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Fishery characterisation and Catch-Per-Unit-Effort indices for giant stargazer in STA 5

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A.D. Langley,
N. Bentley

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Langley, A.D.; Bentley, N. (2014). Fishery characterisation and Catch-Per-Unit-Effort indices for giant stargazer in STA 5.

***New Zealand Fisheries Assessment Report 2014/64.* 45 p.**

The STA 5 fishstock is primarily monitored based on the analysis of catch and effort data from the target bottom trawl fishery. This report summarises recent trends in the operation of the fishery and provides an update of previous standardised CPUE analyses, including data from the 1989/90–2012/13 fishing years.

The target stargazer trawl fishery operates in a relatively small area off the south-west Southland coast (Statistical Area 030). The fleet is comprised of inshore trawl vessels and some of the main vessels have operated in the fishery for over 20 years. Over the last decade, there have been some changes in the operation of the fishery with one of the main vessels converting from a single bottom trawl to twin-rig bottom trawl gear.

Annual CPUE indices were derived from the target trawl fishery catch and effort data, aggregated by vessel fishing day. The CPUE indices from the final model fluctuated without trend (1989/90–2012/13) with peaks in 1991/92–1993/94 and 2006/07–2009/08. The 2012/13 value is slightly lower than the average of the series. A CPUE index was also derived from the time-series TCER data from 2007/08 to 2012/13. These indices revealed a similar general trend to the corresponding annual indices from the primary CPUE model, although the magnitude of the decline in the CPUE indices from 2009/10 was greater and there was no increase in the index in 2012/13. These differences appear to be partly related to changes in the spatial distribution of fishing effort, at a finer level of spatial resolution than the statistical areas. Thus, for the recent years the CPUE indices derived from the individual trawl TCER records probably represents a more reliable index of stock abundance than the daily aggregated CPUE indices.

There are no additional sources of data available from the fishery to corroborate the recent trends in stock abundance from the CPUE indices. The continued decline in the trawl based CPUE indices suggests that monitoring of the stock should be maintained over the next few years.

1 INTRODUCTION

Giant stargazer (*Kathetostoma giganteum*) in STA 5 is primarily caught by the inshore trawl fleet operating in Southland. Most (80%) of the catch is taken by the target bottom trawl fishery, predominantly in an area off the south-west Southland coast (Statistical Area 030) (Kendrick 2009). Since 1998/99, annual catches from STA 5 have fluctuated about the level of the current TACC of 1264 t (MPI 2013).

Monitoring of STA 5 has essentially been limited to the analysis of catch and effort data from the main target fishery. A standardised CPUE analysis was first conducted by Vignaux (1997) based on data from the 1991–92 to 1995–96 fishing years. The CPUE analysis was updated by Phillips in 2001 (unpublished) and further refined by Manning (2007). The CPUE indices derived by Manning (2007) were accepted by the Inshore FAWG as an index of relative abundance for STA 5 (MPI 2013). The analysis was further updated by Kendrick (2009) to include catch and effort data from the 1989/90–2006/07 fishing years. The current study extends the analysis of catch and effort data from the STA 5 fishery to include the 1989/90–2012/13 fishing years. The study was funded by Southern Inshore Fisheries Management Company Limited.

2 DATA SOURCES AND METHODS

The catch effort data extract (from the MPI database "*warehou*") defined qualifying trips as those that landed STA 5, or that had fishing events in a statistical area valid for STA 5. For the qualifying trips, we obtained all effort data, whether or not stargazer was landed, so that we could include relevant but unsuccessful effort in any analysis of CPUE based on bottom trawl. The associated estimated catch and landed catch data for all species were also obtained for all qualifying fishing trips.

Catch and effort has historically been reported by many inshore vessels on the Catch Effort Landing Return (CELR) which reports daily totals of effort and the estimated catch of the top species unless the fisher has changed statistical area or target species, in which case a single record may represent only part of a day. The verified landed greenweight that is obtained at the end of the trip is also reported on the bottom part of the form.

Since 1989/90, larger trawlers have reported on the Trawl, Catch, Effort and Processing, Return (TCEPR) at the resolution of a single trawl. In 2007/08, a similar event-based form was introduced for the inshore trawl fleet, replacing the CELR form. The Trawl, Catch and Effort Return (TCER) records detailed fishing activity and associated catches for individual trawls conducted by these vessels. Landed catch associated with trips reported on TCEPR and TCER forms is reported at the end of a trip on the Catch Landing Return (CLR). Estimated catch and effort for the trawl methods are therefore available in either daily or individual trawl resolution data formats, in proportions that have changed over time. Landed catch is available only at trip resolution regardless of the form.

The Quota Management System (QMS) totals are collected from fishing permit holders on a monthly basis (Monthly Harvest Return, MHR) and are subjected to a different regime of storage and checking. Differences between annual landed catch totals are not uncommon. The grooming and allocation of landed catch data obtained from catch effort forms should improve the correspondence with QMS totals.

2.1 Data processing

Three separate data sets were generated for the various analyses:

i. A STA 5 fishery characterisation data set;
ii. A target bottom trawl CPUE data set aggregated by vessel fishing day (format equivalent to the CELR format), 1989/90–2012/13; and
iii. A target bottom trawl CPUE data set in TCER format, 2007/08–2012/13.

2.1.1 Fishery characterisation data set

Prior to 2007/08, most (80–90%) of the STA 5 landed catch was associated with fishing effort recorded in the CELR format. Since 2007/08, most of the catch has continued to be reported by the inshore trawl fleet and, consequently, the reporting of STA 5 catch has been associated with the TCER reporting form (Figure 1). Approximately 10–20% of the annual STA 5 landed catch has been associated with vessels reporting fishing effort data using the TCEPR form.

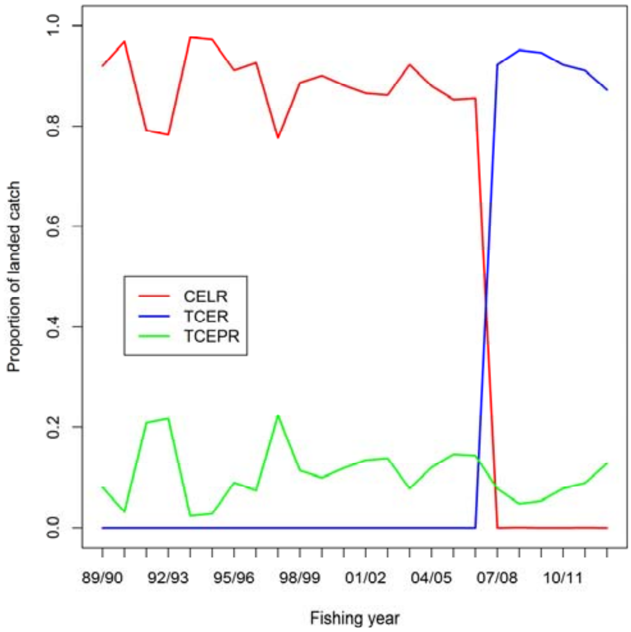

Figure 1: Annual proportion of the total STA5 landed catch associated with the statutory catch and effort reporting forms.

The STA 5 characterisation data set included all fishing trips that landed STA 5 and the associated fishing effort from within the statistical areas that approximate the fishstock area (Statistical Areas 026–032, 503, and 601–605). The initial set of STA 5 landed catch records was screened to retain the records that represented the final destination of the STA 5 catch (destination codes L, A, C, E, and O). This resulted in a 3.3% reduction in the total STA 5 landed catch included in the landings data set (Table 1). Most of the reduction was attributable to the removal of records that represented the transfer of STA 5 catch to another vessel (transhipment, destination code T).

Table 1: Total STA 5 landed catch included in the fishery characterisation data set at each step of the catch grooming process.

Criterion	STA5 landed catch (t)	Percent of total landed catch
All landing records	26 973.2	100.0%
Destination codes (L, A, C, E, O)	26 063.1	96.7%
Exclude landed catch outliers	24 765.0	91.8%
Associated effort records	24 225.3	89.8%

Potential landed catch outliers were examined by comparing the landed catch from a trip with the aggregated estimated catches from a trip. In most cases, the ratio of the trip landed catch to the estimated catch approximated 1.0 indicating a good correspondence between the landed catch and estimated catch (Figure 2). There was a smaller proportion of trips with a ratio of about 2.0. These records are likely to correspond to the reporting of estimated catches in terms of processed weight. Most stargazer catches are processed at sea to DVC state with a conversion factor of 2.15.

Potentially erroneous landed catch records were identified based on the ratio of the trip landed catch to the aggregated estimated catch; i.e. where the ratio exceeded a factor of 4.0 and landed catches exceeded 1000 kg. A total of 132 trips (of a total of 13 343 trips) met these criteria and the landed catches for these trips were further examined by comparing the landed catch with the corresponding processed catch weight multiplied by the conversion factor of the associated state code. A subset of those trips (32 of 132 trips) had catch values derived from the processed catch data that were considerably lower than the landed catch, including three trips with landed catches exceeding 100 t and one landing that exceeded 500 t. For the subset of 32 trips, the landed catches were corrected using the green weight equivalent of the processed catches. This resulted in a reduction in the total STA 5 catch included in the data set, primarily due to the correction of the catch data from three large landings (Table 1).

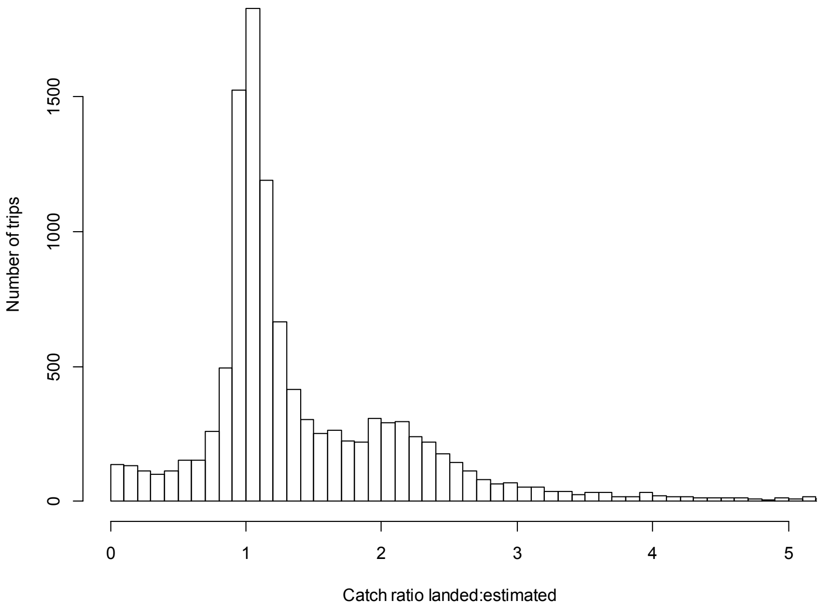

Figure 2: Ratio of the STA 5 landed catch and the sum of stargazer estimated catches from individual fishing trips.

Catch and effort data from the qualifying fishing trips were aggregated in a manner that approximates the daily aggregate format of the CELR following the approach of Langley (2014). The approach aggregates method specific fishing effort (number of trawls and hours fished) for each fishing vessel and fishing day. The resulting records are assigned a statistical area and target species based on the predominant statistical area and declared target species from the day of fishing. The estimated species catches are also aggregated for the vessel fishing day and the aggregate catches are ranked based on species catch weight. The five largest species estimated catches are retained, replicating the recording of the top five species estimated catches from the CELR. The estimated catches of the remainder of the species (non top five) are not included in the subsequent analysis.

This aggregation approach reduces the potential for temporal trends in the catch and effort data set to be influenced by the changes in reporting formats, especially from CELR to TCER. Given the high proportion of the landed catch reported in the CELR format prior to 2007/08 it was considered important to maintain a consistent reporting format in the subsequent years. The aggregation of the catch and effort data means that the additional detail associated with the trawl based reporting from the TCER and TCEPR forms is not included within the main characterisation data set. Nonetheless, these data were included in a number of supplementary analyses and the TCER data were utilised to characterise the operation of the inshore target stargazer trawl fishery.

The landed catches of STA 5 from each fishing trip were apportioned to the aggregate fishing effort records following the approach developed by Starr (2007). For fishing trips that recorded at least one top five estimated catch of stargazer, the STA 5 landed catch was allocated to the individual fishing effort records in proportion to the individual estimated catches. For fishing trips with no associated top five estimated catches, the landed catch was assigned to the daily fishing records in proportion to the number of trawls per day.

A total of 13 224 trips (from 13 343 trips) with a landed catch of STA 5 were successfully linked to the aggregated fishing effort records. However, the number of trips was reduced by the exclusion of fishing effort records in statistical areas outside of STA 5 and/or fishing effort records that would not be expected to catch STA 5 (e.g. surface longline and troll) (12 721 trips). There were also fishing effort records that were missing the data fields required to generate the aggregated effort records. The reduction in the number of fishing trips included in the final data set resulted in a small reduction in the overall quantity of STA 5 landed catch (Table 1).

The final landed catch data set represented approximately 90% of the total annual STA 5 landed catch reported from the fishery by MHRs (Figure 3). The lower level of landed catch associated with the catch and effort is a feature of the data set that was evident in the study by Manning (2007). The discrepancy is not accounted for by the exclusion of landed catches associated with the transfer of catch between vessels (destination type T).

The estimated catches of stargazer represented about 80–90% of the final landed catch for 1998/99–2006/07 (Figure 3). Since 2007/08, the estimated catches have represented about 95% of the landed catch and the higher level of reporting of estimated catch is likely to be attributable to the introduction of the TCER reporting form for the inshore trawl fleet.

Over the study period, there have been a number of changes in the conversion factors for the main processed states of stargazer (see Section 2.1.2). The fishery characterisation data set did not account for these changes but maintained the original conversion factors used to derive the landed catches, thereby maintaining a consistency with the reported QMS/MHR catches.

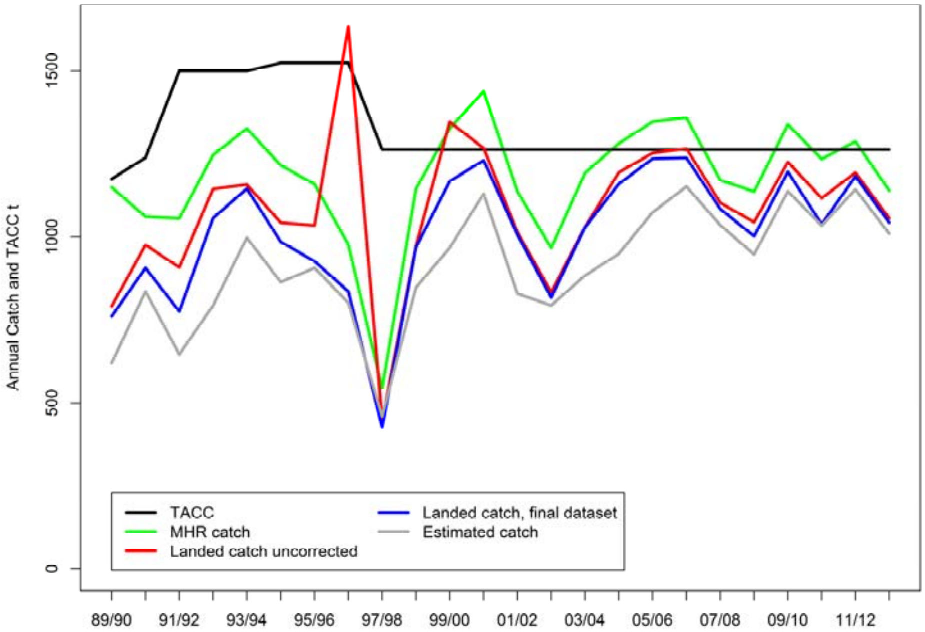

Figure 3: Comparison of total (uncorrected) annual STA 5 landed catches (t) by fishing year from vessel trip landing returns and the total reported landings (t) to the QMS (MHR). Also shown are the landed catch totals (t) which remain after the dataset has been prepared for the characterisation analysis (final data set) and the estimated catch from trips retained in the characterisation dataset.

2.1.2 Daily aggregated target trawl CPUE data set

The target trawl fishery accounts for most of the catch from STA 5 and was identified from the fishery characterisation as the only candidate fishery for the development of CPUE indices. The fishery is limited to inshore trawl vessels and all catch and effort data were recorded in either CELR format (1989/90– 2007/08) or TCER format (2007/08–2012/13).

The initial CPUE data set included all catch and effort records for fishing trips that conducted target STA trawls and the data were configured following the approach described for the fishery characterisation data set (Section 2.1.1). The approach aggregated the TCER fishing effort records in a manner that closely approximates the CELR data and, thereby, minimises the potential biases in the CPUE analysis that might be introduced due to changes in reporting (Langley 2014).

Primary processing of stargazer generally occurs at-sea, typically removing the head and viscera. A conversion factor is applied to the weight of the processed catch to determine the equivalent green weight of the landed catch. Most of the STA 5 catch has been landed in HGU (head-and-gutted), DRE (dressed cut) and DVC (dressed-v cut) processed states. The definition of these processed states primarily differs based on the type of cut used to sever the head from the body. Over the study period, there was a transition in the processing of stargazer initially from HGU to DRE and then to DVC. Since the early 2000s, the stargazer catch has almost exclusively been processed at sea to the DVC state (Figure 4).

During the study period, there were a number of changes to the conversion factors applied to the main stargazer processed states (Table 2). The landed catches of stargazer from individual fishing trips were corrected to account for these changes. Individual fishing trips almost exclusively landed stargazer in one processed state. The corrected landed green weight of stargazer for individual trips was calculated by multiplying the reported landed green weight by the ratio of the current (2012/13)

DVC conversion factor to the conversion factor that was applicable at the date of landing (CF $Year_{2012/13}/Year_{Landing}$). Fish processed in the HGU and DRE state were assumed to have actually been processed to the DVC state (Table 2).

