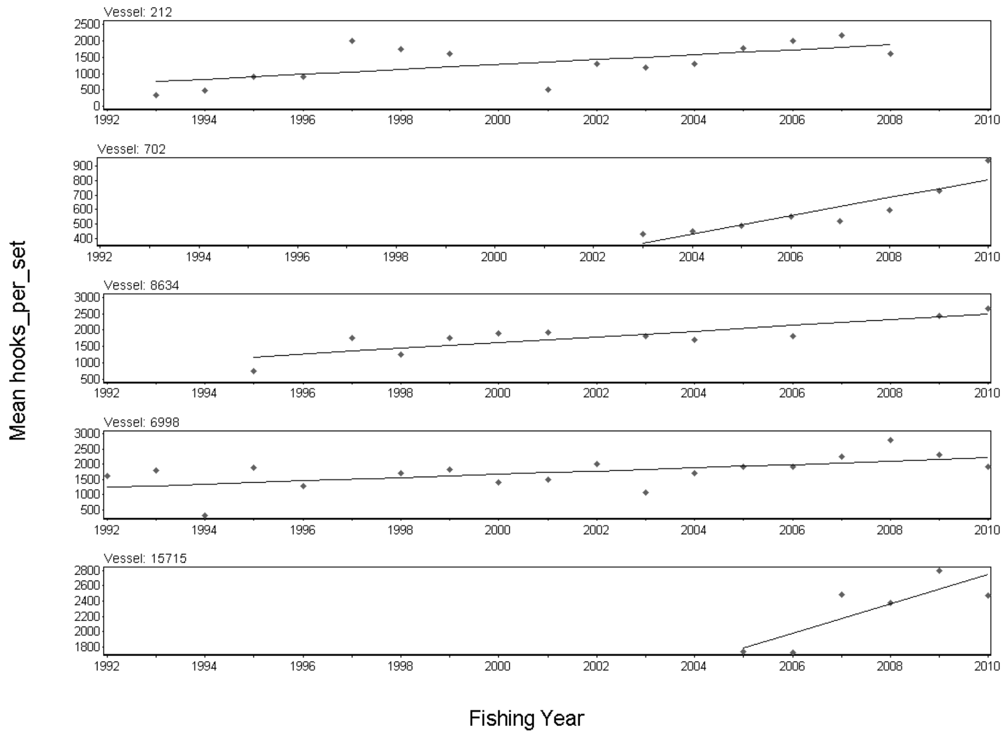

Figure E.5: Plots of the mean number of hooks/set for the 5 vessels with significant positive slopes (Table E.1) from the core vessel set in the BLL(BNS 7&8) CPUE analysis.

