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Catch per unit effort (CPUE) analyses and characterisation of the South Island commercial freshwater eel fishery, 1990–91 to 2009–10

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The results of a catch-per-unit-effort (CPUE) analysis for the South Island commercial freshwater eel fishery (*Anguilla australis*, shortfin; *A. dieffenbachii*, longfin) for the fishing years 1991 to 2000 (1990–91 to 2009–10) are presented. Analyses were carried out individually for all ten South Island eel statistical areas (ESAs AN–AW), except AP and AQ which were combined. CPUE analyses were carried out for all areas for the period before introduction of South Island eels into the Quota Management System (pre-QMS, 1990–91 to 1999–2000), and post-QMS CPUE analyses for areas with sufficient data and fishers (i.e., ESAs AX, AV, AW, and AS1).

Overall, total estimated catch for the 20 years of catch effort data was 96% of the reported landed catch and followed the same trend over time. The reported estimated catch over 20 years was 50% shortfin, 45% longfin, and 5% unidentified (EEU). Shortfin and longfin catches were made in all South Island ESAs, but 60% of the shortfin catch is from Te Waihora (AS) and 75% of longfin from three ESAs (Otago AV, Southland AW, and Westland AX). Catch rates (kg per lift) of total catch were generally similar across all areas, and most commonly were between 4 and 6 kg per lift with no trends.

Standardised and unstandardised CPUE analyses were carried out on core fishers' estimated catch for individual species (longfin and shortfin), except AS1 which was restricted to shortfin. Standardised CPUE analyses used a Generalised Linear Model (GLM) ignoring zero catches, where the response variable was daily catch. Predictor variables permit, lifts, and month were accepted by nearly all models, with lifts and permit explaining the most variability in the models. Permit and month were accepted by the Te Waihora (AS1) model, but lifts were not offered to the Te Waihora model as a predictor variable because of changes in gear use over time. The results indicate that catch rates are very dependent on fisher experience and/or ability, number of nets used, and season.

Shortfin

For the data poor areas (AN, AP-AQ, AR, AT, and AU), all pre-QMS shortfin indices showed some indications of a declining trend in CPUE from 1991 to 2000, and this was most marked in ESA AP-AQ. For the data rich areas (AX, AV, AW, and AS1), pre-QMS shortfin indices showed declines in CPUE for ESAs AV and AW, but in AX the initial decline was followed by a sharp increase in CPUE for the most recent years. Post-QMS, shortfin showed trends of increasing CPUE in all areas and that was most marked in AW and AS1.

Longfin

For the data poor areas (AN, AP-AQ, AR, AT, and AU), the pre-QMS longfin indices were less clear cut than for shortfin, with no area displaying strong and consistent trends in CPUE over time, with the exception of AP-AQ where CPUE has generally declined. For the data rich areas (AX, AV, AW, and AS1), pre-QMS longfin indices showed clear declines in CPUE for ESAs AV and AW, but in AX CPUE increased over time. Post-QMS, longfin showed clear trends of increasing CPUE in AX and AV, and to a lesser extent in AW.

1. INTRODUCTION

This report presents the results of a catch-per-unit-effort analysis (CPUE) for freshwater eels (*Anguilla australis* and *A. dieffenbachii*) for all South Island eel statistical areas (ESA) for the fishing years 1990–91 to 2009–10, and updates previous similar analyses (Beentjes & Bull 2002, Beentjes & Dunn 2003a, 2008).

1.1 Commercial fishery

The commercial freshwater eel fishery in New Zealand developed in the late 1960s and landings consist of both the endemic longfin eel (*Anguilla dieffenbachii*), and the shortfin eel (*A. australis*) which is also found in southeast Australia. Landings from the north of the North Island can include the occasional Australian longfin eel (*A. reinhardtii*). Total New Zealand eel catches peaked in 1972 at about 2100 t and from 1972 to 1999 catch fluctuated somewhat, but there was no clear trend with an annual average catch of about 1300 t (Figure 1). Since 1999, however, New Zealand catches have progressively declined with landings of 560 t in 2009–10 (Ministry for Primary Industries 2012). South Island catches are only available since 1991–92 with contributions of between 28 and 44 % of the total New Zealand eel catch (Ministry for Primary Industries 2012). The South Island shows a similar trend to New Zealand catch, although catches have been reasonably stable since 2000–01 averaging about 280 t (Figure 1).

The South Island eel fishery was introduced into the Quota Management System (QMS) in 2000–01, with five Quota Management Areas (ANG 11 to ANG 16) and Total Allowable Commercial Catches (TACC) set for both species combined (Table 1, Figure 2). TACCs have been consistently undercaught in all South Island QMAs, with the exception of ANG 13 (Te Waihora), which was 100% caught between 2003–04 and 2008–09 (Ministry for Primary Industries 2012). The combined South Island TACC (420 t) has been between 51 and 68% caught over the last five years (up to 2009–10) (Figure 1). The Chatham Island eel fishery was introduced into the QMS in 2003–04 with single QMAs for each species (SFE 17, and LFE 17). Subsequently, the North Island eel fishery was the introduced into the QMS in 2004–05 with four separate QMAs each for shortfin and longfin (LFE 20–23 and SFE 20–23).

Based on landed catches from eel catch landing returns (ECLR), longfin accounted for between 24 and 64% (average of 42%) of all South Island landings between 1990–91 and 2010–11 and was more predominant in the south of the South Island and the west coast (Ministry for Primary Industries 2012). The bulk of the South Island shortfin landings are from Te Waihora and Lake Brunner, but also from coastal lakes, lower river reaches, and estuaries (Beentjes & Chisnall 1997, 1998, Beentjes 1999). By contrast, shortfins are the dominant species in North Island catches (green weight), representing about 77% of landed weight between 2003–04 and 2008–09 (Beentjes 2011).

1.2 Reporting

The introduction of the Catch Effort Landing Return (CELR) in October 1989 replaced the Fisheries Statistics Unit (FSU) eel returns. Data quality for the first two years of the CELR system was poor (Jellyman 1993), and the data from 1989–90 were not suitable for inclusion in the analysis. The CELR form was in turn replaced by an Eel Catch Effort Return (ECER) and an Eel Catch Landing Return (ECLR) on 1 October 2001. The main change in data reported on the new forms was that the target species is no longer recorded and the generic species code EEU (unidentified) was no longer valid. Before this later change, the proportion of total eel catch recorded as EEU ranged from about 0% (Te Waihora, ESA 21 and AS) to 83% (ESA AD), although the EEU code tended to be used more often in the North Island. Data from ECER forms also provide data on the estimated catch of longfin and shortfin separately which is absent from QMRs and MHR for the South Island where catches are reported as ANG.

The data used in the CPUE analyses presented in this report include data from CELR (1990–91 to 1999–2000) and ECER (2001–02 to 2009–10) forms. Statistical areas for reporting catch effort data were changed from numeric codes (1–23) to alpha codes (AA–AZ) in July 2000; ESA boundaries were virtually unchanged except ESA 14 which was divided into Marlborough and South Marlborough (AP and AQ) (Figure 3, Table 1). In this report we refer to ESAs by the current alpha codes, although some previous analyses used the numeric codes. Table 1 provides a useful key for relating ESAs (numeric and alpha), QMAs, and area names.

1.3 Previous catch effort analyses

Catch location associated with effort on CELRs/ECERs is recorded as ESA (Figure 3), which generally include multiple catchments. Hence, assuming there are sufficient data, the highest resolution that CPUE analyses can be carried out for is at the level of ESA.

Previous eel fishery CPUE analyses include the following:

1. **All ESAs throughout New Zealand for 1990–91 to 1998–99**. Results indicated that in some areas abundance of longfin was declining (Beentjes & Bull 2002). This was most apparent in combined ESAs AB and AC (Auckland, Hauraki), AH to AM (Rangitikei-Wanganui, Taranaki, Manawatu, Wairarapa, Wellington), AT to AV (south Canterbury, Waitaki, Otago), and particularly ESA AW (Southland).
2. **ESAs of concern (highlighted from the first analyses) for 1990–91 2000–01**. Results showed continuing declines in longfin abundance (Beentjes & Dunn 2003a).
3. **North Island ESA groupings corresponding to QMAs 20, 21, 22, and 23, for 1990–91 to 2002–03 (before North Island eels were introduced into the QMS in 2004–05).** The trend of declining longfin abundance was clearly evident in all four QMAs (Beentjes & Dunn 2003b).
4. **All South Island ESAs for 1990–91 to 2005–06.** Both longfin and shortfin eels showed a general increase in CPUE across most ESAs since about 2000 (Beentjes & Dunn 2008). For some areas this represented a reversal of the trend of declining CPUE apparent from the previous South Island CPUE analyses.
5. **All North Island ESAs for 1990–91 to 2006–07.** Shortfin did not show any consistent trend in CPUE across ESAs and were regarded as relatively stable (Beentjes & Dunn 2010). Longfin in contrast showed strong evidence of earlier declines in CPUE in all ESAs, but with indications of a flattening or reversal of these trends in recent years.

1.4 Specific objective

To analyse CPUE trends in the South Island commercial eel fisheries (ANG 11, ANG 12, ANG 13, ANG 14, ANG 15, and ANG 16) using data up to the end of the fishing year 2008/09[1].

2. METHODS

2.1 Catch effort data extraction

Estimates of catch and effort for each day's fishing were recorded on CELR forms up to 30 September 2001, and then on ECERs after this time, although there was a transition period in early 2001–02 when either form was accepted. The catch effort data used in this report were extracted from the Ministry for Primary Industries Catch Effort Database *Warehou*, and for each daily record from fishing years

[1] The delay in awarding the tender allowed an additional fishing year to be included in the analyses and hence we included data up to the end of 2009–10 as requested by the Ministry for Primary Industries.

(1 October to 30 September) 1990–91 to 2009–10 for all South Island ESAs (excluding Stewart Island, ESA AY, where no commercial fishing occurs), the following variables were extracted.

CELR (1990–91 to 2001–02)

- Date nets were lifted
- Permit number (encoded)
- Vessel registration number
- Location landed
- Method
- Form number
- Eel statistical area (ESA)
- Number of net lifts
- Nets in the water at midnight
- Target species
- Total weight (weight of shortfin, SFE; longfin, LFE; unidentified, EEU; and bycatch)
- Weight of individual species (includes SFE, LFE, EEU, and bycatch species)

ECER (2001–02 to 2009–10)

- Date nets were lifted
- Permit number (encoded)
- Method
- Eel statistical area (ESA)
- Number of net lifts
- Estimated catch of weight of shortfin (SFE)
- Estimated catch of weight of longfin (LFE)

The 1990–91 to 1998–99 data for South Island ESAs were extracted and groomed as part of the first CPUE analysis (Beentjes & Bull 2002). This dataset was then updated by including data for 1999–2000 and 2000–01 fishing years, but only for selected ESAs AT–AV, and AW (Beentjes & Dunn 2003a). Subsequent to that we extracted complementary data for year and area combinations that had not previously been extracted and groomed. These included data from 1999–2000 to 2005–06 (seven years) for all ESAs except AT–AV and AW, which were extracted from 2001–02 to 2005–06 (five years) (Beentjes & Dunn 2008). In the current analyses we extracted data for the years 2006–07 to 2009–10 (four years) for all South Island ESAs and appended these to the existing groomed data sets creating a time series for each ESA from 1990–91 to 2009–10 (20 years).

In this report, henceforth, fishing years are referred to by the second year, e.g., 1990–91 is referred to as 1991.

2.2 Environmental variables

Mean daily river flow data for some important rivers from, or near each ESA (except ESA AS, Te Waihora) were obtained from regional councils and the NIWA hydrological database (NIWA Water Resources and Climate Archive) (Appendix 1). Moon phase was included as a possible explanatory term to account for changes in catchability with changes in the lunar cycle. The relative phase (0–1) of the moon (moon cycle) was determined for each record in the data set based on the date of each record, using an algorithm from Meeuse (1998). Both river flow and moon phase were included as predictor variables because they have been shown to affect eel catch rates (Jellyman 1991, Beentjes & Willsman 2000, Beentjes & Bull 2002, Beentjes & Dunn 2008, 2010).When river flow from more than one river per area was used in standardised CPUE analyses, they were treated as separate variables.

2.3 Data error checking

CELR data – Catch effort data from CELRs were error checked and groomed using the criteria of Beentjes & Willsman (2000). Errors were corrected where possible, or the record was deleted. Details of corrections and deletions and the percentage of data remaining after grooming for the 1991 to 2001 data used in the previous CPUE analyses were documented by Beentjes & Bull (2002), and Beentjes & Dunn (2003a).

The variables *net lifts*, *catch*, and *area* were intensively checked as these variables have the most effect on CPUE. Corrections and deletions were made as follows.

1. Net lift errors: Records without an entry for number of fyke nets lifted were deleted or corrected where ancillary data such as nets in the water at midnight (CELR only) allowed an estimate to be made. Records with more than 100 nets were either corrected by inferring the true number from the value in the midnight nets column, or otherwise deleted.
2. Catch weight errors: Records were deleted if there was no total weight and no weights in the species column to allow the correct values to be entered (CELRs). Where species weights were present they were checked against the total weight and corrections were made where there was an obvious error. (The sum of individual species should add up to total weight: see Beentjes & Willsman (2000) for types of catch weight errors.) Records with catch weights greater than 1000 kg were checked for validity by comparing with other fishing events and/or the catch by the permit holder. If considered to be invalid these records were deleted.
3. Location errors: Records where location (ESA) was incorrect were generally deleted; however, some corrections could be made by using information such as permit number and landing location.

ECER data – data were of much higher quality than CELR data and few corrections or deletions were required.

2.4 Analysis of CPUE data

Following grooming, these new datasets were appended to those used in previous analyses, but grouped by individual ESA, resulting in nine discrete data sets containing 20 years of data from 1991 to 2010 (Table 2).

An initial CPUE analysis of the data for each ESA as a continuous time series (1991 to 2010) was presented to the Eel Working Group meeting (EELWG-2012-05) in April 2012. The working group noted that following the introduction of South Island eels into the QMS in 2000–01, there was generally a reduction in both numbers of fishers and catch. Further, it was suspected that some of the post-QMS new entrants had previously fished for existing permit holders under a fishing agreement and hence were not, strictly speaking, new entrants. It was not possible to link the identity of South Island fishers pre- and post-QMS because the ECER form, which includes a field identifying fishers that landed the catch, did not come into effect until 2001–02, a year after South Island eels were introduced into the QMS. This approach was used in the North Island CPUE analyses where eels were introduced into the QMS in 2004–05, three years after reporting by the ECER form came into effect (Beentjes & Dunn 2010).

Given this, the working group concluded that separate analyses should be carried out pre-QMS and post-QMS for areas with sufficient data and fishers (i.e., ESAs AX, AV, AW, and AS1). For the remaining areas (ESAs AN, AQ-AQ, AR, AU, and AT) CPUE analyses should be restricted to pre-QMS (1991 to 2000), but the characterisation of the fishery post-QMS should still be carried out. Further, CPUE analyses of all-eels should be dropped (SFE, LFE, and EEE combined), and analyses in Te Waihora restricted to shortfin eels in AS1 (outside the concession area) from 2001 onwards when the codes AS1 and AS2 were introduced enabling reporting of catches from inside and outside the concession area.

2.4.1 Unstandardised CPUE analyses

Unstandardised CPUE analyses were carried out for each of the data sets for SFE and LFE separately. It is presented in two forms 1) as total catch/total lifts per year using all raw data, and as total catch per year for core fishers (see below) which is plotted alongside the standardised CPUE indices.

2.4.2 Standardised CPUE analyses

Core fishers

For each ESA standardised CPUE analyses were conducted separately for SFE and LFE. A selection criterion was applied to each dataset restricting data analysis to core fishers (identified by permit number). Core fishers were defined as those that recorded a total catch (all eels) of 1000 kg or more over all years, and landed eel catch in at least three years. These selection criteria ensure that the fishers have a long-term commitment to the fishery.

The GLM model

Estimates of year effects and associated standard errors were obtained using a forward stepwise Generalised Linear Model (GLM) (McCullagh & Nelder 1989), with daily catch modelled as the response variable. In the first CPUE analyses (Beentjes & Bull 2002), the GLM model was fitted using daily catch per lift (kg per lift) as the response variable, but preliminary investigations suggested that the relationship between daily catch and lifts may not be linear. Using daily catch as the response variable and lift as a possible predictor allows the model to consider non-linear relationships between the daily catch and lifts.

GLM models were used that considered positive catches only. Whilst zero catches can provide useful information in some fisheries, it is generally not so in eel fisheries: first, fishers that catch 0 kg in a day generally do not complete catch-effort returns; and second, each individual catch often comprises a mix of the two eel species, where small proportions of one species are likely to recorded as zeros as fishers tend to estimate these based on a visual inspection of unsorted catches.

The GLM model used the log-normal transformation of positive daily catch. This implies a multiplicative model, i.e., the combined effect of two predictors is the product of their individual effects. The predictor variables used in the model were fishing year, permit number (fisher), number of lifts (excluded for Te Waihora), month (season), river flow (for selected rivers within each ESA analysis), and moon phase. Variables were treated as categorical, except number of lifts, daily mean river flow, and moon phase, which were entered as continuous variables. Continuous variables were typically fitted as a 3-degree polynomial, with the number of lifts fitted as a 3-degree polynomial in log space.

A stepwise regression procedure was used to fit the GLM of CPUE (daily catch) on these predictor variables. The relative year effect from the model was then interpreted as the CPUE index, and presented using the canonical form, scaled to have a mean of 1.0. Model fits were investigated using standard residual diagnostics. Plots of model residuals and fitted values were investigated for evidence of departure from model assumptions. Influence step plots and coefficient-distribution-influence plots (CDI), were used to interpret the standardisation effects of explanatory variables (Bentley et al. 2012).

The stepwise fitting method began with a basic model in which the only predictor was the year, and iteratively included predictors until there was insufficient improvement in the model. For all analyses, the improvement in the residual deviance, i.e., (new deviance – old deviance) / (saturated deviance – null deviance), and termed R^2 was used as the criterion for including predictors. At each step, the predictor with the greatest improvement in R^2 was included, providing that its inclusion resulted in an improvement in R^2 of at least 0.5%.

The inclusion of first order interaction terms was considered, but it was found that they generally required many additional degrees of freedom and often appeared to have a spurious significance. Interactions tended to be between permit number (typically the most important predictor) and the other variables. These interactions appeared to be a reflection of variability in predictor variables among fishers rather than relative changes in the CPUE index.

2.4.2.1 Te Waihora analyses

Unlike the analyses for each of the ESAs, the analyses for Te Waihora (ESAs AS1 and AS2) excluded the variable lifts from the models. The number of net lifts per set declined markedly from 1991 to 2006 as fishers progressively reduced deployment of large numbers of small fyke nets in favour of fewer larger nets (Clem Smith, Te Waihora commercial fisher, pers. comm.) (Beentjes & Bull 2002, Beentjes & Dunn 2008). Without a variable to describe the change in nets used by each fisher on each day, the changing nature of the effort variable would have introduced bias into the resulting CPUE indices.

The migration area (concession area) was introduced in 1996 to allow fishers to take undersized migrating male shortfins during the months February and March each year. However, catches for this area were not distinguished from those caught elsewhere in the lake until 2001 when specific area codes were introduced for the migration area (AS2) and the lake excluding the migration area (AS1). As instructed by the Eel Working Group, CPUE analyses were carried out only for AS1 (lake outside the migration area) from 2001 onward, and only for shortfin eels which make up more than 99% of the catch. Before 2001 there was no accurate way to identify catches that were from AS1 or AS2. No analyses were carried out for AS2 (migration area) because of the seasonal nature of this fishery and because the working group considered that any indices would be unreliable.

3. RESULTS

3.1 Descriptive analyses

3.1.1 Groomed data used the CPE analyses

A comparison of groomed total estimated catch for the South Island from CELRs/ECERs with the actual landed weights is shown in Figure 4. The total estimated catch was less than or equal to the landed catch for all years except 2010 when it was slightly greater than the landed catch. Overall, estimated catches were 96% of the total landed catch for 1990–91 to 2009–10. Grooming of estimated catch data before 2001 resulted in the deletion of between 6 and 11% of records because of uncertainty in the key variables landing location, effort, or validity of the catch (Beentjes & Dunn 2003a). This resulted in an underestimate of the total estimated catch over this period. However, in both cases, the total estimated and landed catches have the same declining trend over time.

In general, the quality of the eel fishery catch effort data has improved over time to the extent that over 99% of all records over the period 2000 to 2010 were retained after grooming and were included in the CPUE analyses.

3.1.2 Spatial and temporal distribution of species catch

The relative amounts of estimated catch reported as SFE, LFE, or EEU in each ESA for all years combined are shown in Table 3 and Figure 5. Overall, the total South Island catch from 1991 to 2010 was recorded as 45% longfin, 50% shortfin, and 5% EEU (Table 3). Northern South Island ESAs had relatively high proportions of annual catch recorded as EEU compared to the west coast and southern South Island where it was low to negligible. In Te Waihora (ESA AS) no catch was reported as EEU (Table 3, Figure 5). From 2001 onward, EEU was not recorded in any ESA with all catches reported by species (LFE or SFE); this pre-dates the introduction of the ECER by one year, after which EEU was no longer a valid code (Figure 6). Ignoring EEU, within each ESA shortfin are the dominant species in northern South Island ESAs (AP and AQ, AR, AT), and in Te Waihora (AS) virtually all the catch is shortfin (Table 3, Figure 5). In contrast, longfin dominate the species mix in Nelson (AN), the West Coast (AX), and the southern ESAs (AU and AV), particularly Southland (AW). Among ESAs, most shortfin is taken from Te Waihora (ESA AS) and most longfin from the west coast (AX), Otago and Southland (AV and AW) (Table 3, Figure 5).

There is a trend of declining catch of all eels from 1992 to about 2000 after which annual estimated catch is comparatively stable (Figure 6). Further, while shortfin annual estimated catch has remained about the same over the 20 year time series, longfin catch has declined with longfin catches from 1991 to 2000 averaging 199 t and from 2001 to 2010 only 107 t.

3.2 Fishery characterisation and CPUE analyses by ESA

The number of records (including those with zero catch), number of fishers, and estimated catch of shortfin, longfin, and unidentified eels are presented in Table 2. Results are presented standalone for each ESA beginning with the characterisation of the fishery, followed by the CPUE analyses and diagnostics for shortfin, and longfin, in that order. The data poor areas for which only pre-QMS CPUE analyses were carried out are presented first (ESAs AN, AP-AQ, AR, AT, and AU) in Appendices A to E, followed by the ESAs AX, AV, AW, and AS1 which are considered to have sufficient data and fishers to conduct CPUE analyses pre- and post QMS (Appendices F to I).

3.2.1 Nelson (ESA AN)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AN have been variable, but declined sharply after 1996 (Appendix A1). There was little shortfin catch reported before 1996, and no or very little catch of either shortfin or longfin in 2004, 2005, and 2009 (Appendix A1). A high proportion of catch (34%) has been reported as unidentified (EEU), particularly before 1996 when it was about half, but the EEU code was not used after 2000 (Table 3, Appendix A1). Over the 20 year time series, longfin have been the dominant species in the catch (LFE 49%, SFE 16%), although in recent years there has been a more even mix (Table 3, Appendix A1).

The number of lifts ranges between a few to over 60 per day (mean 26), but most often 20, 25, or 30 lifts per day have been reported (Appendix A2), with the median number of lifts per day declining in the last 10 years (Appendix A3).

There were very few zero records for total catch, which suggests that there were few trips where eels were not caught (Appendix A4). The very high proportion of zeros for shortfin before 1996 indicates that either it was not caught, or it was not reported. Notwithstanding this, there were no trends in the proportion of zeros for total catch, shortfin, and longfin.

Annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data show no clear trends for all eels or by species, although the time series is weakened by the lack of shortfin catch before 1996 and the years with poor or no catch (Appendix A5). Overall the all eel catch rate is about 5 kg per lift, with the notable exception of 2009 when it was about 14 kg per lift.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 100 kg per day (mean 12), with no trend in the median catch per day (Appendices A6 and A7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix A8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain most of the catch, but lose all but one from six original fishers (Appendix A9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day with indications of decline in the first few years (Appendix A10). Very large confidence intervals around some indices, combined with inadequate data in the model to produce indices for several years, are indicative of the paucity of fishers and catches in these analyses. The variables month, Buller River flow, lifts, and moon phase were included in the model and explained 18% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix A11, influence step plots in Appendix A12, and CDI plots for each of the model predictor variables in Appendices A13–A16. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 20 and 120 kg per day (mean 37), with median catch per day increasing in the last two years (Appendices A17 and A18).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix A19. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain about one-half of the catch, and three from sixteen original fishers (Appendix A20, Appendix 2). No shortfin post-QMS CPUE analyses were carried out for ESA AN.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 40 and 140 kg per day (mean 65), with no trend in the median catch per day (Appendices A21 and A22).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix A23. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and four of the six original fishers (Appendix A24, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day with indications of decline in the first and an increase in the last few years (Appendix A25). The variables lifts, permit, month, and Buller River flow were included in the model and explained 39% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix A26, influence step plots in Appendix A27, and CDI plots for each of the model predictor variables in Appendices A28–A31. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 120 kg per day (mean 54), with no trend in the median catch per day (Appendices A32 and A33).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix A34. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain about one-third of the catch, and two of fourteen original fishers (Appendix A35, Appendix 2). No longfin post-QMS CPUE analyses were carried out for ESA AN.

3.2.2 Marlborough (ESAs AP and AQ)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AP-AQ have been variable, but declined sharply after 1999 (Appendix B1). A high proportion of catch (36%) has been reported as unidentified (EEU), but EEU was not used after 2000 (Table 3, Appendix B1). Over the 20 year time series, shortfin have been the dominant species in the catch (SFE 39%, LFE 25%), although in some years the catch has been a more even mix (Table 3, Appendix B1).

The number of lifts ranges between a few to over 80 per day (mean 22), but most often 20, 25, or 30 lifts per day have been reported (Appendix B2), with no trend in the median number of lifts per day (Appendix B3).

There were no zero records for total catch, which suggests that eels were caught on all trips (Appendix B4). The proportion of zero catches for both SFE and LFE have generally declined over time, reflecting the phasing out of EEU as an acceptable species code.

Annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data show no clear trends for all eels or by species (Appendix B5). Overall the all eel catch rate ranges from about 5 to 10 kg per lift.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 100 kg per day (mean 35), with no trend in the median catch per day which is most commonly zero (Appendices B6 and B7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix B8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain nearly all the catch, but lose three of the six original fishers (Appendix B9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day with a steep decline until 1998 after which it increased (Appendix B10). The variables permit, lifts, month, and Wairau River flow were included in the model and explained 64% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix B11, influence step plots in Appendix B12, and CDI plots for each of the model predictor variables in Appendices B13–B16. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 60 and 160 kg per day (mean 80), but variable, with no trend in the median catch per day (Appendices B17 and B18).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix B19. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain about three-quarters of the catch, but lose all but two of the fifteen original fishers (Appendix B20, Appendix 2). No shortfin post-QMS CPUE analyses were carried out for ESA AP-AQ.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 120 kg per day (mean 26), with no trend in the median catch per day which was often equal to zero (Appendices B21 and B22).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix B23. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and three of the seven original fishers (Appendix B24, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day with indications of a decline over time (Appendix B25). The variables permit, month, lifts, and moon phase were included in the model and explained 45% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix B26, influence step plots in Appendix B27, and CDI plots for each of the model predictor variables in Appendices B28–B31. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 43), with no trend in the median catch per day which was often zero (Appendices B32 and B33).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix B34. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain about three-quarters of the catch, but lose all but two of twelve original fishers (Appendix B35, Appendix 2). No longfin post-QMS CPUE analyses were carried out for ESA AQ-AQ.

3.2.3 North Canterbury (ESA AR)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AR have been variable, but have gradually declined since the peak in 1995 (Appendix C1) and there was relatively little catch of either shortfin or longfin reported in 2009 (Appendix C1). A moderate proportion of catch (13%) has been reported as unidentified (EEU), but EEU was not used after 2000 (Table 3, Appendix C1). Over the 20 year time series, shortfin have been the dominant species in the catch (SFE 48%, LFE 39%), although in some years longfin has contributed a greater proportion of the annual catch than shortfin (Table 3, Appendix C1).

The number of lifts ranges between a few to over 100 per day (mean 24), but most often between 10 and 40 lifts per day have been reported (Appendix C2), with no trend in the median number of lifts per day (Appendix C3).

There were very few zero records for total catch, which suggests that there were few trips where eels were not caught (Appendix C4). The proportions of zeros were highly variable among years, but there were no trends for total catch, shortfin or longfin.

Annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data show no clear trends for all eels or by species (Appendix C5). Overall the all eel catch rate ranged between about 6 and 8 kg per lift, but was variable in the last few years.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 220 kg per day (mean 76), with no trend in the median catch per day which was zero in a few years (Appendices C6 and C7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix C8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain nearly all the catch, and nine of the seventeen original fishers (Appendix C9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day with no consistent trend until 2000 when it declined markedly (Appendix C10). The variables permit, lifts, and month were included in the model and explained 58% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix C11, influence step plots in Appendix C12, and CDI plots for each of the model predictor variables in Appendices C13–C15. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 43), but variable, with no trend in the median catch per day which was zero for about half the years (Appendices C16 and C17).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix C18. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain about three-quarters of the catch, and six of the seventeen original fishers (Appendix C19, Appendix 2). No shortfin post-QMS CPUE analyses were carried out for ESA AR.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 160 kg per day (mean 47), with no trend in the median catch per day which was most often equal to zero (Appendices C20 and C21).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix C22. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and eight of the 22 original fishers (Appendix C23, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day with indications of a slight increase over time (Appendix C24). The variables permit, lifts, and month were included in the model and explained 48% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix C25, influence step plots in Appendix C26, and CDI plots for each of the model predictor variables in Appendices C27–C29. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 80), with no trend in the median catch per day which was zero for a few years (Appendices C30 and C31).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix C32. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain about three-quarters of the catch and six of nineteen original fishers (Appendix C33, Appendix 2). No longfin post-QMS CPUE analyses were carried out for ESA AR.

3.2.4 South Canterbury (ESA AT)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AT have been variable, but generally declined since about 1996 (Appendix D1). Only a 3% of catch has been reported as unidentified (EEU), but EEU was not used after 1999 (Table 3, Appendix D1). Over the 20 year time series, the mix of longfin and shortfin has been roughly even (SFE 49%, LFE 47%) (Table 3, Appendix D1).

The number of lifts ranges between a few to over 90 per day (mean 21), but most often 10, 20, 30 or 40 lifts per day have been reported (Appendix D2), with the median number of lifts per day declining in the last 10 years (Appendix D3).

There were very few zero records for total catch, which suggests that there were few trips where eels were not caught (Appendix D4). The proportion of zeros was similar for shortfin and longfin and there were no trends.

Annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data have increased for all eels, with weaker trends for shortfin and longfin (Appendix D5). The all eel catch rate ranges from about 4 to 9 kg per lift.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 160 kg per day (mean 51), with no trend in the median catch per day which was zero in a few years (Appendices D6 and D7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix D8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain nearly all the catch, and nine of the eleven original fishers (Appendix D9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day with a decline in the first few years after which it was generally flat. (Appendix D10). The variables permit, lifts, and month were included in the model and explained 46% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix D11, influence step plots in Appendix D12, and CDI plots for each of the model predictor variables in Appendices D13–D15. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 51), but variable, with no trend in the median catch per day which was zero for two years (Appendices D16 and D17).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix D18. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain about two-thirds of the catch, and five of the nineteen original fishers (Appendix D19, Appendix 2). No shortfin post-QMS CPUE analyses were carried out for ESA AT.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 160 kg per day (mean 49), with no trend in the median catch per day (Appendices D20 and D21).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix D22. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and eight of the seventeen original fishers (Appendix D23, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day and is generally flat with the exception of a marked decrease between 1991 and 1992 and increase between 1999 and 2000 (Appendix D24). The variables permit, lifts, and month were included in the model and explained 44% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix D25, influence step plots in Appendix D26, and CDI plots for each of the model predictor variables in Appendices D27–D29. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 48), with no trend in the median catch per day which was zero for two years (Appendices D30 and D31).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix D32. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain about two-thirds of the catch and six of 20 original fishers (Appendix D33, Appendix 2). No longfin post-QMS CPUE analyses were carried out for ESA AT.

3.2.5 Waitaki (ESA AU)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AU have been variable, but generally declined after 2000 (Appendix E1). A low proportion of catch (2%) has been reported as unidentified (EEU) and this was only used in 1996 and 1997 (Table 3, Appendix E1). Over the 20 year time series, longfin have been the dominant species in the catch (LFE 67%, SFE 30%), although in 2009 the entire landed catch was reported as shortfin and in 2010 no catch was reported from ESA AU (Table 3, Appendix E1).

The number of lifts ranges between a few to over 90 per day (mean 26), but most often 10, 20, 30, or 40 lifts per day have been reported (Appendix E2), with no trend in the median number of lifts per day (Appendix E3).

There were very few zero records for total catch, which suggests that there were few trips where eels were not caught and there were no trends in the proportion of zeros for total catch, shortfin, and longfin (Appendix E4).

Annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data show no clear trends for all eels or by species (Appendix E5). Overall the all eel catch rate is about 5 kg per lift.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 100 kg per day (mean 40), with no trend in the median catch per day which was zero for most years (Appendices E6 and E7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix E8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain nearly all the catch, and seven of the thirteen original fishers (Appendix E9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day and was variable with no consistent trend. (Appendix E10). The variables permit, lifts, and month were included in the model and explained 63% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix E11, influence step plots in Appendix E12, and CDI plots for each of the model predictor variables in Appendices E13–E15. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 20 and 100 kg per day (mean 33) with no trend in the median catch per day which was zero for most years, but was over 300 kg per day in 2009 when catch was exclusively shortfin (Appendices E16 and E17).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix E18. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain about three-quarters of the catch, and two of the eleven original fishers (Appendix E19, Appendix 2). No shortfin post-QMS CPUE analyses were carried out for ESA AU.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 120 kg per day (mean 80), with no trend in the median catch per day (Appendices E20 and E21).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix E22. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and eight of the seventeen original fishers (Appendix E23, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day and is variable with no consistent trend (Appendix E24). The variables lifts, permit, month, and moon phase were included in the model and explained 51% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix E25, influence step plots in Appendix E26, and CDI plots for each of the model predictor variables in Appendices E27–E30. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 102), with no trend in the median catch per day which was zero for two years (Appendices E31 and E32).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix E33. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain just over half of the catch and three of seventeen original fishers (Appendix E34, Appendix 2). No longfin post-QMS CPUE analyses were carried out for ESA AU.

3.2.6 Westland (ESA AX)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AX have been variable and, overall, declined after 1999 (Appendix F1). Only 4% of the catch has been reported as unidentified (EEU), but EEU was not used after 2000 (Table 3, Appendix F1). In all 20 years of the time series, with exception of 2009 and 2010, longfin have been by far the dominant species in the catch (LFE 68%, SFE 27%) (Table 3, Appendix F1).

The number of lifts ranges between a few to over 70 per day but most often about 25 lifts per day (mean 22), have been reported (Appendix F2), with no trend in the median number of lifts per day (Appendix F3).

There were very few zero records for total catch, which suggests that there were few trips where eels were not caught (Appendix F4). The proportion of zeros for shortfin has generally declined over time, whereas for longfin it was higher in the last two years as shortfin were more dominant in the catch.

Annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data appear to have increased for all eels and shortfin, with no clear trend for longfin. (Appendix F5). Overall the all eel catch rate ranges from about 4 to 5 kg per lift.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 100 kg per day (mean 21), with no trend in the median catch per day which was zero in most years (Appendices F6 and F7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix F8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain nearly all the catch, and six of the fifteen original fishers (Appendix F9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day, with the exception of the last two years, and is generally flat until 1997 after which it rises sharply (Appendix F10). The variables permit, lifts, and month were included in the model and explained 68% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix F11, influence step plots in Appendix F12, and CDI plots for each of the model predictor variables in Appendices F13–F15. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics and CPUE (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 20 and 120 kg per day (mean 51), but with landings of 300, 400, 500, and 600 kg commonly reported. There is no trend in the median catch per day which was zero for most years (Appendices F16 and F17).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix F18. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain most of the catch, and seven of the fourteen original fishers (Appendix F19, Appendix 2).

The standardised CPUE for post-QMS shortfin catch followed the same general pattern as unstandardised catch per day, with a generally increasing trend, particularly in the last two years (Appendix F20). The variables permit, lifts, and Buller River flow were included in the model and explained 71% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix F21, influence step plots in Appendix F22, and CDI plots for each of the model predictor variables in Appendices F23–F25. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 160 kg per day (mean 76), with no trend in the median catch per day (Appendices F26 and F27).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix F28. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and eleven of the sixteen original fishers (Appendix F29, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day and is flat, but with indications of increasing CPUE in the last two years (Appendix F30). The variables permit, lifts, and month were included in the model and explained 60% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix F31, influence step plots in Appendix F32, and CDI plots for each of the model predictor variables in Appendices F33–F35. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics and CPUE (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 81). The median catch per day has declined in recent years (Appendices F36 and F37).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix F38. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain most of the catch and eight of eighteen original fishers (Appendix F39, Appendix 2).

The standardised CPUE for post-QMS longfin catch is different from the unstandardised catch per day in that the latter shows a general decline, whereas the standardised indices show an overall increase in CPUE (Appendix F40). The variables permit, lifts, and month were included in the model and explained 59% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix F41, influence step plots in Appendix F42, and CDI plots for each of the model predictor variables in Appendices F43–F45. Permit is the variable that has the most influence on CPUE indices and specifically the addition of new permit holders in 2005 onward (see Appendices F42 and F43). Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

3.2.7 Otago (ESA AV)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AV have been variable and overall have been declining since 1996 with the two smallest catches reported in 2009 and 2010 (Appendix G1). A low proportion of catch (1%) has been reported as unidentified (EEU) and this was used in 1994 to 1997, and 1999 (Table 3, Appendix G1). In all 20 years of the time series, with exception of 2009, longfin have been by far the dominant species in the catch (LFE 74%, SFE 25%) (Table 3, Appendix G1).

The number of lifts ranges between a few to over 90 per day but most often 10, 20, 30,40 or 50 lifts per day (mean 28) have been reported (Appendix G2), with no trend in the median number of lifts per day (Appendix G3).

There were very few zero records for total catch, which suggests that there were few trips where eels were not caught (Appendix G4). There is no trend in the proportion of zeros for either shortfin or longfin.

There are no consistent trends in annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data for all eels, shortfin, or longfin (Appendix G5). Overall the all eel catch rate ranges from about 3 to 6 kg per lift.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 120 kg per day (mean 25), with no trend in the median catch per day which was zero in all but one year (Appendices G6 and G7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix G8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain nearly all the catch, and seventeen of the 22 original fishers (Appendix G9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day, with a declining trend until 1999 after which it increases sharply (Appendix G10). The variables permit, lifts, and month were included in the model and explained 49% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix G11, influence step plots in Appendix G12, and CDI plots for each of the model predictor variables in Appendices G13–G15. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics and CPUE (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 20 and 120 kg per day (mean 27). There is no trend in the median catch per day which was zero for all but one year (Appendices G16 and G17).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix G18. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain about two-thirds of the catch, and seven of the twenty five original fishers (Appendix G19, Appendix 2).

The standardised CPUE for post-QMS shortfin catch followed the same general pattern as unstandardised catch per day with the exception of the last two years Standardised CPUE shows a generally increasing trend with the exception of 2008 (Appendix G20). The variables permit, lifts, and month were included in the model and explained 55% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix G21, influence step plots in Appendix G22, and CDI plots for each of the model predictor variables in Appendices G23–G25. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 160 kg per day (mean 83), with a drop in the median catch per day after 1995 (Appendices G26 and G27).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix G28. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and nineteen of the 26 original fishers (Appendix G29, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day and showed a decline until 1996, after which it was flat (Appendix G30). The variables permit, lifts, and month were included in the model and explained 53% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix G31, influence step plots in Appendix G32, and CDI plots for each of the model predictor variables in Appendices G33–G35. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics and CPUE (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 120 kg per day (mean 71) with no trend in the median catch per day (Appendices G36 and G37).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix G38. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain more than three-quarters of the catch and ten of 32 original fishers (Appendix G39, Appendix 2).

The standardised CPUE for post-QMS longfin catch followed the same general pattern as unstandardised catch per day with a trend of increasing CPUE until 2007 and thereafter a decline (Appendix G40). The variables permit, lifts, and month were included in the model and explained 56% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix G41, influence step plots in Appendix G42, and CDI plots for each of the model predictor variables in Appendices G43–G45. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

3.2.8 Southland (ESA AW)

Fishery characteristics 1991–2010

Reported annual eel catches in ESA AW overall declined after 1995 but have been stable after this time, although the lowest catches were in the last two years (2009 and 2010) (Appendix H1). A low proportion of catch (0.3%) has been reported as unidentified (EEU) and this was only used from 1996 to 2000 (Table 3, Appendix H1). In all 20 years of the time series longfin have been by far the dominant species in the catch (LFE 81%, SFE 19%) with no trend in species proportions (Table 3, Appendix H1).

The number of lifts ranges between a few to over 150 per day but most often between 10 and 50 lifts per day (mean 30) have been reported (Appendix H2), with no trend in the median number of lifts per day (Appendix H3).

There were very few zero records for total catch, which suggests that there were few trips where eels were not caught (Appendix H4). There were substantially more catches that had no shortfin reported than catches that had no longfin reported. There is no trend in the proportion of zeros for either shortfin or longfin.

There are no consistent trends in annual unstandardized catch rates (total catch in each year/ total number of lifts in each year) using raw data for all eels, shortfin, or longfin (Appendix H5). Overall the all eel catch rate ranges from about 4 to 7 kg per lift.

Shortfin pre-QMS fishery characteristics and CPUE (1991–2000)

Shortfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 160 kg per day (mean 26), with no trend in the median catch per day which was zero in all years (Appendices H6 and H7).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix H8. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The shortfin core data used in the CPUE analyses retain nearly all the catch, and twelve of the 25 original fishers (Appendix H9, Appendix 2).

The standardised CPUE for pre-QMS shortfin catch followed the same general pattern as unstandardised catch per day, with indications of a slight downward trend (Appendix H10). The variables permit, lifts, and month were included in the model and explained 72% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix H11, influence step plots in Appendix H12, and CDI plots for each of the model predictor variables in Appendices H13–H15. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Shortfin post-QMS fishery characteristics and CPUE (2001–2010)

Shortfin daily catch is dominated by zeros with positive catch most commonly between 20 and 160 kg per day (mean 34). There is no trend in the median catch per day which was zero for all but one year (Appendices H16 and H17).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix H18. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain most of the catch, and eight of the twenty five original fishers (Appendix H19, Appendix 2).

The standardised CPUE for post-QMS shortfin catch followed the same general pattern as unstandardised catch per day and shows a clear increasing trend in CPUE (Appendix H20). The variables permit, lifts, moon phase, month, and Mataura River flow were included in the model and explained 42% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix H21, influence step plots in Appendix H22, and CDI plots for each of the model predictor variables in Appendices H23–H27. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin pre-QMS (1991–2000)

Longfin pre-QMS daily catch was dominated by zeros, with positive catch most commonly between 20 and 220 kg per day (mean 118), with no trends in the median catch per day (Appendices H28 and H29).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix H30. The original number of records (positive catches only), fishers, and longfin catch, and those included in the CPUE model core data following the restrictions are shown in Appendix 2. The longfin core data used in the CPUE analyses retain most of the catch and sixteen of the 28 original fishers (Appendix H31, Appendix 2).

The standardised CPUE for pre-QMS longfin catch followed the same general pattern as unstandardised catch per day and showed a steady decline until 2000 when it has increased sharply (Appendix H32). The variables permit, lifts, and month were included in the model and explained 49% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix H33, influence step plots in Appendix H34, and CDI plots for each of the model predictor variables in Appendices H35–H37. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

Longfin post-QMS fishery characteristics and CPUE (2001–2010)

Longfin daily catch is dominated by zeros with positive catch most commonly between 20 and 220 kg per day (mean 132) with no trend in the median catch per day (Appendices H38 and H39).

The relationship between longfin catch and years of participation in the fishery is shown in Appendix H40. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The longfin core data retain most of catch and ten of 27 original fishers (Appendix H41, Appendix 2).

The standardised CPUE for post-QMS longfin catch followed the same general pattern as unstandardised catch per day with no clear trend until after 2007 when CPUE increases (Appendix H42). The variables permit, lifts, and month were included in the model and explained 47% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix H43, influence step plots in Appendix H44, and CDI plots for each of the model predictor variables in Appendices H45–H47. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

3.2.9 Te Waihora (ESAs 21, AS1, and AS2)

Fishery characteristics (ESA AS) 1991–2010

ESA 21 includes the entire lake before AS codes were introduced. Thereafter, AS1 includes the fishery within the entire lake outside the migration concession area, and AS2 the portion of the lake inside the migration area which operates only for the months of February and March. Catches were especially low in 1994, the year a minimum legal size (MLS) of 140 g was introduced, increasing by 10 g per year until 2002 when it reached the national MLS of 220 g. Reported estimated annual eel catches in ESA combined AS1 and AS2, with the exception of a few years, have been reasonably stable over the time series averaging about 105 t (Appendix I1). No catch in Te Waihora was reported as unidentified (EEU) (Table 3, Appendix I1). In all 20 years of the time series shortfin have been by far the dominant species in the catch (SFE 99%, LFE 1%) (Table 3).

3.2.10 Te Waihora (AS1, lake outside migration area)

Fishery characteristics (ESA AS1)

AS1 includes the Te Waihora fishery outside the migration area (AS2) which was established in 1996, but reporting codes were not introduced until 2001 and hence the beginning of our time series is taken from 2001 when we could positively identify catch location within the lake. This also marks the year that South Island eels, including Te Waihora, were introduced into the QMS.

Reported annual eel catches in ESA AS1 average about 69 t per year (Appendix I2). In all 10 years of the time series shortfin have been by far the dominant species in the catch (SFE 99%, LFE 1%) with no trend in species proportions (Appendix I2).

The number of lifts ranges between a few to over 80 per day, but most often less than 20 lifts per day (mean 13) have been reported (Appendix I3), with indications of a declining trend in median number of lifts per day, accentuated by the high median value in 2001 (Appendix I4).

There were very few zero records for total catch or shortfin, which suggests that there were few trips where eels, including shortfin, were not caught (Appendix I5). There were substantially more catches that had little or no reported longfin in the catch and there are indications that the proportion of zeros has been gradually declining for longfin.

There is a clear trend of increasing annual unstandardized shortfin catch rates (total catch in each year/ total number of days in each year) using raw data (Appendix I6). Overall the all eel catch rate ranges from about 150 to 450 kg per day.

Shortfin post-QMS fishery characteristics and CPUE (2001–2010)

Shortfin daily catch is most commonly between 40 and 400 kg per day (mean 254) and there is a clear trend of increasing median catch per day (Appendices I7 and I8).

The relationship between shortfin catch and years of participation in the fishery is shown in Appendix I9. The original number of records (positive catches only), fishers, and shortfin catch, and those included in the core data following the restrictions are shown in Appendix 2. The shortfin core data retain most of the catch, and seven of the eleven original fishers (Appendices I9 and I10).

The standardised CPUE for post-QMS shortfin catch followed the same general pattern as unstandardised catch per day and shows a clear increasing trend in CPUE until 2007 after which it is generally flat (Appendix I11). The variables permit and month were included in the model and explained 40% of the variation in CPUE (Appendix 3).

Residual diagnostics are shown in Appendix I12, influence step plots in Appendix I13, and CDI plots for each of the model predictor variables in Appendices I14–I15. Standardised indices and 95% confidence intervals are tabulated in Appendix 4.

4. DISCUSSION

This report presents catch per unit effort analyses for the South Island commercial freshwater eel fishery from 1991 to 2010 carried out at the level of statistical area, with the exception of the analyses for ESAs AP and AQ which were combined. In Te Waihora analyses were carried out only for AS1 (the lake) from 2001 onward when codes were introduced to distinguish catches from AS2 (migration area). Unlike previous CPUE analyses (Beentjes & Bull 2002, Beentjes & Dunn 2003a, 2008), which were continuous, all analyses in the present report were split between pre- and post-QMS because of concerns that new entrants dominated the effort post-QMS and further that many of these were individuals that had previously fished for a permit holder. There was concern at the effect that this could have on the permit holder coefficients.

4.1 Estimated catch used in CPUE analyses

In the freshwater eel fishery, catch of each species is estimated by observation of catches in fyke nets or in holding bags, and not using standard fish bins containing separated species. There is therefore the possibility that in catches dominated by one species, the minor catch may be overlooked or underestimated. Only two species (SFE and LFE) are caught in any abundance in fyke nets and these will always have been included in the catch-effort section of CELRs, whereas current ECER form has dedicated fields for SFE and LFE catch. Overall, total groomed estimated catch used in the CPUE analyses was 96% of the total reported landed catch for the South Island (see Figure 4). The data before 2001 had between 6 and 11% of records deleted because of errors in CELR reporting (Beentjes & Dunn 2003a), and thereafter with the introduction of the ECER form very few records were removed from the analyses during grooming. The trends in estimated and landed eel catch are similar, indicating that estimated catch is likely to be proportional to total landed catch, and hence suitable for CPUE analysis.

4.2 Catch and species distribution

The trend of declining estimated eel catch of all South Island eels from 1992 to about 2000 is mostly due to the decrease in longfin catch as shortfin catch is reasonably stable throughout the time series (see Figure 6). Indeed the South Island longfin average catch from 2001 onward is nearly half that of the period up to 2001. The trend is of declining estimated eel catch is evident in all ESAs except Te Waihora which has maintained a reasonably stable catch over the 20 year time series (see Appendices A1 to I1). The decline in longfin catch cannot be attributed to the introduction of the QMS in 2001 because there are no quotas set for individual eel species, but is consistent with the trends of declining longfin CPUE over the same period (Beentjes & Bull 2002, Beentjes & Dunn 2008).

All South Island ESAs have both shortfin and longfin reported catches, but in general shortfin was the dominant species in Te Waihora and the north east areas, whereas longfin was dominant in the south and west (see Figure 5). The bulk of the shortfin catch in ESA AX is probably from Lake Brunner on the Grey River, an important shortfin fishery (Beentjes & Chisnall 1997, 1998, Beentjes 1999).

The relative proportions of the South Island catch contributed by each ESA up to 2010 have remained largely unchanged since the 1980s (Jellyman 1994), although the proportion contributed by Te Waihora (AS) has increased from about 21% (1984–1992) to 30% (1991 to 2010) and similarly, the proportion contributed by the west coast (ESA AX) has doubled from 7% to 14%. In the 1980s the catches from Otago (AV) and Southland (AW) each were larger than that from Te Waihora, whereas catch from the latter area is now by far the largest contributor of eel catch in the South Island, albeit mostly shortfin (see Figure 5).

Reporting catches as EEU presents problems in catch effort analyses for individual species. The extent to which EEU, rather than LFE or SFE, was recorded by fishers varied between regions. In general, a high proportion of the catch was recorded by species where one species was dominant, e.g., Southland and Te Waihora. In these ESAs, catches were predominantly longfin or shortfin respectively, compared to other areas where a mixture of both species made it more difficult for fishers to estimate the true proportion. The introduction of South Island freshwater eels into the Quota Management System in October 2000 required fishers to be more diligent in completing the CELR form resulting in an improved quality of catch effort data. Indeed, there are no records of EEU being used in 2001 with all catches being identified to species. Replacement of the CELR form with the ECER and ECLR on 1 October 2001 did not give the option of recording EEU and there have been no records of EEU in the catch effort data since 2000.

Te Waihora catches were relatively stable over the time series apart from a very large catch in 1992 (exceeding the controlled fishery limit of 121 t), and sharp drops in catch in 1994 (when the minimum legal size was introduced to the lake — 140 g increasing by 10 g a year until 220 g) and in 2000 (the year before the fishery was introduced into the QMS). There appears to be a reciprocal relationship between catches from the migration area (AS2) and outside the migration area (AS1). In other words, high catches in AS2 coincided with low catches in AS1 and vice versa, an outcome of having the total catch capped (controlled fishery until 2000, then a TACC from 1 October 2000, under the QMS). The estimated catches in Te Waihora for AS1 and AS2 combined in 2010 was 148 t (see Appendix I1) which greatly exceeds the landed catch of 98 t reported in Table 4 of Ministry of Fisheries (2011). In previous years the correlation between estimated and landed catch is also poor and this is to some extent a result of the 1 February to 31 January fishing year that has been in effect in Te Waihora since 2002, whereas our analyses are structured on the standard 1 October to 30 September fishing year.

4.3 CPUE analyses

Catch rates

Unstandardised catch rates (kg per lift) for total catches were generally similar among all areas, and ranged between about 3 and 14 kg per lift, but most frequently was between about 4 and 6 kg per lift. An analysis of catch per lift for six years in the late 1980s (Jellyman 1994), showed that mean catch rates historically were overall higher for each ESA. For example catch rates for Southland (AW) ranged from about 7 to 10 kg per lift compared with catch rates from 1991 to 2010 of about 4 to 7 kg per lift indicating that catch rates have declined over time. For the north and northeast ESAs (AN, AP-AQ, AR, AT, and AU) the variable nature of the indices makes it difficult to comment on the trend in catch rates for total catch or individual species. However, for the key areas over the period 1991 to 2010, catch rates of total eel and shortfin catch increased slightly in ESA AX, longfin decreased in ESA AV, and in ESA AW no trends were evident.

Standardised CPUE analyses

Past South Island eel CPUE analyses were carried out as continuous time series beginning in 1991 for each of the ESAs (Beentjes & Dunn 2008). This produced some equivocal results for areas with sparse data and few fishers in the core data set. For these areas, CPUE exhibited high annual variation and had very large confidence intervals around the indices with the result that indices of abundance were spurious. This was compounded by the reduction in total numbers of fishers following the introduction of eels into the QMS in 2000 after which the number of core fishers in the analyses frequently dropped away dramatically. Further, many of the existing fishers were replaced by new entrants after 2001. Given this, the Eel Working Group (EELWG-2012-05) made the decision to split CPUE analyses into pre- and post-QMS time series with post-QMS CPUE analyses only required for areas with sufficient data and fishers (ESAs AX, AV, AW and AS1). Summary plots of the standardised CPUE indices for all areas are shown in Figures 7 to 11 for pre-QMS analyses only (ESAs AN, AP-AQ, AR, AT and AU), Figures 12 to 14 for areas with both pre- and post QMS analyses (ESAs AX, AV, AW), and Figure 15 for AS1 where only post-QMS analyses was done.

The standardised CPUE analyses take into account the effects that the variables lifts, fisher (permit), season (month), moon phase, and river flow may have had on catch rates (see Appendix 3). Excluding Te Waihora, the three variables permit, lifts, and month were included in nearly all models, with lifts and permit typically explaining the most variability in the models (see Appendix 3). The finding that month was an important variable affecting catch rates is understandable since water temperature varies seasonally and eel catch rates have been found to decline markedly in winter (Jellyman 1991, 1997). Further, very little fishing and processing of eels occurs in the South Island in the winter months. The inclusion of permit also indicates the importance of fisher experience and/or ability on catch rates. Lifts was generally included as it is the key indicator of relative effort. River flow entered the model for ESAs AN, AP-AQ, AX, and AW and more often for shortfin. Moon phase entered the model for ESAs AN, AP-AQ, AU and AW. Despite the inclusion of explanatory variables into the model there was little difference between the plotted trends of the unstandardised and the standardised CPUE indices.

In Te Waihora, neither lifts nor river flow were offered to the model because of the change in type and number of nets over time (Beentjes & Bull 2002), and river flow was not relevant to a lake. Permit and month were included in the Te Waihora AS1 model.

Shortfin CPUE summary

For the data poor areas (AN, AP-AQ, AR, AT, and AU), all pre-QMS shortfin indices showed some indications of a declining trend in CPUE from 1991 to 2000, and this was most marked in ESA AP-AQ (Figures 7 to 11).

For the data rich areas (AX, AV, AW, and AS1), pre-QMS shortfin indices showed declines in CPUE for ESAs AV and AW, but in AX the initial decline was followed by a sharp increase in CPUE for the most recent years (Figures 12 to 14). Post-QMS shortfin showed trends of increasing CPUE in all areas and this was most marked in AW and AS1 (Figures 14 and 15).

Longfin CPUE summary

For the data poor areas (AN, AP-AQ, AR, AT, and AU), the pre-QMS longfin indices were less clear cut than for shortfin with no area displaying strong and consistent trends in CPUE over time, with the exception of AP-AQ where CPUE has generally declined (Figures 7 to 11).

For the data rich areas (AX, AV, and AW), pre-QMS longfin indices showed clear declines in CPUE for ESAs AV and AW, but in AX the CPUE increased over time (Figures 12 to 14). Post-QMS longfin showed clear trends of increasing CPUE in AX and AV, and to a lesser extent in AW.

CPUE trends

Overall, for shortfin in the key areas (excluding Te Waihora) CPUE has been increasing since about 2000 following declines. Similarly, for longfin in key areas, CPUE are trending in a similar manner except for the West Coast (AX) where CPUE has been steadily increasing throughout both the pre- and post QMS periods.

Increases in CPUE may partially be a result of the introduction of TACCs that were set well below previous catches and have only been 67–75% caught each year (see Figure 1). Since the introduction of eels to the QMS, numbers of fishers and hence effort have declined substantially in all ESAs, and there has been a transition from long term existing fishers to new entrants. The most recent commercial catch sampling programme for Southland in 2004 showed that mean size of eels from inland river strata were about 5 cm larger than from 1996 to 1998 (Beentjes 2005), a finding consistent with reduced effort and increasing CPUE.

For Te Waihora (ESA AS1) shortfin, CPUE has increased dramatically since 2002. Before 2000 Te Waihora was managed as a controlled fishery with a capped catch limit of 136.5 t, fished by 11 permit holders. Following introduction into the QMS the TACC was reduced to 122 t (Ministry of Fisheries 2007) and in the first three years the TACC was under-caught by 11–43% and thereafter was 100% caught with the exception of 2010. Fisher numbers also declined as quota was purchased and aggregated. Interpretation of CPUE analysis in Te Waihora also needs to consider the effect of the introduction of the migration concession area in 1996 to harvest undersized migrating shortfin males (between February and March each year) and the incremental changes to the minimum size. Catches in the migration area (AS2) showed large fluctuations from 89 t to 5 t in a just a few years in part because smaller eels have less value and catches are subject to market demands (see Appendix I1). The very low AS2 catch in 2008 was a result of a late start to the season relating to a dispute of the customary ownership of the lake bed (Clem Smith, commercial fisher, pers. comm.) In summary, it is not entirely clear why the CPUE indices for shortfin eels have increased so markedly in Te Waihora, but is probably related to a combination of the above factors, in particular the reduction in effort and catch in the lake since 2001. A discussion with a commercial fisher (pers. comm. Clem Smith) confirms that catches are noticeably better in recent years, consistent with the steep increase in CPUE.

5. ACKNOWLEDGMENTS

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Table 1: Eel Quota Management Areas (QMAs) for longfin (LFE) and shortfin (SFE) eel stocks and both species combined (ANG), current Eel Statistical Areas (ESA, from October 2001), and the associated historical Eel Statistical Areas (ESA, up to September 2001).

	QMA		ESA (alpha) (after 1 Oct 2001)		ESA (numeric) (before 1 Oct 2001)
Area	LFE	SFE			
Northland	LFE 20	SFE 20	AA		1
Auckland	LFE 20	SFE 20	AB		2
Hauraki	LFE 21	SFE 21	AC		3
Waikato	LFE 21	SFE 21	AD		4
Bay of Plenty	LFE 21	SFE 21	AE		5
Poverty Bay	LFE 21	SFE 21	AF		6
Hawke's Bay	LFE 22	SFE 22	AG		7
Rangitikei-Wanganui	LFE 23	SFE 23	AH		8
Taranaki	LFE 23	SFE 23	AJ		9
Manawatu	LFE 22	SFE 22	AK		10
Wairarapa	LFE 22	SFE 22	AL		11
Wellington	LFE 22	SFE 22	AM		12
Nelson	ANG 11	ANG 11	AN		13
Marlborough	ANG 11	ANG 11	AP	}	14
South Marlborough	ANG 12	ANG 12	AQ	}	14
Westland	ANG 16	ANG 16	AX		15
North Canterbury	ANG 12	ANG 12	AR		16
South Canterbury	ANG 14	ANG 14	AT		17
Waitaki	ANG 14	ANG 14	AU		18
Otago	ANG 15	ANG 15	AV		19
Southland	ANG 15	ANG 15	AW		20
Te Waihora (outside-migration area)	ANG 13	ANG 13	AS1	}	21
Te Waihora migration area	ANG 13	ANG 13	AS2	}	21
Chatham Islands	LFE 17	SFE 17	AZ		22
Stewart Island	ANG 15	ANG 15	AY		23

Table 2: ESAs, regions, and the number of groomed records (equivalent to the number of fisher days), and estimated catch for shortfin, longfin, and unidentified eels from 1991 to 2010.

			Estimated catch (t)			
ESA	Region	Records	Shortfin	Longfin	Unidentified	Total
13 (AN)	Nelson	2 289	46	141	99	286
14 (AP and AQ)	Marlborough	2 865	136	88	127	352
15 (AX)	Westland	8 526	267	665	44	976
16 (AR)	North Canterbury	3 661	251	201	65	517
17 (AT)	South Canterbury	3 157	161	155	11	327
18 (AU)	Waitaki	1 290	50	110	4	164
19 (AV)	Otago	7 797	202	613	7	823
20 (AW)	Southland	8 647	253	1 067	4	1 325
21 (AS1 and AS2)	Te Waihora (lake and migration area)	8 294	2057	22	0	2079
Totals		46 526	3 423	3 063	361	6 848

Table 3: Percent of estimated species catch within and among ESAs from combined years 1991 to 2010. Groomed data used in the CPUE analyses. LFE, longfin; SFE, shortfin; EEU, unclassified.

	Percent species catch within areas				Percent species catch among area			
ESA	SFE	LFE	EEU		Total	SFE	LFE	EEU
13 (AN)	16.1	49.4	34.5	100	4.2	1.4	4.6	27.4
14 (AP and AQ)	38.8	25.1	36.1	100	5.1	4.0	2.9	35.2
15 (AX)	27.4	68.1	4.5	100	14.2	7.8	21.7	12.2
16 (AR)	48.5	39.0	12.6	100	7.5	7.3	6.6	18.0
17 (AT)	49.2	47.4	3.4	100	4.8	4.7	5.1	3.1
18 (AU)	30.4	67.3	2.2	100	2.4	1.5	3.6	1.0
19 (AV)	24.6	74.5	0.9	100	12.0	5.9	20.0	2.1
20 (AW)	19.1	80.6	0.3	100	19.3	7.4	34.8	1.1
21 (AS1 and AS2)	98.9	1.1	0.0	100	30.4	60.1	0.7	0.0
Overall	50.0	44.7	5.3	100	100	100	100	100

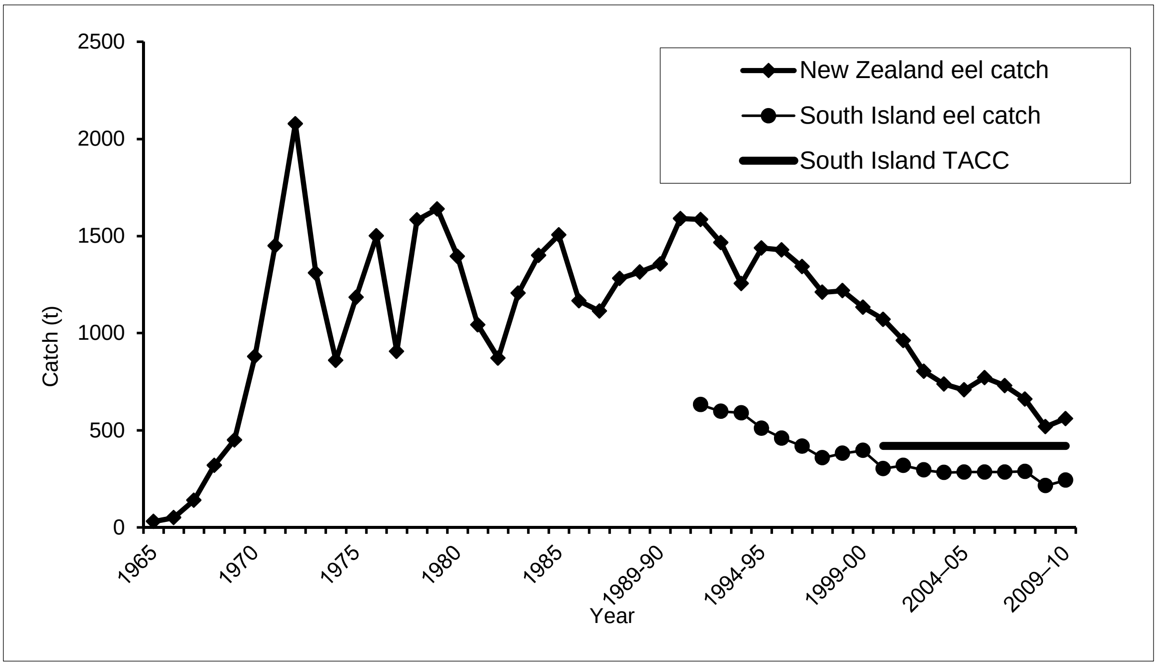

Figure 1: Landed catches of eels from New Zealand and the South Island for shortfin and longfin eel combined. Data for New Zealand catch are shown by calendar year up until 1988 and by fishing year from 1988–99 onward (Data from Ministry for Primary Industries 2012; Tables 1, 2 and 4). These catches are bases on based on MAF Fisheries Statistics Unit (FSU), Licensed Fish Receiver Returns (LFRR), Quota Management Reports (QMR), and Monthly Harvest Returns (MHR).

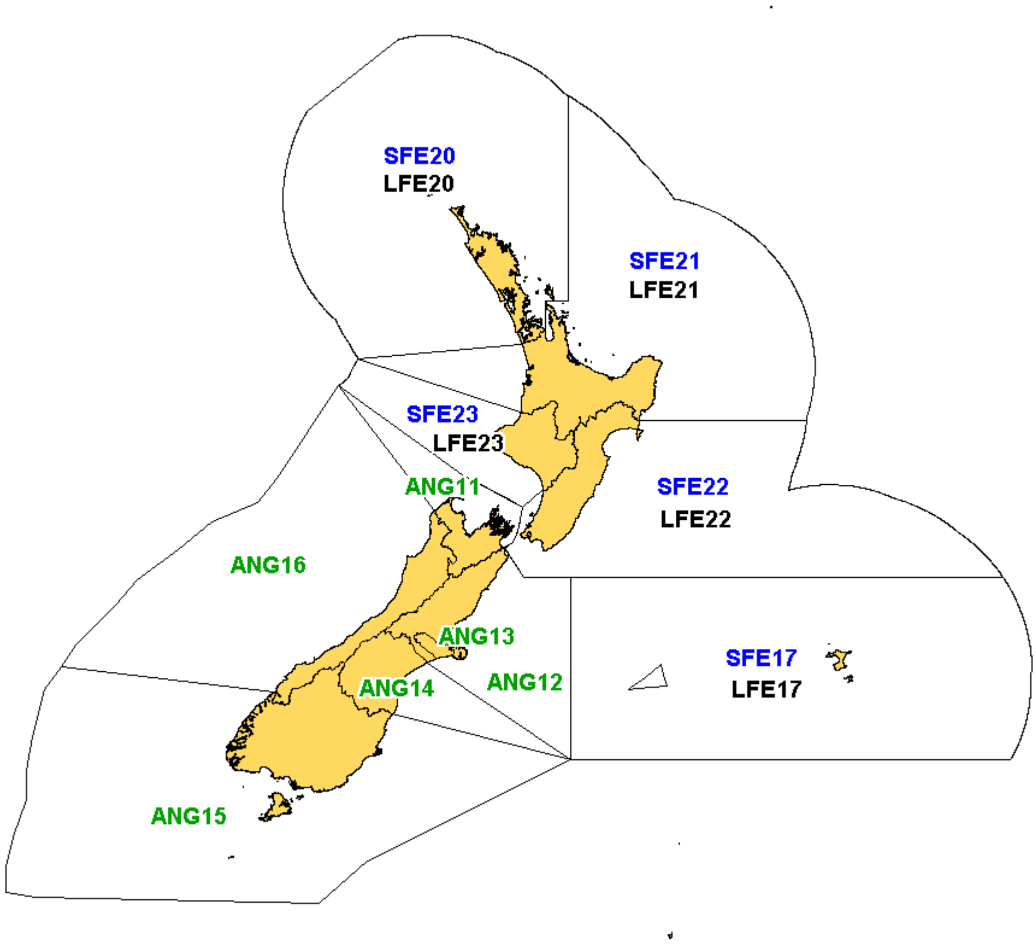

Figure 2: Quota Management Areas for the New Zealand eel fishery (see Table 1 for breakdown by eel statistical areas). Shortfin stocks are denoted by the prefix SFE, and longfin by LFE. ANG comprises both shortfin and longfin combined. (Figure from Ministry of Fisheries 2011).

Figure 3: South Island eel statistical areas (ESAs). See Table 1 for old ESA numeric codes 13 to 23.

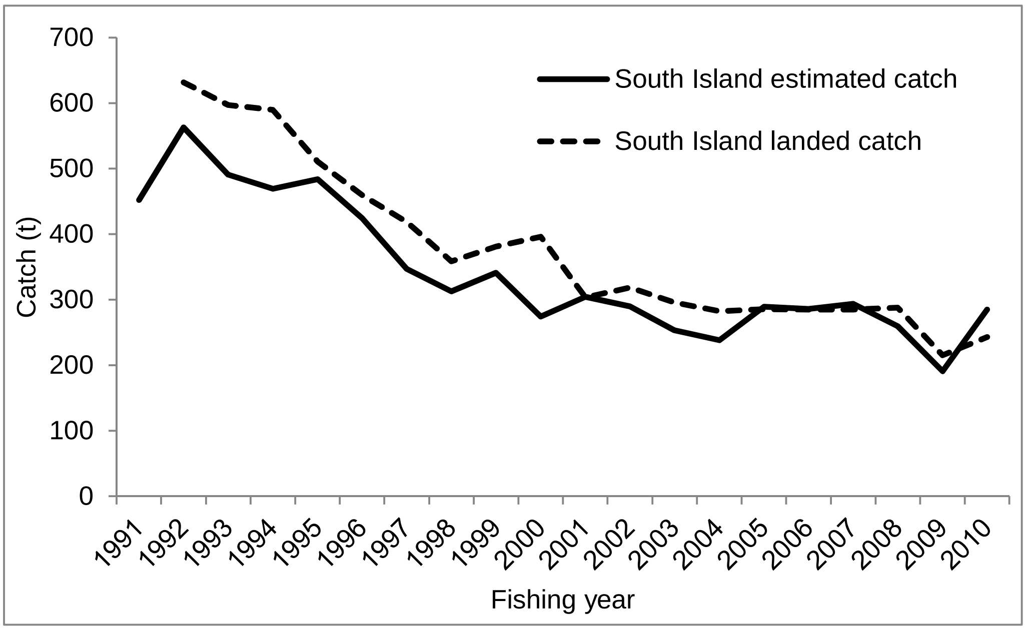

Figure 4: South Island estimated commercial catch of all eels (shortfin, longfin, and unclassified) from 1991 to 2010, and landed catch from 1992 to 2010. Estimated catches are from CELR and ECER (after 2001) and represents the groomed data used in the current CPUE analyses. The landed catches are from processors (1992–2000) and LFRR/QMR (2001–2010) (Ministry of Fisheries 2011, Table 3). 1991 represents the 1990–91 fishing year.

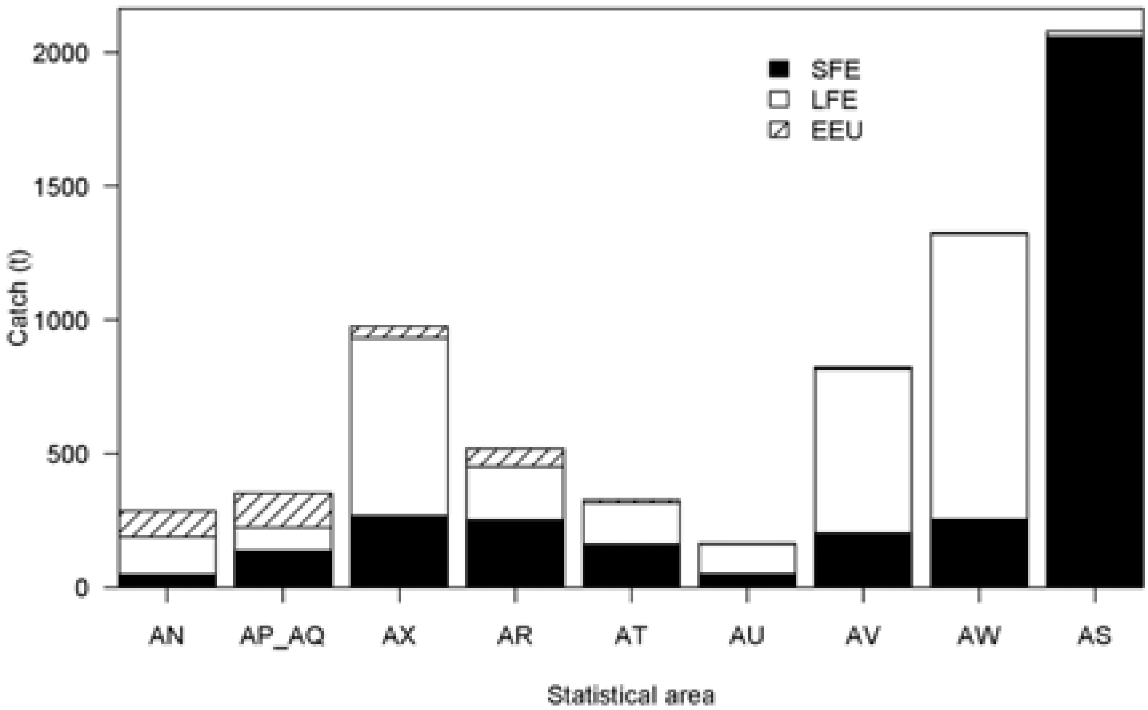

Figure 5: South Island total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) by statistical area for the years 1990–91 to 2009–10.

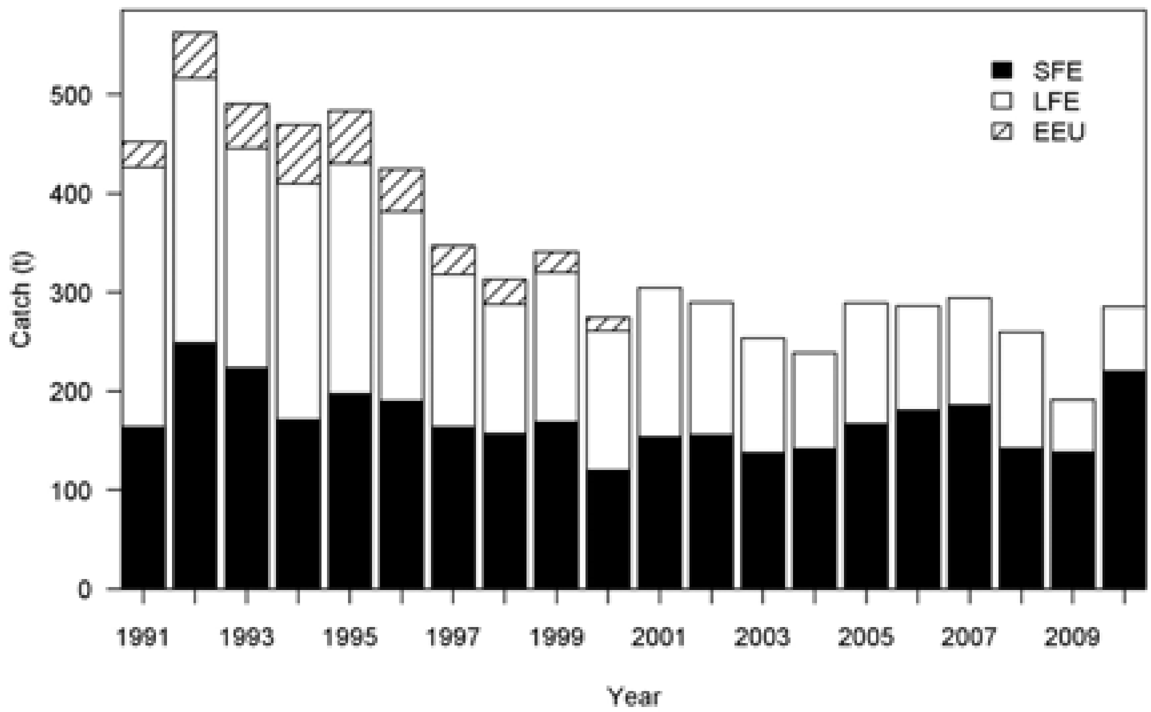

Figure 6: South Island total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10.

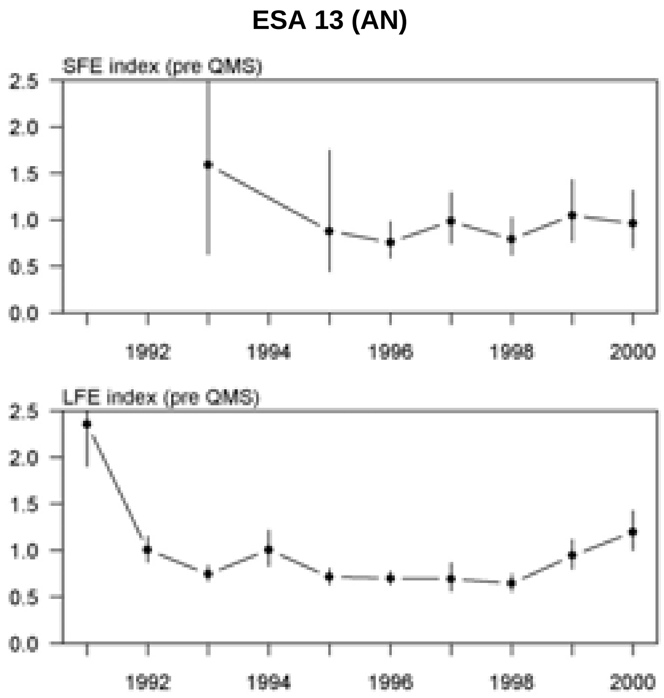

Figure 7: Standardised CPUE indices for shortfin and longfin eel for ESA AN for the years 1991–2000 (pre-QMS).

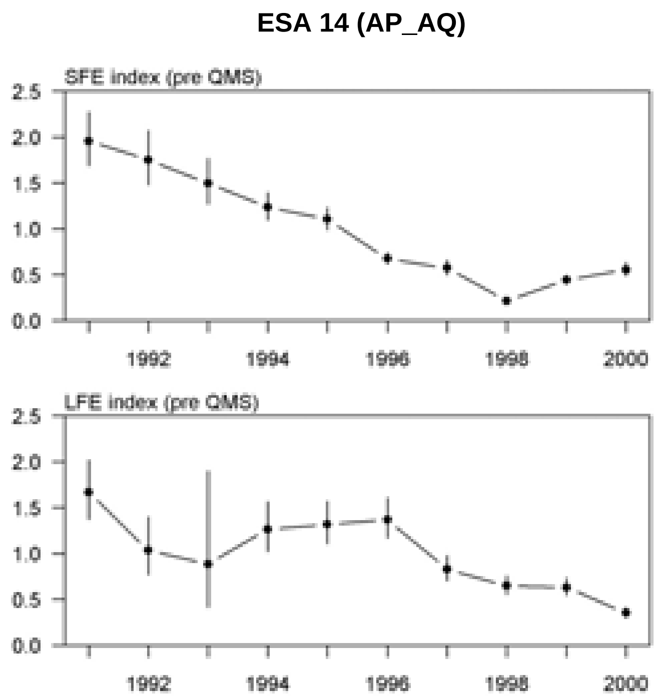

Figure 8: Standardised CPUE indices for shortfin and longfin eel for ESA AP-AQ for the years 1991–2000 (pre-QMS).

ESA 16 (AR)

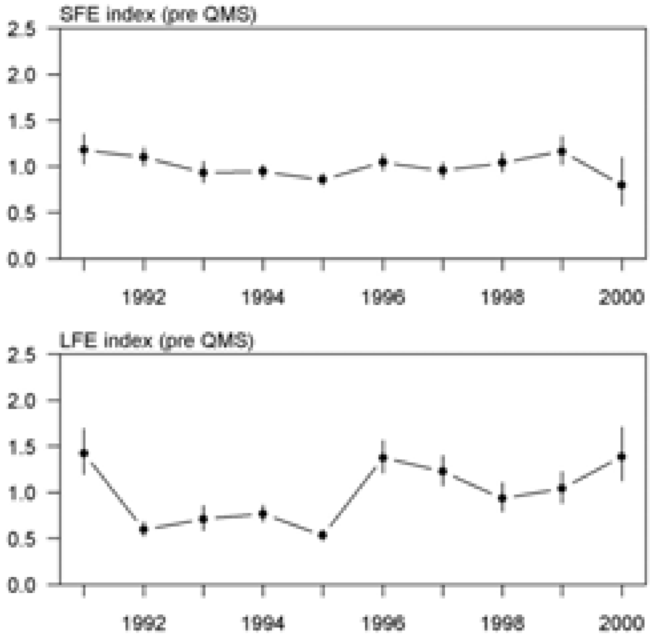

Figure 9: Standardised CPUE indices for shortfin and longfin eel for ESA AR for the years 1991–2000 (pre-QMS).

ESA 17 (AT)

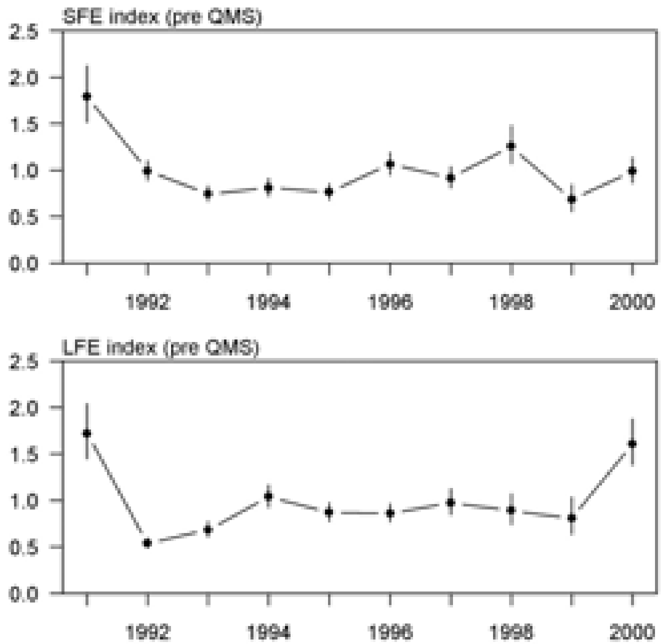

Figure 10: Standardised CPUE indices for shortfin and longfin eel for ESA AT for the years 1991–2000 (pre-QMS).

ESA 18 (AU)

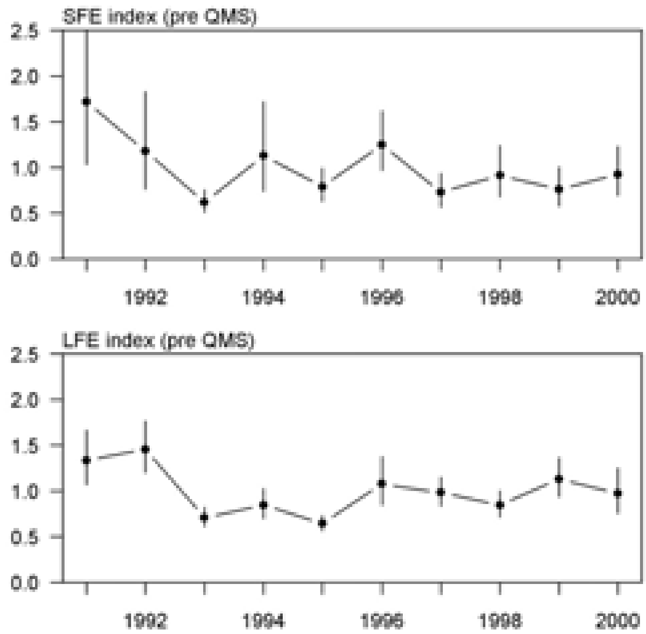

Figure 11: Standardised CPUE indices for shortfin and longfin eel for ESA AU for the years 1991–2000 (pre QMS).

ESA 15 (AX)

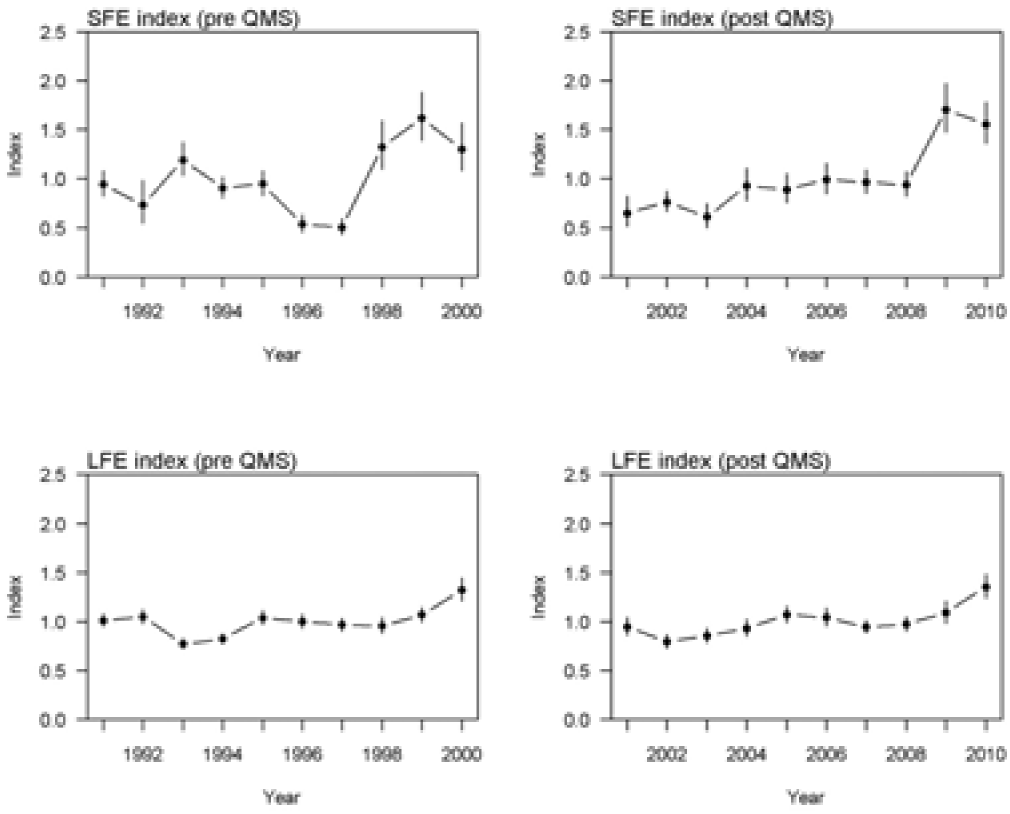

Figure 12: Standardised CPUE indices for shortfin and longfin eel for ESA AX for the years 1991–2000 (pre QMS) and 2001–2010 (post-QMS).

ESA 19 (AV)

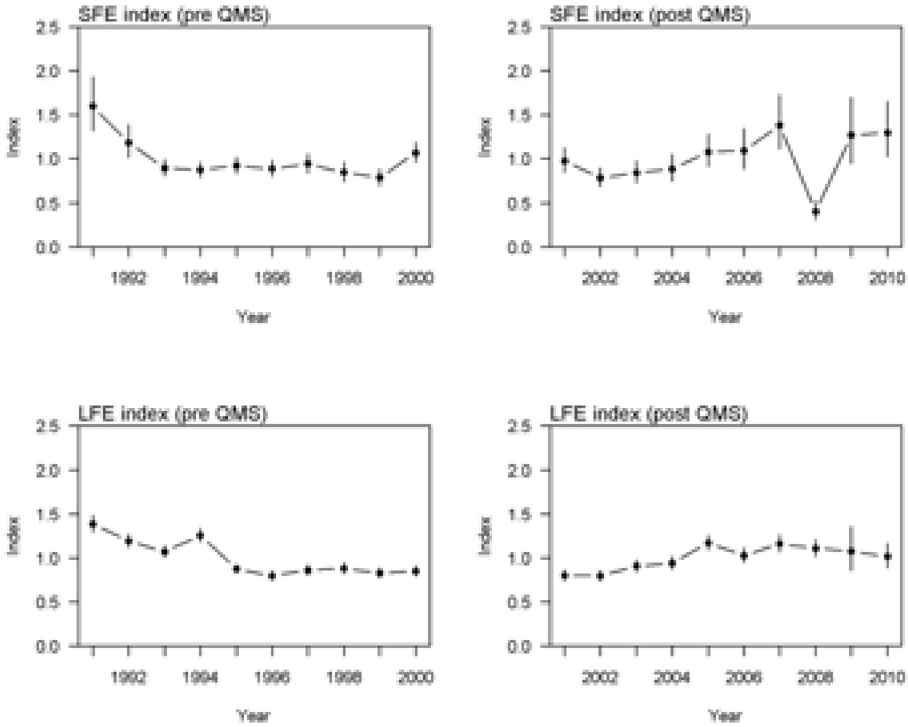

Figure 13: Standardised CPUE indices for shortfin and longfin eel for ESA AV for the years 1991–2000 (pre QMS) and 2001–2010 (post-QMS).