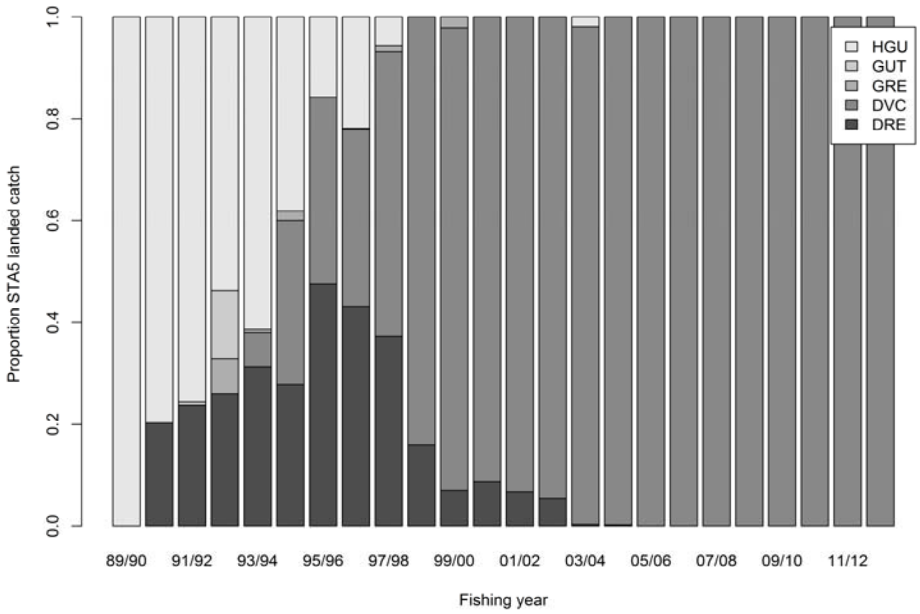

Figure 4: Proportion of annual stargazer landings (reported green weight) by process state code for the core vessel, target fleet.

Table 2: Gazetted conversion factors for the main processed states used for stargazer (from Manning 2007 and Fisheries (Conversion Factors) Notice 2011 (No. F607)) and the correction factor applied to the corresponding STA 5 landed green weight data.

State code	Start date	End date	Conversion factor	Correction
HGU	1 Oct 1986	30 Sept 1991	1.80	2.15/1.80
HGU	1 Oct 1991	current	1.50	2.15/1.50
DRE	1 Oct 1990	30 Sept 1996	2.00	2.15/2.00
DVC	1 Oct 1991	30 Sept 1996	2.00	2.15/2.00
DVC	1 Oct 1996	30 Sept 1999	2.05	2.15/2.05
DVC	1 Oct 1999	current	2.15	-

Cumulatively, the correction for the changes in the conversion factors resulted in an increase (9–34%) in the annual landed catches of stargazer from 1989/90 to 1996/97 (Figure 5).

The corrected landed catches from each target stargazer fishing trip were apportioned to the aggregated fishing records in proportion to the (aggregated, top five species) estimated catches of stargazer from the associated fishing records.

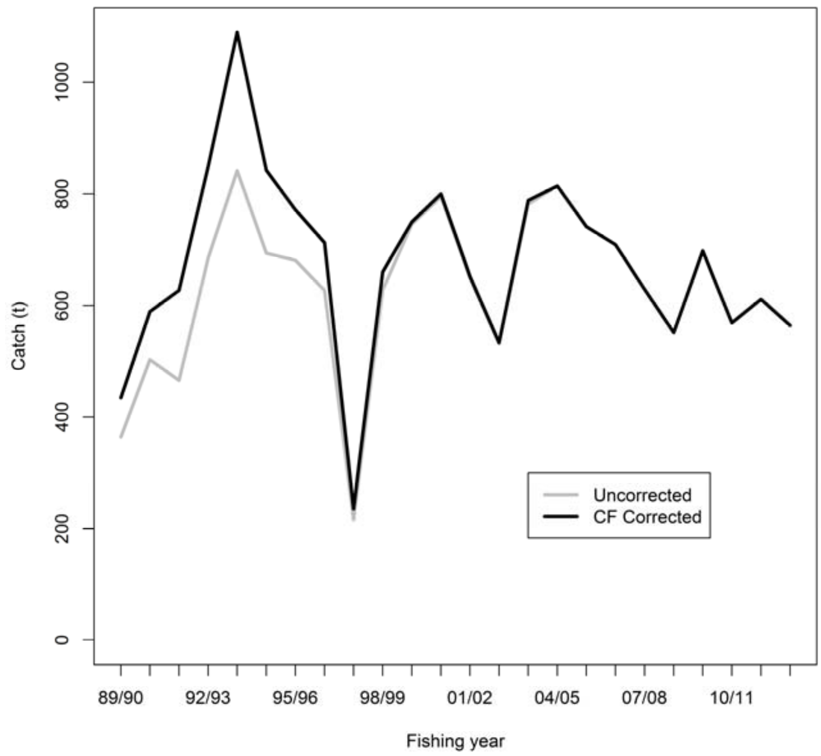

Figure 5: A comparison of the total annual stargazer catch for the core vessel target fleet with and without the correction for the change in the processed state conversion factors.

2.1.3 Individual trawl target CPUE data set

Since 2007/08, the STA5 target trawl fishery has exclusively reported catch and effort data using the TCER form. This form records the details of individual trawls including start and end time, target species, trawl speed, and the location and bottom depth at the start of a trawl. The catch of up to eight species is also recorded for each trawl.

The individual trawl records enable a more thorough analysis of the recent catch and effort data from the target trawl fishery. The initial data set retained all the available TCER fishing effort records from fishing trips that conducted at least one trawl targeting stargazer. The landed catch of STA 5 from these fishing trips was apportioned amongst the corresponding effort records in proportion to the estimated catch of stargazer from the individual trawls. All fishing trips included at least one estimated catch of stargazer.

3 RESULTS

3.1 Characterisation of the bottom trawl fishery

Stargazer in STA 5 is caught almost entirely by bottom trawl with the method accounting for at least 99% of the annual catch. The bottom trawl catch is predominantly taken by the target fishery which accounted for 75–95% of the annual catch from all years from 1989/90–2012/13, with the exception of 1997/98 (Figure 6 and Table 3). The lower proportion of the catch taken by the target fishery in 1997/98 (62%) occurred in the year when catches were well below the TACC. The low catch in that year has been attributed to the collapse in the market demand for stargazer during the 1997 Asian financial crisis.

Most of the remainder of the annual STA 5 trawl catch (5–15%) has been taken by the target flatfish trawl fishery (Figure 6 and Table 3). Stargazer is also caught in the range of other target trawl fisheries that operate in the middle depths around the Snares Shelf (primarily hoki, squid, ling and barracouta) and as a small bycatch of the inshore red gurnard and tarakihi trawl fisheries.

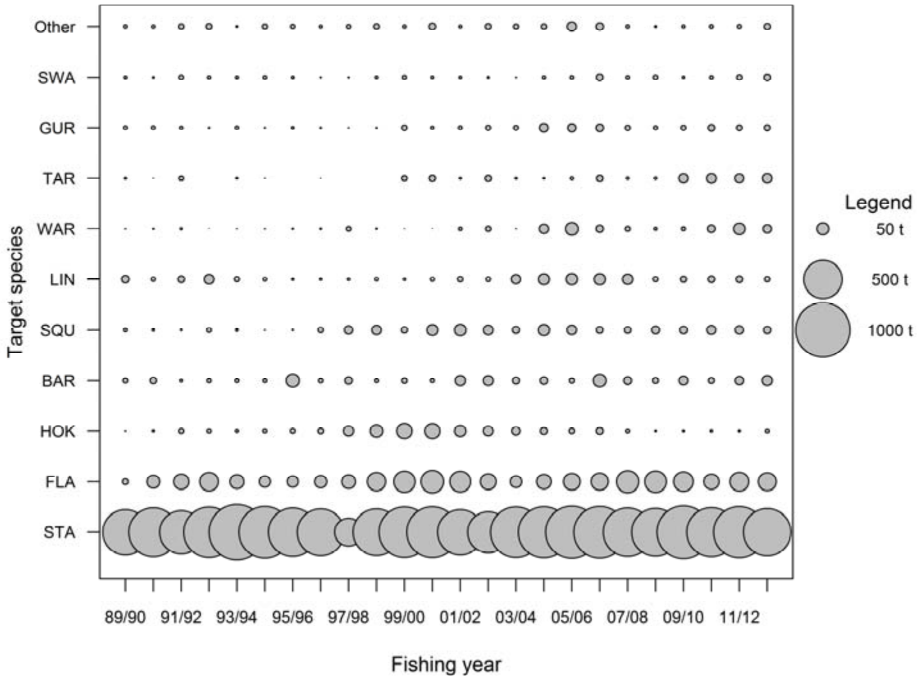

Figure 6: Landed catch of stargazer by target species and fishing year for the 10 target species that accounted for the largest proportion of the total stargazer catch. Maximum catch is 1045.3 t.

Table 3: Distribution of stargazer bottom trawl catch (t) by target species and fishing year for STA 5.

Fishing	Target species (t)										
year	STA	FLA	HOK	BAR	SQU	LIN	WAR	TAR	GUR	SWA	Other
89/90	698.7	12.6	0.4	9.1	4.4	19.8	0.4	2.4	5.3	3.3	4.6
90/91	812.9	56.4	2.1	15.3	2.1	6.2	0.9	0.2	5.4	1.2	4.3
91/92	633.5	79.6	9.6	3.2	1.1	15.6	2.1	8.7	4.1	8.0	10.6
92/93	867.0	118.3	6.4	6.4	7.6	33.3	0.0	0.0	1.0	4.0	12.5
93/94	1045.3	67.5	3.8	5.8	2.5	9.0	0.3	2.0	4.7	3.3	1.6
94/95	910.6	42.9	6.0	5.5	0.2	4.7	0.3	0.2	0.5	4.9	9.8
95/96	797.9	43.0	9.0	60.9	0.8	1.7	1.1	0.0	2.6	3.0	6.9
96/97	746.4	51.2	12.2	7.7	10.0	2.1	1.4	0.1	0.9	0.6	3.6
97/98	264.3	65.0	36.0	19.2	24.1	2.5	8.3	0.0	0.3	0.6	6.6
98/99	742.0	115.3	54.7	5.7	30.9	4.5	1.2	0.0	0.7	3.0	11.1
99/00	872.4	155.3	81.7	10.6	13.9	2.3	0.0	11.5	10.2	6.0	4.1
00/01	883.9	175.8	79.4	6.0	41.4	5.8	0.0	14.8	3.8	3.0	16.7
01/02	699.1	149.8	44.8	37.3	46.7	10.1	4.8	2.3	5.4	2.8	3.4
02/03	574.6	85.5	33.7	34.8	32.8	7.3	10.6	14.7	9.2	1.7	12.8
03/04	873.1	46.1	24.3	16.9	17.7	30.4	0.3	2.4	7.8	0.4	9.7
04/05	888.3	73.2	18.1	20.5	43.9	41.9	31.2	1.8	25.9	4.0	10.9
05/06	921.7	97.0	11.4	9.6	32.3	44.7	56.4	4.1	23.3	5.1	30.1
06/07	909.6	100.9	17.7	57.2	16.5	44.2	19.5	16.1	20.0	16.5	20.3
07/08	801.6	169.8	5.5	22.2	16.1	37.5	9.5	3.1	9.8	4.8	4.5
08/09	775.2	160.3	1.3	12.2	21.7	9.1	4.0	3.0	5.8	8.0	1.8
09/10	950.0	131.6	1.8	27.9	20.7	13.3	6.1	30.2	9.0	2.4	3.6
10/11	820.5	79.0	2.5	12.7	28.3	15.8	20.8	33.1	15.7	5.0	5.2
11/12	890.7	122.1	2.1	25.1	24.7	16.1	45.8	28.2	11.1	10.6	6.2
12/13	762.5	110.4	5.5	35.9	19.0	10.2	25.6	31.8	12.3	15.8	14.3

The data collected from TCER and TCEPR forms during 2007/08–2012/13 were used to characterise the depth distribution of the STA 5 catch. The catch was dominated by the target trawl fishery with most of the catch taken in the 110–160 m depth range (Figure 7). Most of the remainder of the catch was taken by the flatfish target trawl fishery operating in the 20–60 m depth range.

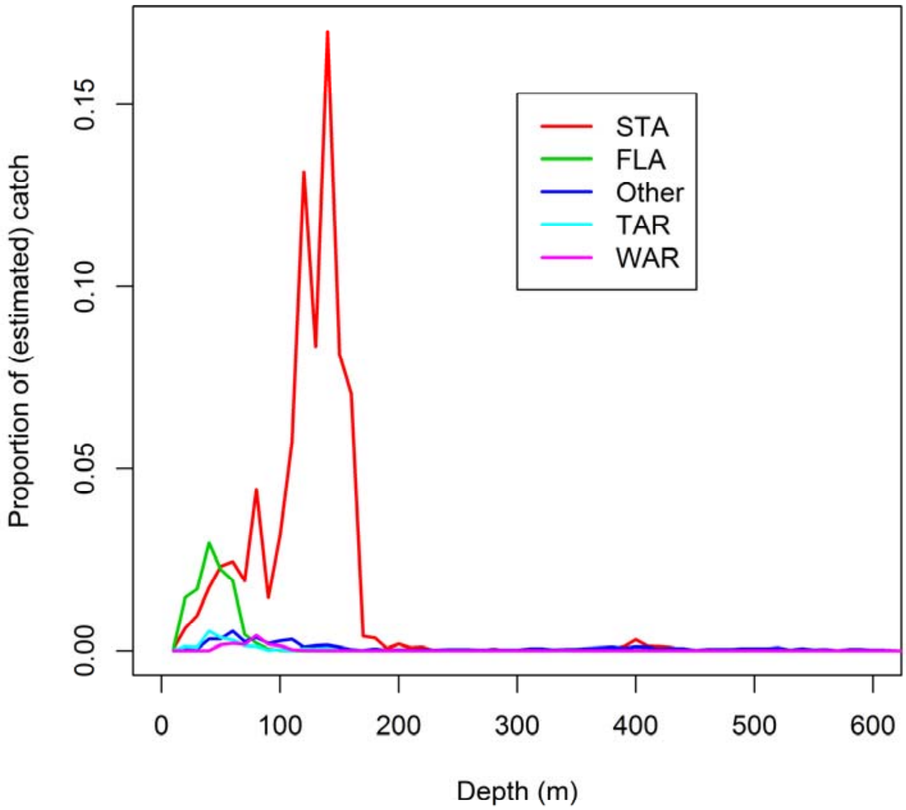

Figure 7: Proportional depth distribution of stargazer estimated catch by bottom depth (10 metre depth intervals) and target species from 2007/08 to 2012/13 for the main bottom trawl target species (TCEPR or TCER records, all years combined).

The bottom trawl catches of STA 5 are predominantly taken in Statistical Areas 030 and, to a lesser extent, 029 in the western approaches to Foveaux Strait (Figure 8 and Figure 9). A smaller catch is also taken in the eastern approach to Foveaux Strait (025) around Ruapuke Island. Minor catches are taken along the edge of the Stewart–Snares Shelf and off Puysegur Point by the middle depths trawl fisheries (Figure 9).

There is no strong seasonal distribution of target stargazer catches, although catches tend to be lower during April–June (Figure 10). This period coincides with the peak in the Foveaux Strait oyster fishing season (March–August) and most of the main vessels operating in the oyster fishery also participate in the stargazer trawl fishery, outside of the oyster season.

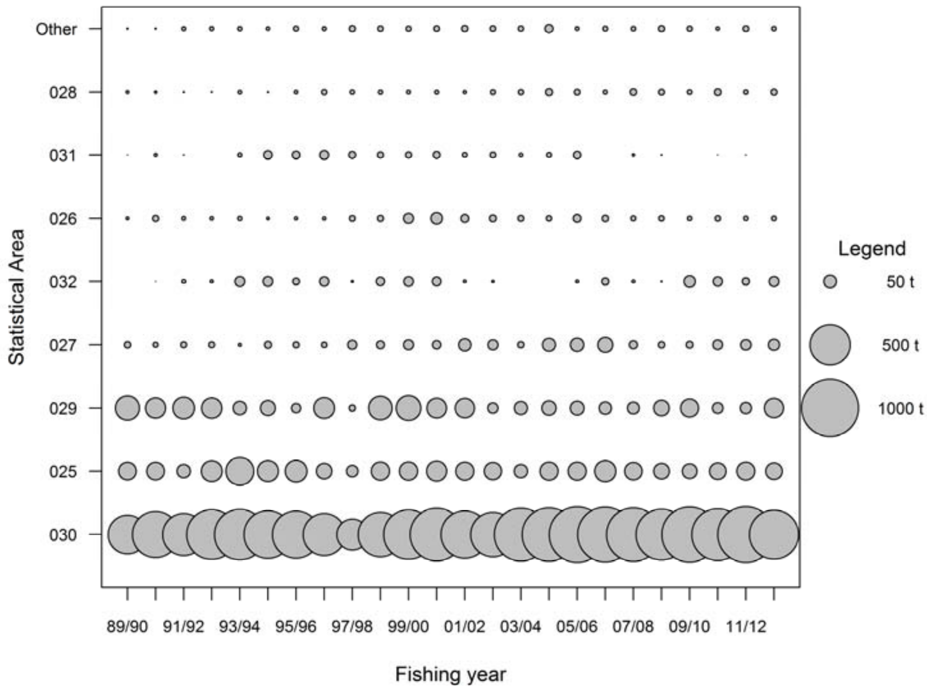

Figure 8: Annual distribution of bottom trawl stargazer catch by statistical area. The area of the circle is proportional to the catch. The maximum catch is 967.7 t.