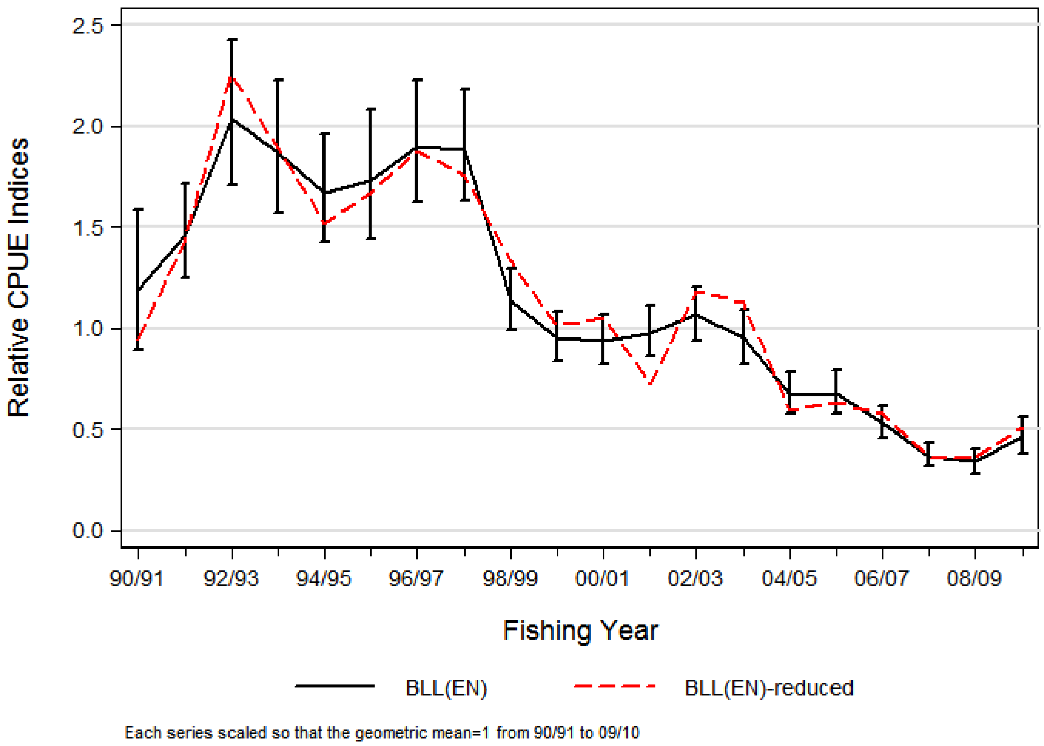

Figure E.6: Comparison of the year indices for the full BLL(EN) model with the model using a reduced core vessel data set (Table E.1).

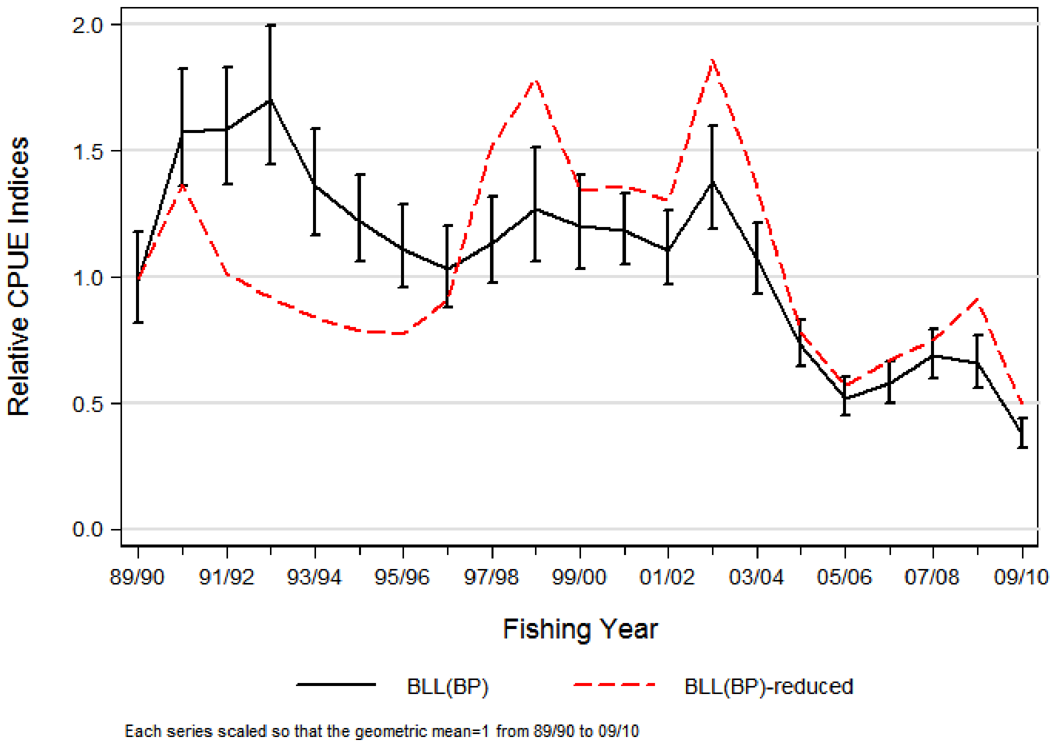

Figure E.7: Comparison of the year indices for the full BLL(BP) model with the model using a reduced core vessel data set (Table E.1).