ESA 20 (AW)

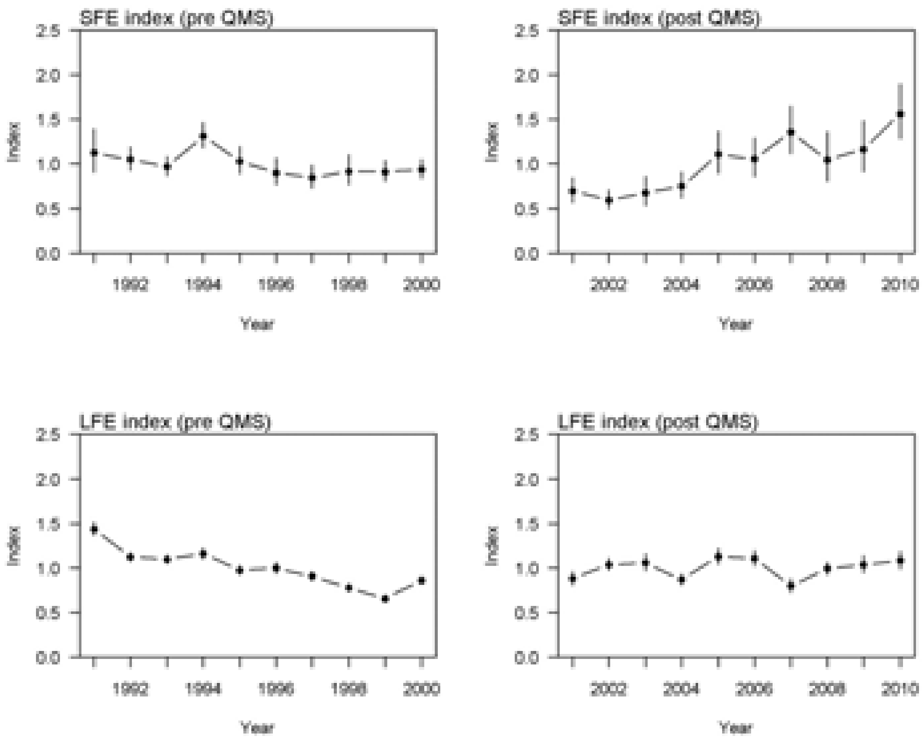

Figure 14: Standardised CPUE indices for shortfin and longfin eel for ESA AW for the years 1991–2000 (pre QMS) and 2001–2010 (post-QMS).

ESA AS1

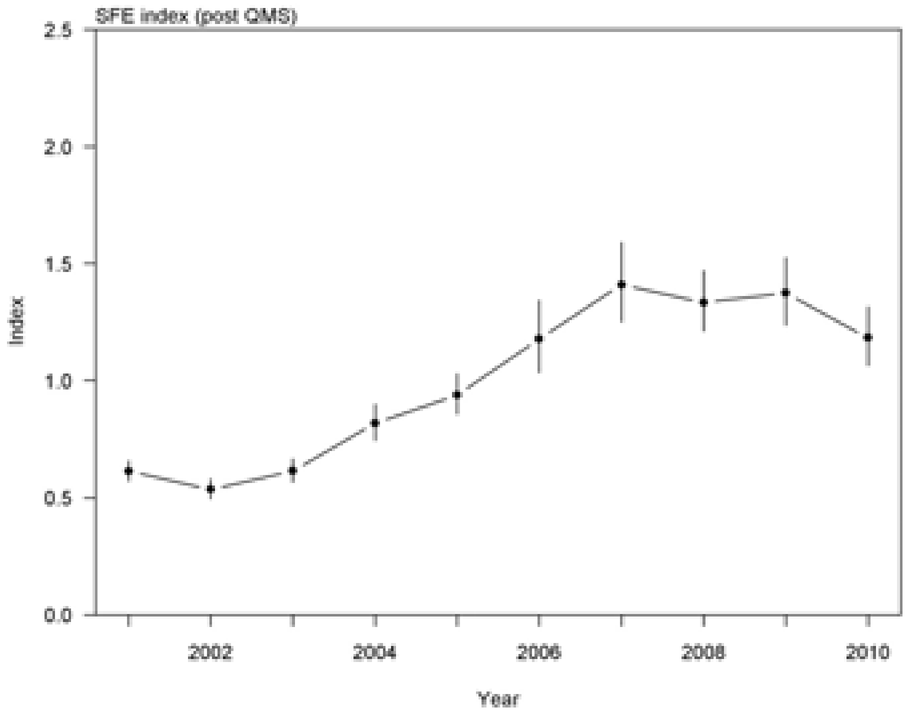

Figure 15: Standardised CPUE indices for shortfin eel for ESA AS1 (Te Waihora) for the years 2001–2010 (post-QMS).

Appendices A to I: Plots of eel fishery characterisation and CPUE analyses by ESA. The plots relating to shortfin eel pre-QMS are shown first, followed by shortfin post QMS, longfin pre-QMS, and then longfin post-QMS.

Appendix A: ESA 13 (AN).

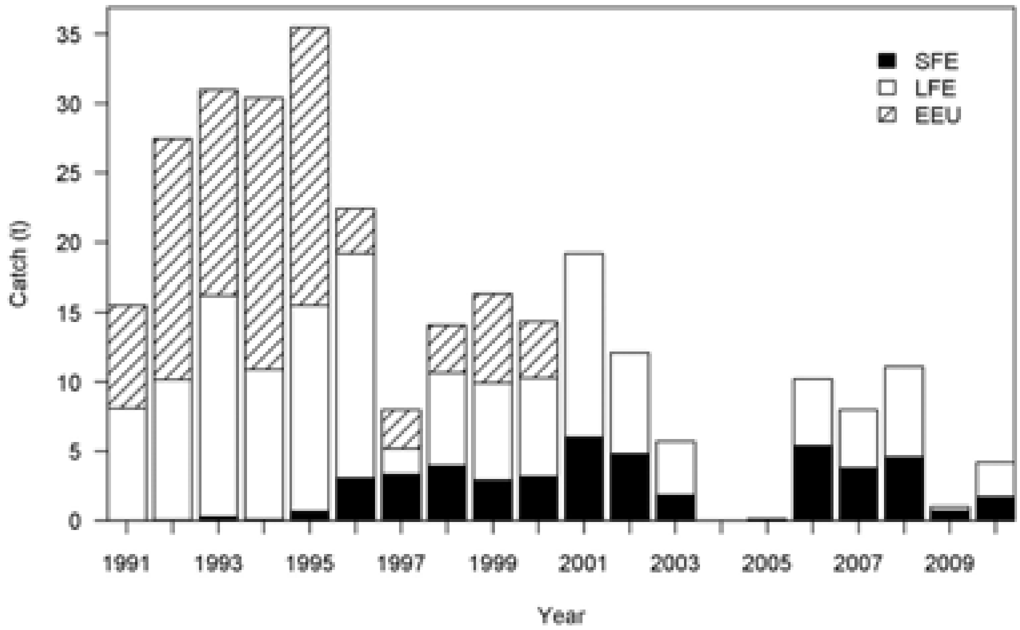

Figure A1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA13 (AN)).

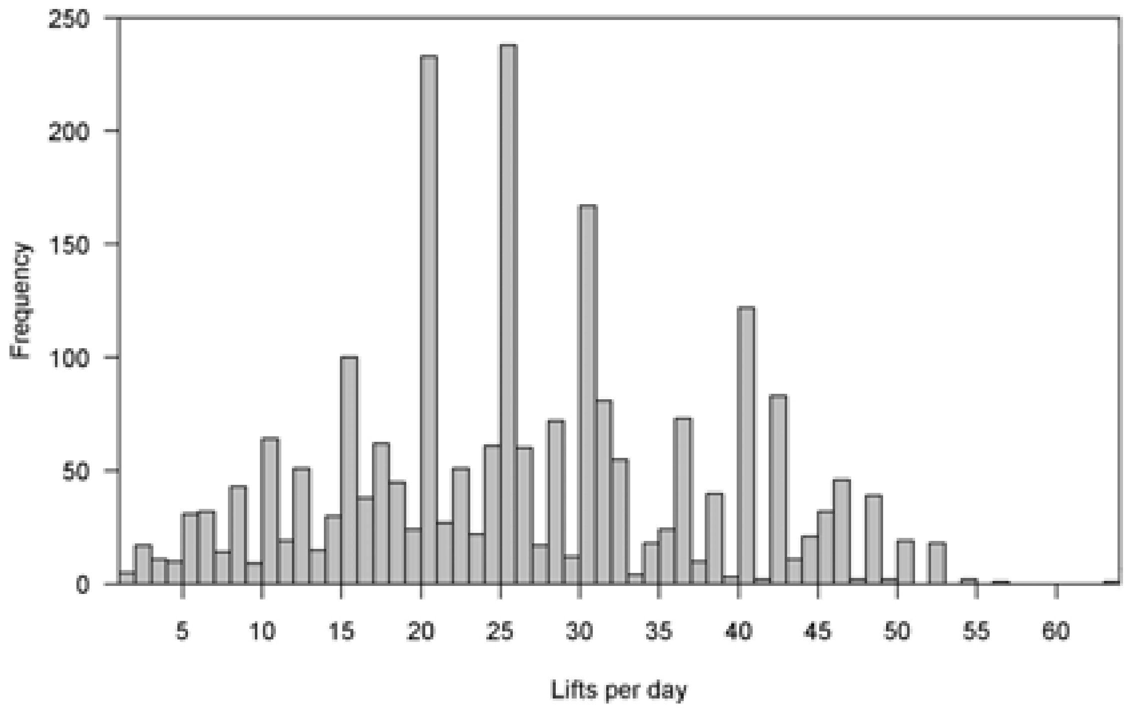

Figure A2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA13 (AN)).

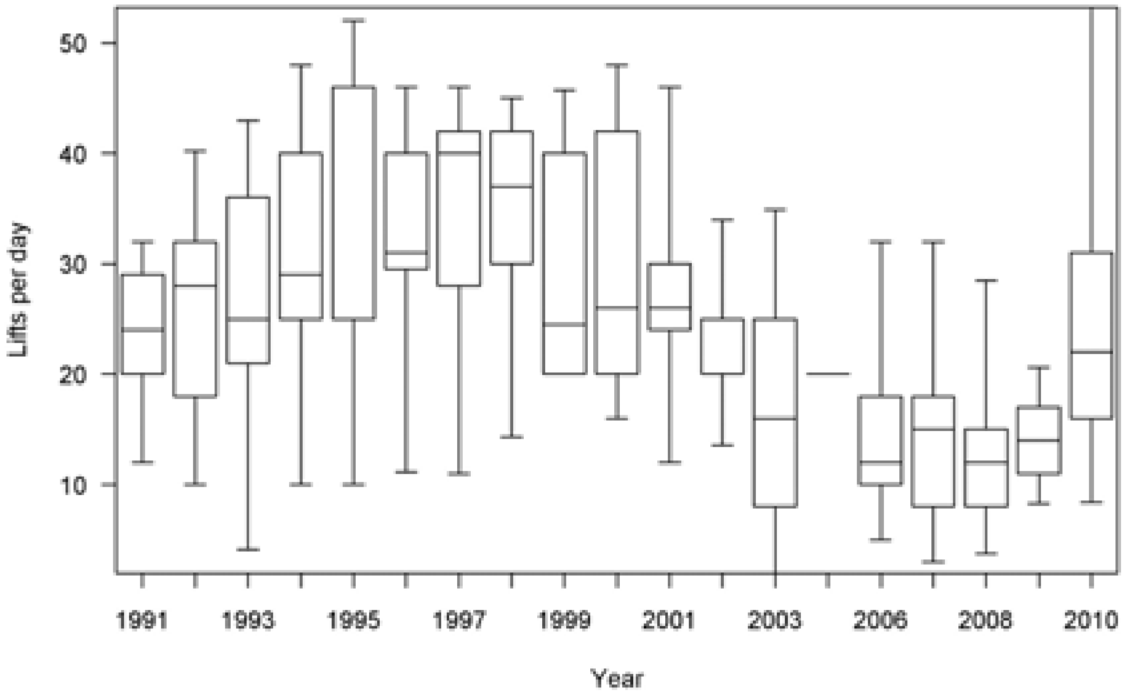

Figure A3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA13 (AN)).

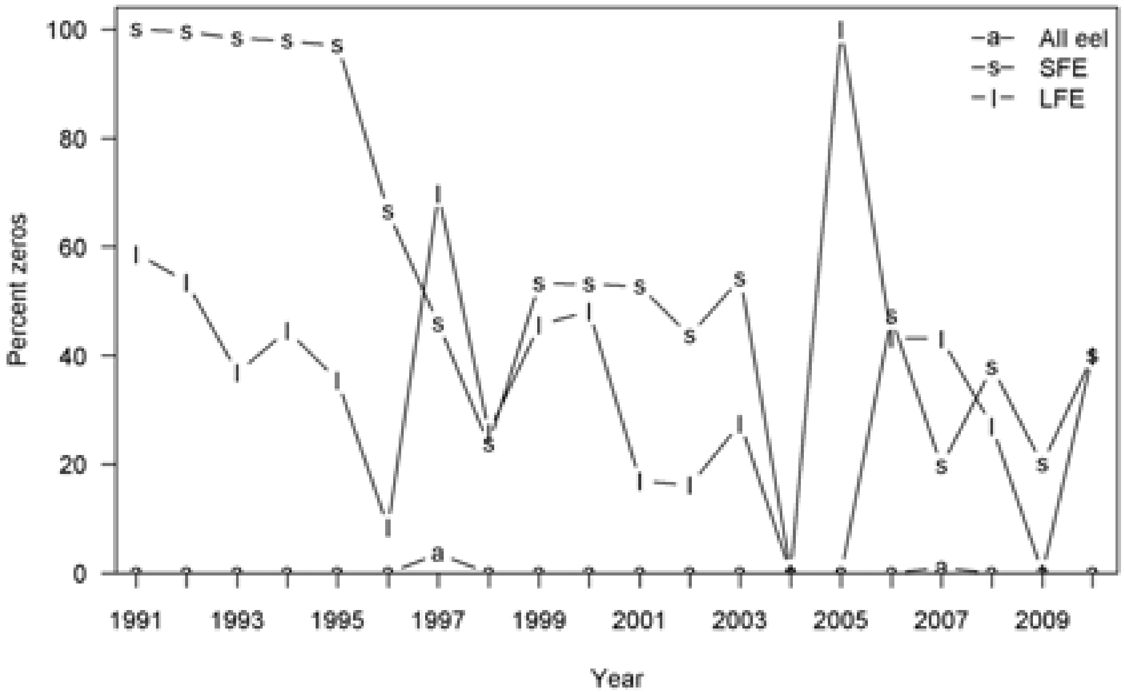

Figure A4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA13 (AN)).

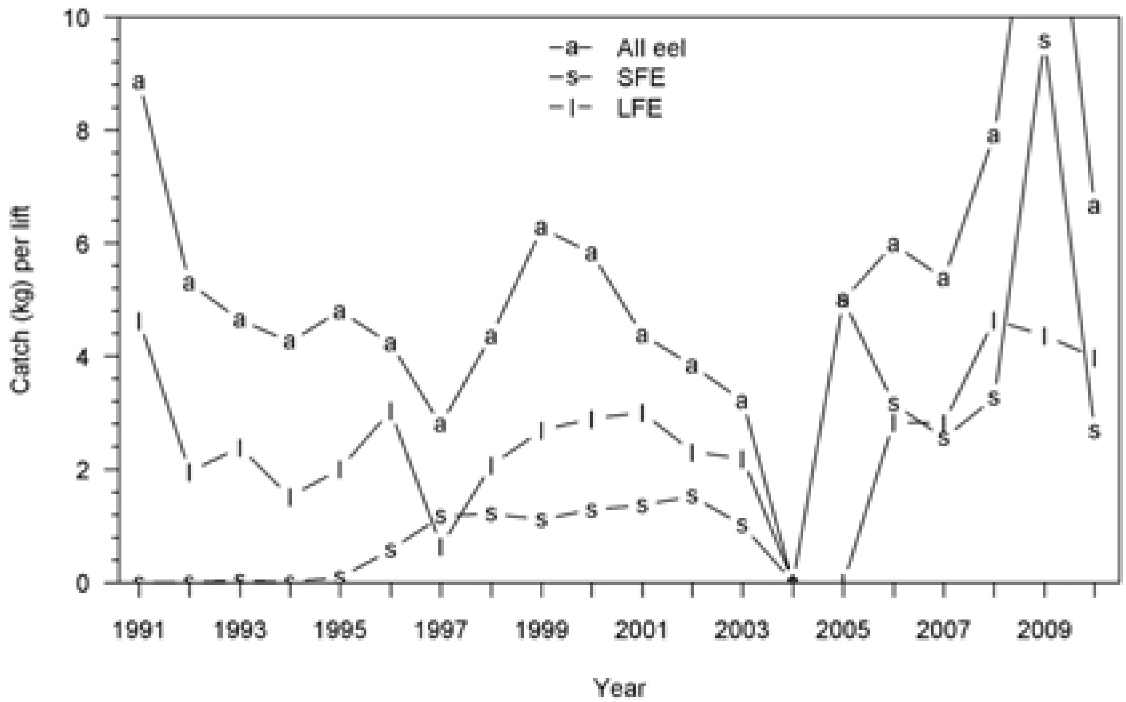

Figure A5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA13 (AN)).

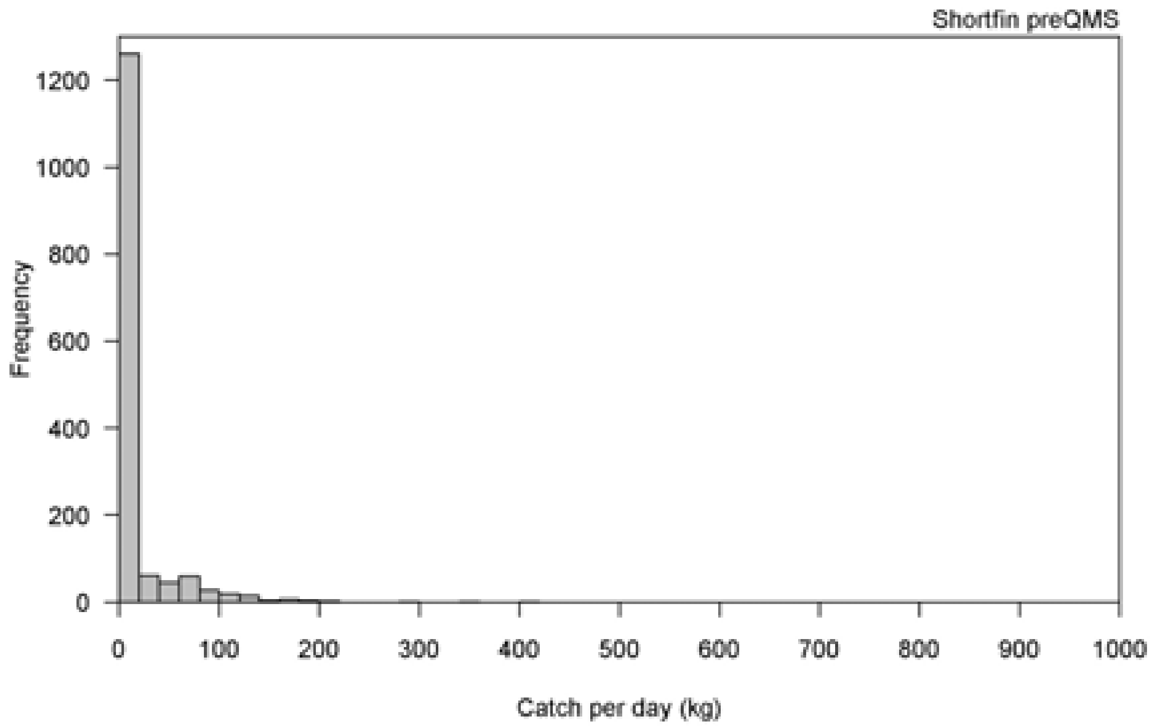

Figure A6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

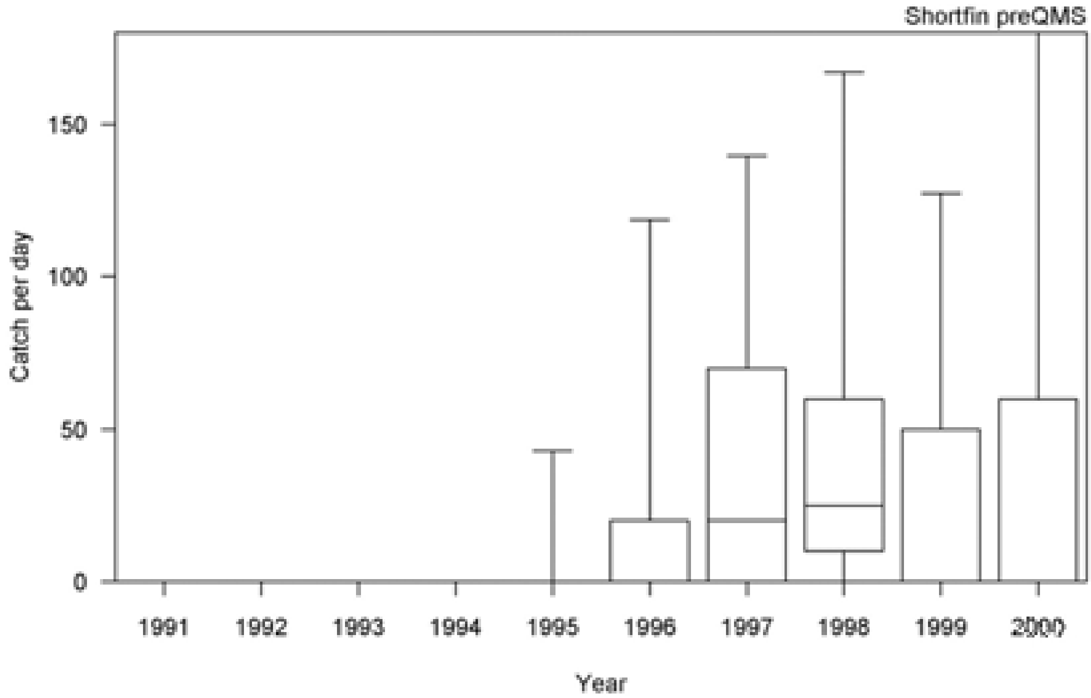

Figure A7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA13 (AN)).

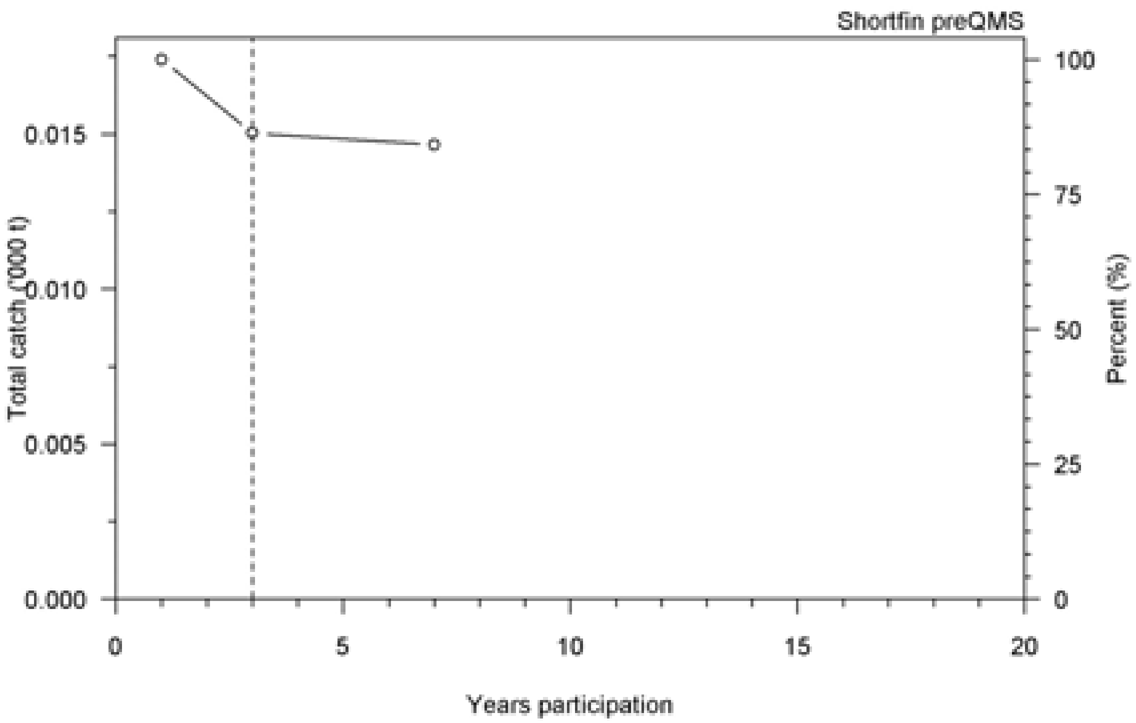

Figure A8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA13 (AN)).

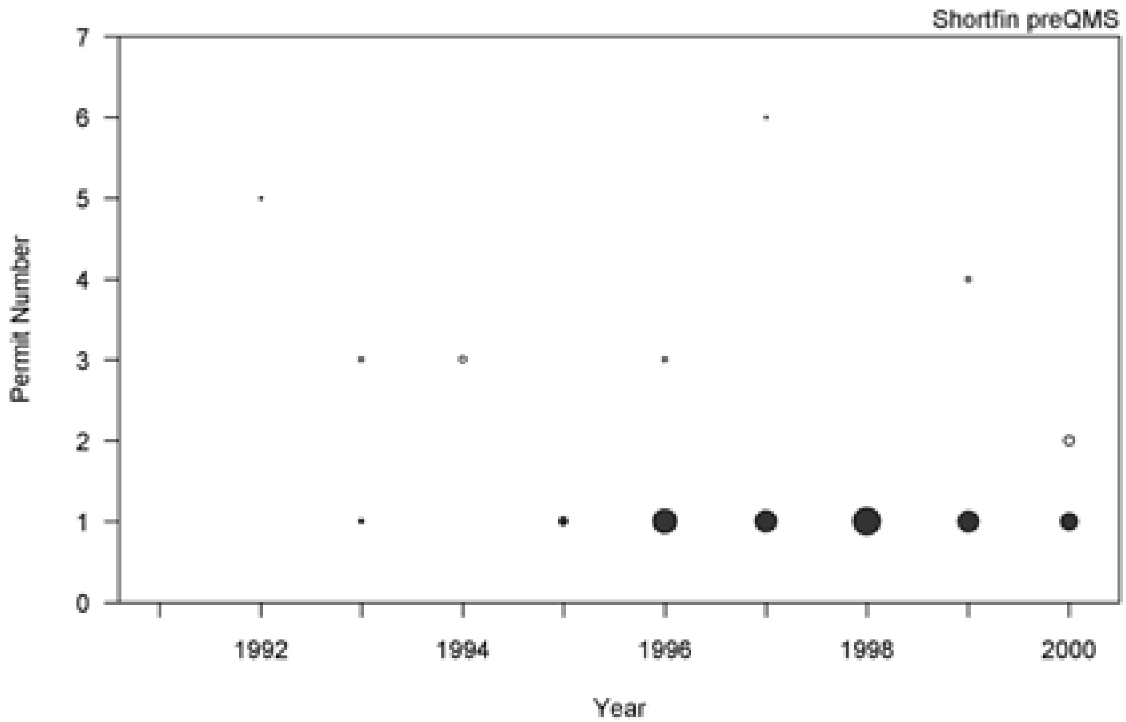

Figure A9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA13 (AN)).

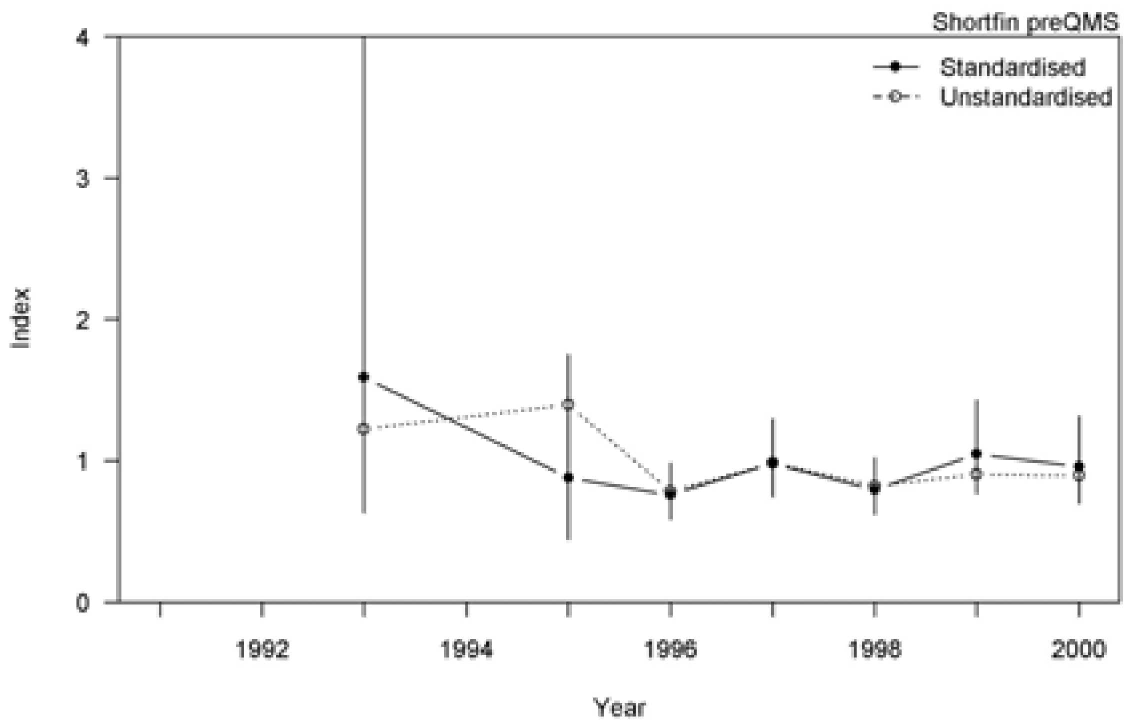

Figure A10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA13 (AN)).

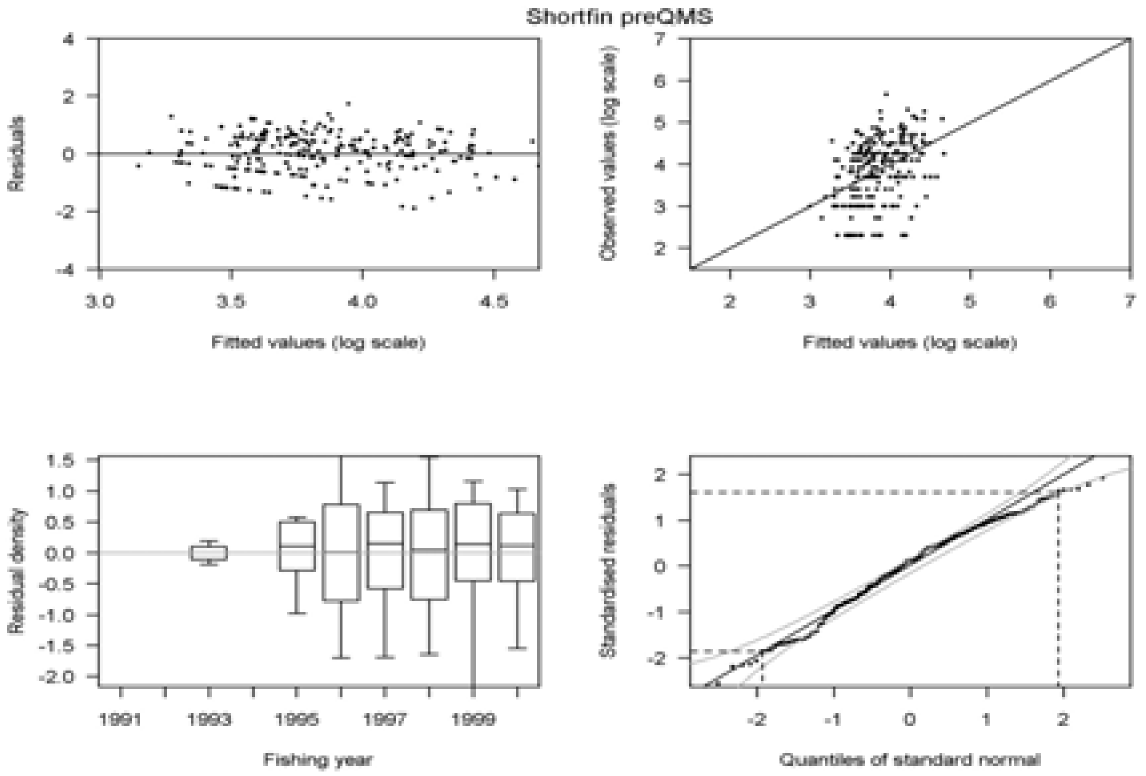

Figure A11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA13 (AN)).

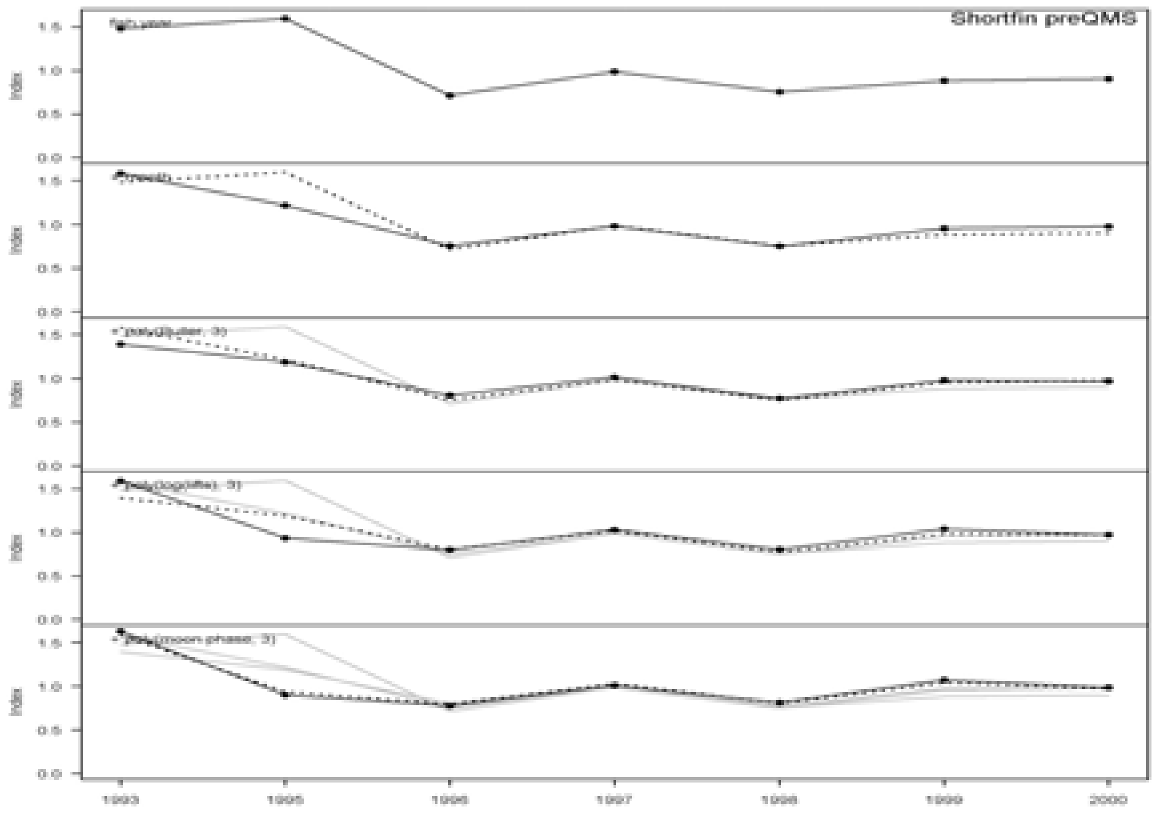

Figure A12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA13 (AN)).

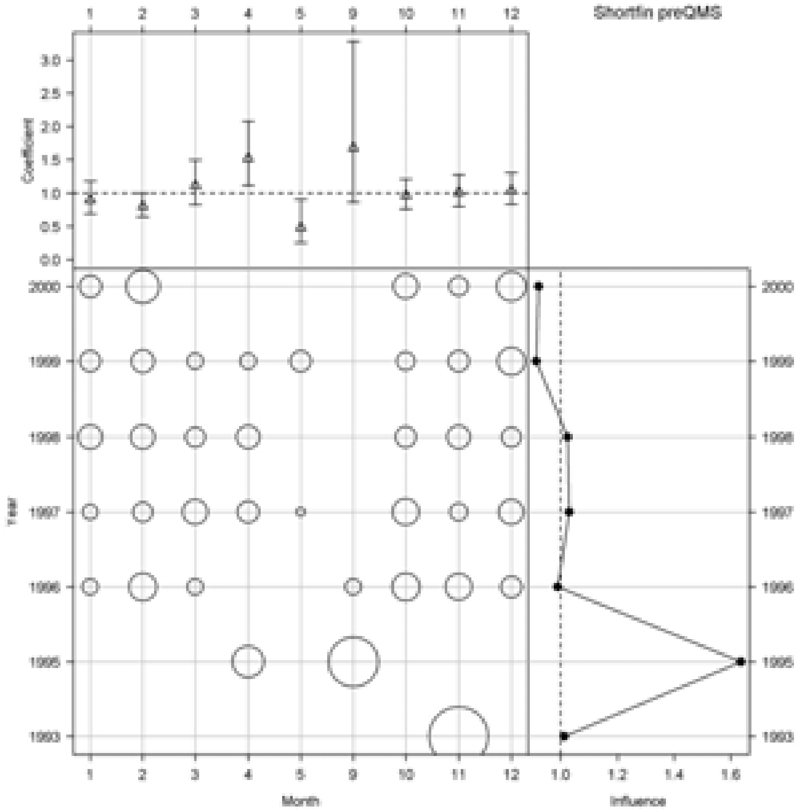

Figure A13: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

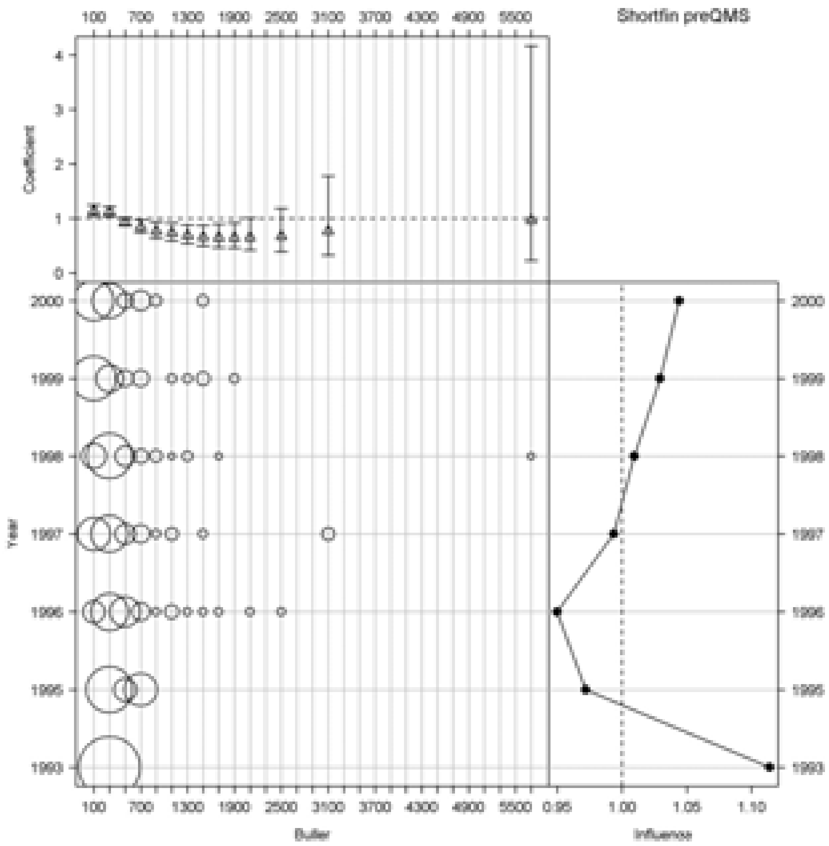

Figure A14: Influence of Buller River flow for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

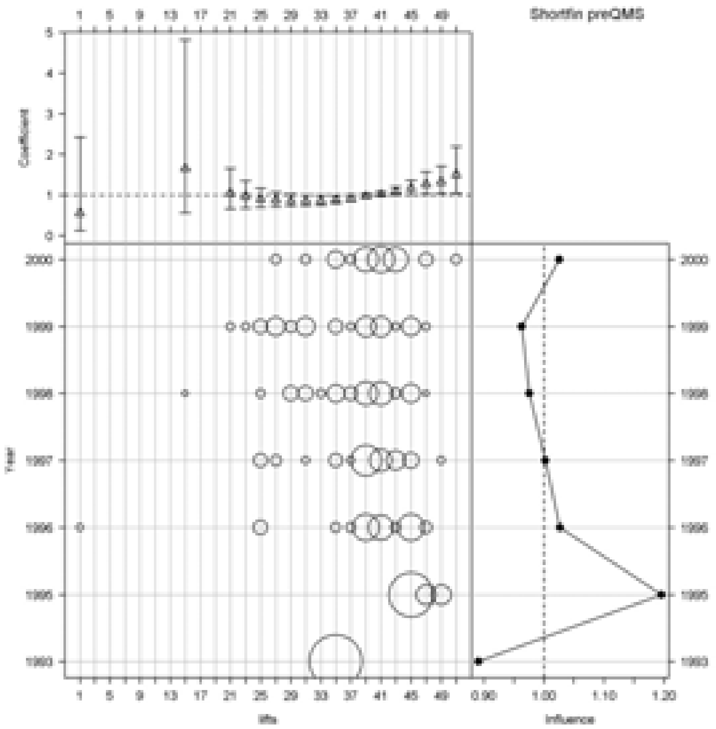

Figure A15: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

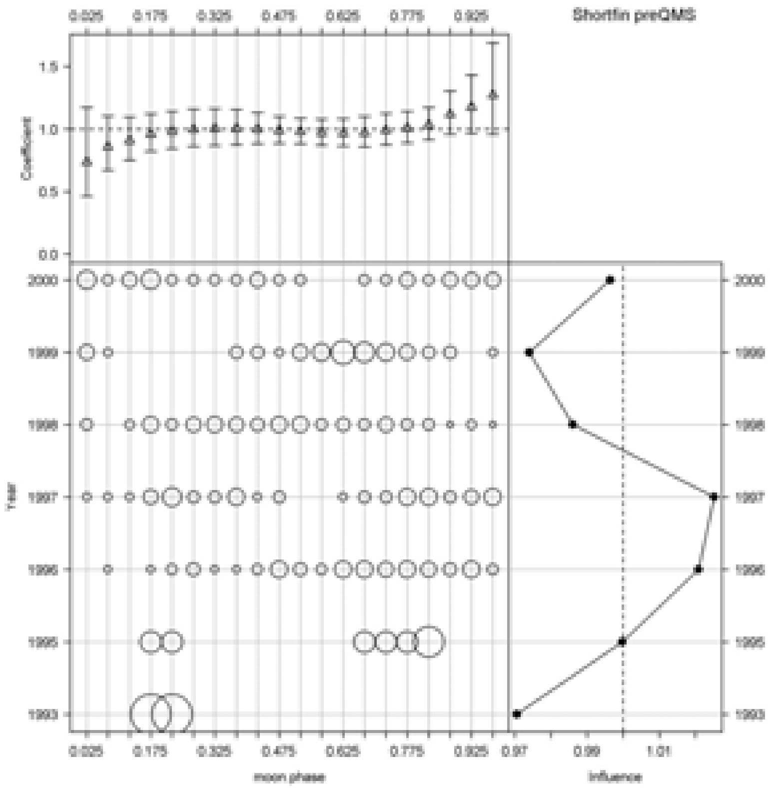

Figure A16: Influence of moon phase for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

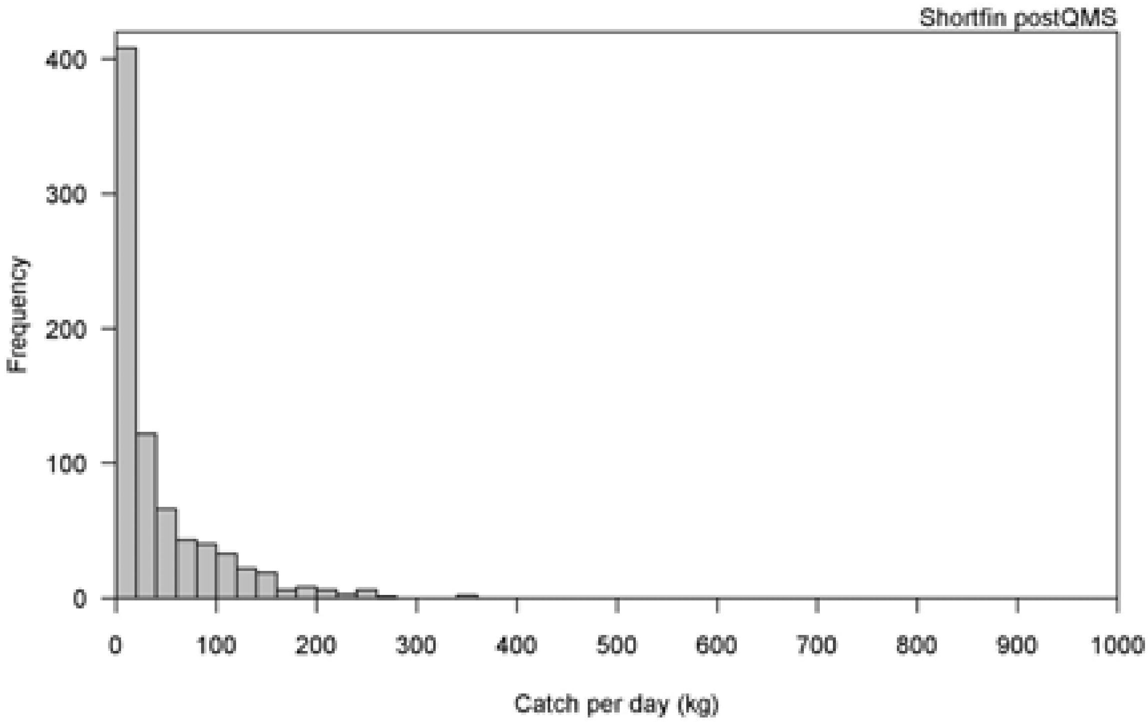

Figure A17: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA13 (AN)).

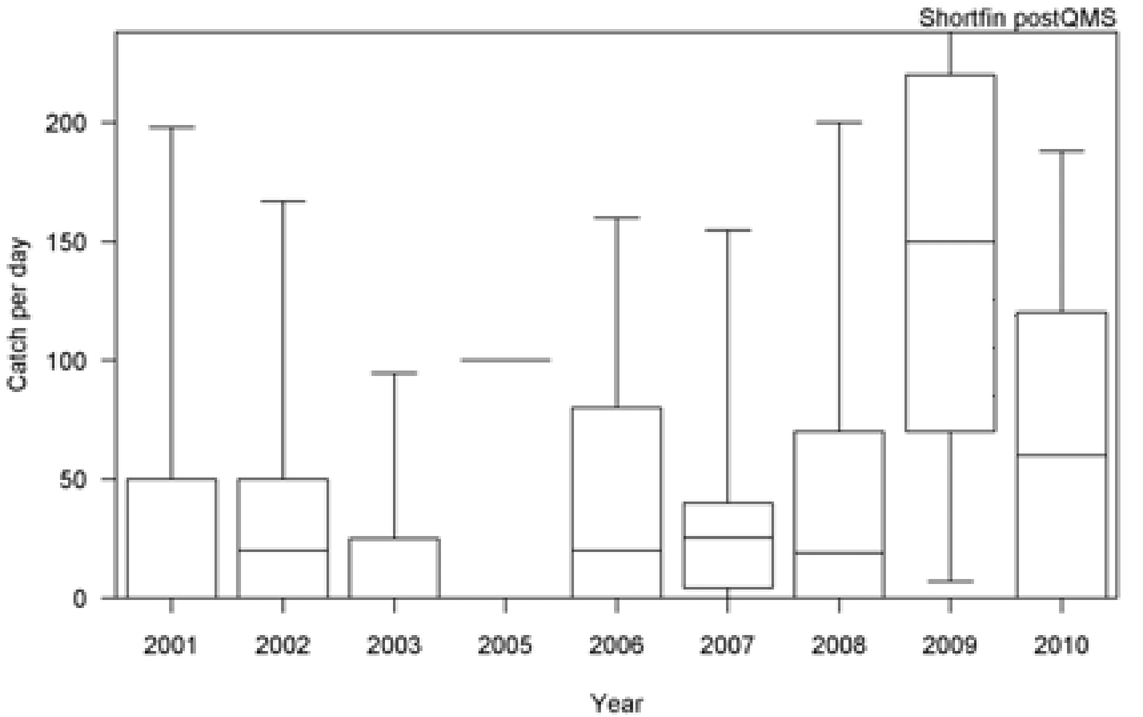

Figure A18: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA13 (AN)).

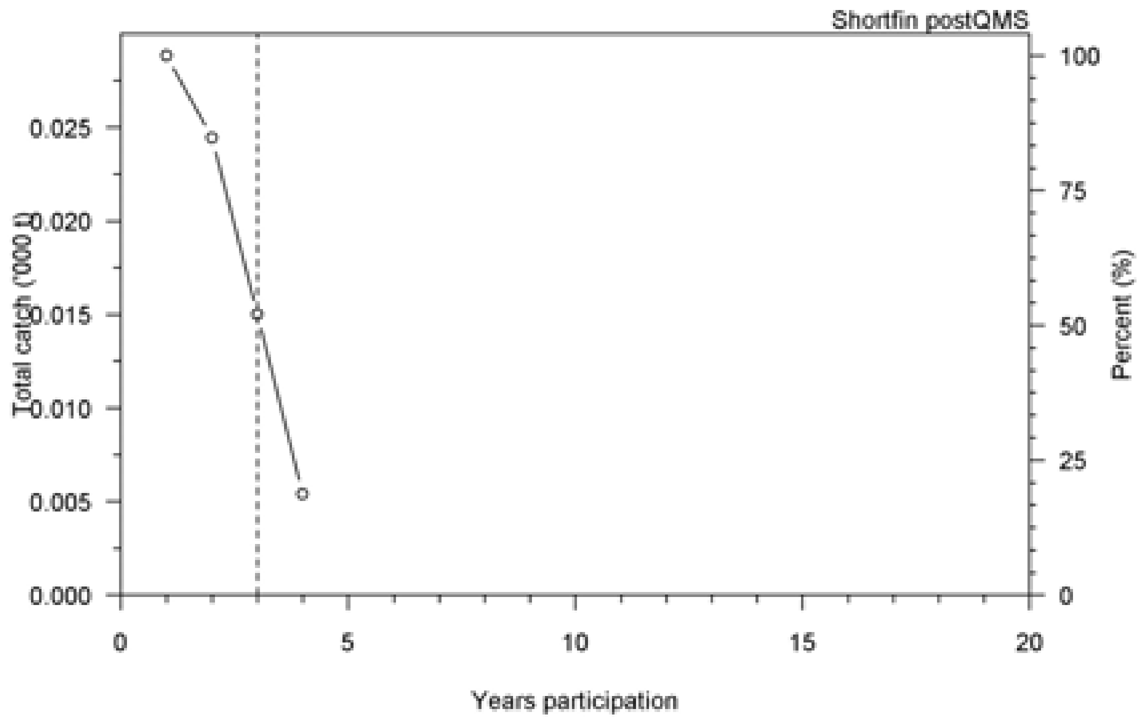

Figure A19: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents 3 years participation and indicates the data included in the core fisher data (ESA13 (AN)).

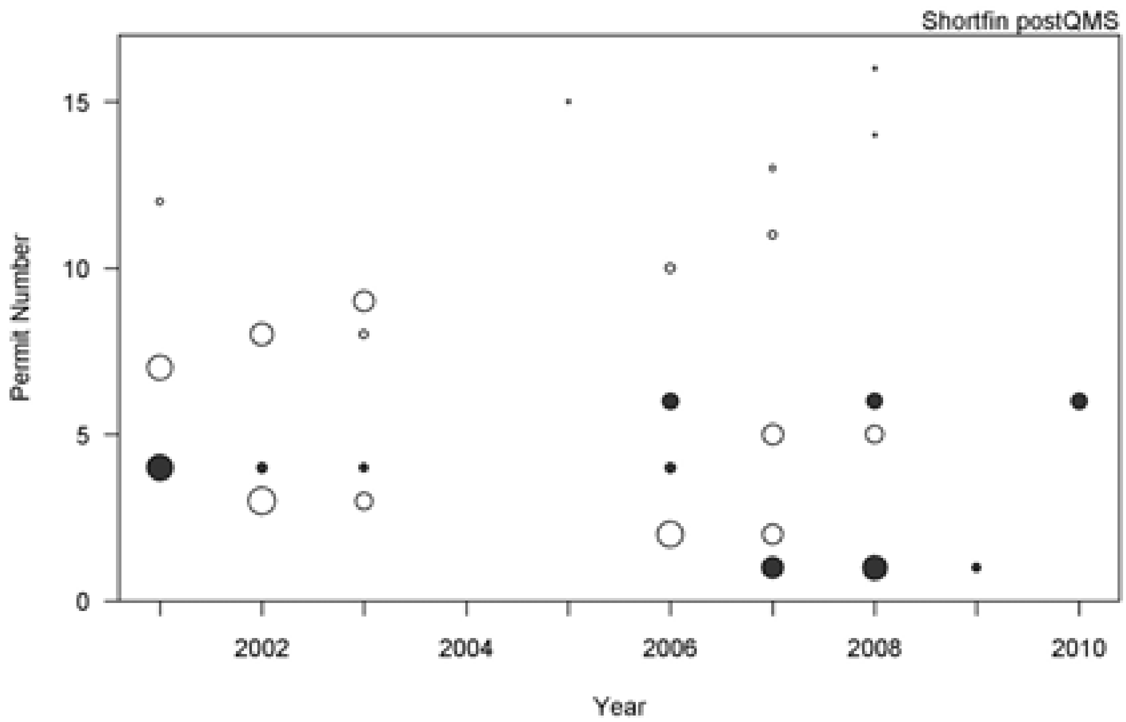

Figure A20: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA13 (AN)).

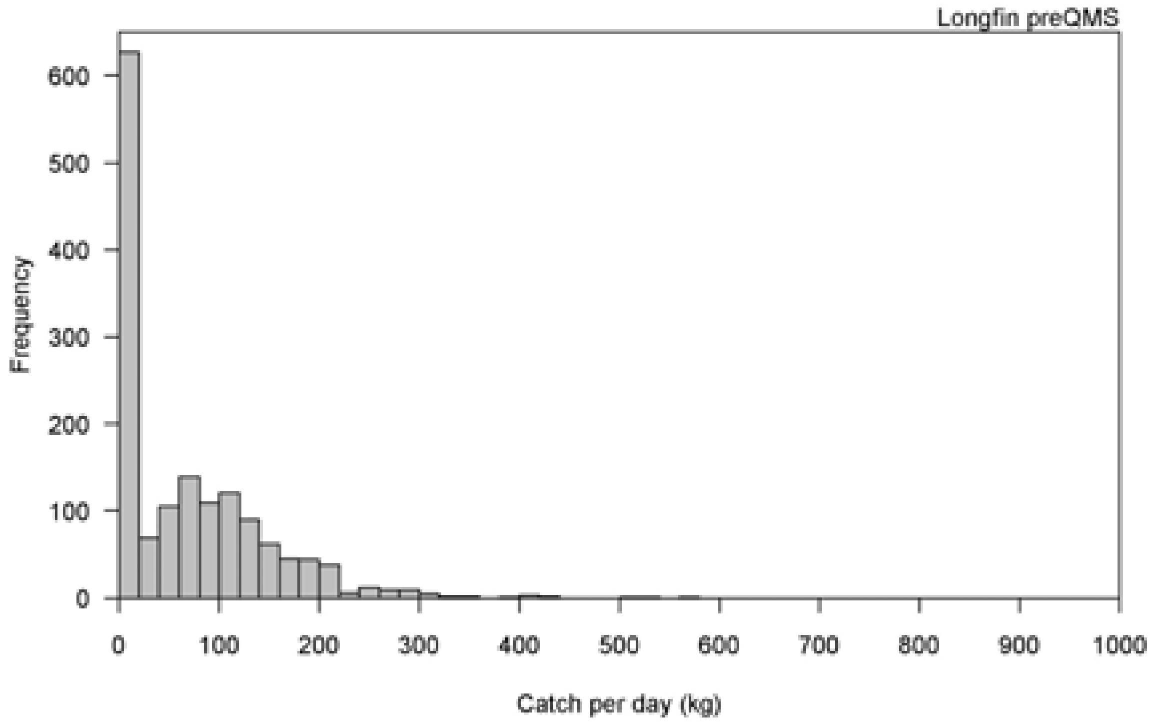

Figure A21: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

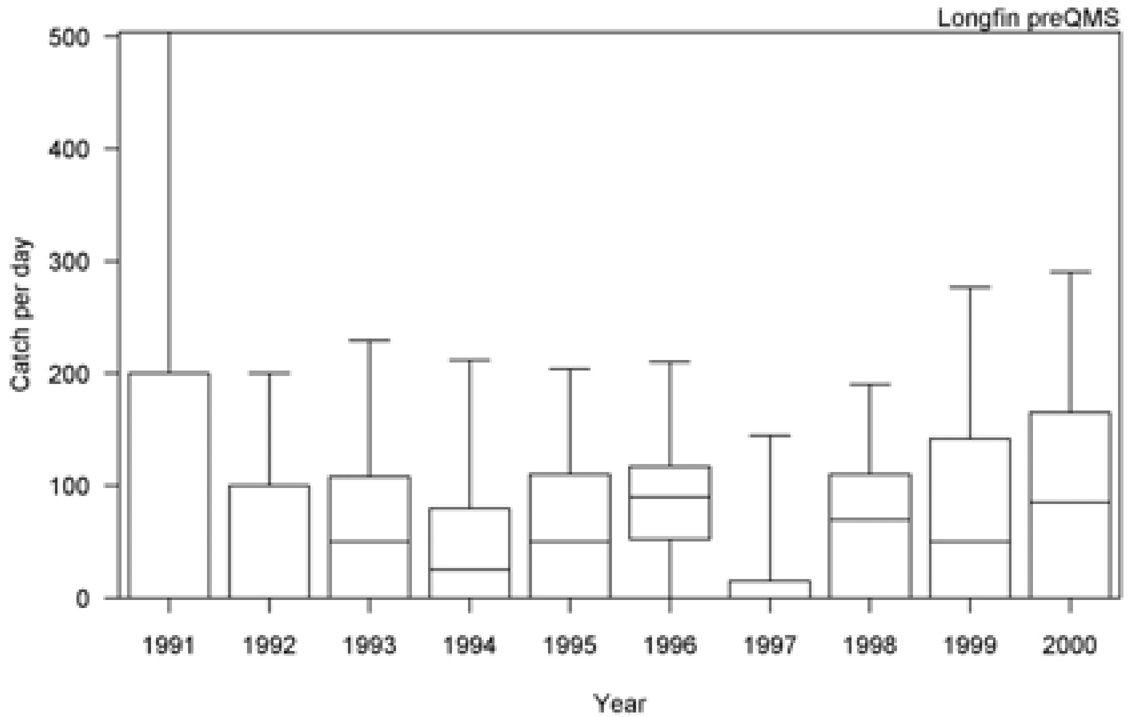

Figure A22: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA13 (AN)).

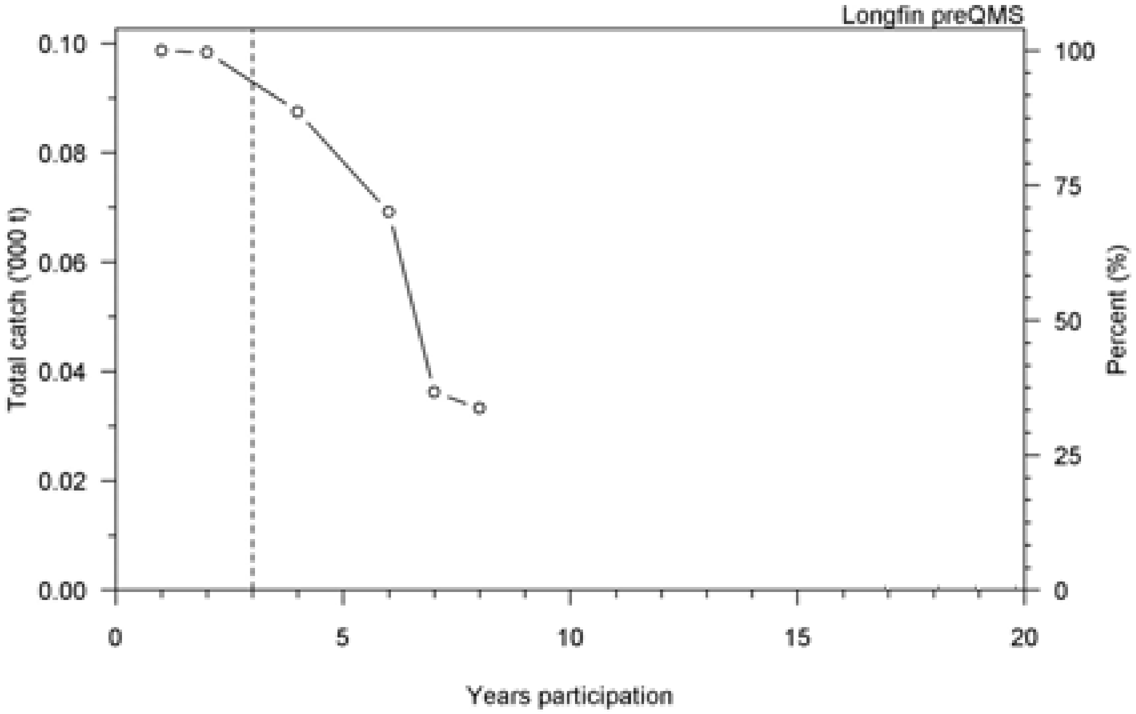

Figure A23: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA13 (AN)).

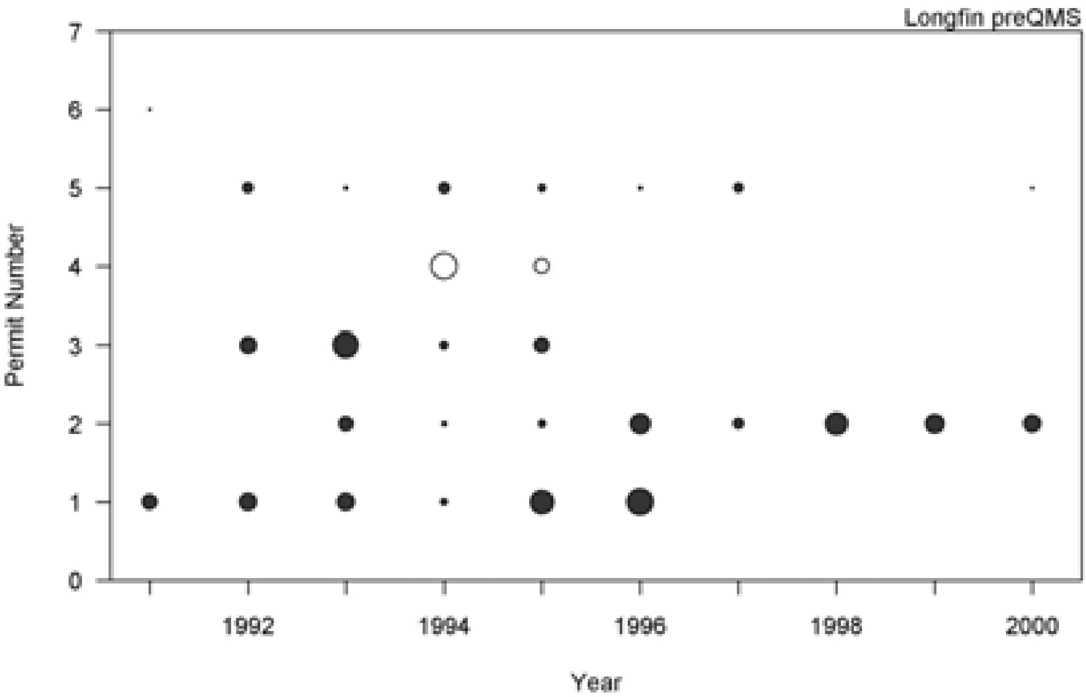

Figure A24: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA13 (AN)).

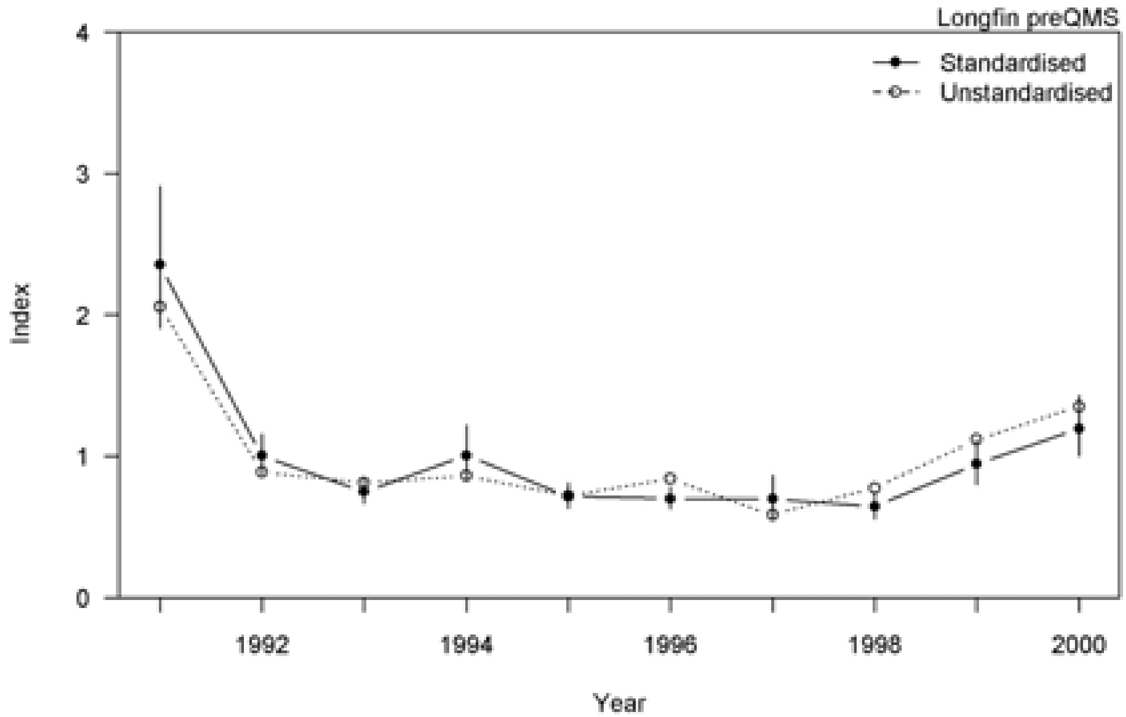

Figure A25: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA13 (AN)).

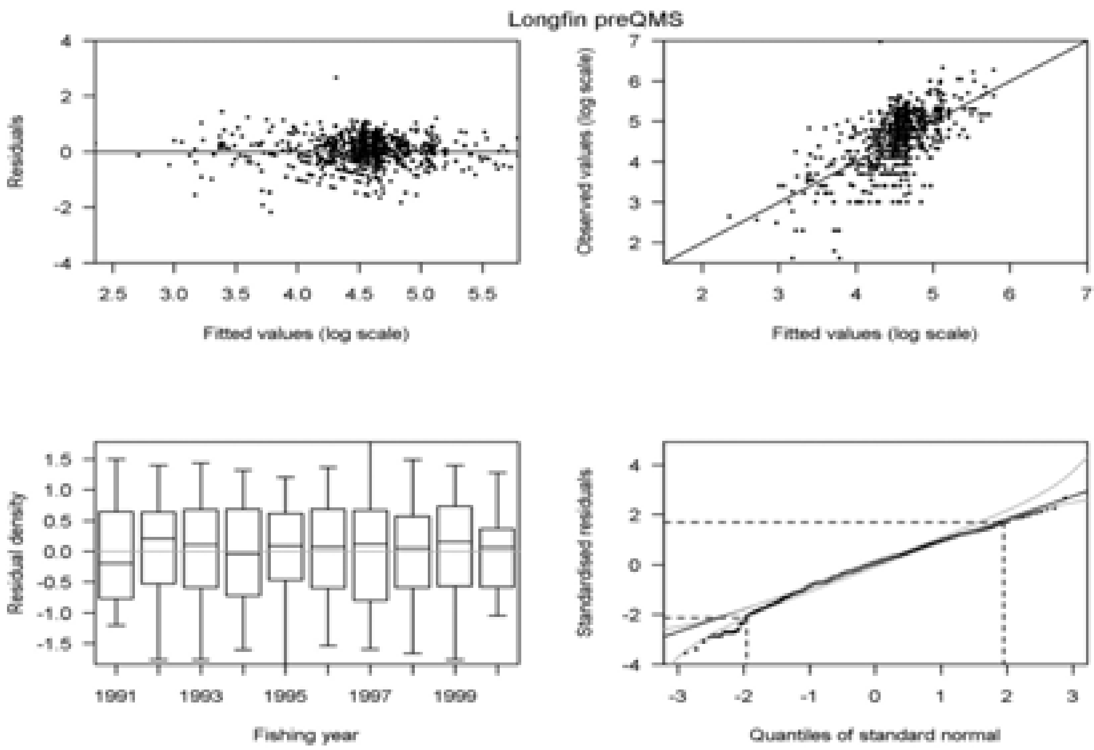

Figure A26: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA13 (AN)).

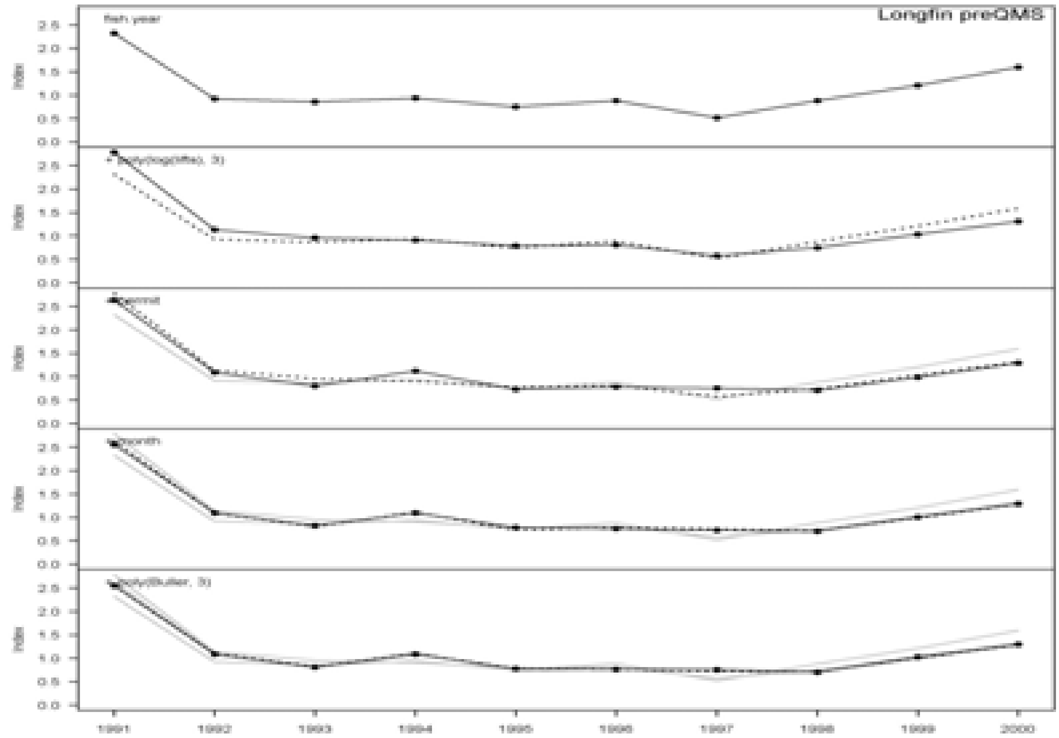

Figure A27: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA13 (AN)).

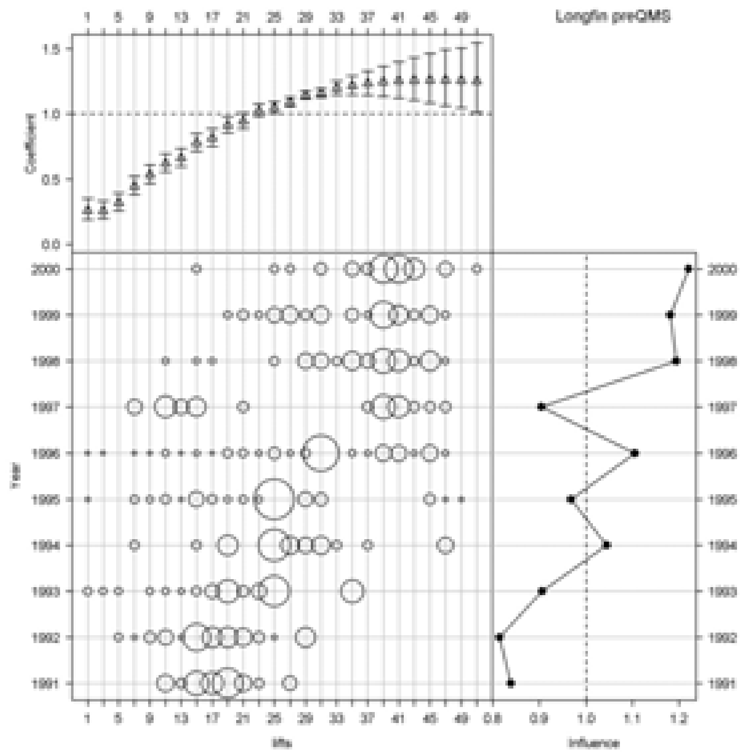

Figure A28: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

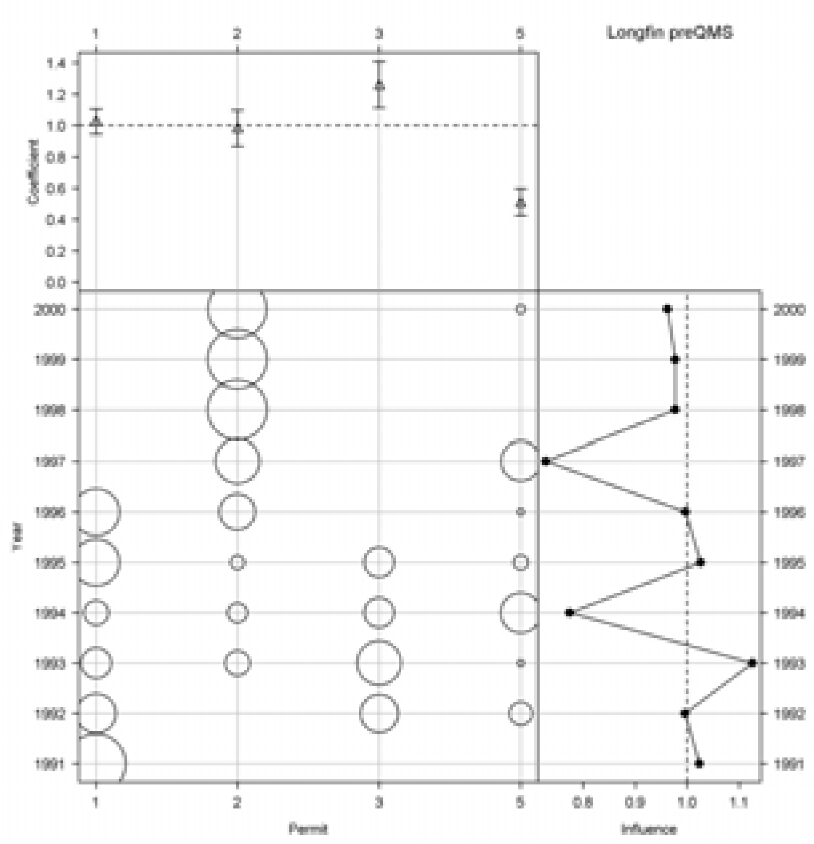

Figure A29: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

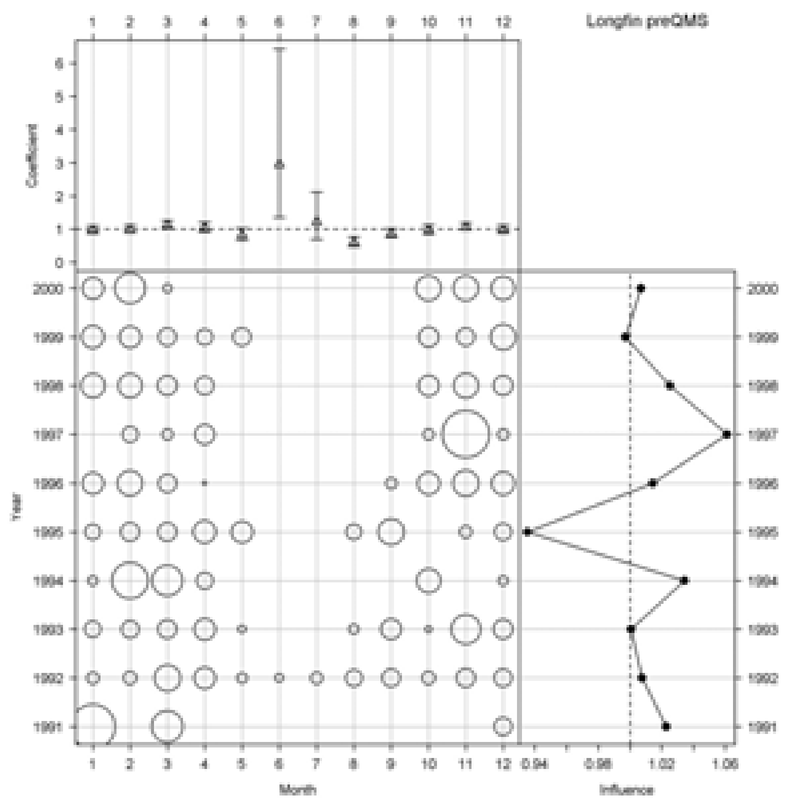

Figure A30: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

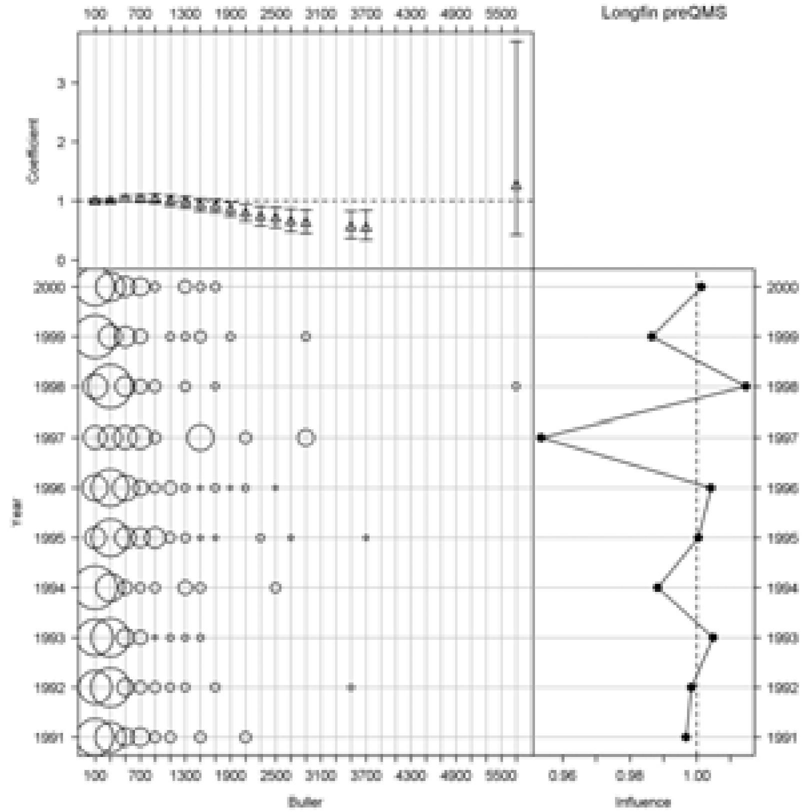

Figure A31: Influence of Buller River flow for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA13 (AN)).

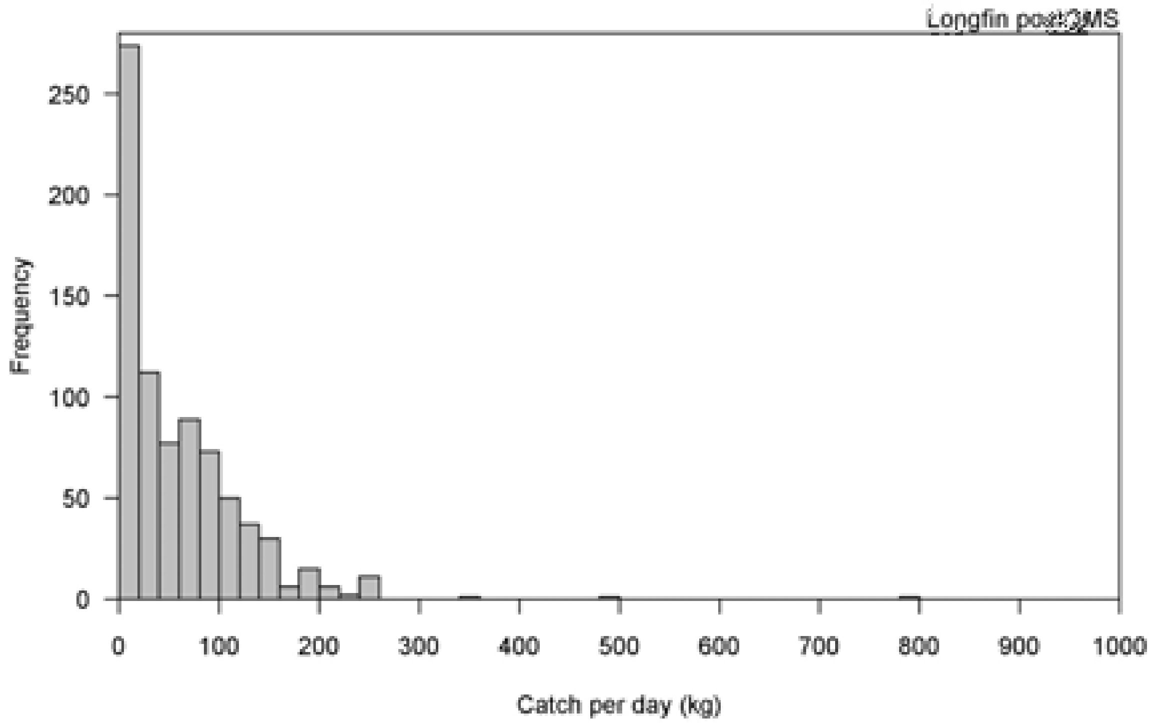

Figure A32: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA13 (AN)).

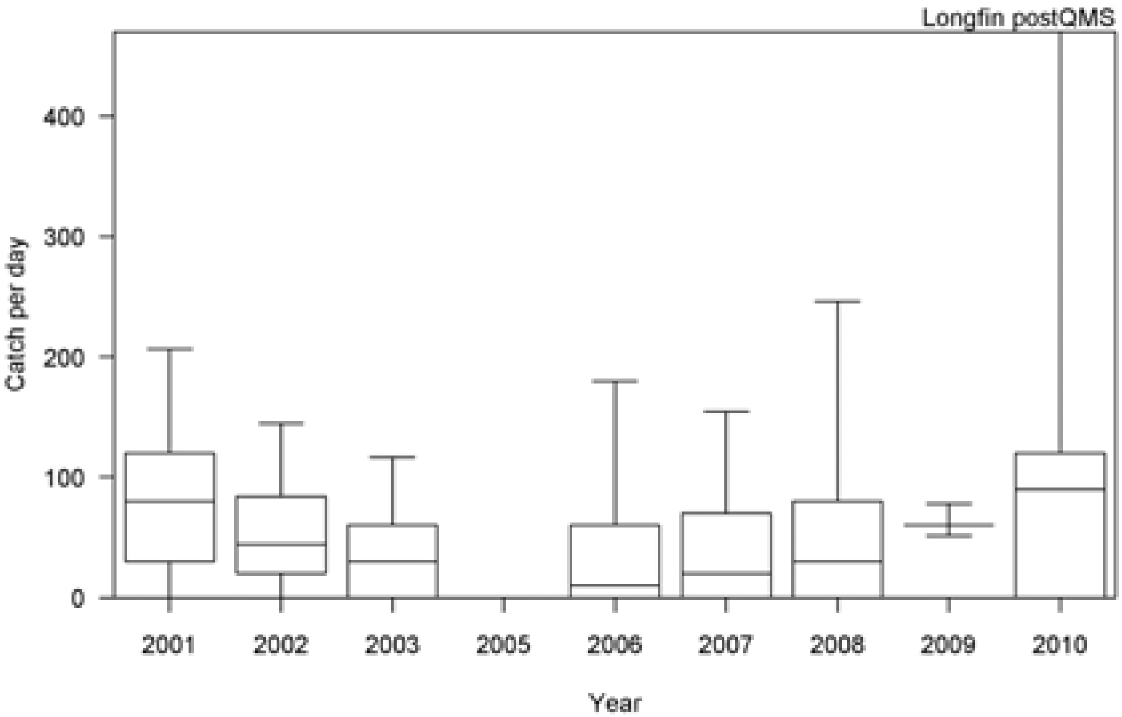

Figure A33: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA13 (AN)).

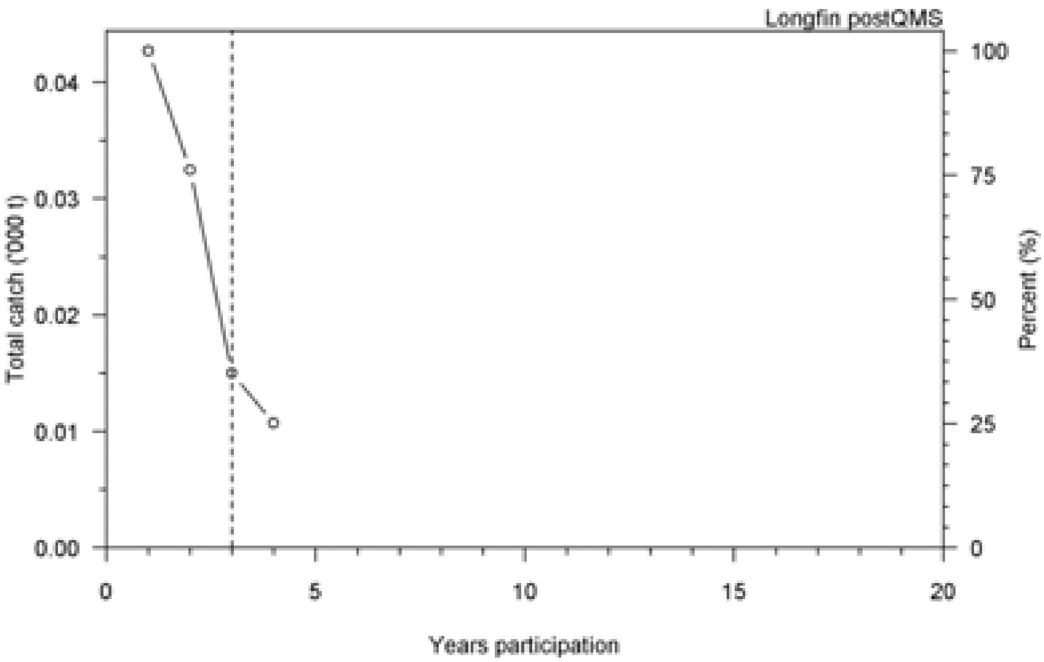

Figure A34: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA13 (AN)).

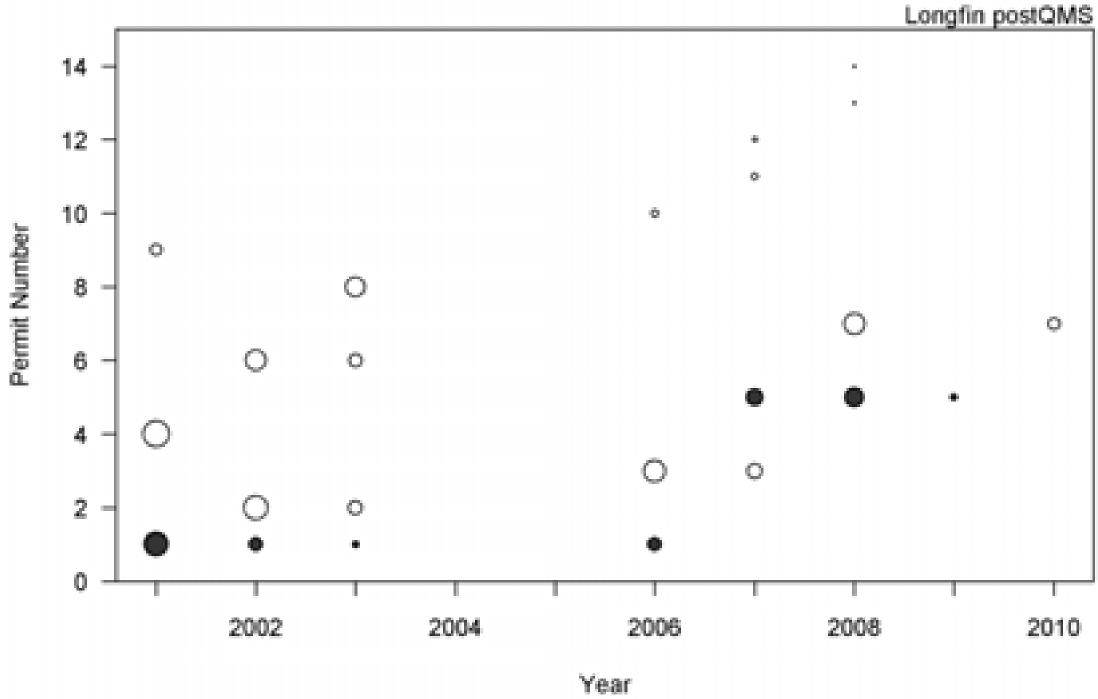

Figure A35: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA13 (AN)).

Appendix B: ESA 14 (AP-AQ).