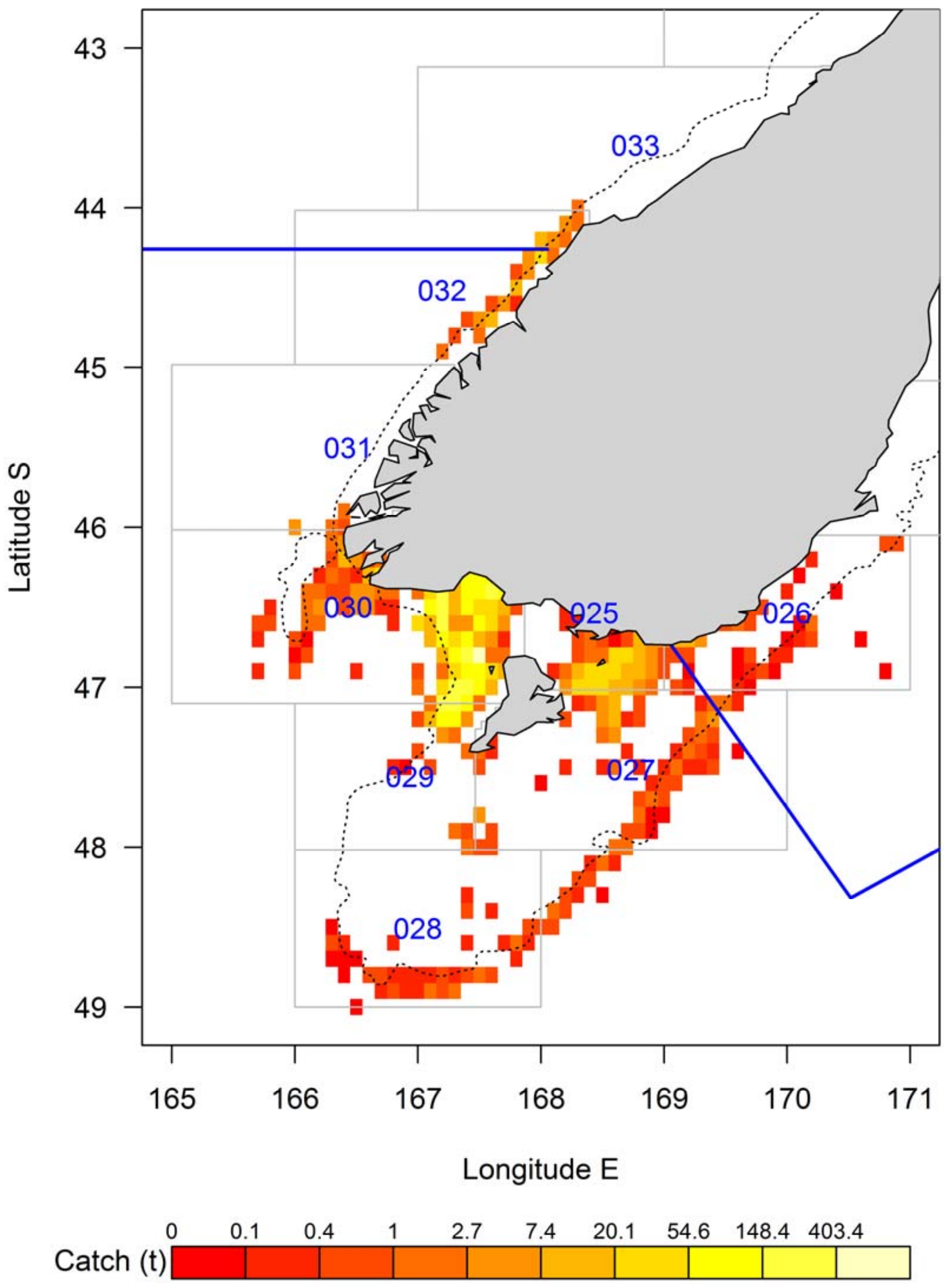

Figure 9: Spatial distribution of stargazer estimated catches from fishing trips catching STA 5 aggregated for 2007/08–2012/13 fishing years (derived from TCER and TCEPR records). The catch data are aggregated by 0.1 lat/long spatial cells. The blue lines represent the boundaries of the STA 5 fishstock area. The dashed line represents the 200 m depth contour.

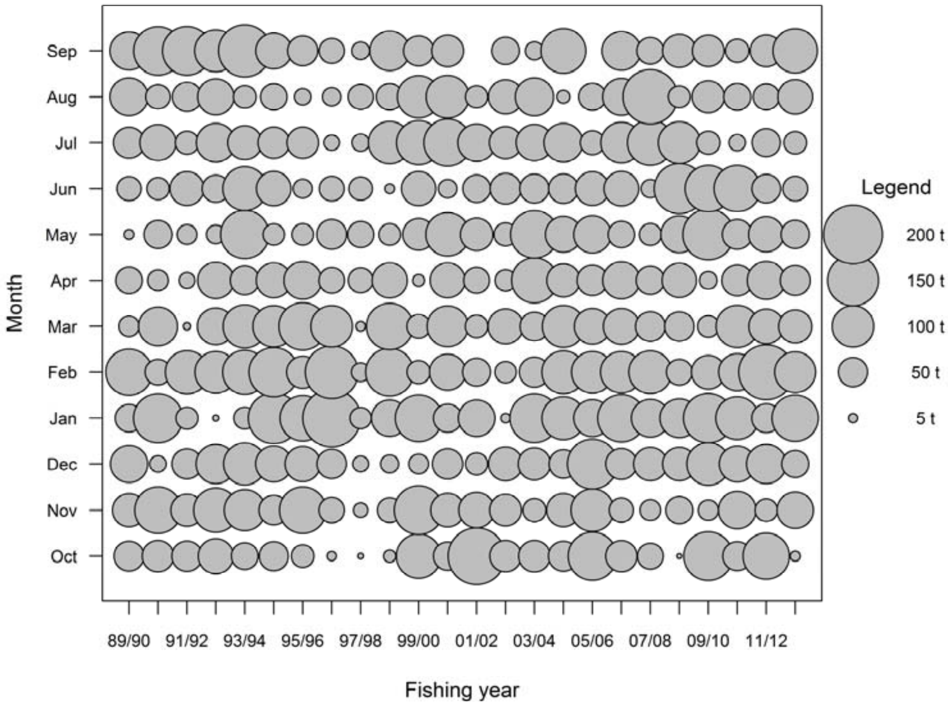

Figure 10: The monthly distribution of target bottom trawl stargazer catches in STA 5 by fishing year. Circle areas are proportional to the catch (maximum catch 192.5 t).

The spatial domain of the target stargazer trawl fishery reflects the distribution of the catch from the entire fishery with most of the catch taken in the western approach to Foveaux Strait. The spatial distribution of the stargazer catch remained relatively constant from 2007/08 to 2012/13 (Figure 11).

The target trawl fleet has been comprised of about 10–15 vessels operating in the fishery during 1989/90 to 2012/13 and six of those vessels have operated in each of the 24 years (Figure 12). One of those vessels has accounted for a substantial proportion of the annual target stargazer catch (22–47%) over the last seven years.

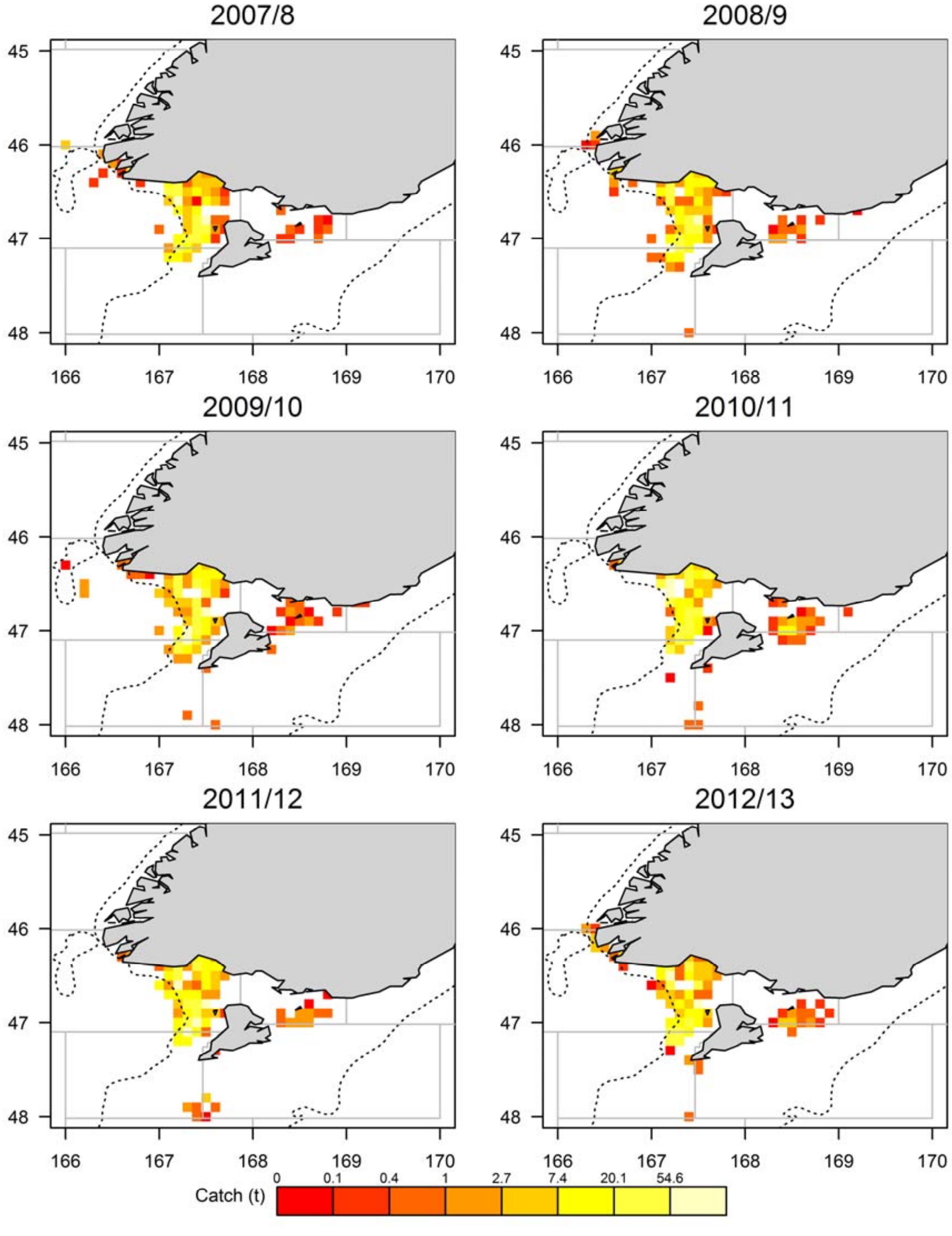

Figure 11: Spatial distribution of stargazer estimated catches from STA 5 target bottom trawls by fishing year from 2007/08 to 2012/13 (derived from TCER records). The catch data are aggregated by 0.1 lat/long spatial cells. The dashed line represents the 200 m depth contour.

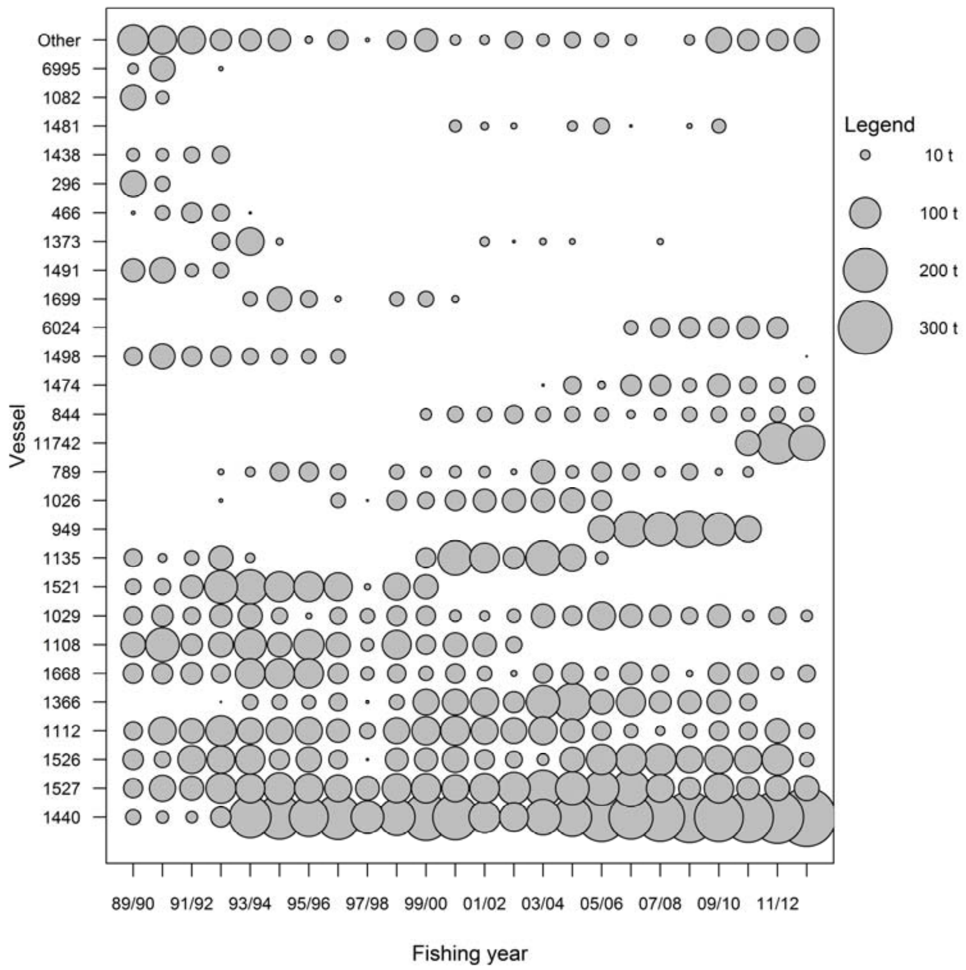

Figure 12: The fleet distribution of target bottom trawl stargazer catches in STA 5 by fishing year for individual vessels accounting for at least 5% of the total catch. Circle areas are proportional to the catch (maximum 359.5 t).

Most (80%) fishing trips that target stargazer, exclusively target the species (Figure 13). Some fishing trips have also included trawls that targeted other inshore finfish species, primarily flatfish. Since the mid-2000s there was also a small increase in the targeting of ling, red gurnard and elephantfish during fishing trips that targeted stargazer (Figure 13).

The total landed catch from fishing trips that targeted stargazer is dominated by the target species (Figure 14), although the proportion of stargazer in the total catch has tended to decline since the early 2000s. The remainder of the landed catch is comprised of a range of finfish species, primarily ling, red gurnard, tarakihi, spiny dogfish, elephantfish, red cod, flatfish species, school shark and skate species (rough skate and smooth skate) (Figure 14). No single species has consistently accounted for a substantial proportion of the total landed catch from the target fishing trips, although the proportion of red gurnard and elephantfish has increased since the early 2000s. There has also been an increase in the proportion of rough skate and spiny dogfish in the catch over the last decade (Figure 14). This probably relates to improved reporting of the catch of these species since the introduction of these species into the QMS.

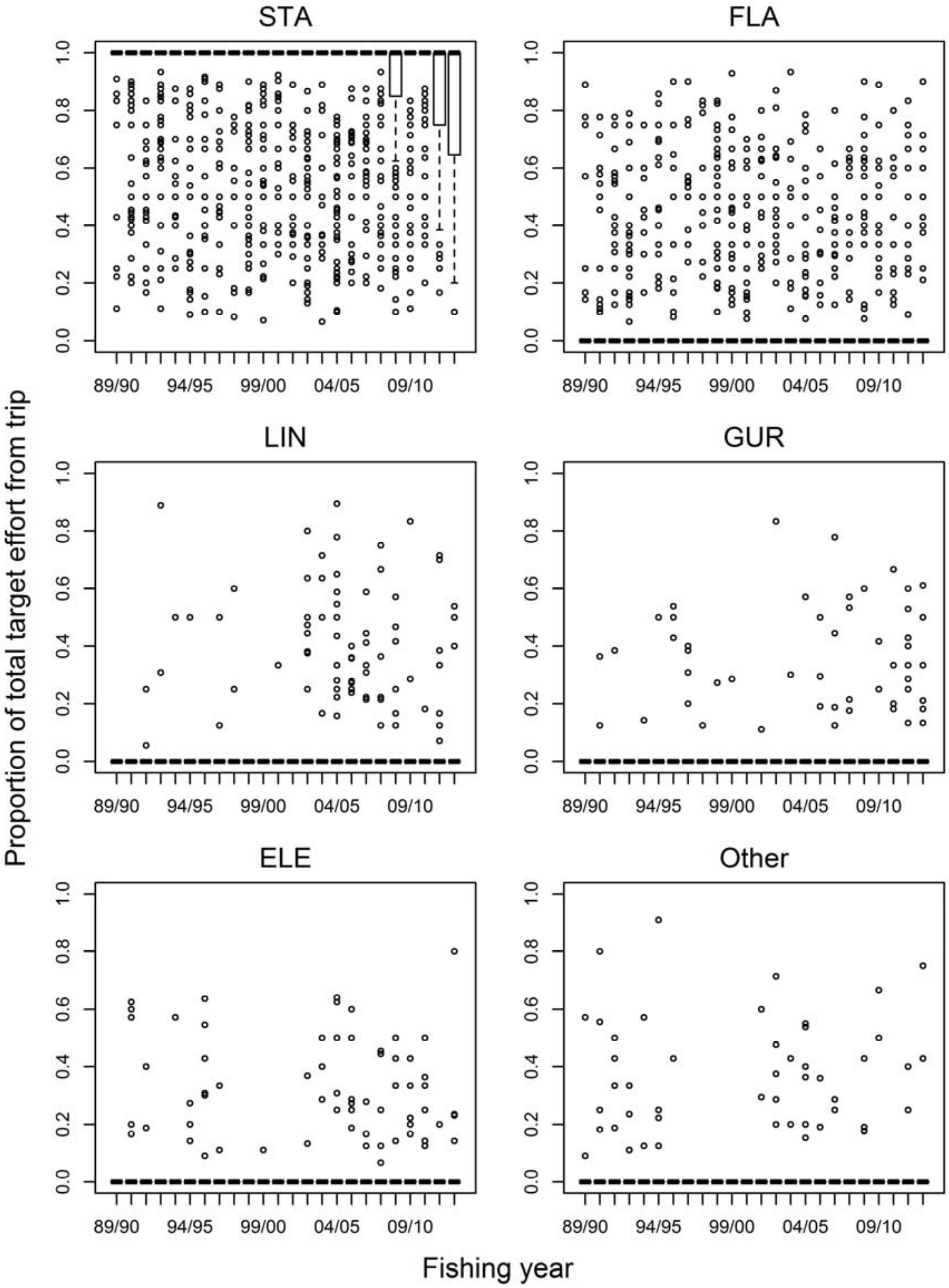

Figure 13: Boxplots of the proportion of trawls by selected target species (panel) from individual fishing trips that conducted target STA 5 bottom trawls, by fishing year (fishery characterisation data set).