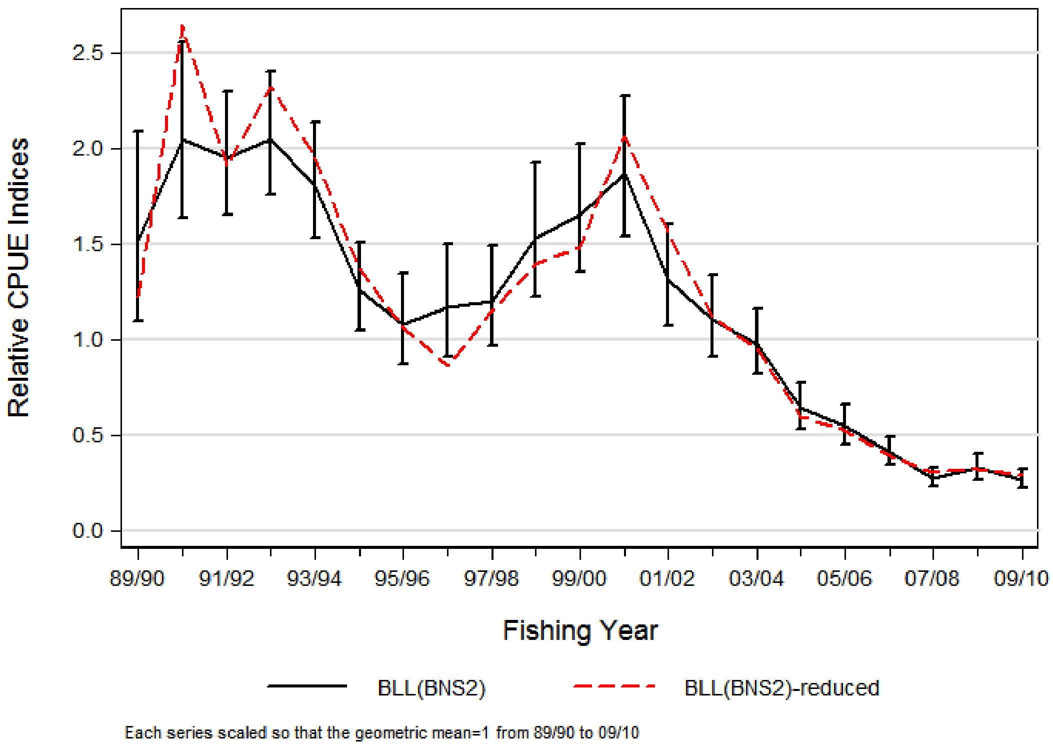

Figure E.8: Comparison of the year indices for the full BLL(BNS2) model with the model using a reduced core vessel data set (Table E.1).

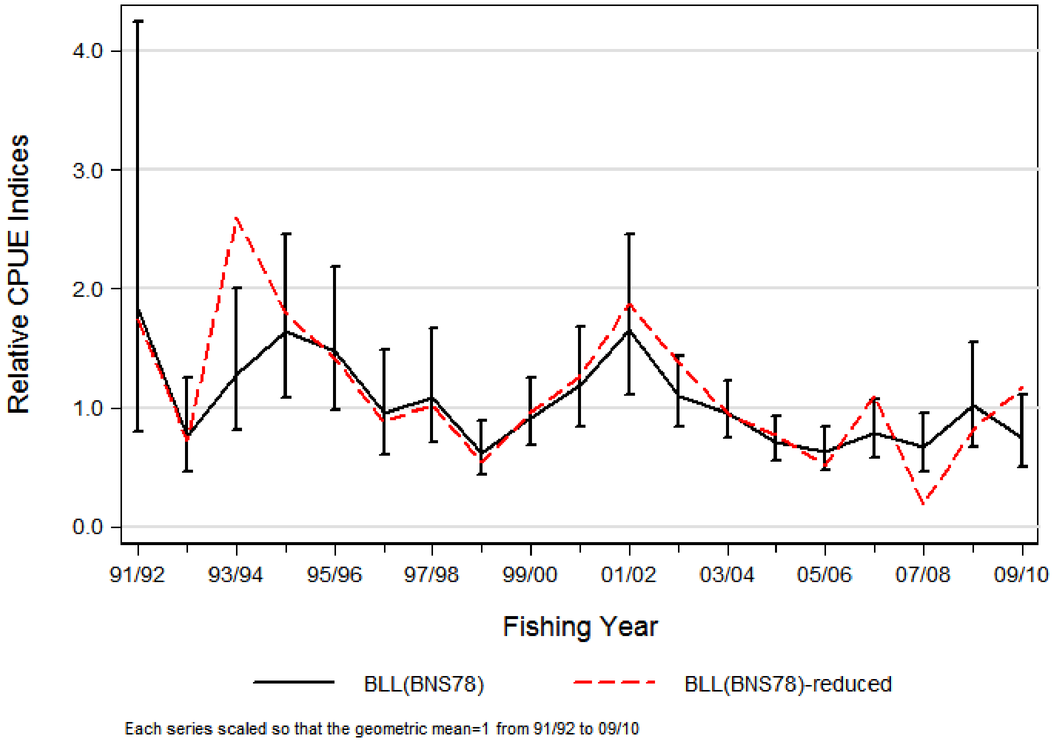

Figure E.9: Comparison of the year indices for the full BLL(BNS 7&8) model with the model using a reduced core vessel data set (Table E.1).