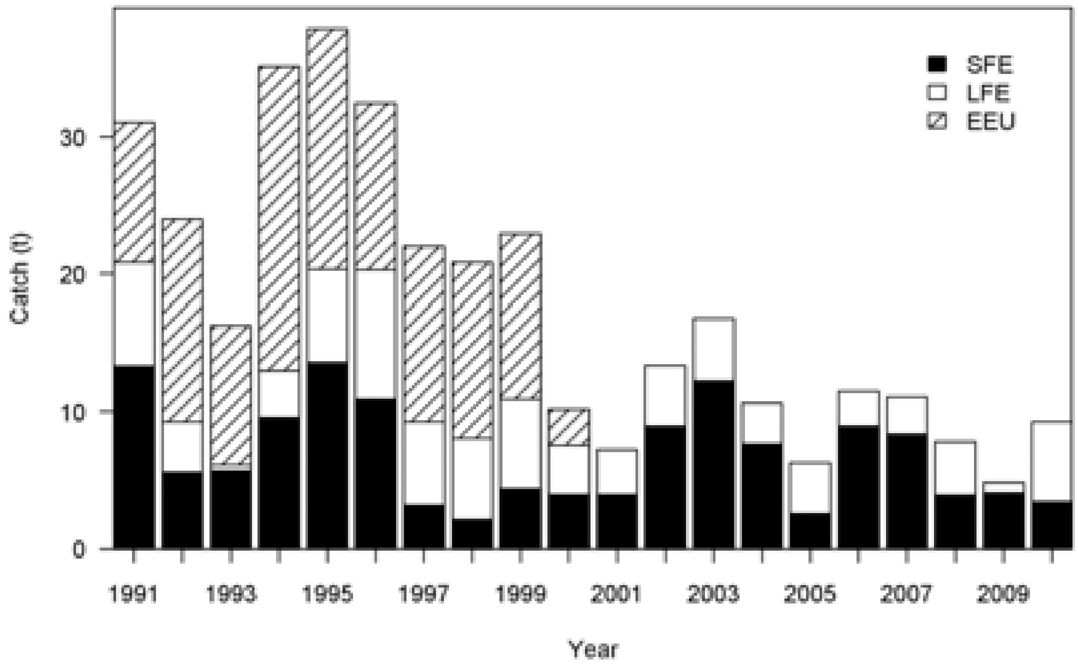

Figure B1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA14 (AP-AQ)).

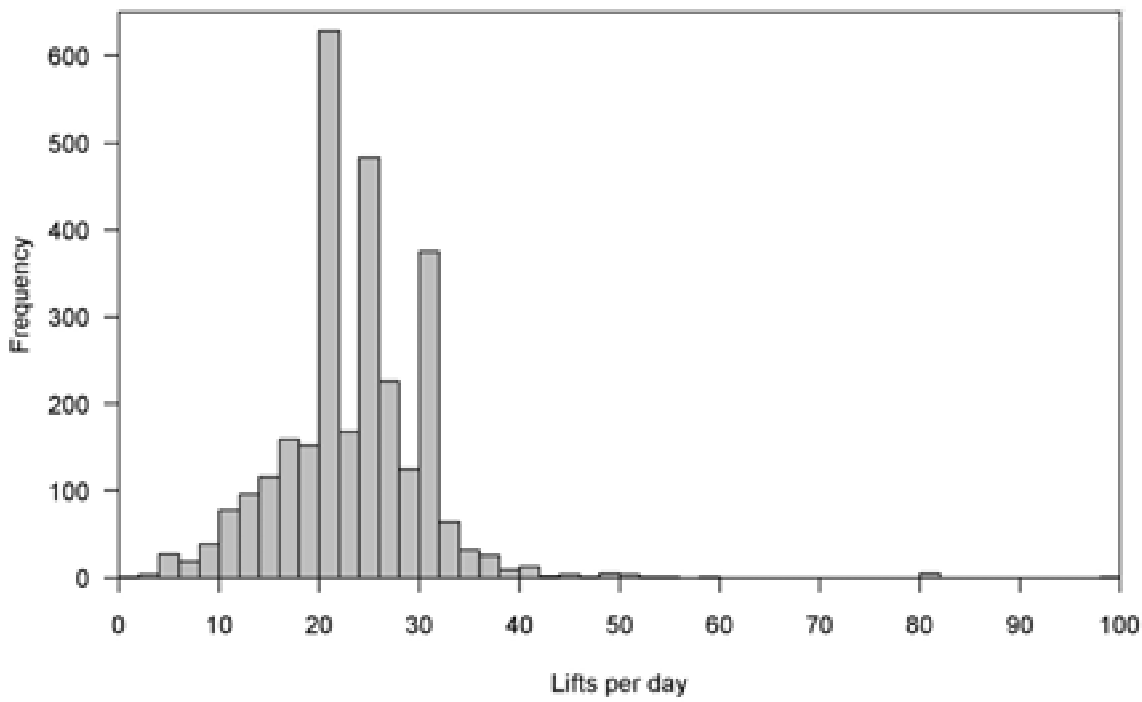

Figure B2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA14 (AP-AQ)).

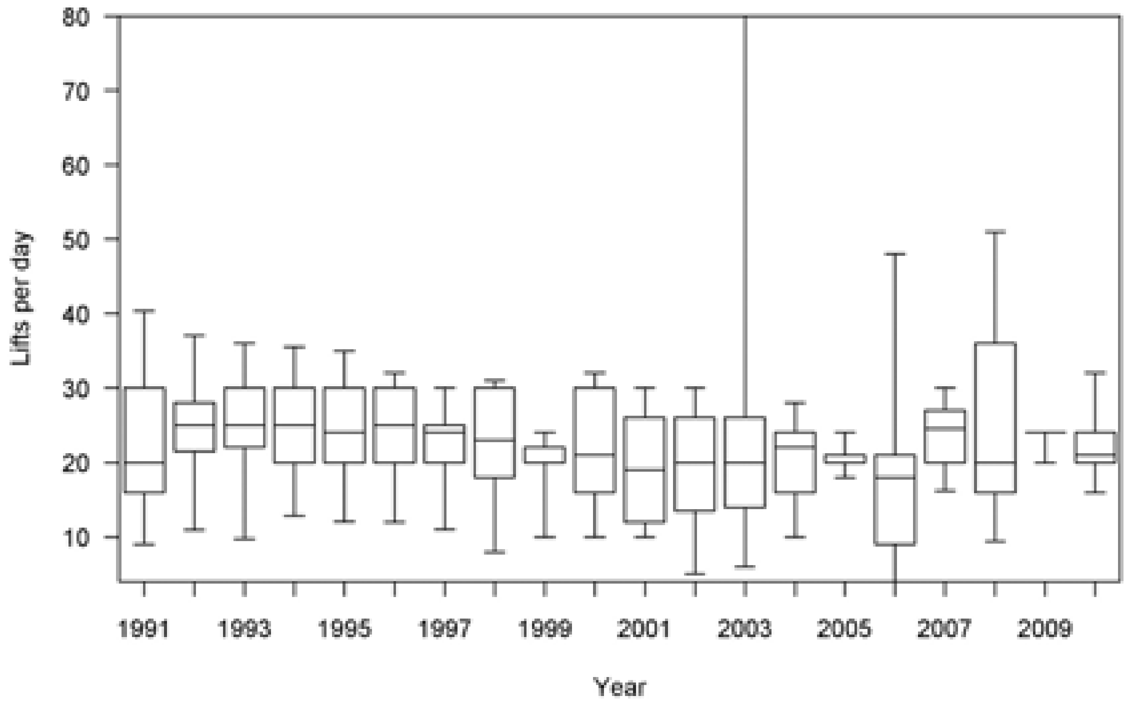

Figure B3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA14 (AP-AQ)).

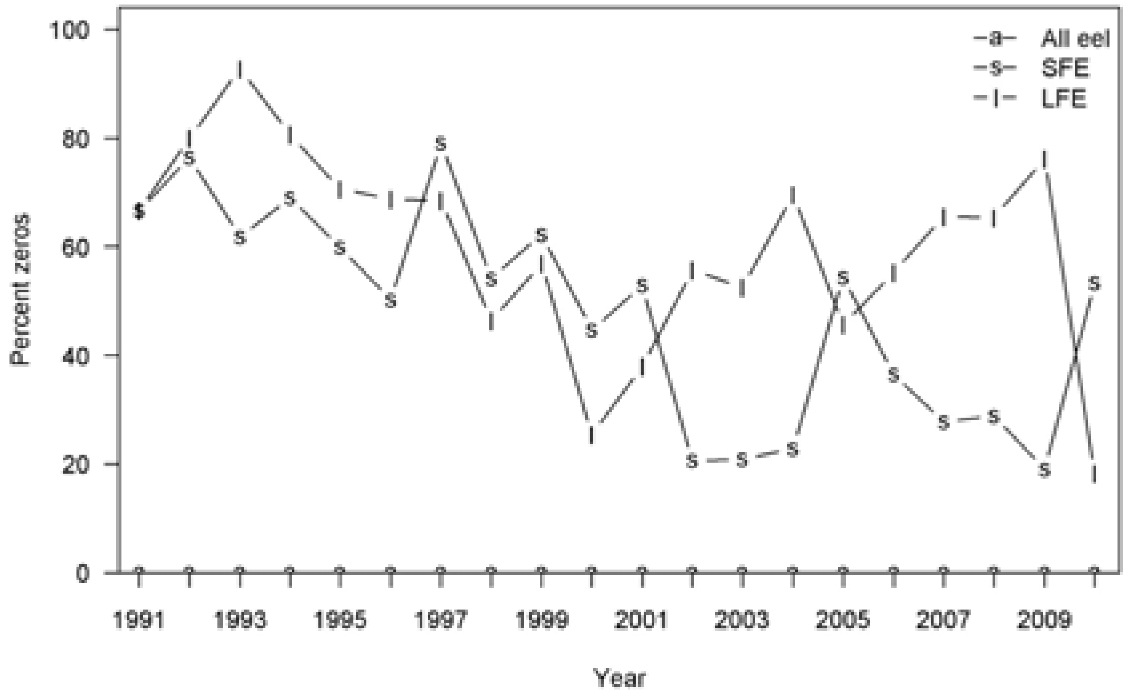

Figure B4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA14 (AP-AQ)).

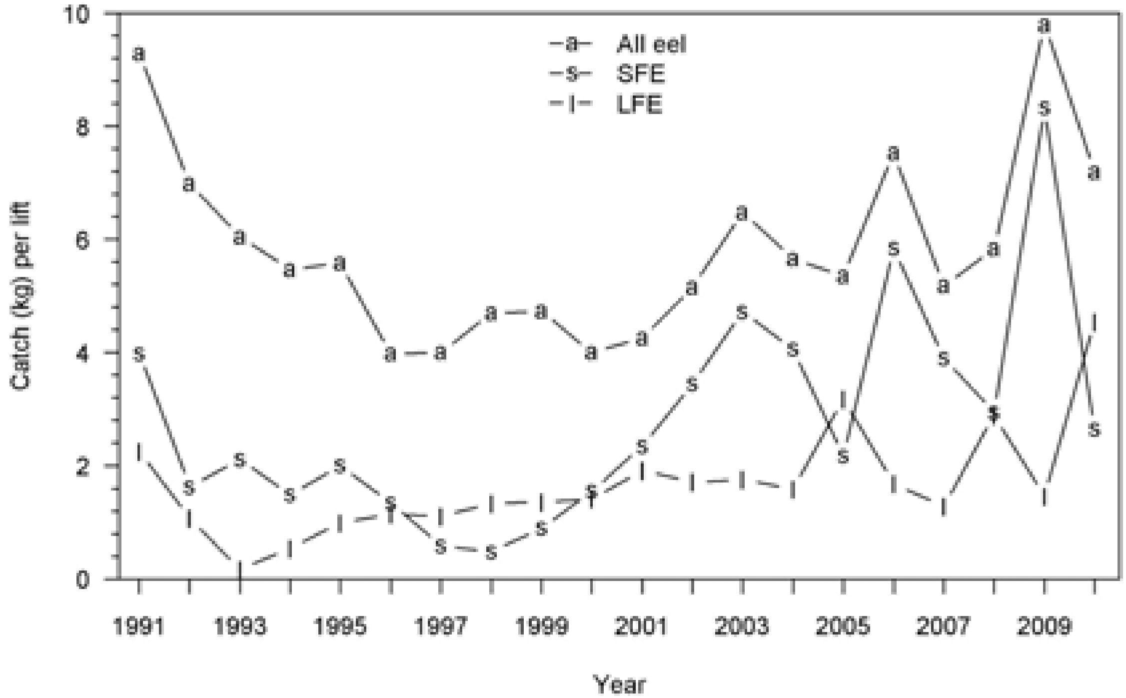

Figure B5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA14 (AP-AQ)).

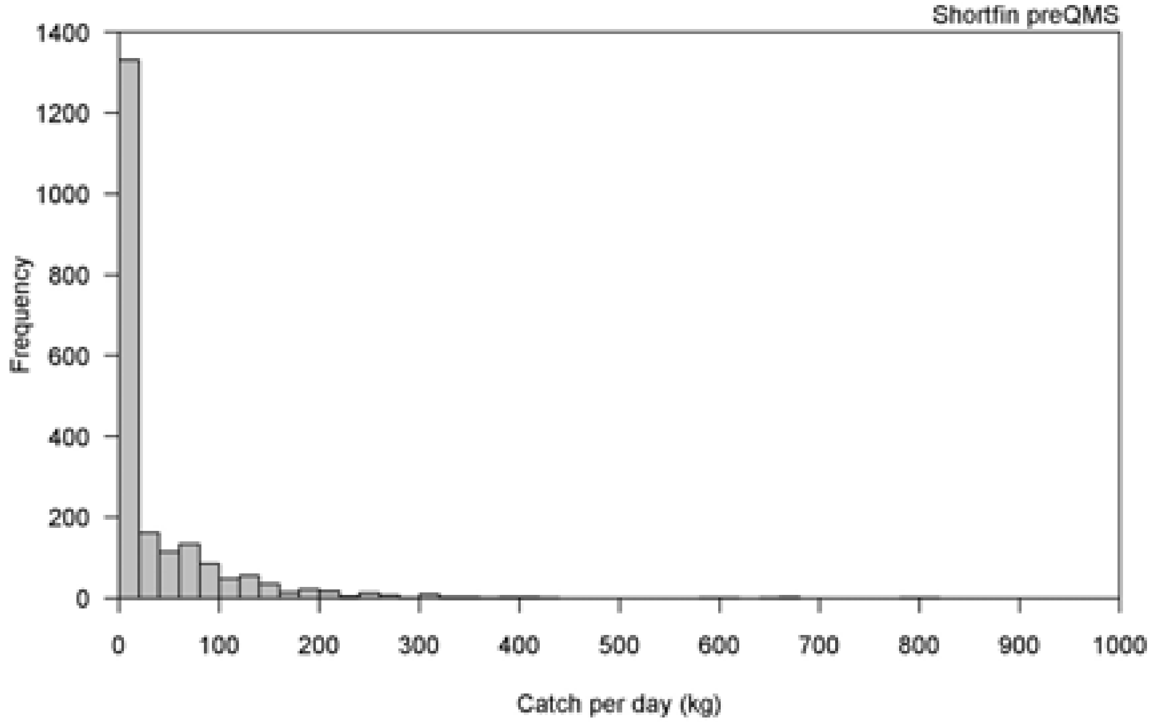

Figure B6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

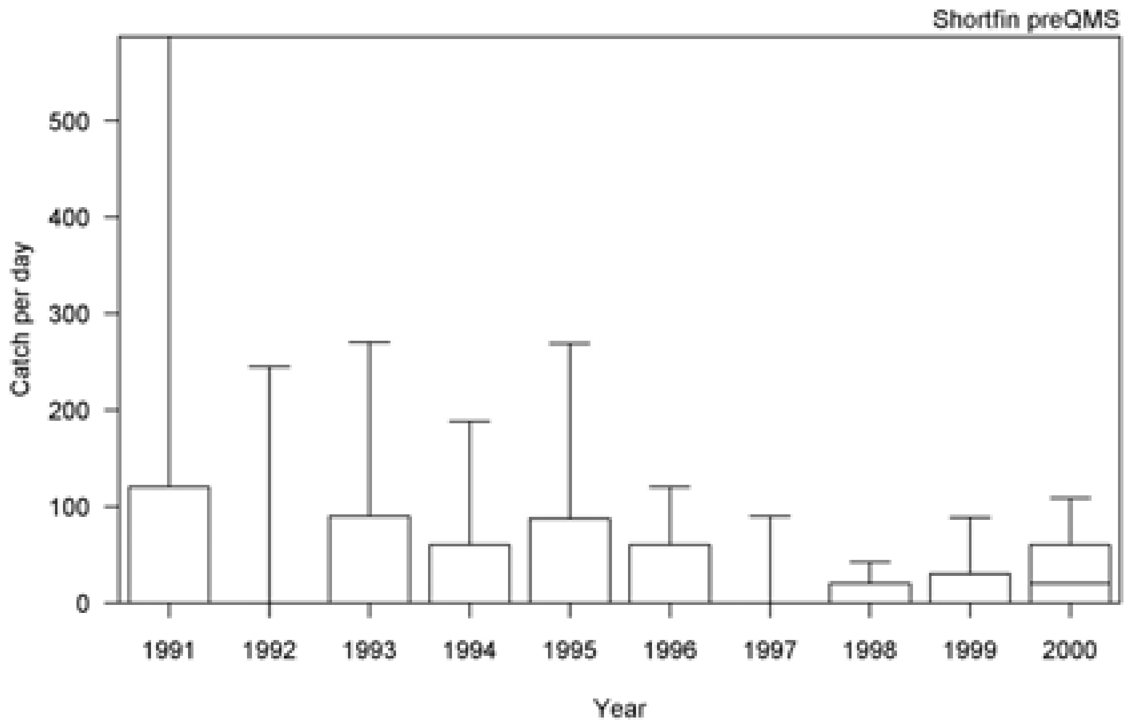

Figure B7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA14 (AP-AQ)).

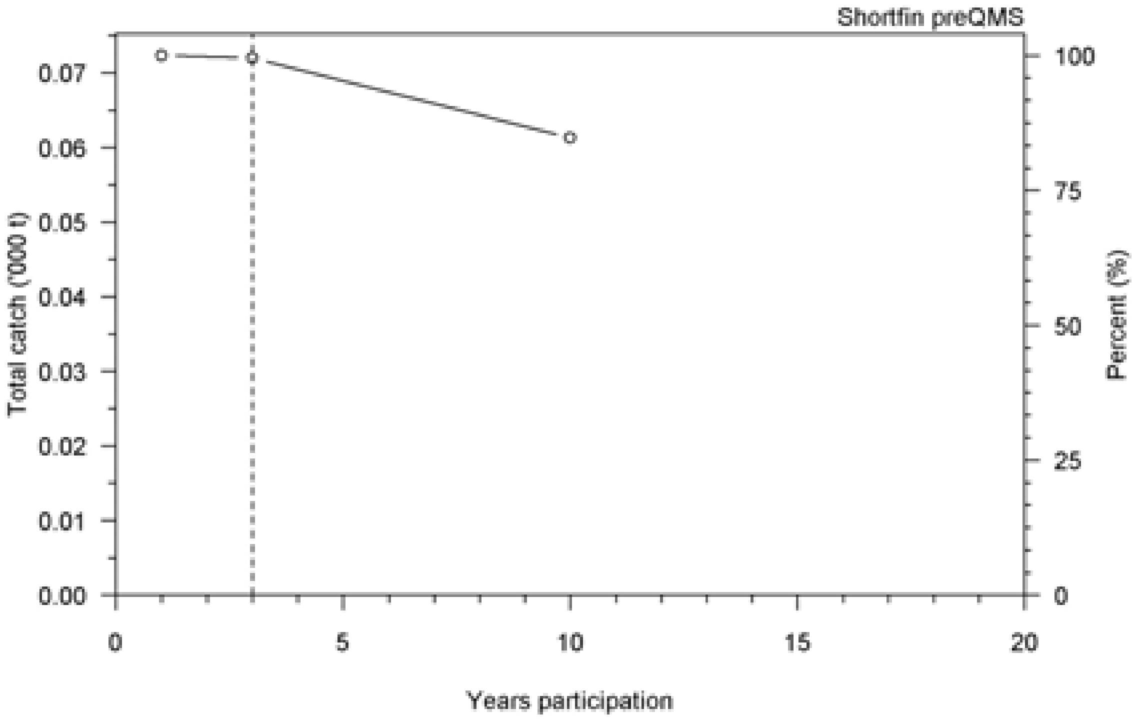

Figure B8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA14 (AP-AQ)).

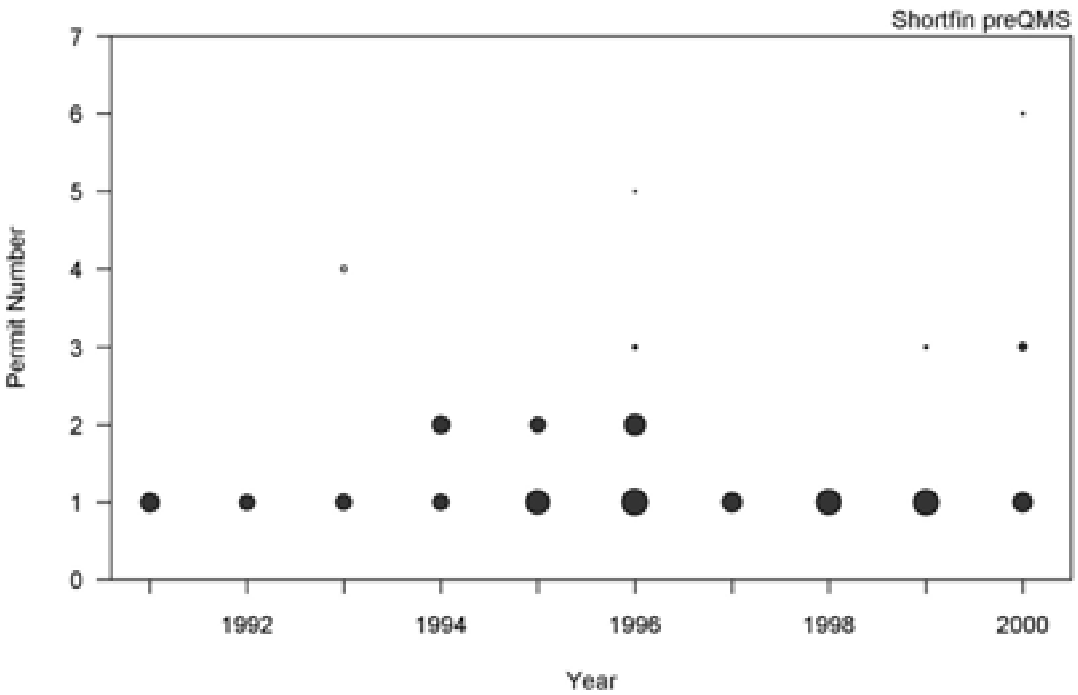

Figure B9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA14 (AP-AQ)).

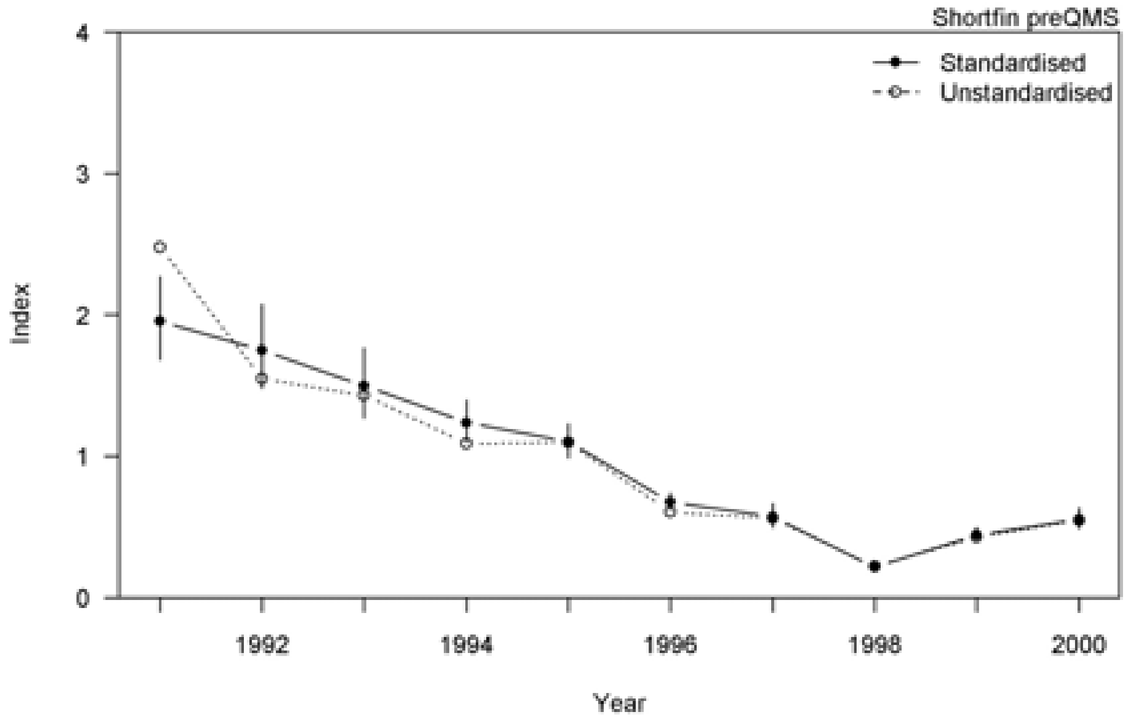

Figure B10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA14 (AP-AQ)).

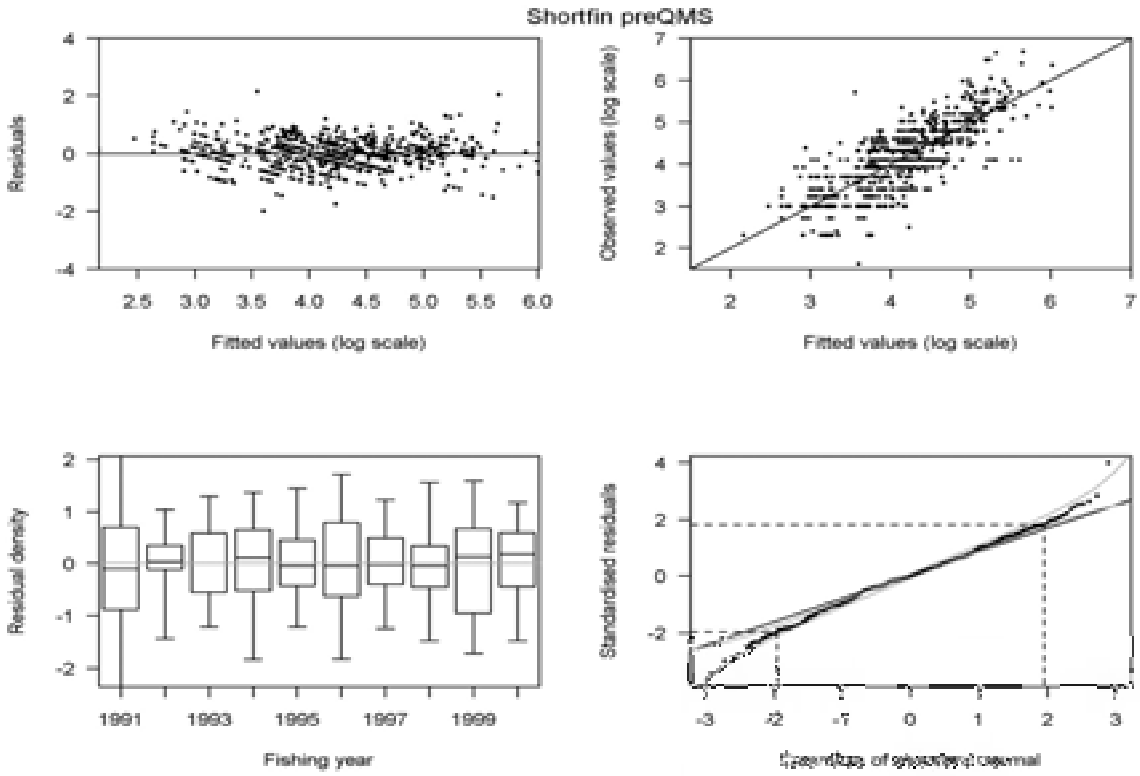

Figure B11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA14 (AP-AQ)).

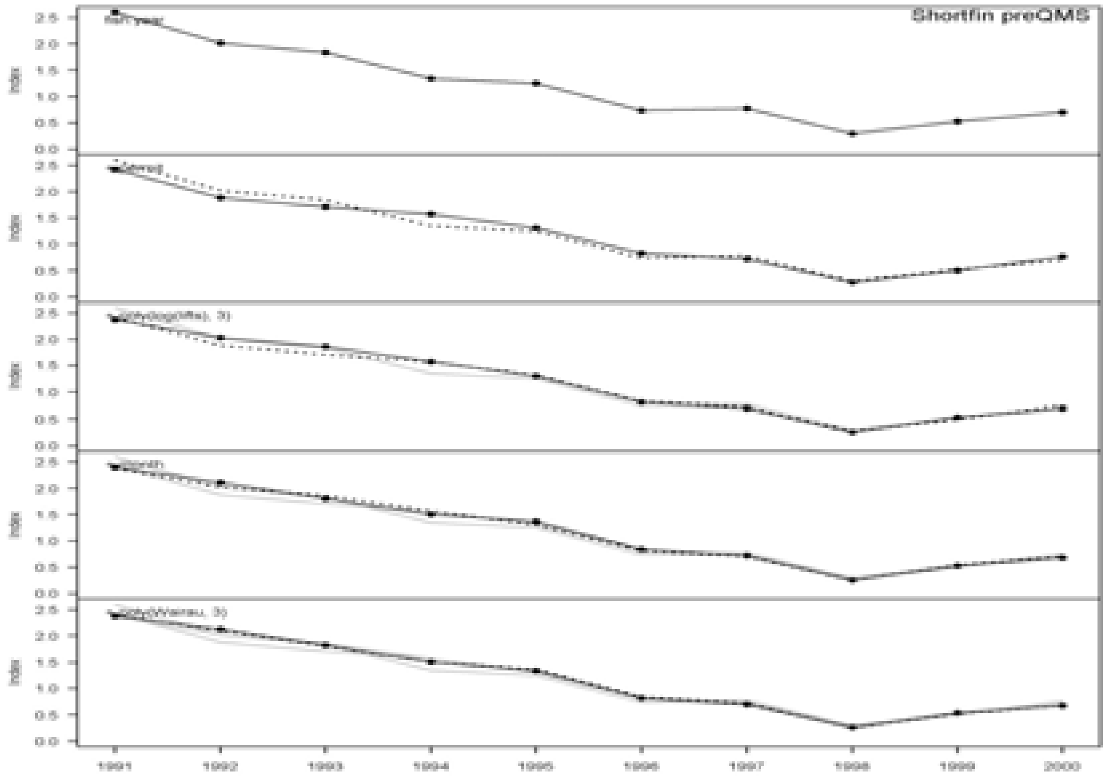

Figure B12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA14 (AP-AQ)).

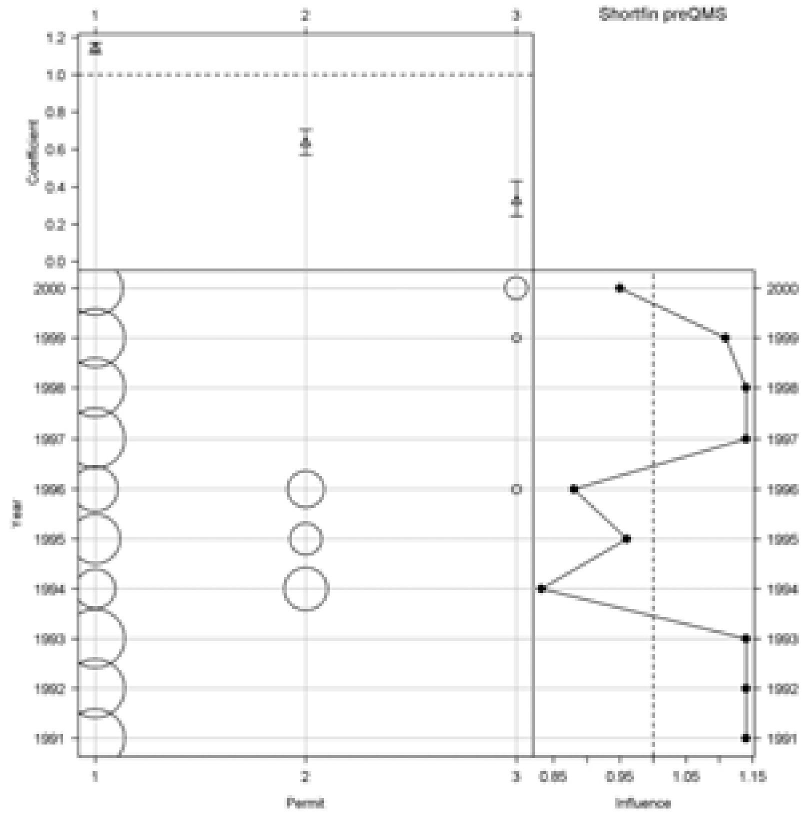

Figure B13: Influence of permit number for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

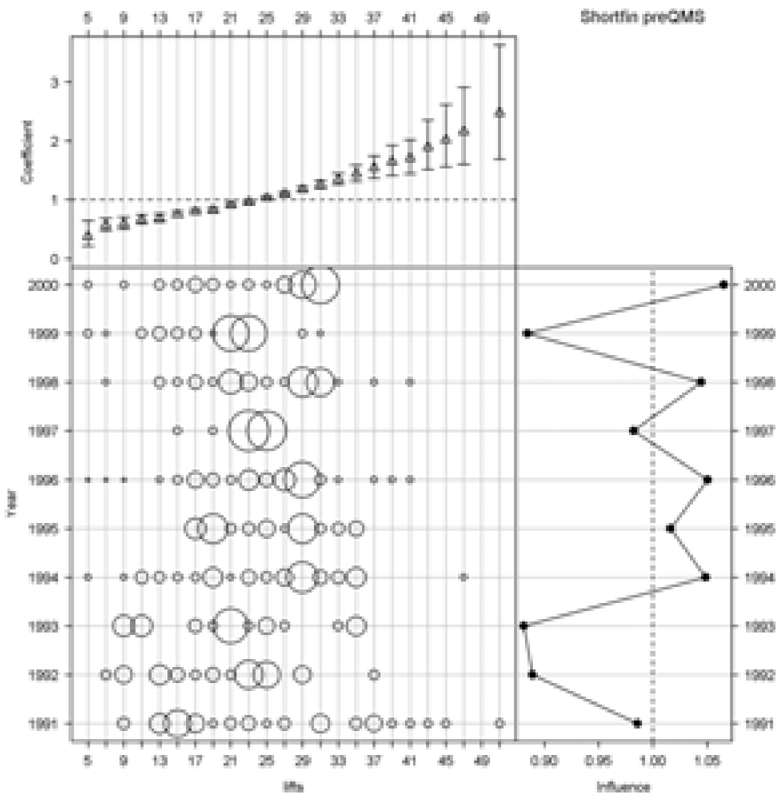

Figure B14: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

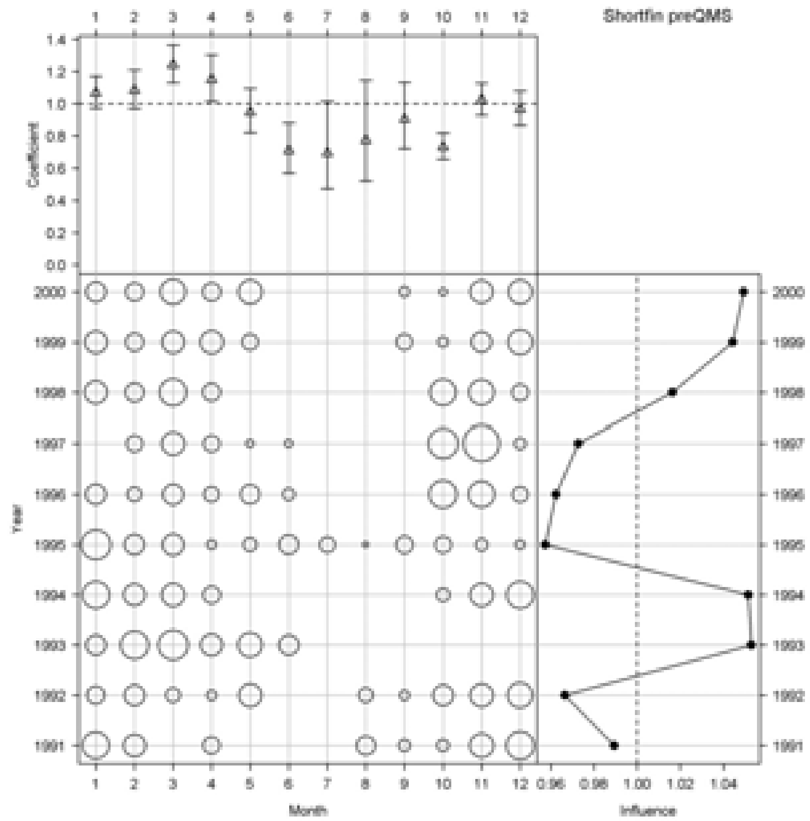

Figure B15: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

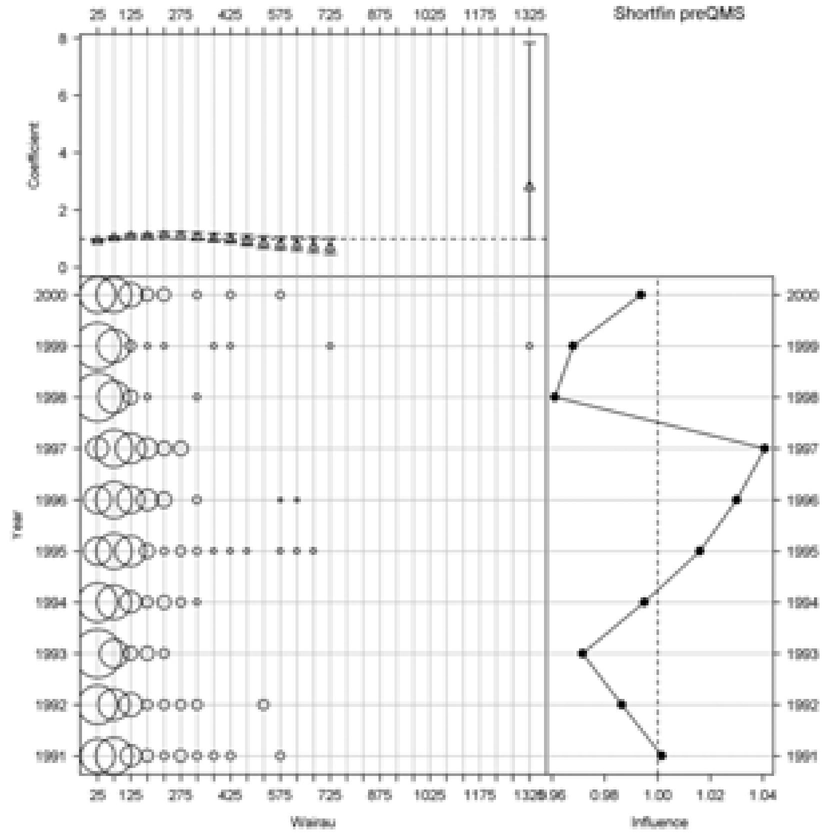

Figure B16: Influence of Wairau River flow for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

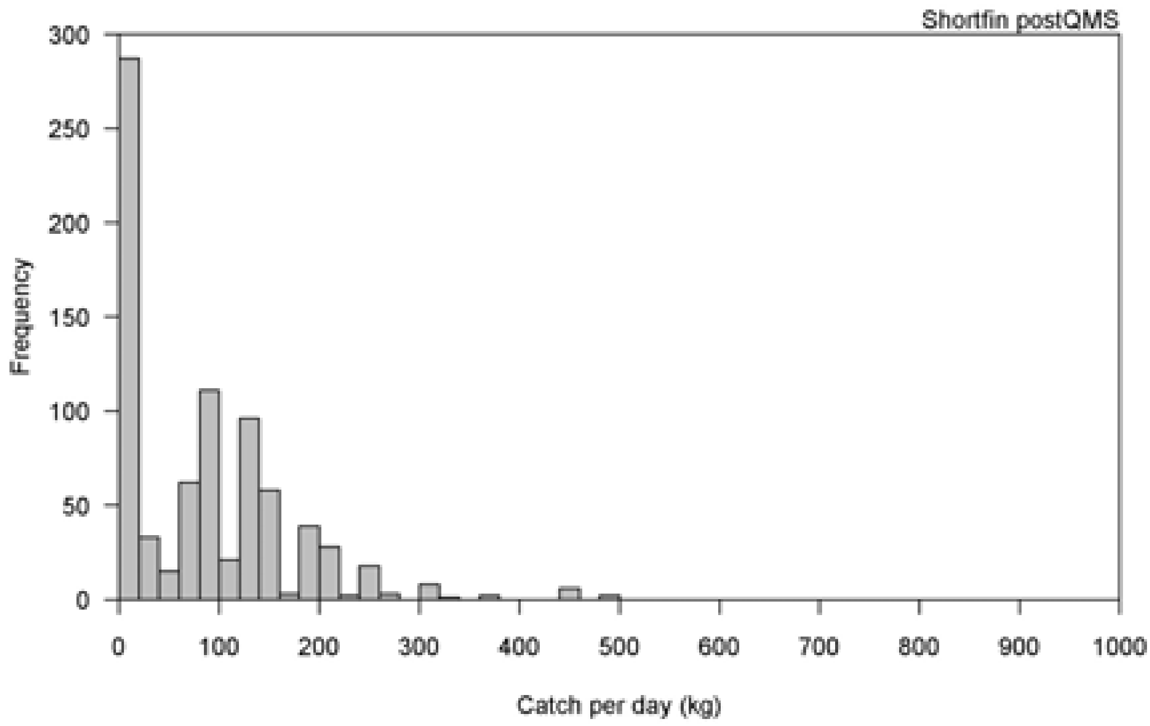

Figure B17: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA14 (AP-AQ)).

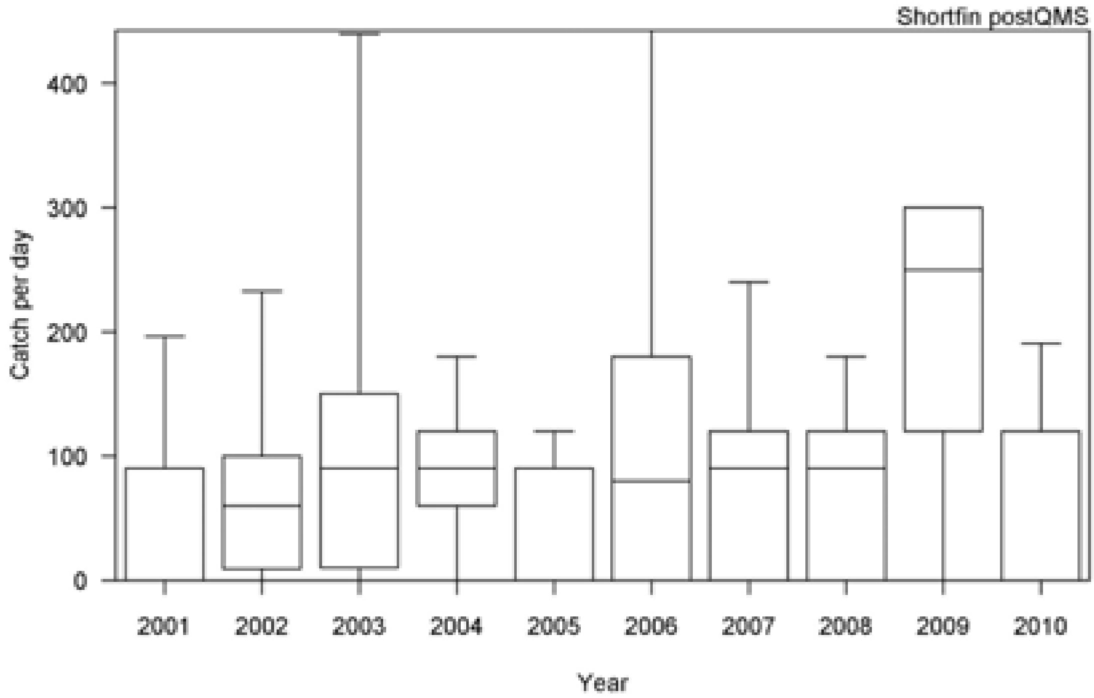

Figure B18: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA14 (AP-AQ)).

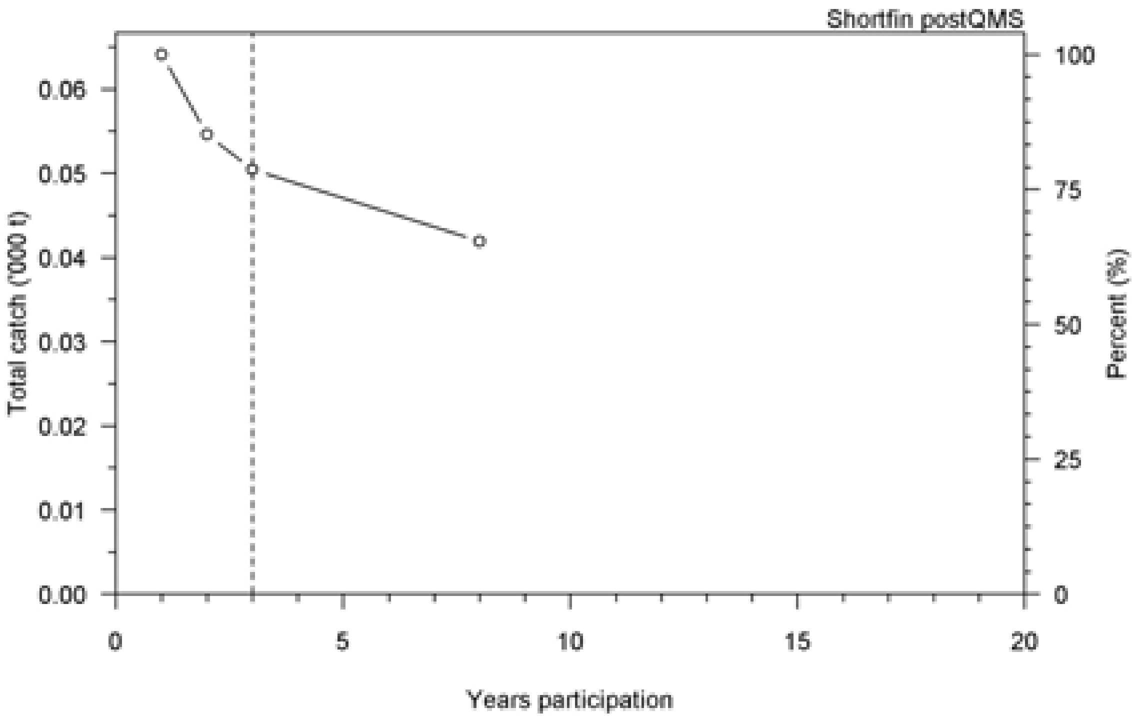

Figure B19: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA14 (AP-AQ)).

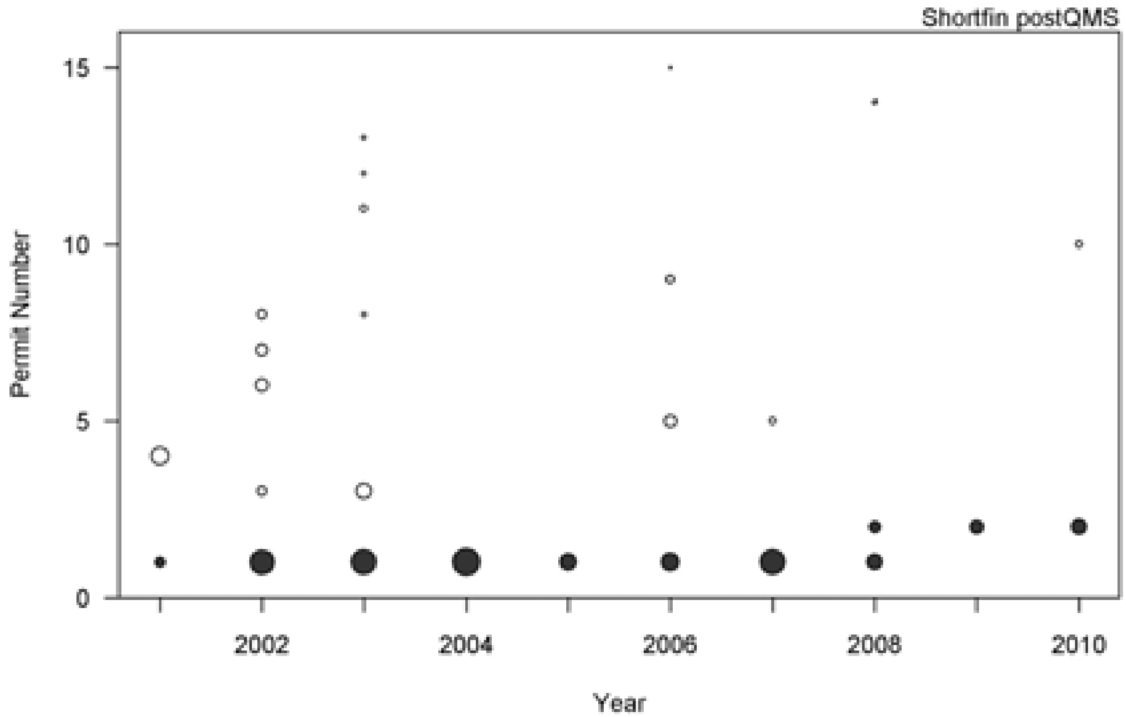

Figure B20: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA14 (AP-AQ)).

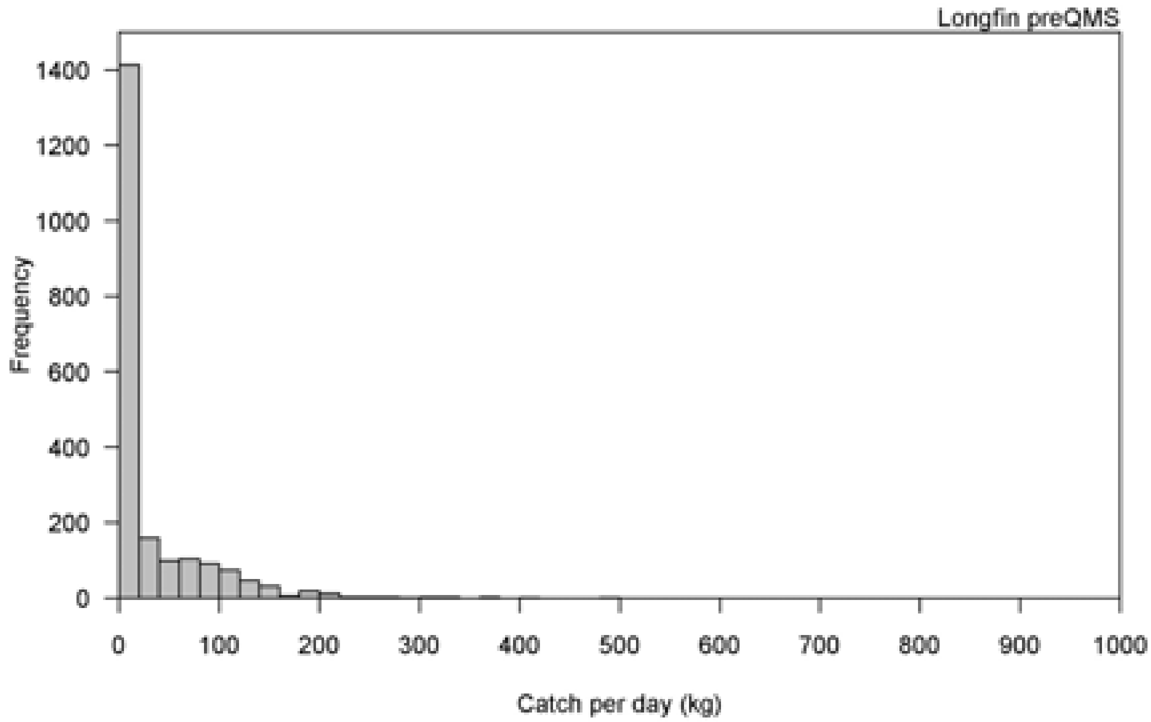

Figure B21: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

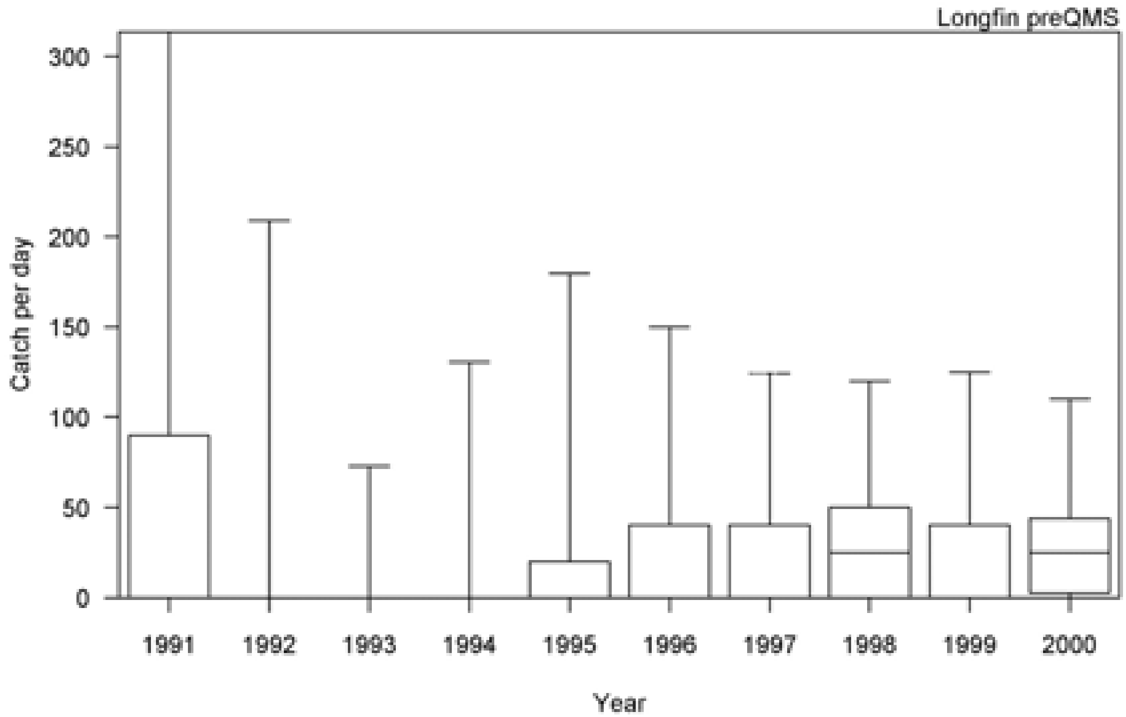

Figure B22: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA14 (AP-AQ)).

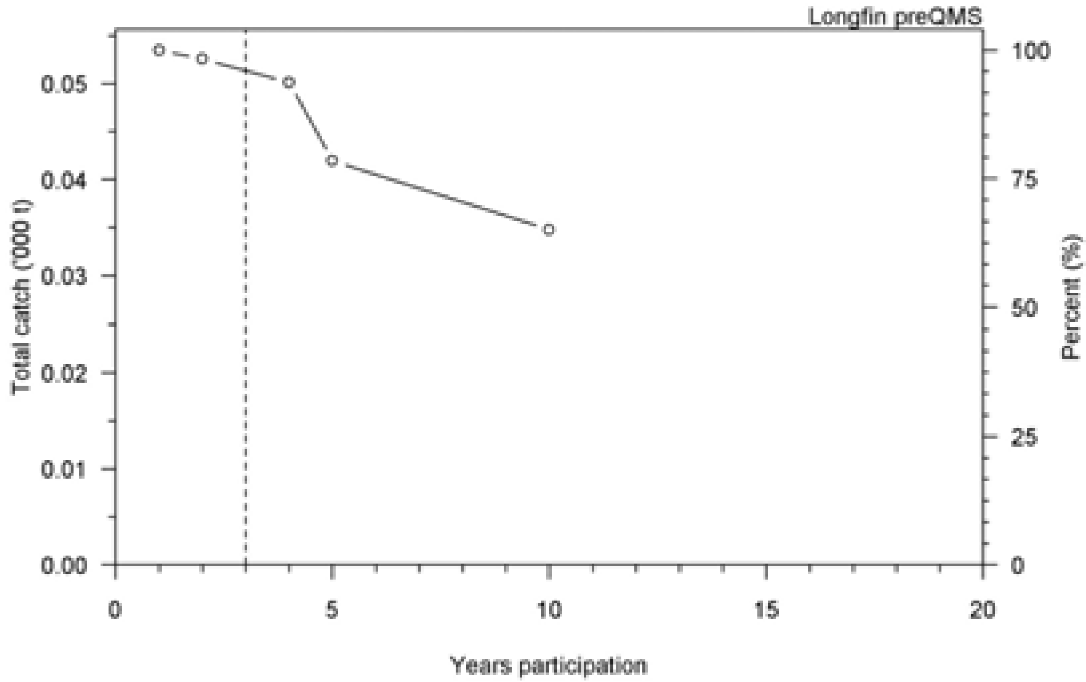

Figure B23: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA14 (AP-AQ)).

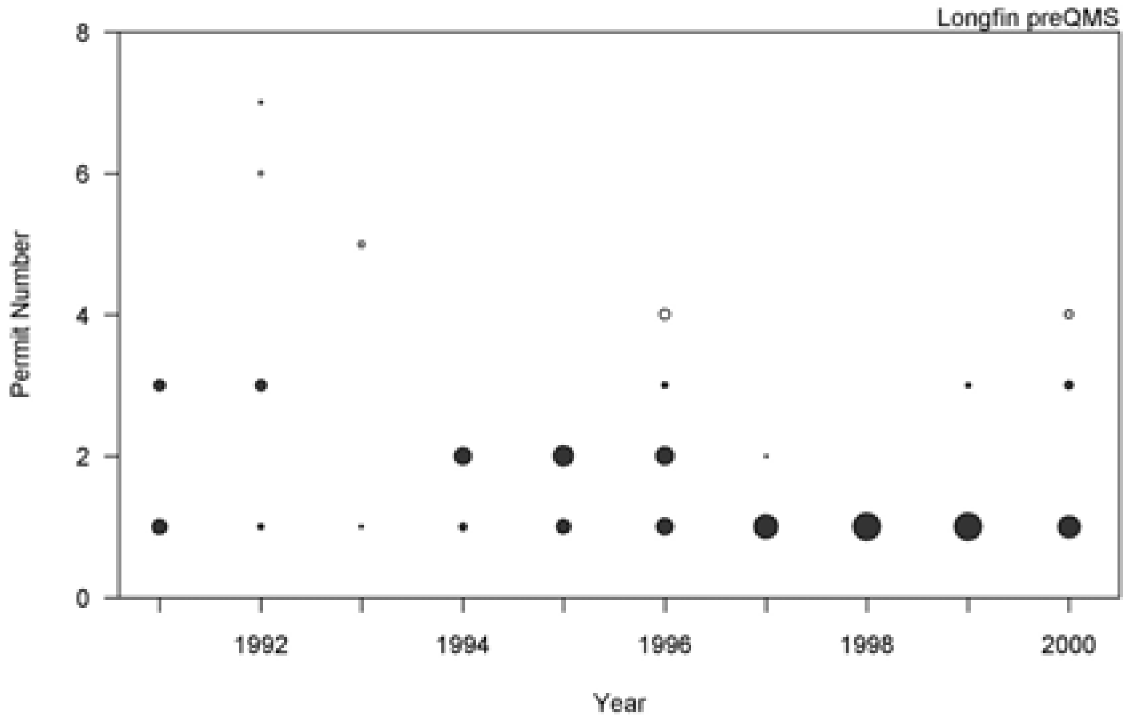

Figure B24: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA14 (AP-AQ)).

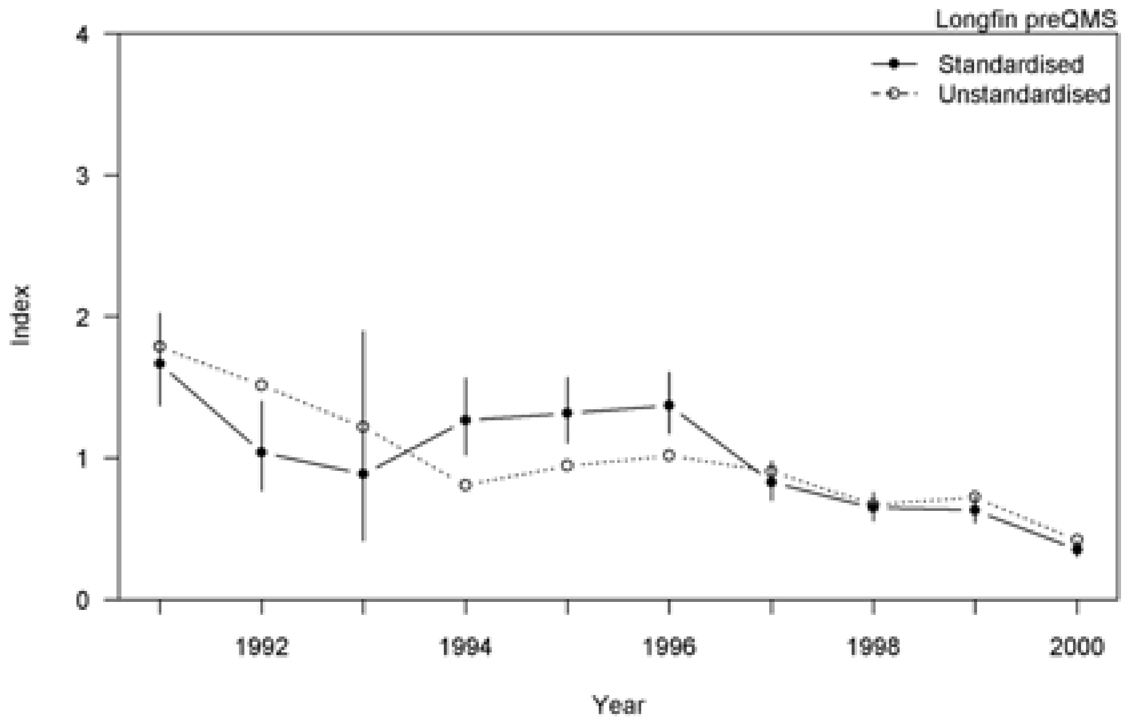

Figure B25: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA14 (AP-AQ)).

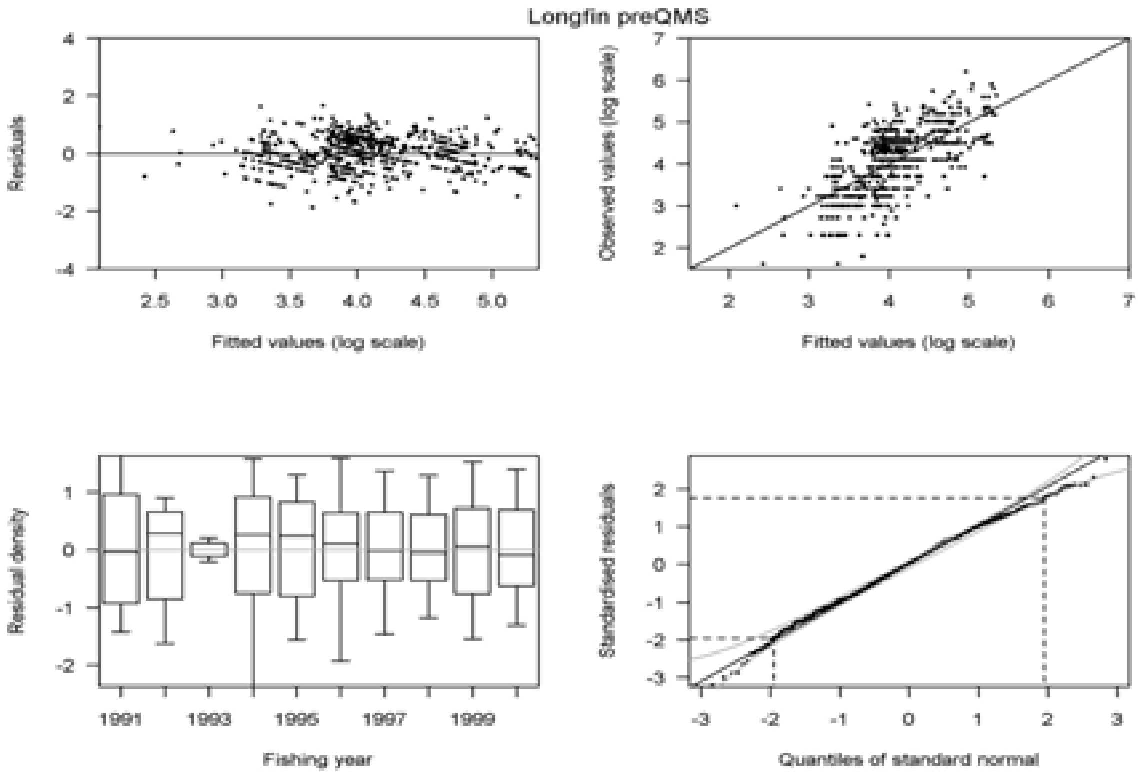

Figure B26: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA14 (AP-AQ)).

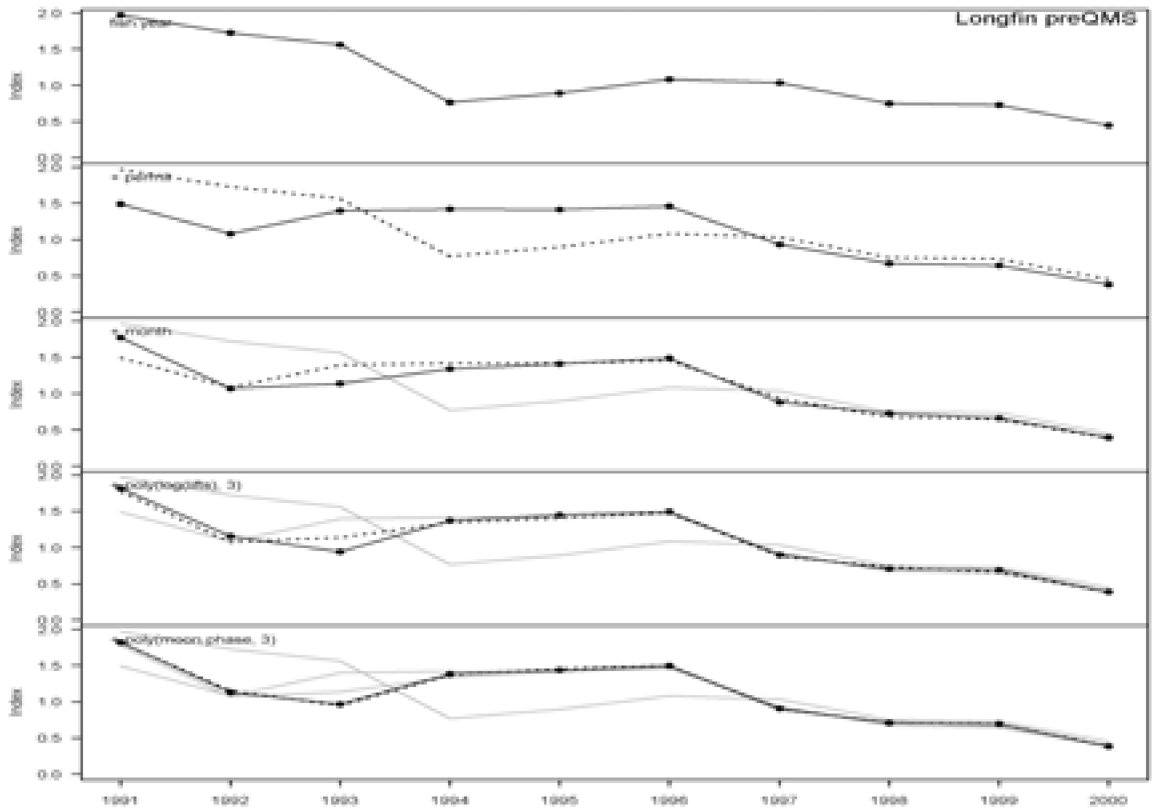

Figure B27: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA14 (AP-AQ)).

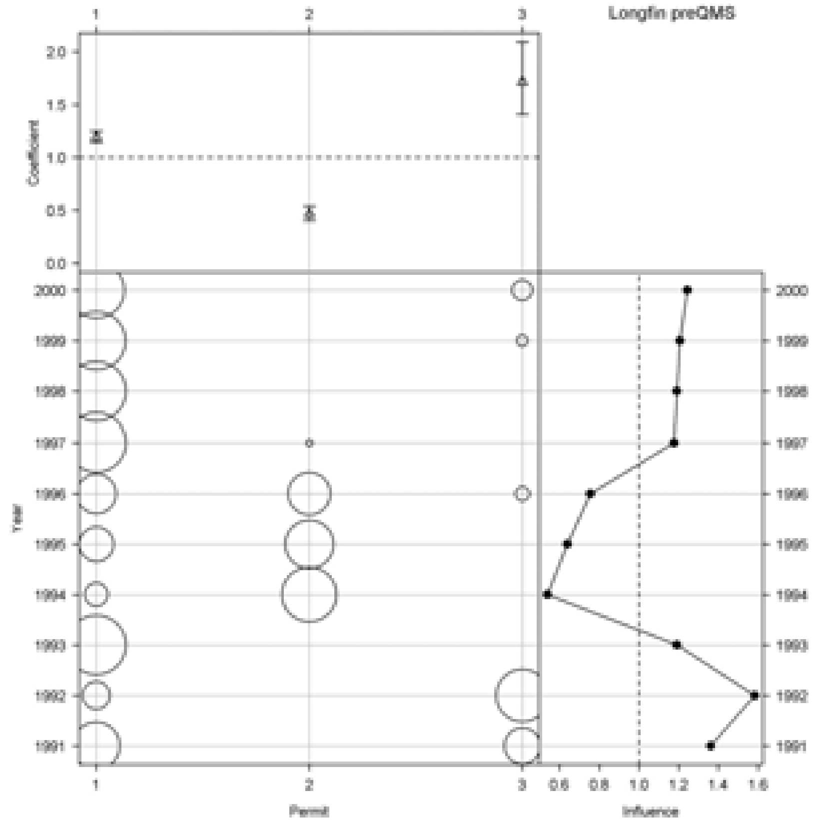

Figure B28: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

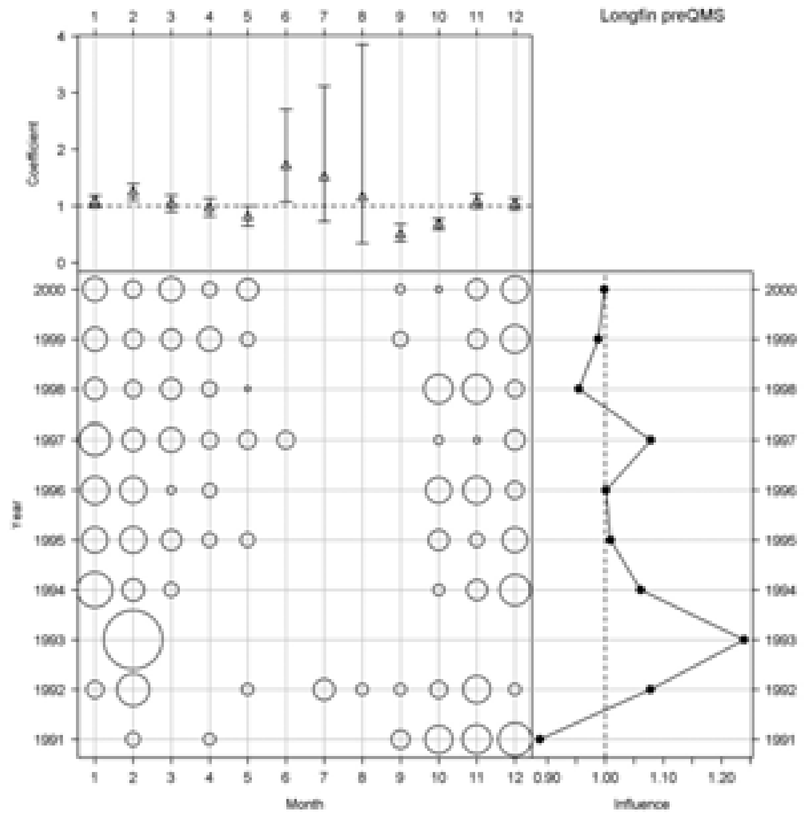

Figure B29: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

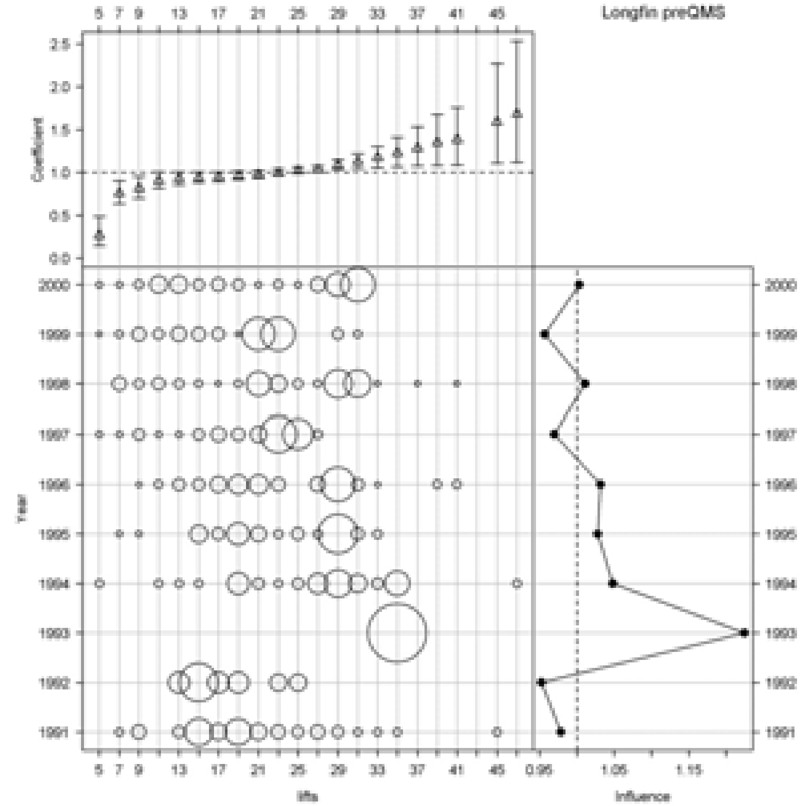

Figure B30: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

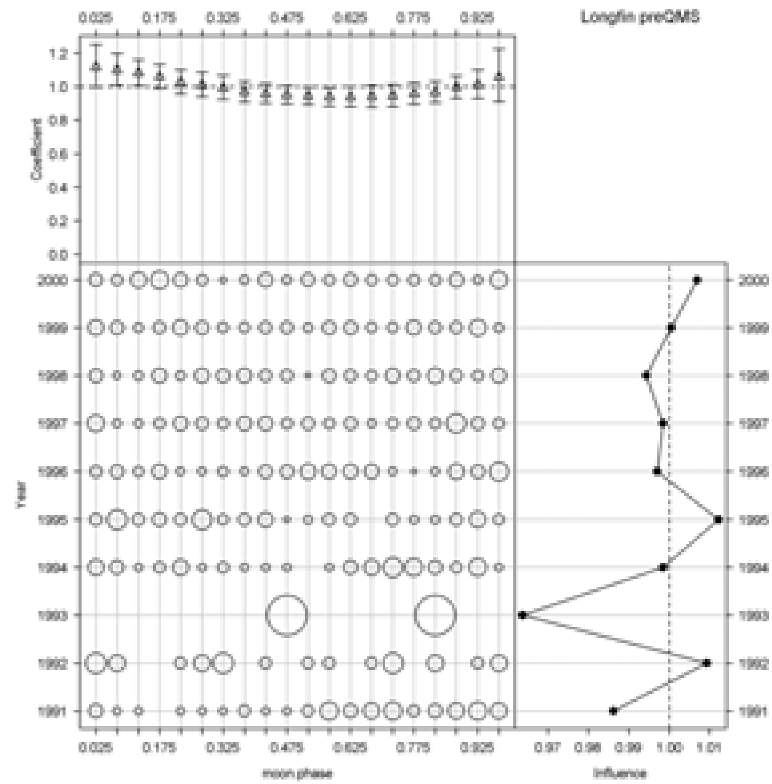

Figure B31: Influence of moon phase for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA14 (AP-AQ)).

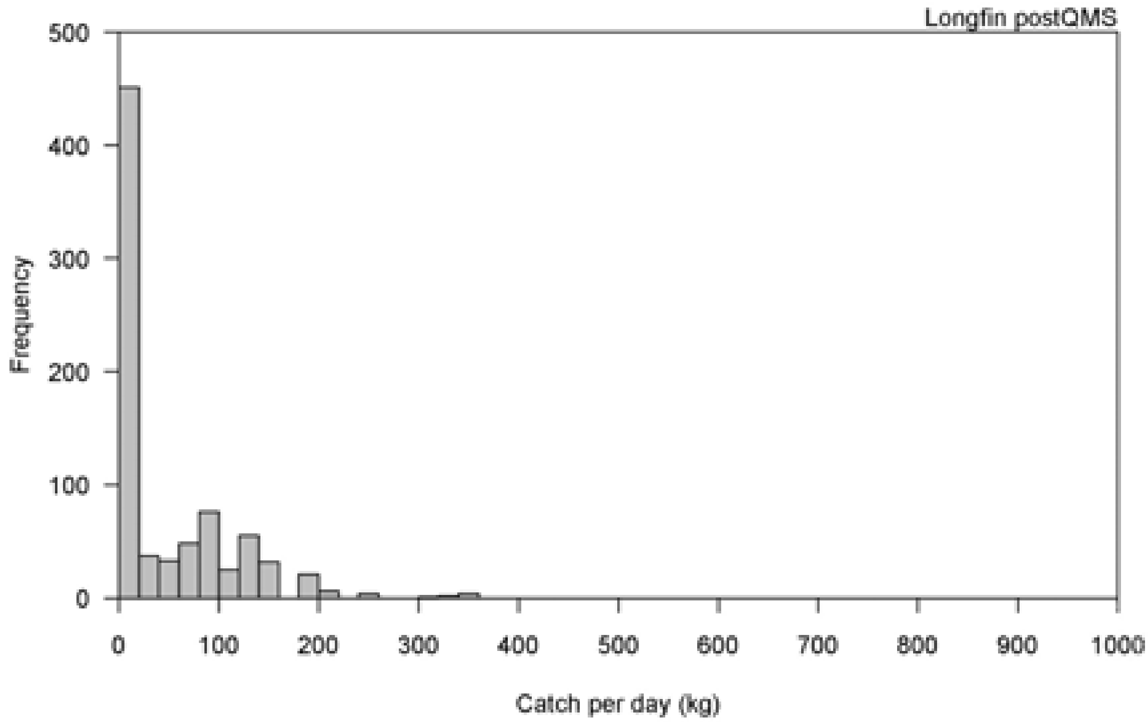

Figure B32: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA14 (AP-AQ)).

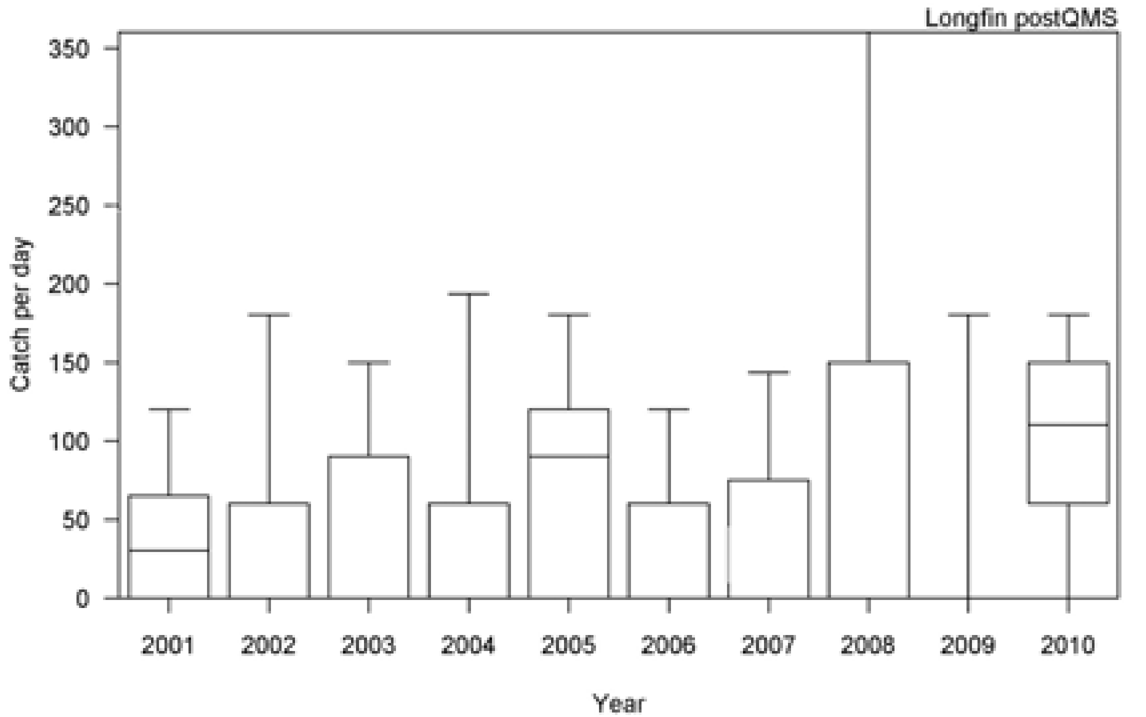

Figure B33: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA14 (AP-AQ)).

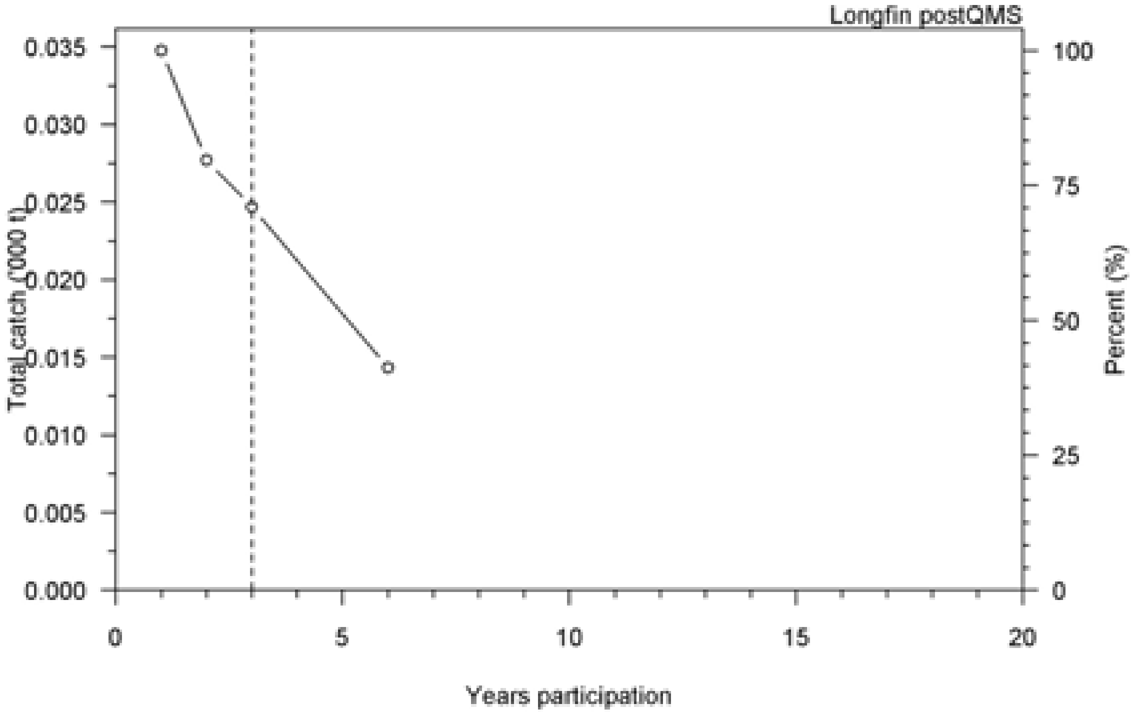

Figure B34: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA14 (AP-AQ)).

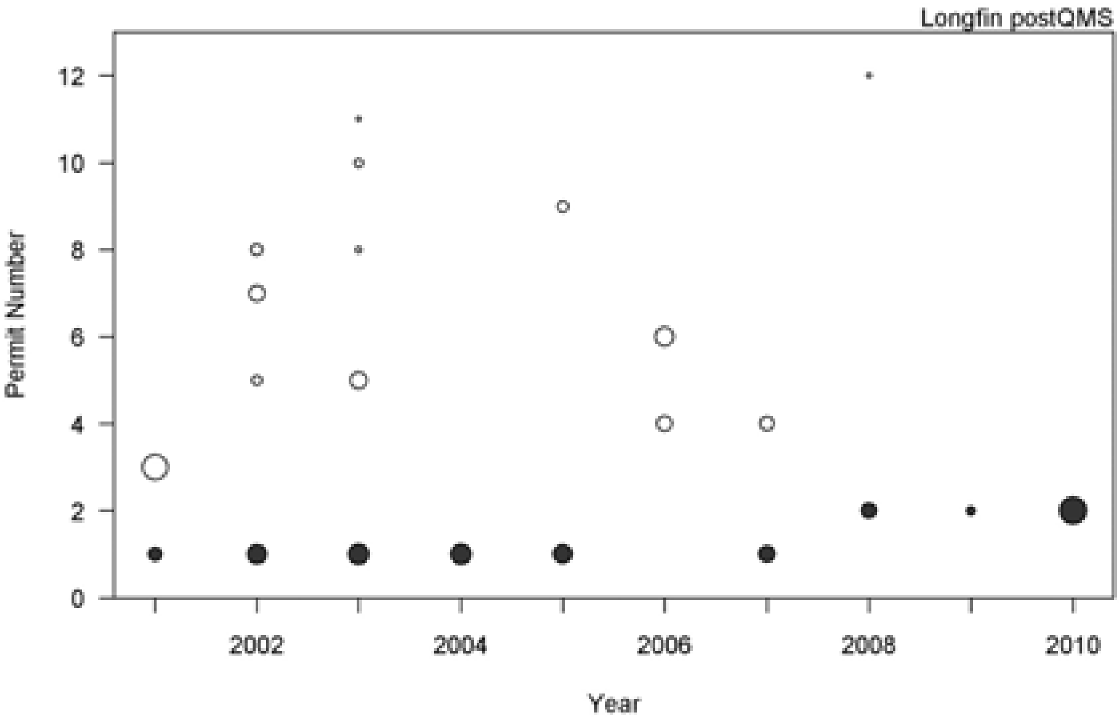

Figure B35: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA14 (AP-AQ)).

Appendix C: ESA 16 (AR).

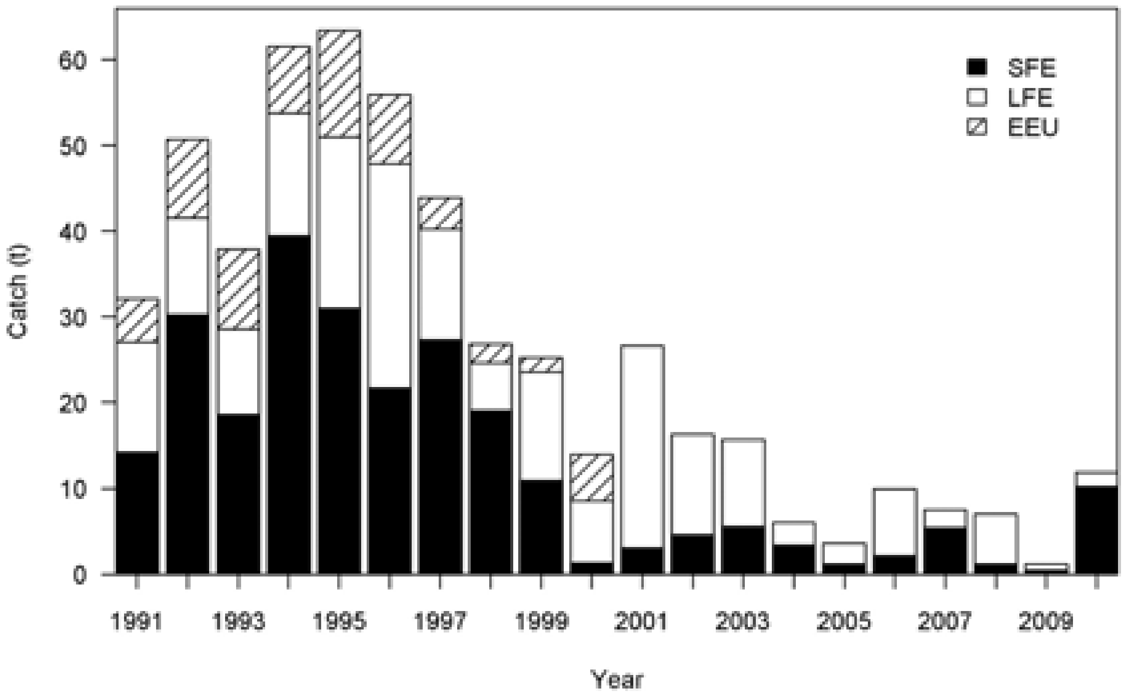

Figure C1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA16 (AR)).