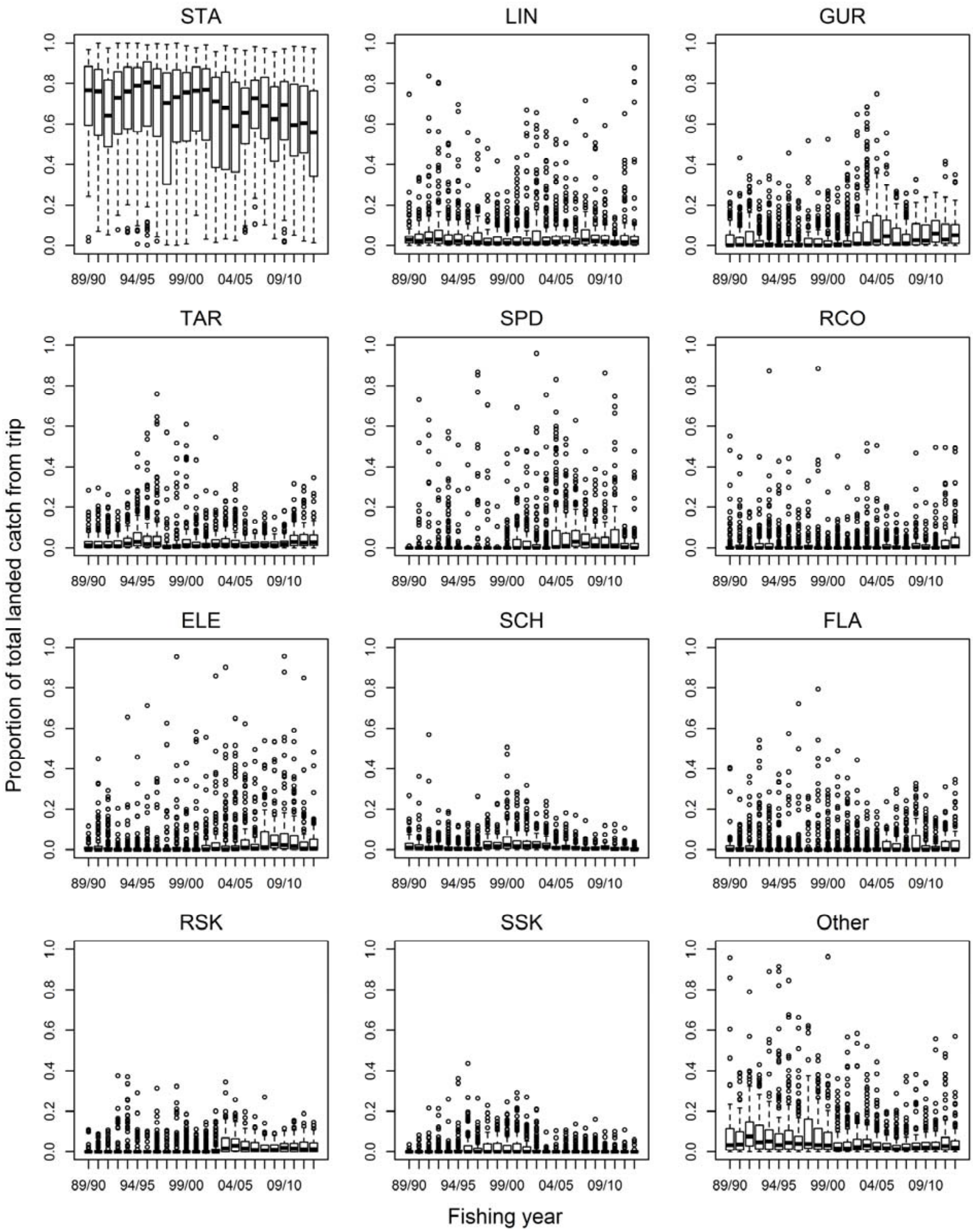

Figure 14: Boxplots of the proportion of the landed catch of individual species from individual fishing trips that conducted target STA 5 bottom trawls, by fishing year. 'Other' represents the aggregate catches of the species not included in the top eleven individual species reported.

3.2 CPUE Analyses

3.3 Daily aggregated CPUE data set

The CPUE analysis was based on the target bottom trawl fishery which accounted for 70–80% of the STA5 landed catch since 1999/2000 (Figure 15). This fishery was also the basis for the previous CPUE analyses (Vignaux 1997, Manning 2007, Kendrick 2009). The configuration of the data set is described in Section 2.1.2. The initial CPUE data set was restricted to stargazer (STA) target trawl records from the main fishing areas of the target fishery, specifically Statistical Areas 030, 029 and 025.

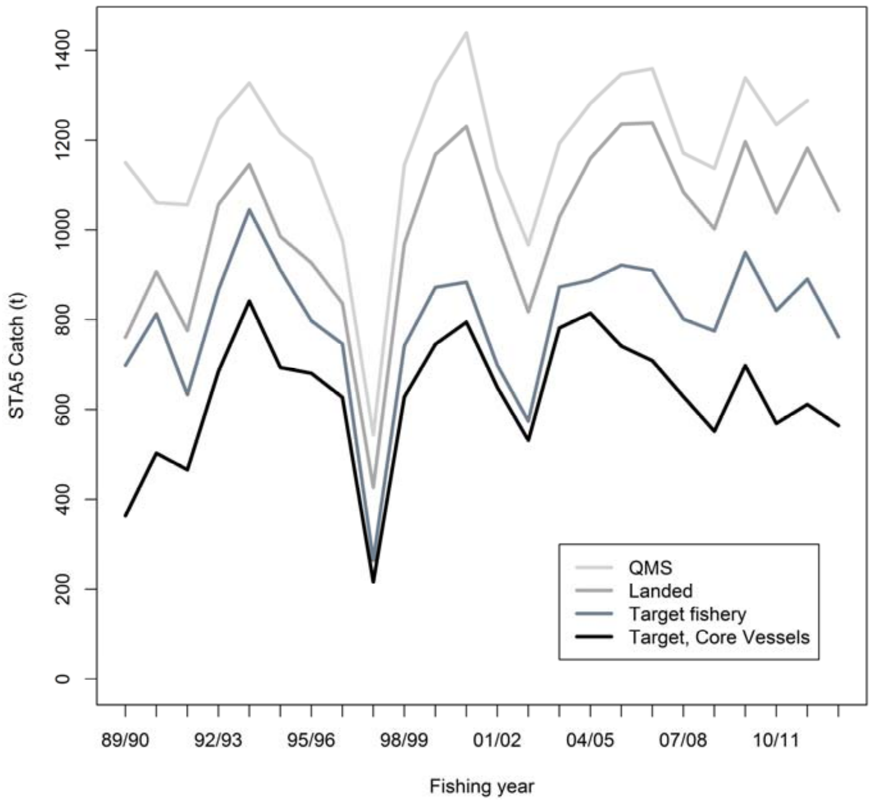

Figure 15: A comparison of the annual STA 5 catch included in various subsets of the final catch and effort data set: the catch included in the final characterisation data set (Landed), the subset of the catch taken by the target stargazer trawl fishery and the target catch taken by the defined core fleet. The total reported QMS catch is also presented.

A core fishing fleet was identified that accounted for at least 80% of the total stargazer catch from the target fishery (from 1989/90 to 2012/13). The continuity criteria were defined as those vessels completing a minimum of 5 trips in a minimum of 8 years (Figure 16). The criteria resulted in the selection of 14 unique vessels which accounted for 3546 of the 4642 individual fishing trips that targeted stargazer. Six of the vessels had operated in the fishery for at least 20 years (Figure 17). The core fleet accounted for 70–90% of the total annual stargazer target catch (Figure 15).

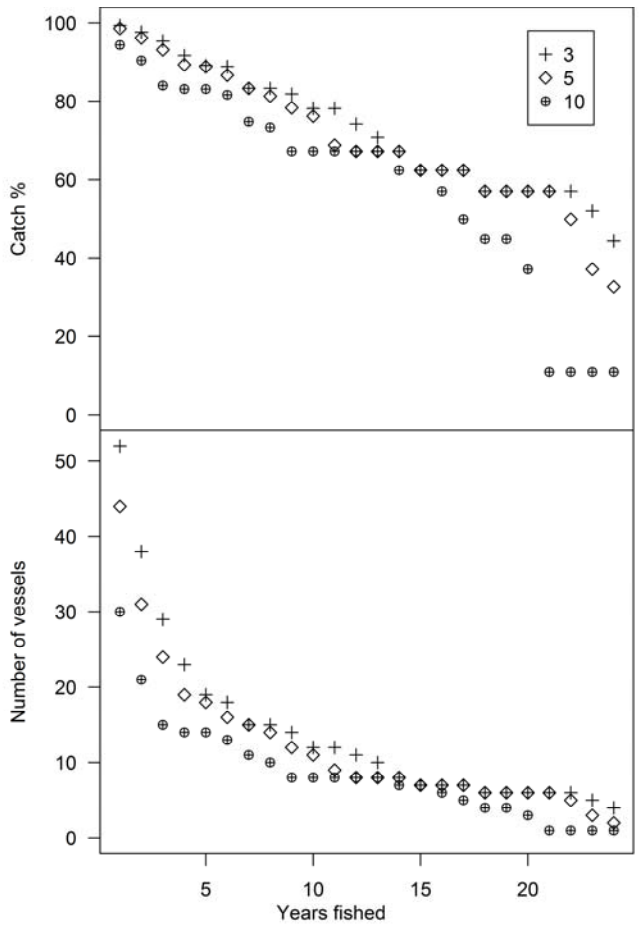

Figure 16: The percentage of the target stargazer catch (top panel) and the number of fishing vessels included in the data set including individual vessels participating in the fishery for a minimum number of years (years fished) where yearly participation is defined as a minimum of three, five or 10 fishing trips.

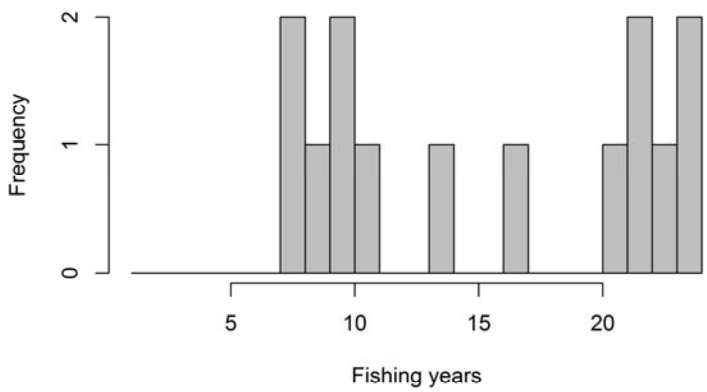

Figure 17: Histogram of the number of years each of the core vessels participated in the target fishery during 1989/90–2012/13.

The fishing effort included within the CPUE data set is aggregated by vessel fishing day; i.e., the number of trawls and cumulative duration of trawling. Broad data range limits were applied to the effort variables and a small number (fewer than 1%) of the records with variables outside the data range were excluded from the final data set (Table 4).

The dimensions of the trawl net (width and headline height) were also available from each fishing record (either CELR or TCER format). For most vessels, the *GearWidth* variable was relatively constant for the data period. However, for the main vessel in the fishery, the gear width effectively doubled (from 22 to 42 m) during the mid-2000s, corresponding to the vessel converting from a single bottom trawl to a twin-rig bottom trawl. The change in gear configuration resulted in a substantial increase in the catch rates of stargazer for the vessel. Thus, in the final CPUE data set the records for this vessel were assigned to two separate vessel categories based on the trawl gear configuration. This resulted in a total of 15 vessel categories from the 14 unique core vessels in the data set.

Table 4: The variables included in the CPUE data set aggregated in a format consistent with the CELR records.

Variable	Definition	Data type	Range
Vessel	Fishing vessel category	Categoric (15)	
FishingYear	Fishing year	Categoric (24)	
Month	Month	Categoric (12)	1–12
StatArea	Main statistical area fished in fishing day	Categoric (3)	025, 029, 030
NumTrawl	Number of trawls conducted	Continuous	1–7
Duration	Total duration of trawling (hrs)	Continuous	1–24
STAcatch	STA catch (kg) (corrected for changes in conversion factors)	Continuous	< 15 000 kg
GearWidth	Width of trawl net (m)	Continuous	5–50
GearHeight	Headline height of trawl (m)	Continuous	0.5–10

For the target fishery the number of trawls conducted during a fishing day remained relatively constant throughout the study period, while there was a general increase in the total daily trawl duration over the time period (Figure 18). Over the study period, there was a decline in the headline height of the trawl gear for the entire fleet.

Most of the target fishing effort occurred within Statistical Area 030, and through the study period target fishing effort became increasingly concentrated in this area, with a corresponding decline in the proportion of fishing effort in Statistical Areas 025 and 029 (Figure 19). Since 2007/08, Statistical Area 030 has accounted for 90–95% of the data records.

The CPUE data set included a small proportion (fewer than 1%) of records with no stargazer catch and there was no overall trend in the proportion of zero catch records (Table 5). These records were therefore excluded from the final data set for the CPUE modelling.

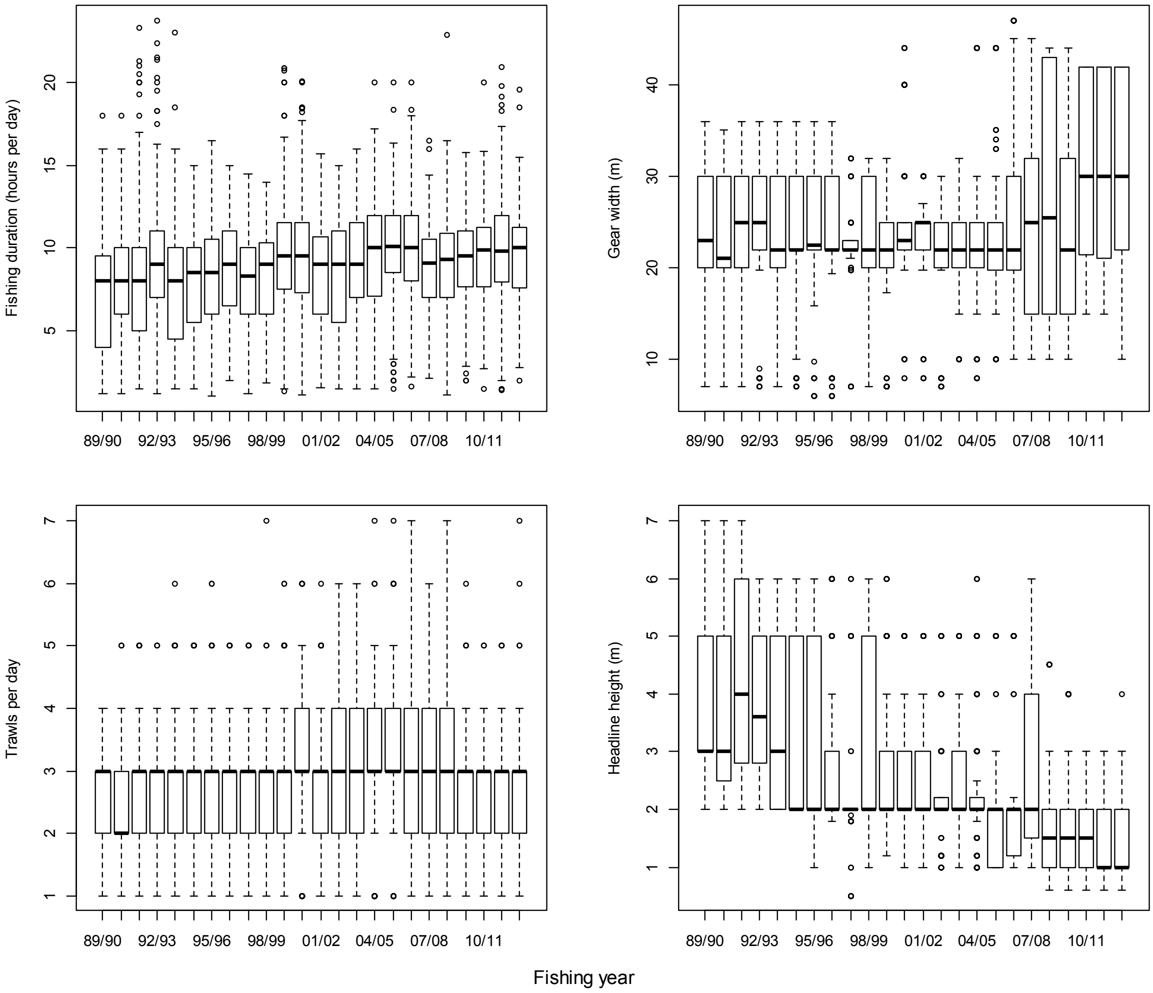

Figure 18: Boxplots of the main fishing effort and gear variables included in the final core vessel CPUE data set.

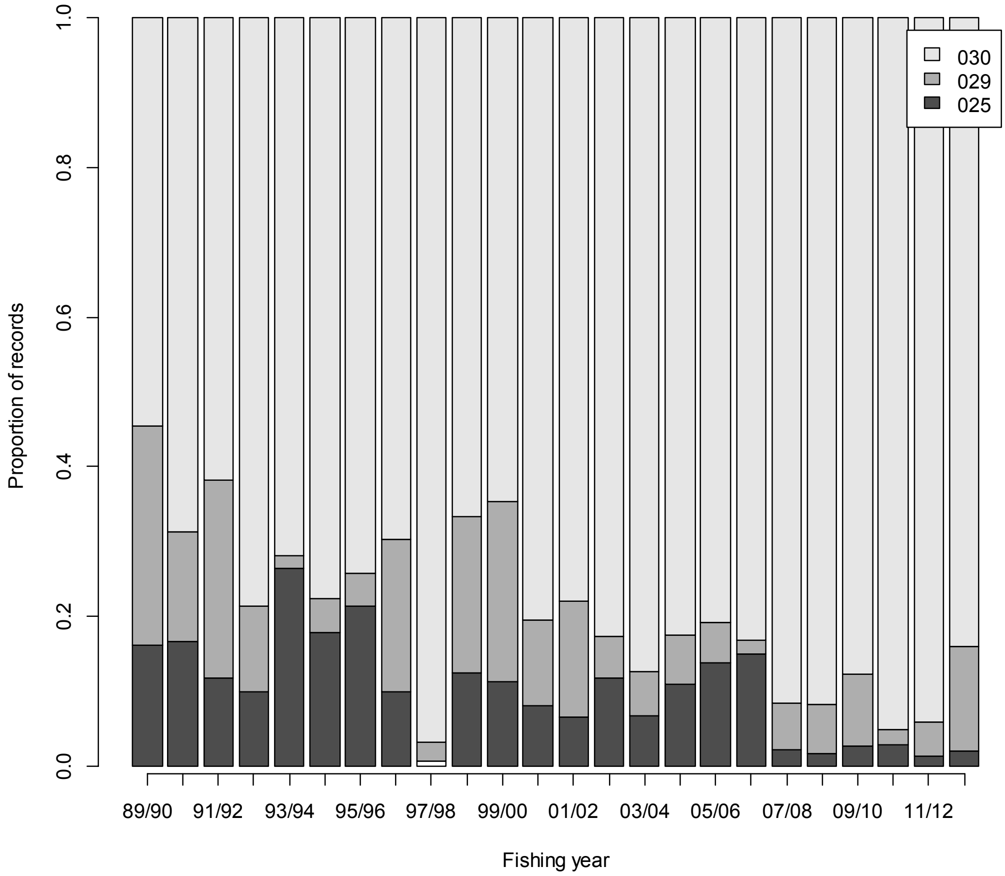

Figure 19: Proportional distribution of CPUE data records by statistical area and fishing year.