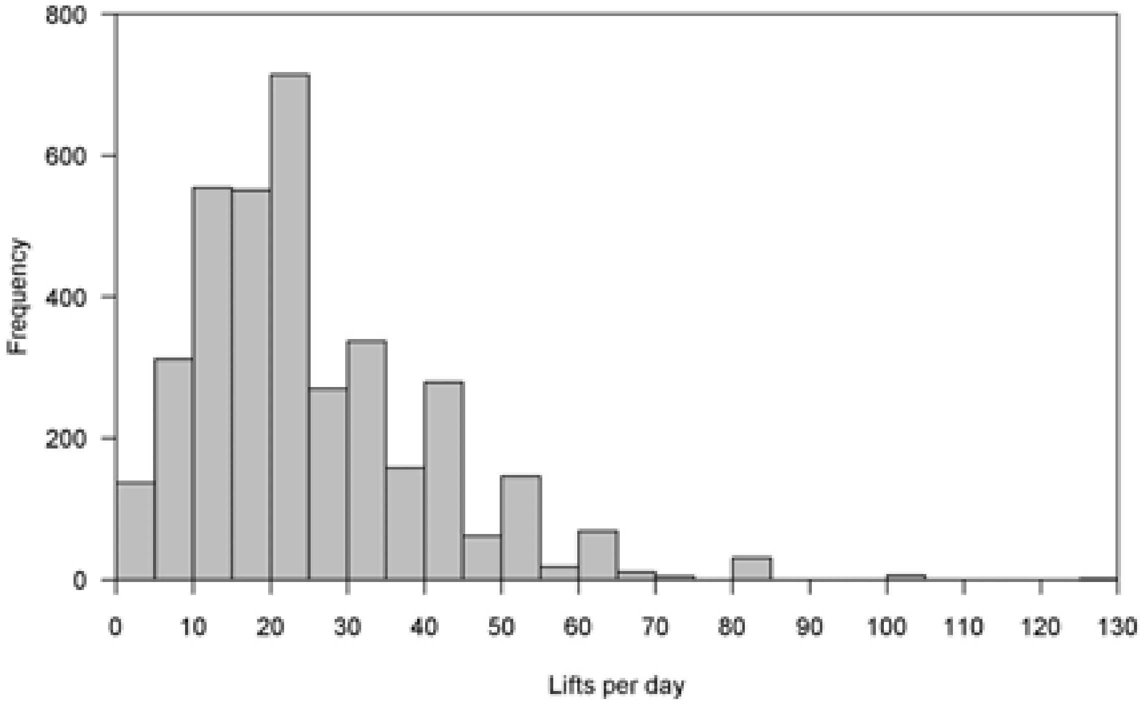

Figure C2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA16 (AR)).

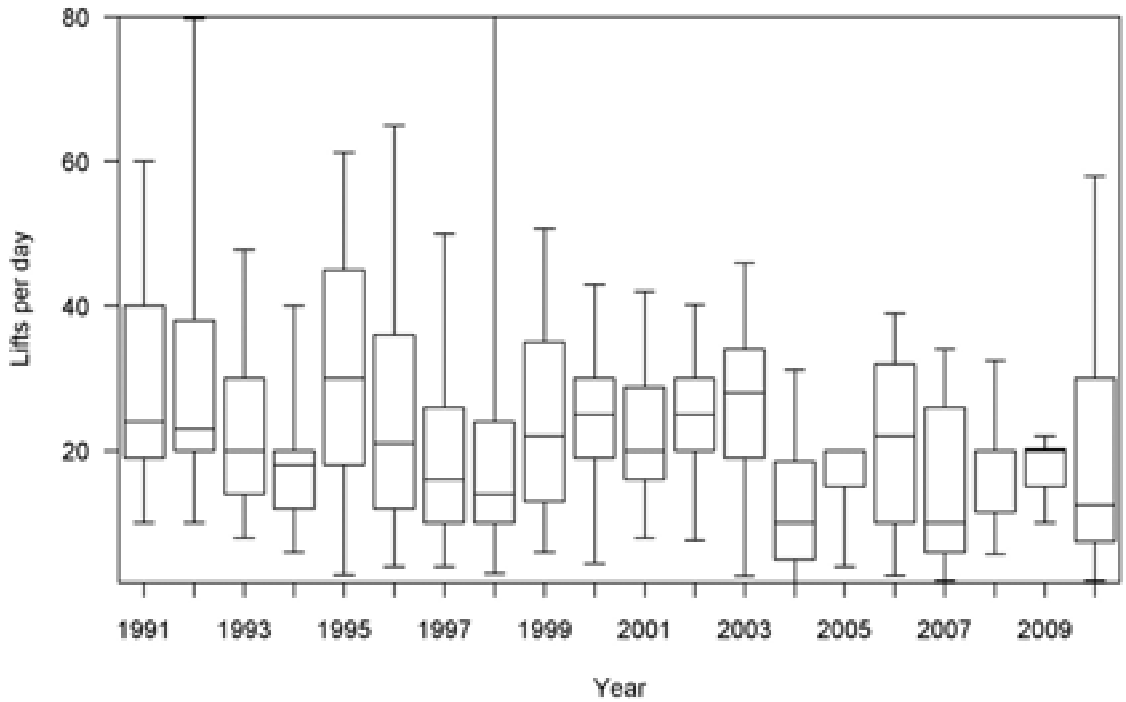

Figure C3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA16 (AR)).

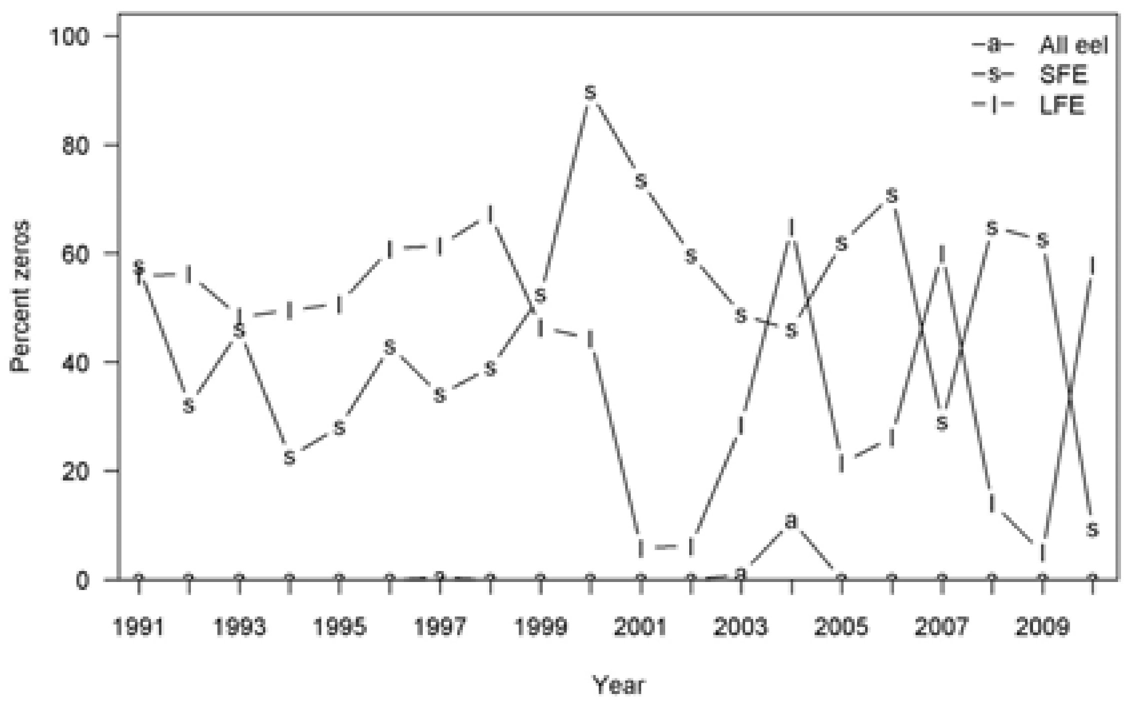

Figure C4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA16 (AR)).

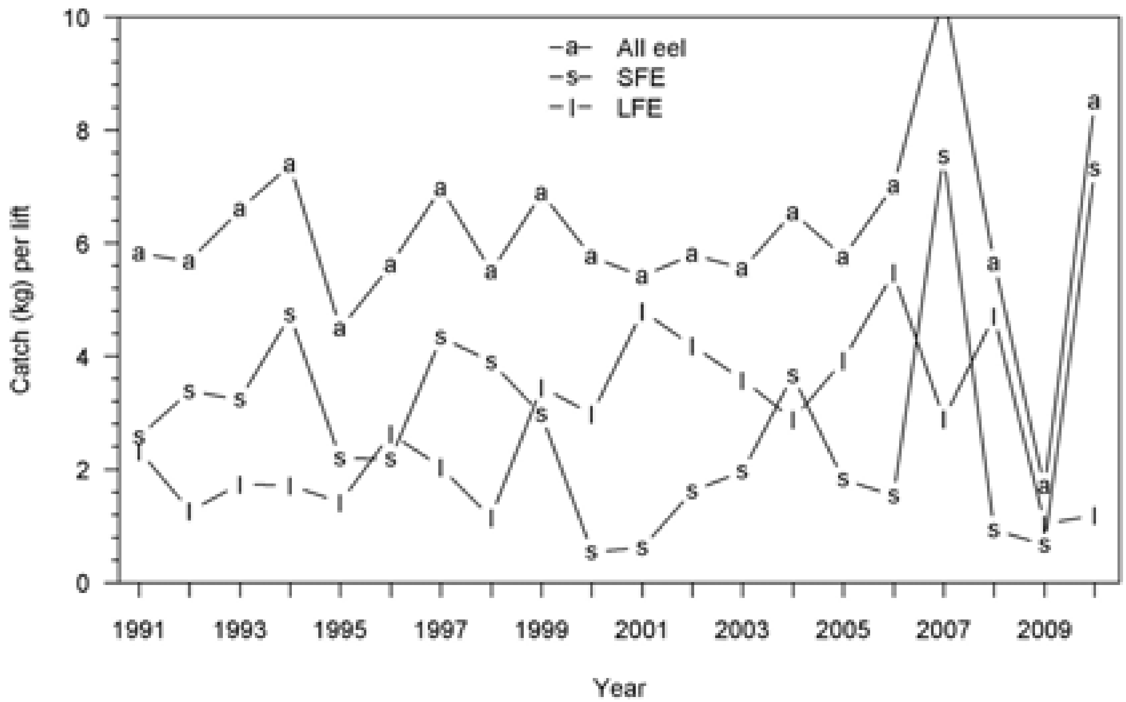

Figure C5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA16 (AR)).

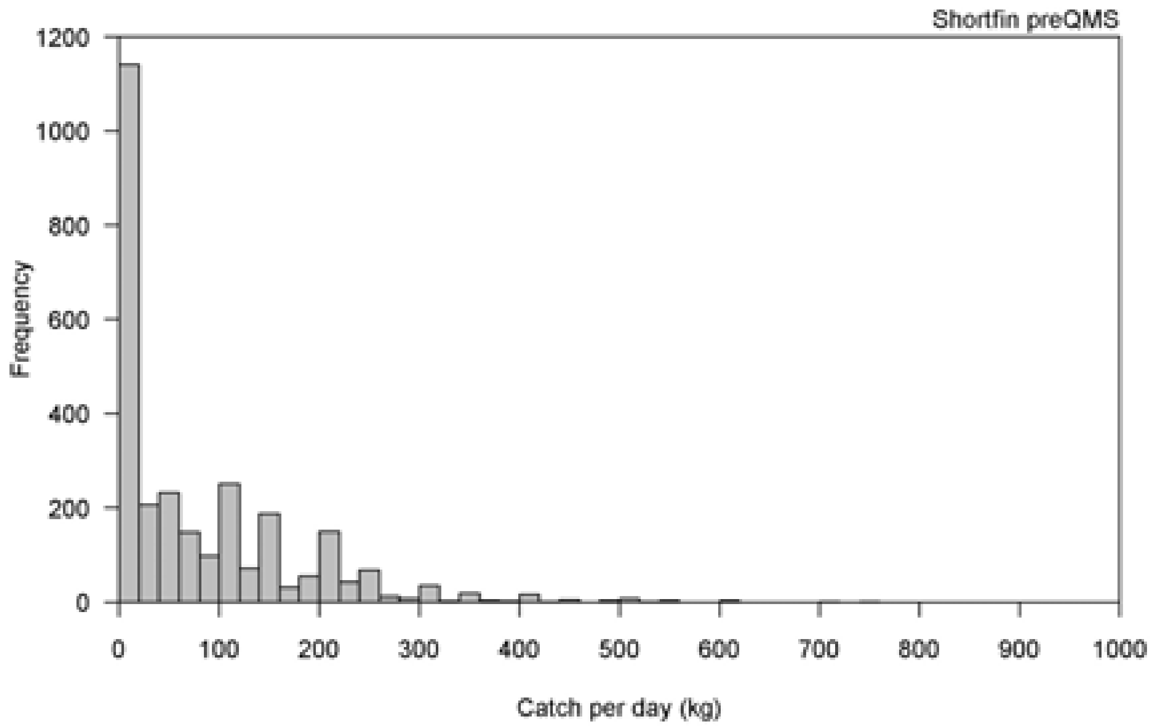

Figure C6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

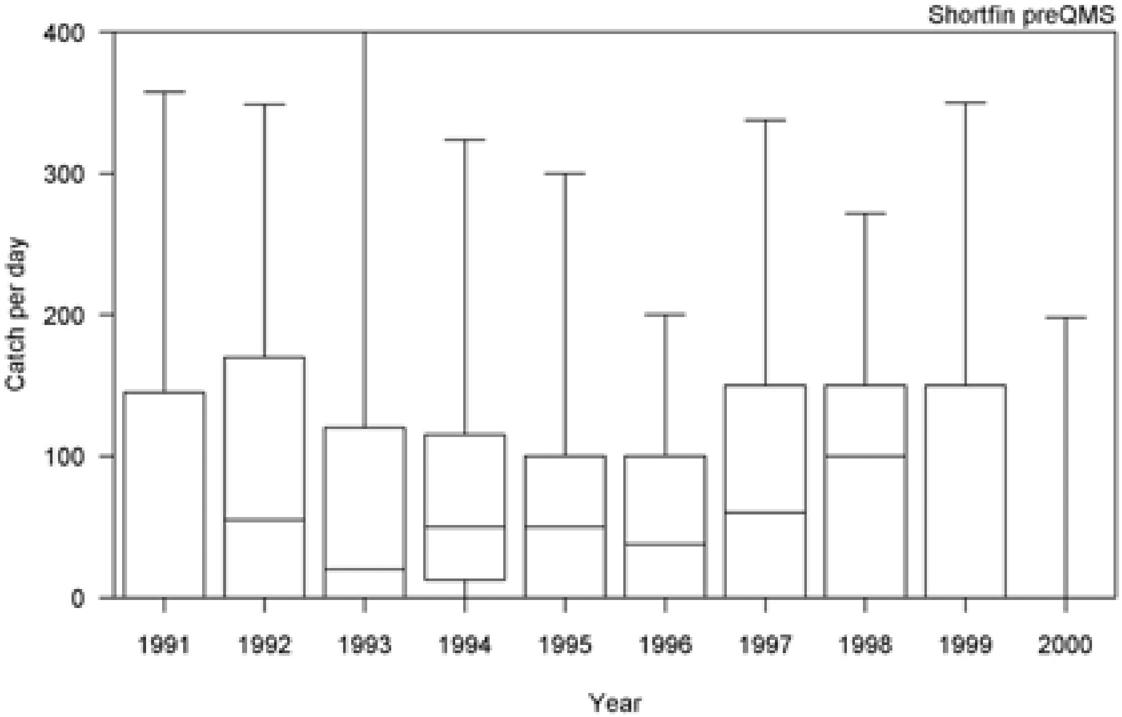

Figure C7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA16 (AR)).

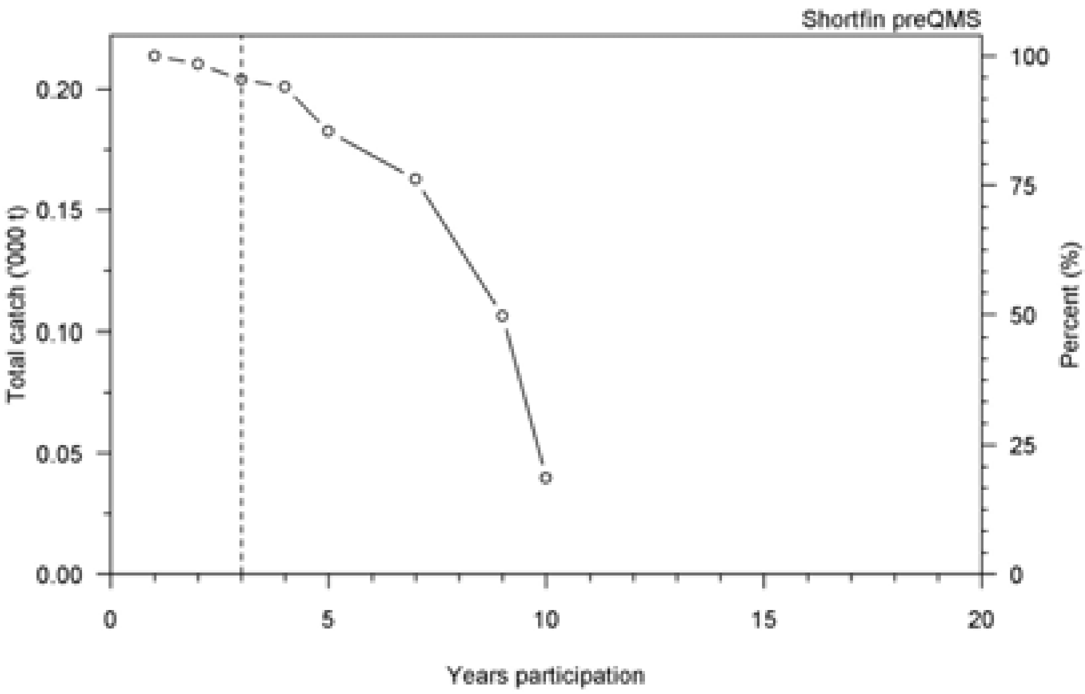

Figure C8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA16 (AR)).

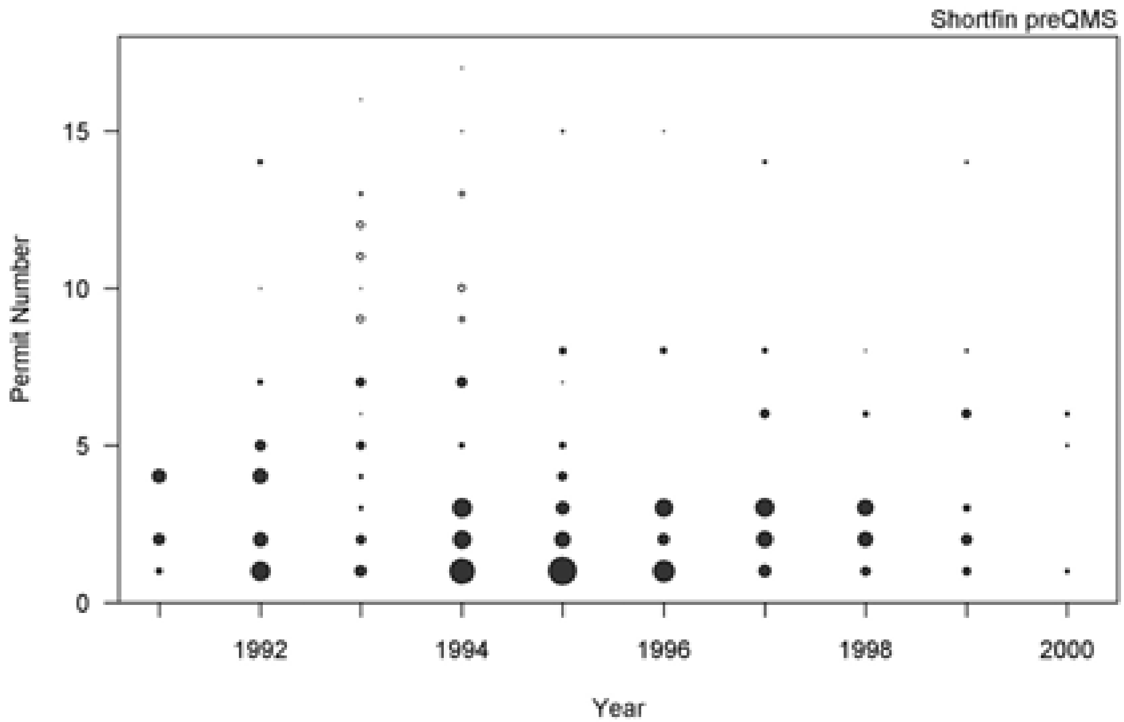

Figure C9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA16 (AR)).

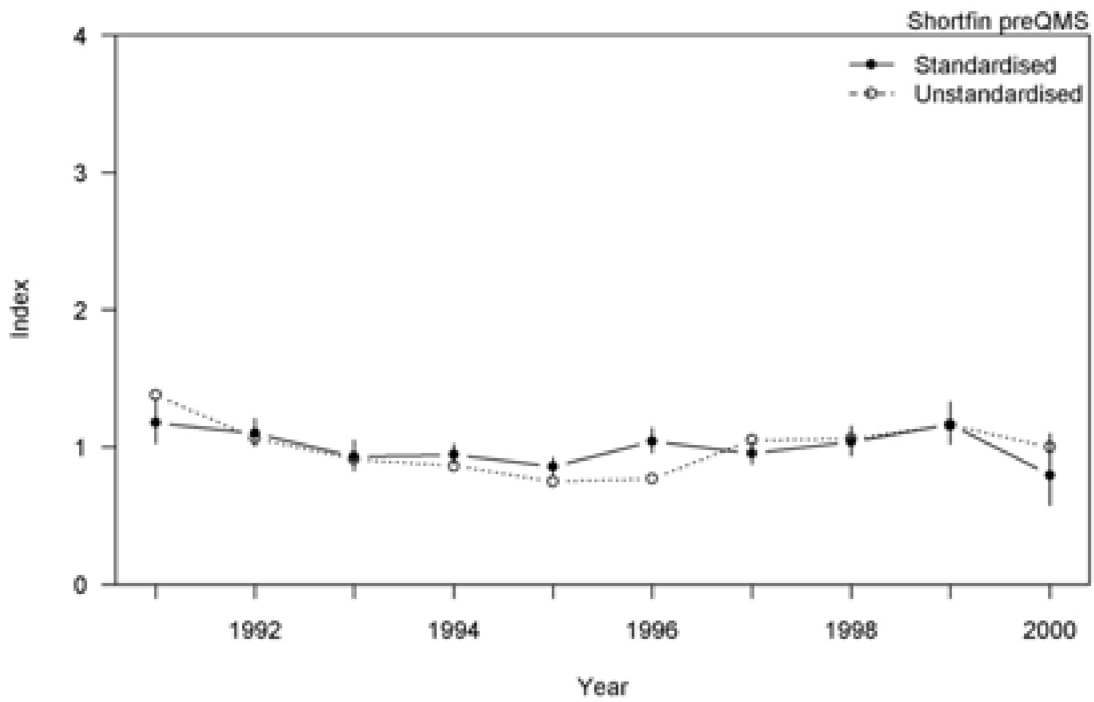

Figure C10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA16 (AR)).

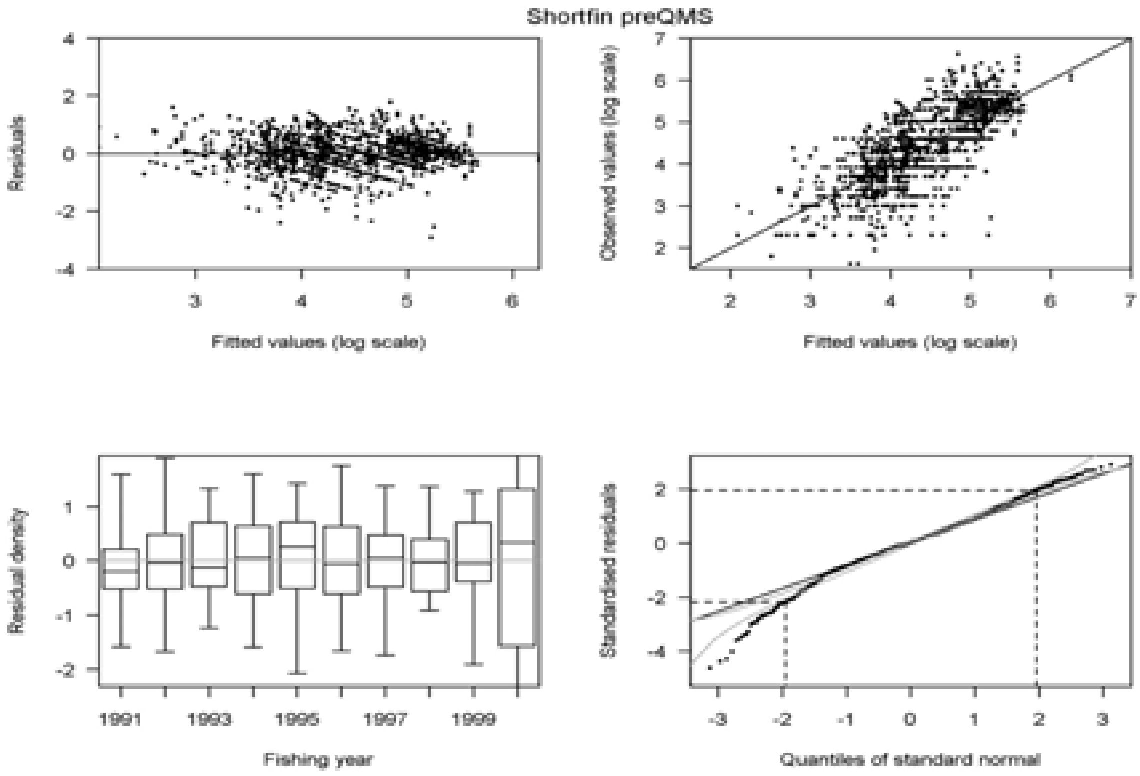

Figure C11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA16 (AR)).

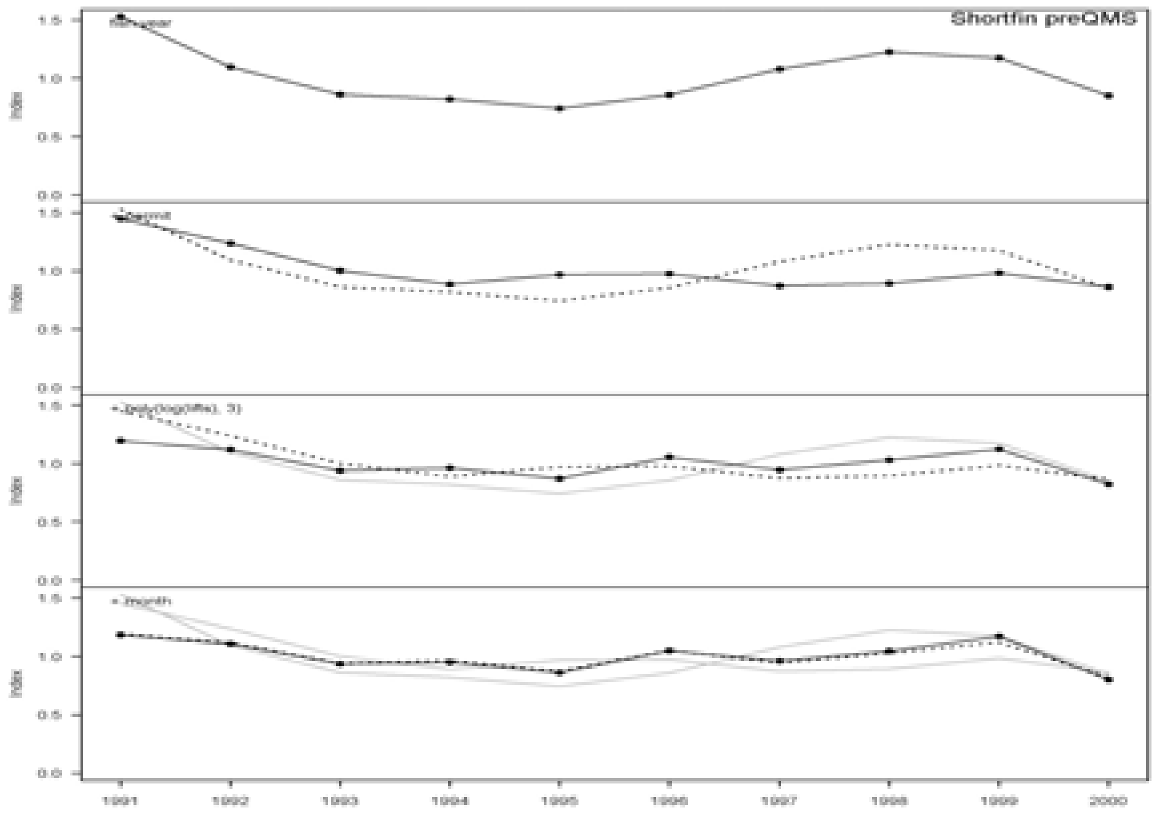

Figure C12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA16 (AR)).

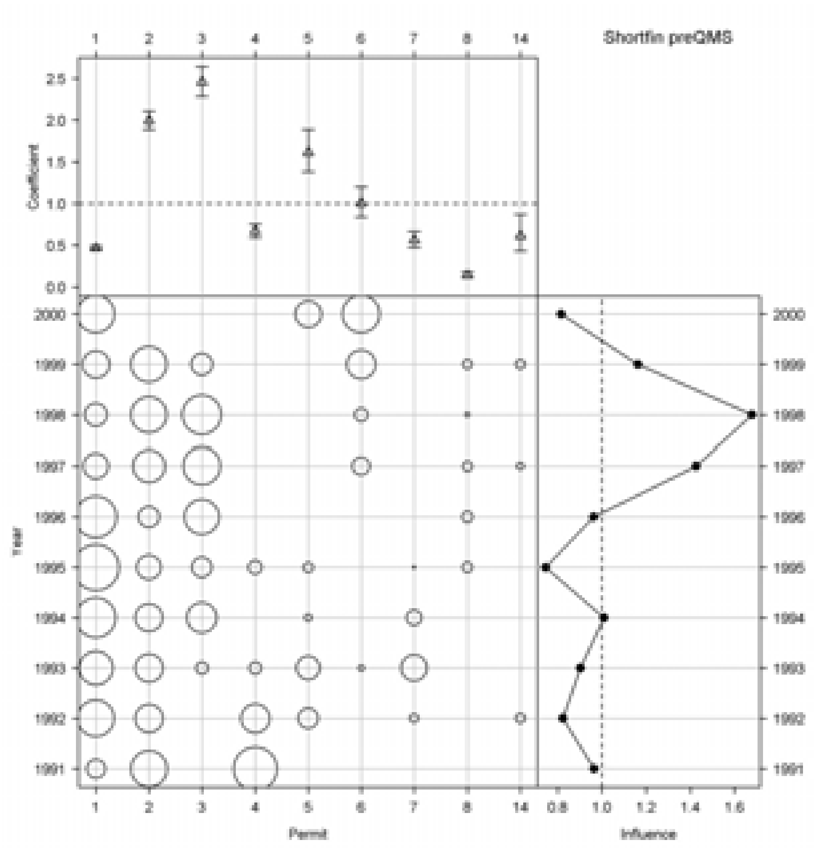

Figure C13: Influence of permit number for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

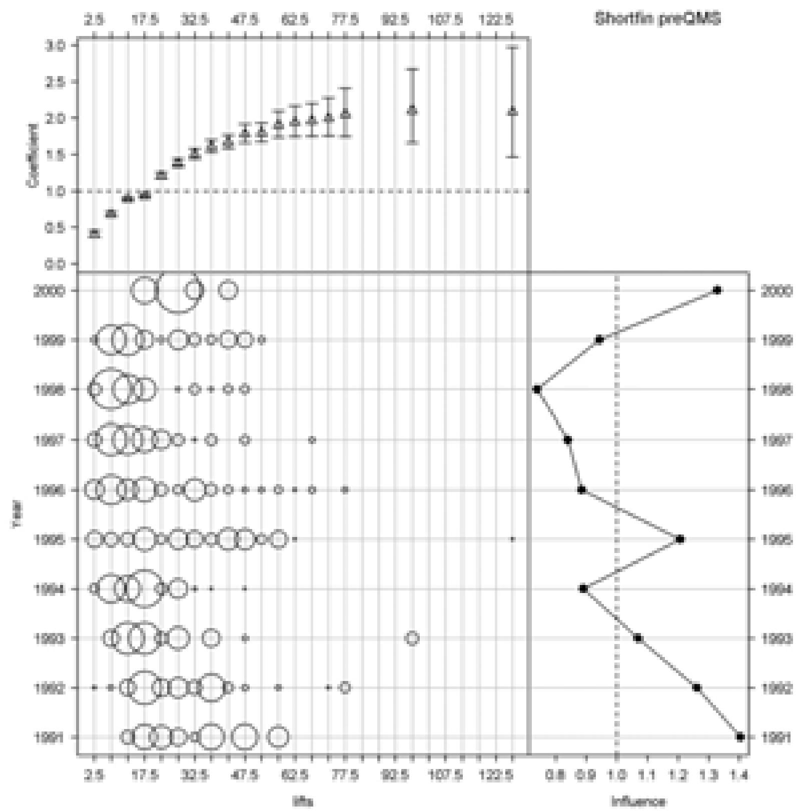

Figure C14: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

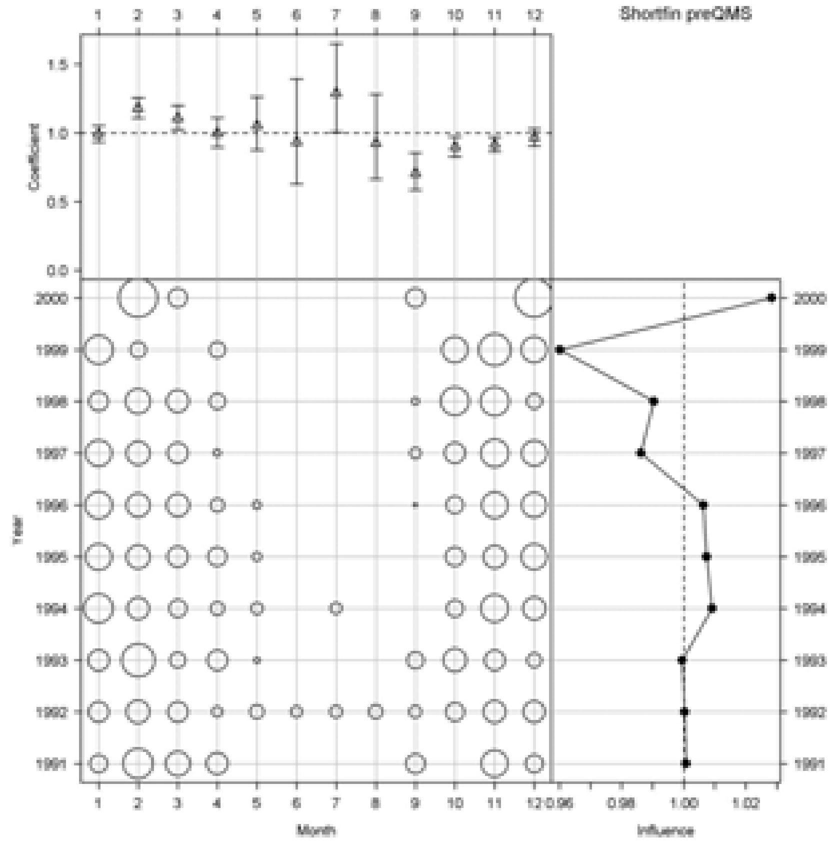

Figure C15: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

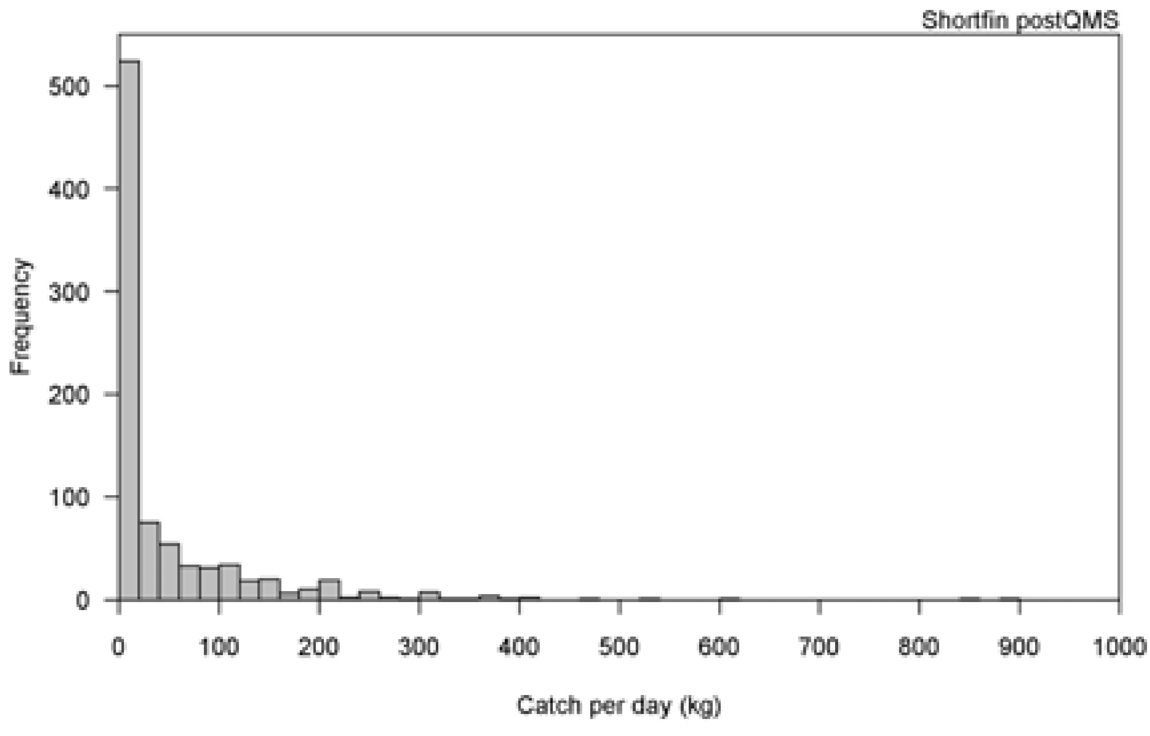

Figure C16: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA16 (AR)).

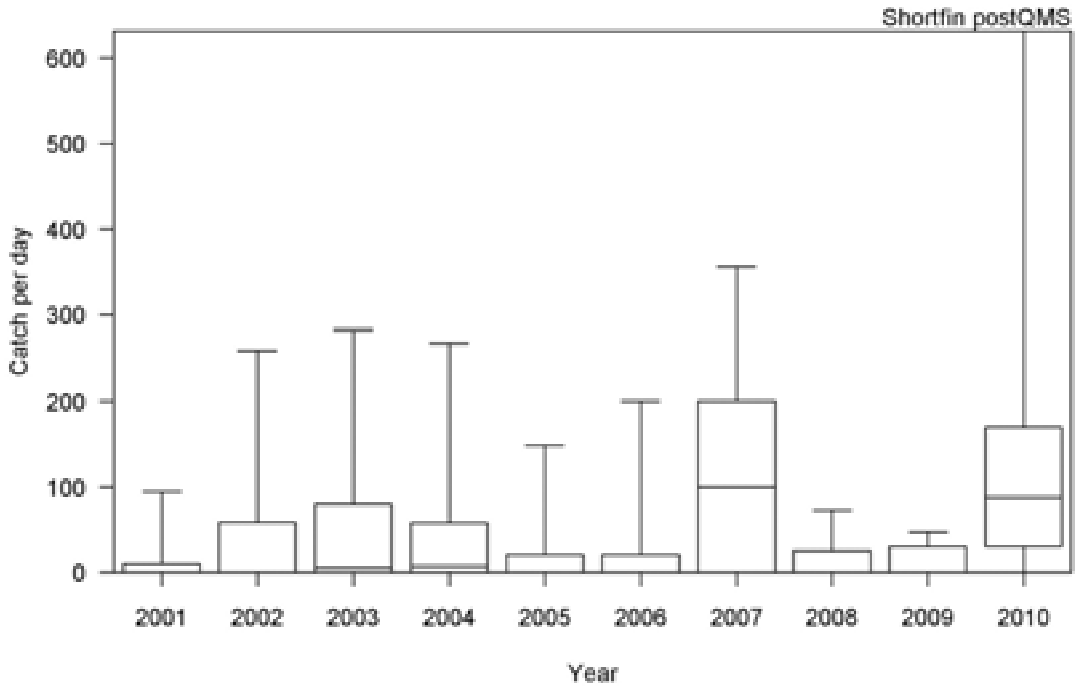

Figure C17: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA16 (AR)).

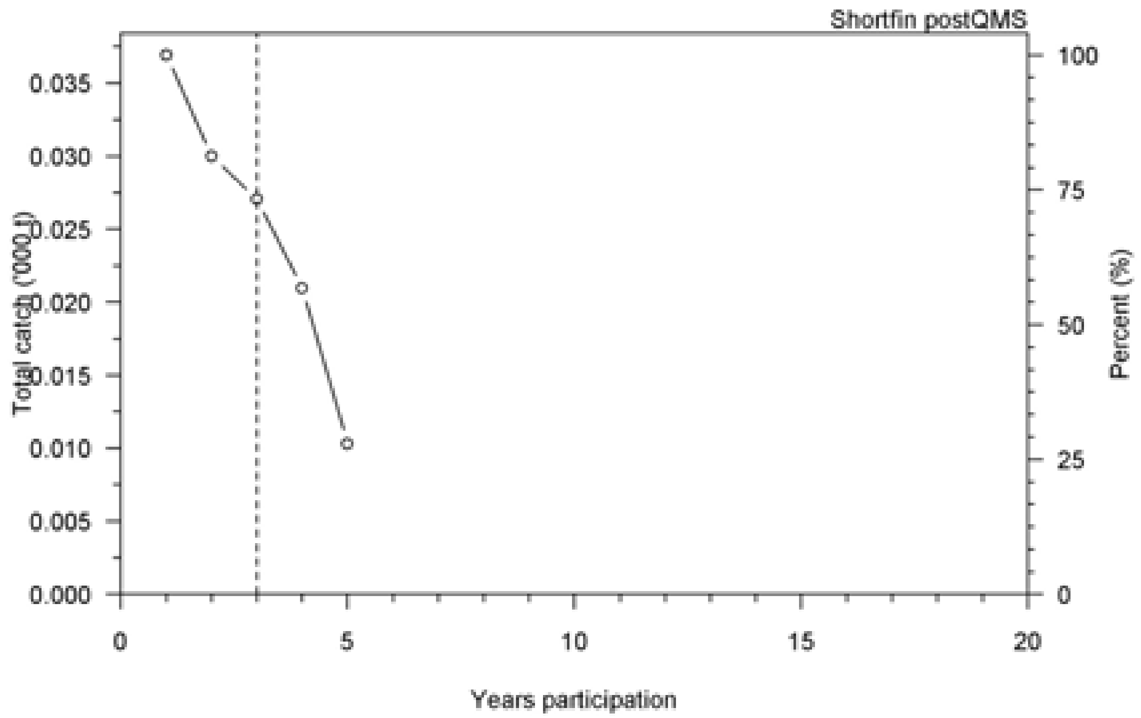

Figure C18: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA16 (AR)).

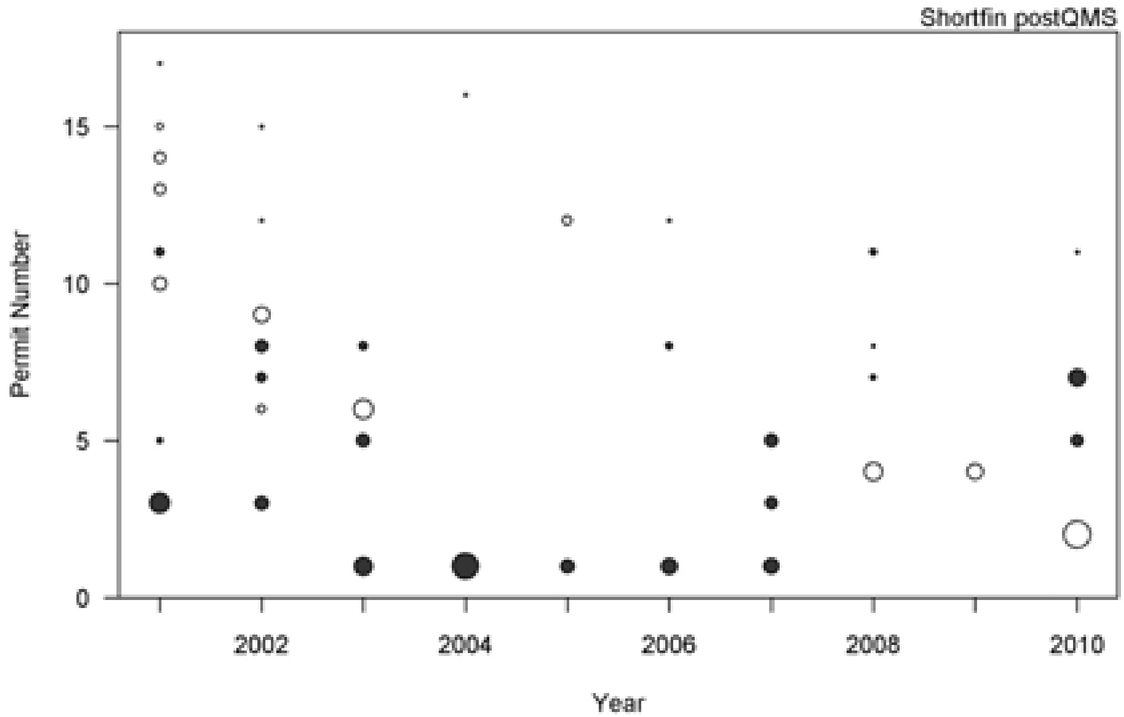

Figure C19: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA16 (AR)).

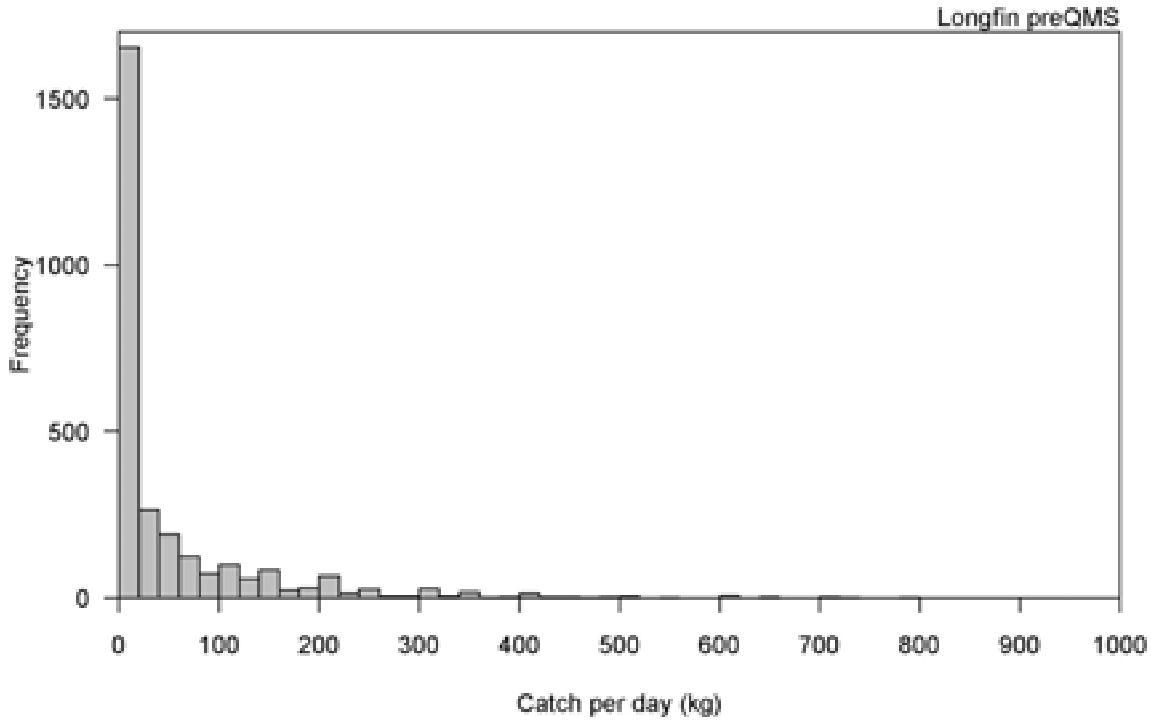

Figure C20: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

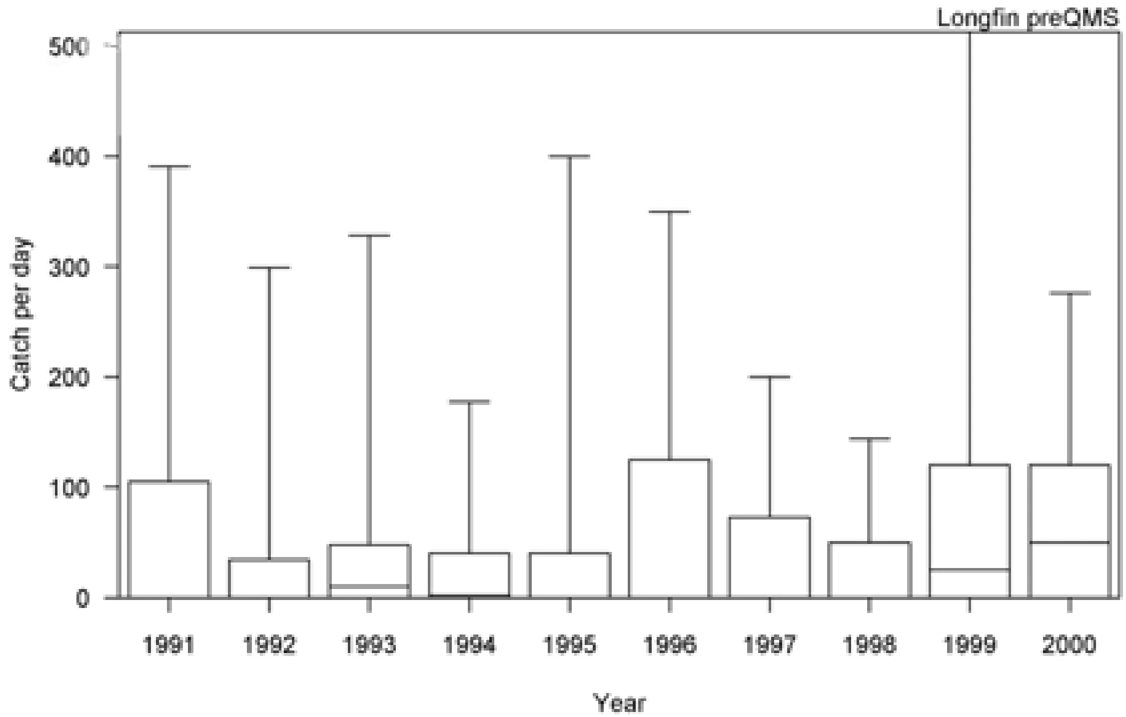

Figure C21: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA16 (AR)).

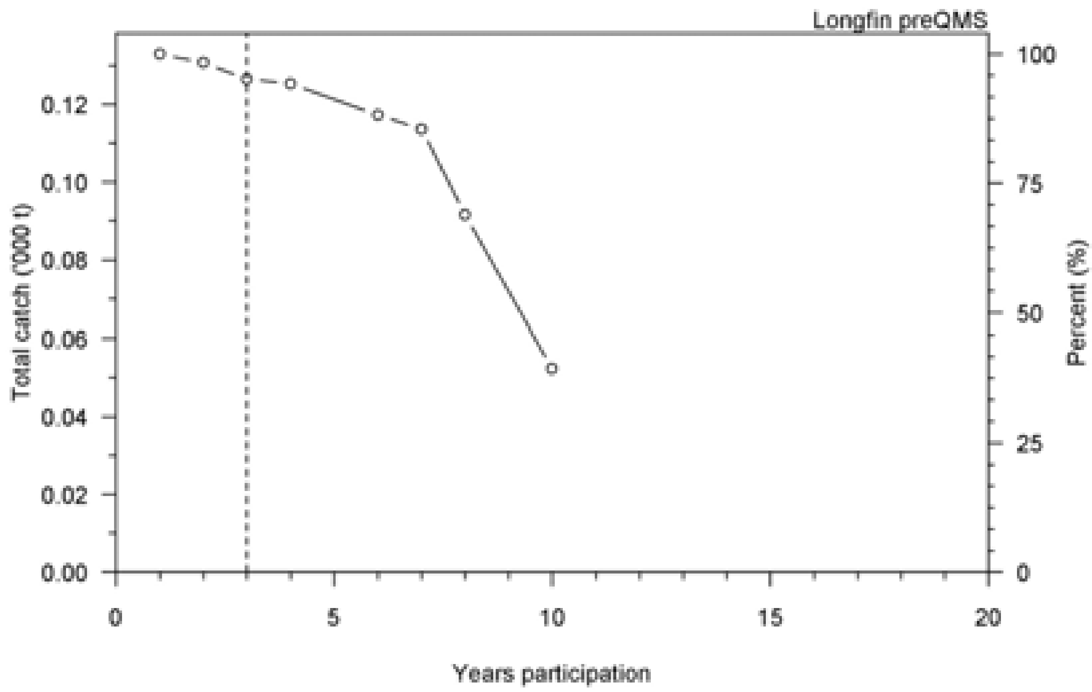

Figure C22: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA16 (AR)).

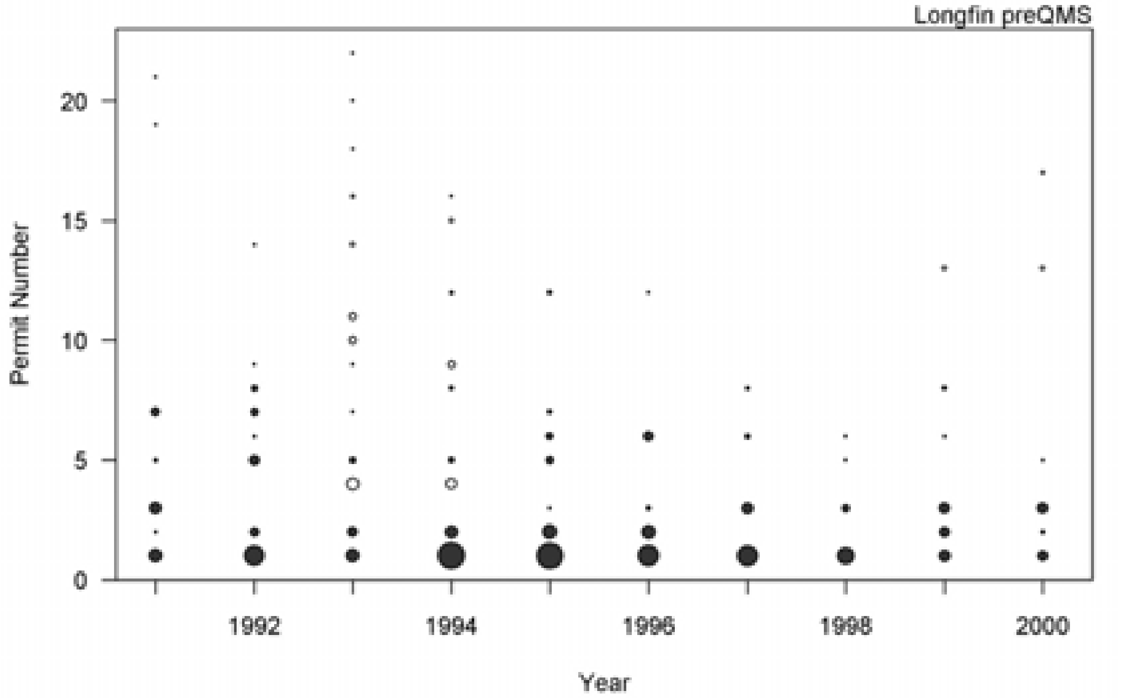

Figure C23: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA16 (AR)).

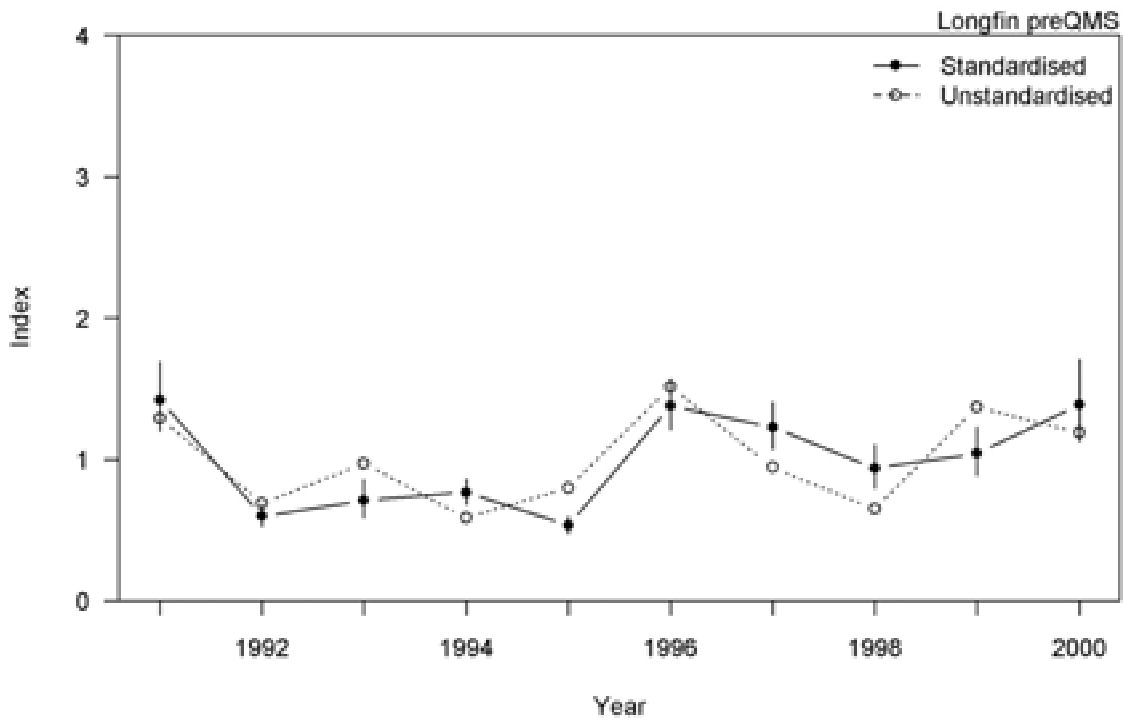

Figure C24: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA16 (AR)).

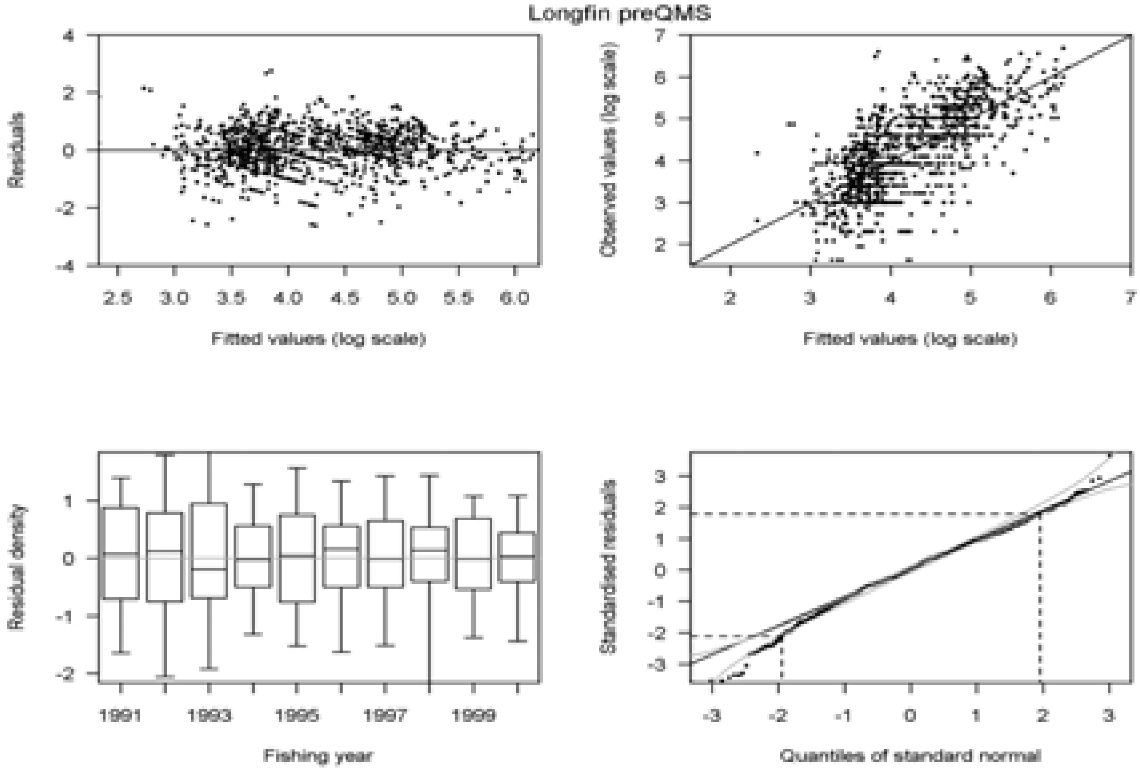

Figure C25: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA16 (AR)).

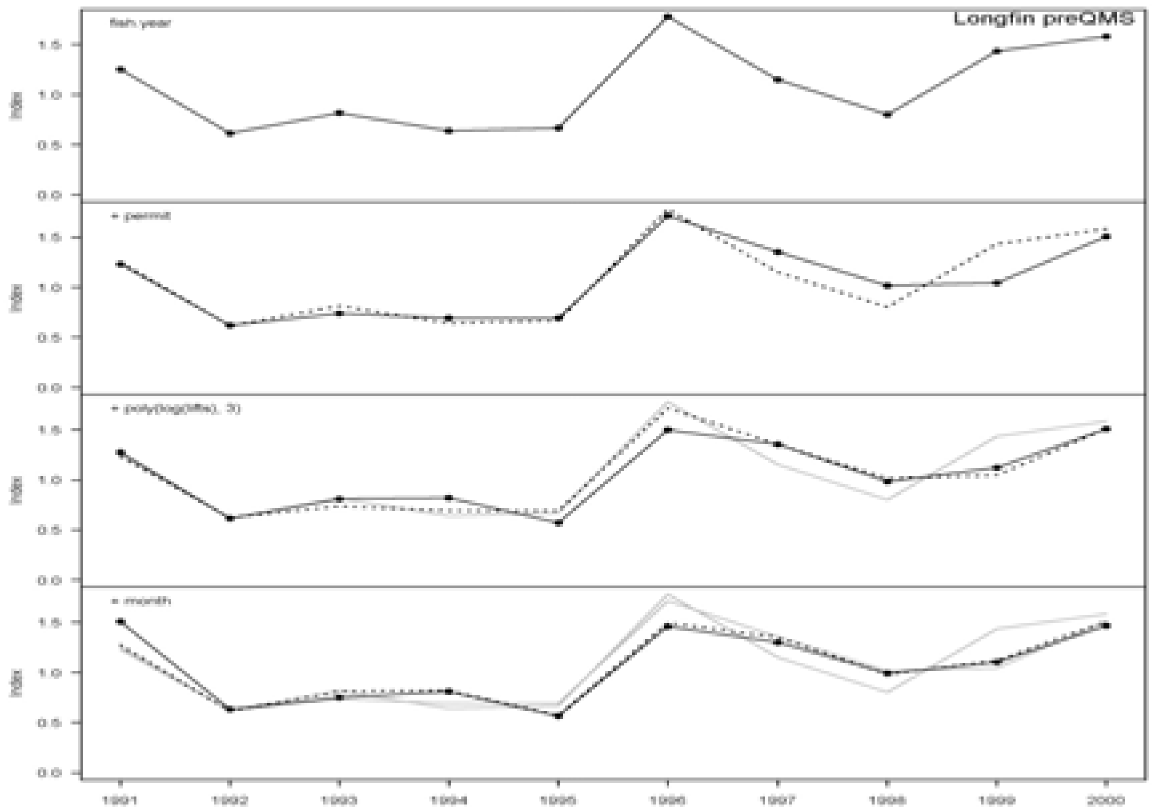

Figure C26: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA16 (AR)).

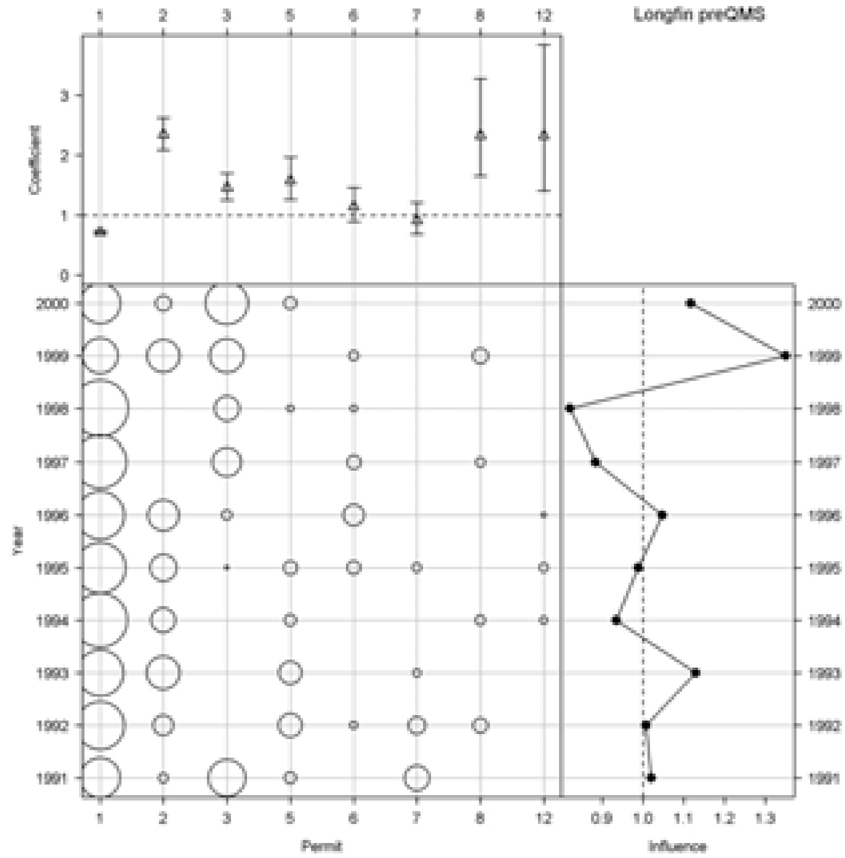

Figure C27: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

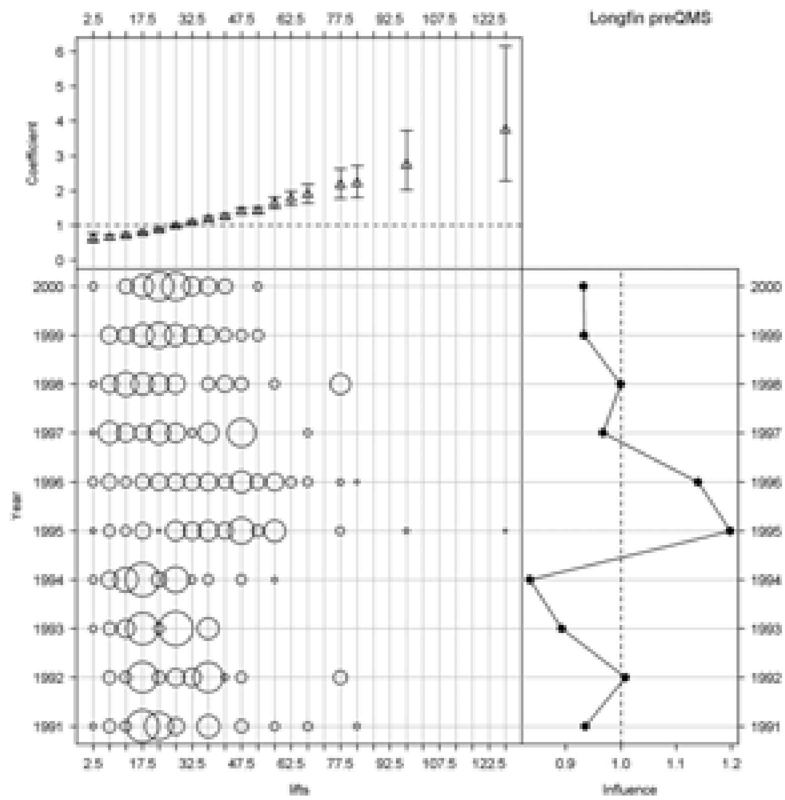

Figure C28: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

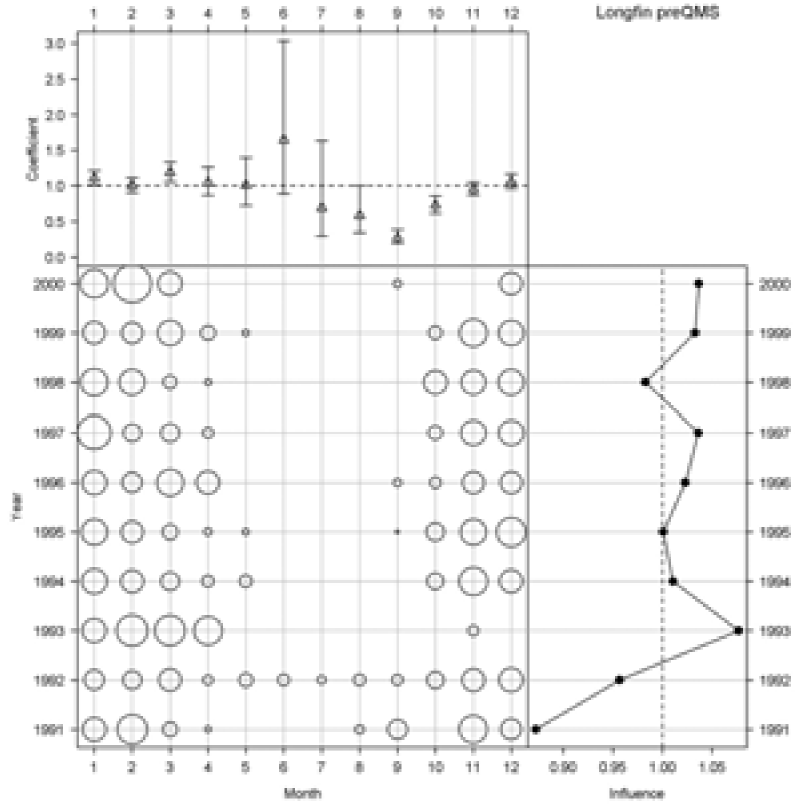

Figure C29: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA16 (AR)).

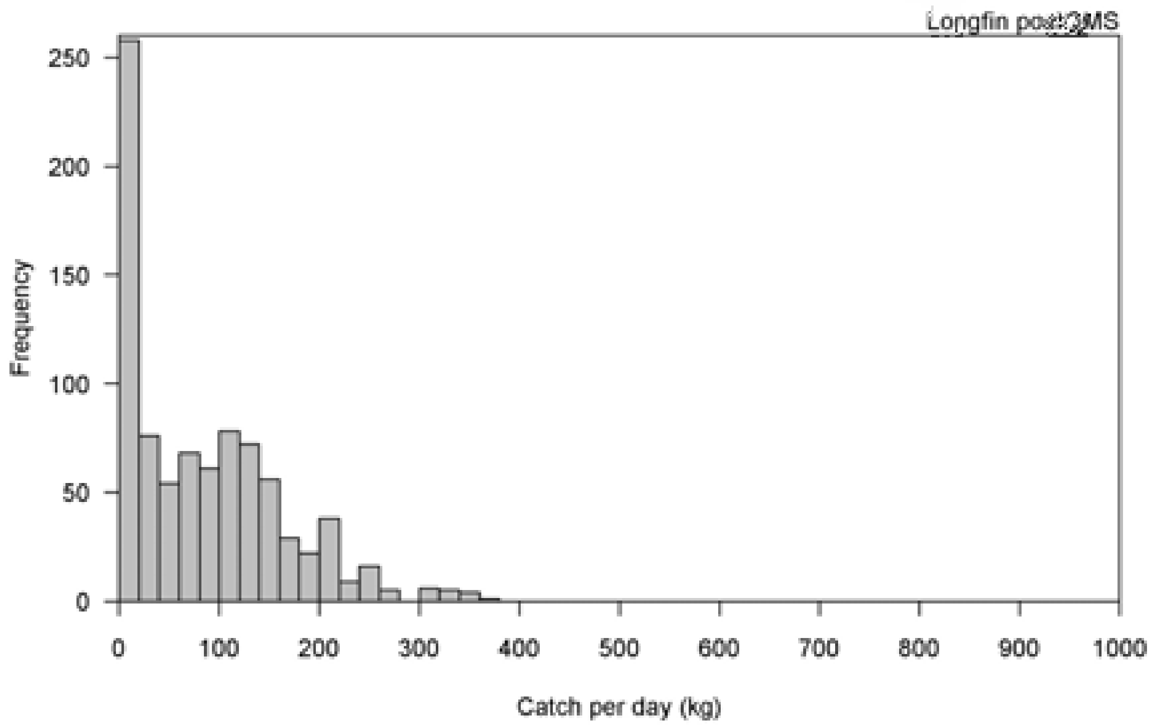

Figure C30: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA16 (AR)).

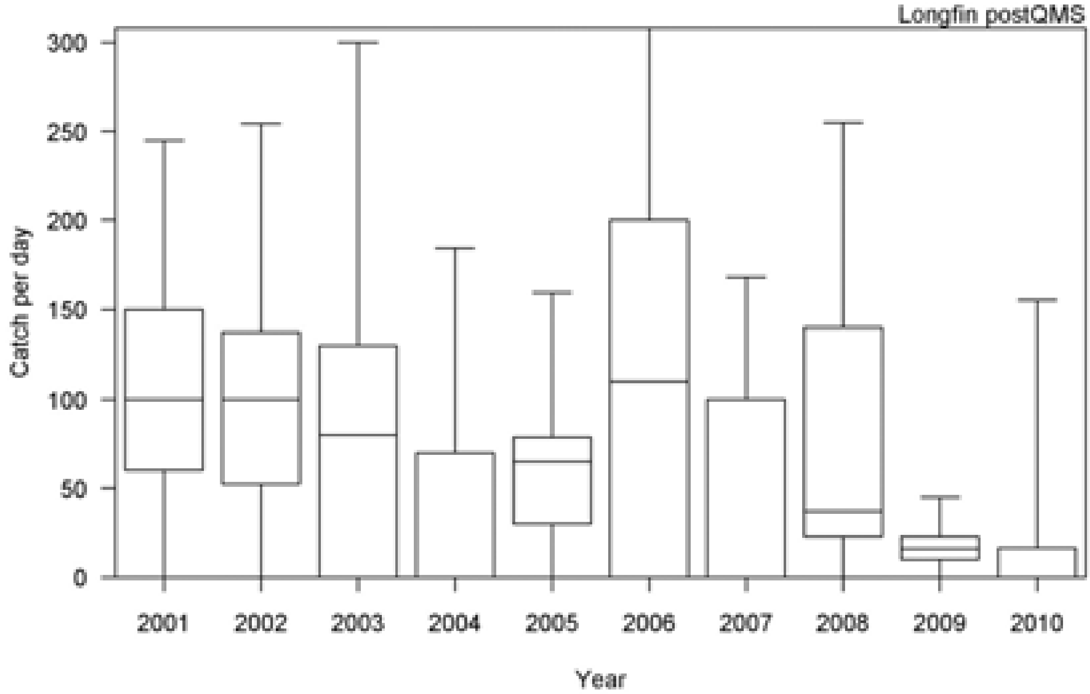

Figure C31: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA16 (AR)).

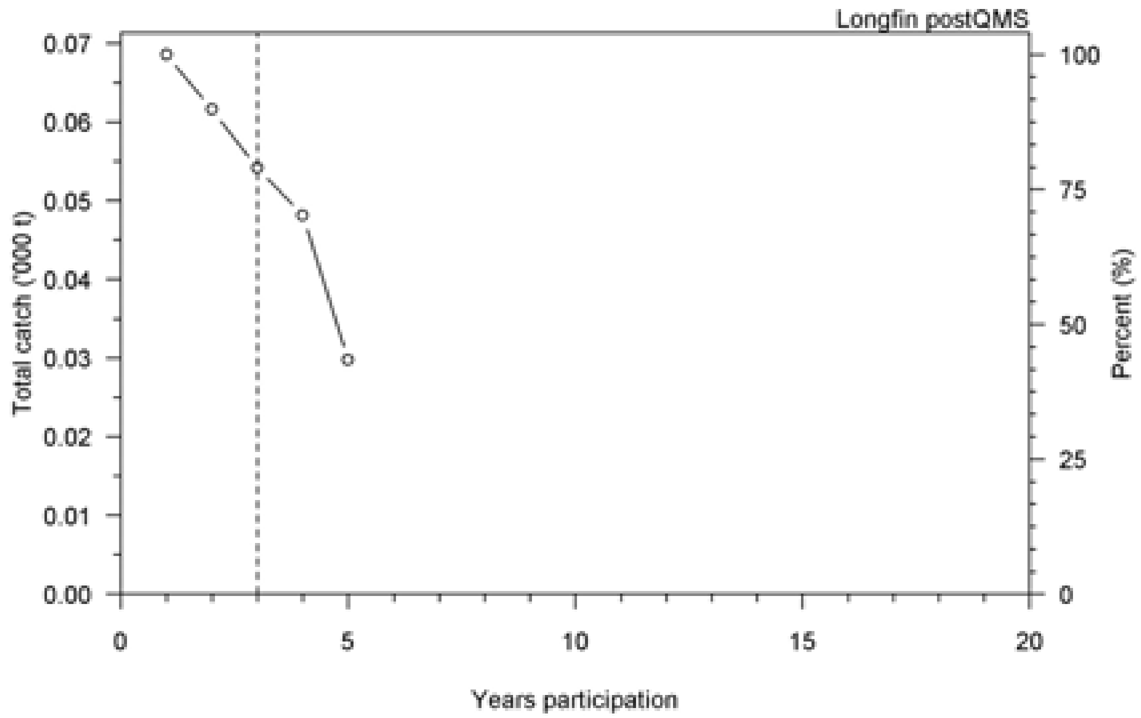

Figure C32: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA16 (AR)).

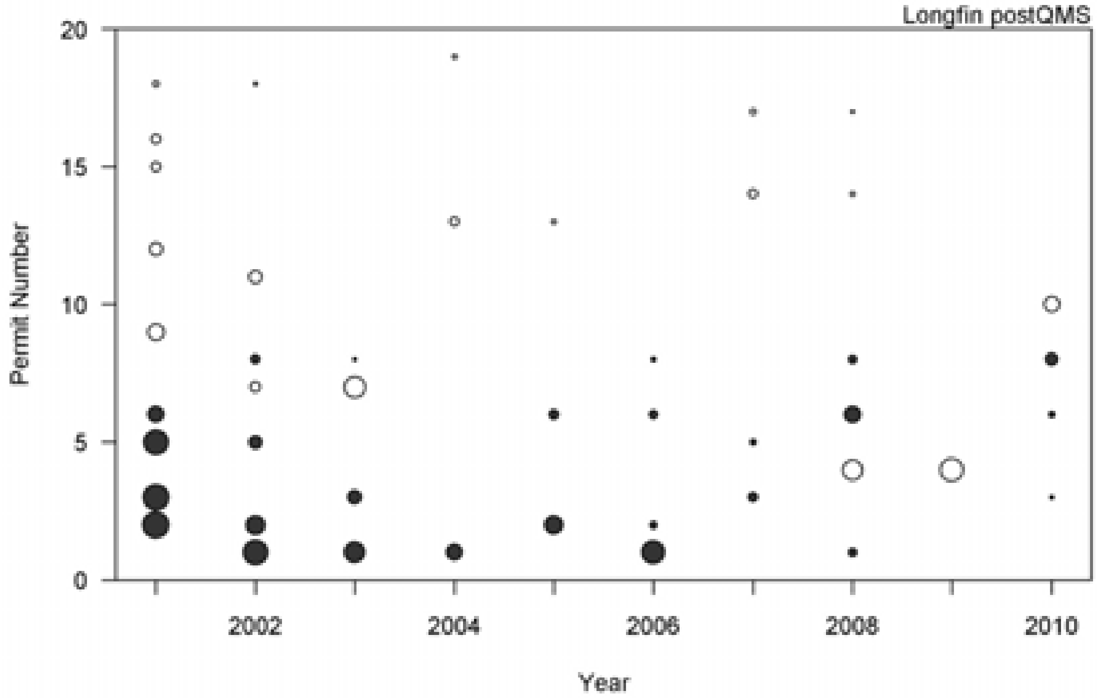

Figure C33: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA16 (AR)).

Appendix D: ESA 17 (AT).

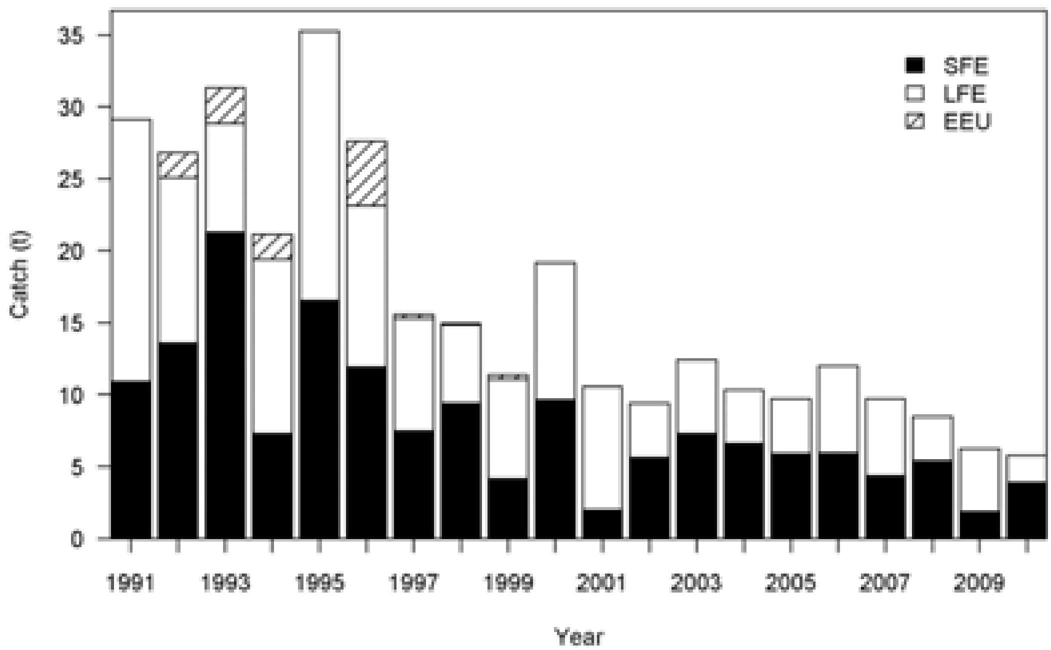

Figure D1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA17 (AT)).

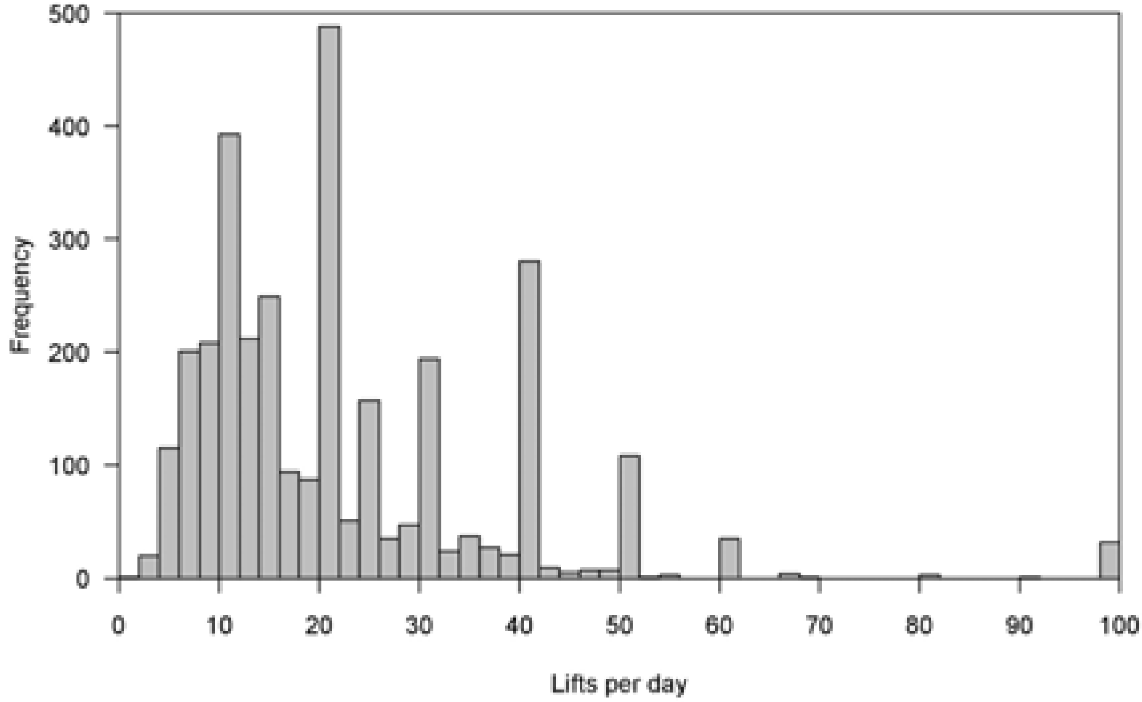

Figure D2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA17 (AT)).

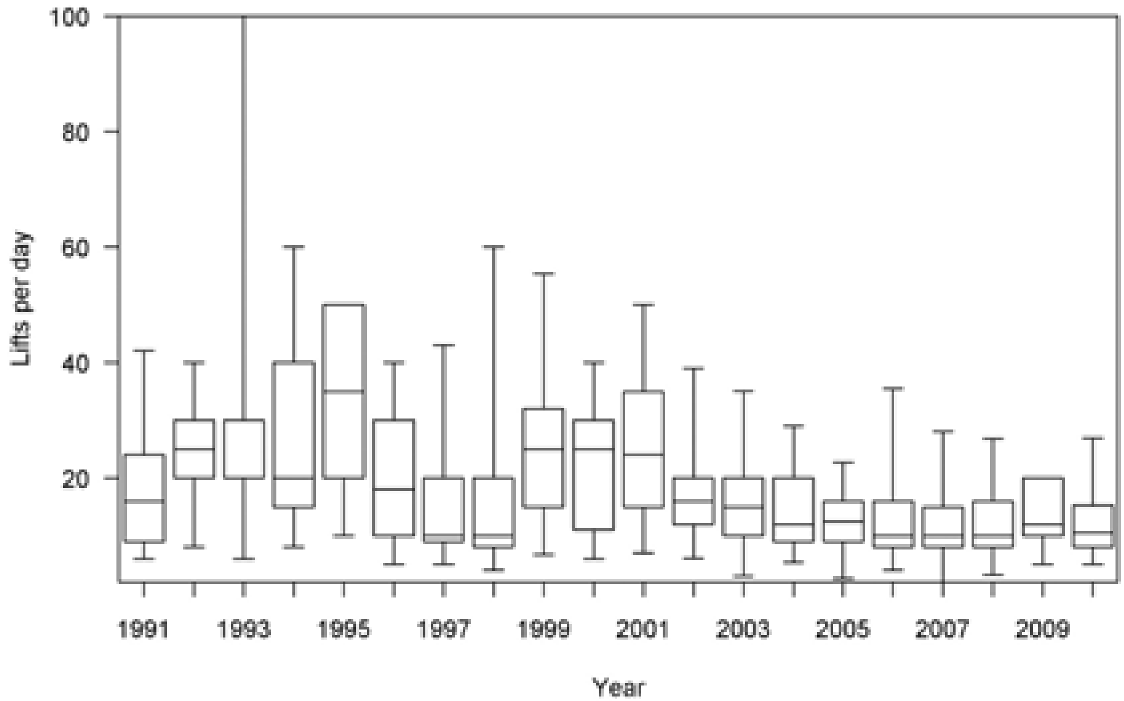

Figure D3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA17 (AT)).

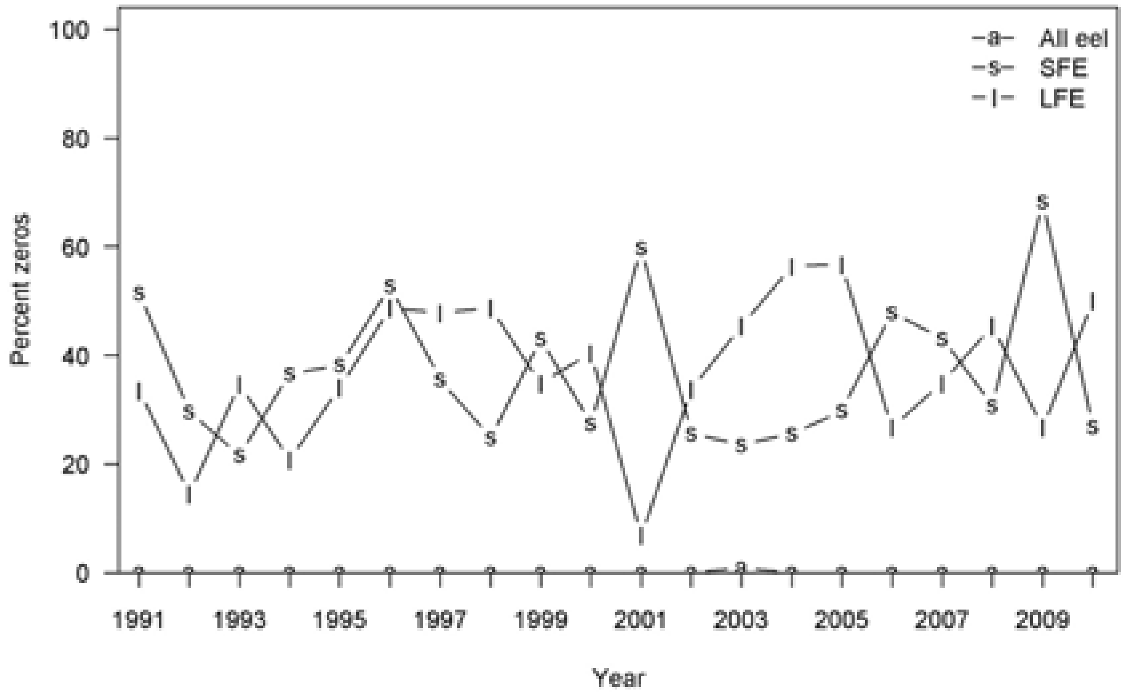

Figure D4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA17 (AT)).

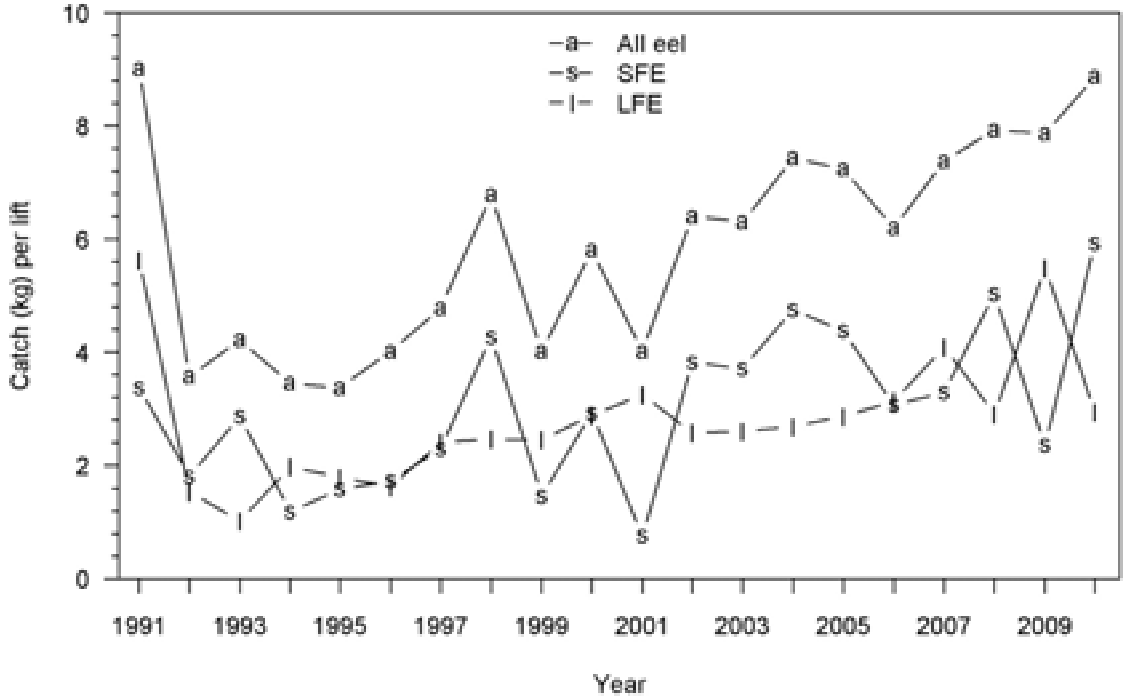

Figure D5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA17 (AT)).

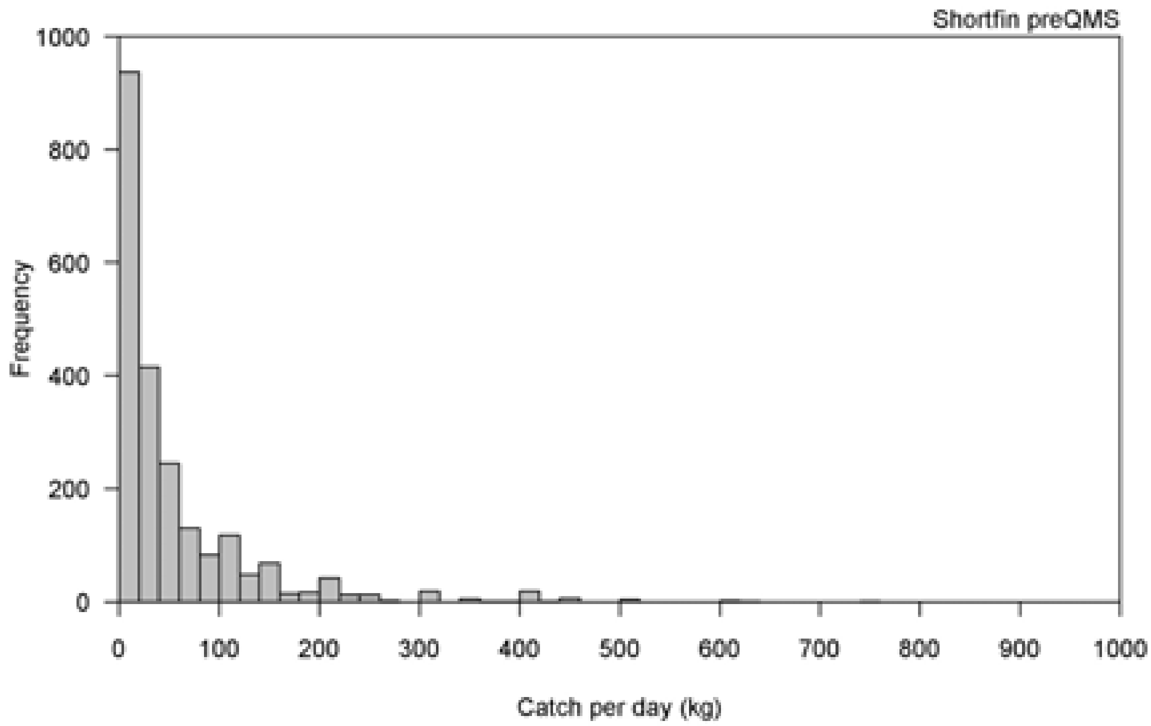

Figure D6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

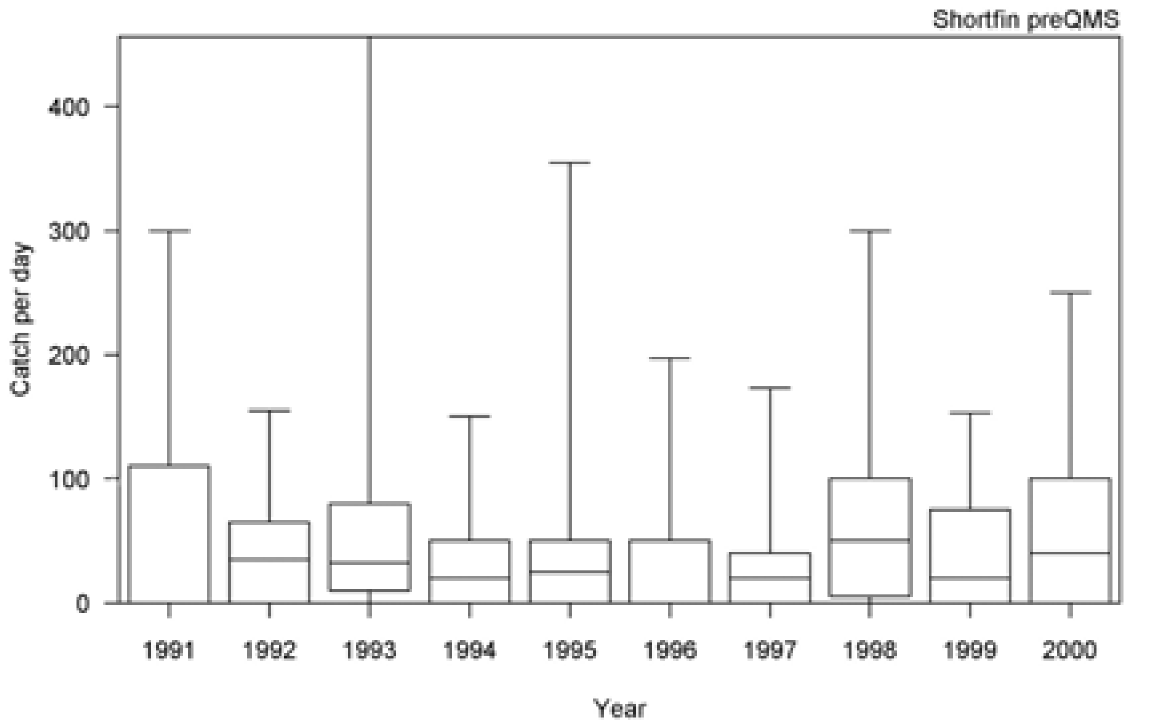

Figure D7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA17 (AT)).

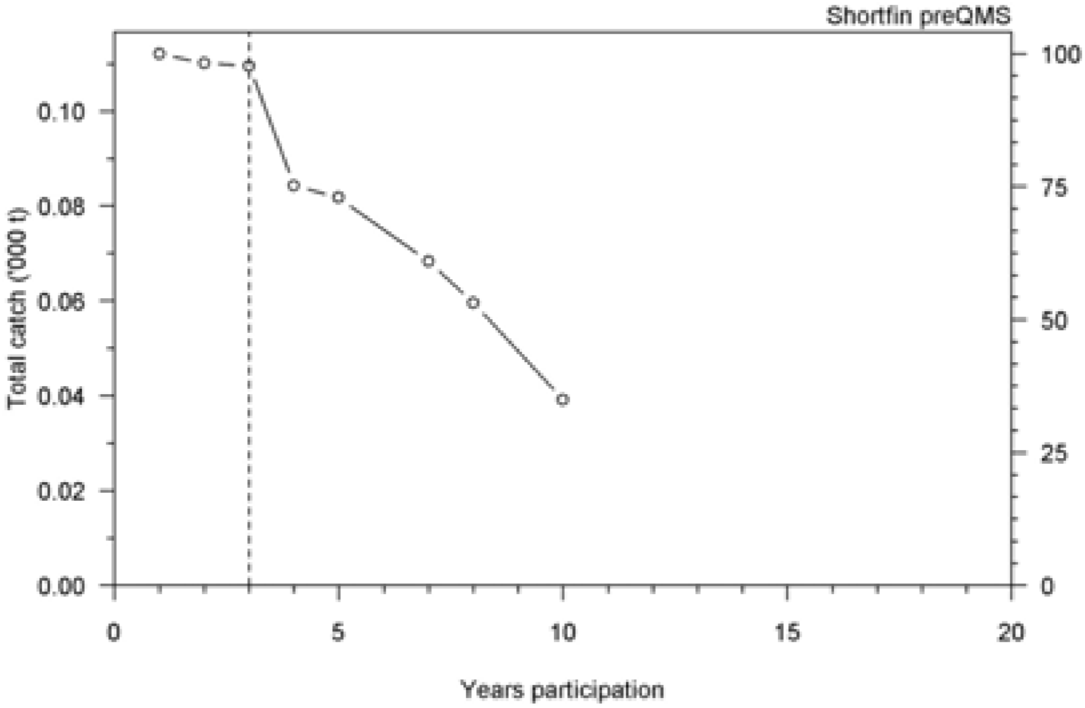

Figure D8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA17 (AT)).

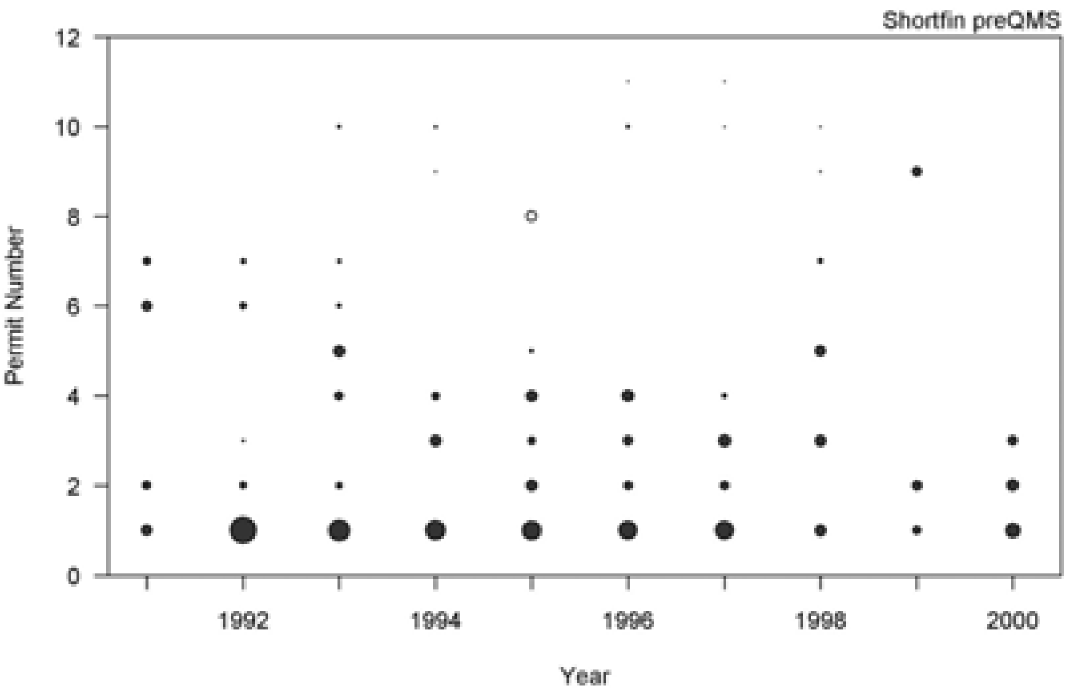

Figure D9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA17 (AT)).

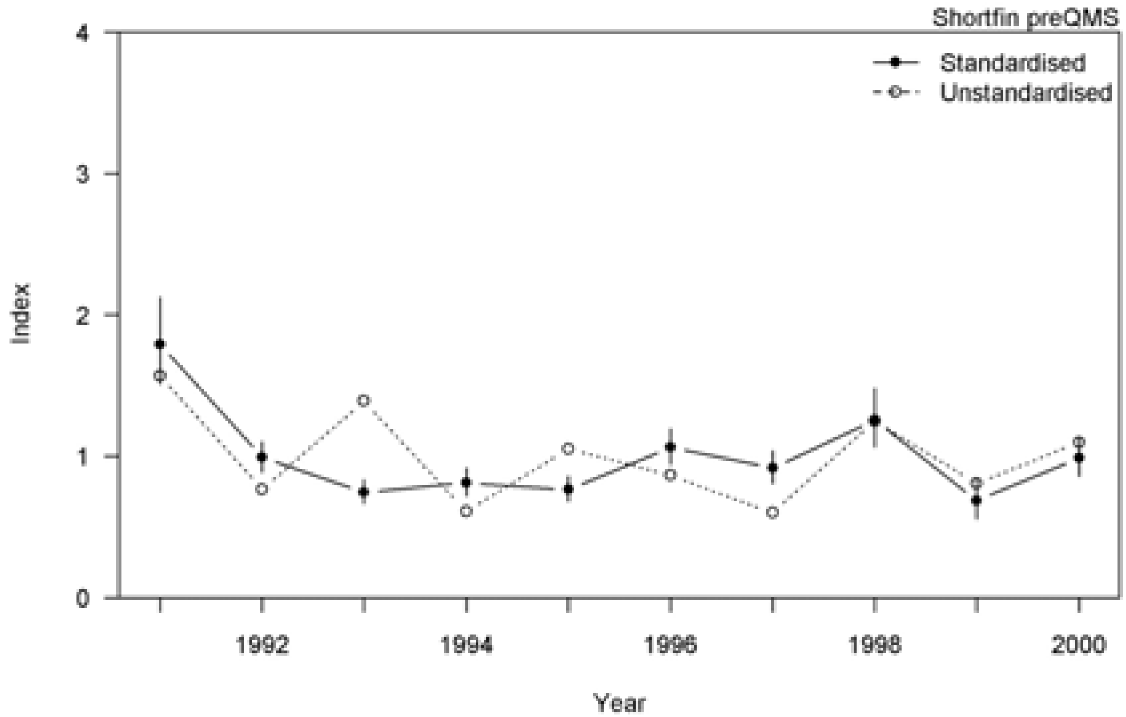

Figure D10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA17 (AT)).

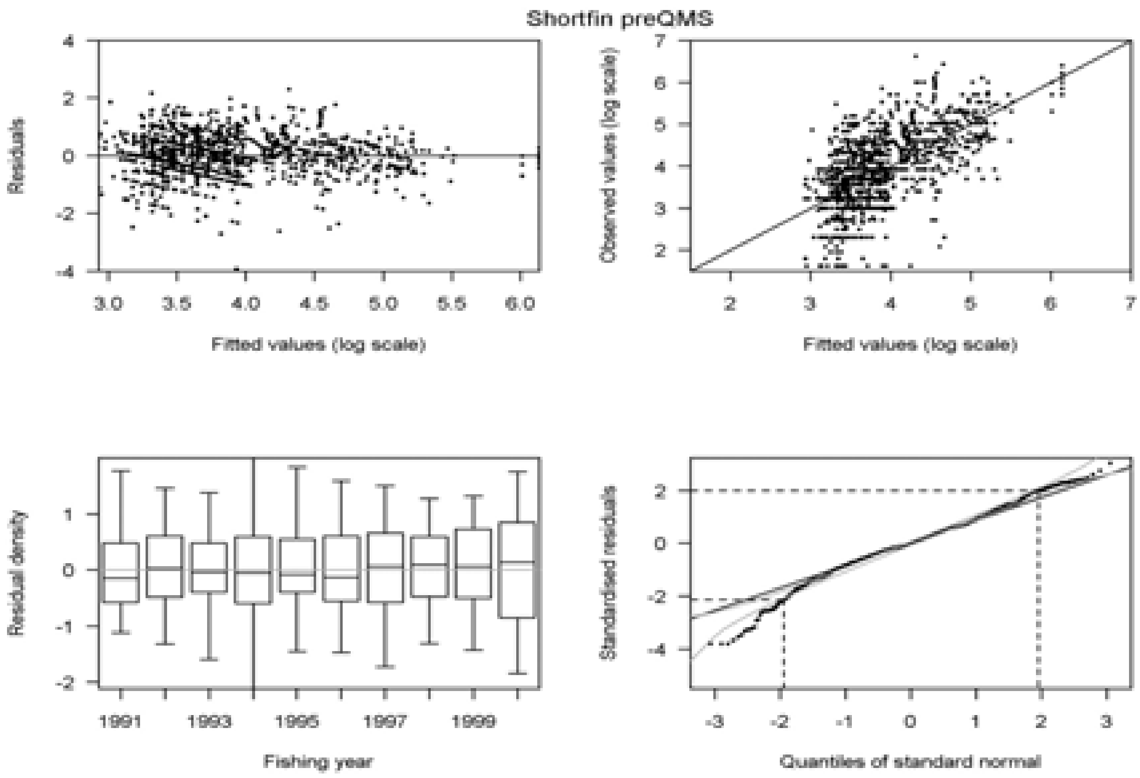

Figure D11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA17 (AT)).

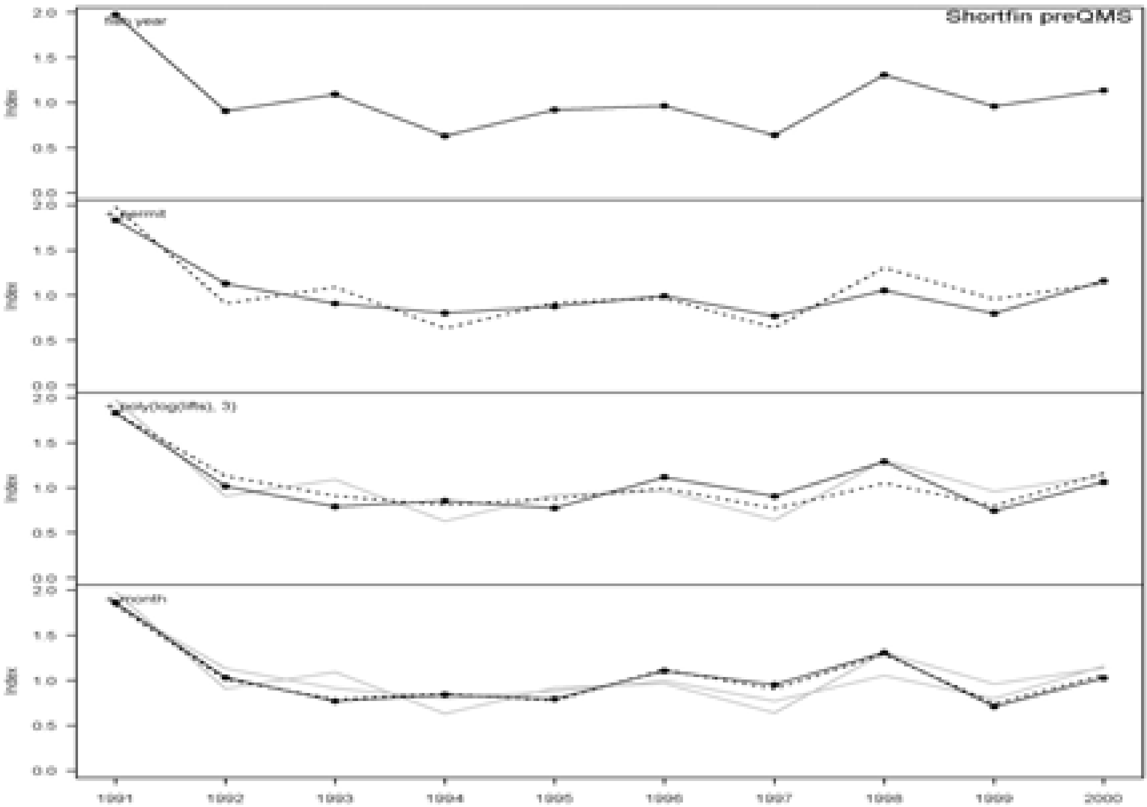

Figure D12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA17 (AT)).

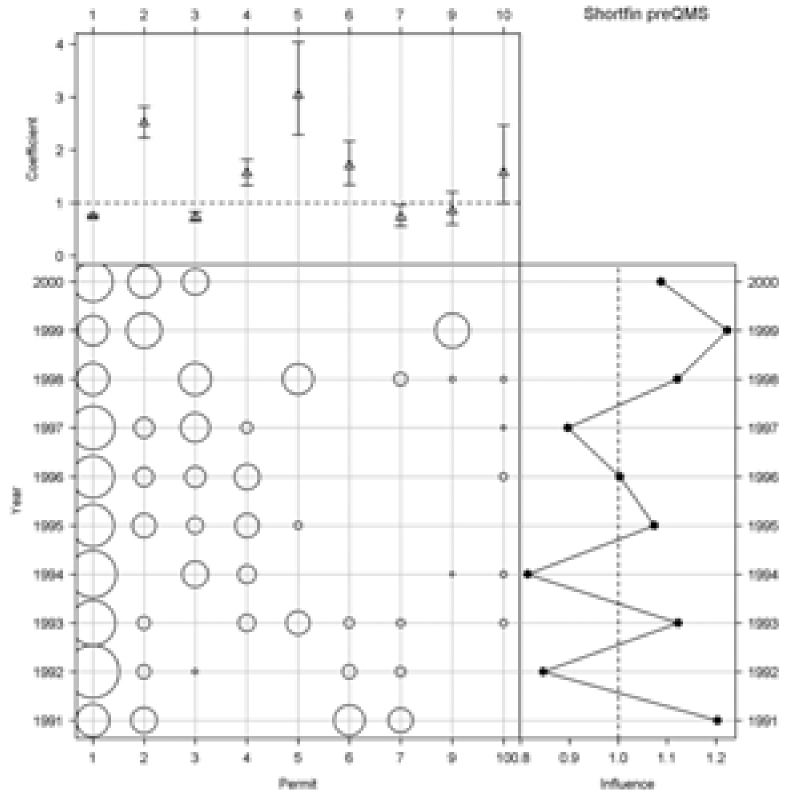

Figure D13: Influence of permit number for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

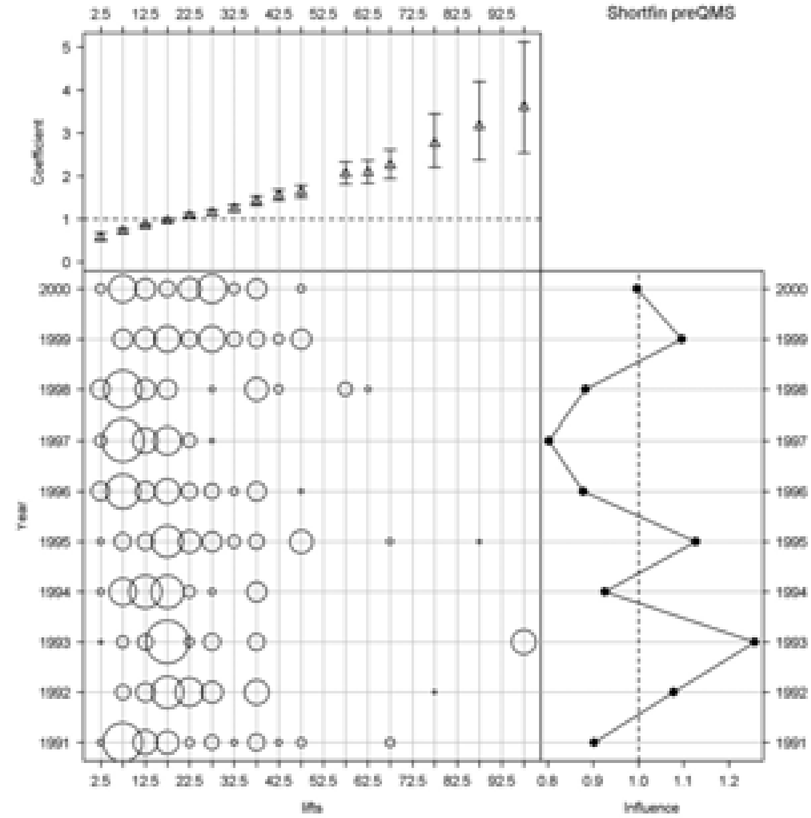

Figure D14: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

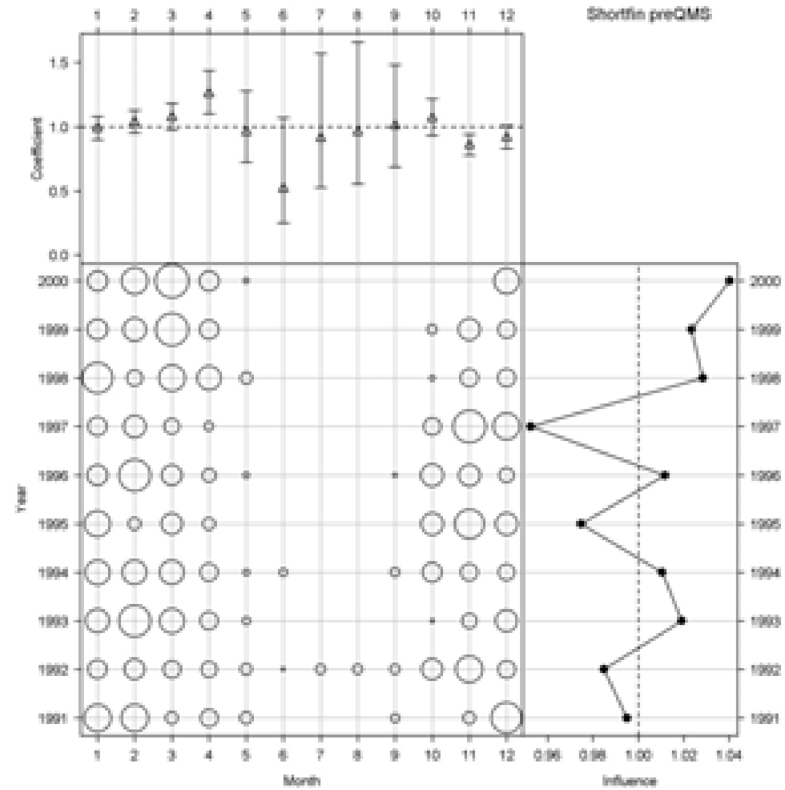

Figure D15: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

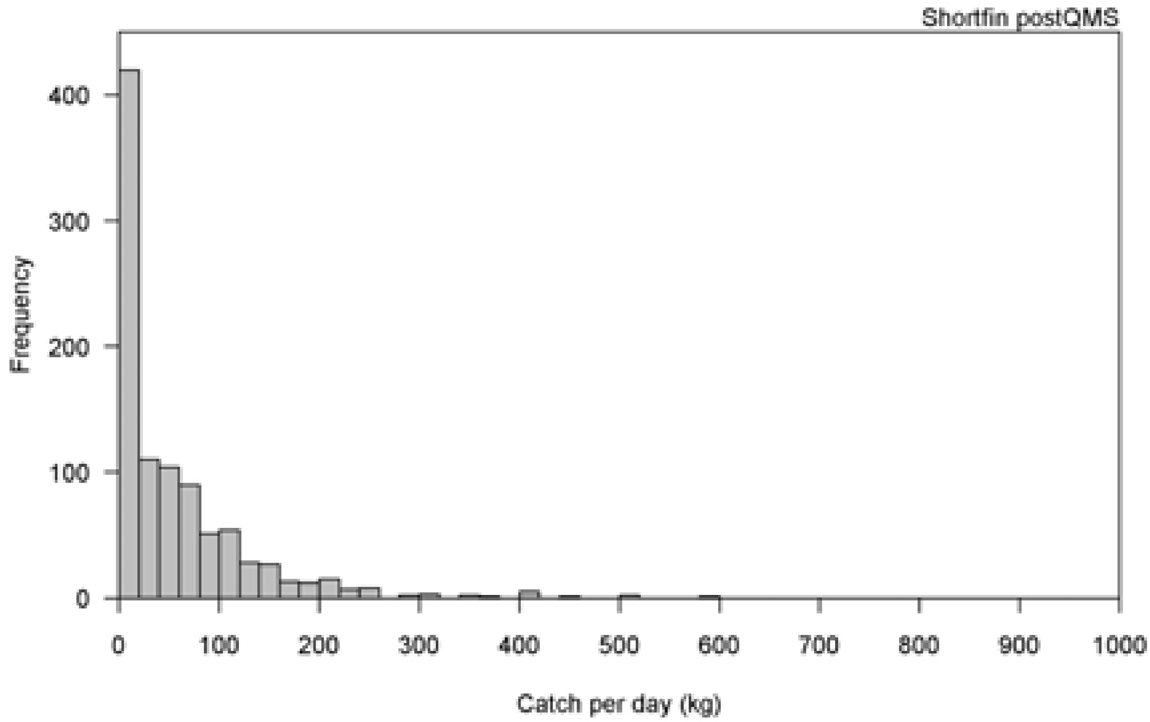

Figure D16: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA17 (AT)).

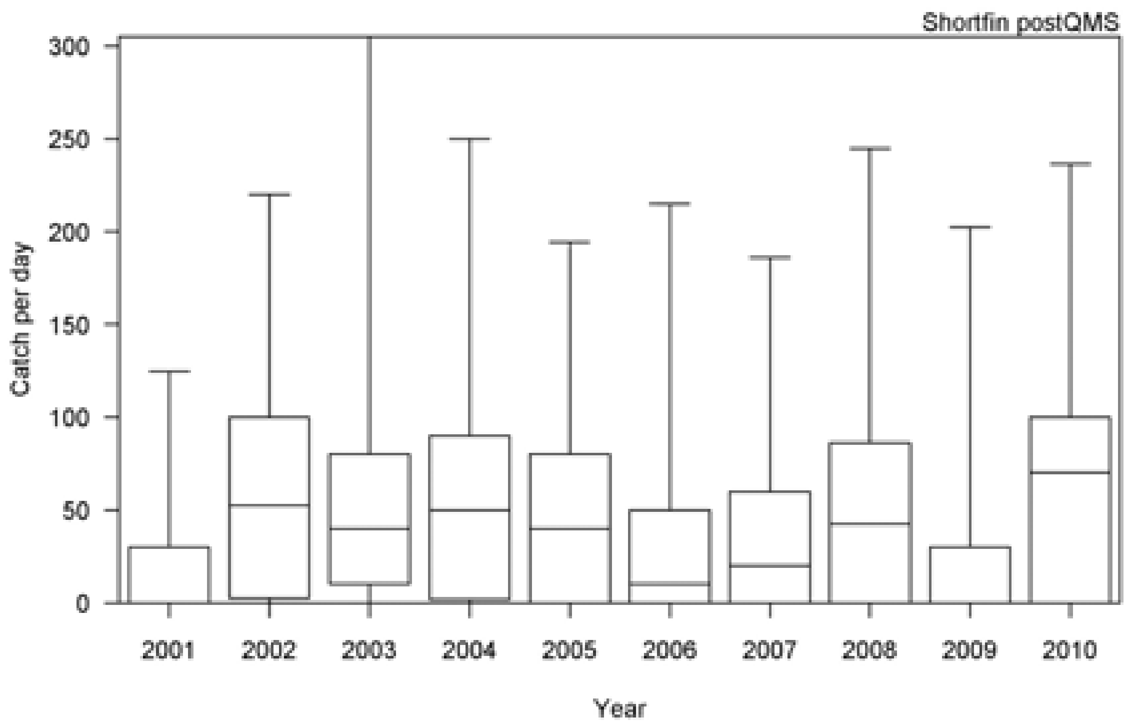

Figure D17: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA17 (AT)).

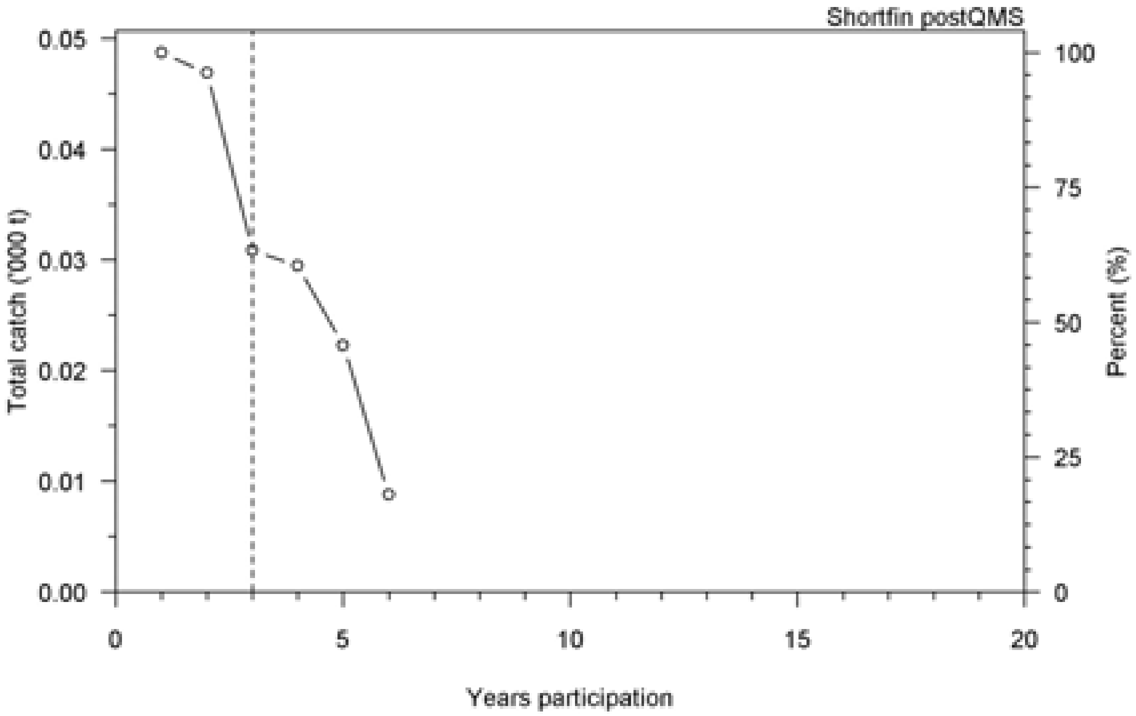

Figure D18: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA17 (AT)).

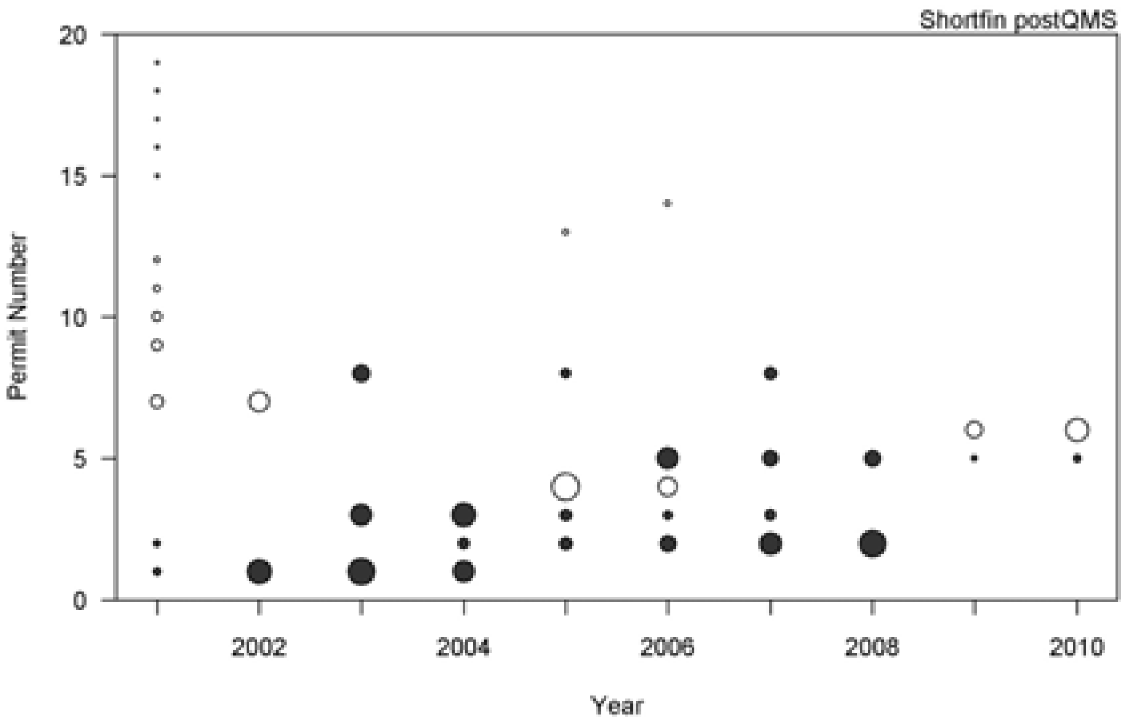

Figure D19: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA17 (AT)).

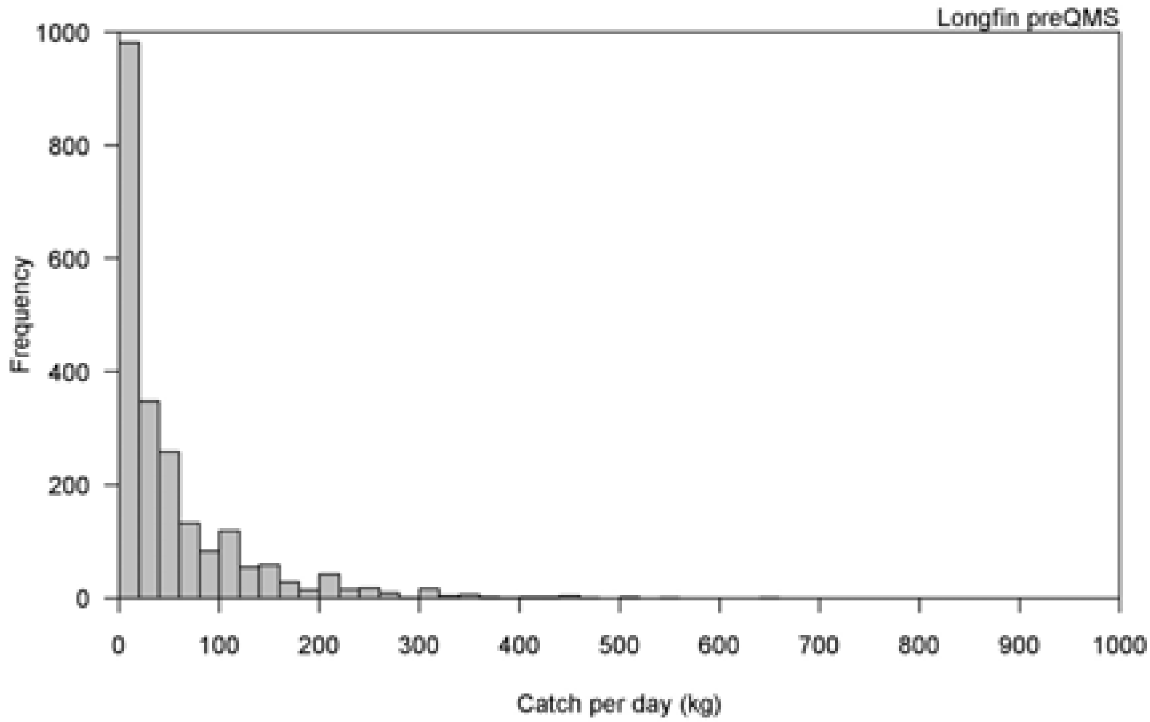

Figure D20: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

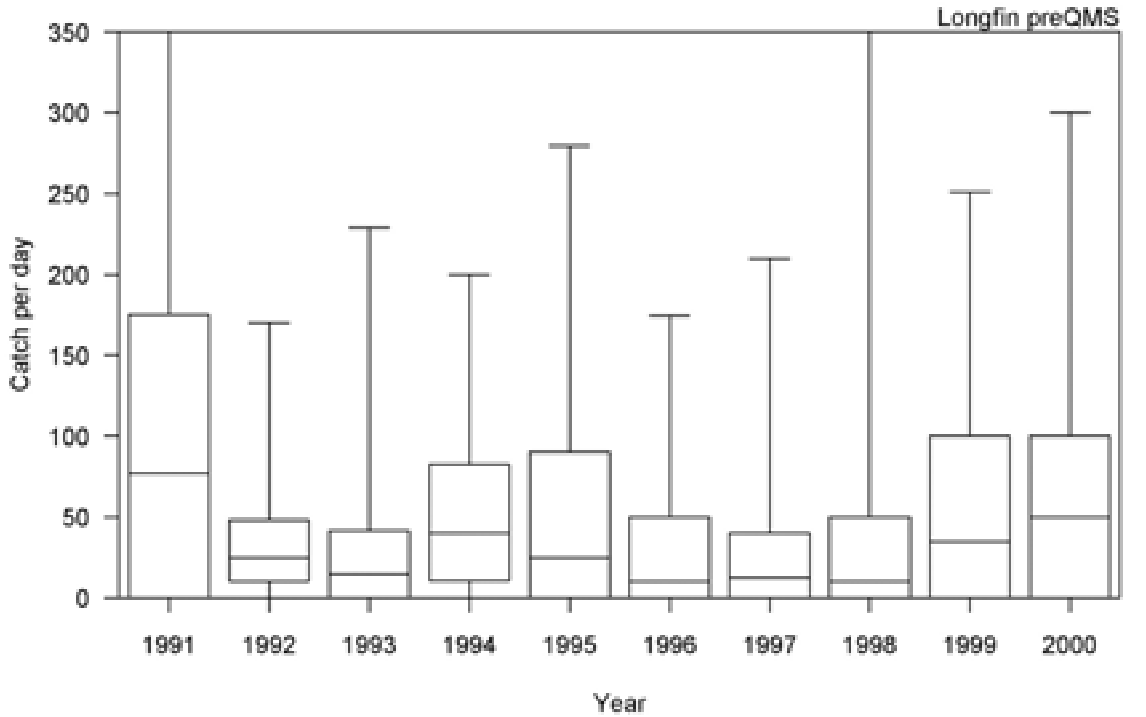

Figure D21: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA17 (AT)).

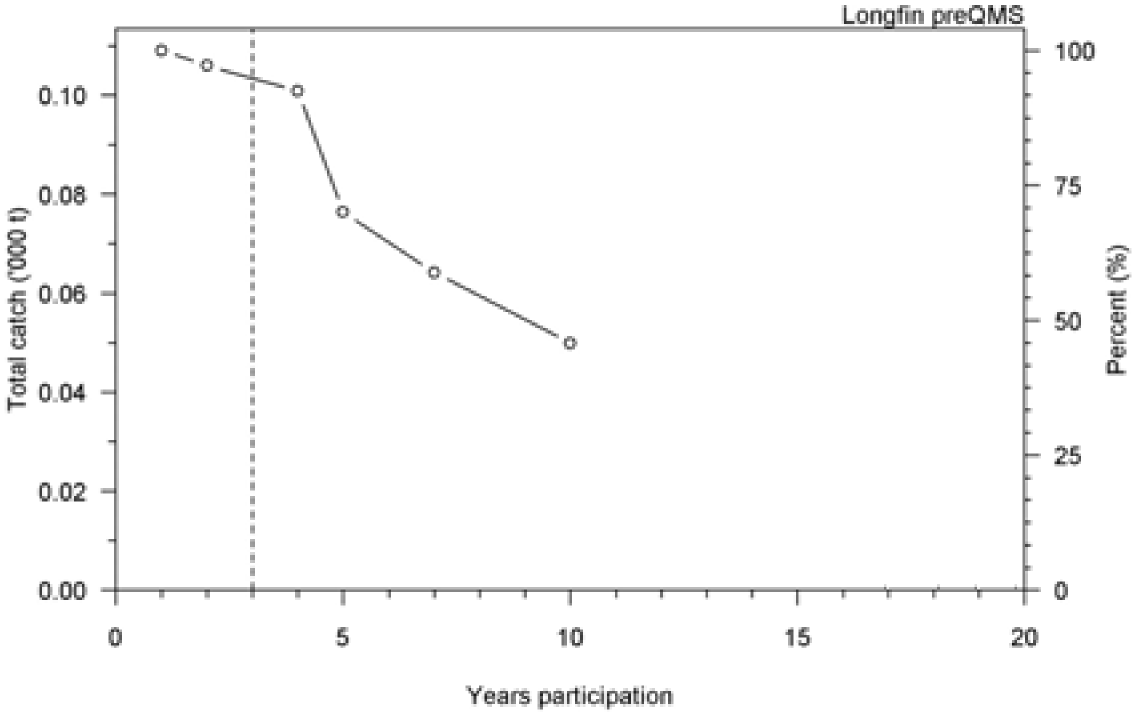

Figure D22: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA17 (AT)).

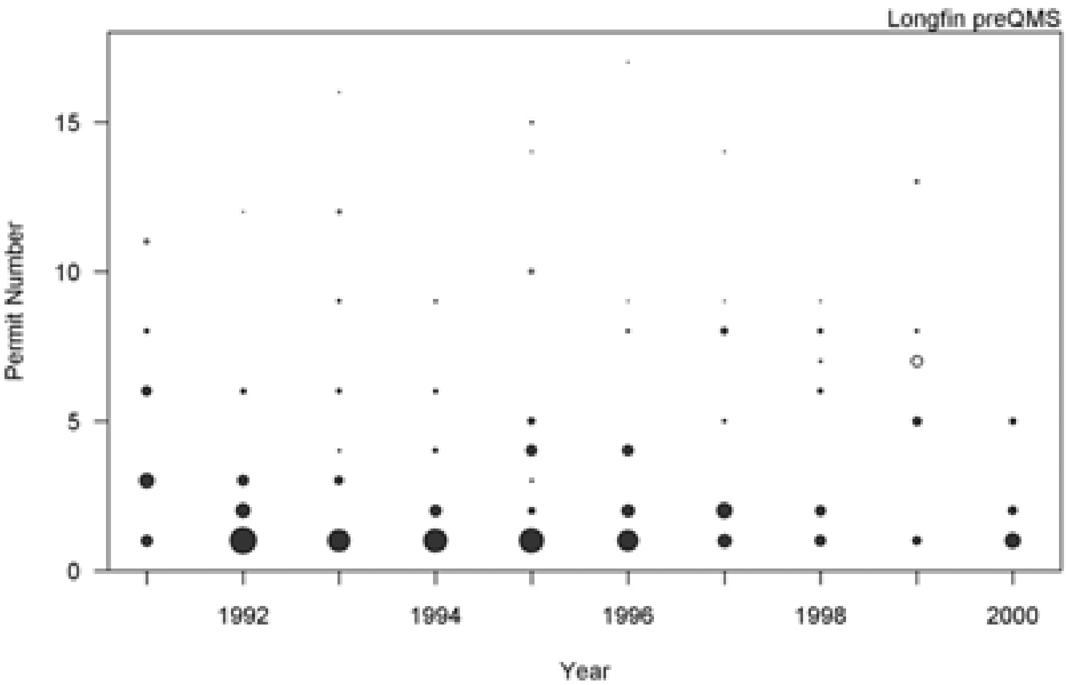

Figure D23: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA17 (AT)).

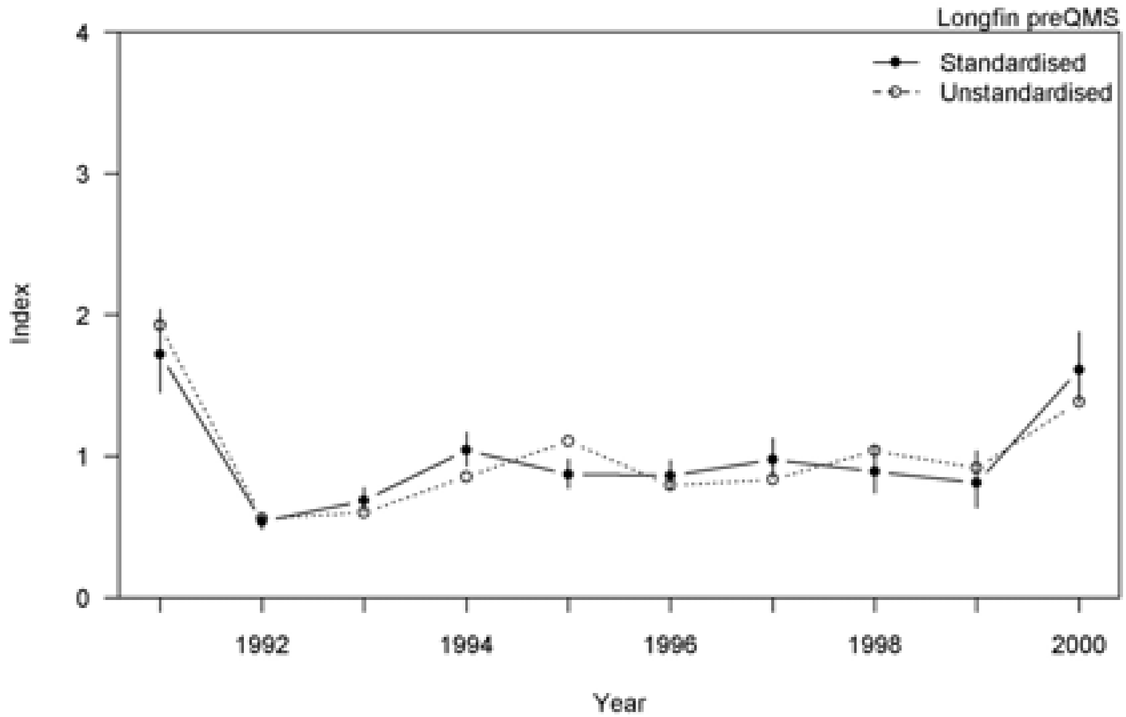

Figure D24: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA17 (AT)).

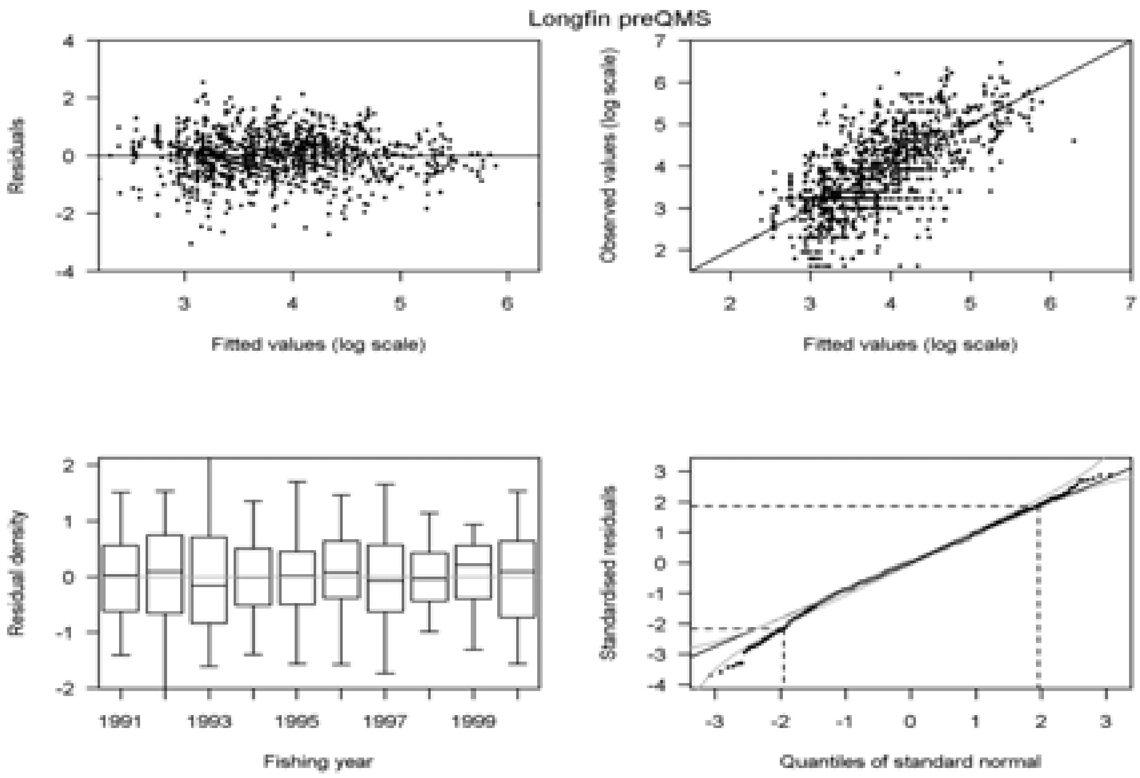

Figure D25: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA17 (AT)).

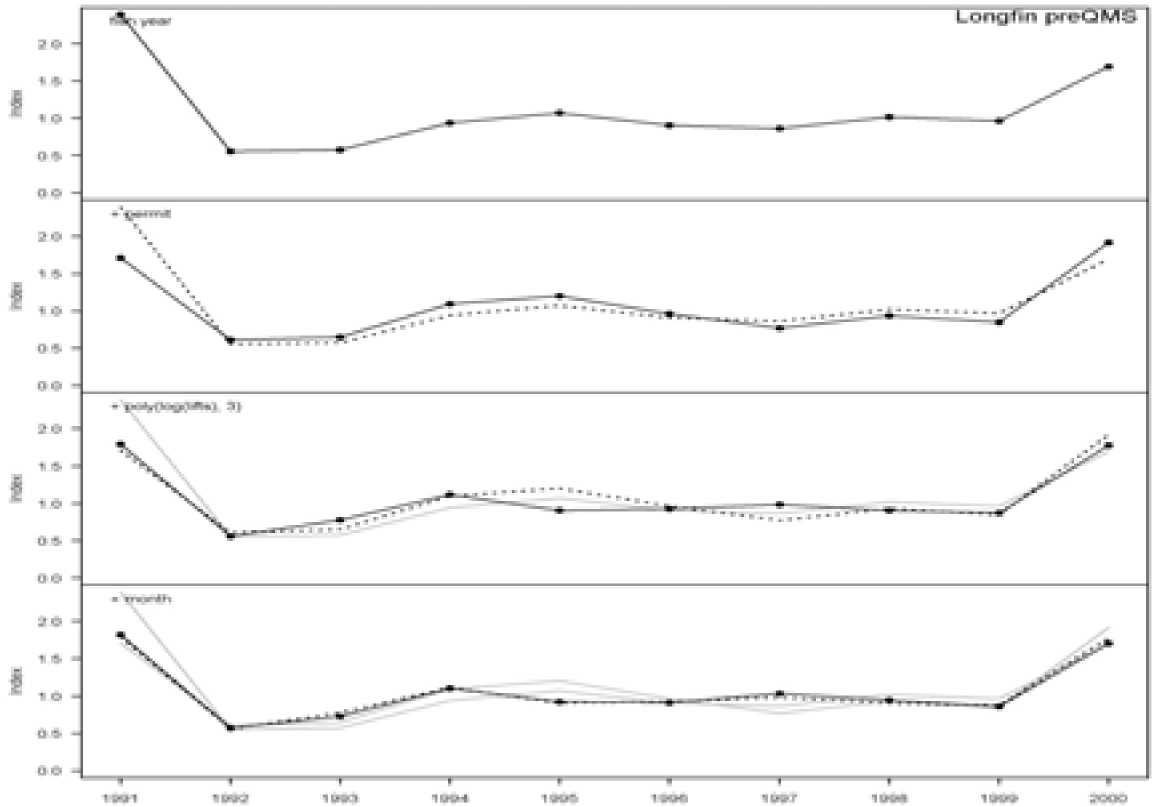

Figure D26: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA17 (AT)).

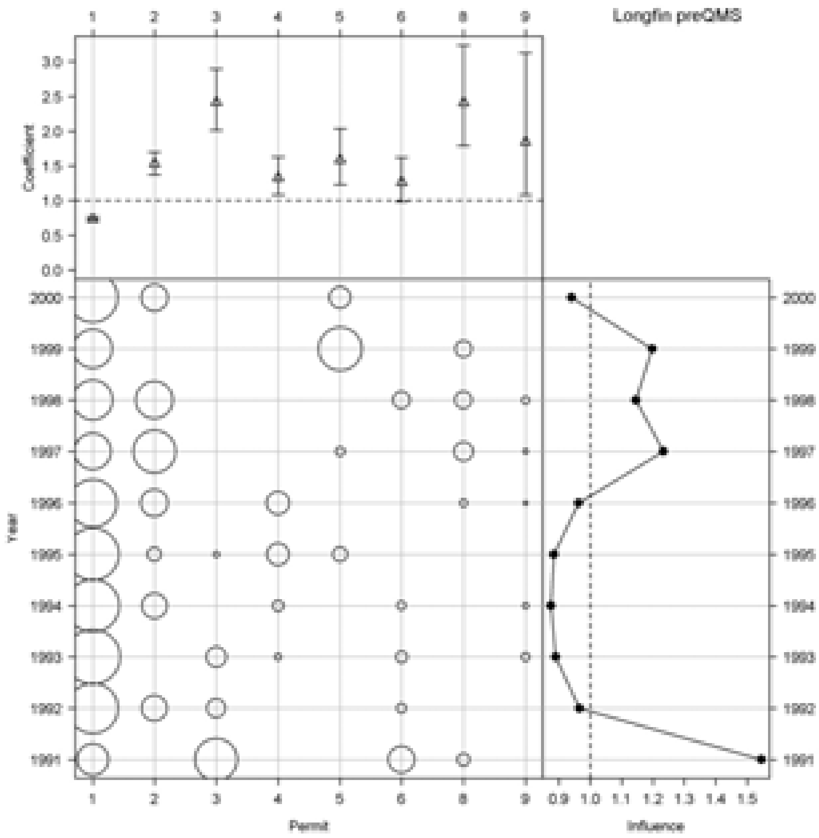

Figure D27: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

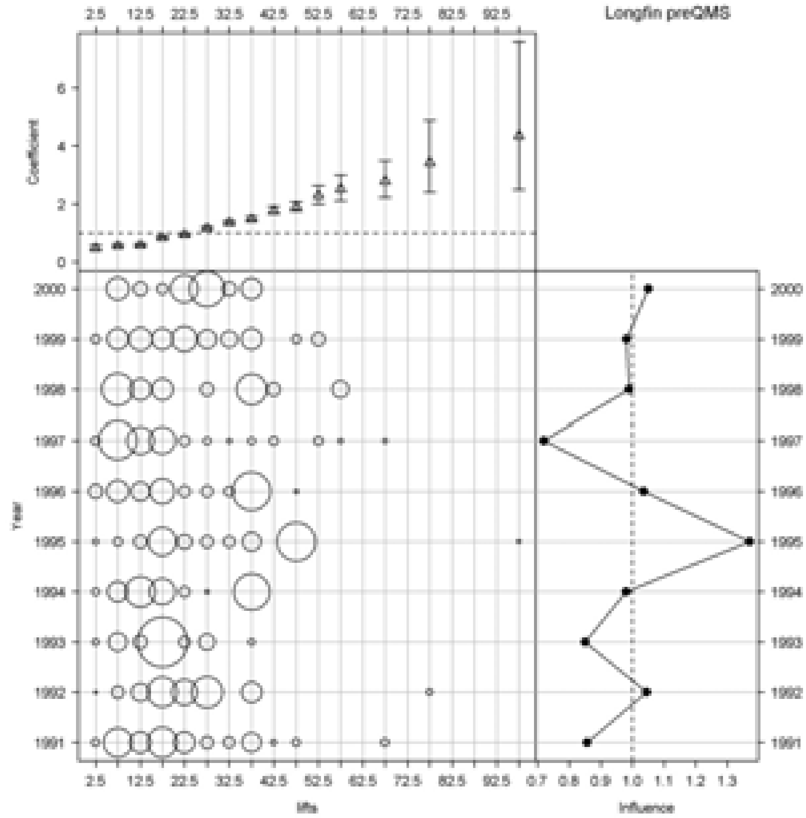

Figure D28: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

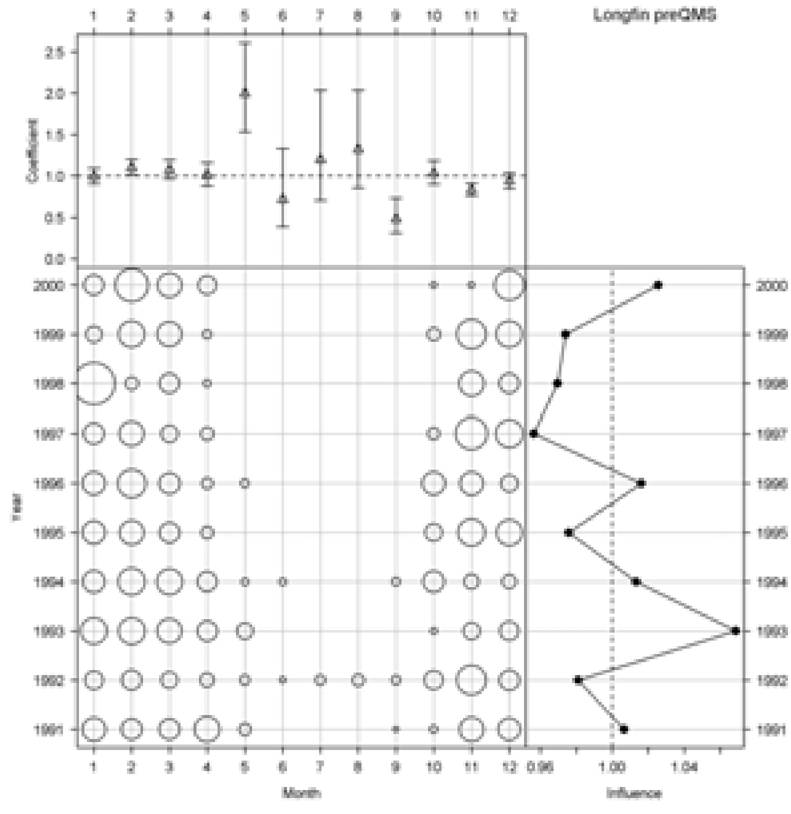

Figure D29: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA17 (AT)).

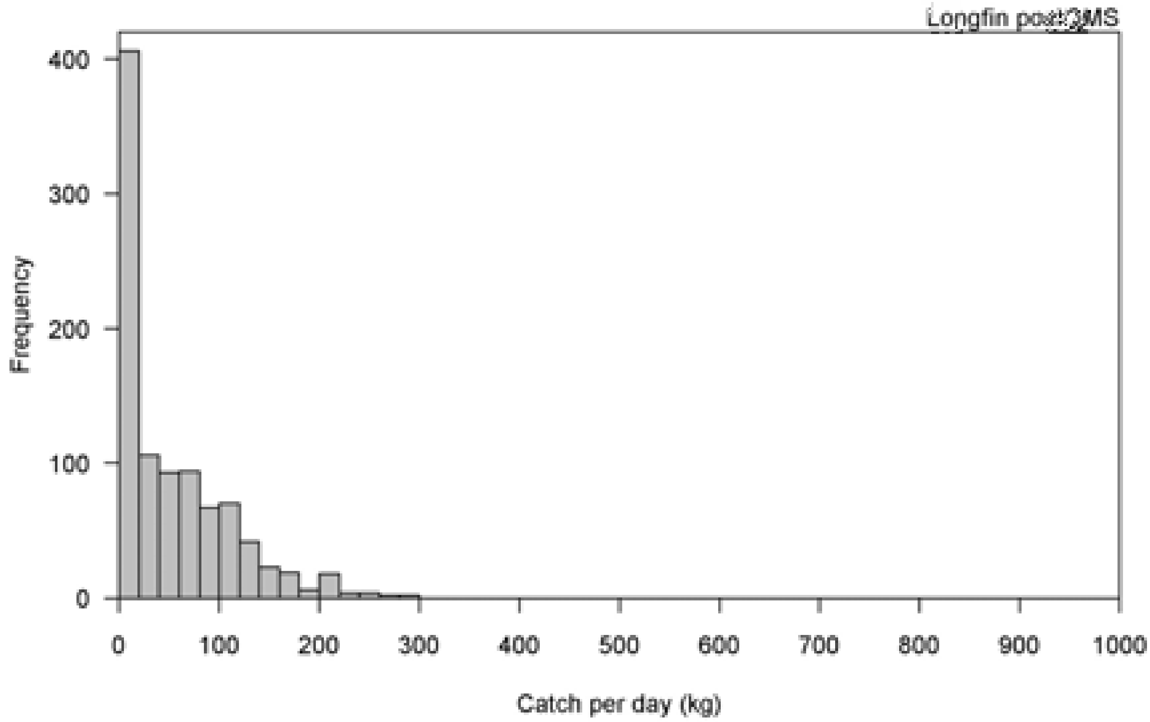

Figure D30: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA17 (AT)).

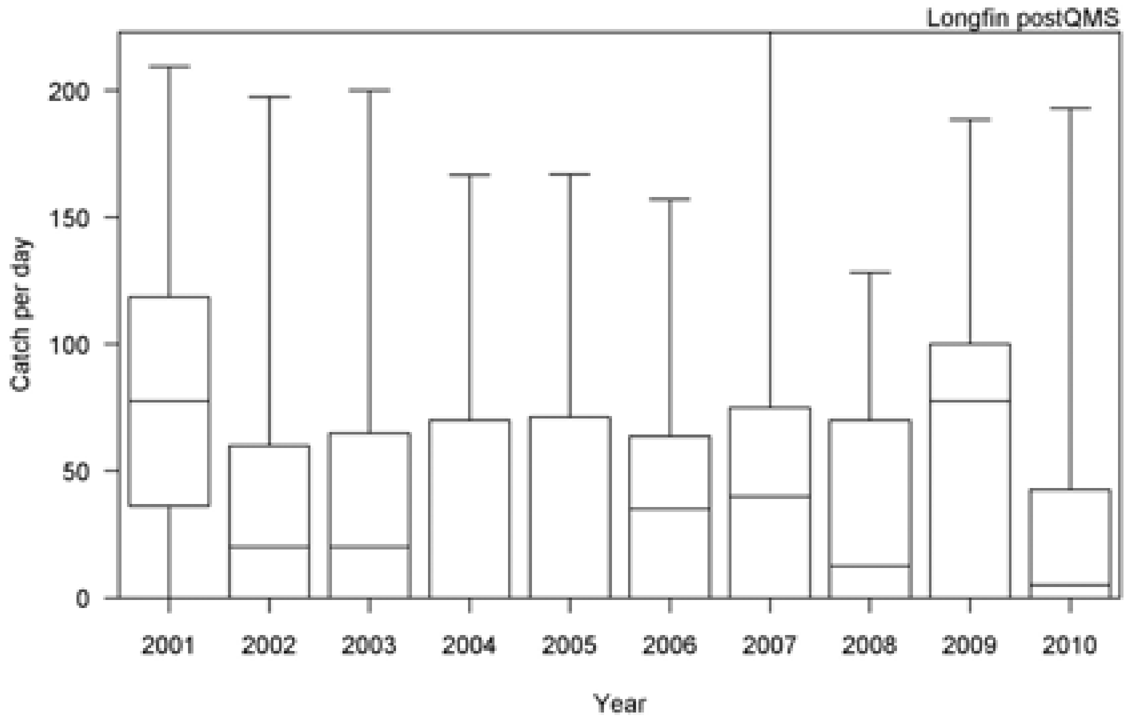

Figure D31: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA17 (AT)).

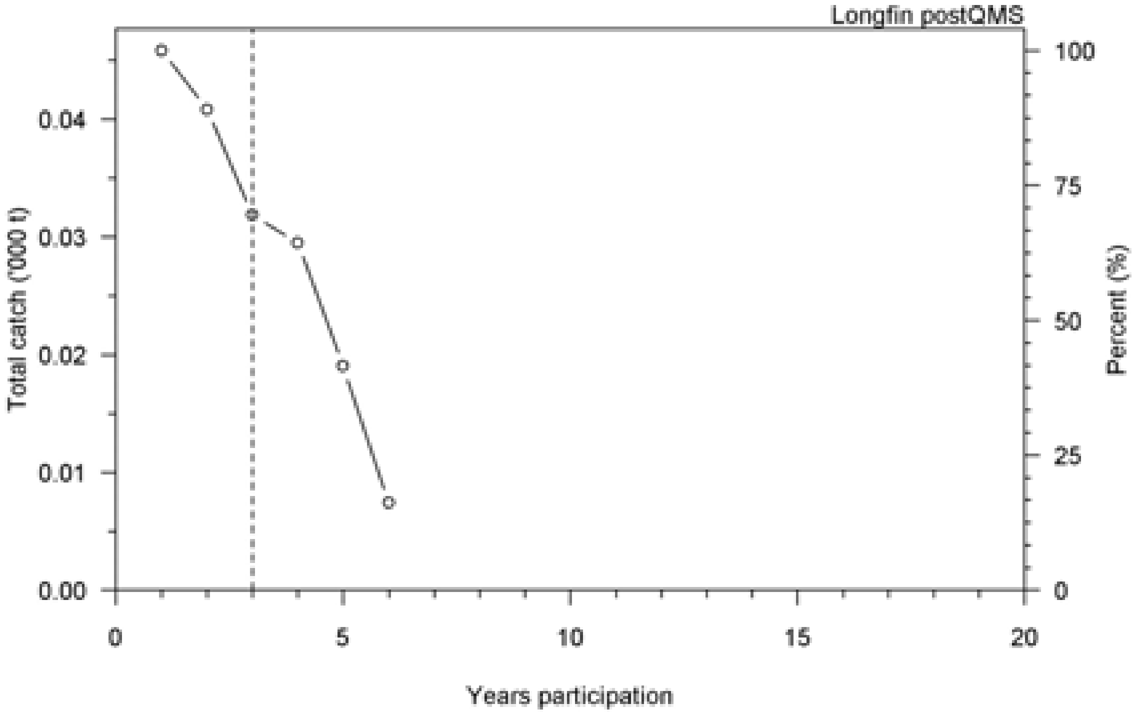

Figure D32: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA17 (AT)).

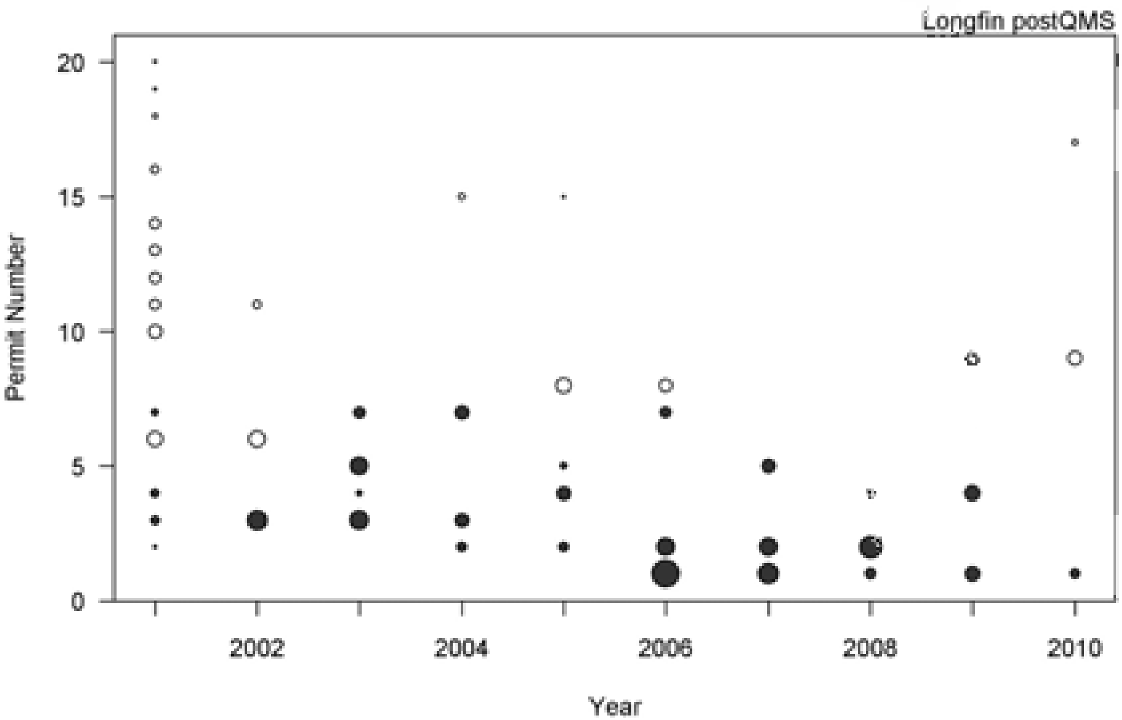

Figure D33: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA17 (AT)).

Appendix E: ESA 18 (AU).

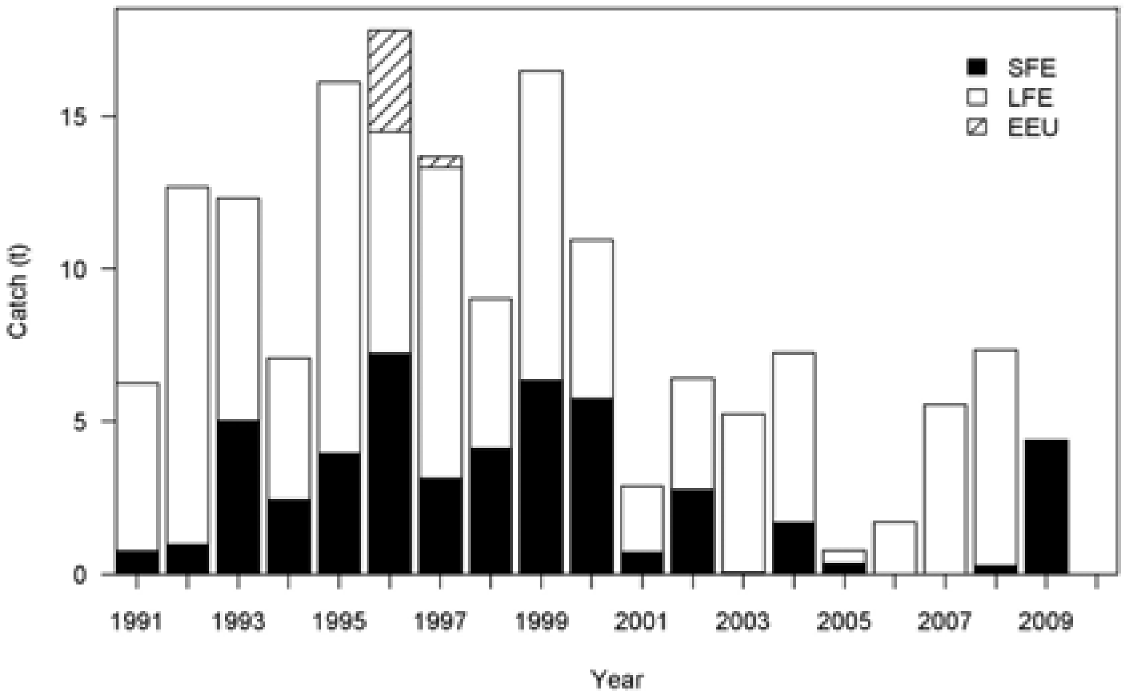

Figure E1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA18 (AU)).

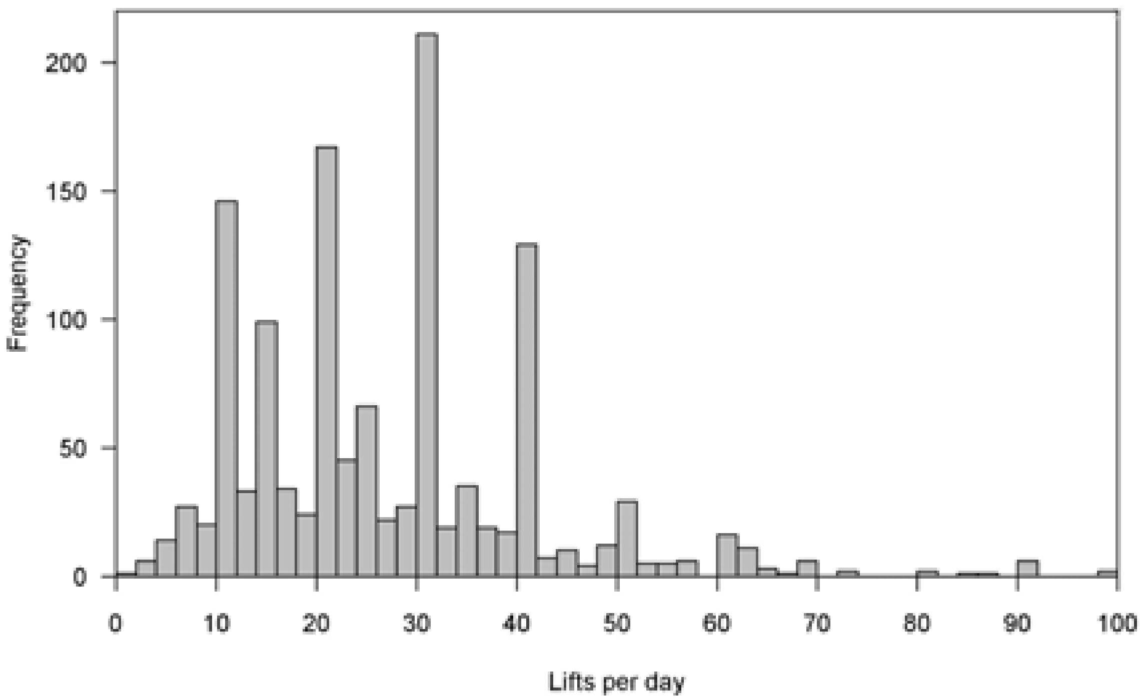

Figure E2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA18 (AU)).

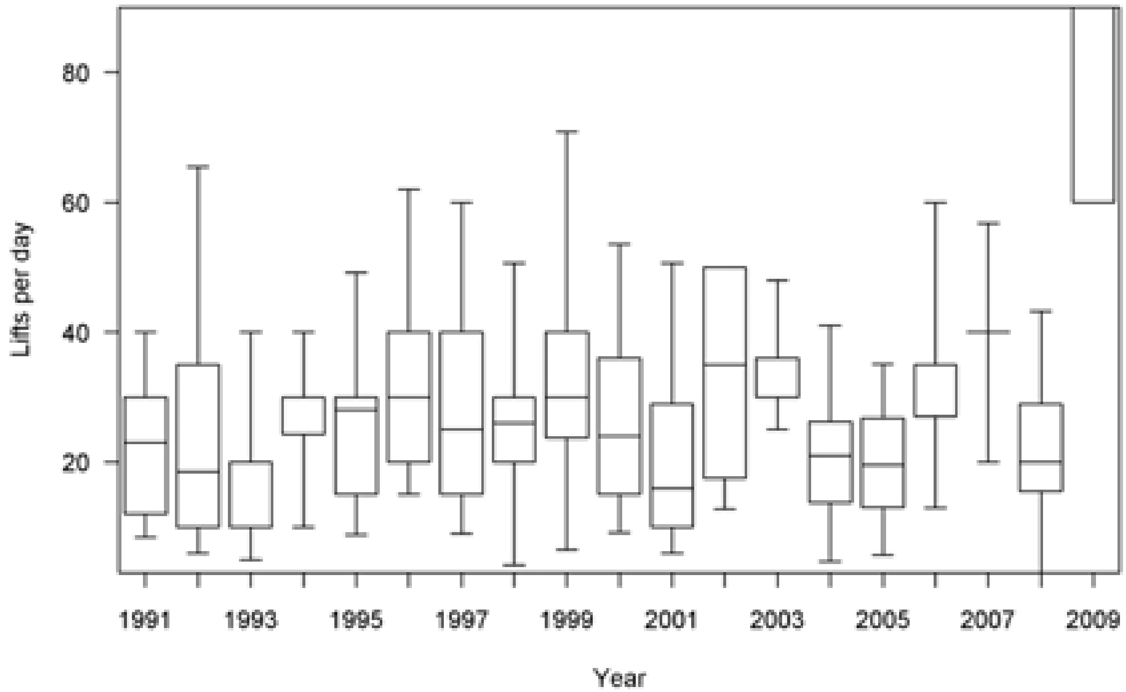

Figure E3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA18 (AU)).

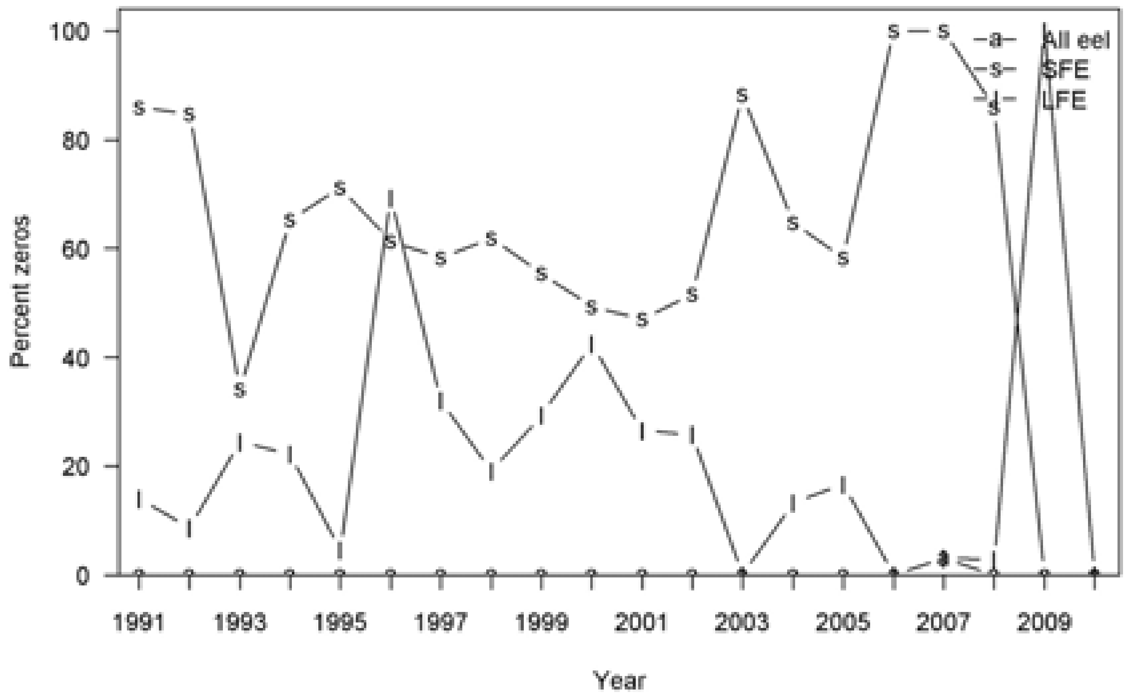

Figure E4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA18 (AU)).

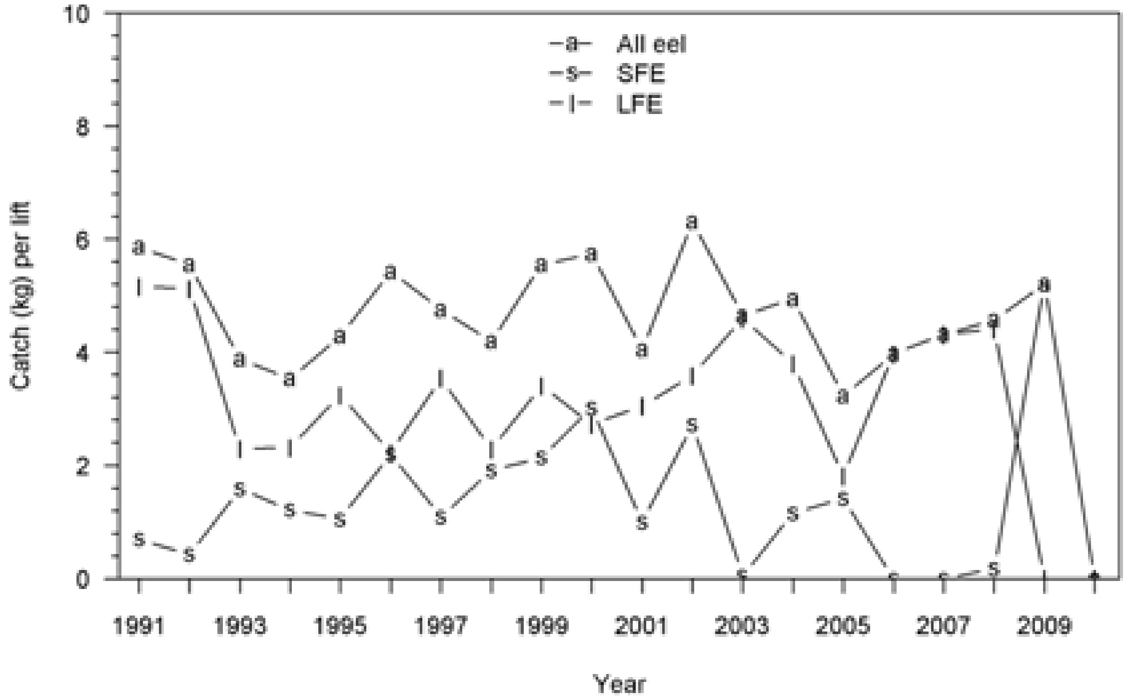

Figure E5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA18 (AU)).

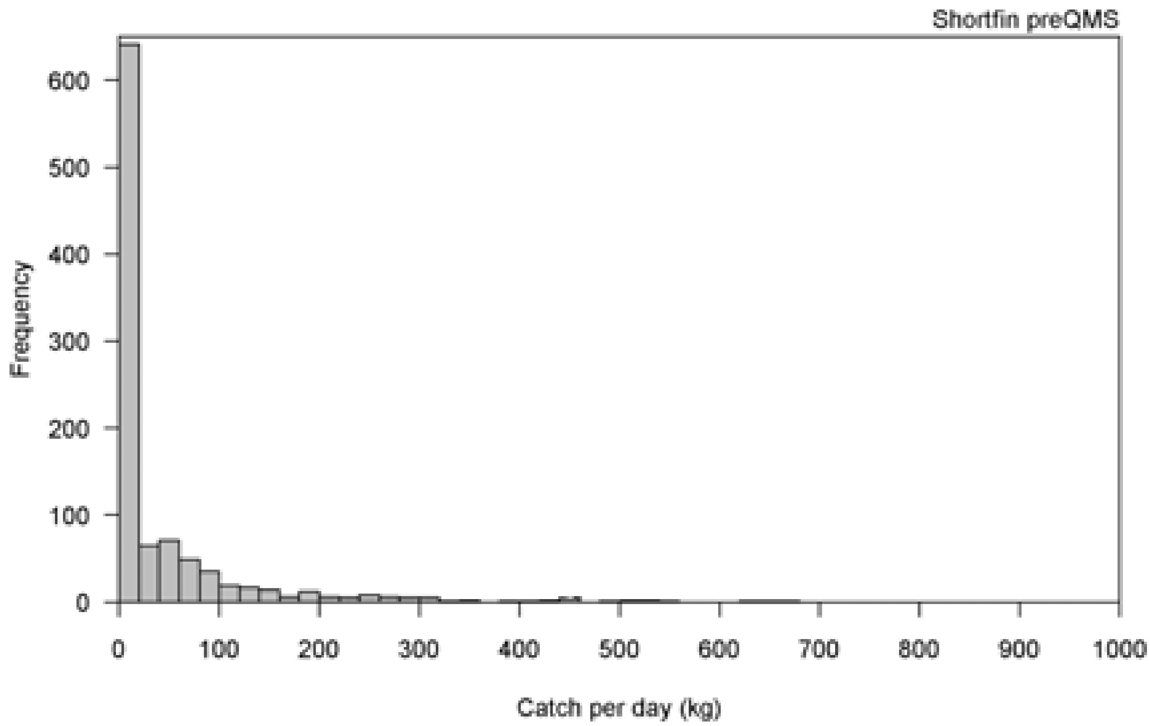

Figure E6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

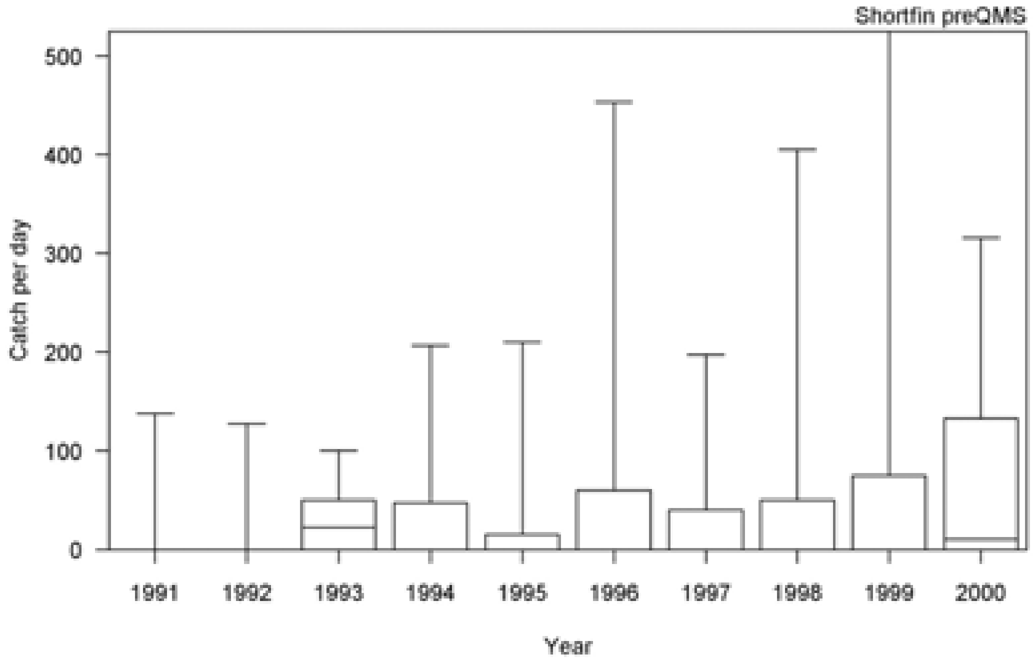

Figure E7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA18 (AU)).