Table 5: Summary of catch and effort (effort strata) included in the final data set (including zero species catch records). The annual catches are presented for the reported catches and catches corrected for changes in conversion factor (CF correct). The percentage of fishing days with no associated stargazer catch area also presented.

Fishing year	No. of records	No. of vessel	No of trips	Catch (t)	Catch (t) CF correct	No. of trawls	Fishing duration (hrs)	Percent zero catch
1989/90	295	10	118	364	435	726	2 157	1.4
1990/91	378	10	142	503	589	937	2 994	1.1
1991/92	362	10	148	466	627	944	2 909	0.3
1992/93	422	11	153	685	849	1 117	3 714	0.2
1993/94	559	10	218	842	1 090	1 553	4 335	0.5
1994/95	497	10	180	694	843	1 400	3 950	0.0
1995/96	503	10	189	681	771	1 415	4 089	0.4
1996/97	415	11	151	627	712	1 166	3 548	1.2
1997/98	163	10	63	216	236	458	1 288	2.5
1998/99	382	10	147	628	660	1 048	3 153	1.0
1999/00	462	11	170	746	749	1 297	4 298	0.2
2000/01	470	11	172	795	800	1 477	4 302	0.0
2001/02	402	11	165	650	653	1 133	3 354	0.5
2002/03	335	11	148	532	534	991	2 725	0.6
2003/04	473	10	195	782	788	1 453	4 308	0.4
2004/05	487	11	213	815	815	1 556	4 625	0.2
2005/06	380	11	145	741	741	1 271	3 829	0.5
2006/07	335	9	124	709	709	1 005	3 310	0.3
2007/08	279	9	116	629	629	802	2 453	0.0
2008/09	246	9	102	552	552	706	2 209	0.0
2009/10	328	9	125	698	698	915	3 016	0.3
2010/11	276	9	123	569	569	765	2 605	0.4
2011/12	319	8	128	611	611	846	3 092	0.0
2012/13	278	9	112	565	565	739	2 628	0.0

3.4 CPUE model, daily aggregated data set

A preliminary CPUE model was configured to determine the most appropriate statistical distribution for the data set. The five alternative distributions were assessed based on the Akaike Information Criterion (AIC) and the degree of conformance of the model residuals to a normal distribution. The Weibull distribution was selected as the most suitable distribution based on these criteria, although the deviation in the distribution of the standardised residuals for the Weibull distribution was somewhat lower than expected from a normal distribution indicating a degree of nonconformity with the underlying statistical assumptions (Figure 20). Nonetheless, the diagnostics indicated that the performance of the Weibull distribution was superior to the other statistical distributions considered and the Weibull distribution was adopted for the final CPUE model (Figure 20).

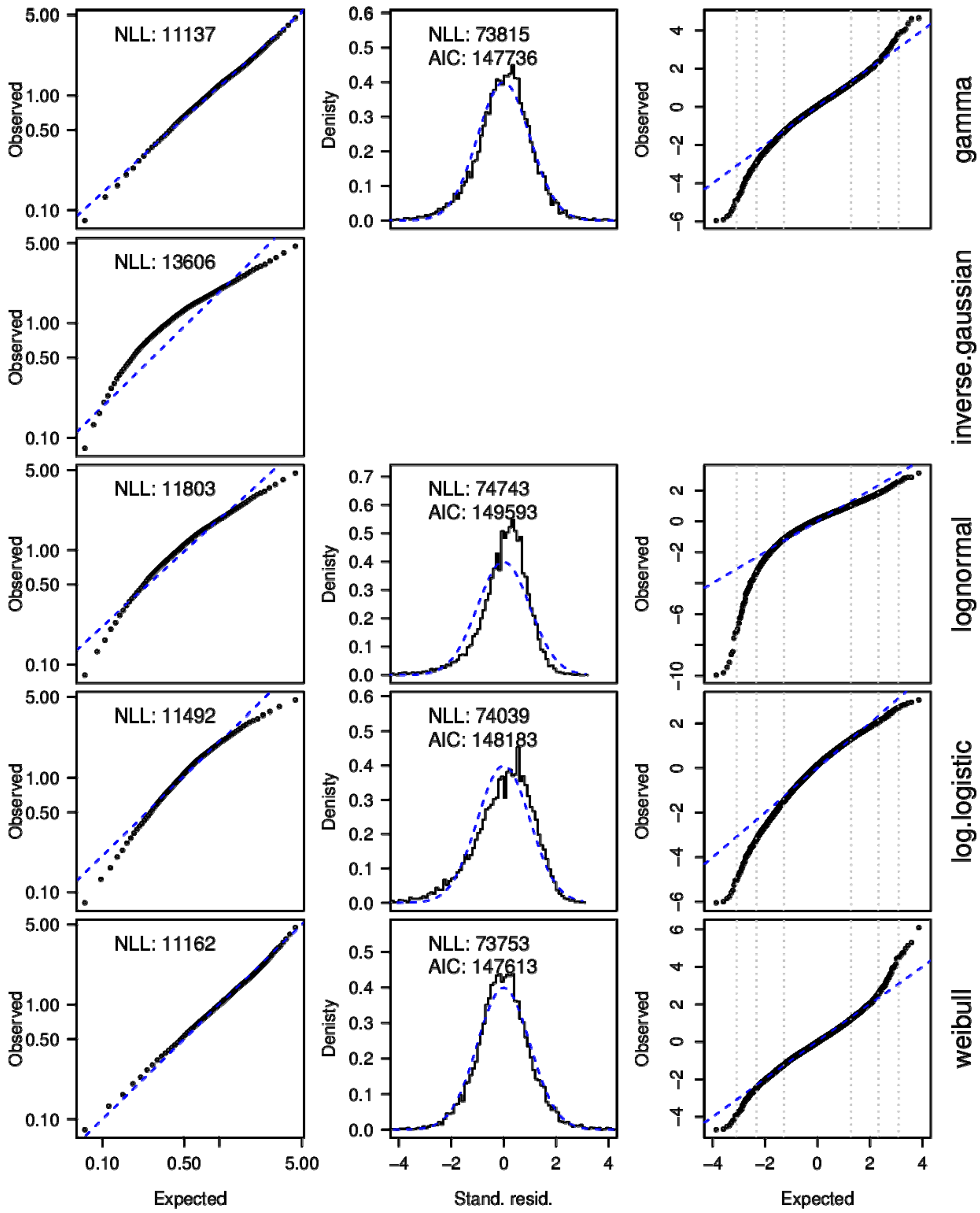

Figure 20: Diagnostics for alternative assumptions regarding the statistical distribution of the response variable. Left: quantile-quantile plot of observed response values(centred (by mean) and scaled (by standard deviation) in log space) versus a maximum likelihood fit of the distribution to those values; Middle: standardised residuals from a generalised linear model fitted using the formula catch ~ fyear + month + area + vessel + poly(log(num), 3) and the distribution (missing panel indicates that the model failed to converge); Right: quantile-quantile plot of model standardised residuals against standard normal (vertical lines represent 0.1%, 1% and 10% percentiles). A missing panel indicates that the fit failed to converge. NLL = negative log-likelihood; AIC = Akaike Information Criterion.

A step-wise fitting procedure was implemented to construct the final CPUE model. The dependent variable was the natural logarithm of the (non zero) catch of stargazer (in kilogrammes) and the variable was assumed to have a Weibull distribution with an estimated scale parameter. The potential explanatory variables included the categoric variables *Vessel*, *FishingYear*, *Month*, and *StatArea,* and the continuous variables, *GearWidth*, *GearHeight,* the natural logarithm of *NumTrawl* and the natural logarithm of *Duration*. The continuous variables were parameterised using a third order polynomial function. The categoric variable *FishingYear* was included in the base model and subsequent variables were included in the model based on the improvement in the AIC. Additional variables were included in the model until the improvement in the Nagelkerke pseudo-R^2 was less than 1%.

The final CPUE model included the predictor variables *FishingYear*, *Vessel*, log *Duration*, log *NumTrawl* and *Month* (Table 6). Overall, the model explained 35.7% of the variation in the stargazer catch (Nagelkerke pseudo-R^2). The scale parameter of the Weibull distribution was estimated as 0.547.

Table 6: Summary of stepwise selection. Model terms are listed in the order of acceptance to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Term	DF	Log likelihood	AIC	Nagelkerke pseudo-R^2 (% Improvement)
FishingYear	23	-73 168	146 386	3.1 *
Vessel	14	-72 592	145 263	12.0 *
poly(log(*Duration*), 3)	3	-71 783	143 650	14.4 *
poly(log(*NumTrawl*), 3)	3	-71 442	142 975	5.3 *
Month	11	-71 375	142 863	1.0 *
StatArea	2	-71 361	142 837	0.2
poly(*GearHeight*, 3)	3	-71 356	142 834	0.0
poly(*GearWidth*, 3)	3	-71 334	142 797	0.0

The distribution of the CPUE model residuals approximates the assumption of normality, although the deviations are somewhat more constrained than expected from a normal distribution (Figure 21). The residual diagnostics from the initial models indicated that the data were more consistent with a Weibull distribution than a lognormal distribution. Nonetheless, a comparison of the annual indices derived from the final model formulation using the two alternative error structures indicated that the CPUE indices were relatively insensitive to the distributional assumptions.

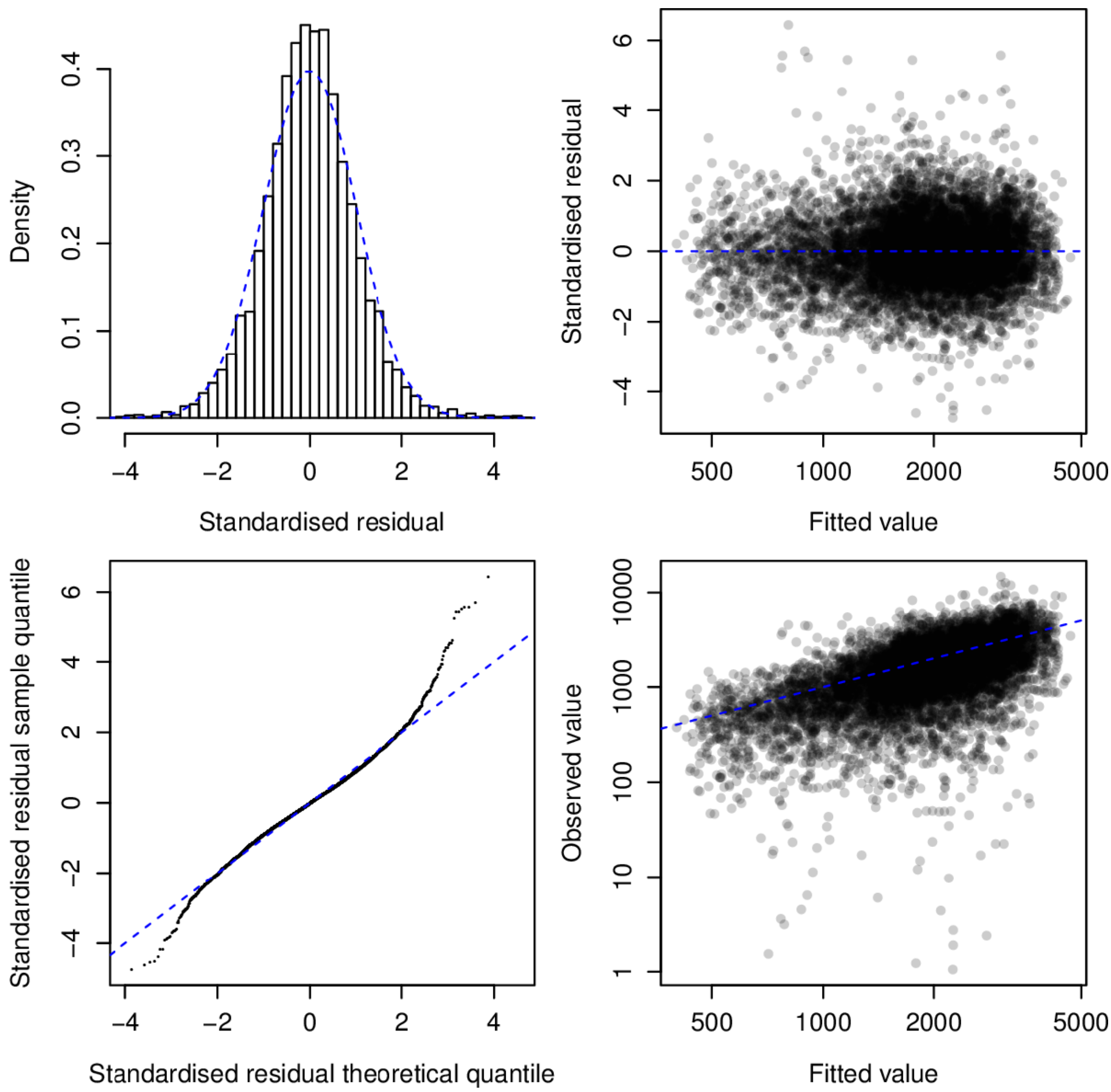

Figure 21: Residual diagnostics for the final model derived from daily aggregated data set. Top left: histogram of standardised residuals compared to standard normal distribution. Bottom left: quantile-quantile plot of standardised residuals. Top right: fitted values versus standardised residuals. Bottom right: observed values versus fitted values.

The annual indices derived from the CPUE model fluctuated over the study period with higher CPUE indices from 1991/92–1993/94 and 2006/07–2009/10 (Figure 22). During the intervening years, the CPUE indices remained relatively stable at a lower level. The CPUE indices from 2010/11–2012/13 were at a level that was comparable to the 1994/95–2005/06 period (Figure 22).

The standardised CPUE indices exhibited a comparable trend to the unstandardised CPUE; although the unstandardised indices were higher during 2005/06–2012/13 (Figure 22). Most of the difference between the standardised and unstandardized CPUE indices is attributed to the influence of the fleet configuration and, to a lesser extent, trawl duration (Figure 23).

Influence plots (Bentley et al. 2011) for the individual model variables are presented in Appendix 1. The influence attributable to the *Vessel* variable is mainly attributable to the increase in catch rate of stargazer related to the introduction of the twin rig trawl gear by one vessel in about 2004/05 (Figure A1). This vessel/gear combination represented an estimated 55% increase in catchability compared to the same vessel fishing with a single rig trawl. The higher unstandardized CPUE was also partly attributable to a general increase in the total daily duration of trawling over the entire study period (Figure A2).

The annual CPUE indices are dominated by the data from Statistical Area 030, the area accounting for approximately 80% of all records included in the final CPUE data set. Statistical area was not included in the final CPUE model; however, a comparison of the residuals by fishing year and statistical area may be informative regarding spatial trends in CPUE among areas (Figure 24). The CPUE trend in Statistical Area 029 is generally comparable to the main fishing area (030), although the variability in CPUE is higher for Statistical Area 029 probably due to the lower number of observations in this area.

In the final model the CPUE index from 2012/13 increased slightly from the 2011/12 level. This trend was not evident in the main fishing area (030) where CPUE declined steadily from a peak in 2009/10 (Figure 24). Instead, the increase in the CPUE index in 2012/13 appears to be related to an increase in the CPUE from Statistical Area 029 (Figure 24). There was an increase in fishing effort in this area in 2012/13 (Figure 19).

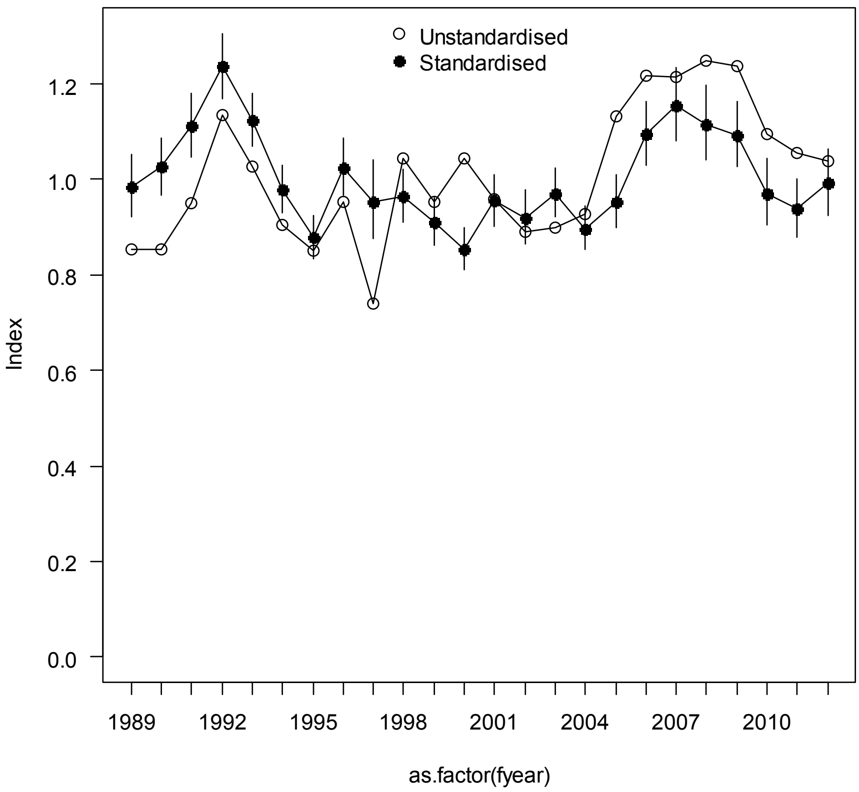

Figure 22: A comparison of the standardised CPUE indices and the geometric mean of the annual catch per trawl (unstandardised). The confidence intervals represent the standard error associated with the index. The fishing year is denoted by the calendar year at the beginning of the fishing year (e.g. 1989 denotes the 1989/90 fishing year).