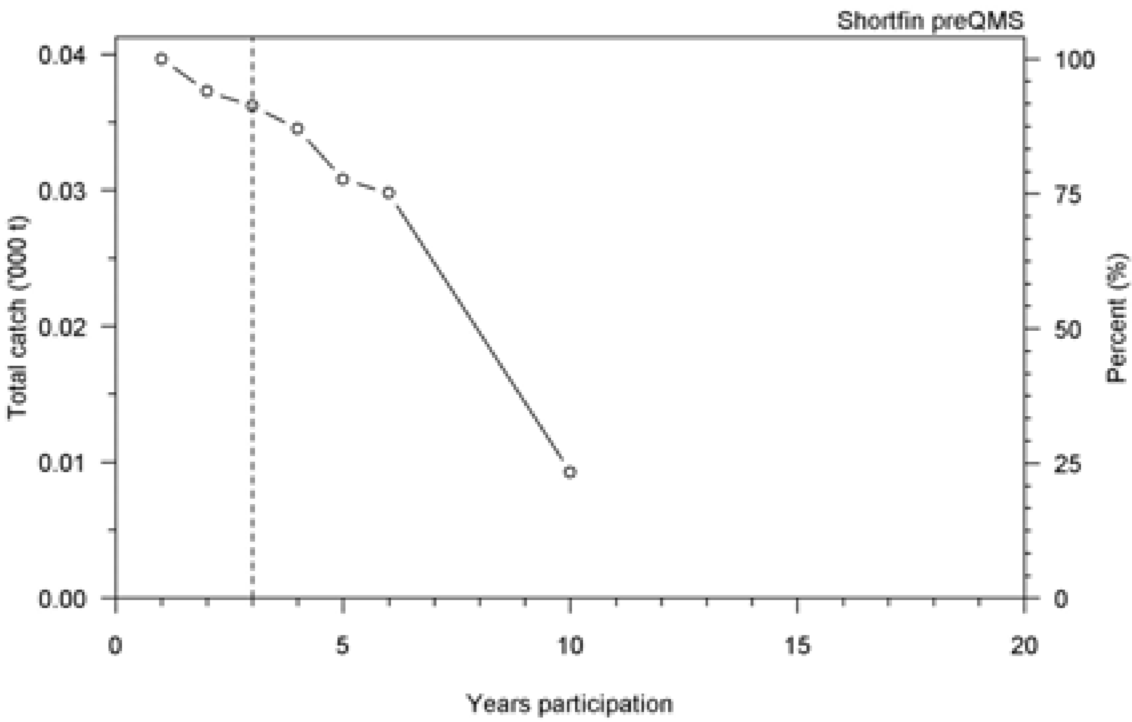

Figure E8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA18 (AU)).

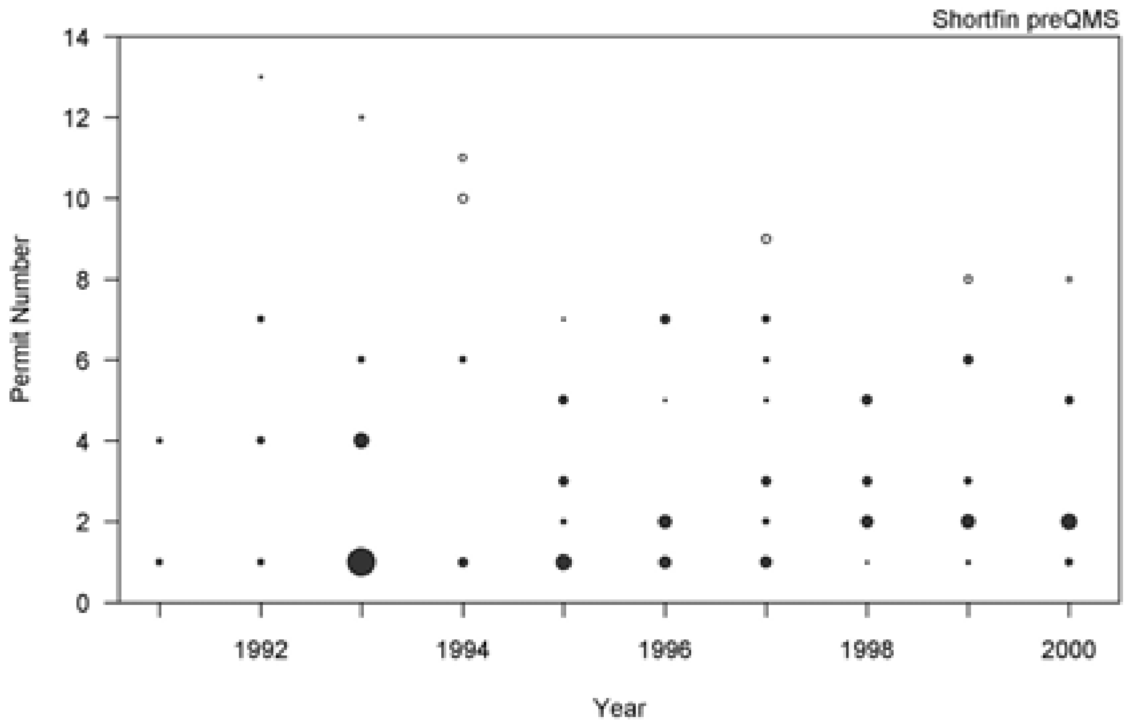

Figure E9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA18 (AU)).

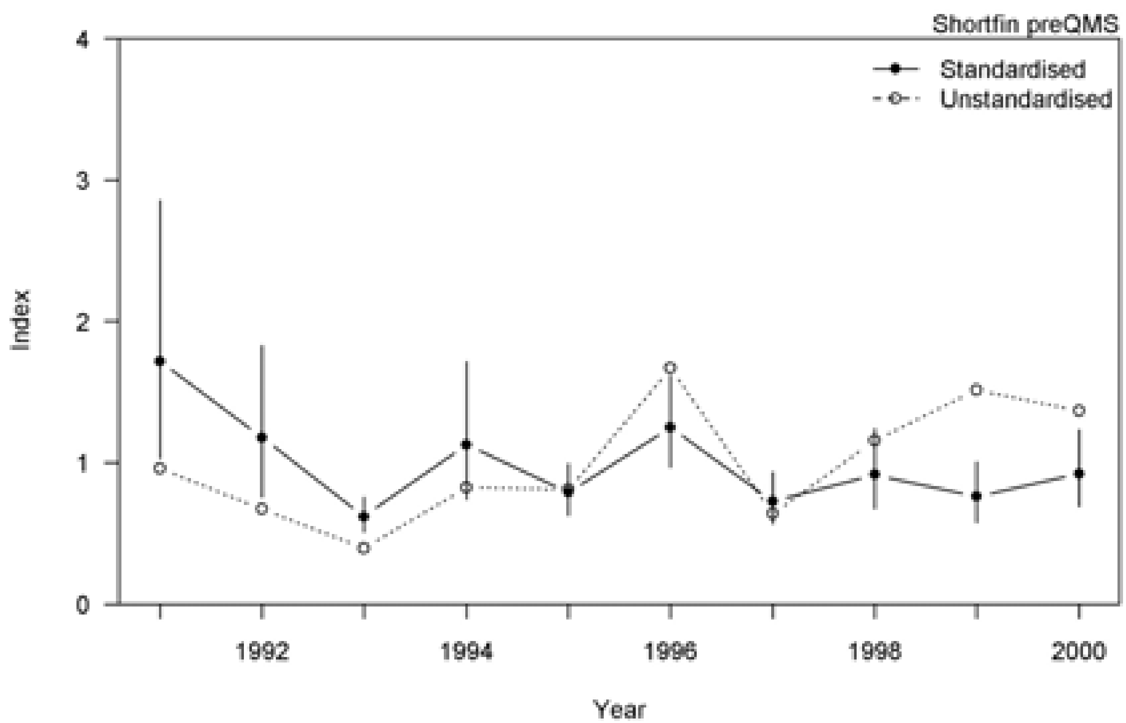

Figure E10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA18 (AU)).

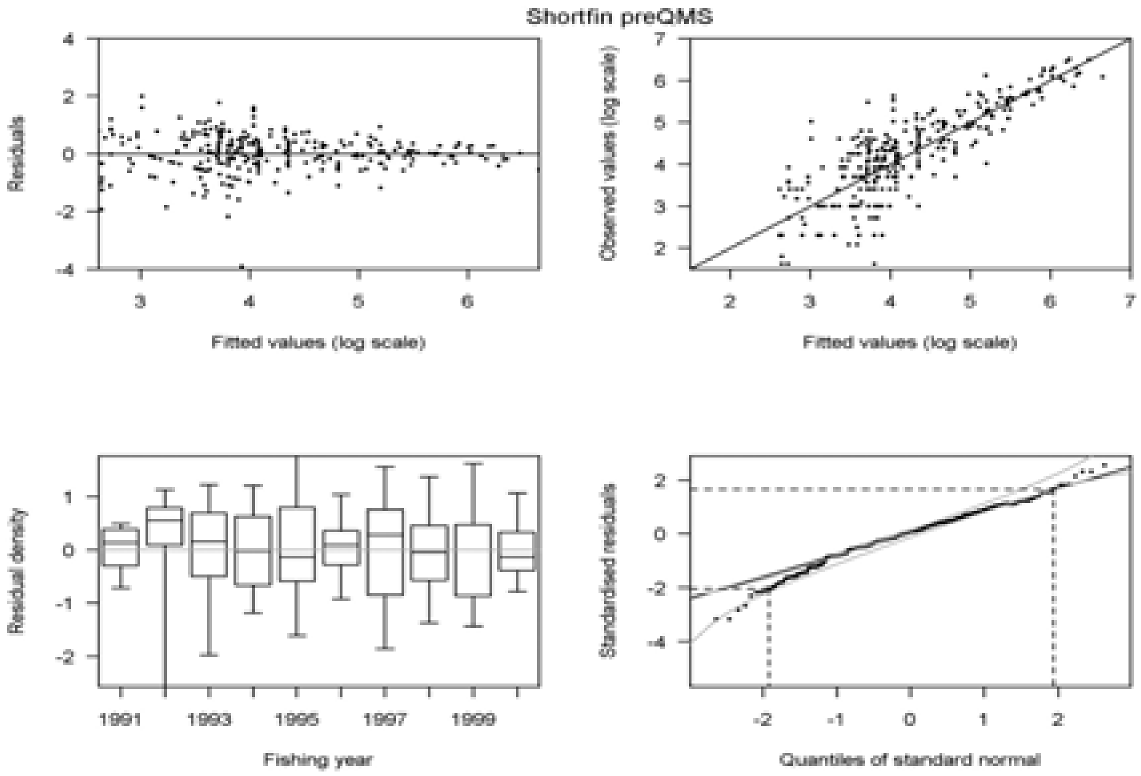

Figure E11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA18 (AU)).

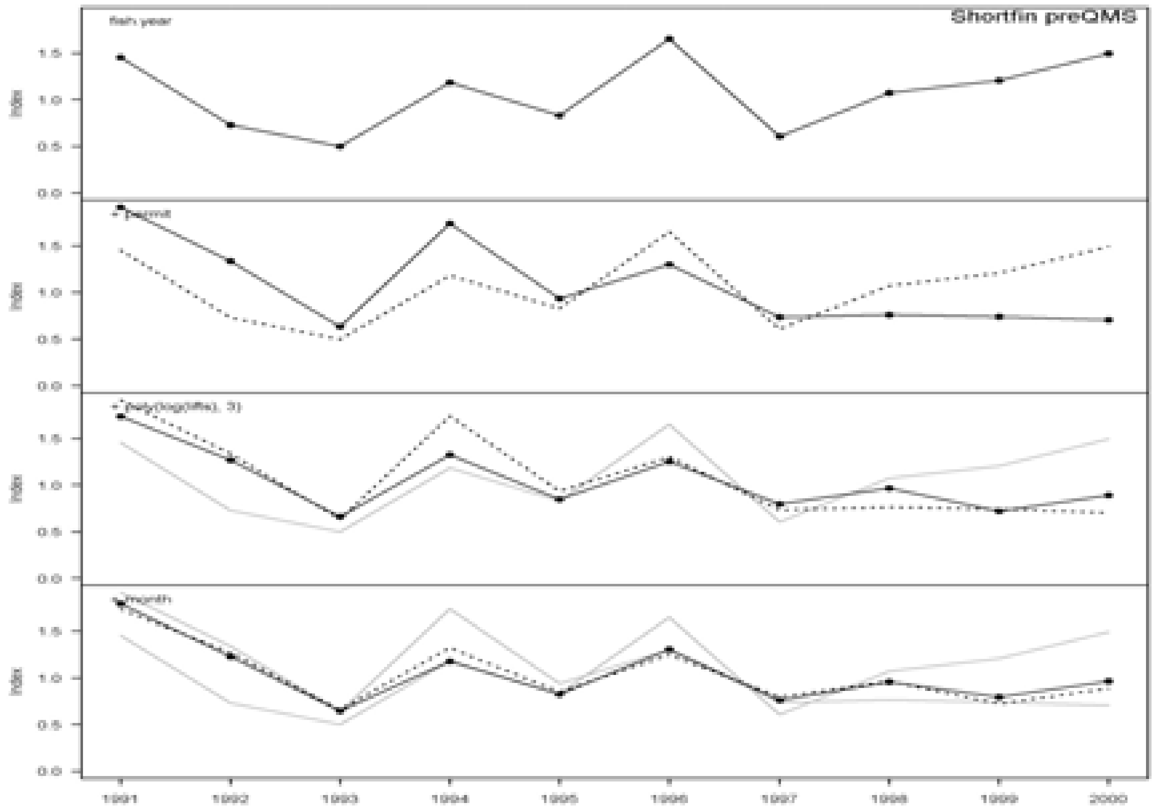

Figure E12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA18 (AU)).

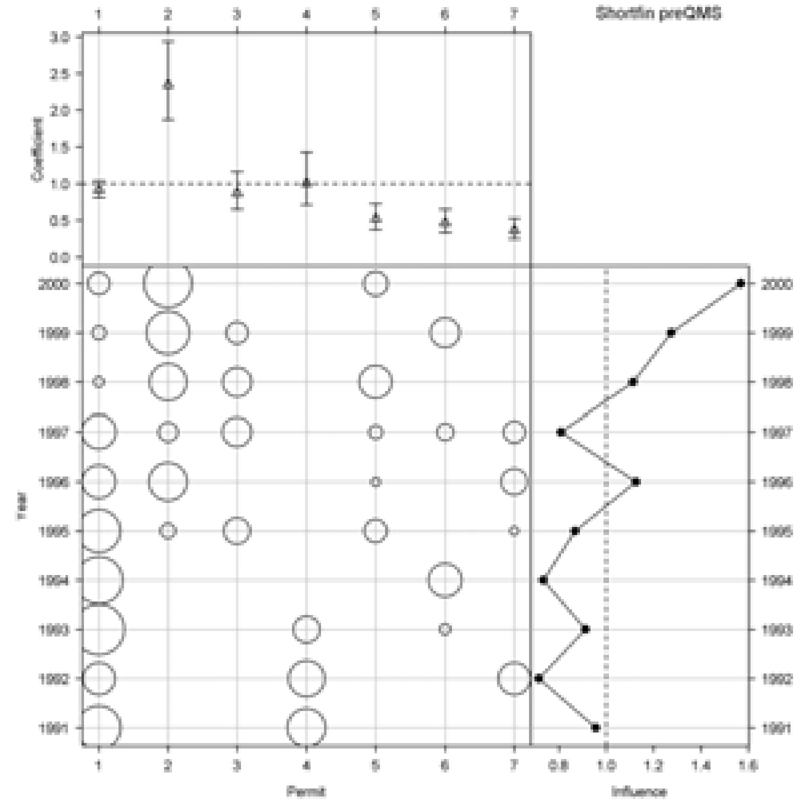

Figure E13: Influence of permit number for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

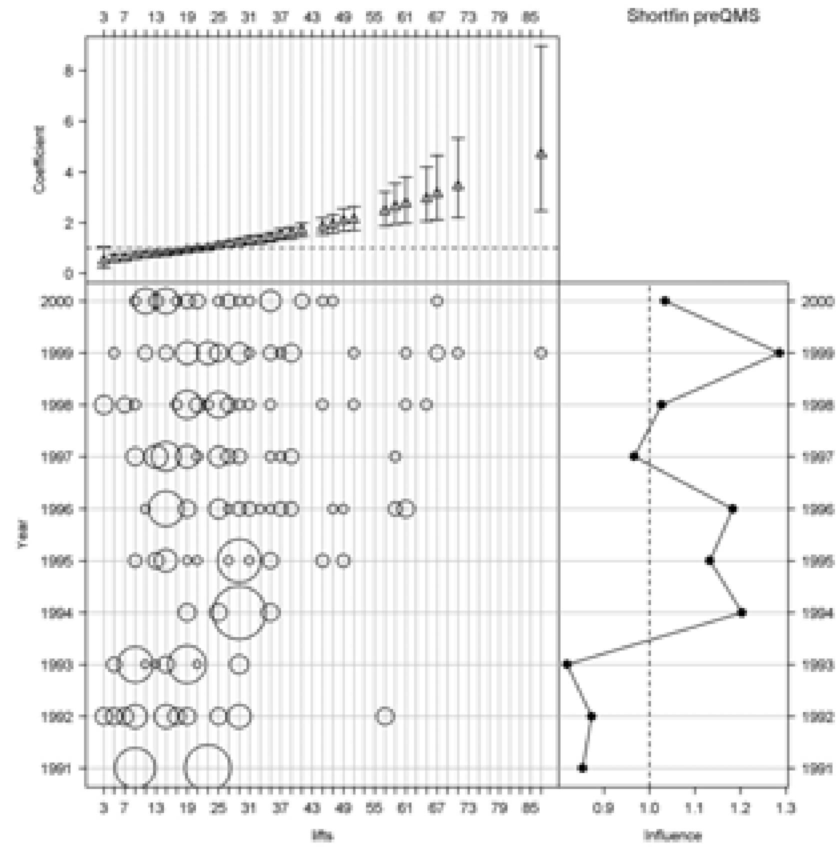

Figure E14: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

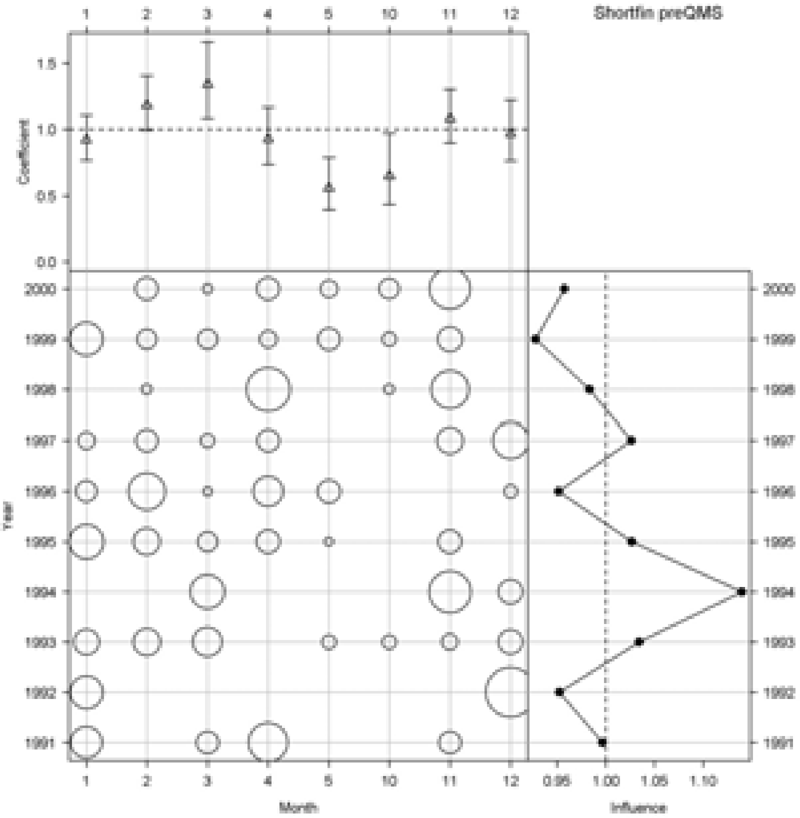

Figure E15: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

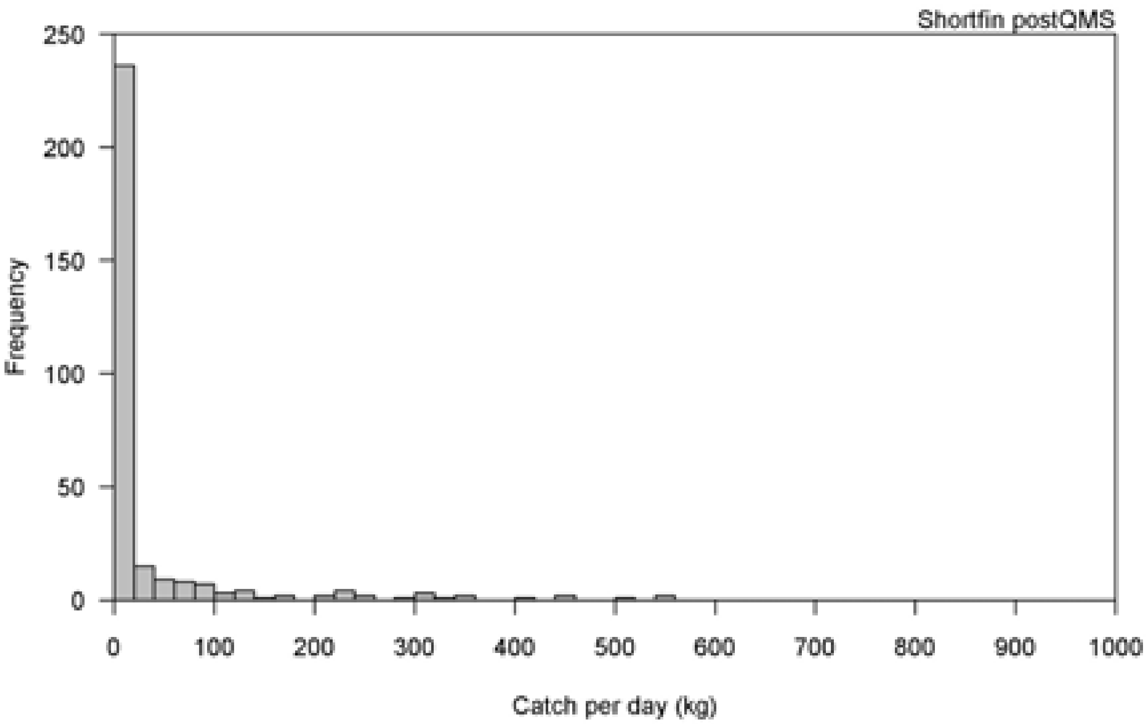

Figure E16: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA18 (AU)).

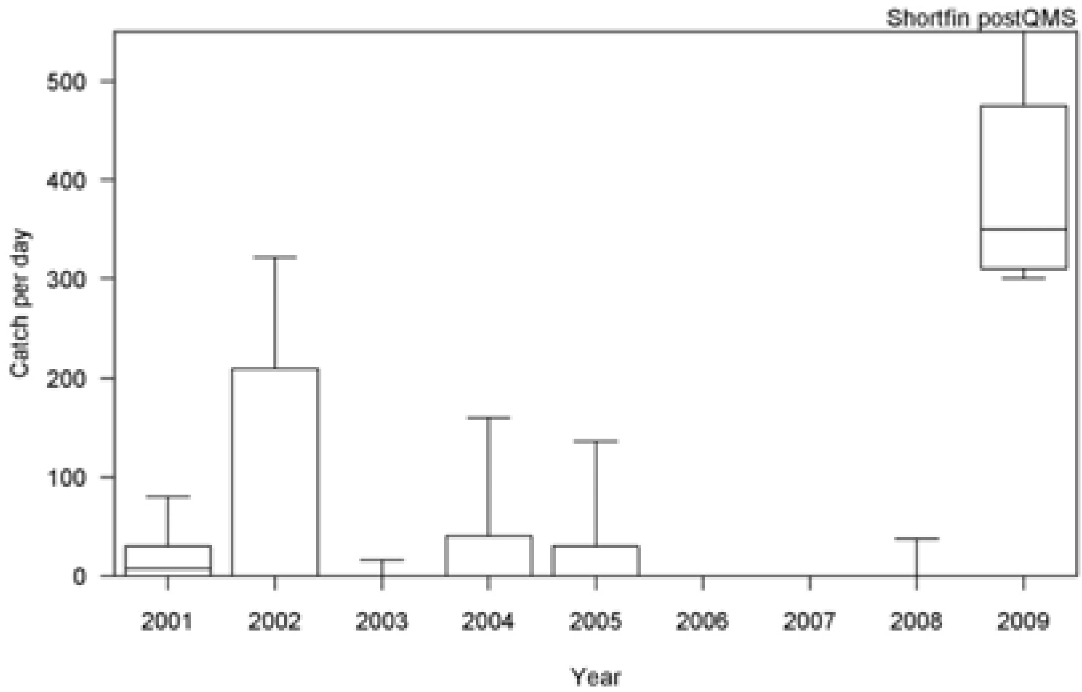

Figure E17: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA18 (AU)).

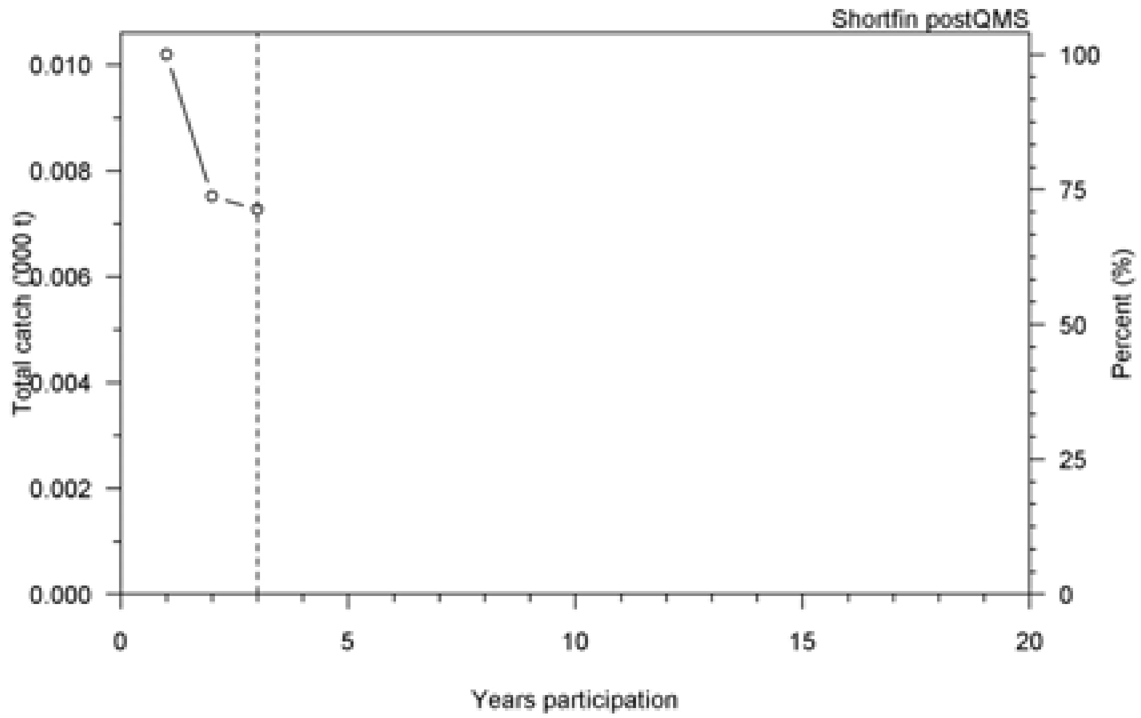

Figure E18: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA18 (AU)).

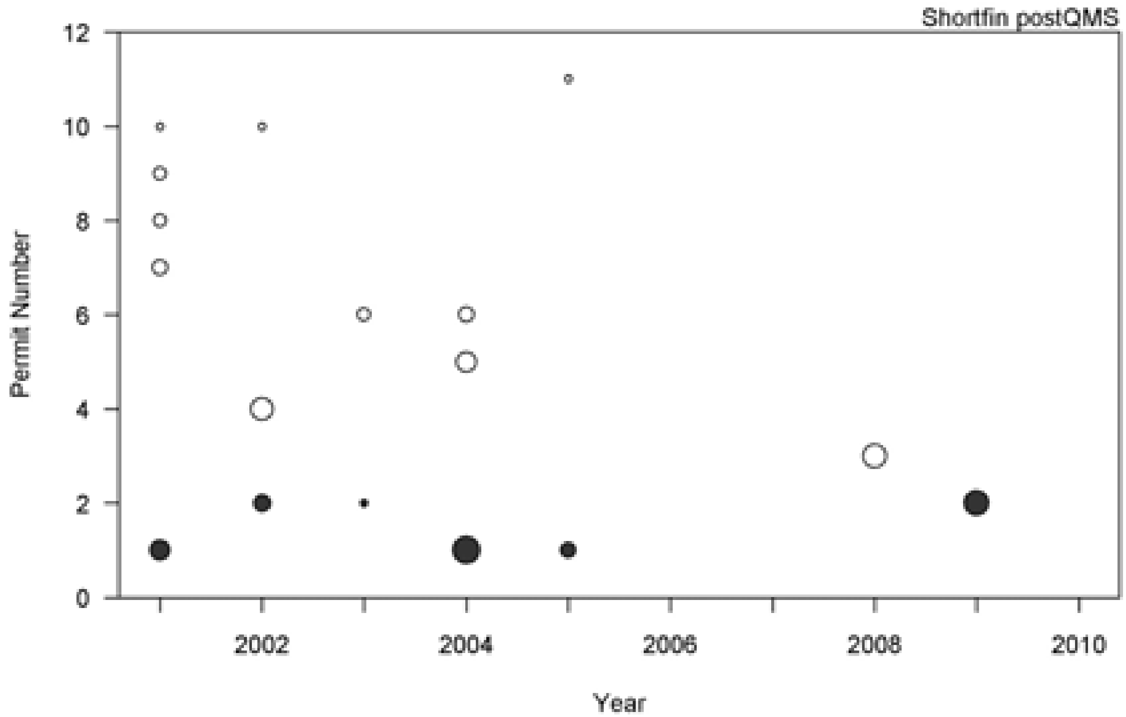

Figure E19: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA18 (AU)).

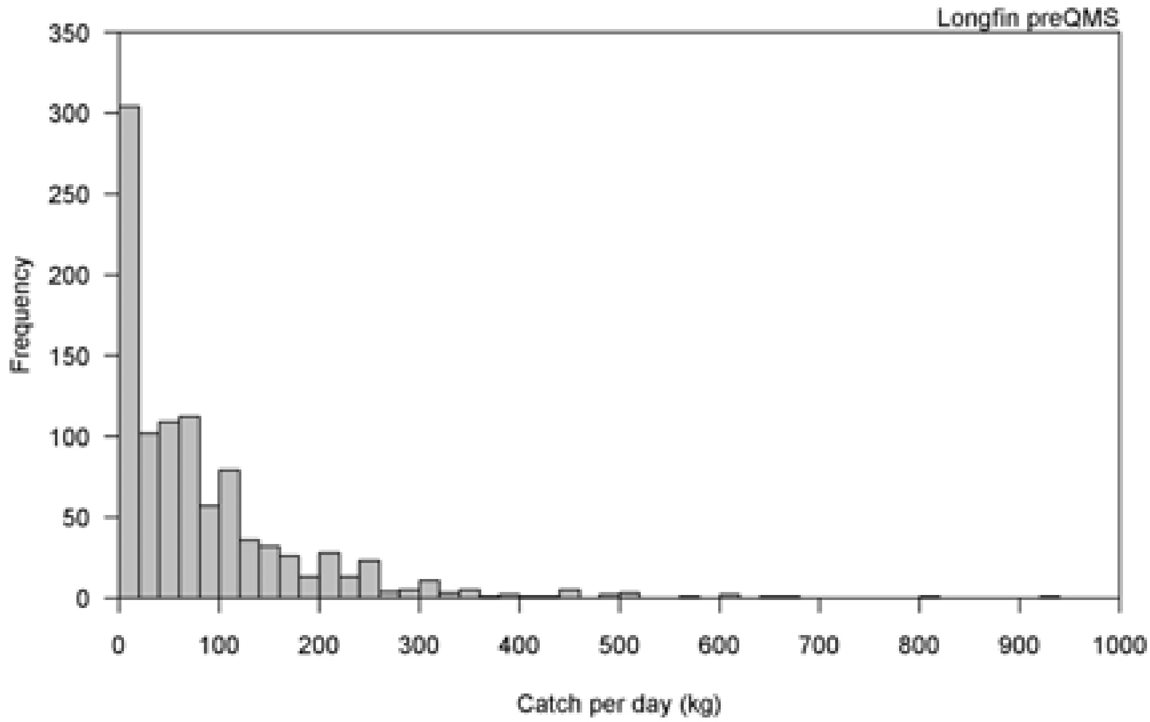

Figure E20: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

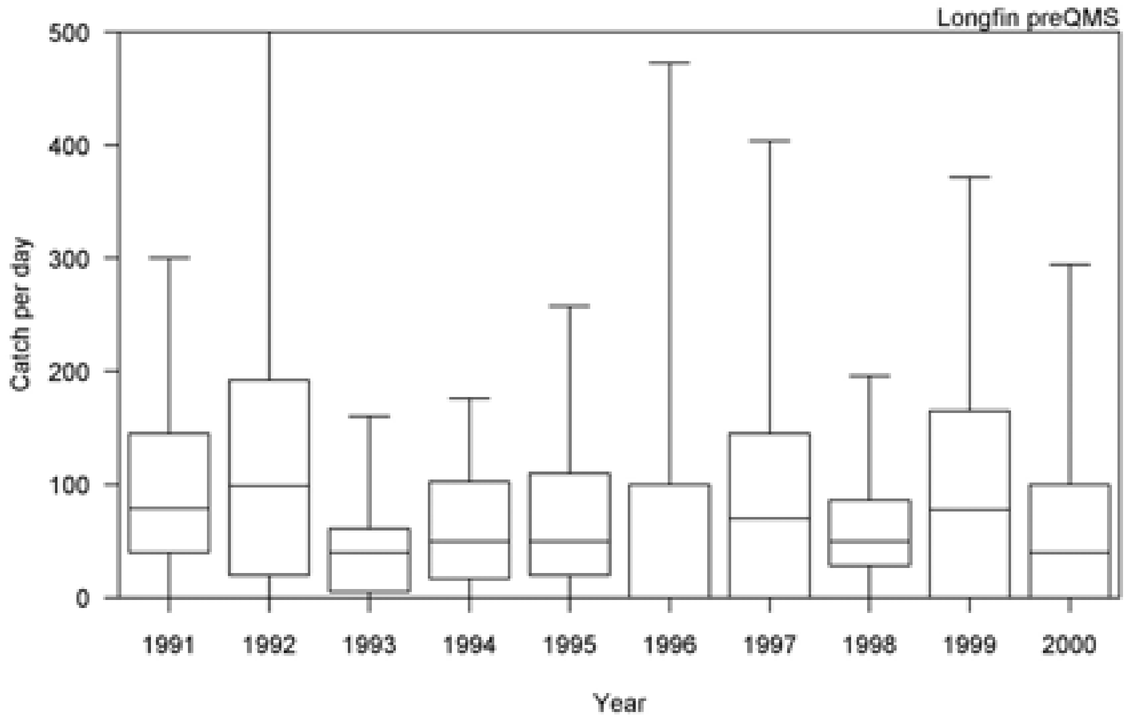

Figure E21: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA18 (AU)).

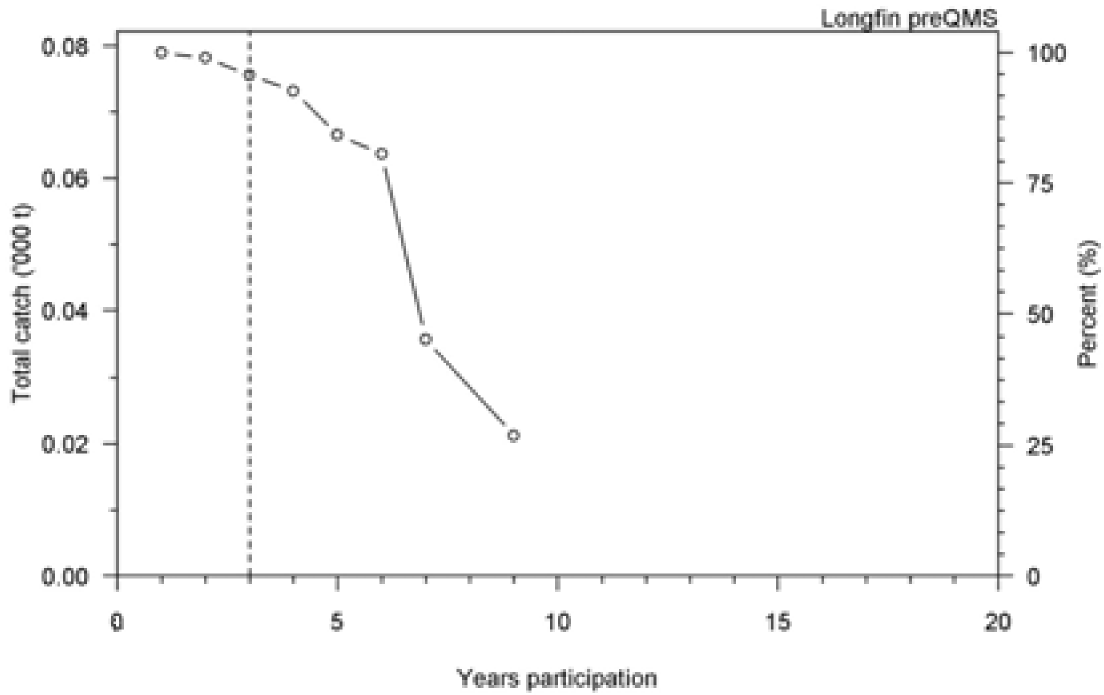

Figure E22: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA18 (AU)).

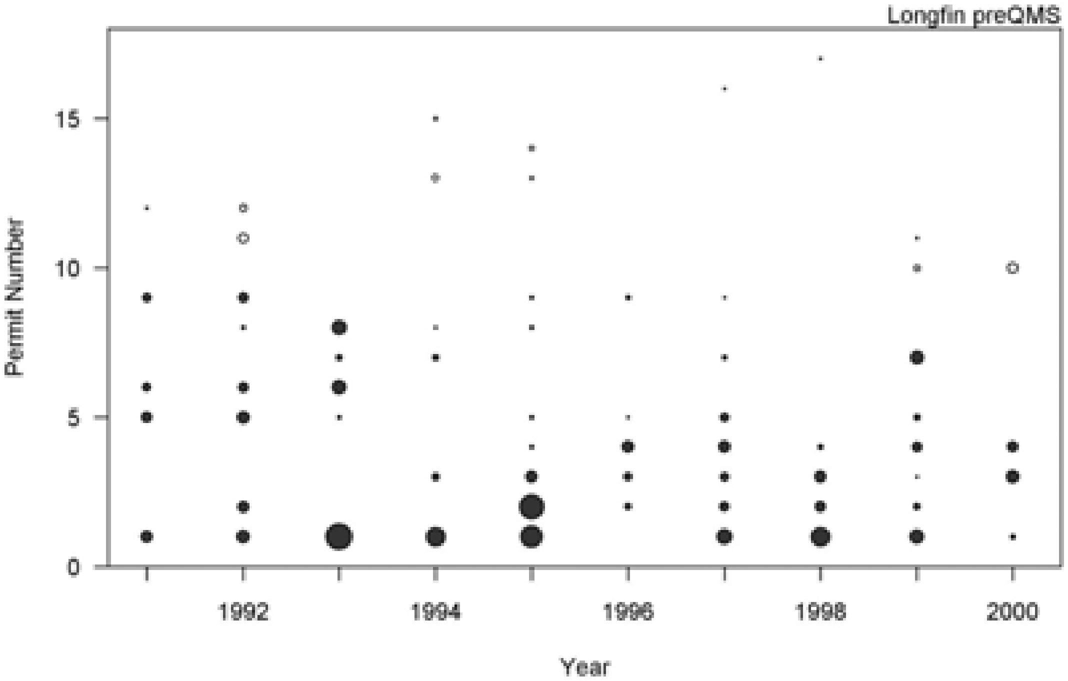

Figure E23: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA18 (AU)).

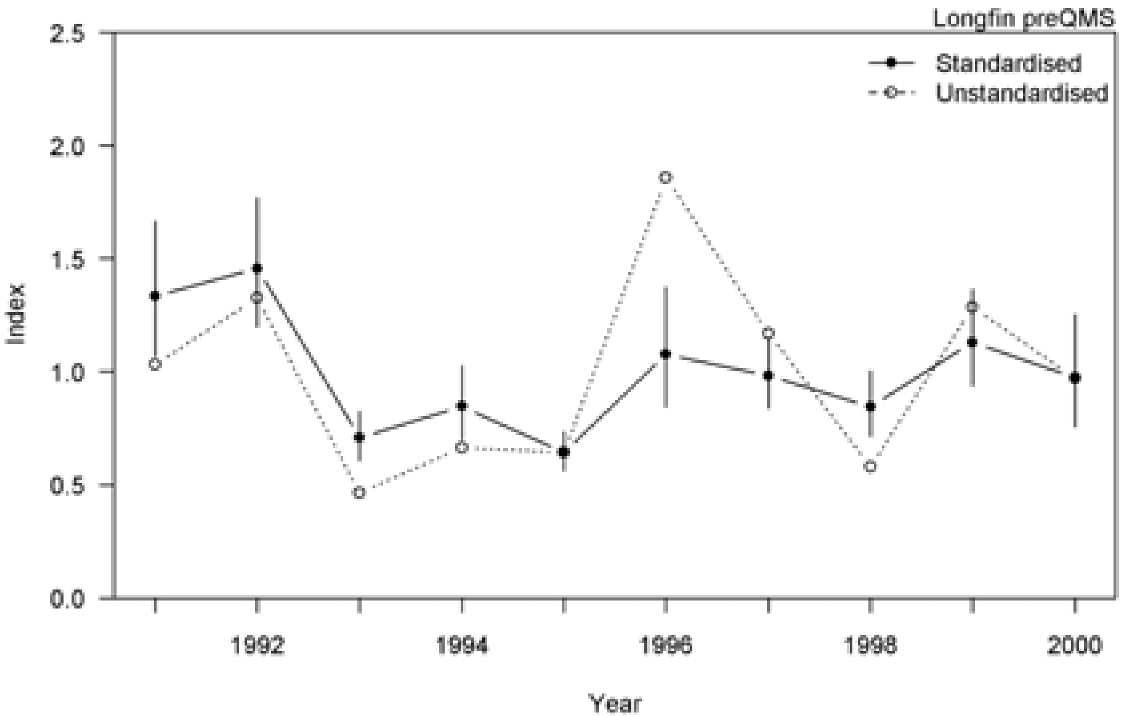

Figure E24: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA18 (AU)).

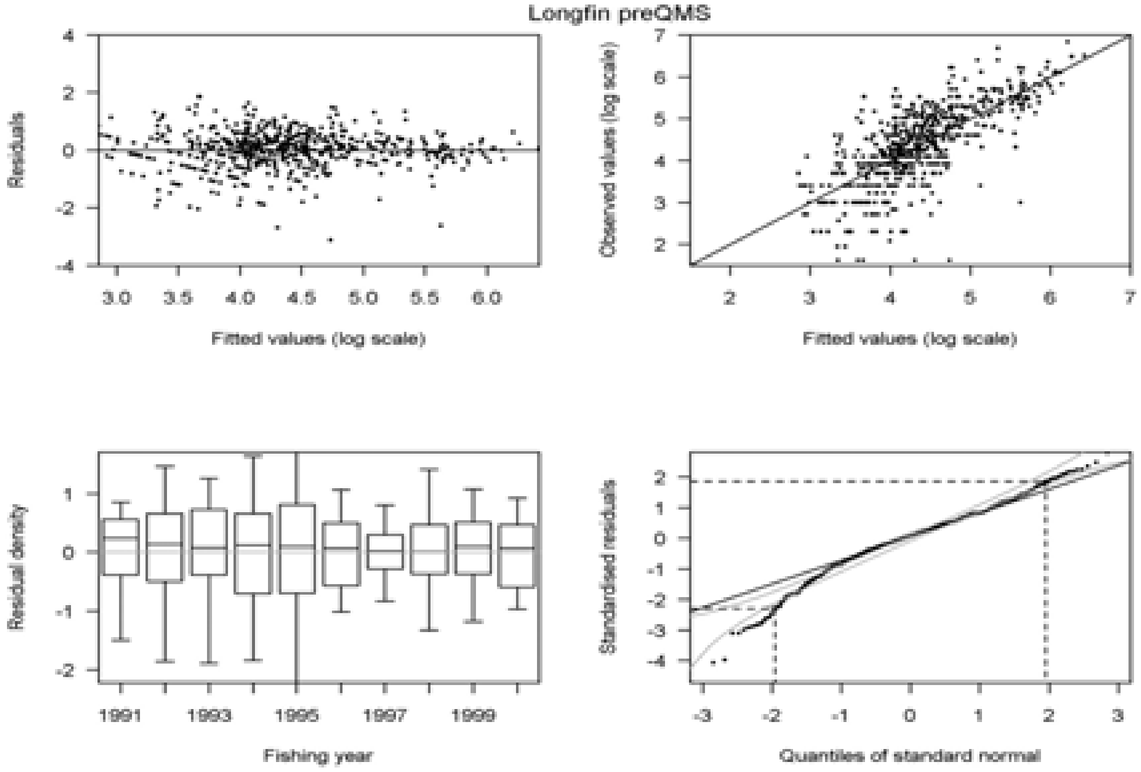

Figure E25: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA18 (AU)).

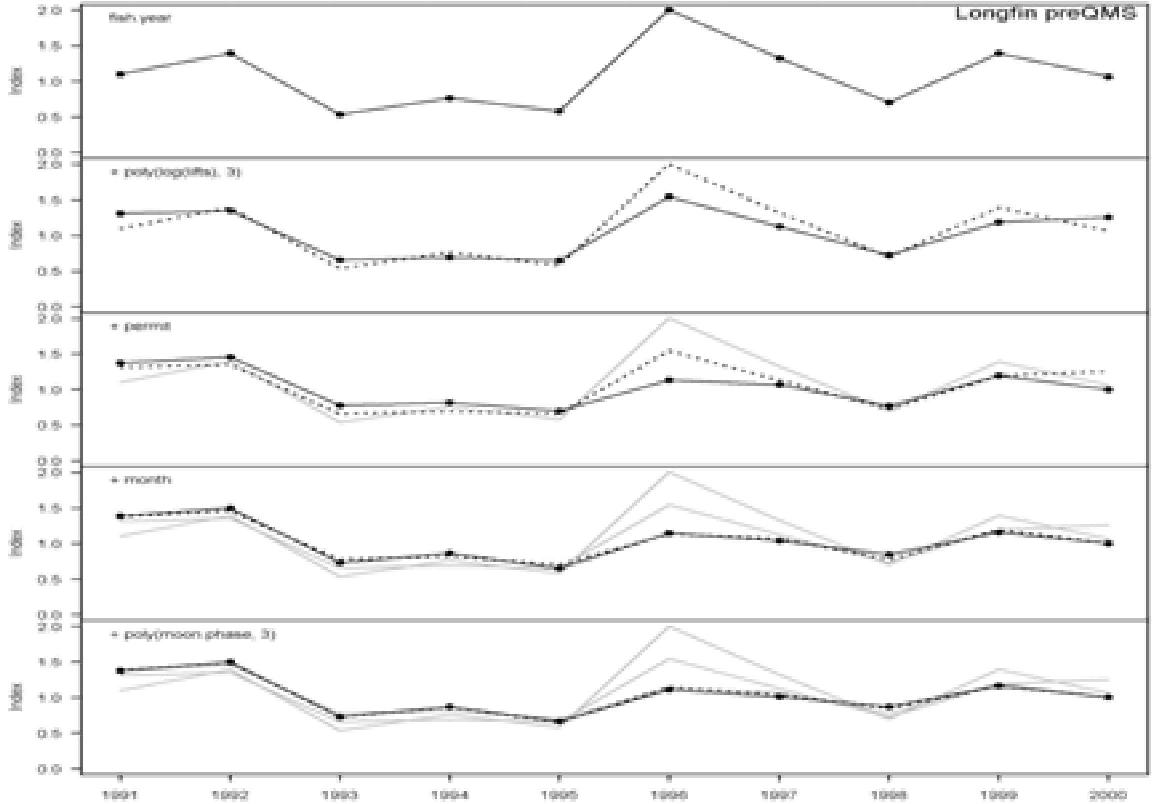

Figure E26: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA18 (AU)).

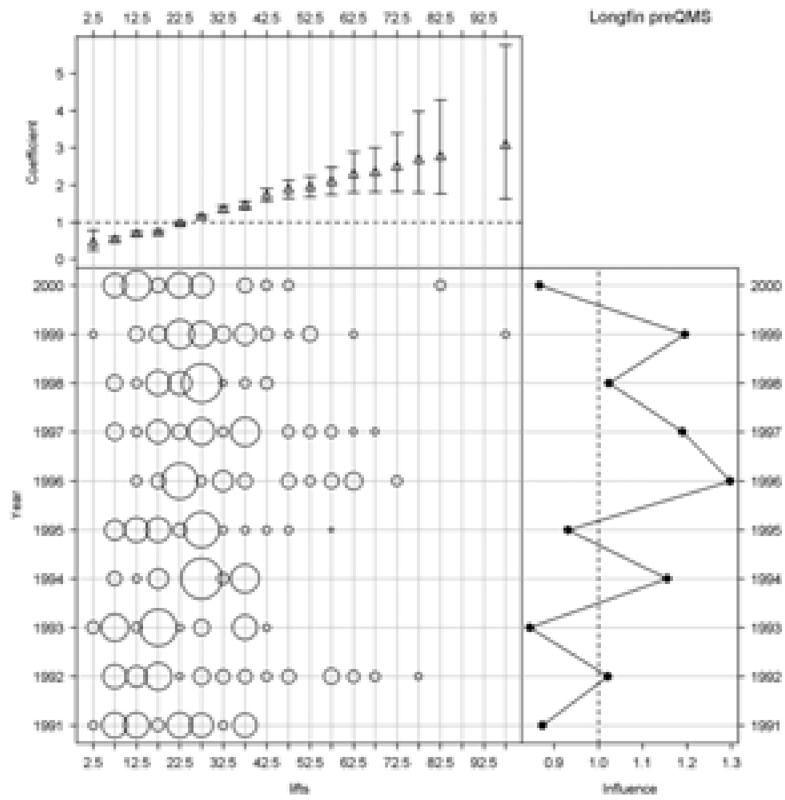

Figure E27: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

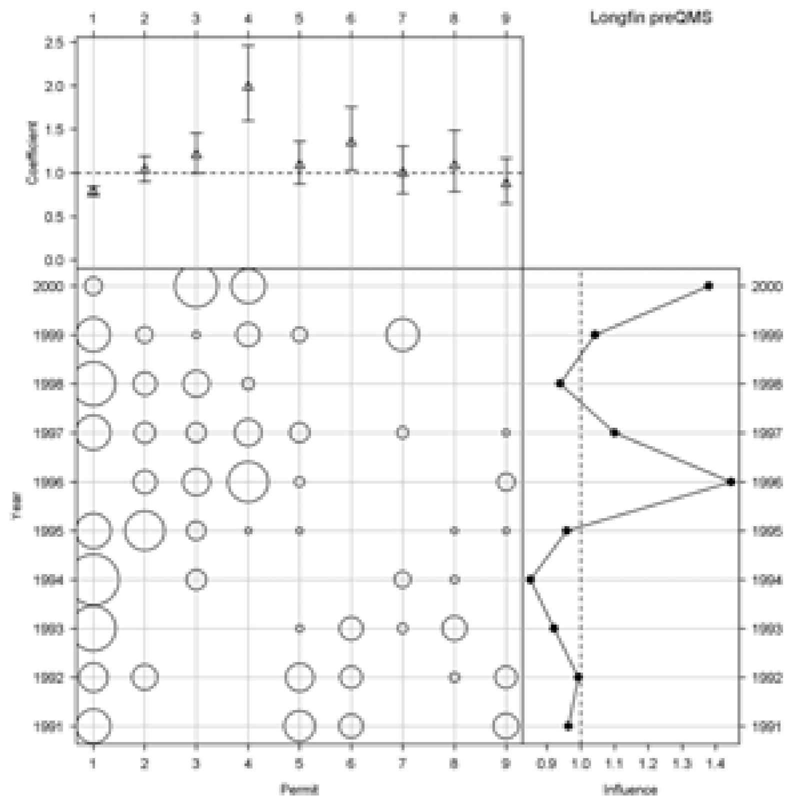

Figure E28: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

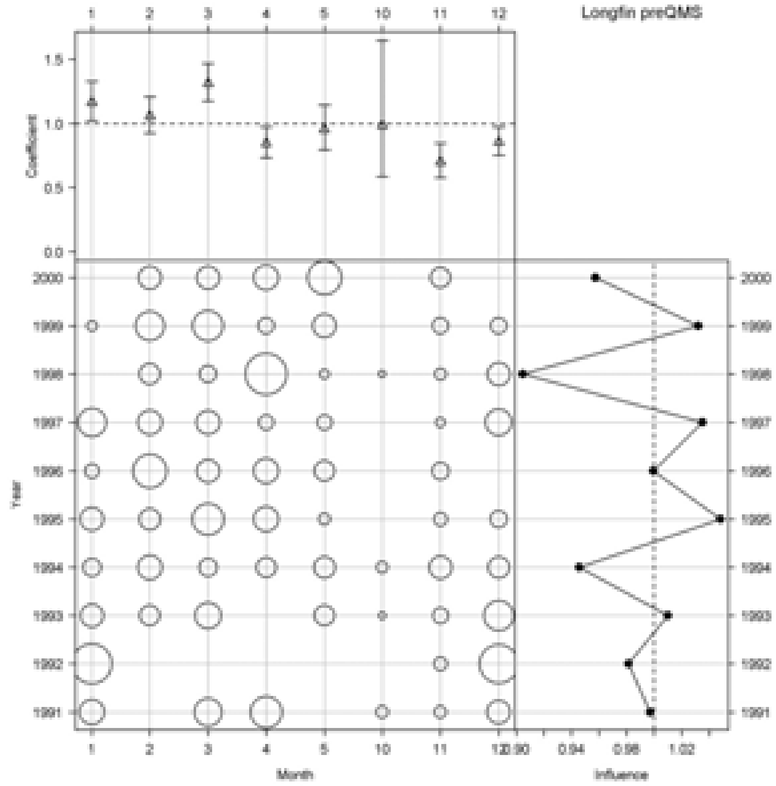

Figure E29: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

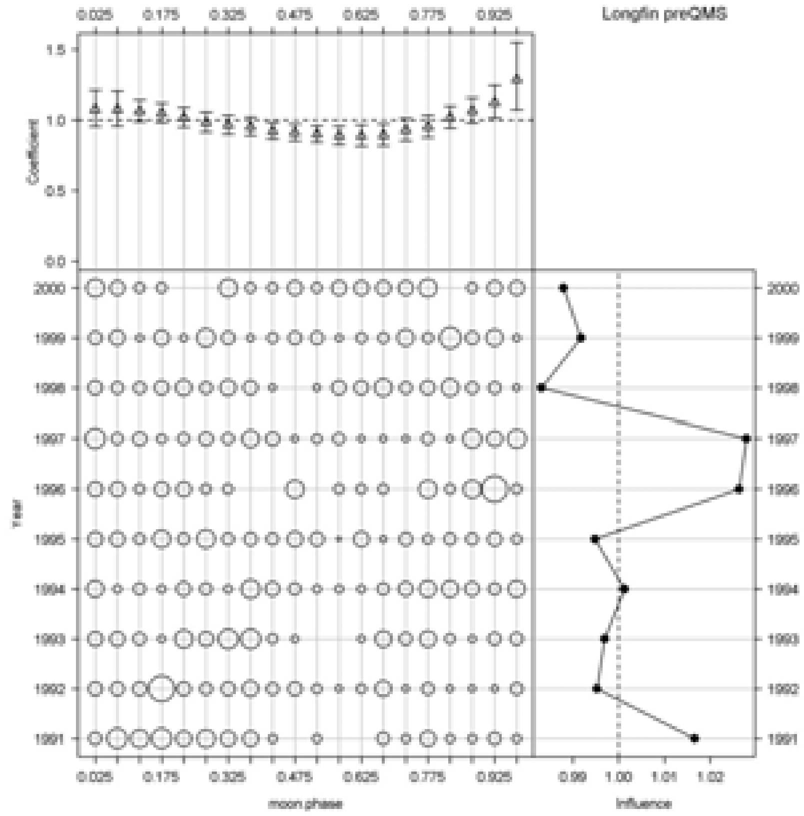

Figure E30: Influence of moon phase for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA18 (AU)).

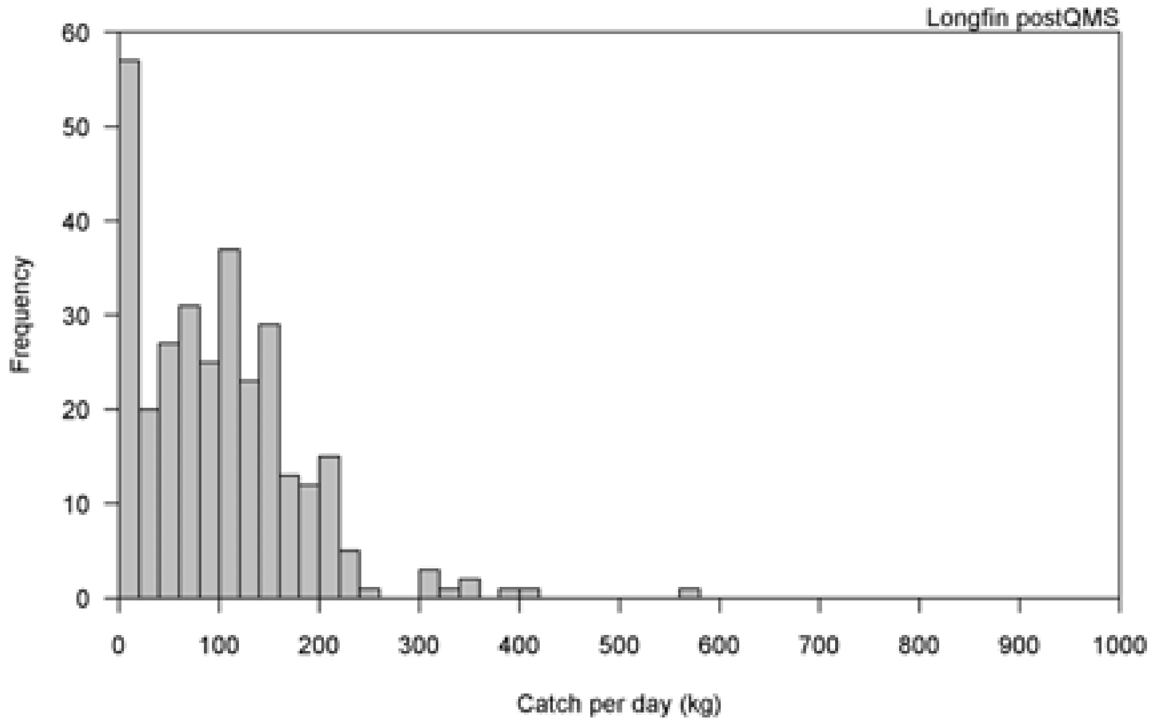

Figure E31: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA18 (AU)).

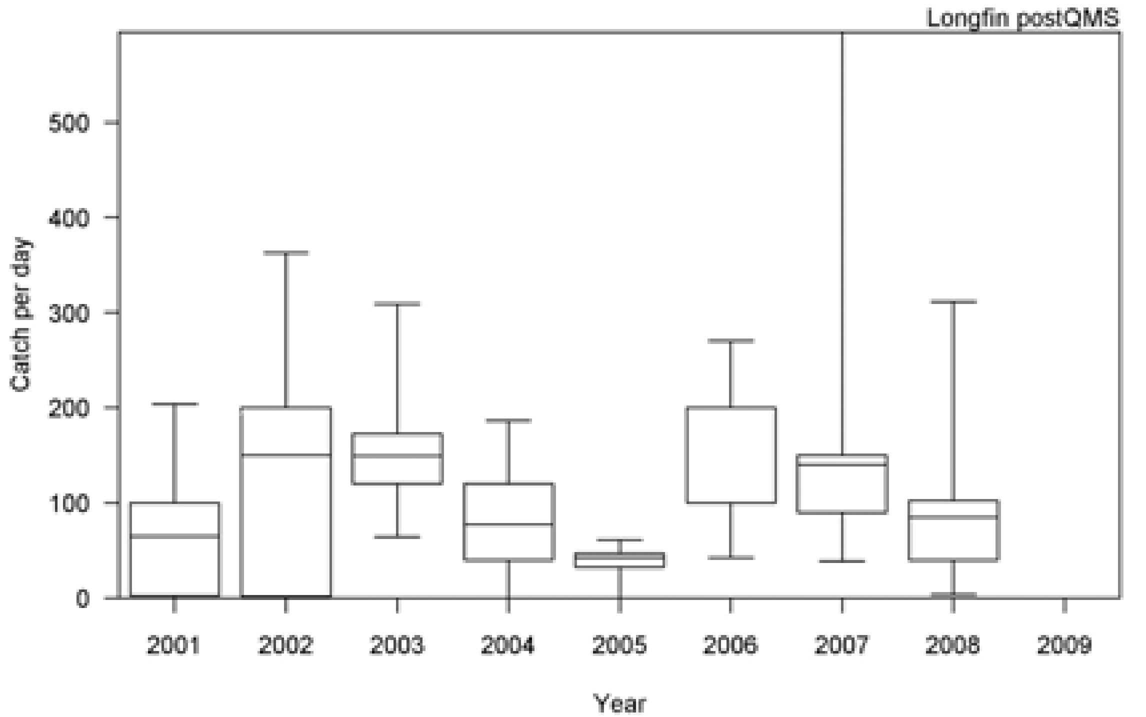

Figure E32: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA18 (AU)).

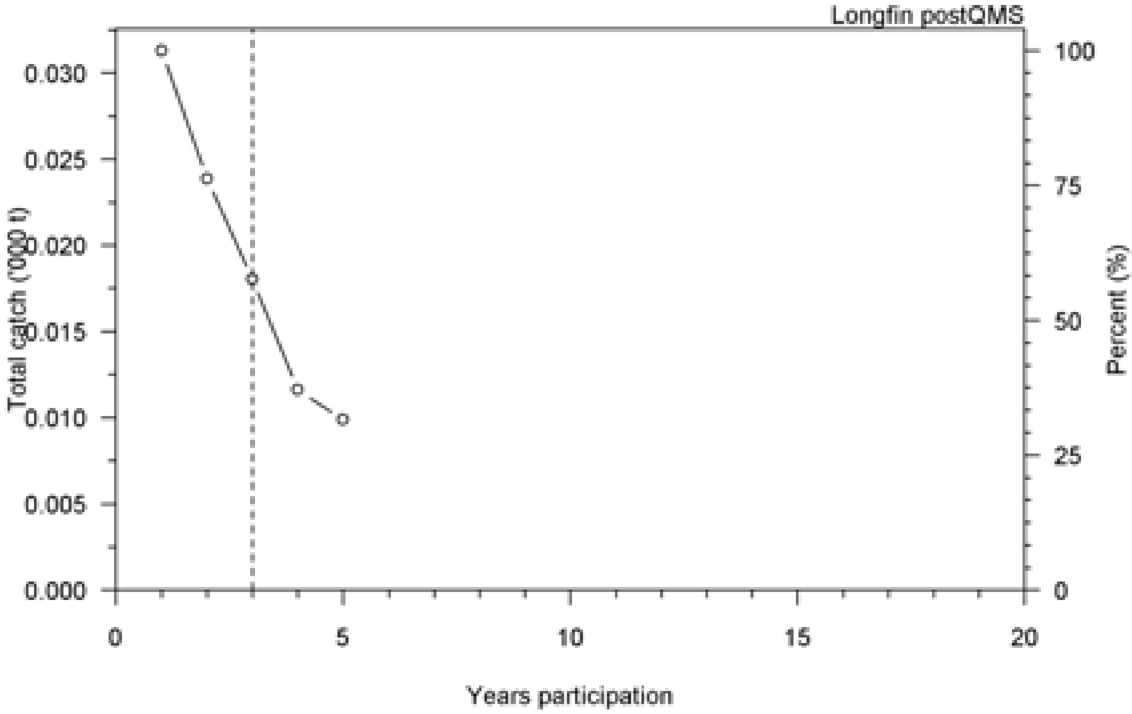

Figure E33: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA18 (AU)).

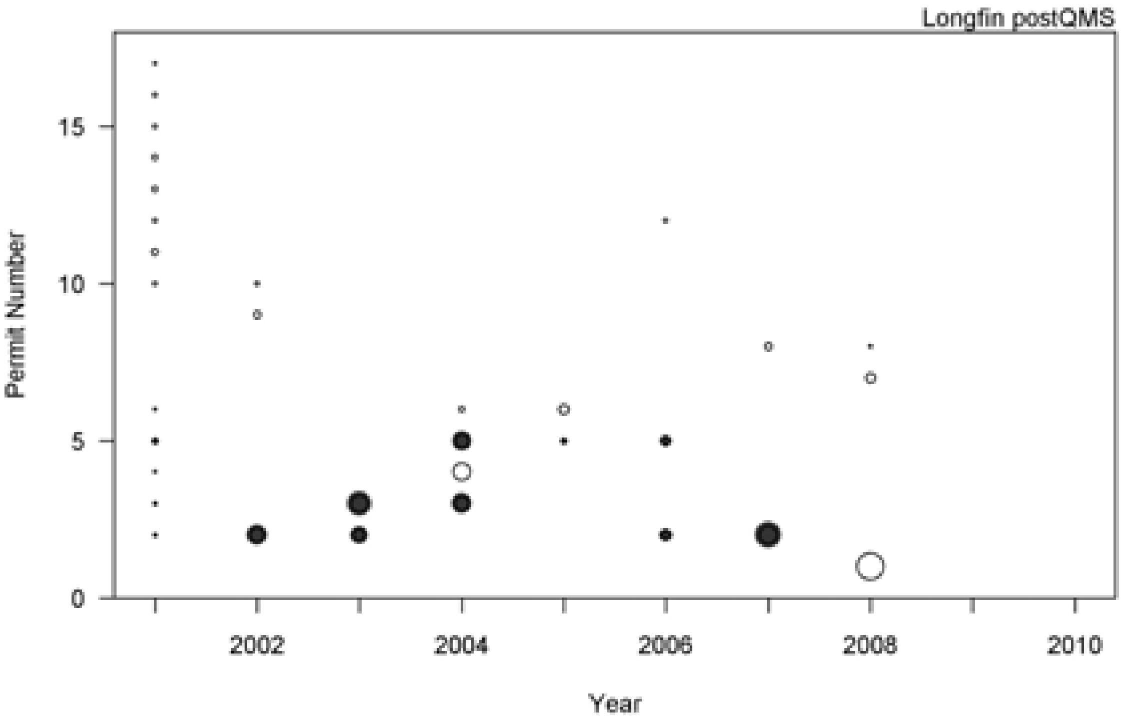

Figure E34: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) (ESA18 (AU)).

Appendix F: ESA 15 (AX).

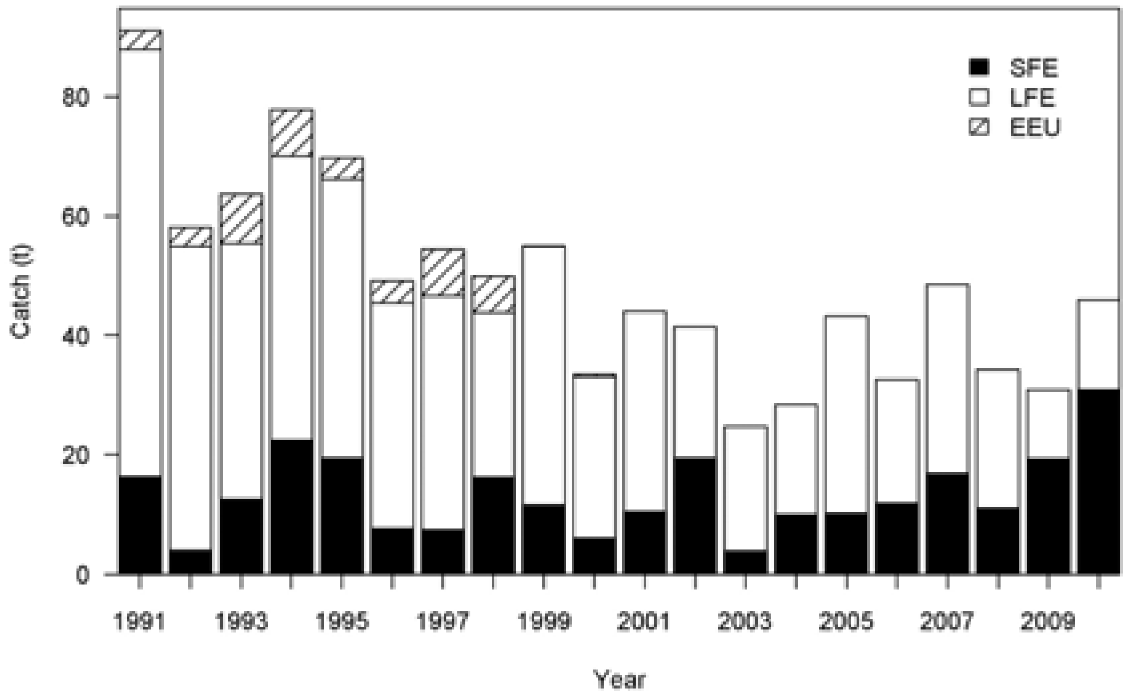

Figure F1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA15 (AX)).

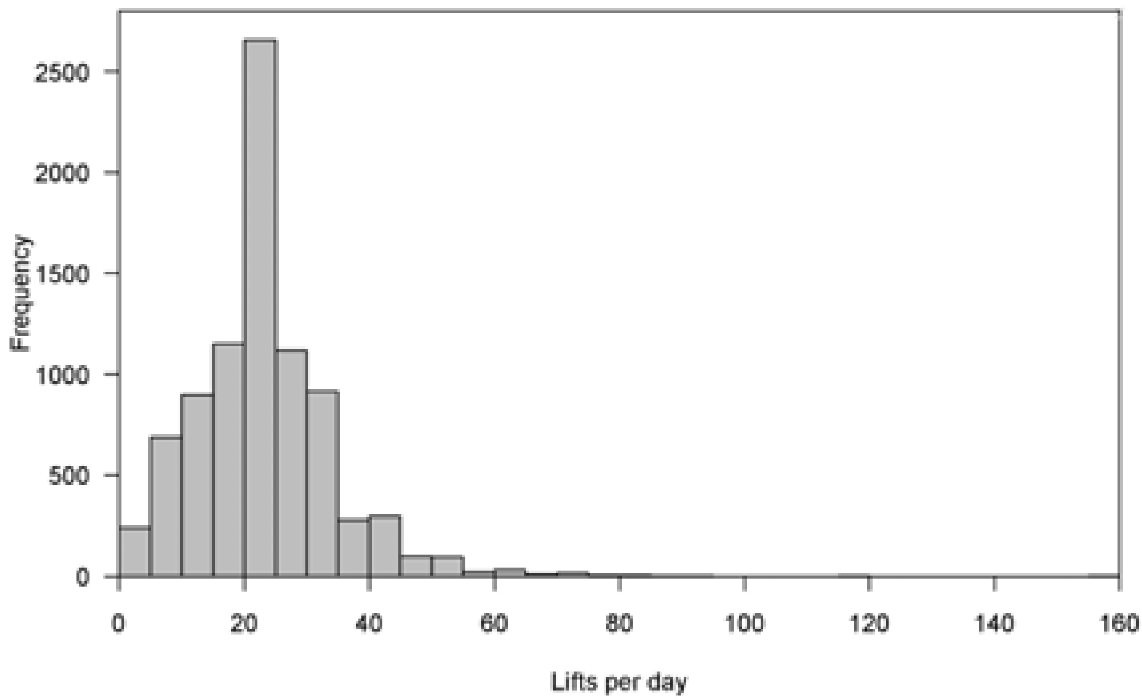

Figure F2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA15 (AX)).

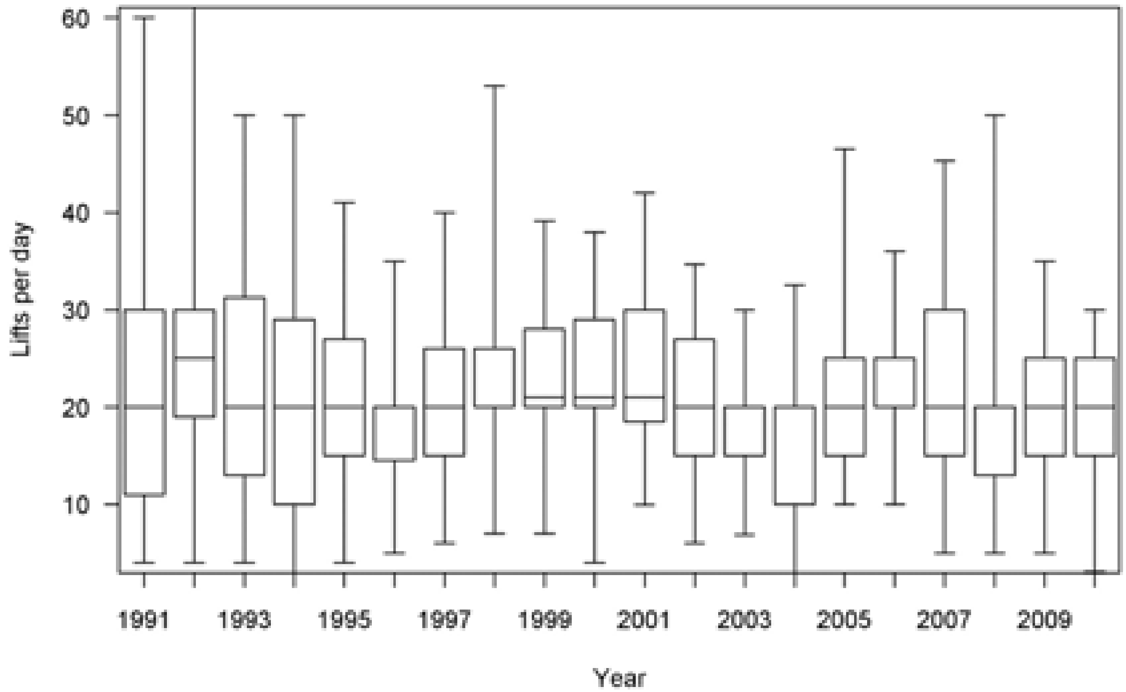

Figure F3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA15 (AX)).

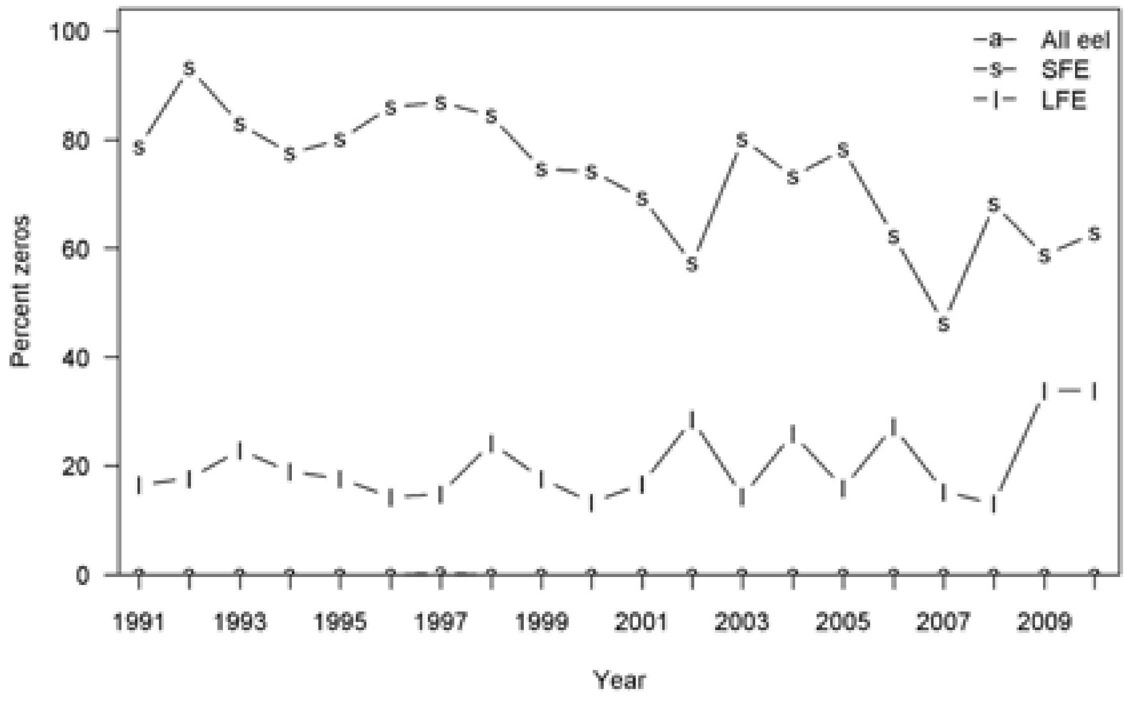

Figure F4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA15 (AX)).

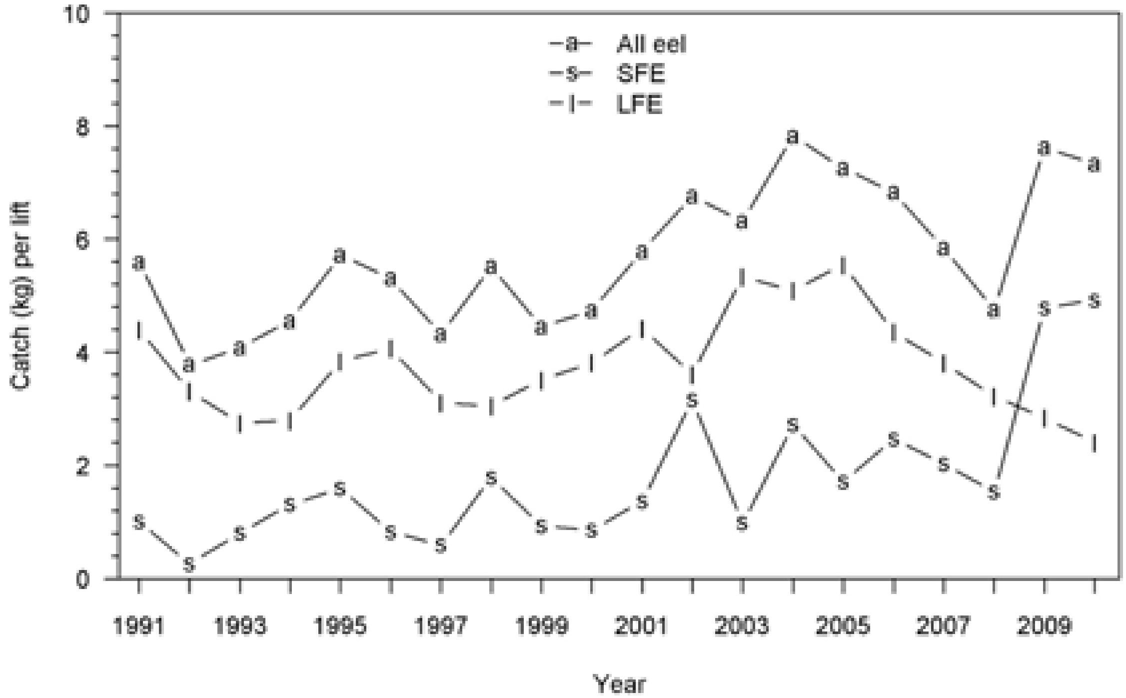

Figure F5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA15 (AX)).

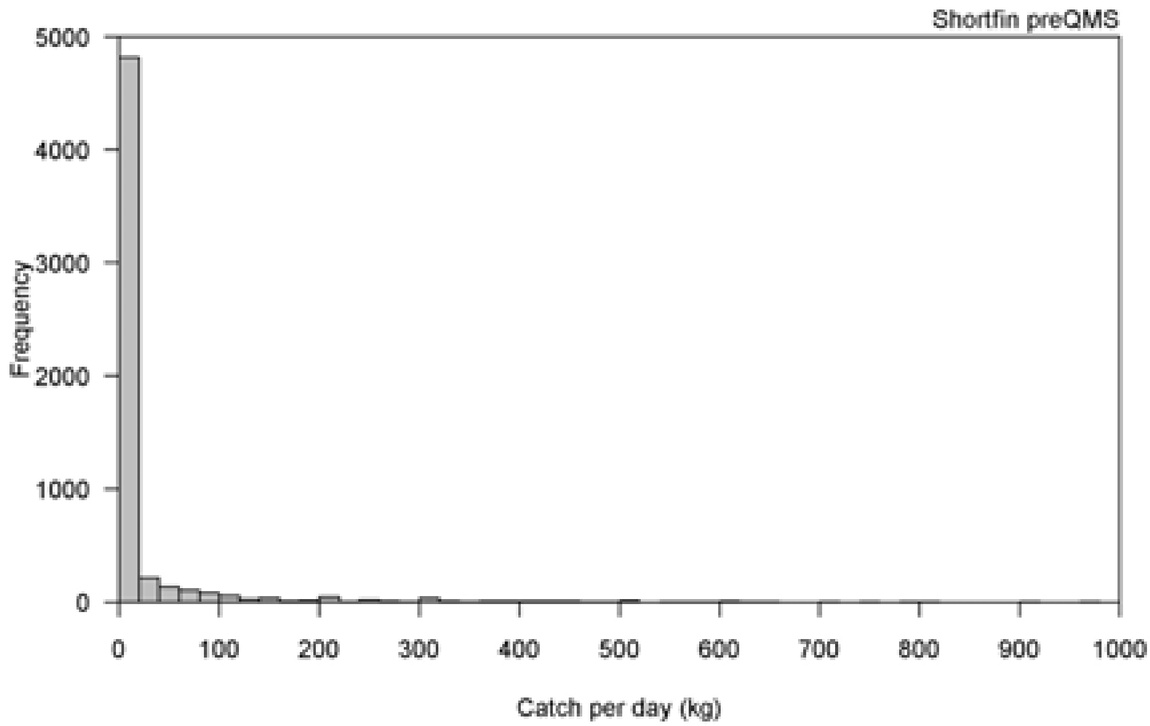

Figure F6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

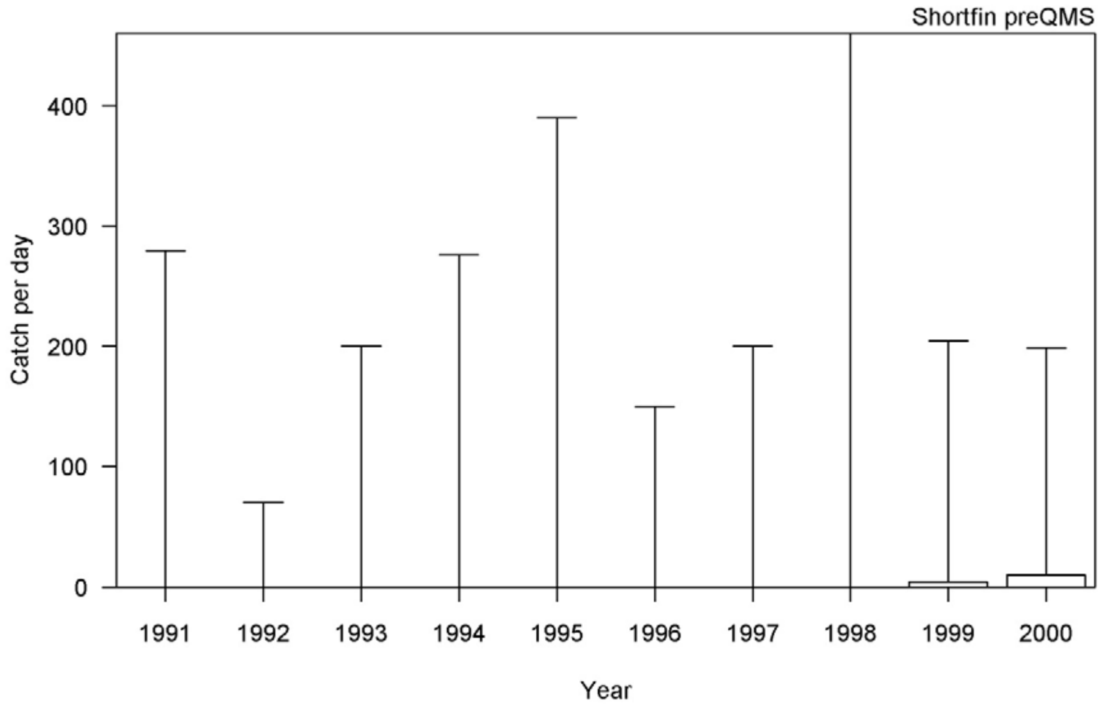

Figure F7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA15 (AX)).

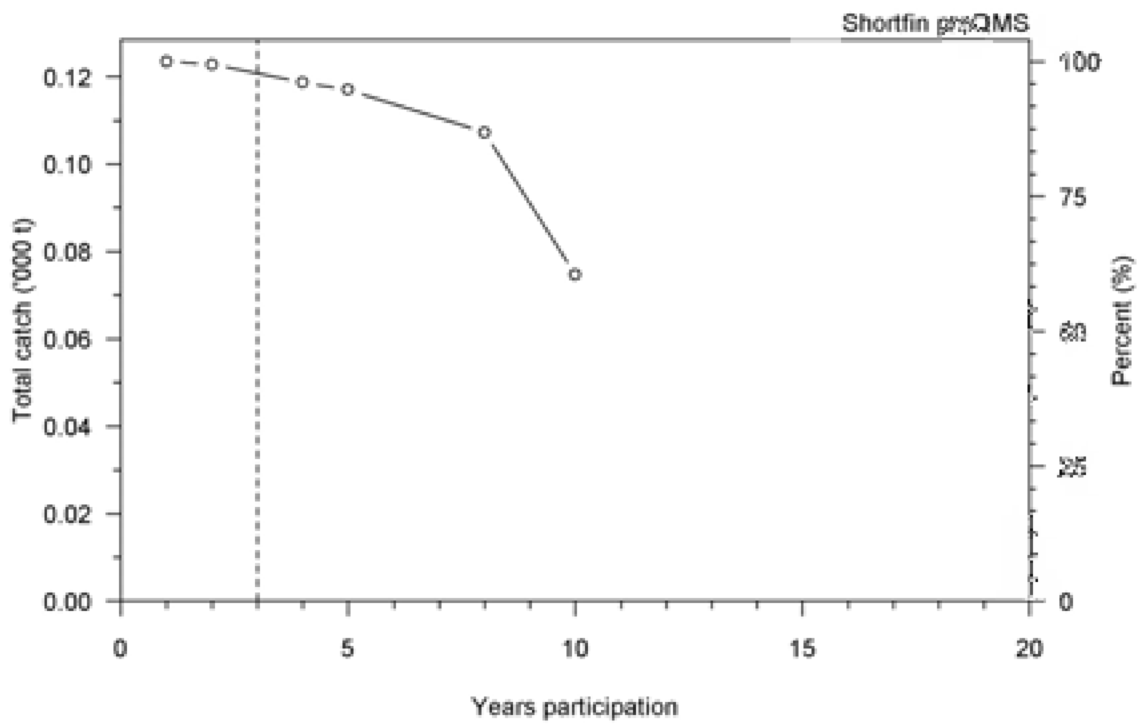

Figure F8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA15 (AX)).

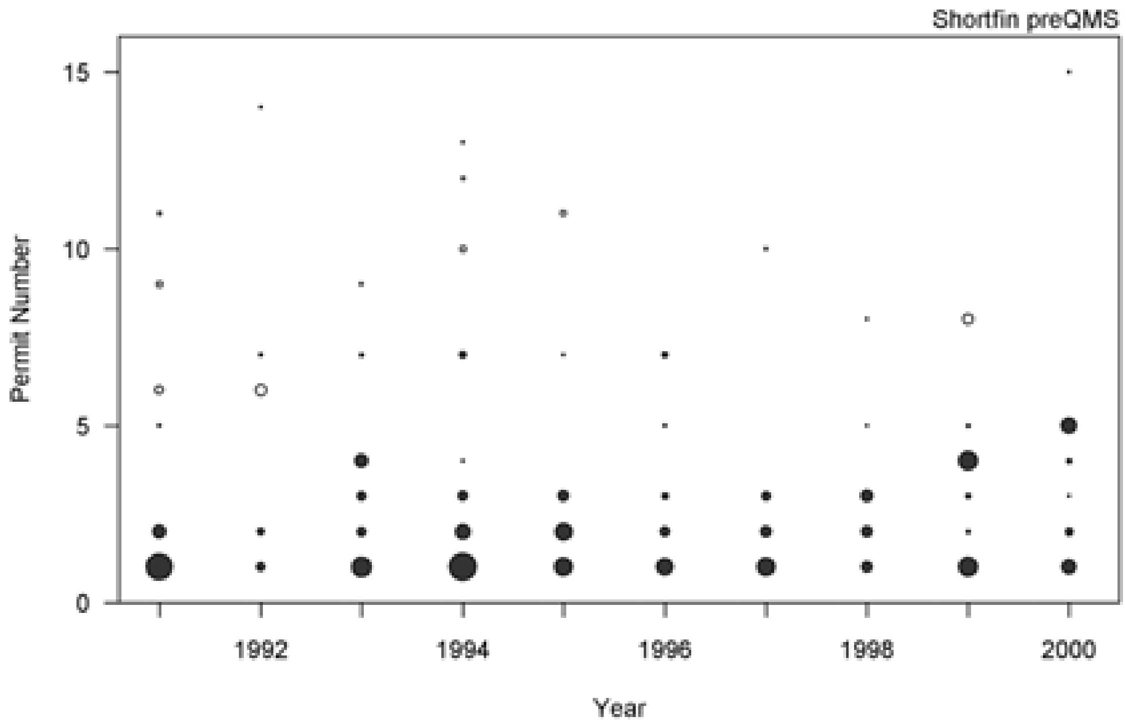

Figure F9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA15 (AX)).