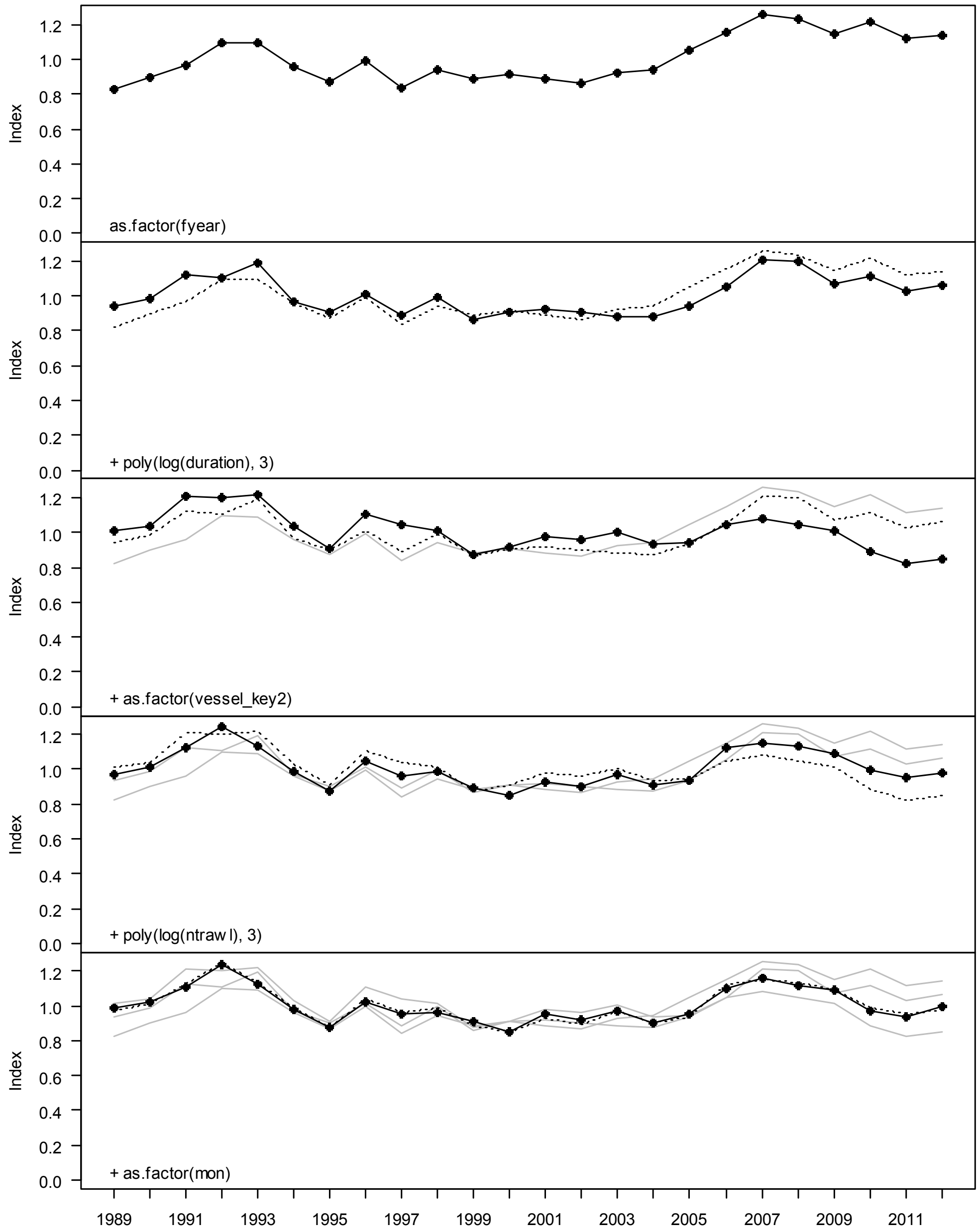

Figure 23: The change in the annual coefficients with the step-wise inclusion of each of the significant variables in the final CPUE model (from top to bottom panel). The solid line and points represent the annual coefficients at each stage. The fishing year is denoted by the calendar year at the beginning of the fishing year (e.g. 1989 denotes the 1989/90 fishing year).

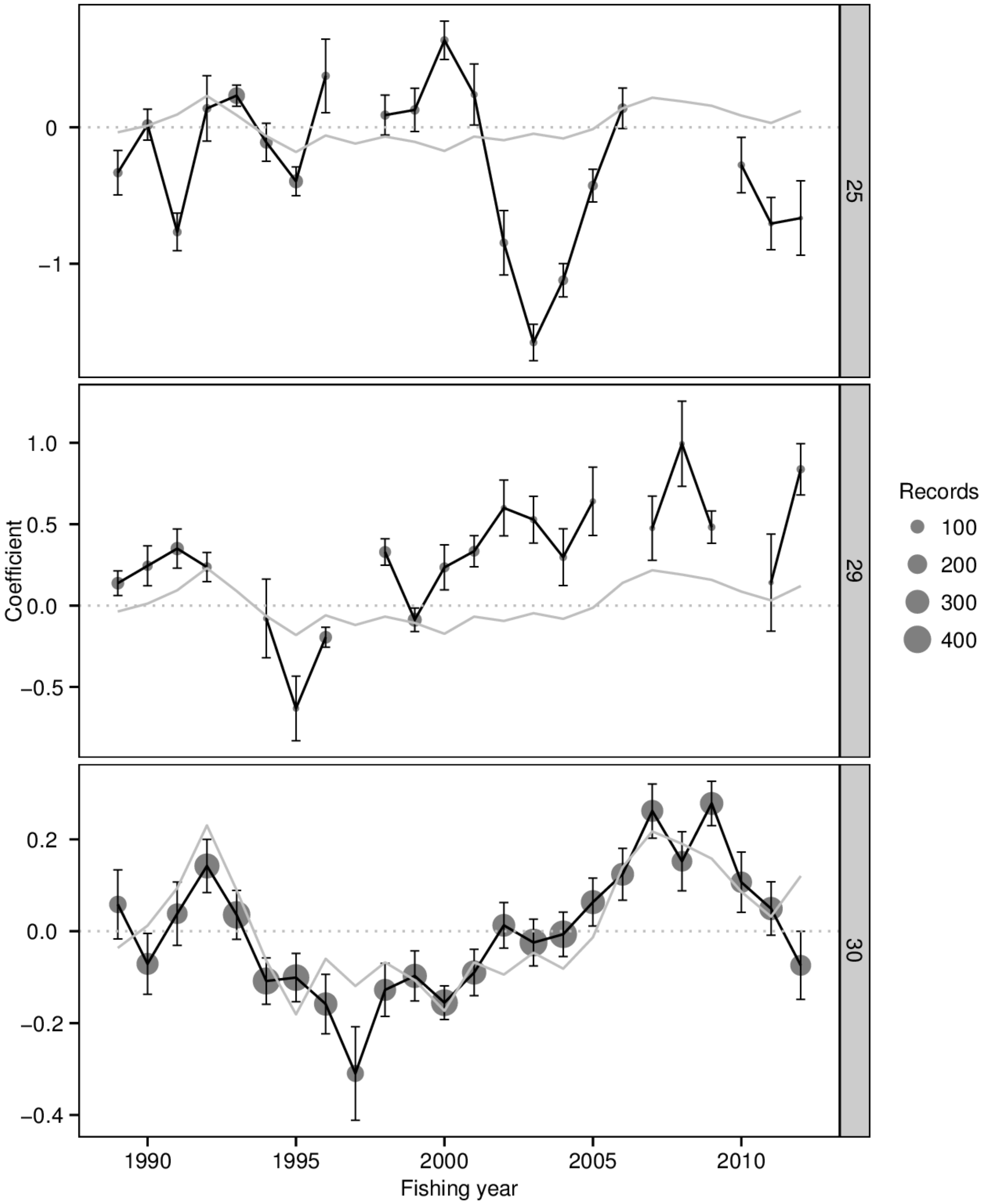

Figure 24: Residual implied coefficients (in log space) for area × fishing year interactions. Implied coefficients (black points) are calculated as the normalised fishing year coefficient (grey line) plus the mean of the standardised residuals in each fishing year and area. These values approximate the coefficients obtained when an area × year interaction term is fitted, particularly for those area × year combinations which have a substantial proportion of the records. The error bars indicate one standard error of the standardised residuals. Combinations with less than 10 records are not shown. Fishing year is denoted by the calendar year at the beginning of the fishing year (e.g. 1989 denotes the 1989/90 fishing year).

3.5 CPUE model, TCER trawl data set

A supplementary CPUE analysis was conducted using the TCER catch and effort records from the core vessels included in the daily aggregated CPUE data set. Fishing effort records were limited to target bottom trawls conducted within Statistical Areas 030, 029 and 025. Landed catches were apportioned to individual fishing records based on the associated estimated catches (stargazer in the top eight species reported per trawl). The TCER data set included 4579 fishing records from 2007/08–2012/13. There were a small proportion of qualifying effort records with no associated catch of stargazer (Table 7).

Table 7: Summary of catch and effort (effort strata) included in the TCER data set (including zero species catch records). The percentage of trawls with no associated catch of stargazer is also presented.

Fishing year	No. of records	No. of vessels	No of trips	Catch (t)	No. of trawls	Fishing duration (hrs)	Percent zero catch
2007/08	779	9	116	608	779	2 397	0.1
2008/09	683	9	102	545	683	2 145	0.4
2009/10	890	9	125	692	890	2 944	0.3
2010/11	745	9	123	568	745	2 539	0.9
2011/12	797	8	128	587	797	2 907	0.6
2012/13	717	8	111	554	717	2 520	1.8

The spatial distribution of the trawl start locations was used to define five relatively discrete fishing areas within Statistical Areas 025, 029 and 030 (Figure 25). Individual trawls were assigned to the respective fishing area based on the trawl start location.

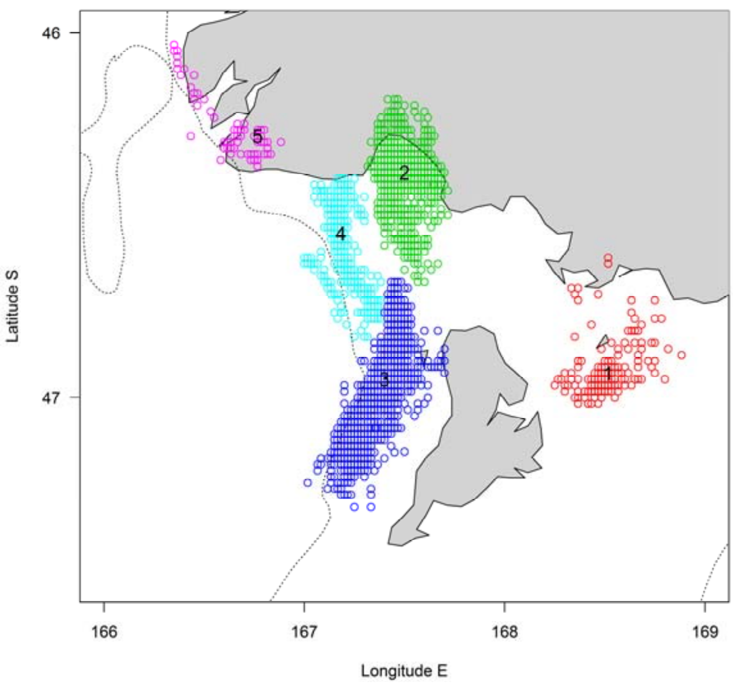

Figure 25: The assignment of individual trawls to the five fishing areas included in the TCER CPUE analysis. The dashed line represents the 200 m depth contour. The coastline is an approximation only.

Initial CPUE models were formulated that compared the performance of lognormal and Weibull distributions. For both options, the distribution of the residuals did not conform to the assumption of normality, principally at the lower quantiles of the residual distributions, indicating that neither model was reliably predicting some of the smaller stargazer catches. However, of the two statistical distributions, the Weibull provided a considerably better fit to the overall data set (AIC 65 755 compared to 66 224) and, on that basis, was selected as the preferred model distribution option.

The final TCER CPUE model included the natural logarithm of the non zero catch of stargazer as the predictor variable and the categoric variable *FishingYear* as the first explanatory variable. The potential explanatory variables were included in the model using a step-wise fitting procedure based on the AIC and improvement in Nagelkerke pseudo-R^2 (1% threshold). The potential explanatory variables were the categoric variables *Area*, *Vessel*, and *Month* and the continuous variables *BottomDepth*, *TrawlSpeed*, *StartTime* and the natural logarithm of *TrawlDuration*. The continuous variables were parameterised using a third order polynomial function.

The final model included the variables *FishingYear, Area*, *Vessel*, the natural logarithm of *TrawlDuration, BottomDepth* and *Month* (Table 8). Overall, the final model accounted for 53.6% of the variation in the natural logarithm of catch per trawl. Of the significant variables, *TrawlDuration* and, to a lesser extent, *Area* and *Vessel* were the main variables influencing the annual indices (Figure A5). The average trawl duration increased during 2007/08–2012/13 and the inclusion of *TrawlDuration* in the CPUE model resulted in a declining trend in the annual CPUE indices (Figure A6). During 2010/11 to 2012/13, there was a shift in fishing effort from Area 2 to Area 3. The model predicts that the latter area yields higher catches of stargazer (Figure A7).

Table 8: Summary of final model for the TCER data set. Independent variables are listed in the order of acceptance to the model. AIC: Akaike Information Criterion; *: Term included in final model. Fishing year was forced as the first variable.

Term	DF	Log likelihood	AIC	Nagelkerke pseudo-R^2 (% Improvement)	
FishingYear	5	-34 598	69 210	0.09	*
Area	5	-33 743	67 511	31.1	*
Vessel	8	-33 338	66 715	11.2	*
poly(log(*TrawlDuration*), 3)	3	-33 012	66 070	7.6	*
poly(*BottomDepth*, 3)	3	-32 899	65 850	2.4	*
Month	11	-32 841	65 755	1.2	*
poly(*TrawlSpeed*,3)	3	-32 822	65 725	0.4	
poly(*StartTime*,3)	3	-32 818	65 723	0.1	

The annual indices derived from the trawl based CPUE data set are generally consistent with the daily aggregated CPUE indices for the corresponding period (2007/08–2012/13) (Figure 26). Both sets of indices decline from 2008/09 to 2011/12 although the decline is more pronounced for the trawl based CPUE indices and the indices continue to decline in 2012/13, while the daily aggregated indices recover slightly.

The differences between the two sets of indices may relate to the differences in the spatial resolution of the data. There are apparent differences in stargazer trawl catch rates between the main fishing areas within Statistical Area 030 (areas 2 and 3) and the spatial resolution of the daily aggregated data is not sufficient to account for changes in the distribution of fishing effort between these two areas.

There are also some differences in the individual vessel coefficients derived from the two separate models that indicate differences in the parameterisation of the two models. This may indicate the potential for significant vessel*fishing year interactions over the longer time period. A supplementary analysis was conducted to include a vessel*fishing year interaction in the daily aggregated CPUE model. An examination of the resulting vessel*fishing year coefficients revealed considerable variability in the annual indices amongst the fleet over the entire period, although for most vessels there was a general decline in CPUE from 2007/08 onwards (Figure 27).

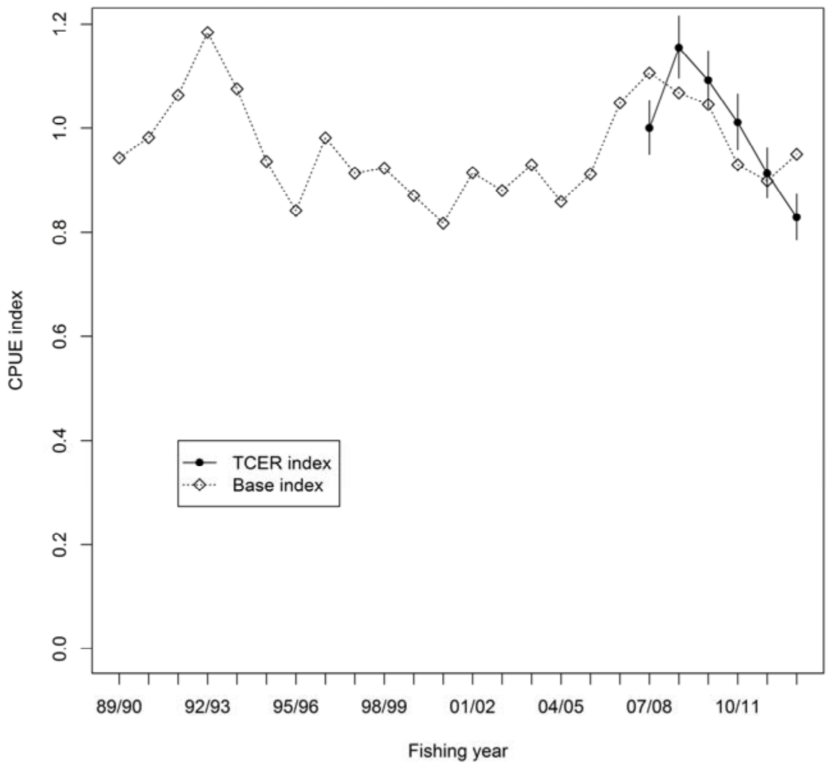

Figure 26: A comparison of annual indices from the base CPUE model (CF corrected catches) and CPUE indices from the TCER model. The error bars represent the 95% confidence intervals.

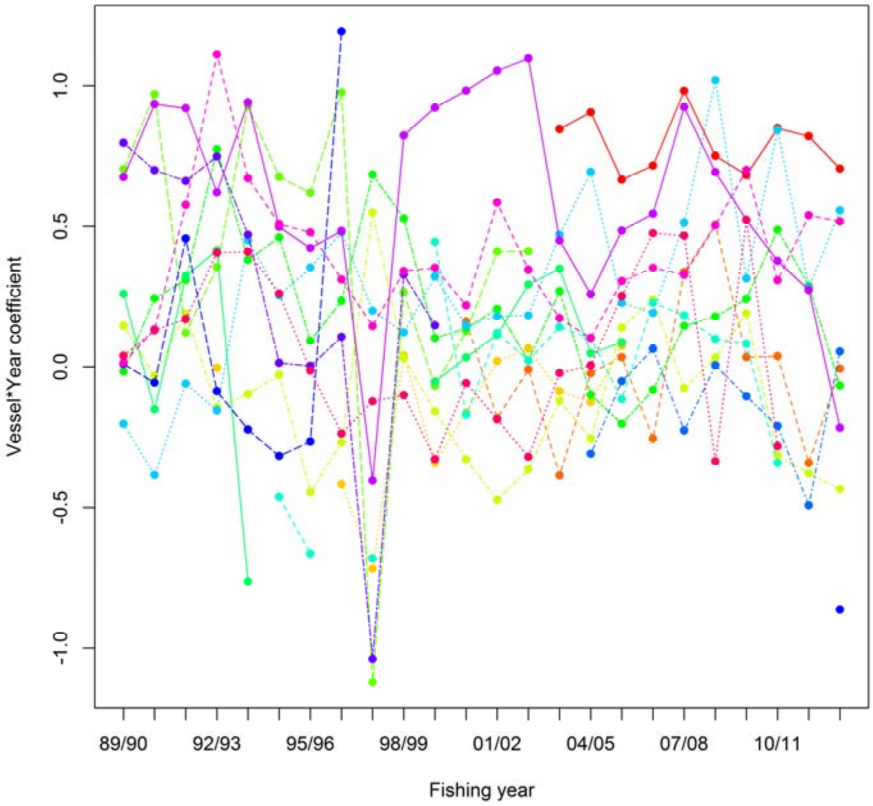

Figure 27: The annual trend in vessel*fishing year coefficients for each of the 15 individual vessels included in the day aggregated CPUE data set derived from the final CPUE model formulated to also include a vessel*year interaction term. The different colours represent the individual vessels.