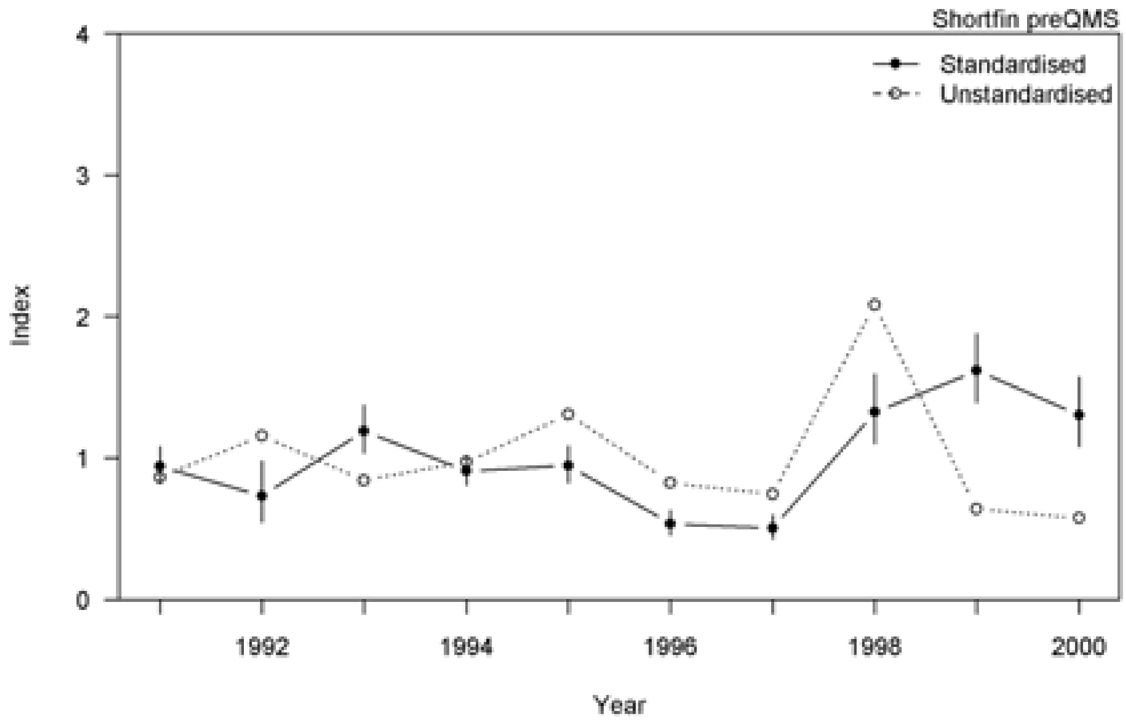

Figure F10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA15 (AX)).

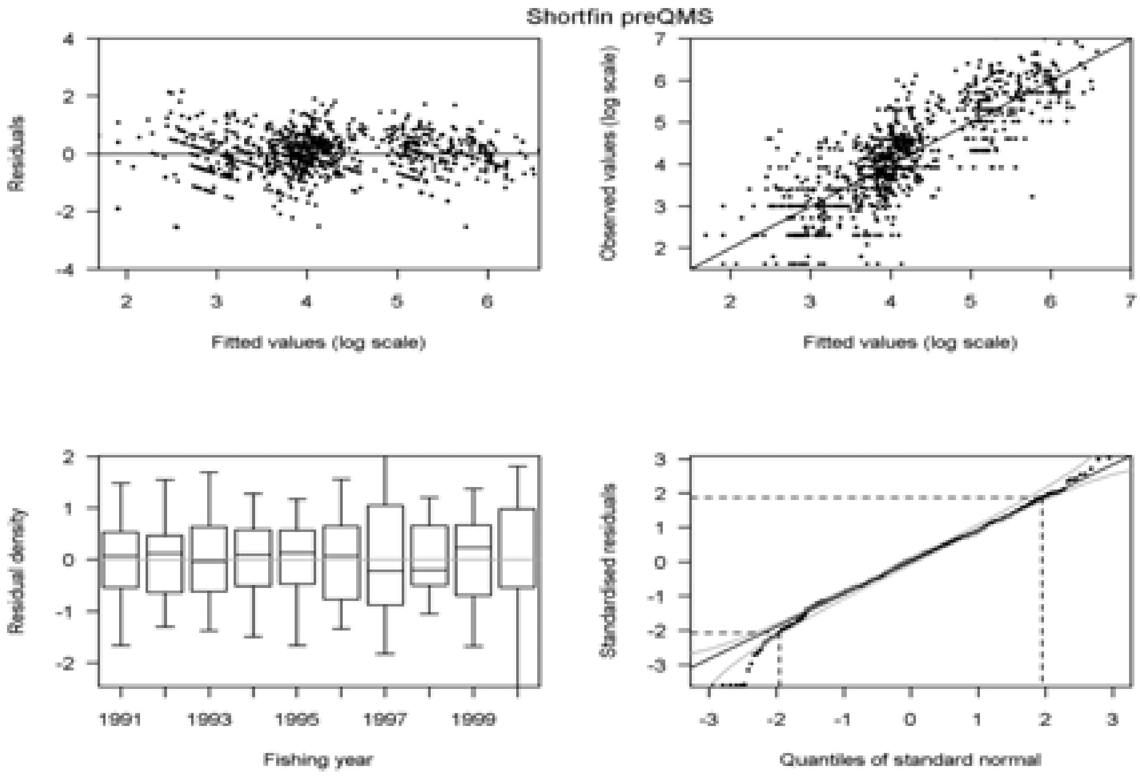

Figure F11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA15 (AX)).

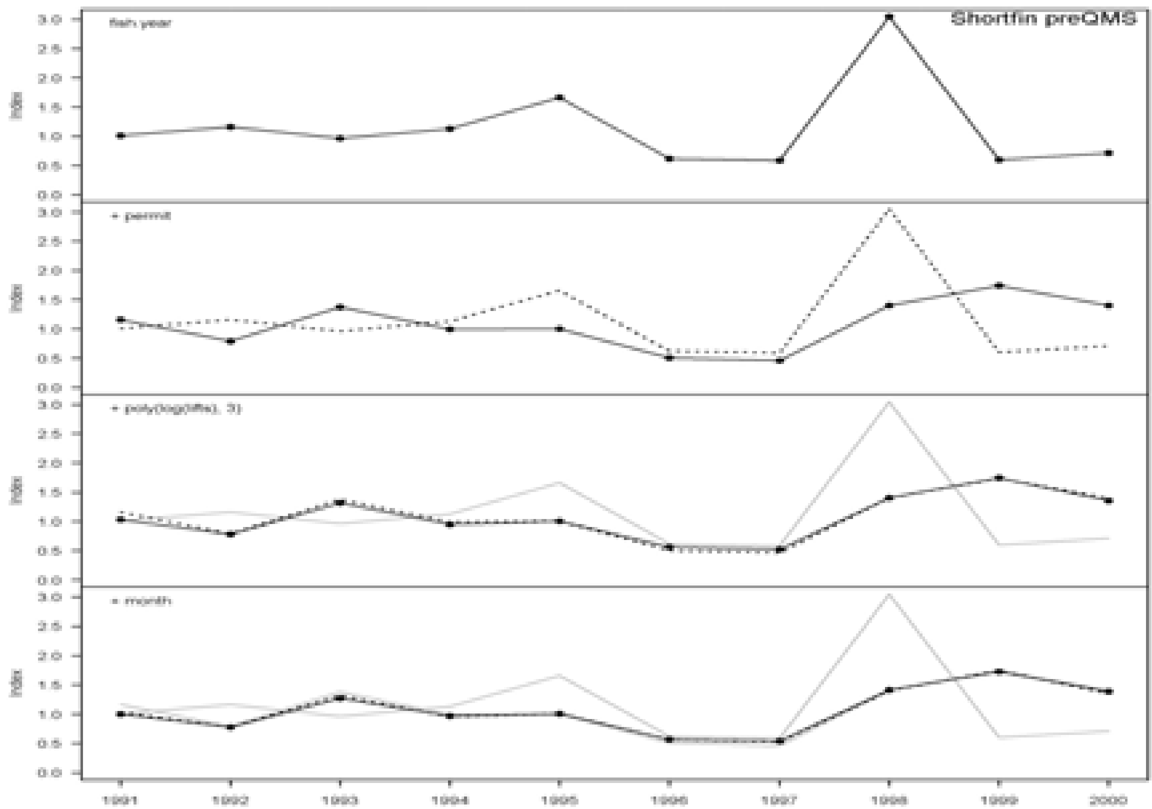

Figure F12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA15 (AX)).

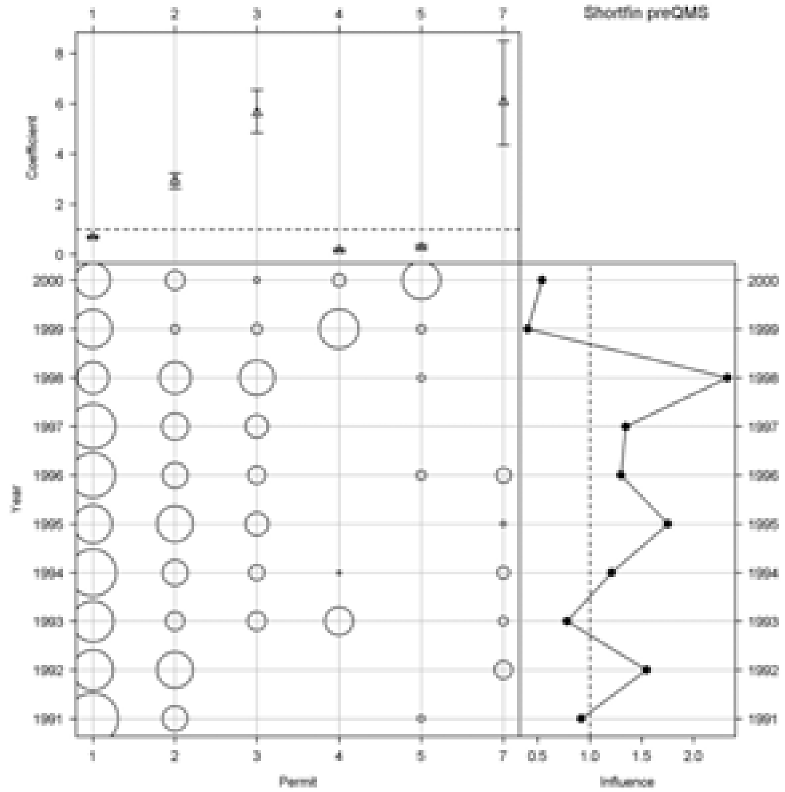

Figure F13: Influence of permit number for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

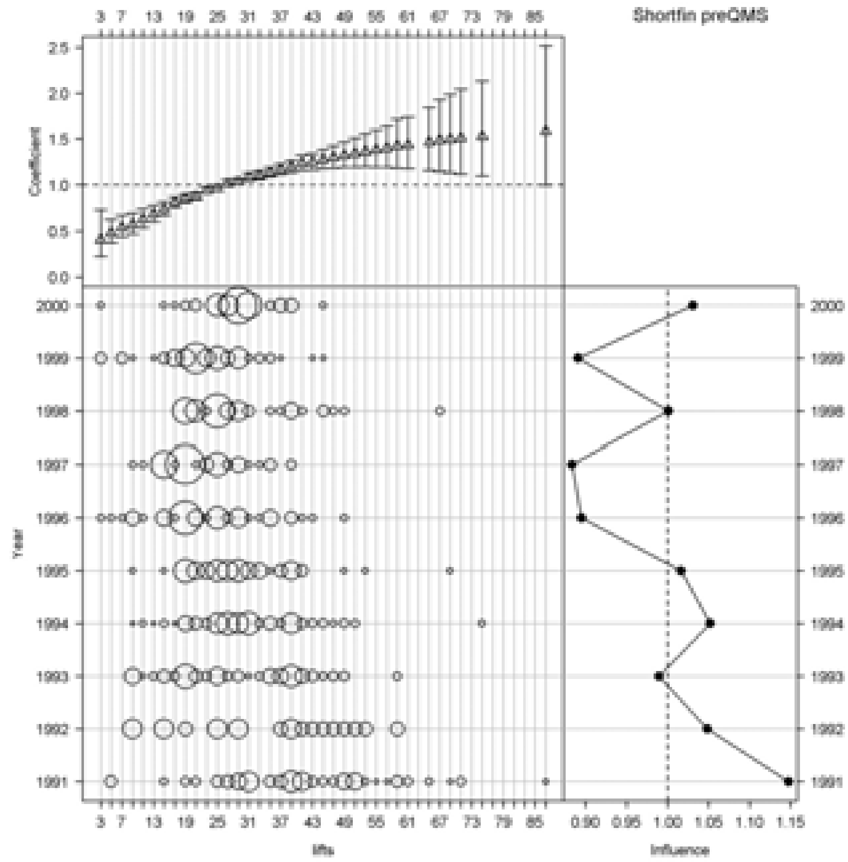

Figure F14: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

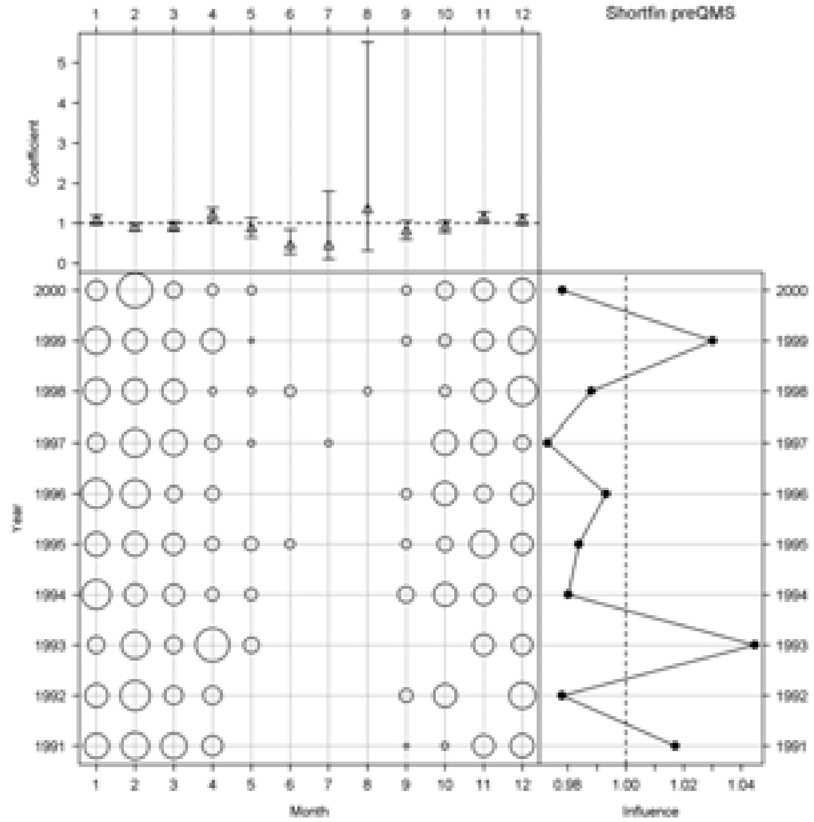

Figure F15: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

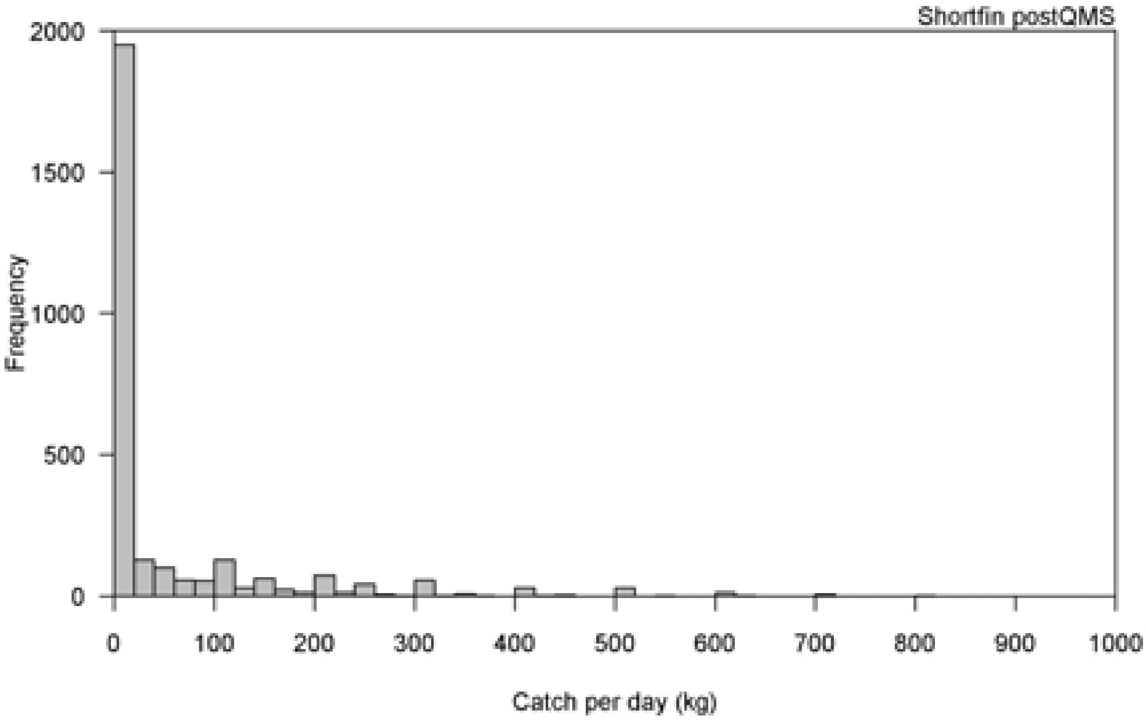

Figure F16: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

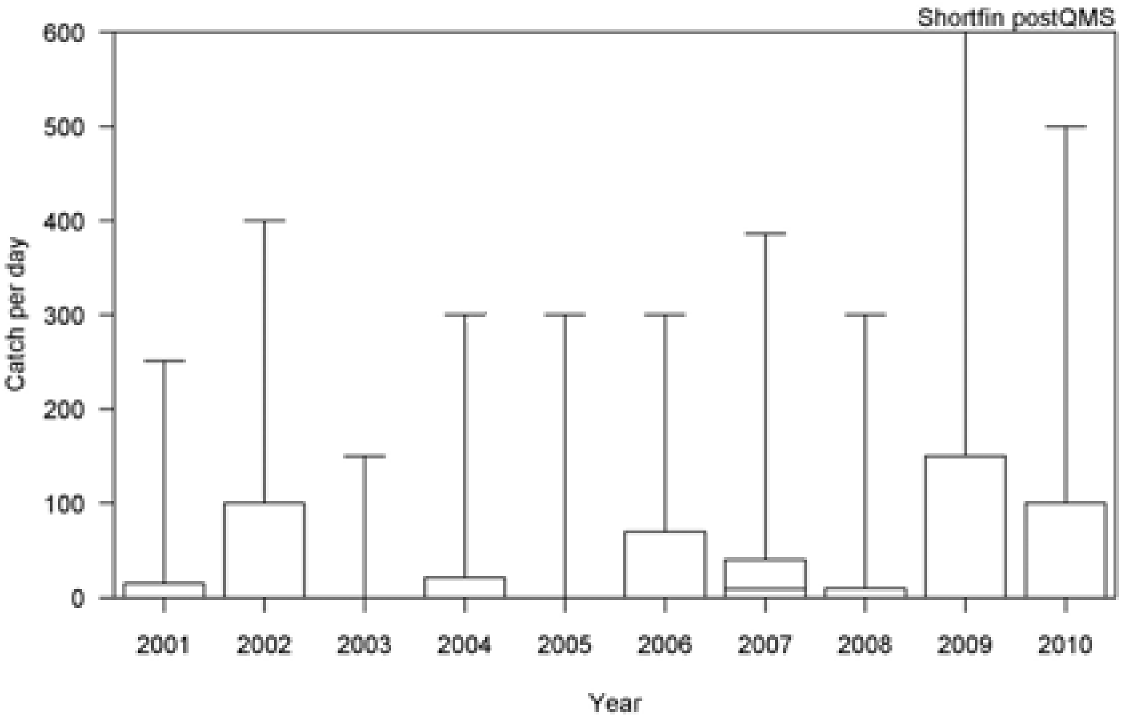

Figure F17: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA15 (AX)).

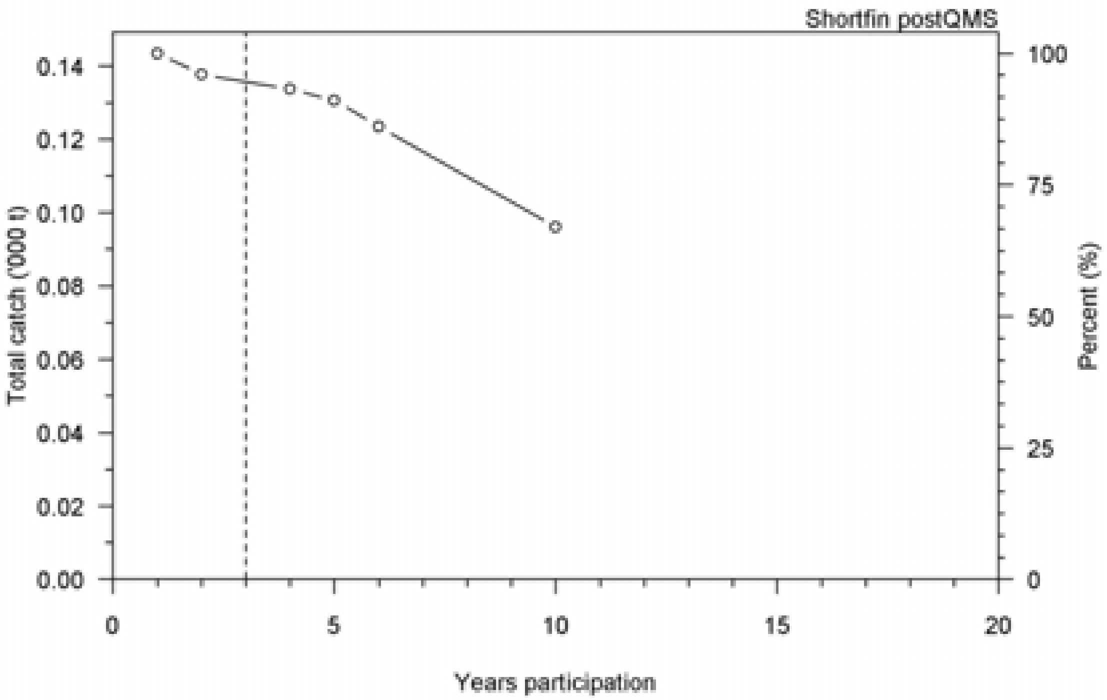

Figure F18: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA15 (AX)).

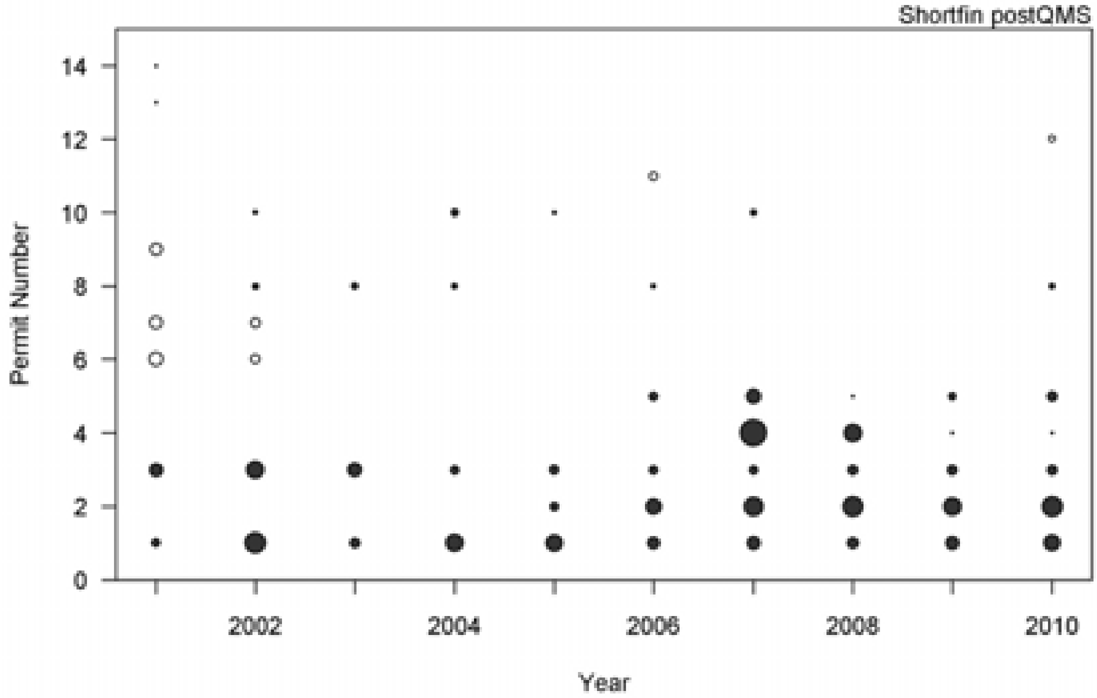

Figure F19: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA15 (AX)).

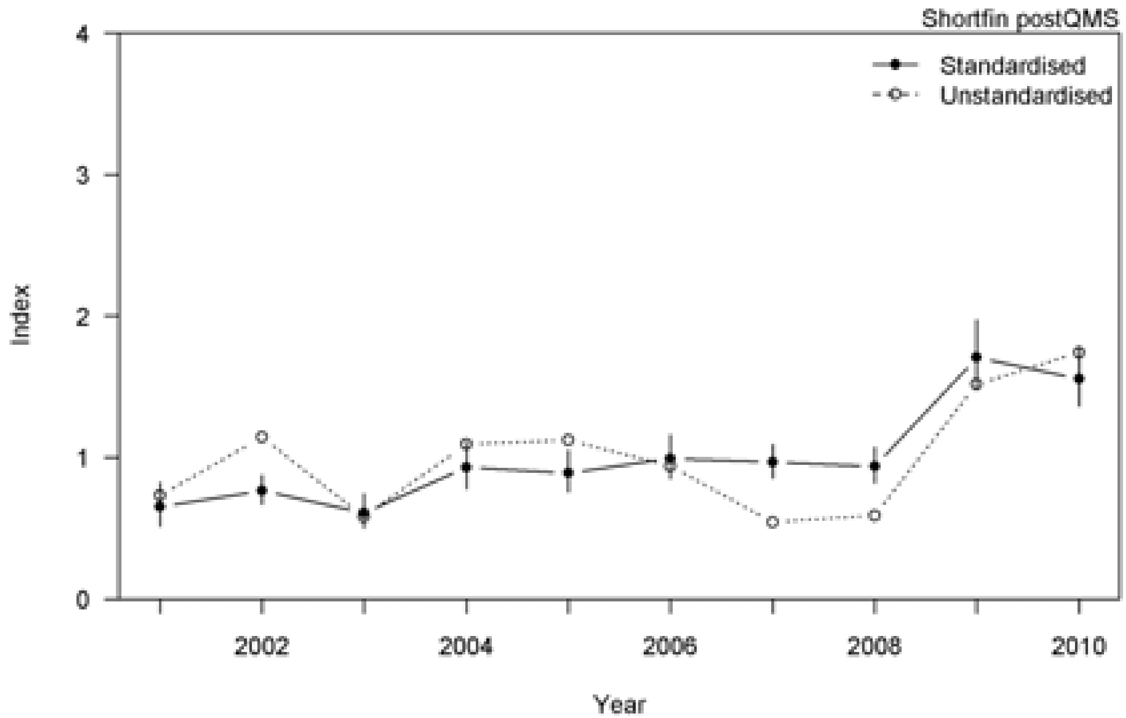

Figure F20: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers post-QMS eel CPUE model for the years 2000–01 to 2009–10 (ESA15 (AX)).

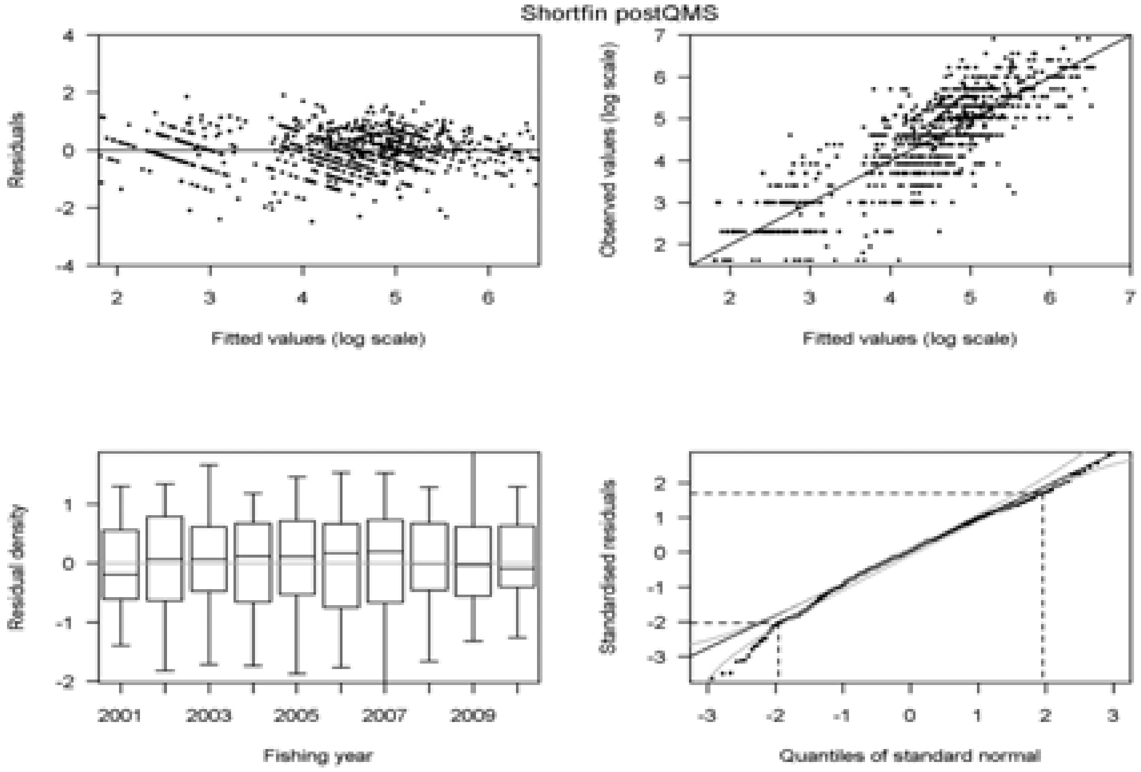

Figure F21: Residual diagnostic plots for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA15 (AX)).

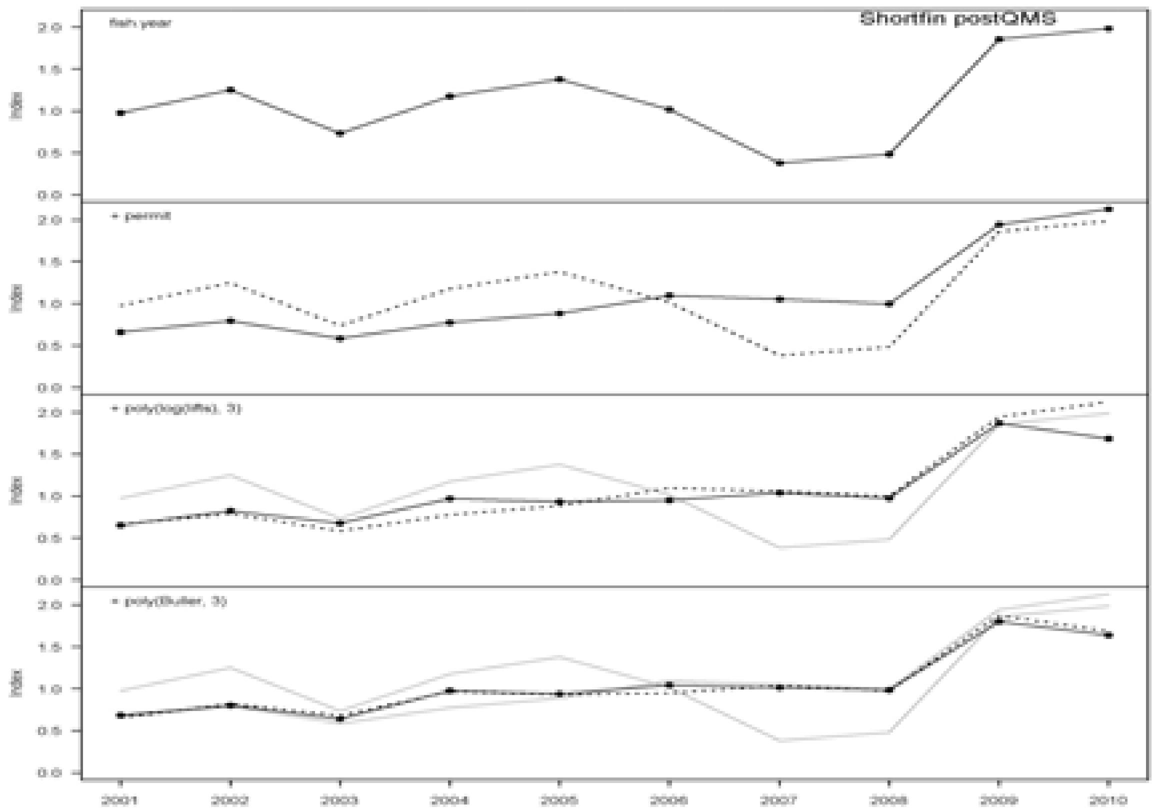

Figure F22: Step plot for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA15 (AX)).

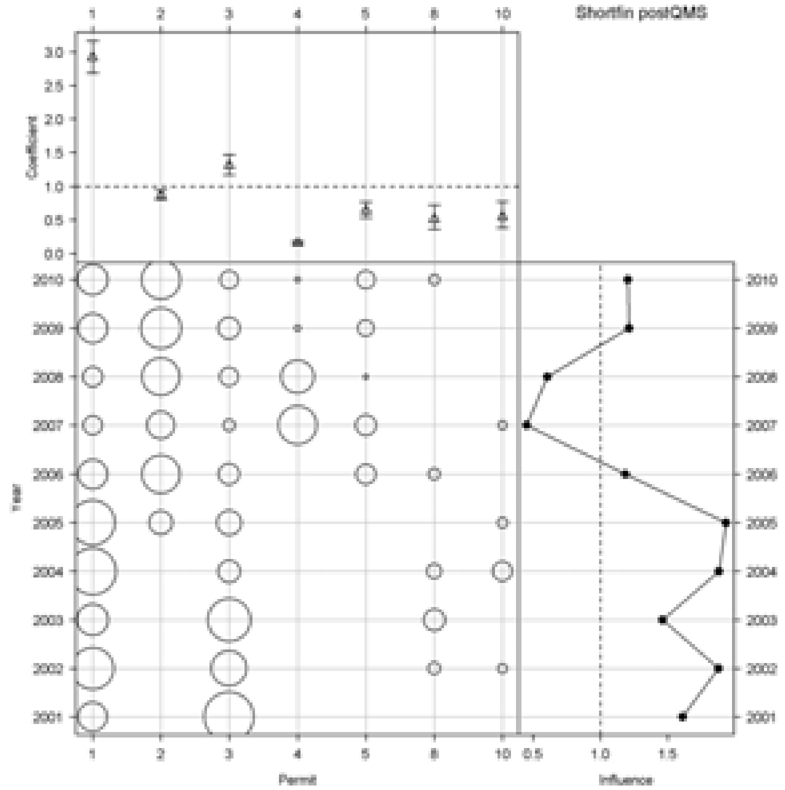

Figure F23: Influence of permit number for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

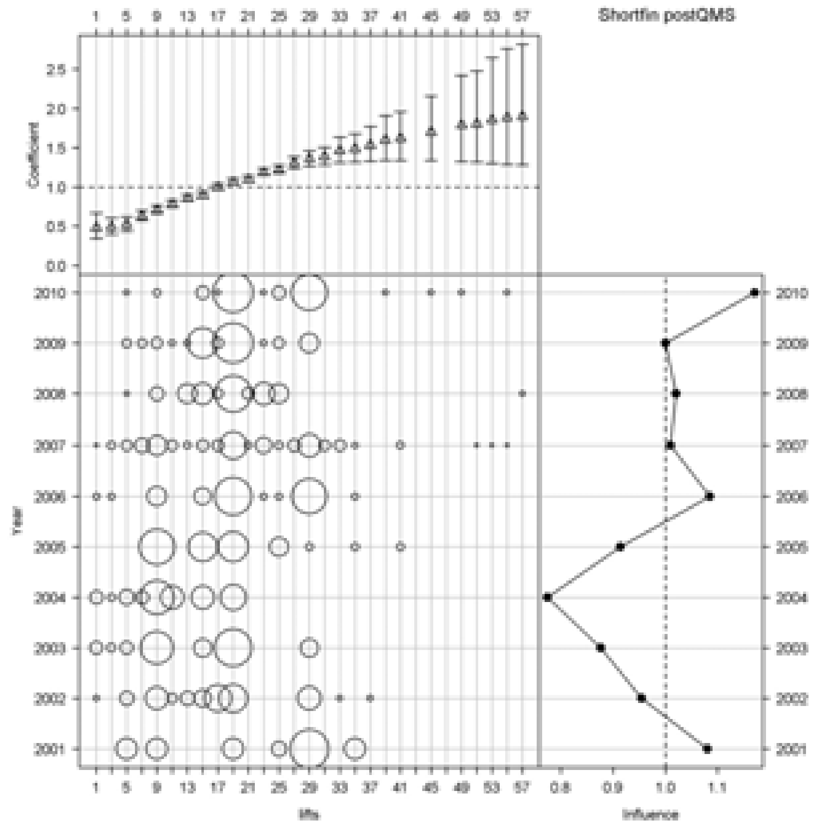

Figure F24: Influence of lifts for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

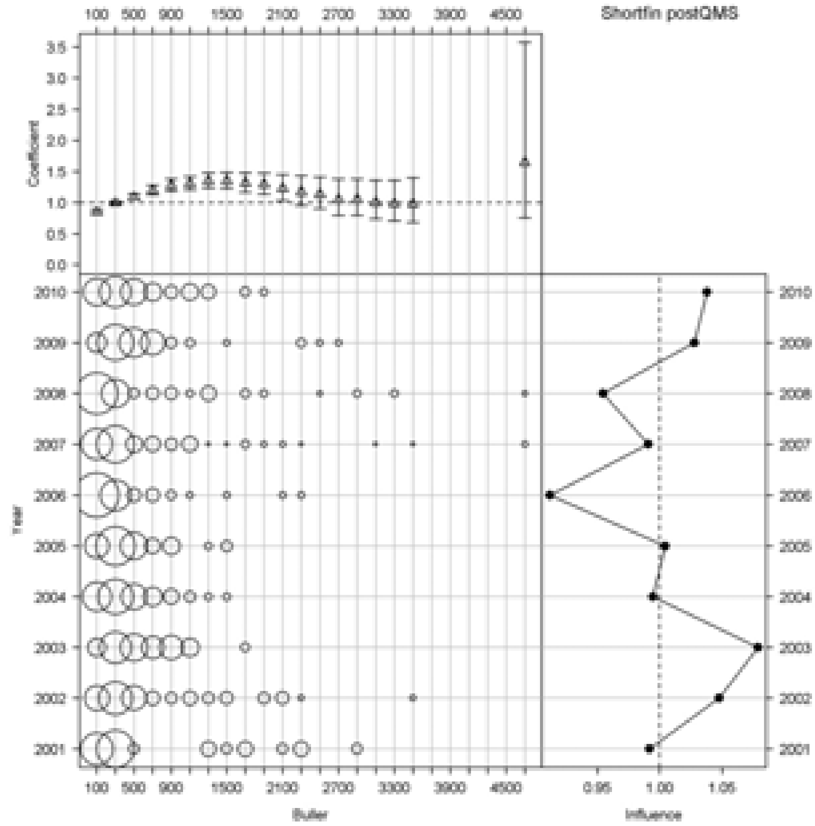

Figure F25: Influence of Buller River flow for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

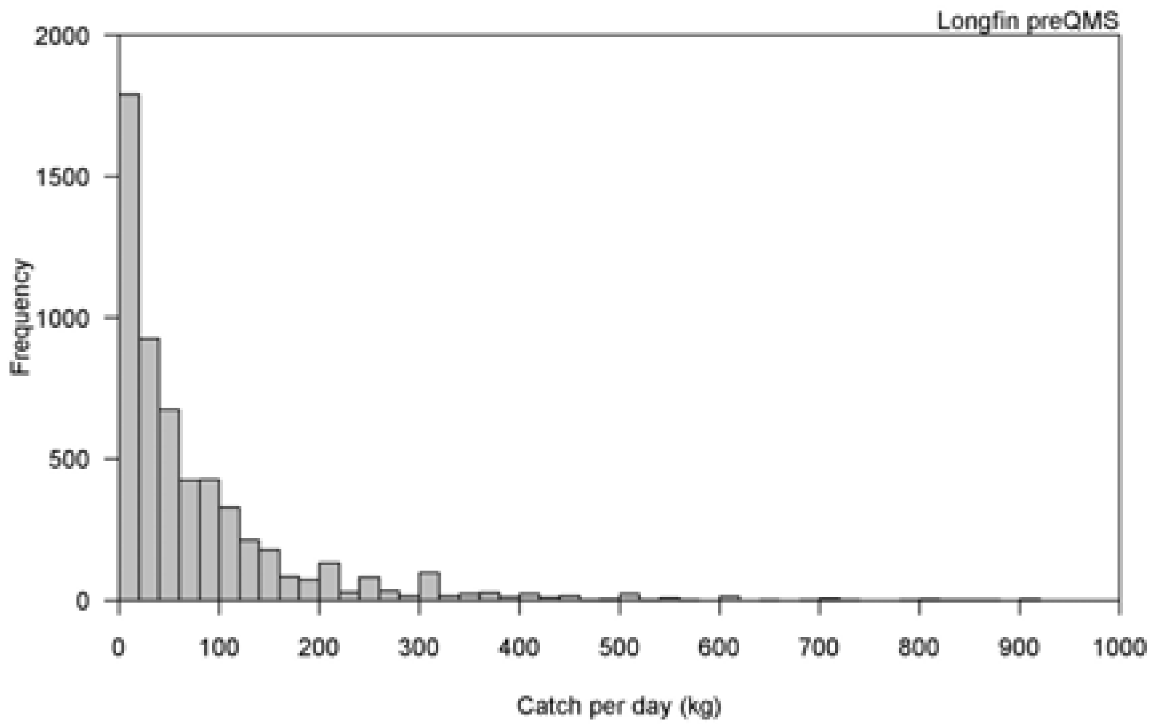

Figure F26: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

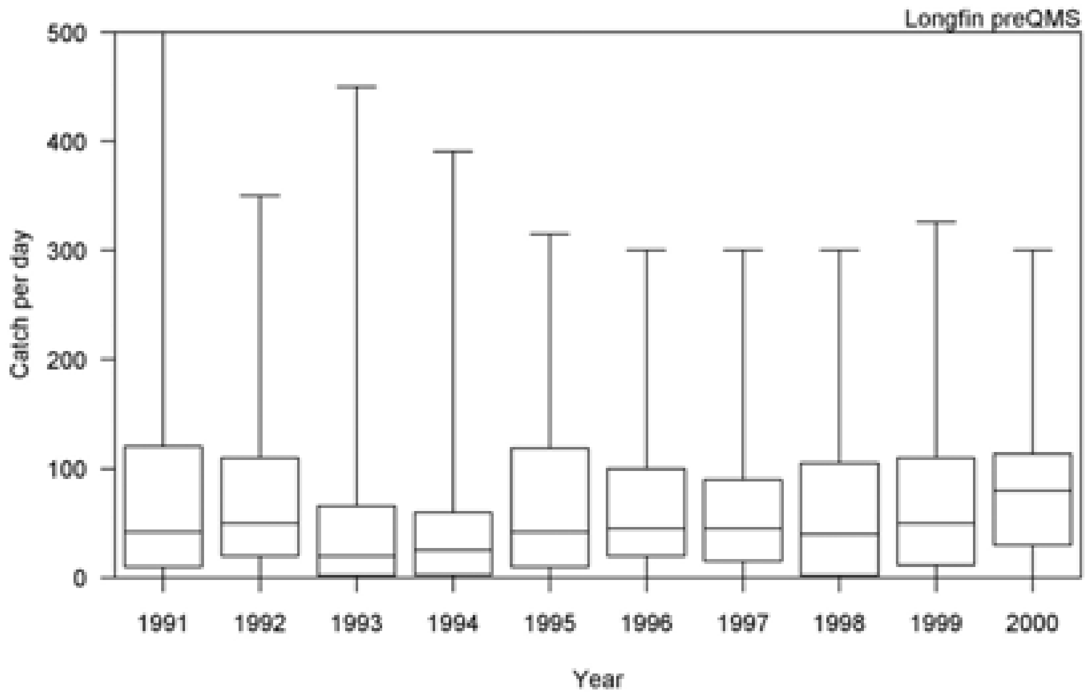

Figure F27: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA15 (AX)).

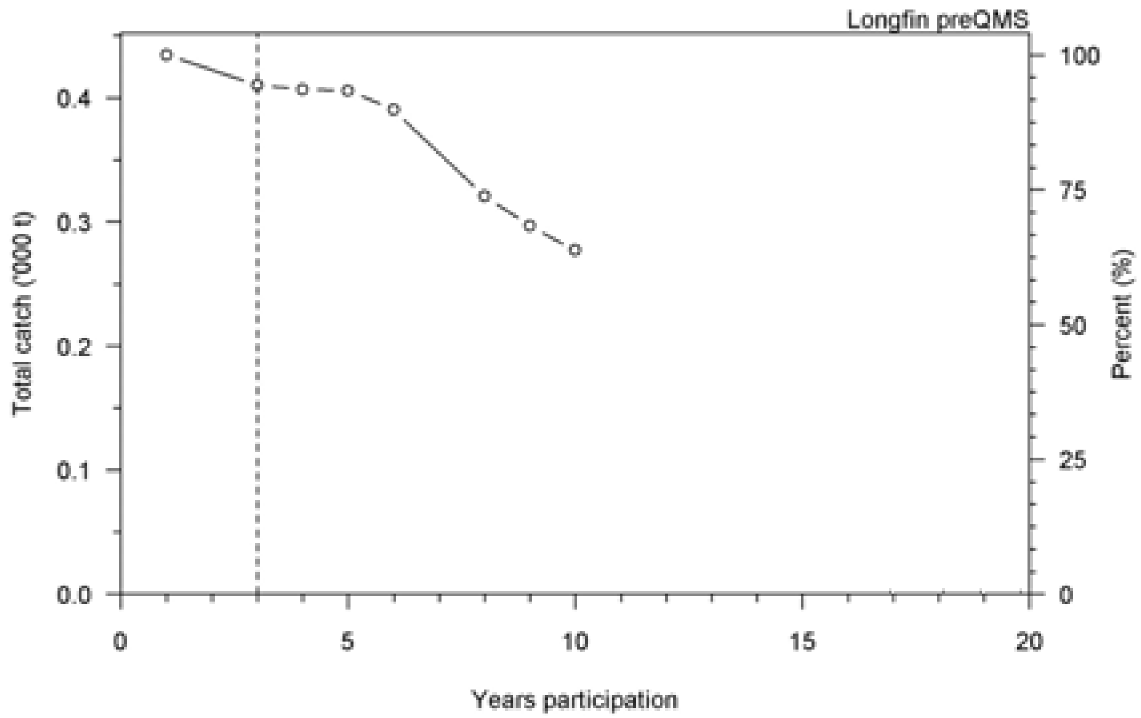

Figure F28: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA15 (AX)).

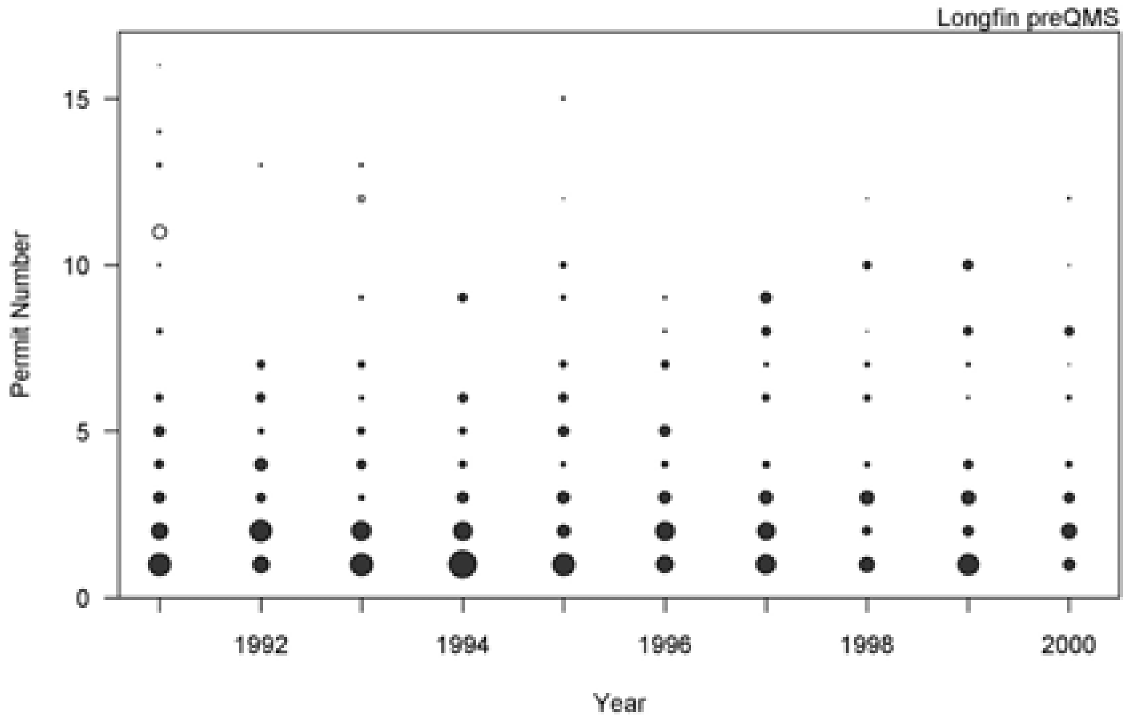

Figure F29: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA15 (AX)).

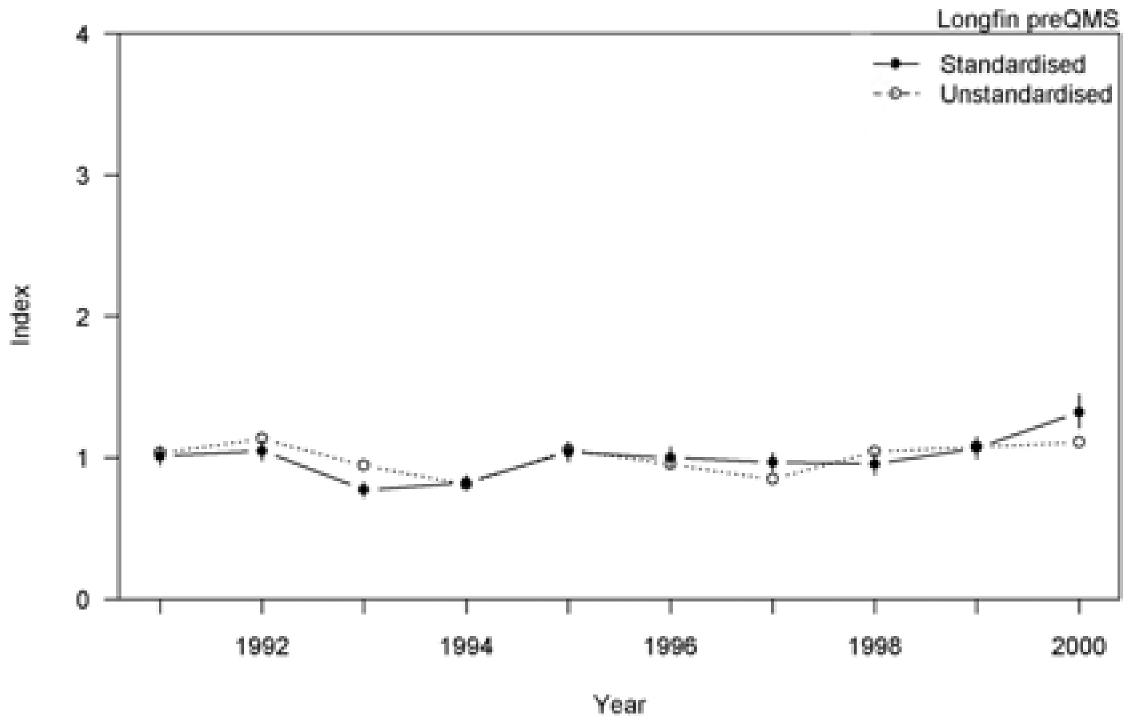

Figure F30: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA15 (AX)).

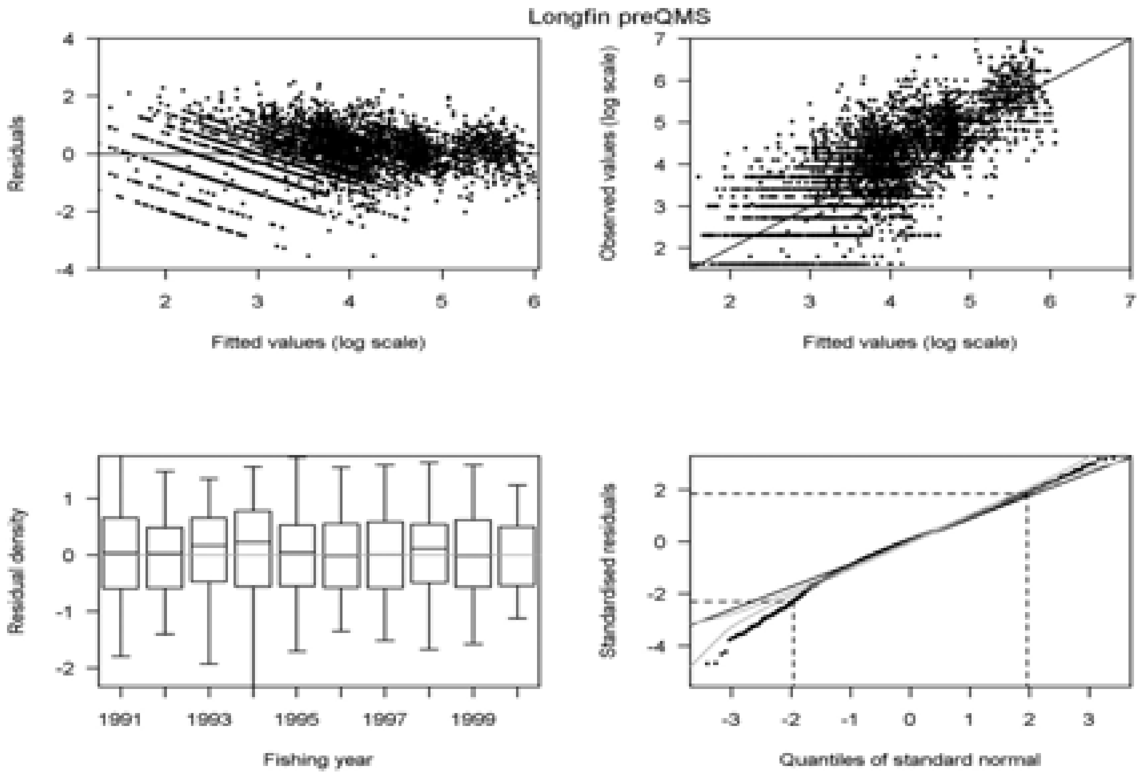

Figure F31: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA15 (AX)).

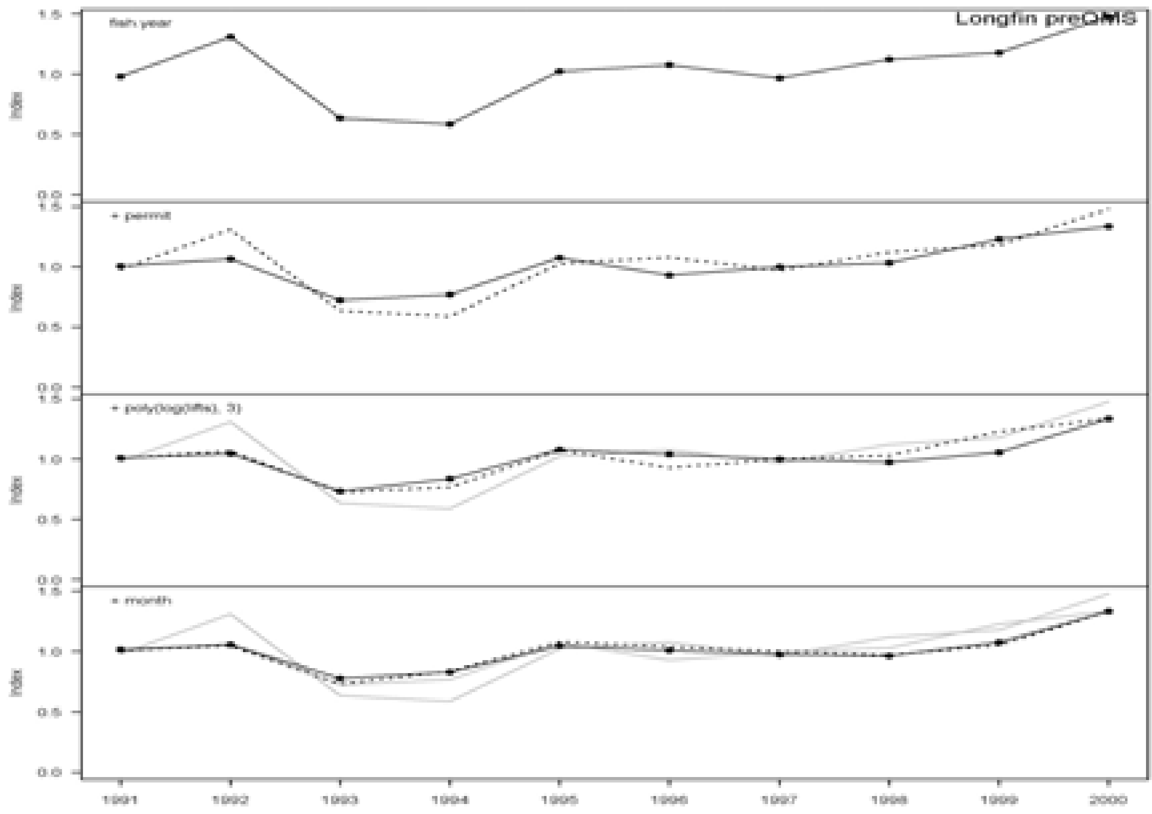

Figure F32: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA15 (AX)).

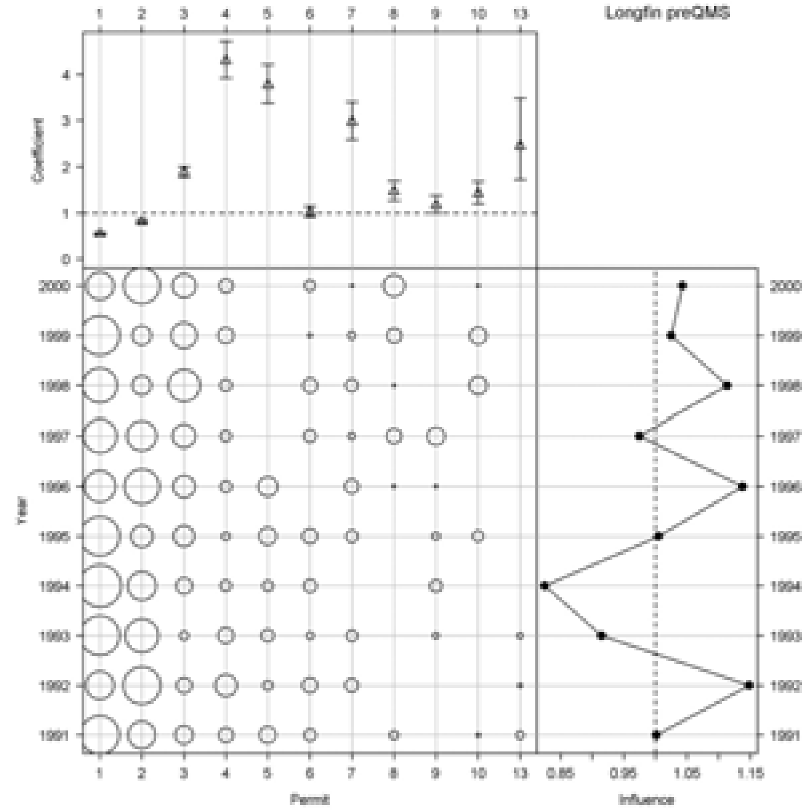

Figure F33: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

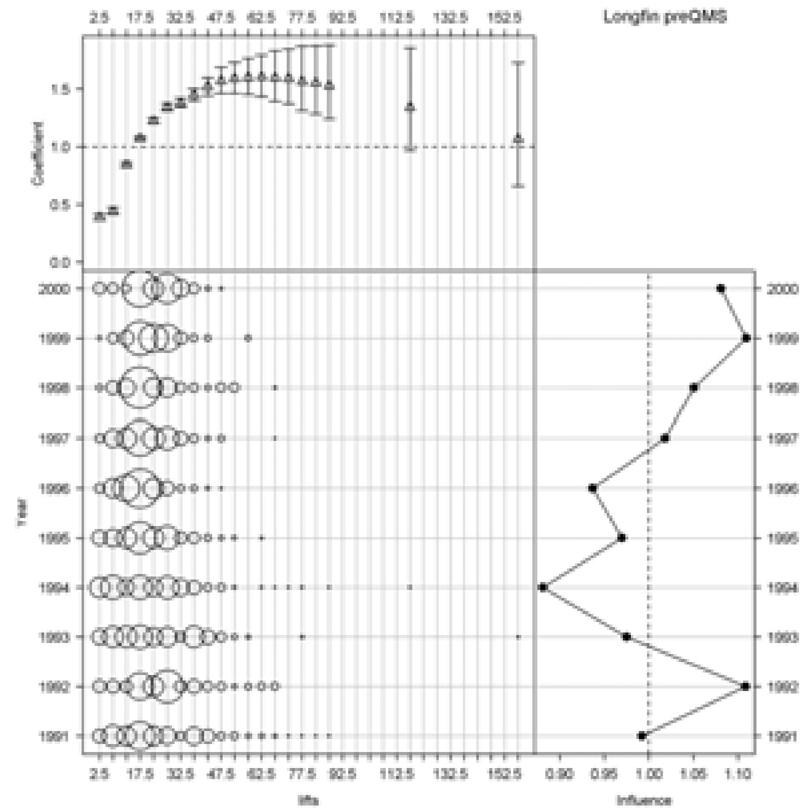

Figure F34: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

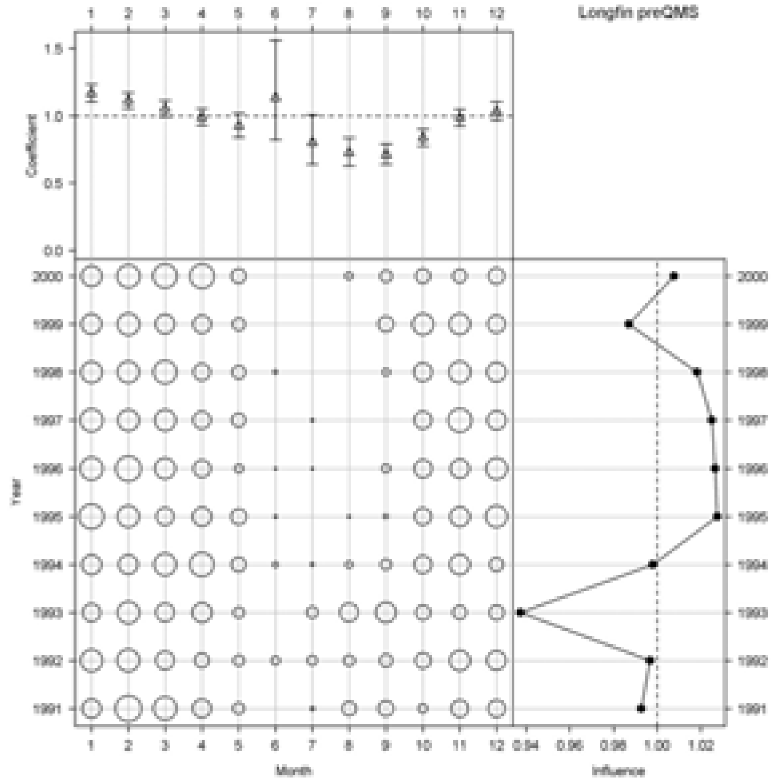

Figure F35: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA15 (AX)).

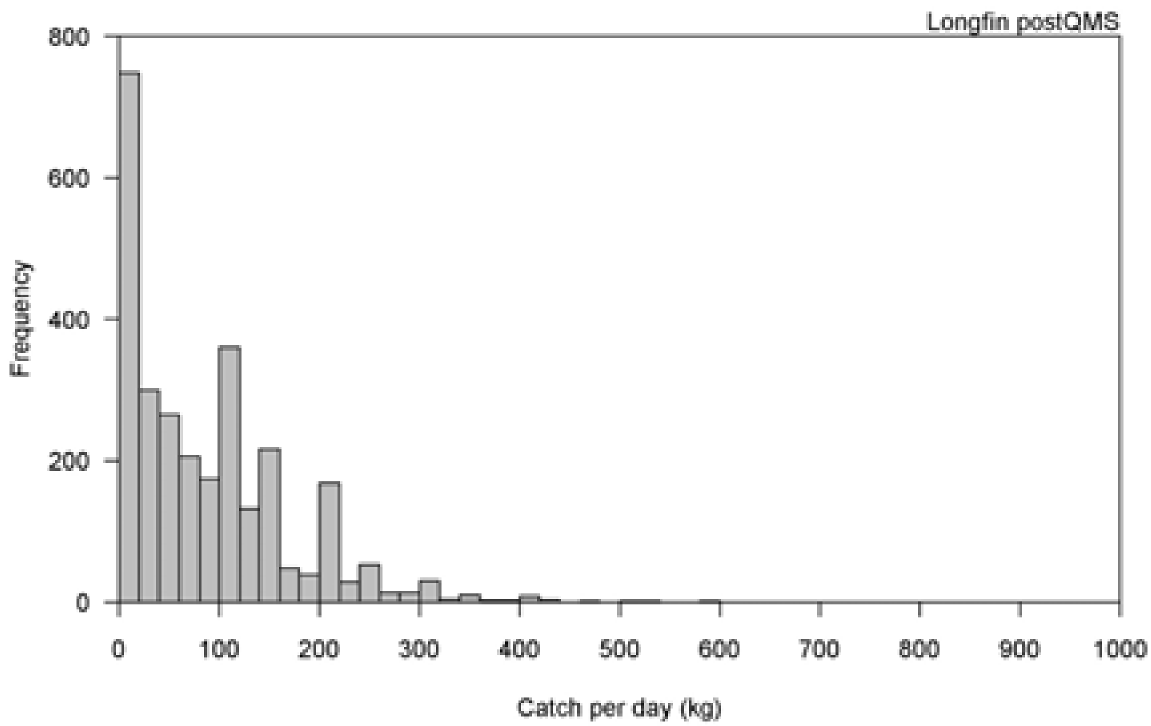

Figure F36: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

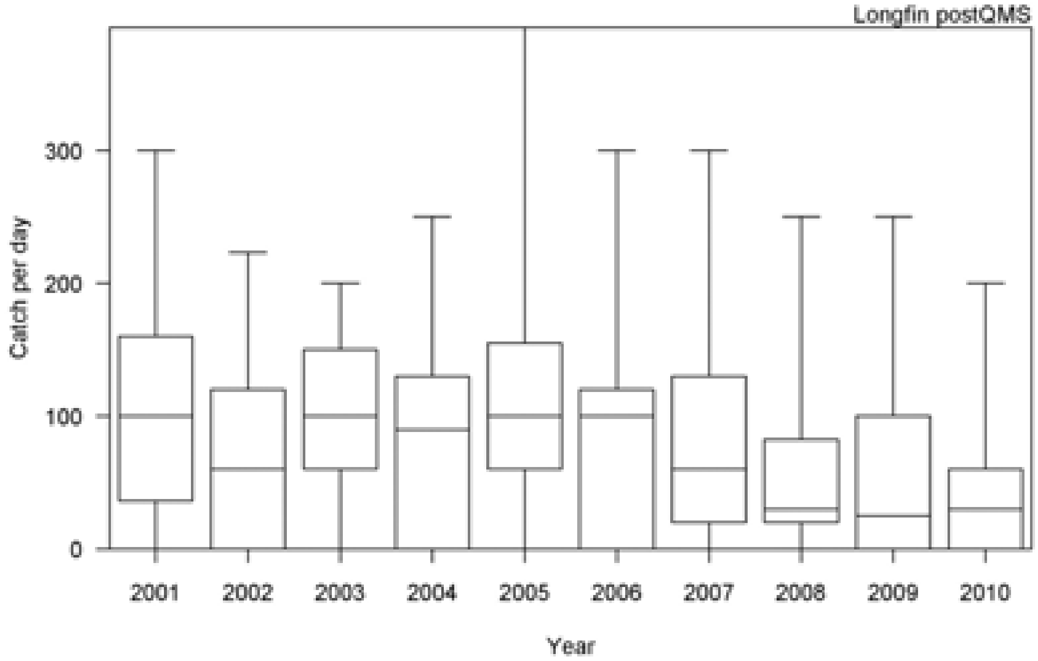

Figure F37: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA15 (AX)).

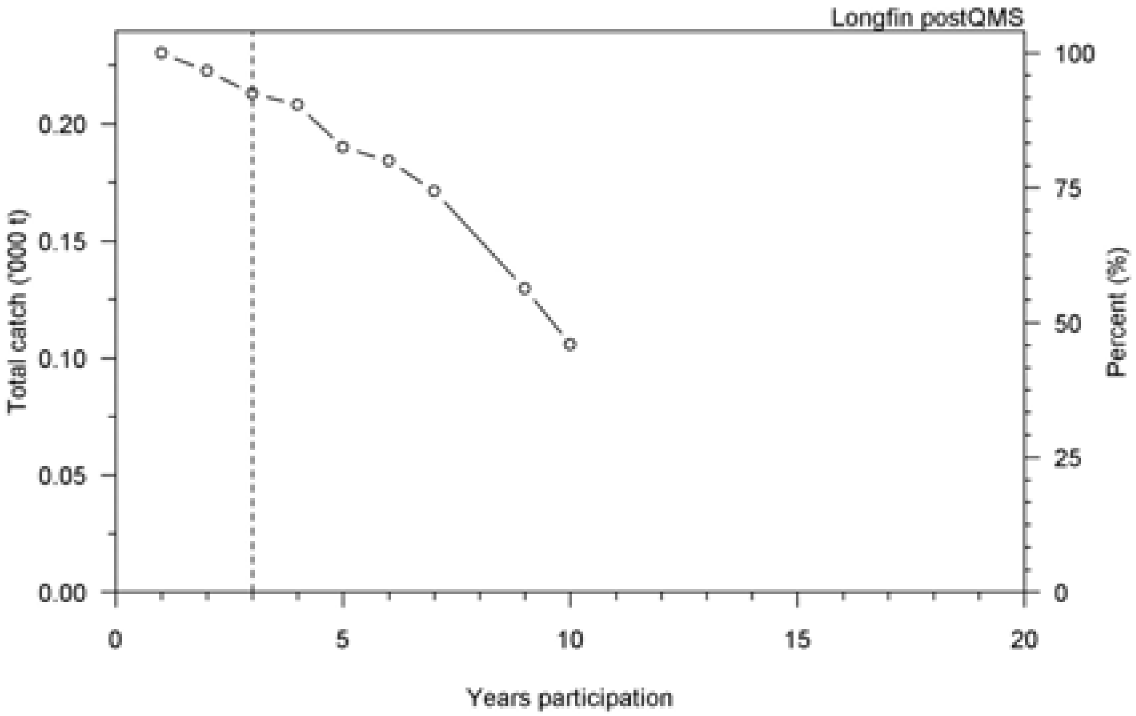

Figure F38: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA15 (AX)).

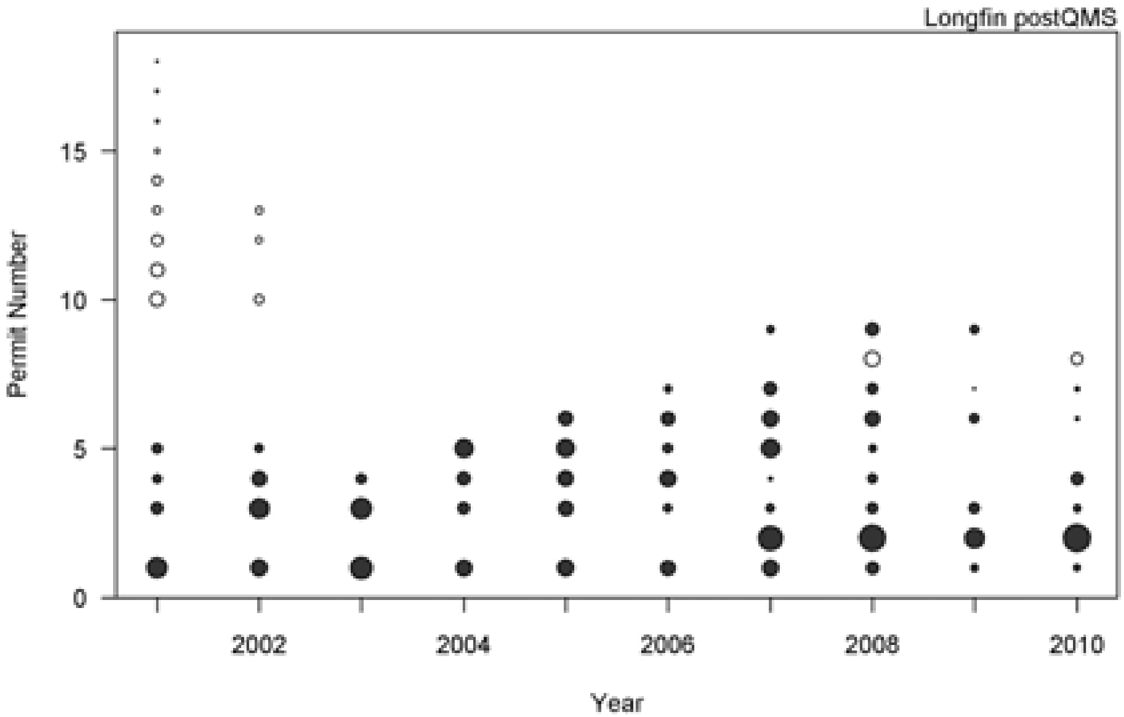

Figure F39: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA15 (AX)).

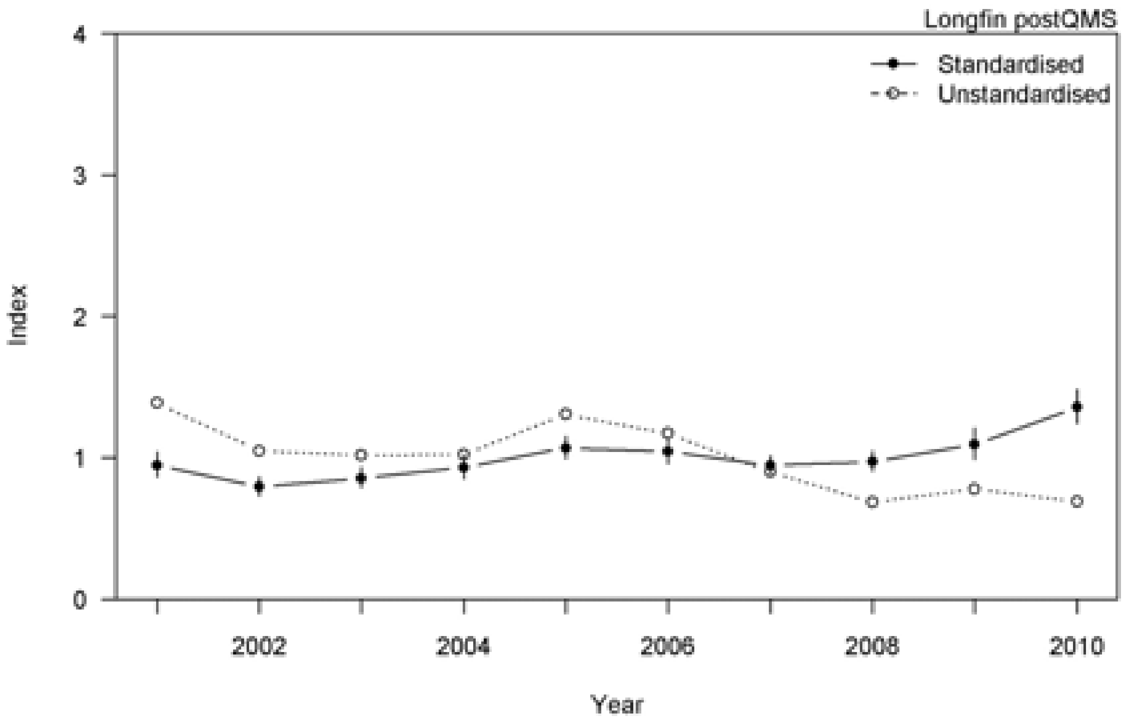

Figure F40: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers post-QMS eel CPUE model for the years 2000–01 to 2009–10 (ESA15 (AX)).

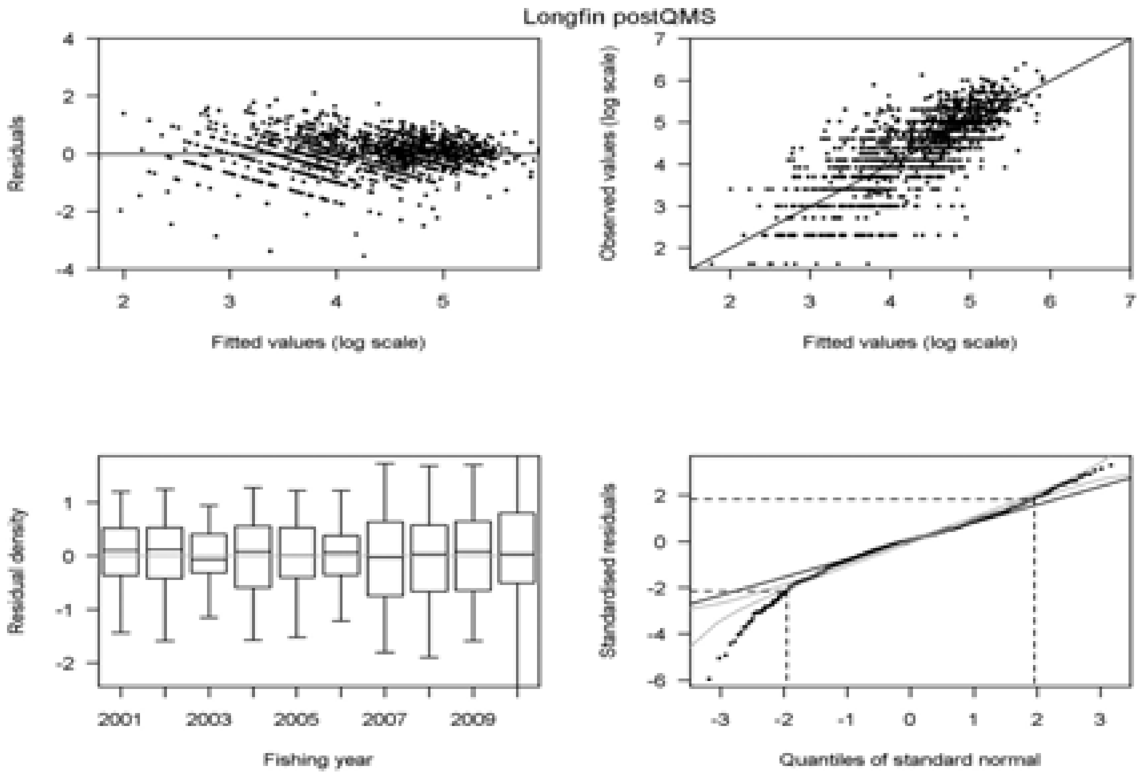

Figure F41: Residual diagnostic plots for the longfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA15 (AX)).

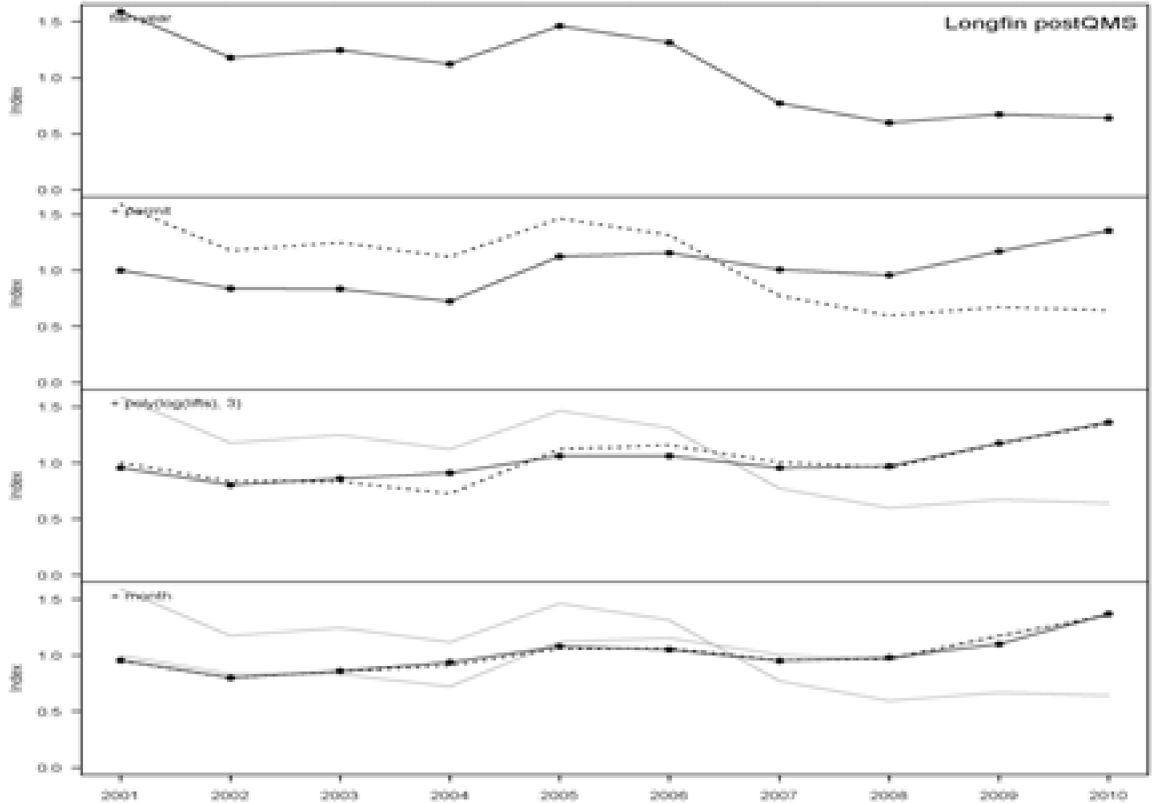

Figure F42: Step plot for the longfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA15 (AX)).

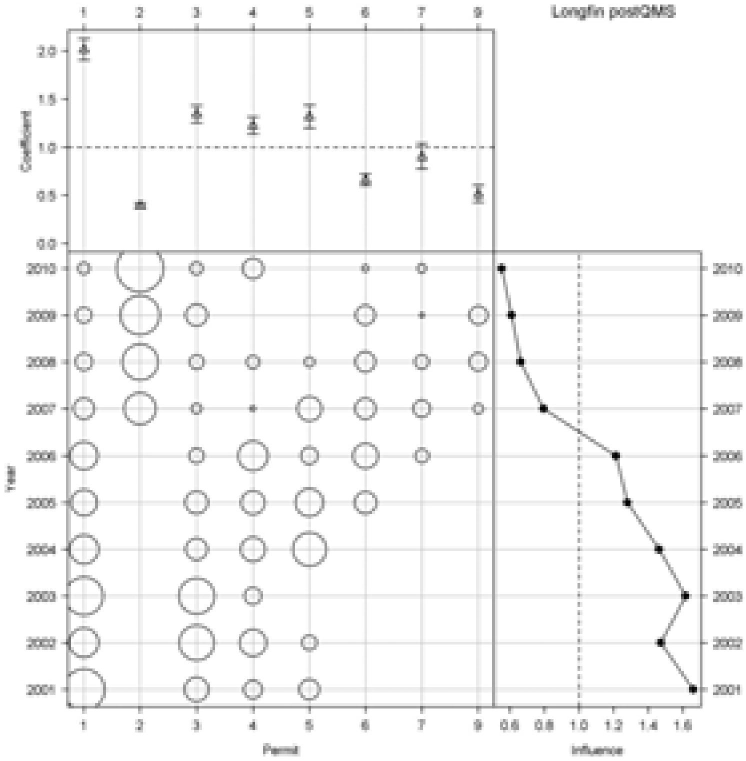

Figure F43: Influence of permit number for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

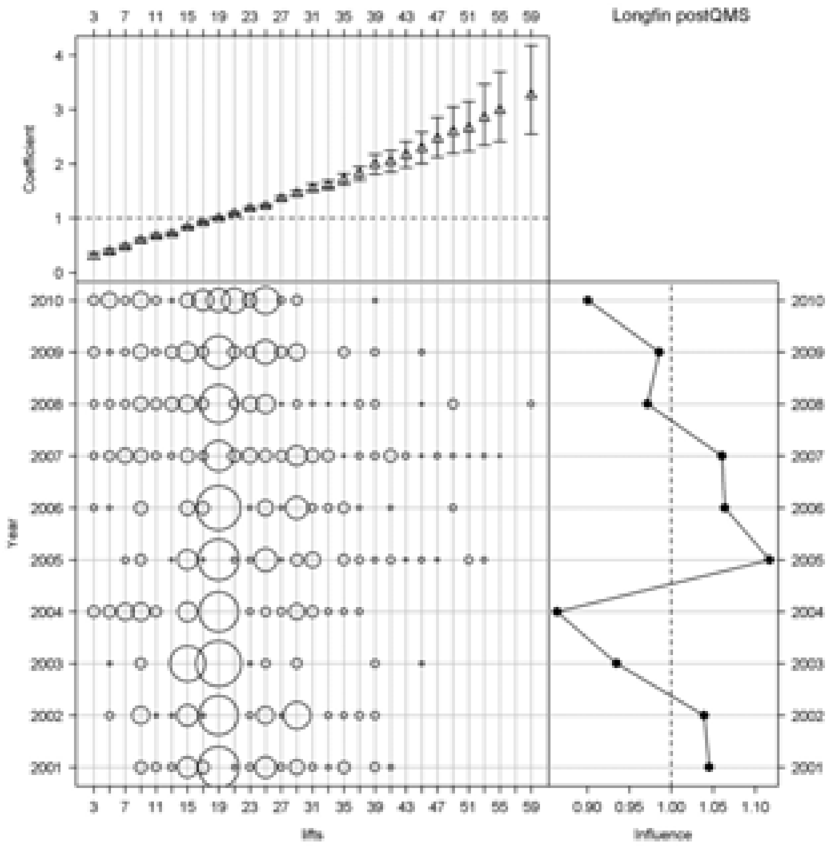

Figure F44: Influence of lifts for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

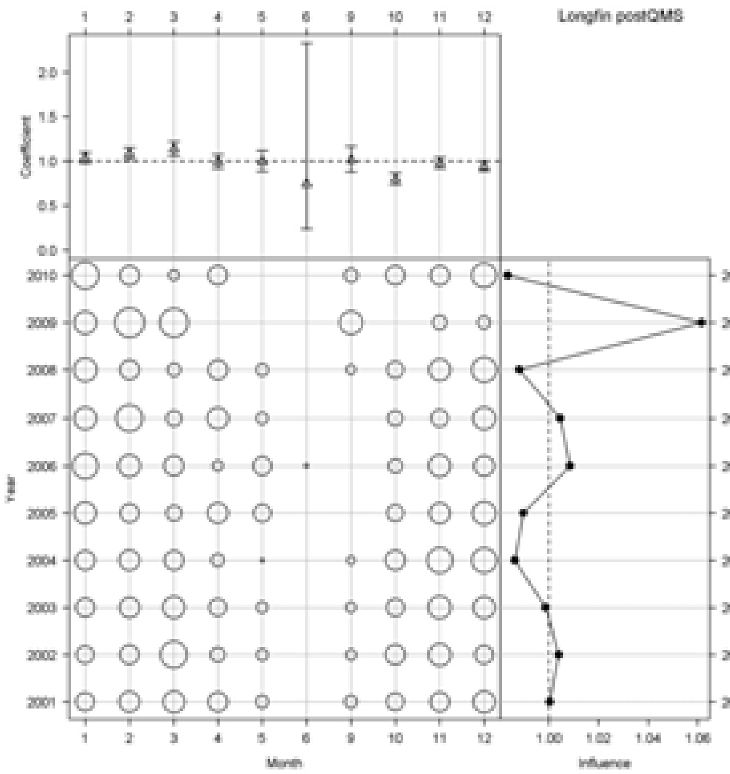

Figure F45: Influence of month for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA15 (AX)).

Appendix G: ESA 19 (AV).