4 DISCUSSION

The CPUE indices derived from the daily aggregated data set are generally comparable with the CPUE indices obtained from previous studies (Manning 2007, Kendrick 2009), despite some differences in the approach to the processing of the catch and effort data (see Appendix 3). The main difference is that the current study aggregated the catch and effort data by fishing day (with statistical area and target species information retained), whereas the previous studies aggregated the catch and effort records by statistical area and target species within a fishing trip (referred to as "trip-stratum"). A comparative analysis of the current data set using the equivalent data aggregation and CPUE model formulation to Manning (2007) yielded indices very similar results (Appendix 3, Figure A8).

These comparisons indicate that while the individual indices were sensitive to the level of data aggregation, the overall trend in the CPUE indices was relatively insensitive to the differences in approaches among the previous studies. Our preference is to maintain the daily structure of the data from individual fishing trips as it essentially maintains the resolution of the original CELR records.

The current analysis extended the time-series of CPUE indices up to the 2012/13 fishing year.

The CPUE indices from the final model fluctuated without trend (1989/90–2012/13) with peaks in 1991/92–1993/94 and 2006/07–2009/08. The 2012/13 value is slightly lower than the average of the series. A CPUE index was also derived from the time-series TCER data from 2007/08 to 2012/13. These indices revealed a similar general trend to the corresponding annual indices from the primary

CPUE model, although the magnitude of the decline in the CPUE indices from 2009/10 was greater and there was no increase in the index in 2012/13.

The CPUE indices increased in the late 2000s and were maintained at a higher level during 2006/07–2009/10. This period corresponded to a change in the operation of the fishery with one of the main vessels in the fleet changing the trawl gear to a twin rig configuration. The daily aggregated CPUE model estimates that this change in fishing gear resulted in a 54% increase in the catch rate of stargazer. During this period, there were also reductions in the reported headline height of the trawl gear used by the fleet, although this variable was not included as a significant variable in the final CPUE model. It is unknown whether the CPUE models have fully accounted for these observed changes in the operation of the fleet.

The recent (2006/07–2009/10) peak in the CPUE indices was similar in magnitude and duration to the peak in the indices during the early 1990s (1991/92–1993/94). These trends may indicate periods of increased stock abundance although the short (3–4 year) duration of these fluctuations do not seem consistent with the relatively low estimate of natural mortality (M=0.2) for the fishstock (Sutton 2004).

There are no additional data available from the fishery to corroborate the recent trends in stock abundance. Relative biomass estimates and associated length and age frequency data are available from four trawl surveys conducted of the Southland area during 1993–96 (Hurst & Bagley 1997, Sutton 2004). Sutton (2004) identified relatively strong cohorts from 1985 and 1986 and these cohorts could potentially have contributed to the higher CPUE indices during 1991/92–1993/94. However, the age of recruitment to the target trawl fishery is unknown as there are no length or age frequency data available from the commercial catch.

The daily aggregated CPUE indices declined from 2007/08 to 2010/11 and then stabilised at the longer term level, while the CPUE indices derived from individual trawl TCER records continued to decline in 2011/12 and 2012/13. These differences appear to be partly related to changes in the spatial distribution of the operation of the fishery at a finer level of resolution than the statistical areas. Thus, the trend in the CPUE indices derived from the individual trawl records probably represents a more reliable index of stock abundance in the recent years than the daily aggregated indices. The decline in the CPUE indices is consistent with the observations of one of the main operators in the fishery. The continued decline in the trawl based CPUE indices suggests that monitoring of the stock should be maintained over the next few years.

5 MANAGEMENT IMPLICATIONS

The SINS WG (26 March 2014) reviewed the CPUE analysis and accepted the daily aggregated CPUE indices as the primary abundance index for STA 5. The CPUE indices were applied to define a proxy target biomass level for the stock, defined as the arithmetic average of the CPUE indices from the entire time series (1989/90–2012/13). Corresponding soft limit and hard limit biomass based reference point were defined to be 50% and 25% of the proxy target biomass level, respectively. It is proposed to update the daily aggregated CPUE indices and the trawl based CPUE indices in 2015 or 2016.

6 ACKNOWLEDGMENTS

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APPENDIX 1. INFLUENCE PLOTS FOR THE VARIABLES INCLUDED IN THE FINAL DAILY AGGREGATED CPUE MODEL

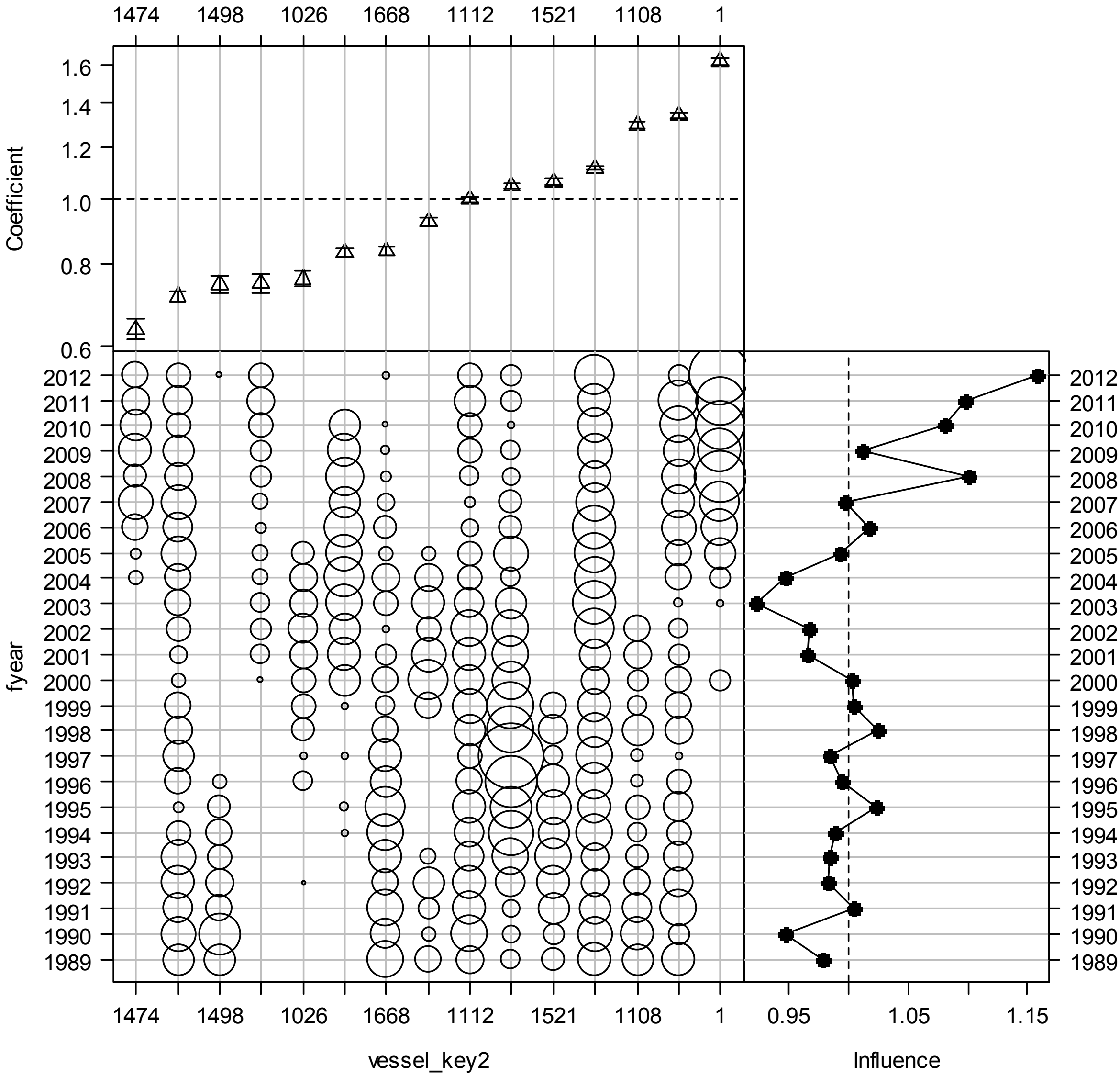

Figure A1: Coefficient-distribution-influence plot for *vessel*.

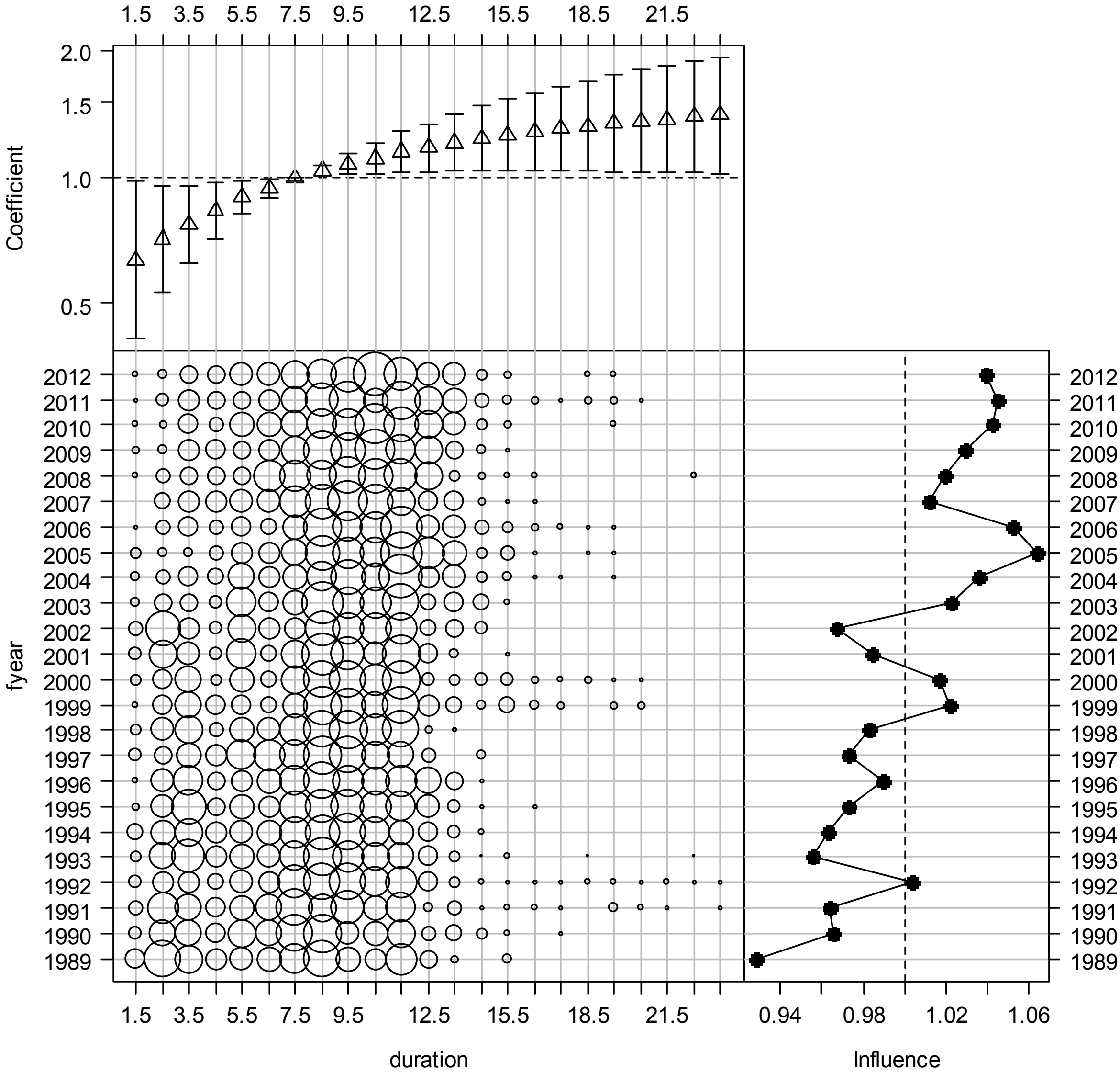

Figure A2: Coefficient-distribution-influence plot for *Duration*.

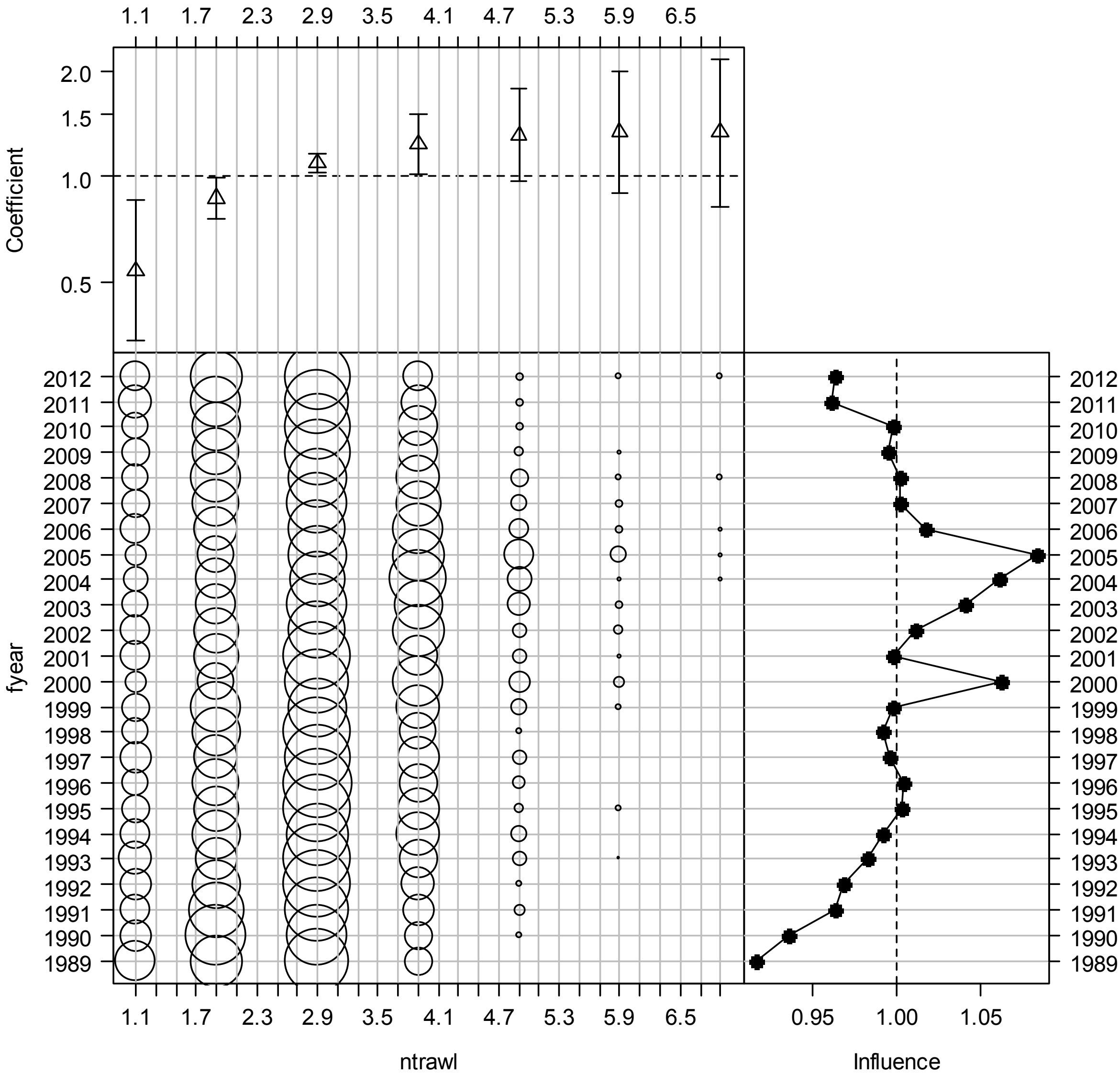

Figure A3: Coefficient-distribution-influence plot for number of trawls (*NumTrawl*).

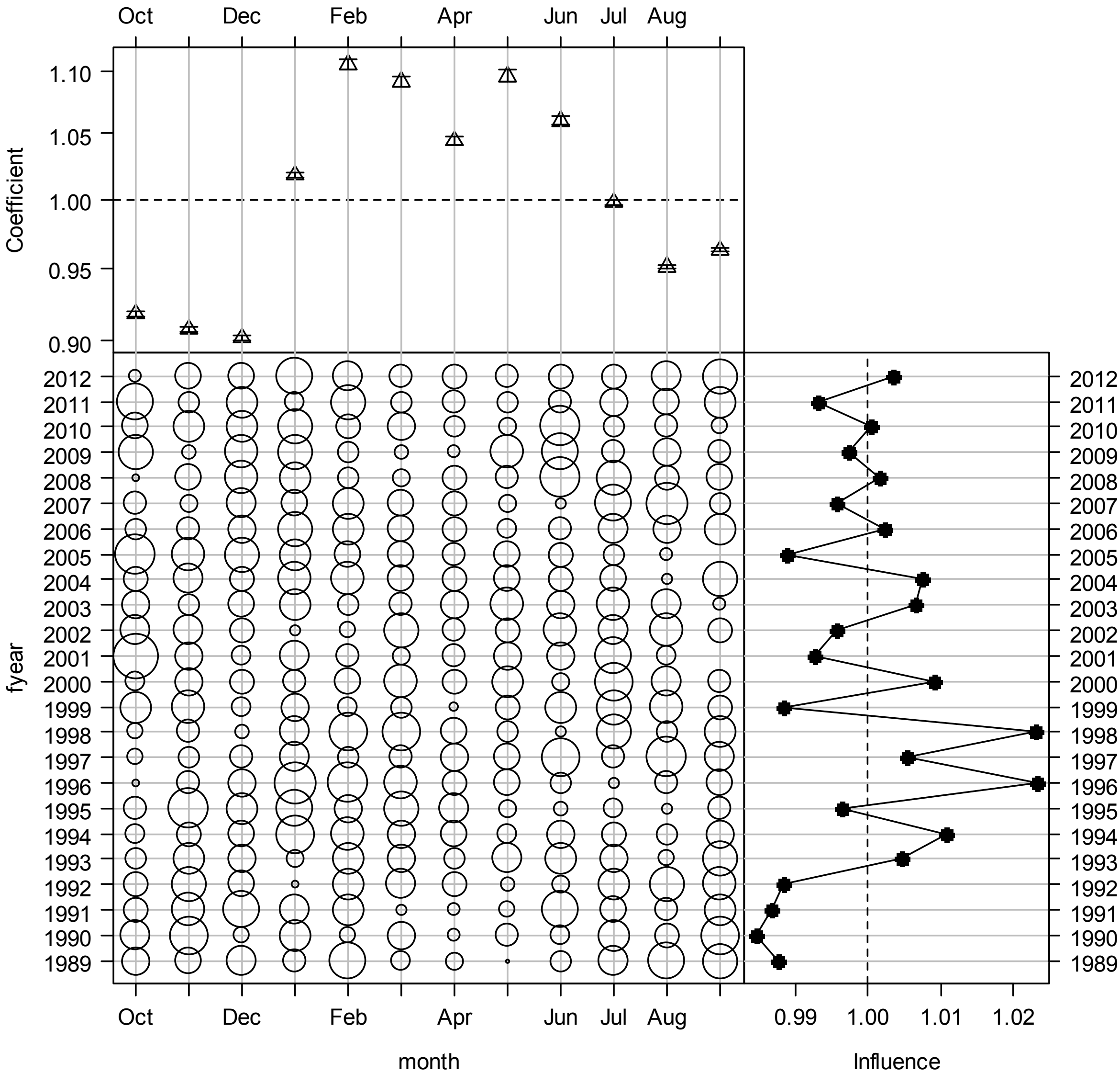

Figure A4: Coefficient-distribution-influence plot for *Month*.

APPENDIX 2. DIAGNOSTIC PLOTS FOR THE VARIABLES INCLUDED IN THE FINAL TRAWL BASED CPUE MODEL

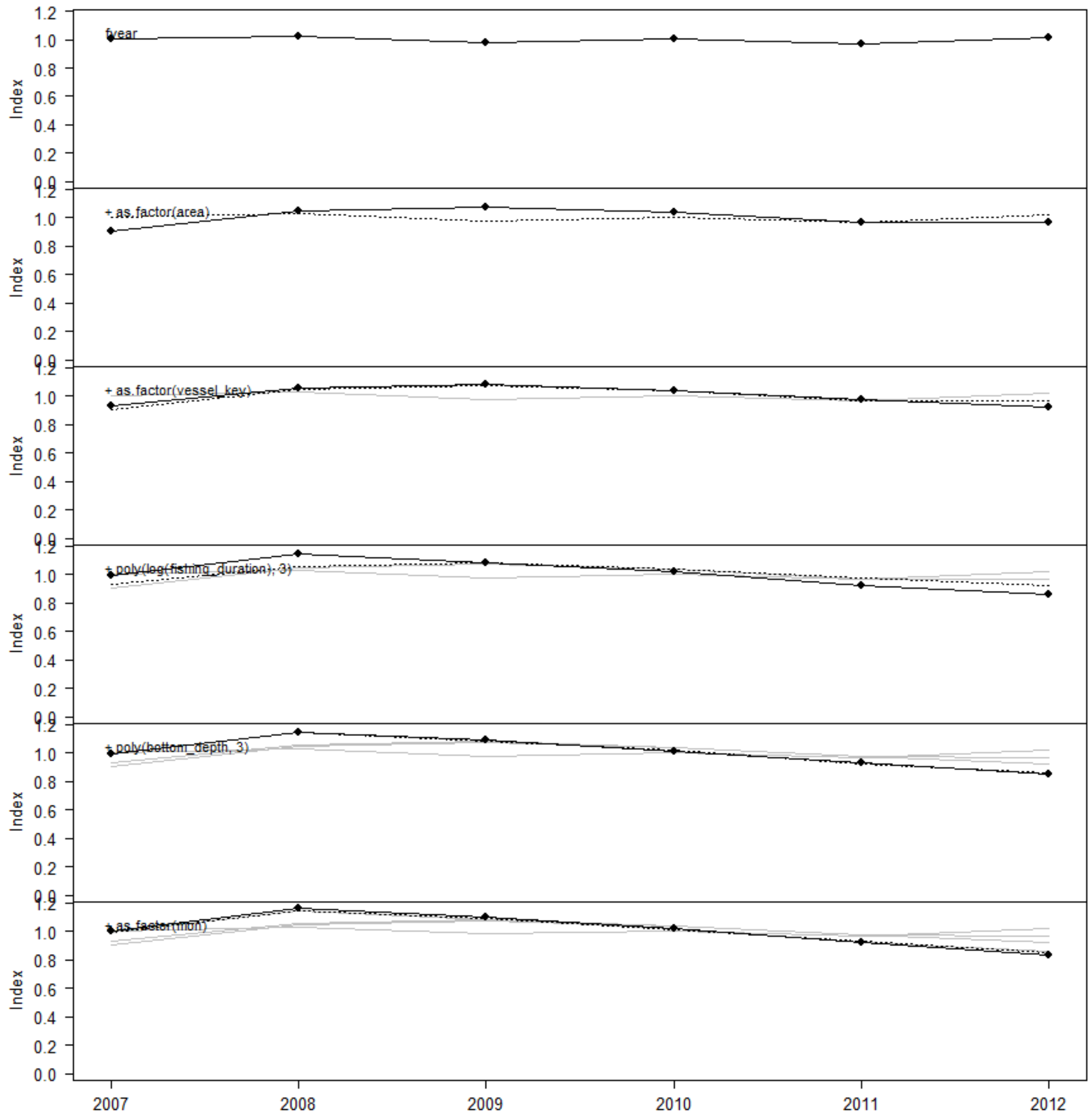

Figure A5: The change in the annual coefficients with the step-wise inclusion of each of the significant variables in the final trawl based CPUE model (from top to bottom panel). The solid line and points represent the annual coefficients at each stage. The fishing year is denoted by the calendar year at the beginning of the fishing year (e.g. 1989 denotes the 1989/90 fishing year).

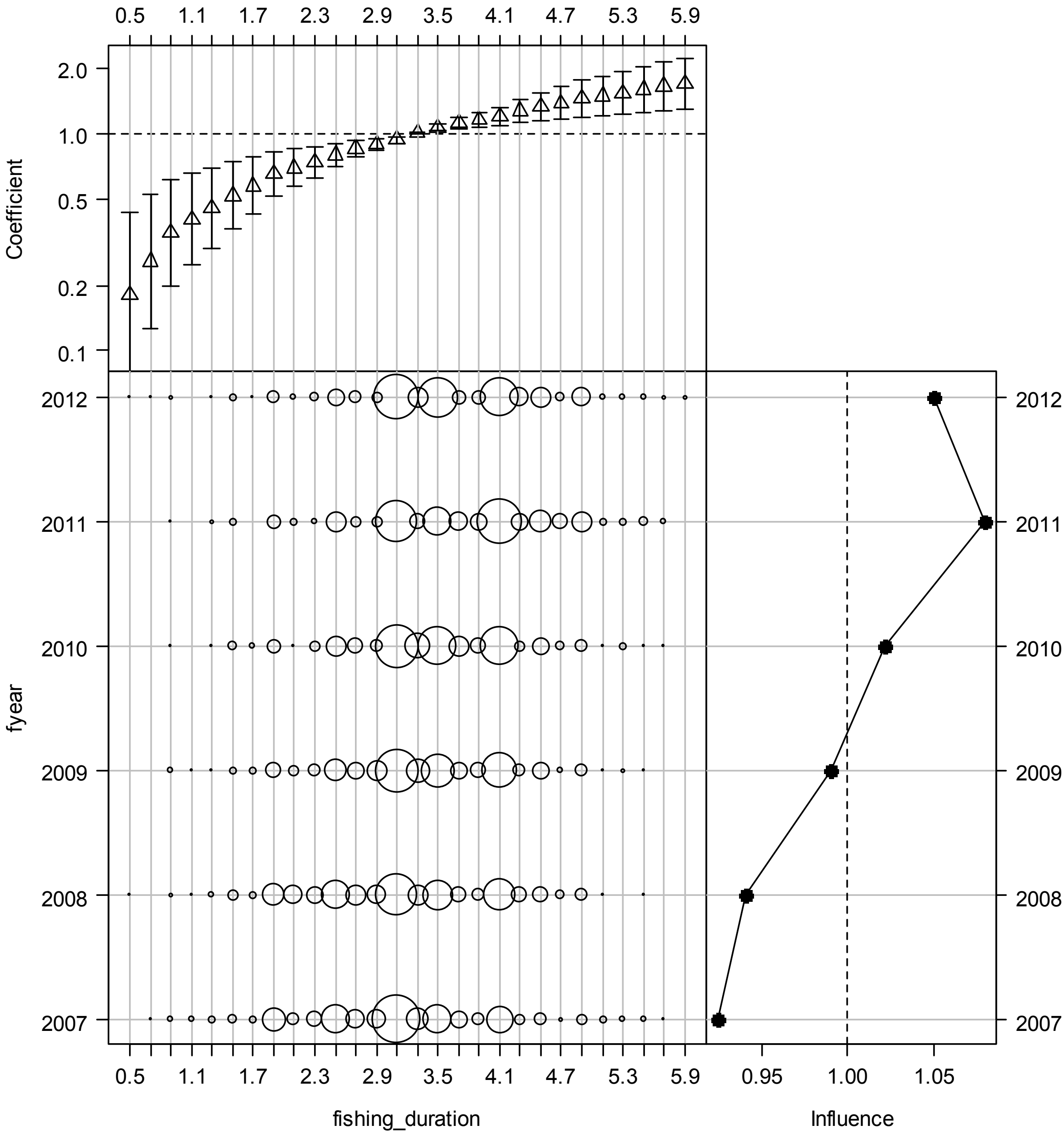

Figure A6: Coefficient-distribution-influence plot for *FishingDuration* for the trawl based CPUE model.

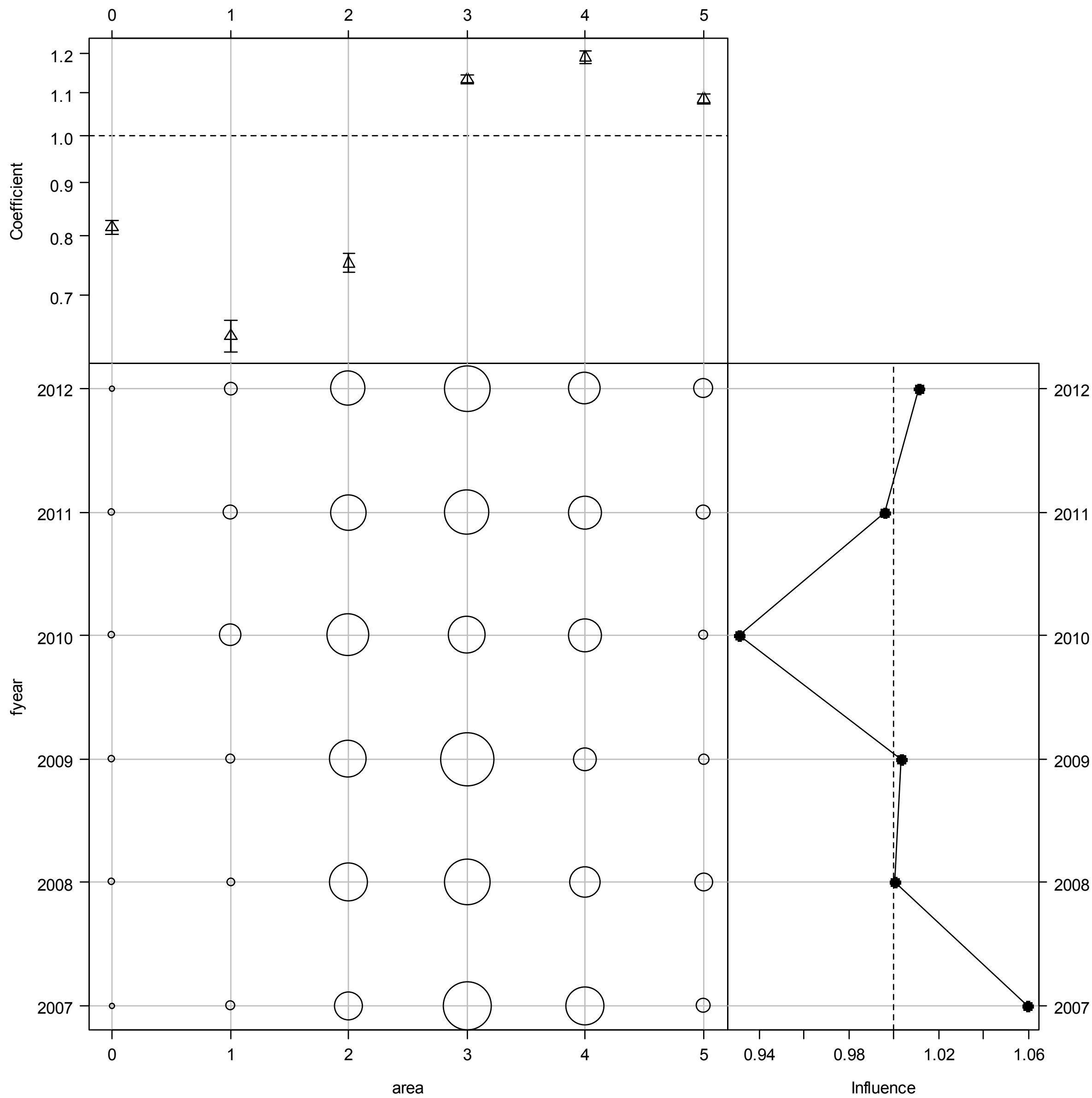

Figure A7: Coefficient-distribution-influence plot for *Area* for the trawl based CPUE model.

APPENDIX 3. A COMPARISON OF THE DAILY AGGREGATED CPUE INDICES WITH PREVIOUS ANALYSES

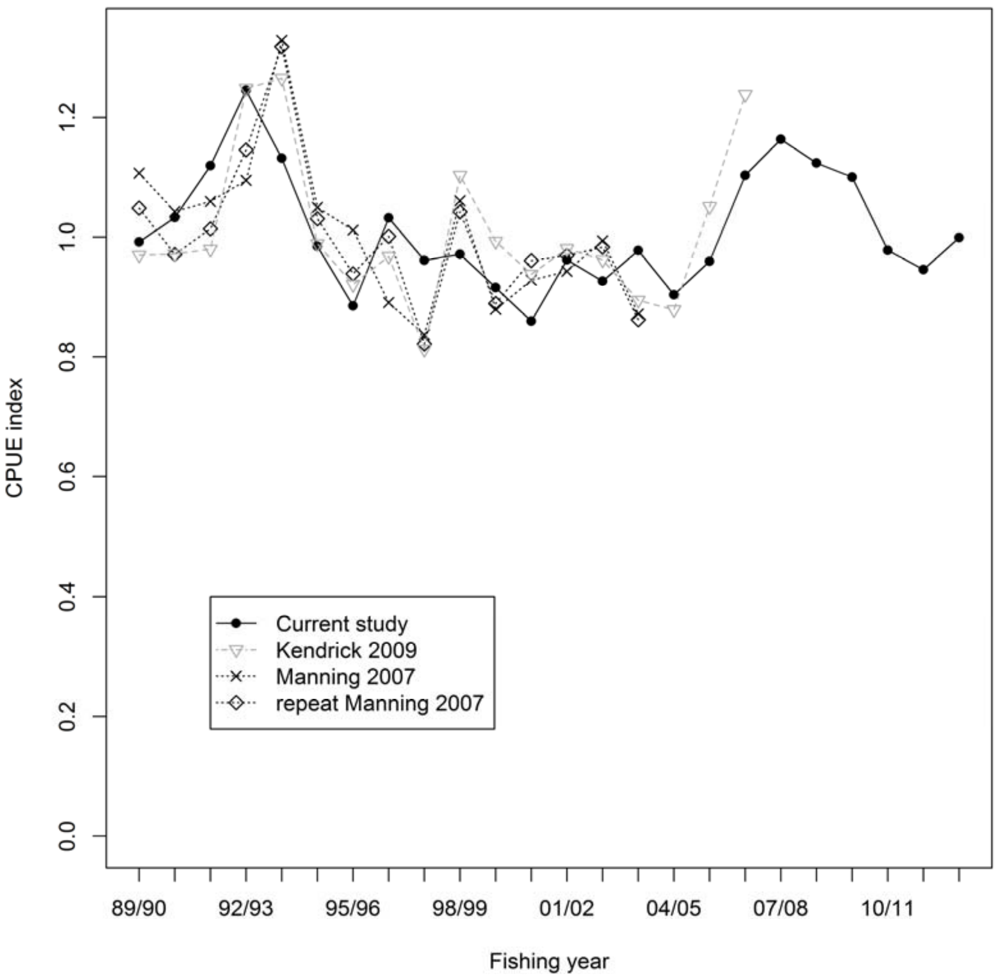

Figure A8: A comparison of the annual CPUE indices from the daily aggregated CPUE model (current study) and the CPUE indices from Manning (2007) and Kendrick (2009). The current data set was also applied to repeat the analysis of Manning (2007).

APPENDIX 4. TABULATED CPUE INDICES

Table A1: Annual CPUE indices and the lower (LCI) and upper (UCI) bounds of the 95% confidence intervals from the final daily aggregated CPUE model and the trawl based CPUE model.

Fishing	Daily aggregated indices			Trawl based indices		
year	Index	LCI	UCI	Index	LCI	UCI
89/90	1.000	0.918	1.089			
90/91	1.041	0.956	1.134			
91/92	1.128	1.035	1.230			
92/93	1.256	1.154	1.365			
93/94	1.141	1.054	1.235			
94/95	0.993	0.915	1.077			
95/96	0.893	0.822	0.969			
96/97	1.041	0.954	1.135			
97/98	0.969	0.869	1.080			
98/99	0.979	0.898	1.068			
99/00	0.923	0.848	1.005			
00/01	0.867	0.797	0.942			
01/02	0.970	0.889	1.058			
02/03	0.934	0.854	1.021			
03/04	0.986	0.906	1.072			
04/05	0.911	0.837	0.991			
05/06	0.967	0.885	1.057			
06/07	1.112	1.016	1.217			
07/08	1.173	1.067	1.289	1.000	0.950	1.053
08/09	1.133	1.027	1.249	1.155	1.096	1.216
09/10	1.109	1.011	1.216	1.092	1.039	1.148
10/11	0.986	0.893	1.089	1.011	0.959	1.066
11/12	0.953	0.868	1.047	0.913	0.867	0.962
12/13	1.007	0.912	1.112	0.829	0.786	0.874