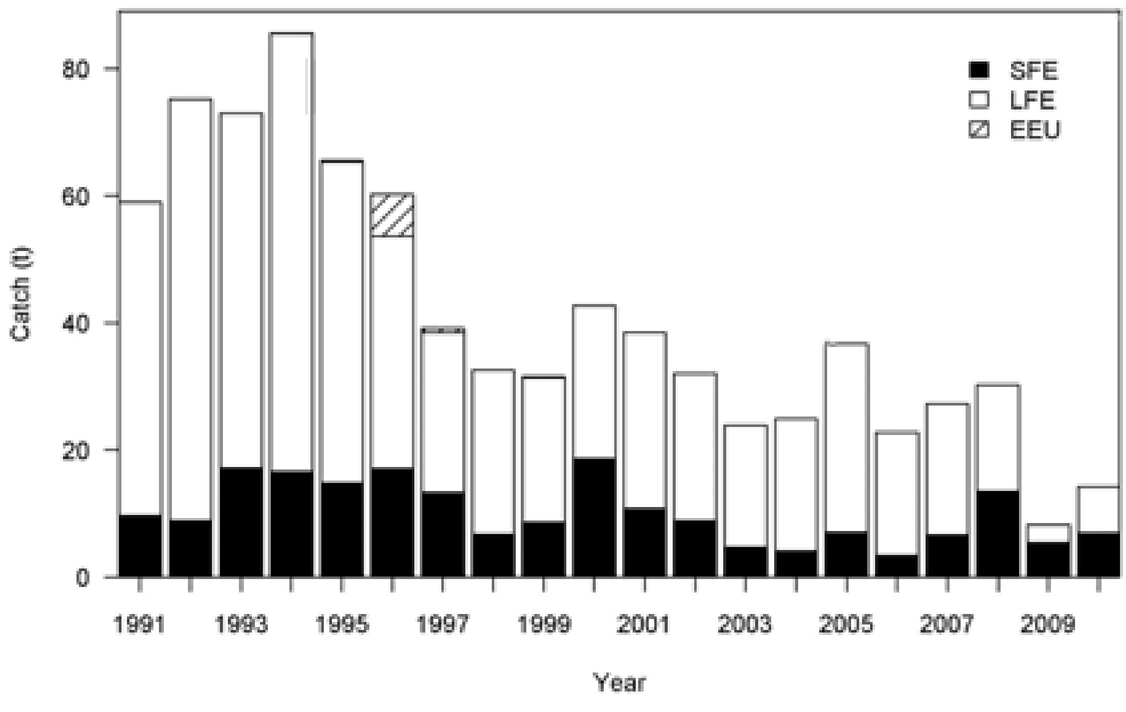

Figure G1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA19 (AV)).

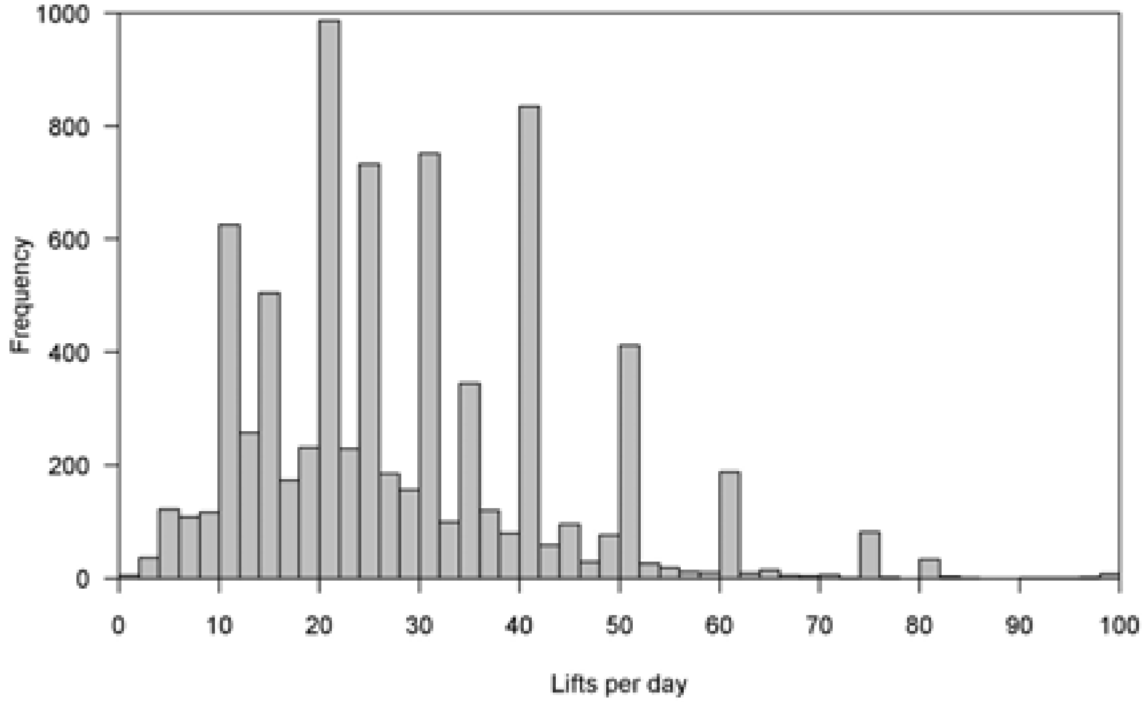

Figure G2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA19 (AV)).

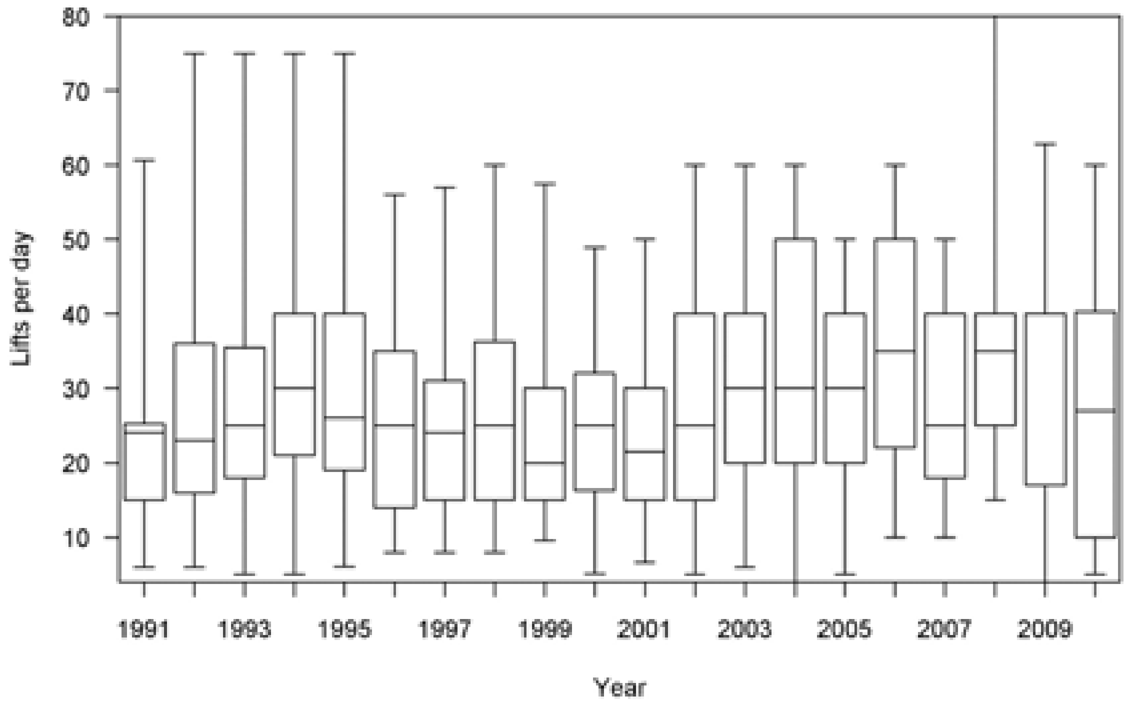

Figure G3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA19 (AV)).

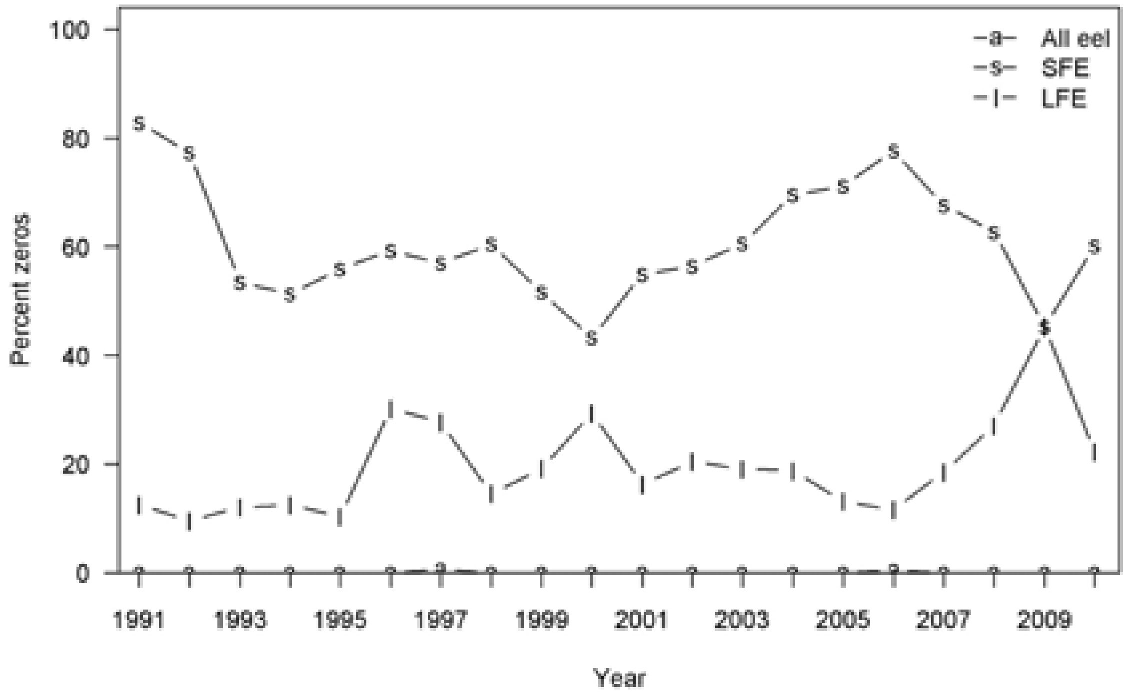

Figure G4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA19 (AV)).

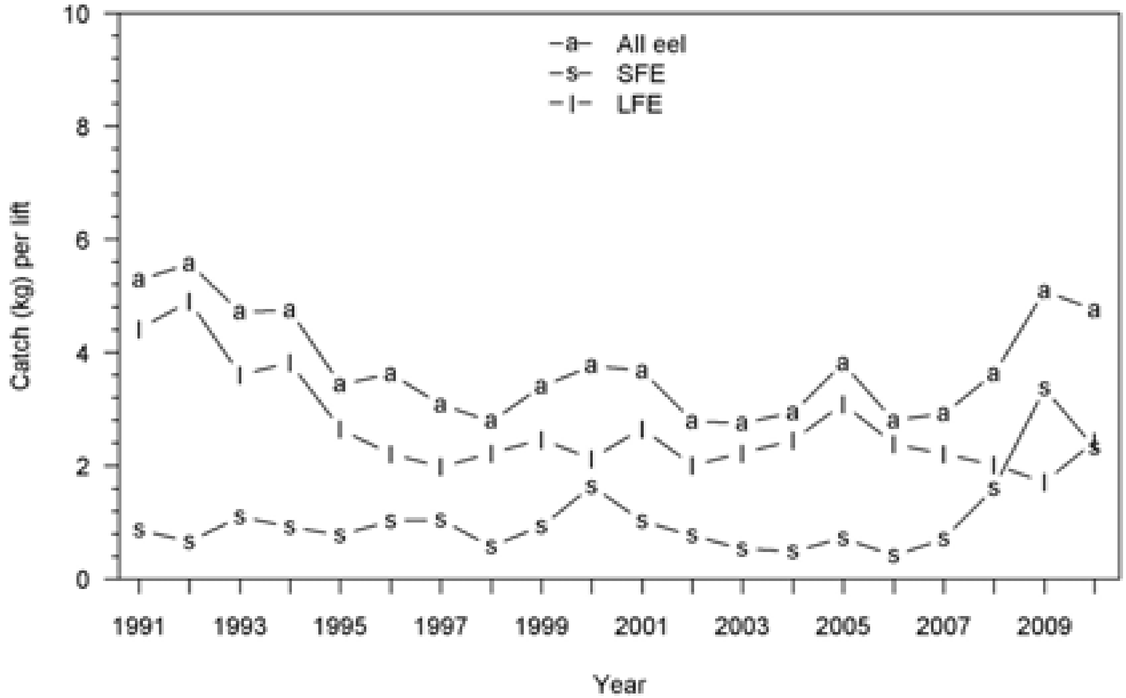

Figure G5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA19 (AV)).

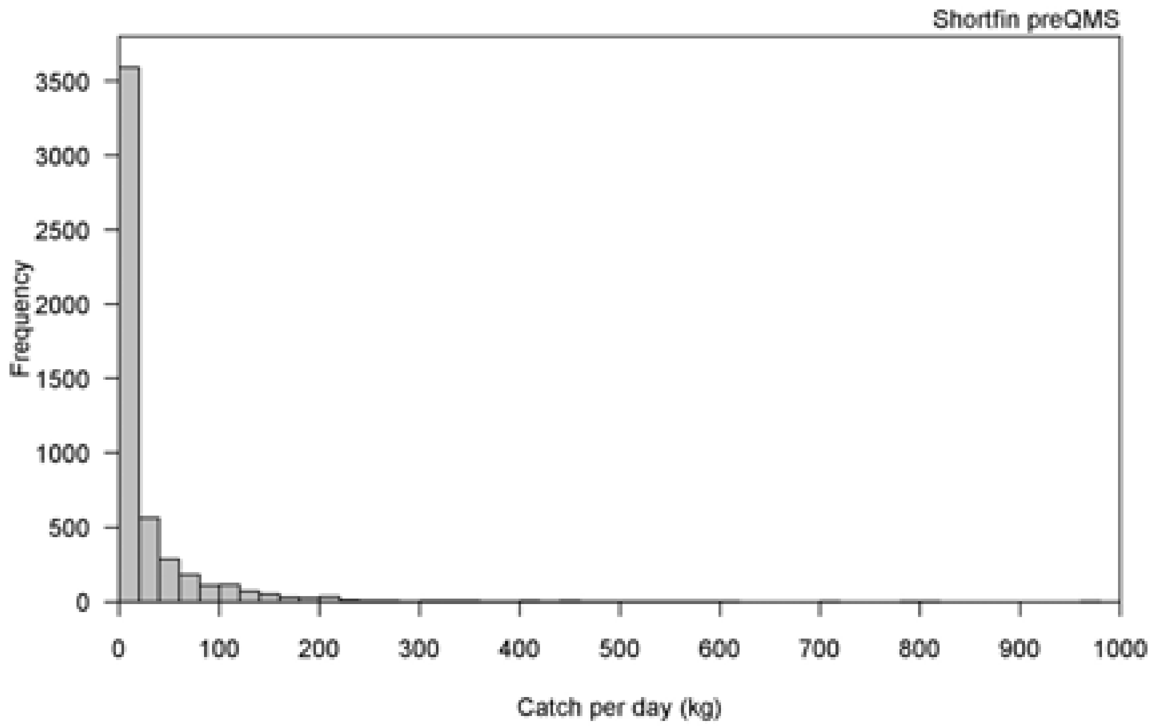

Figure G6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

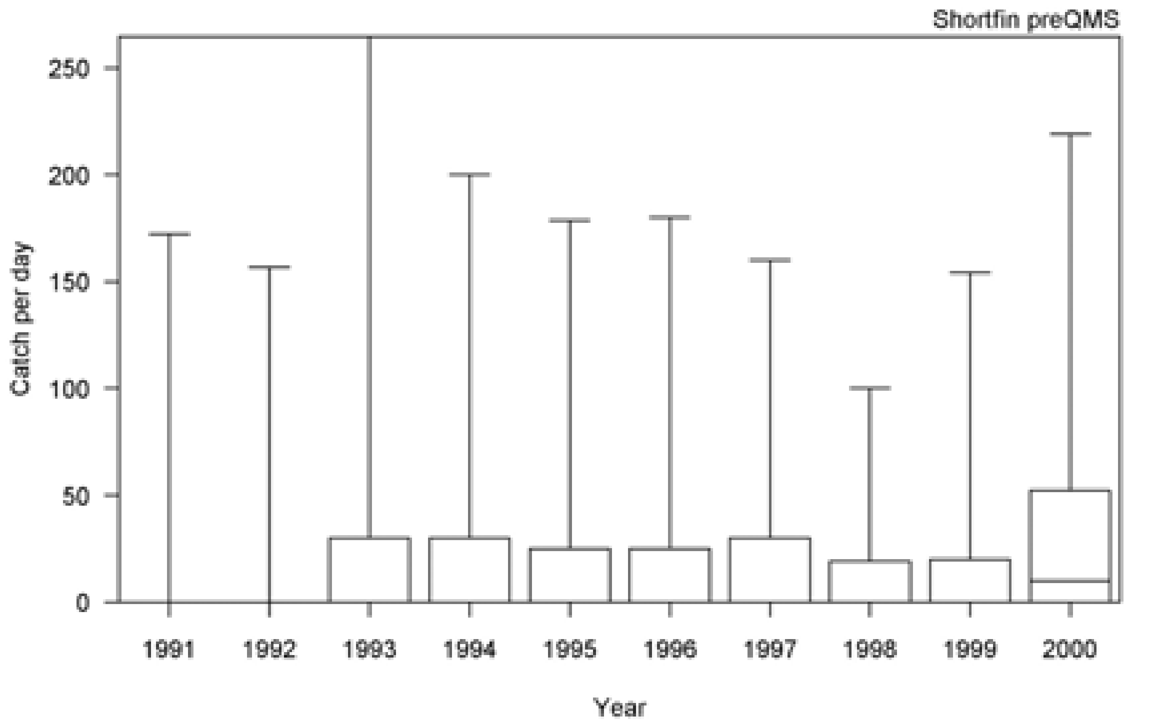

Figure G7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA19 (AV)).

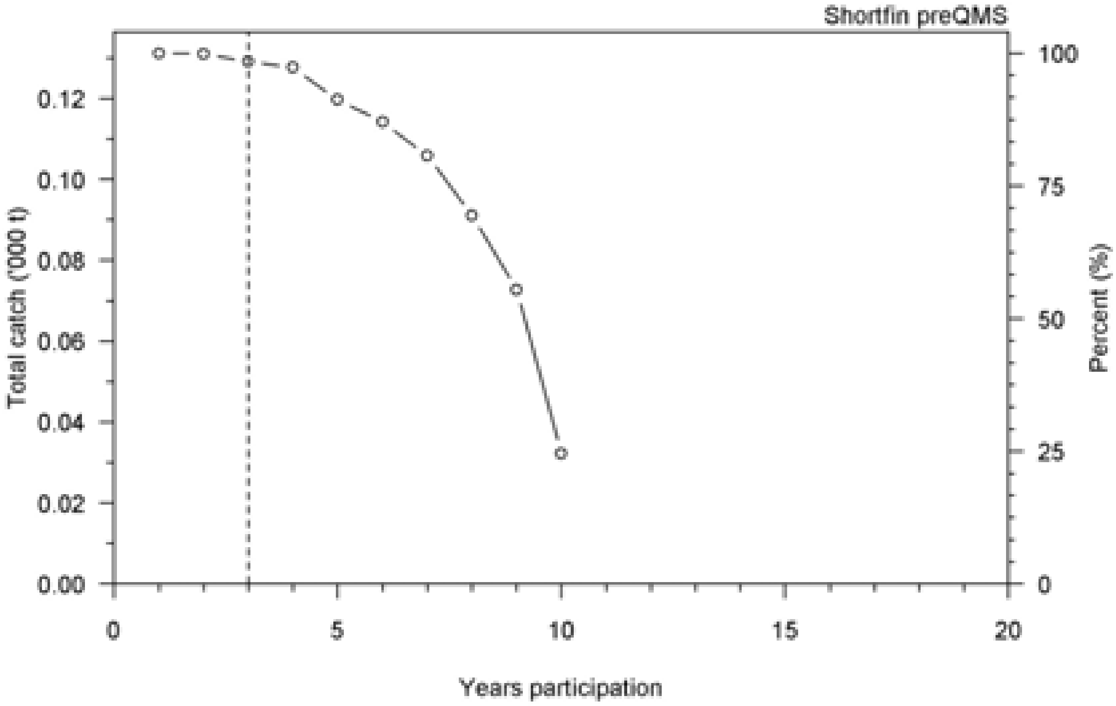

Figure G8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA19 (AV)).

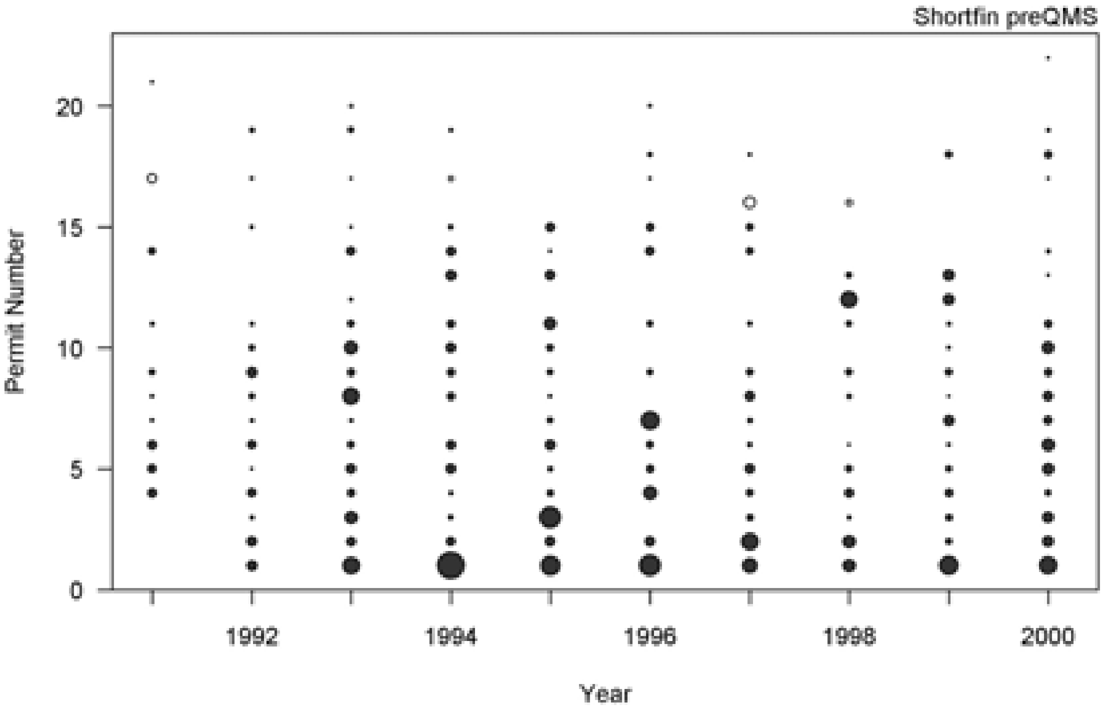

Figure G9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA19 (AV)).

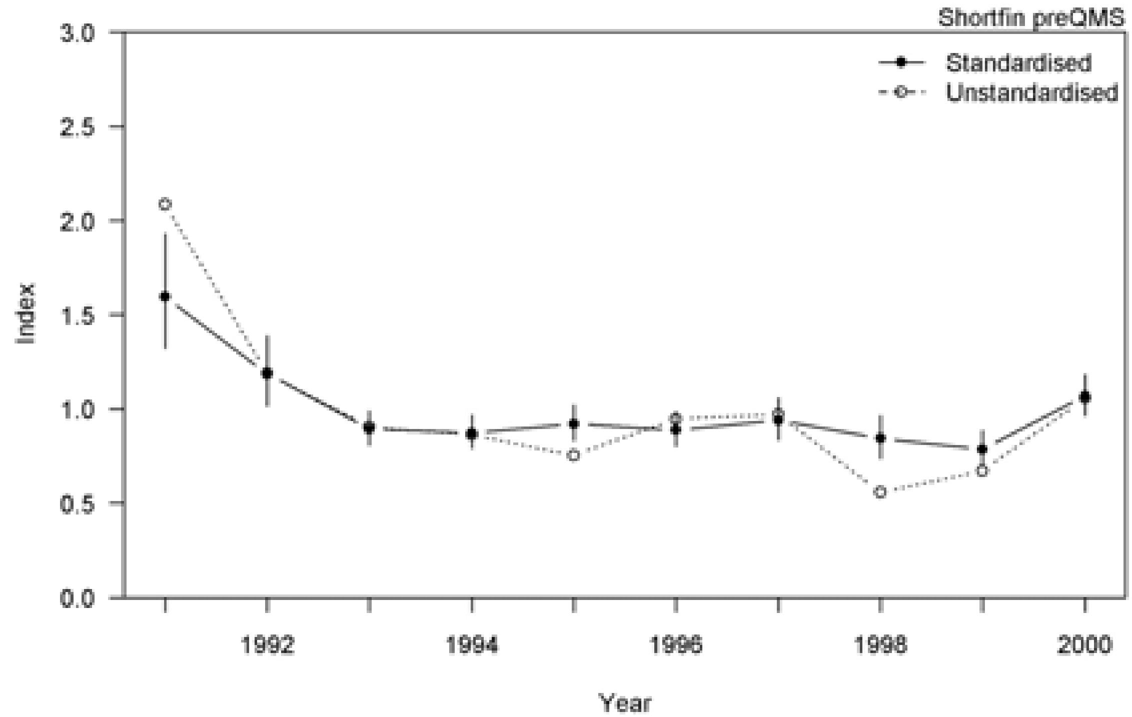

Figure G10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA19 (AV)).

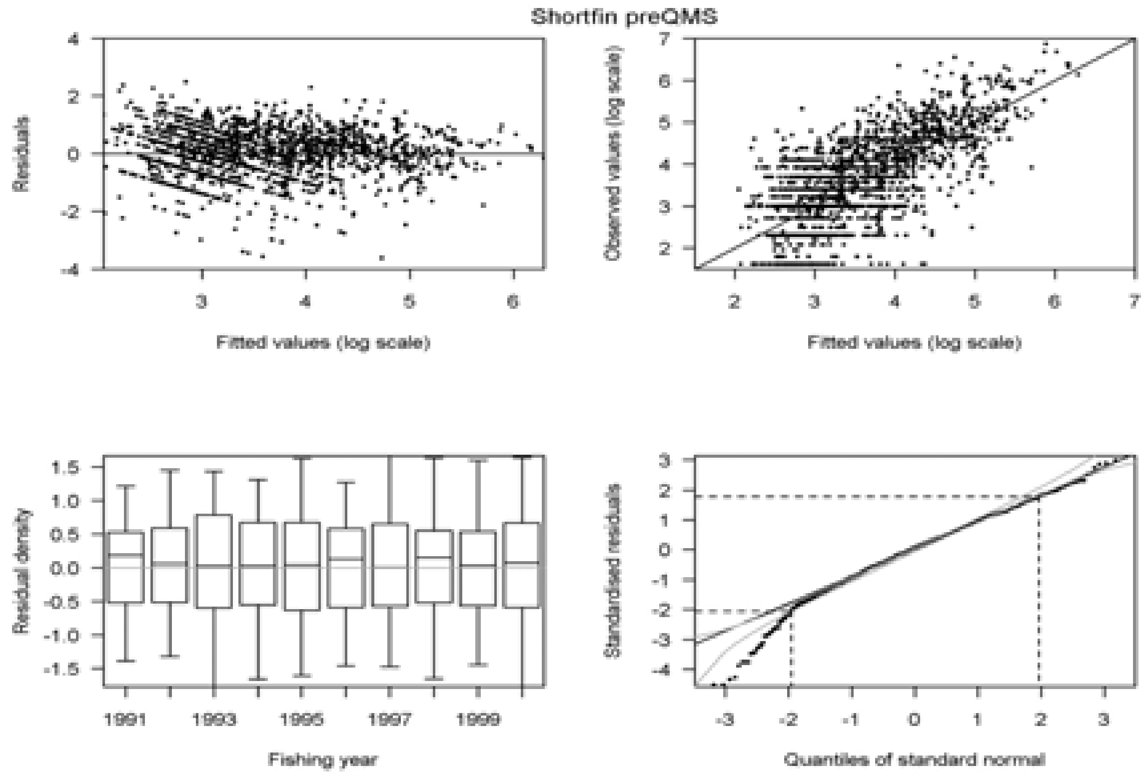

Figure G11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA19 (AV)).

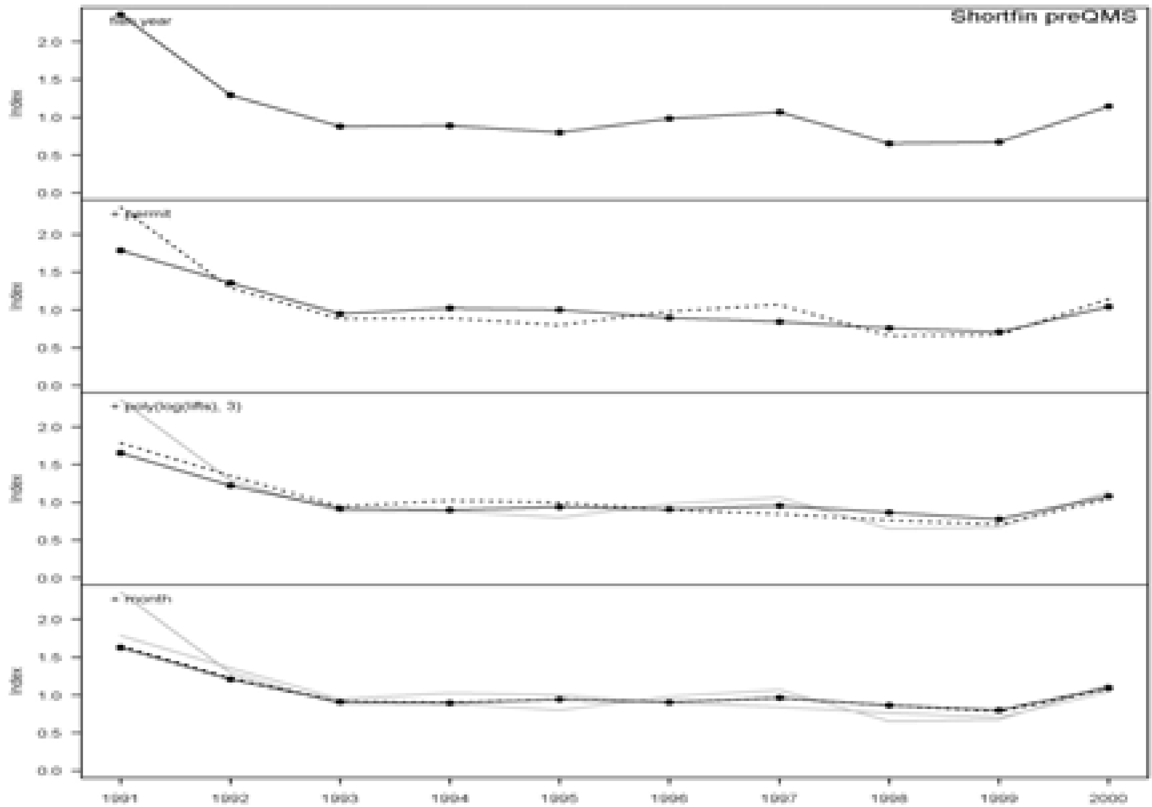

Figure G12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA19 (AV)).

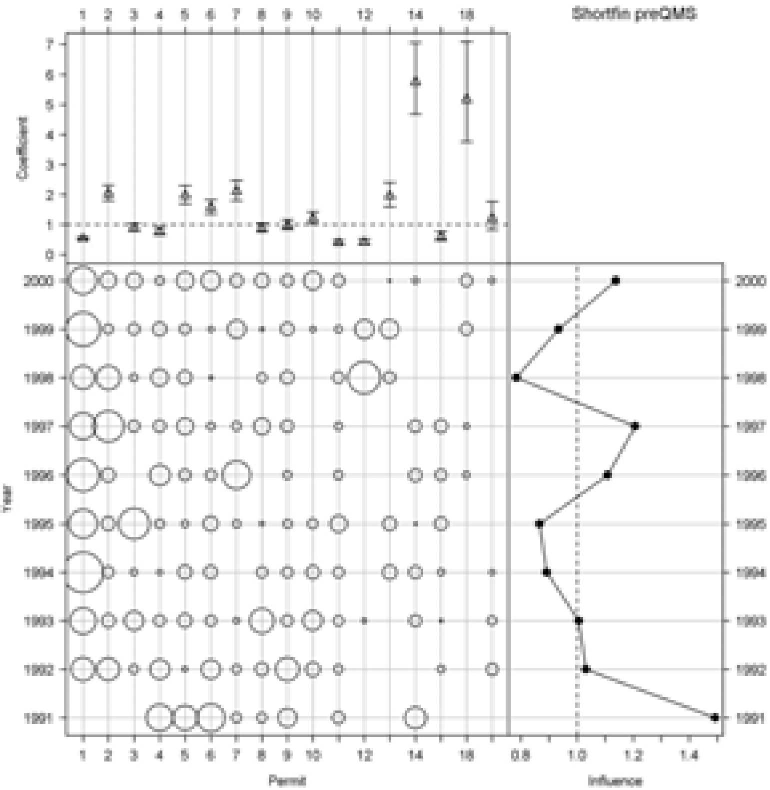

Figure G13: Influence of permit number for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

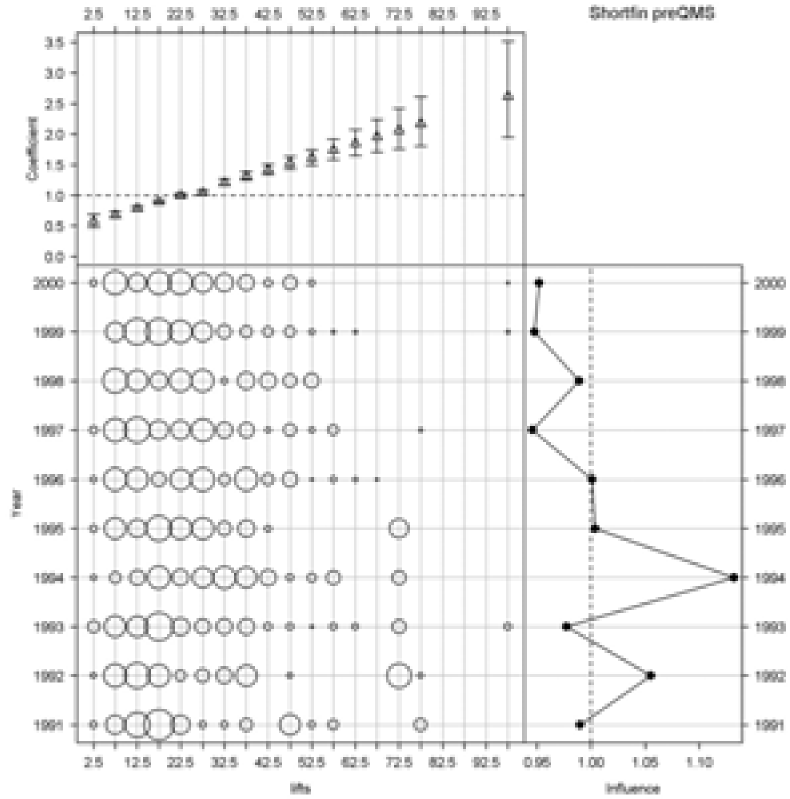

Figure G14: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

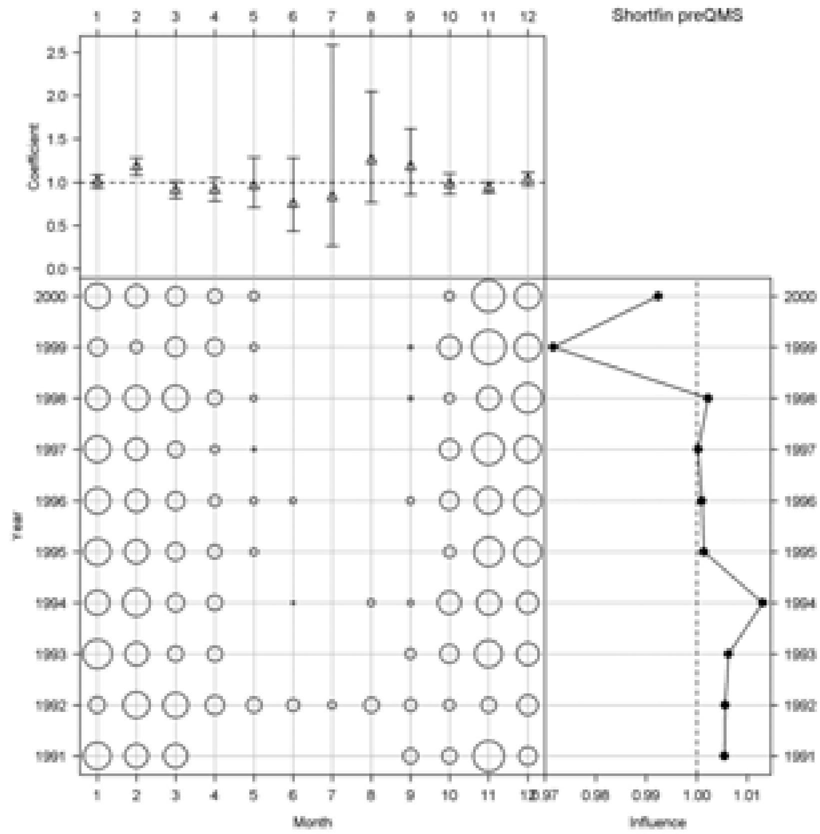

Figure G15: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

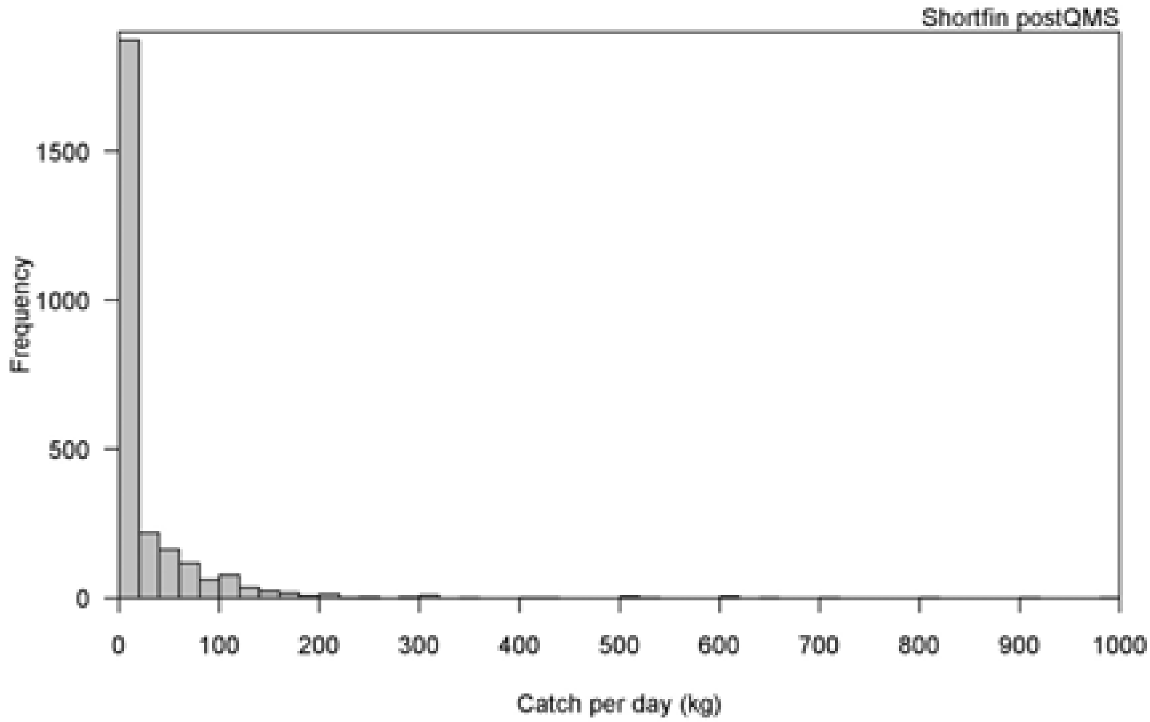

Figure G16: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

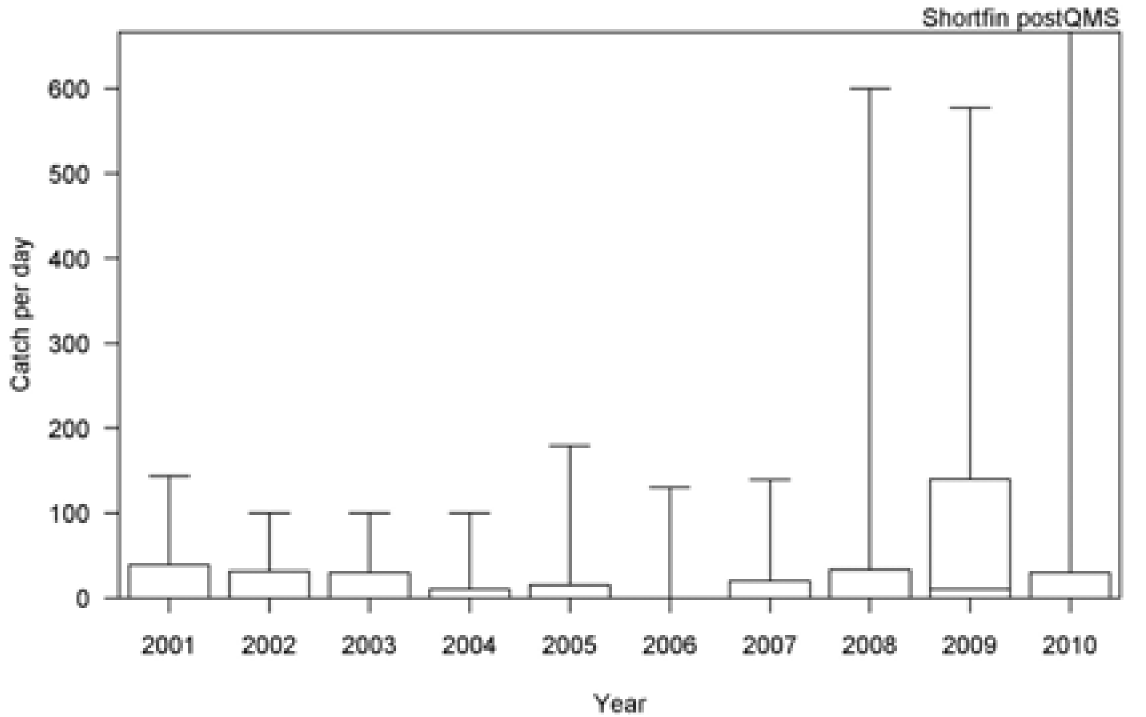

Figure G17: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA19 (AV)).

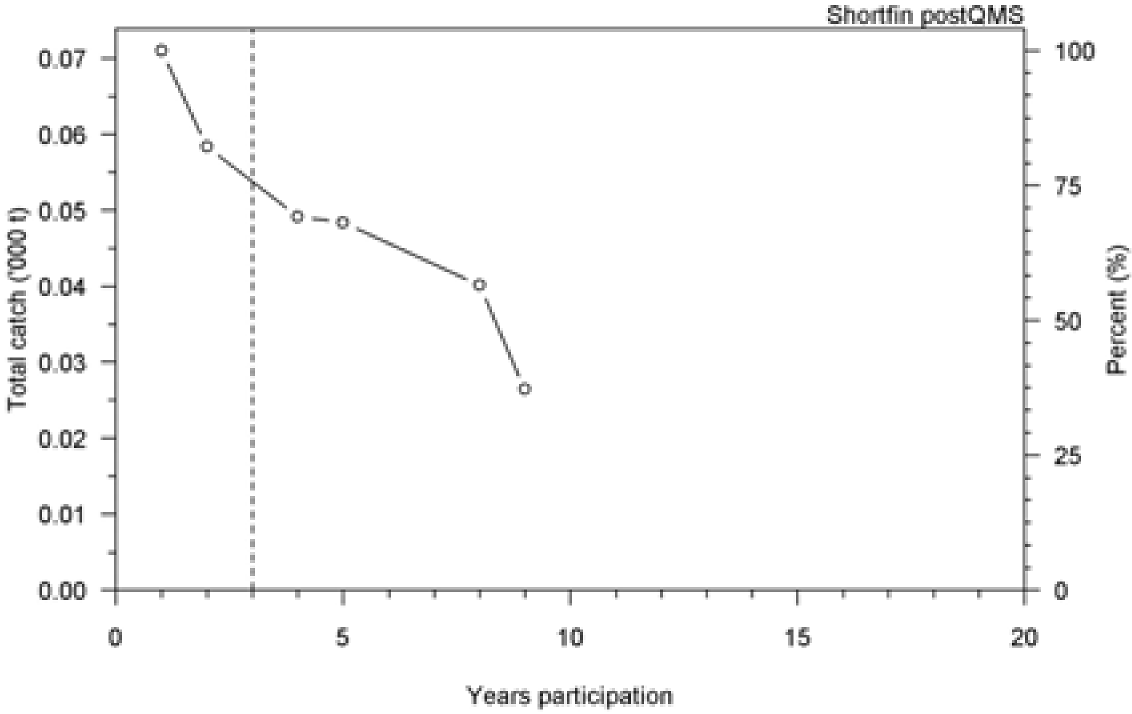

Figure G18: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA19 (AV)).

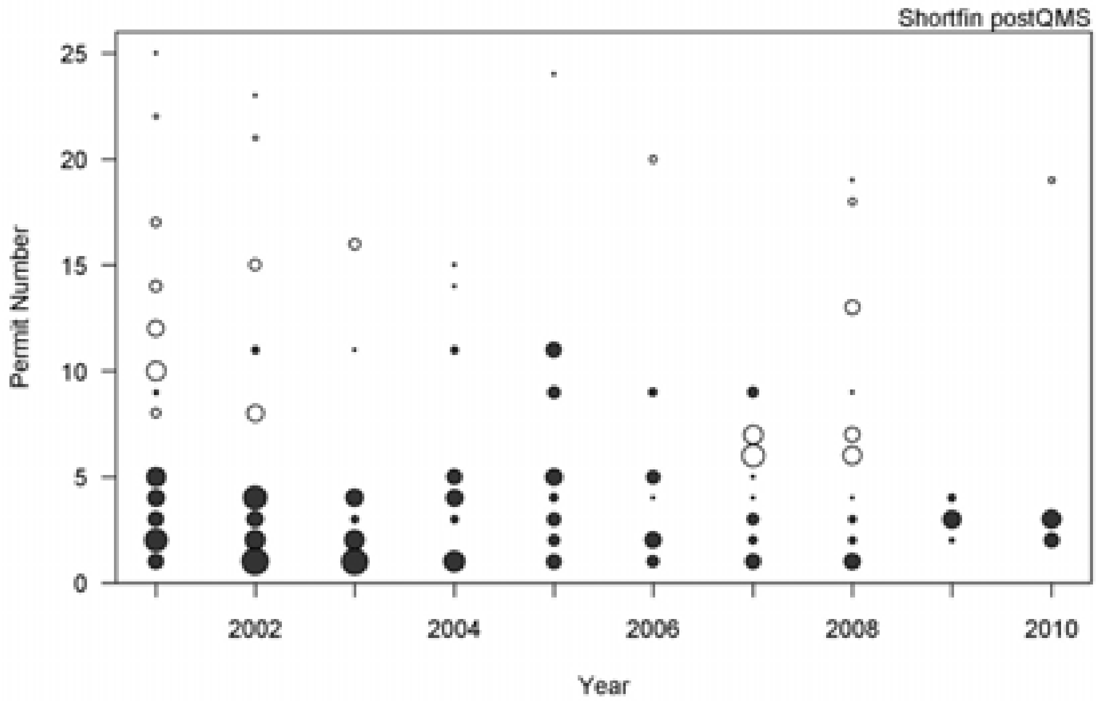

Figure G19: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA19 (AV)).

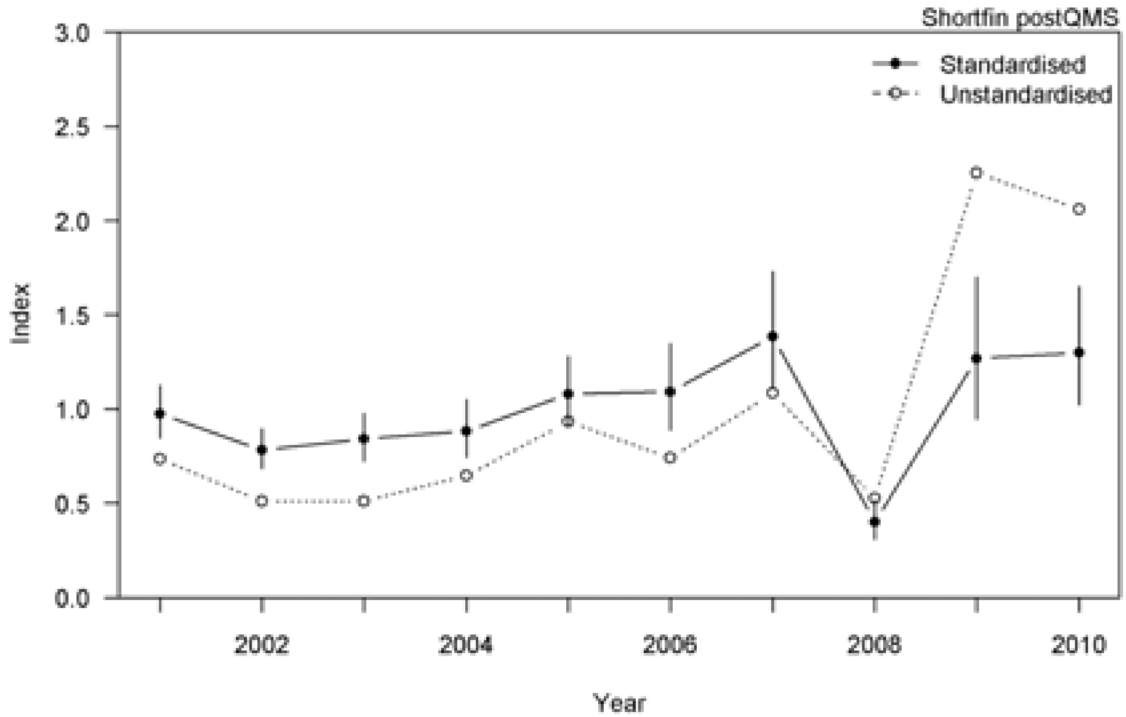

Figure G20: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers post-QMS eel CPUE model for the years 2000–01 to 2009–10 (ESA19 (AV)).

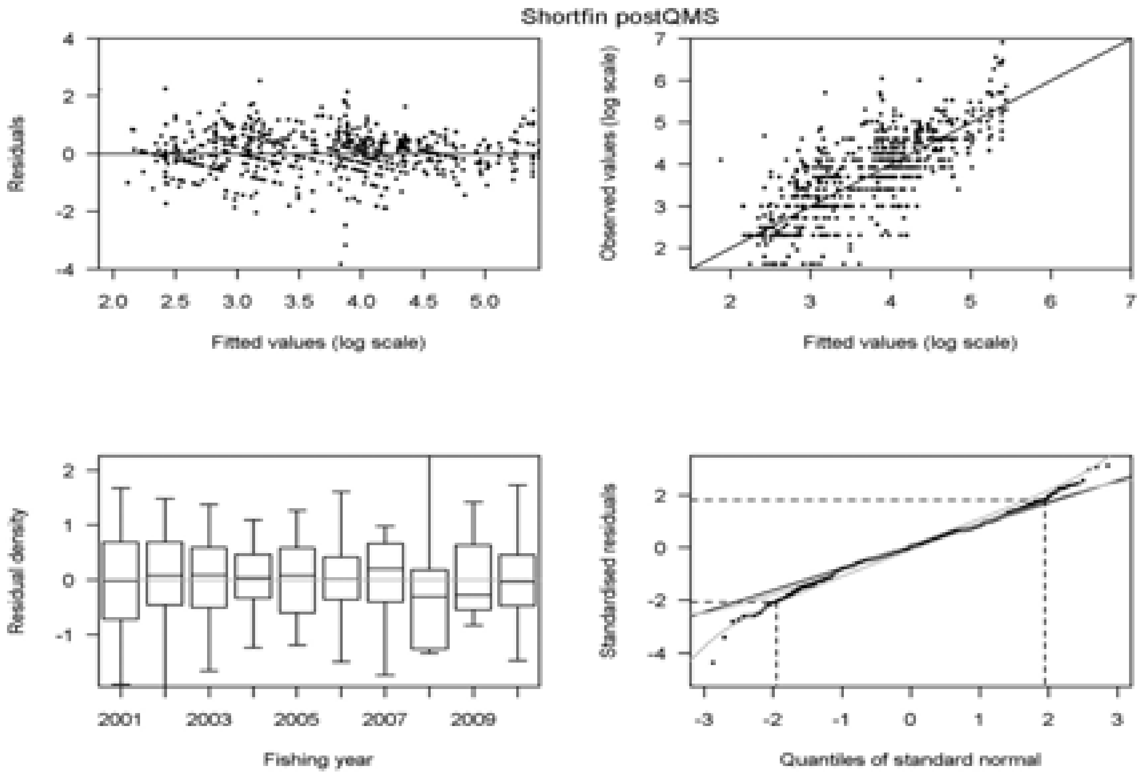

Figure G21: Residual diagnostic plots for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA19 (AV)).

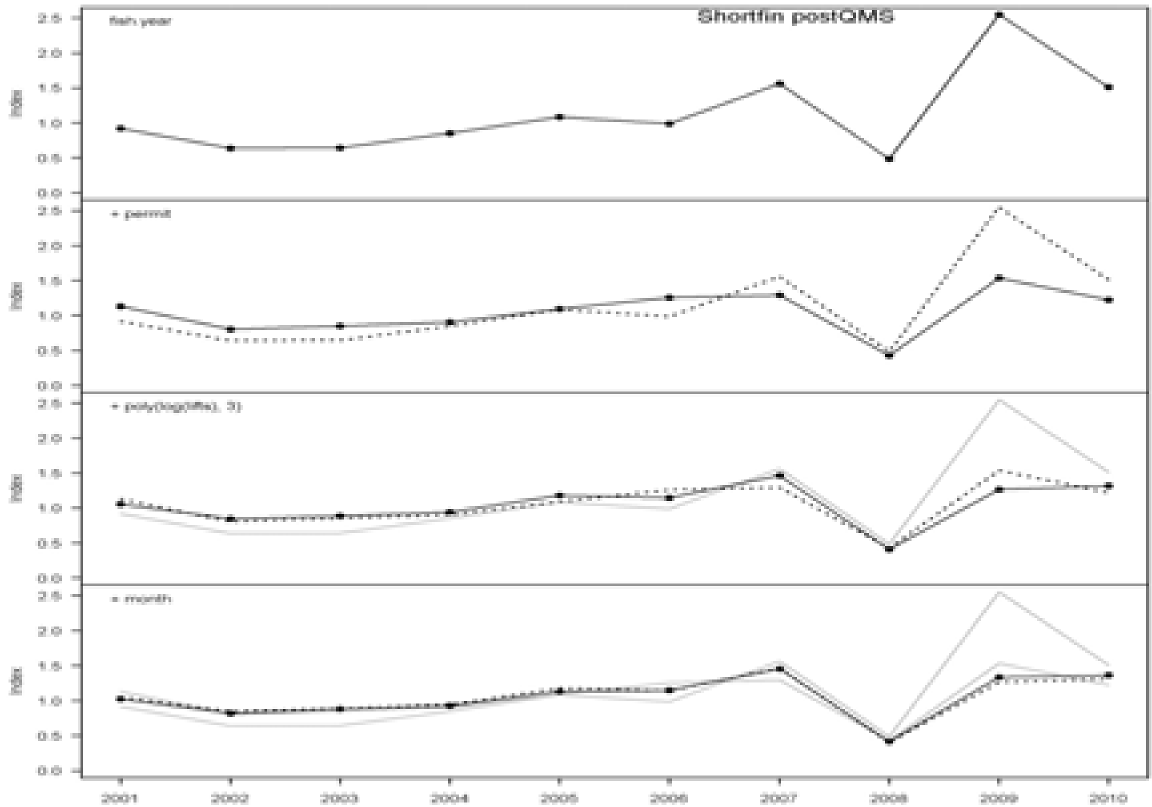

Figure G22: Step plot for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA19 (AV)).

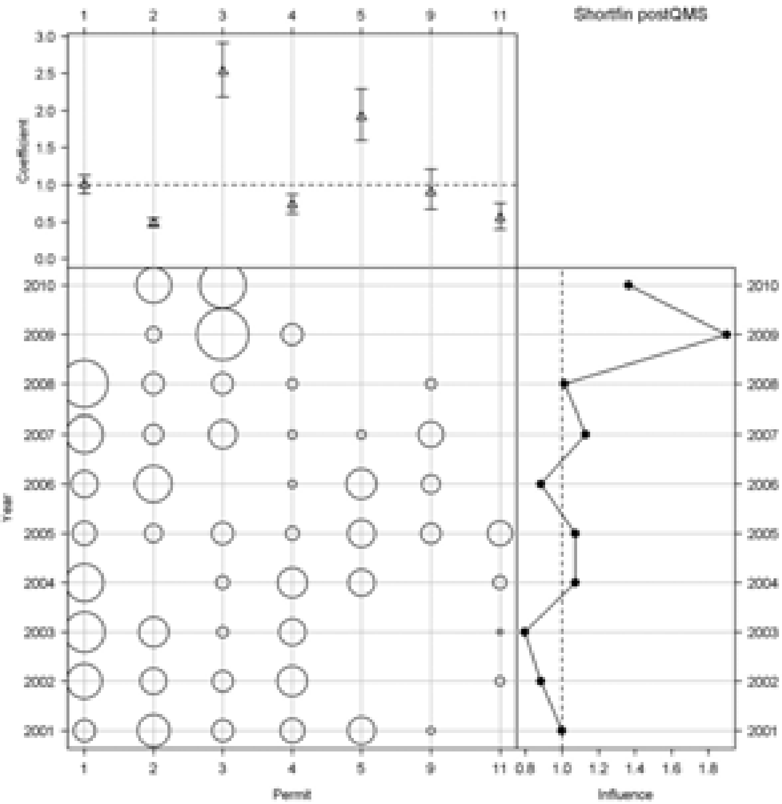

Figure G23: Influence of permit number for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

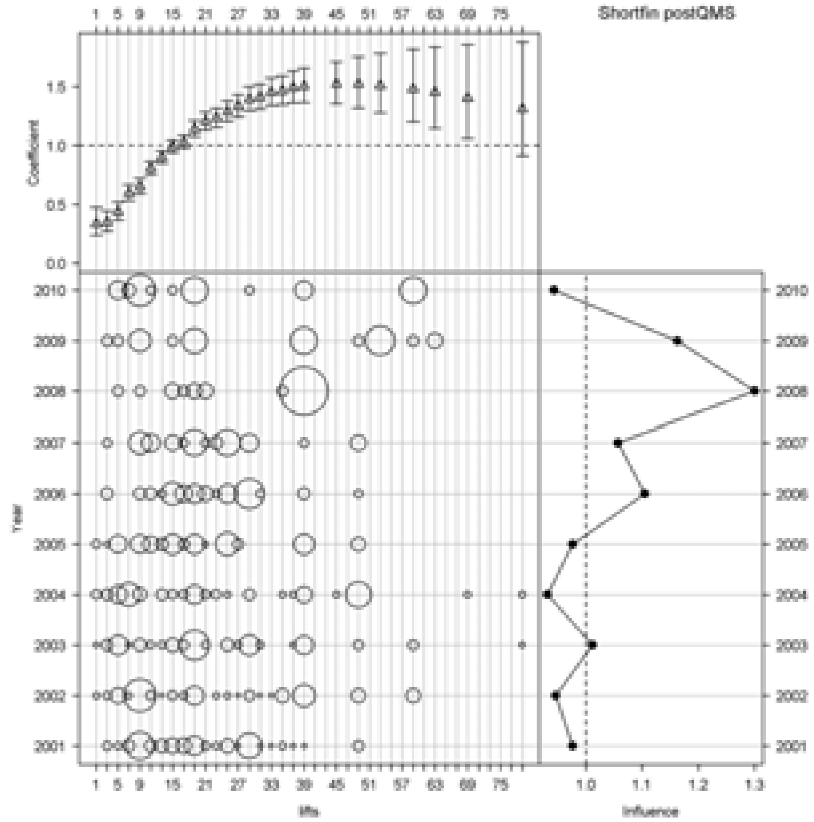

Figure G24: Influence of lifts for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

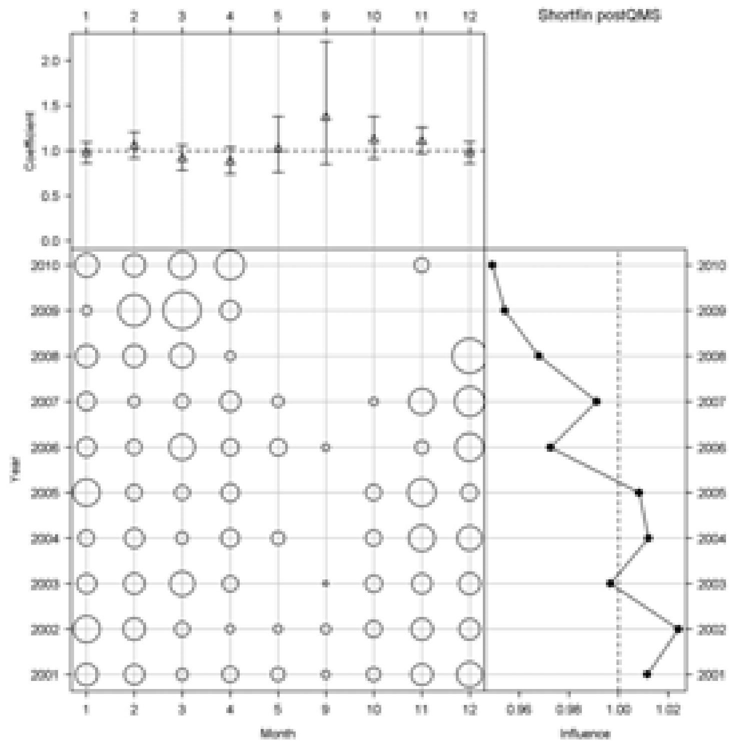

Figure G25: Influence of month for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

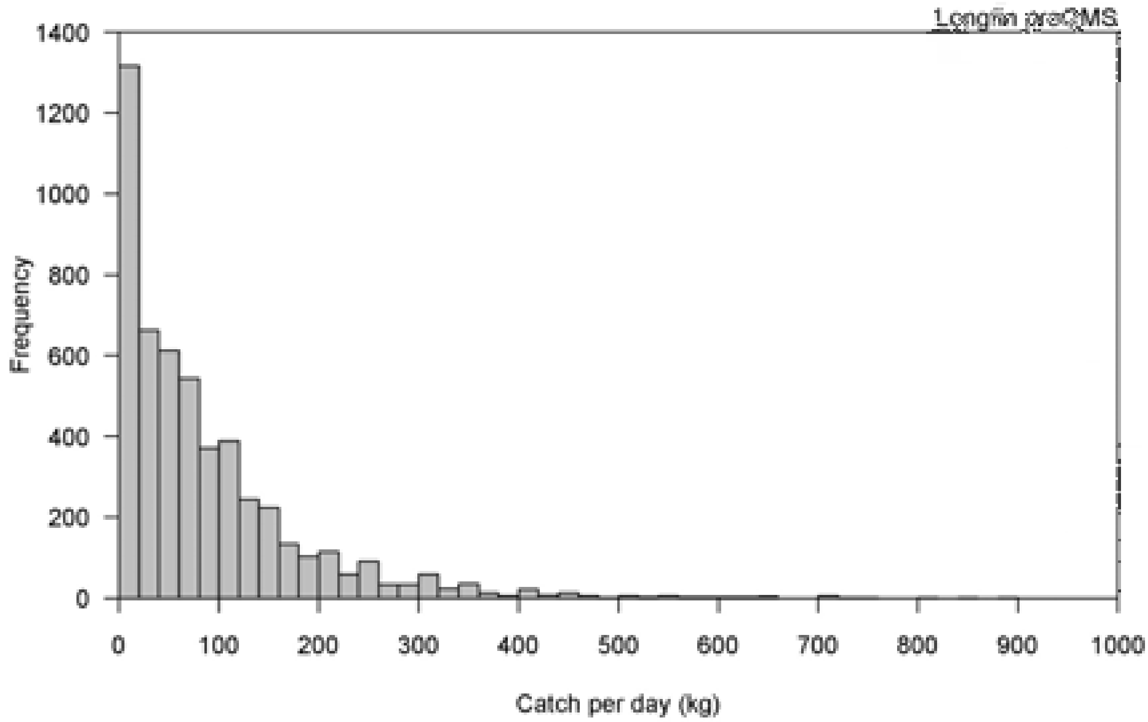

Figure G26: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

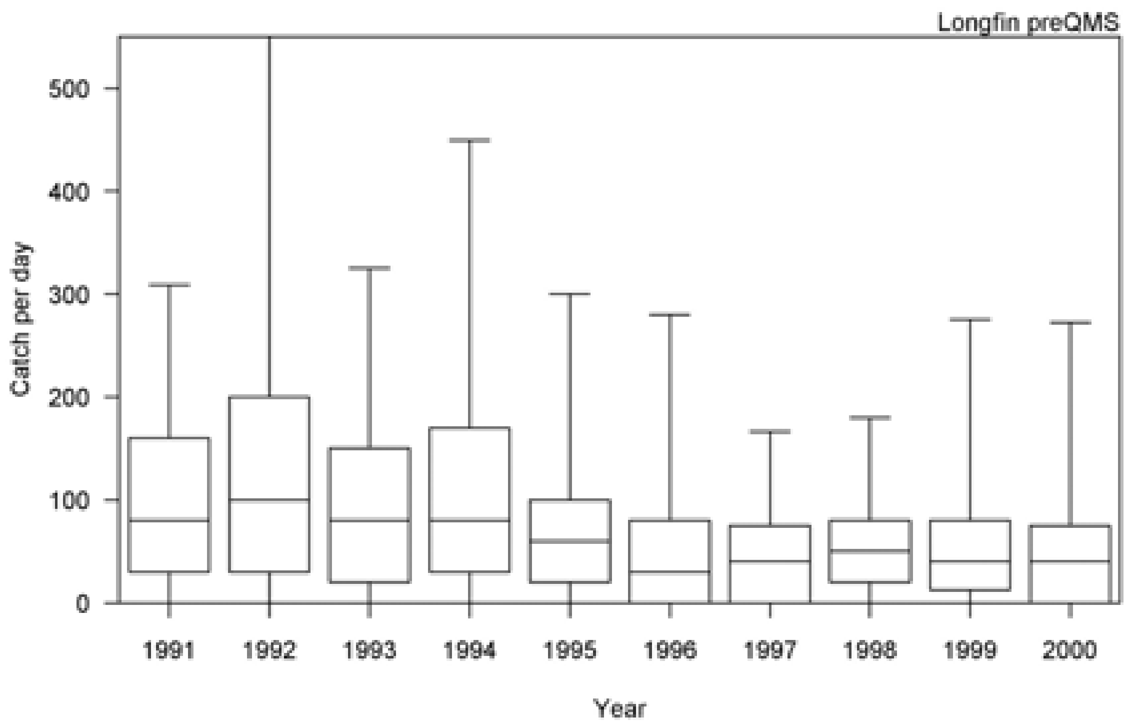

Figure G27: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA19 (AV)).

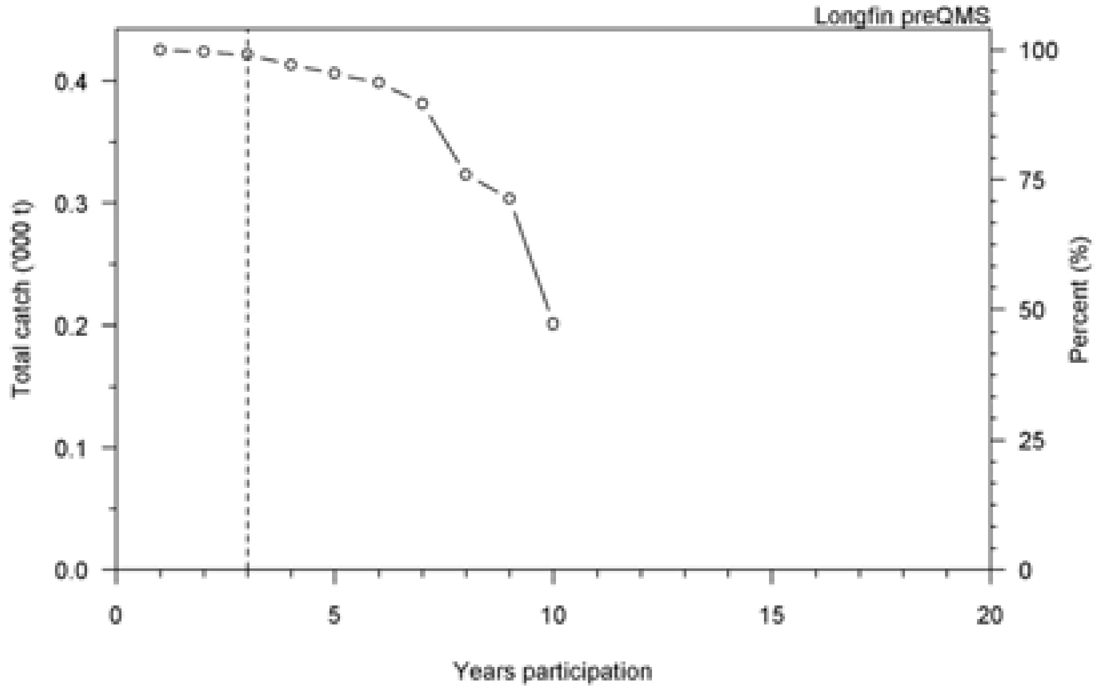

Figure G28: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA19 (AV)).

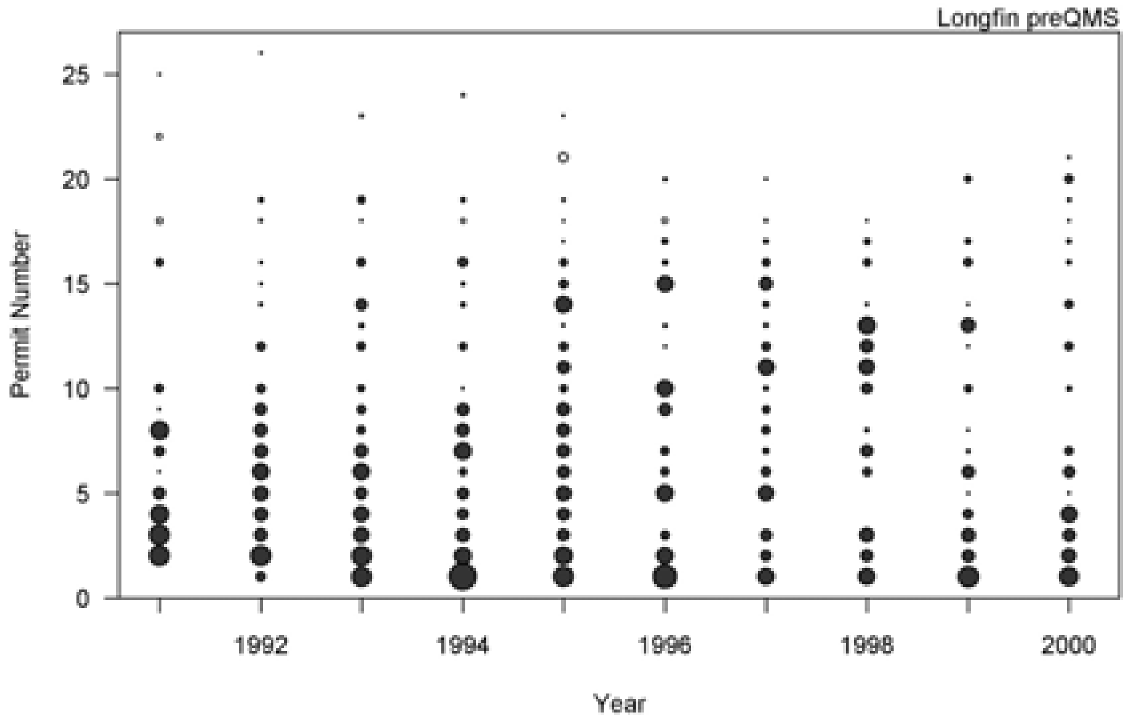

Figure G29: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA19 (AV)).

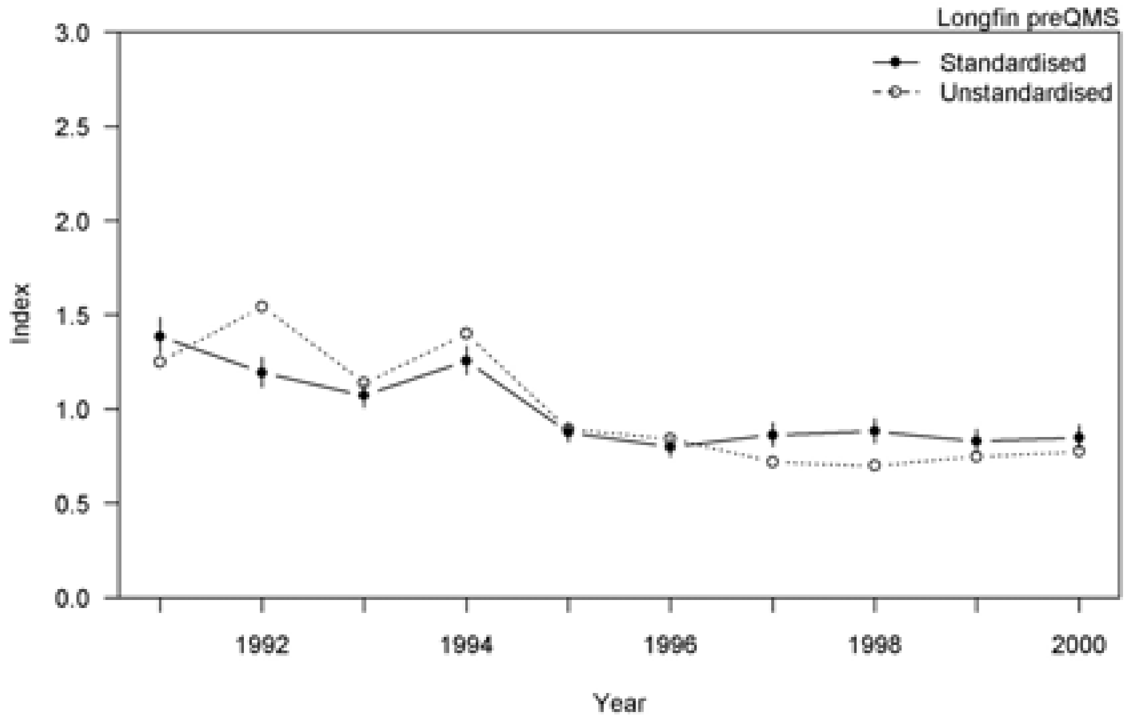

Figure G30: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA19 (AV)).

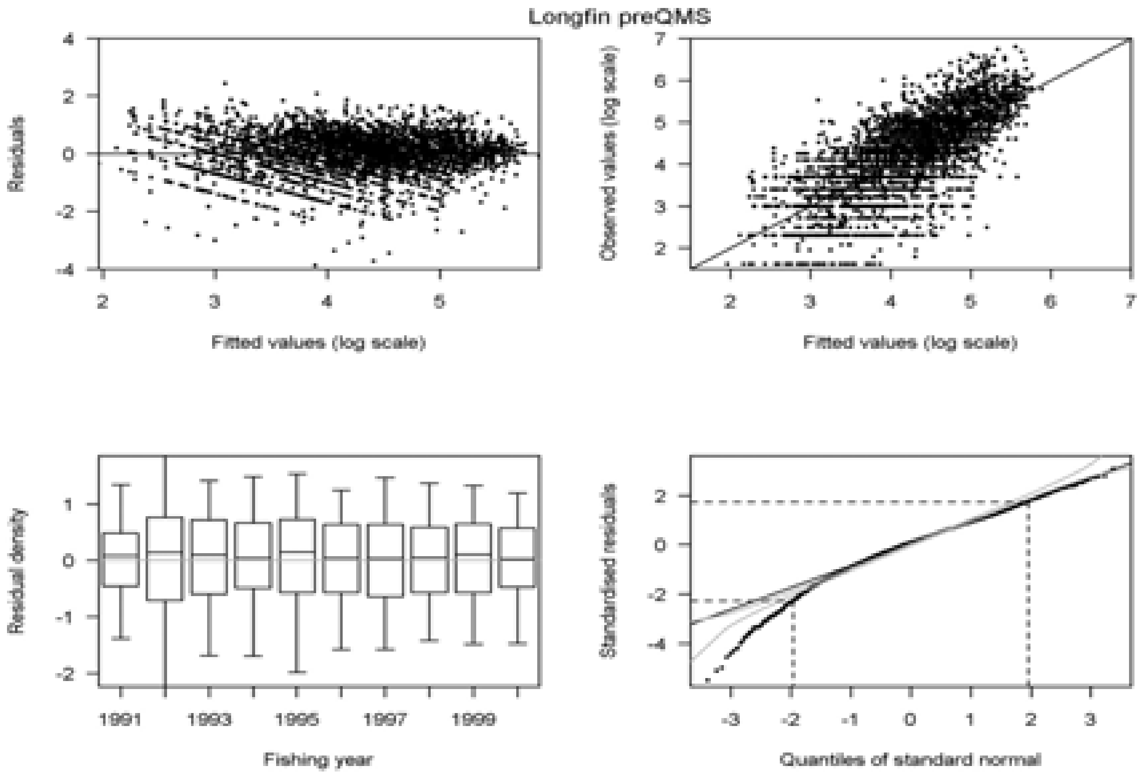

Figure G31: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA19 (AV)).

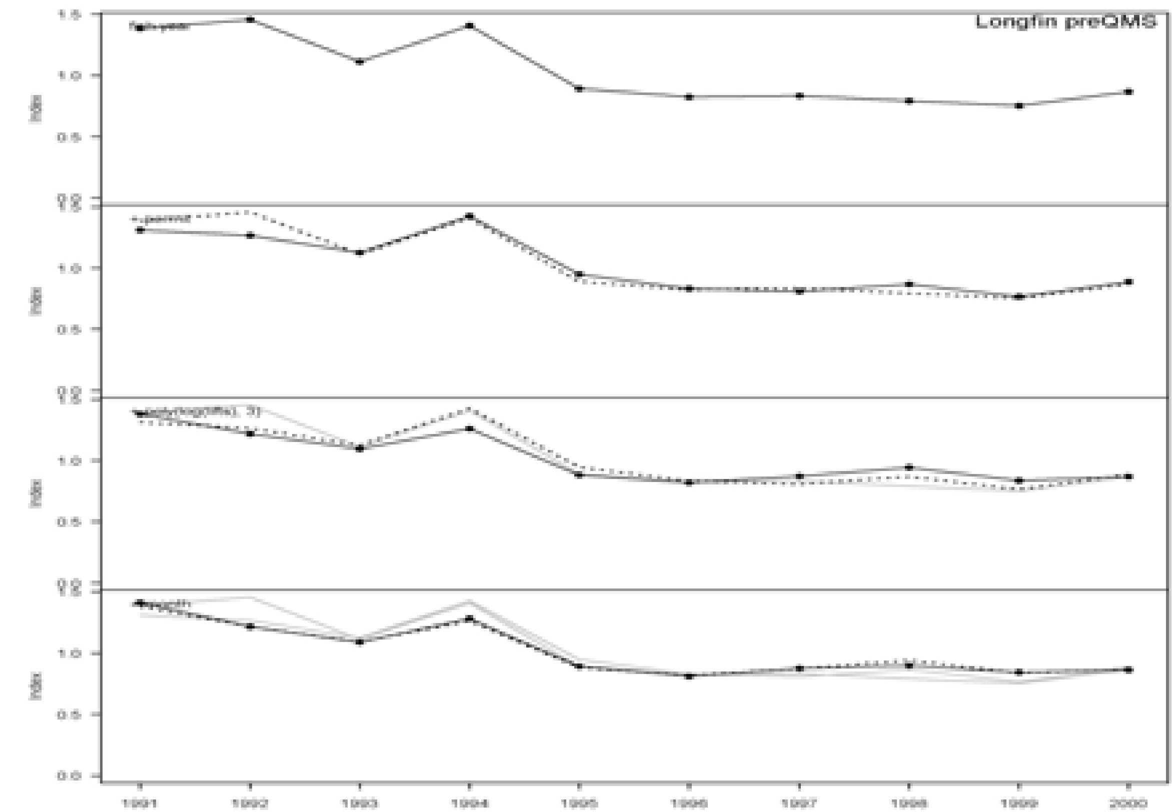

Figure G32: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA19 (AV)).

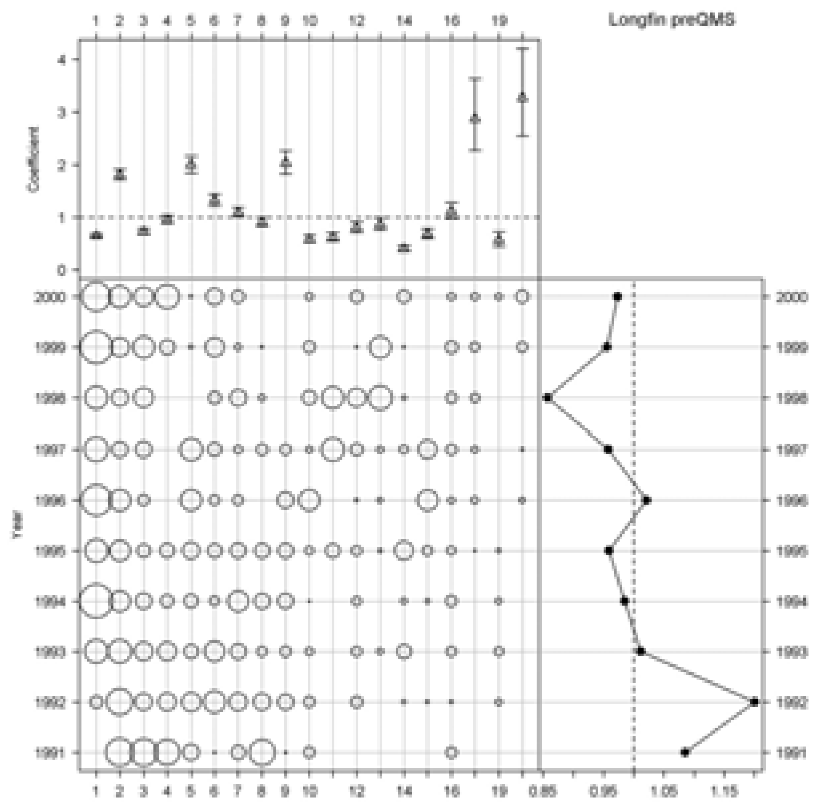

Figure G33: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

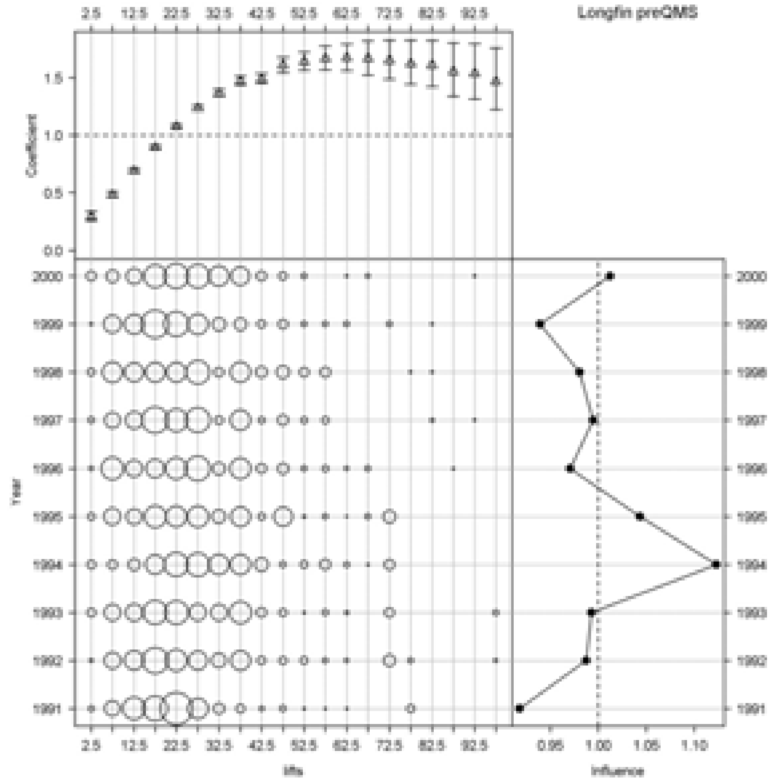

Figure G34: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

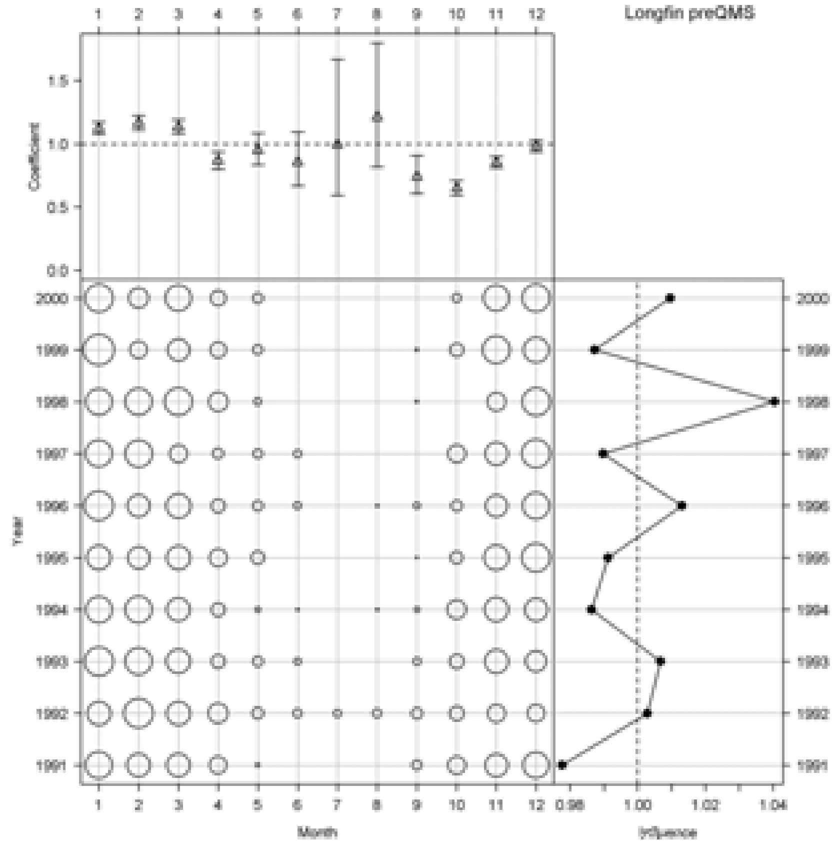

Figure G35: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA19 (AV)).

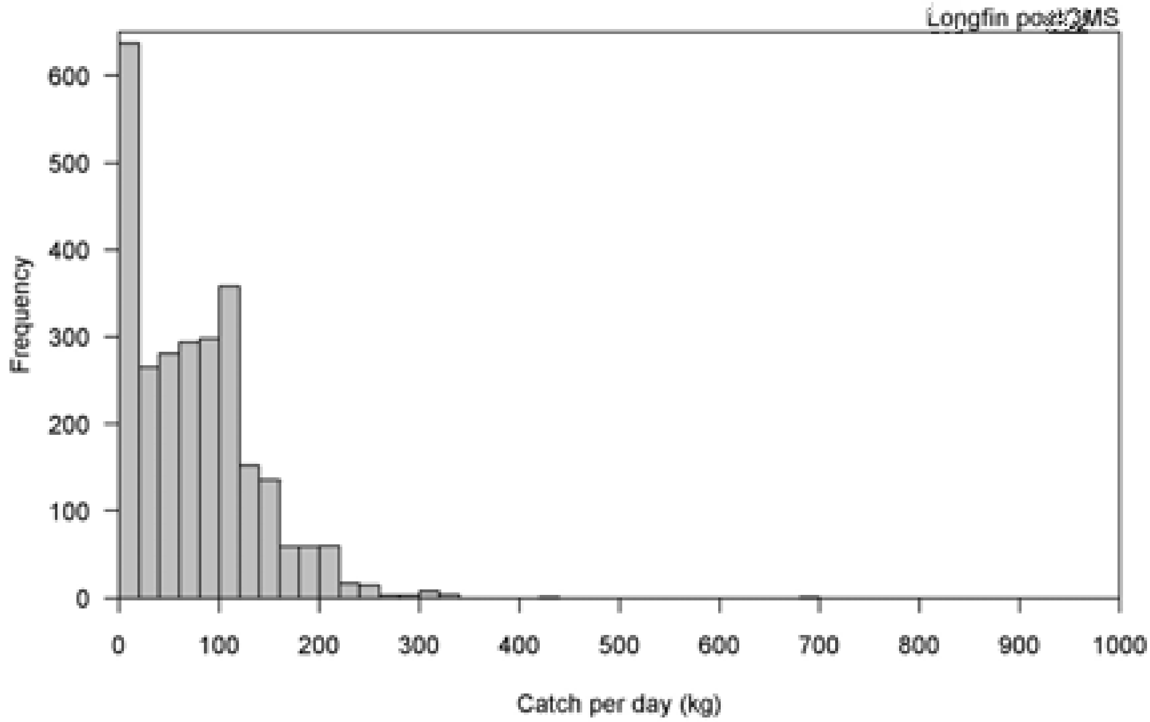

Figure G36: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

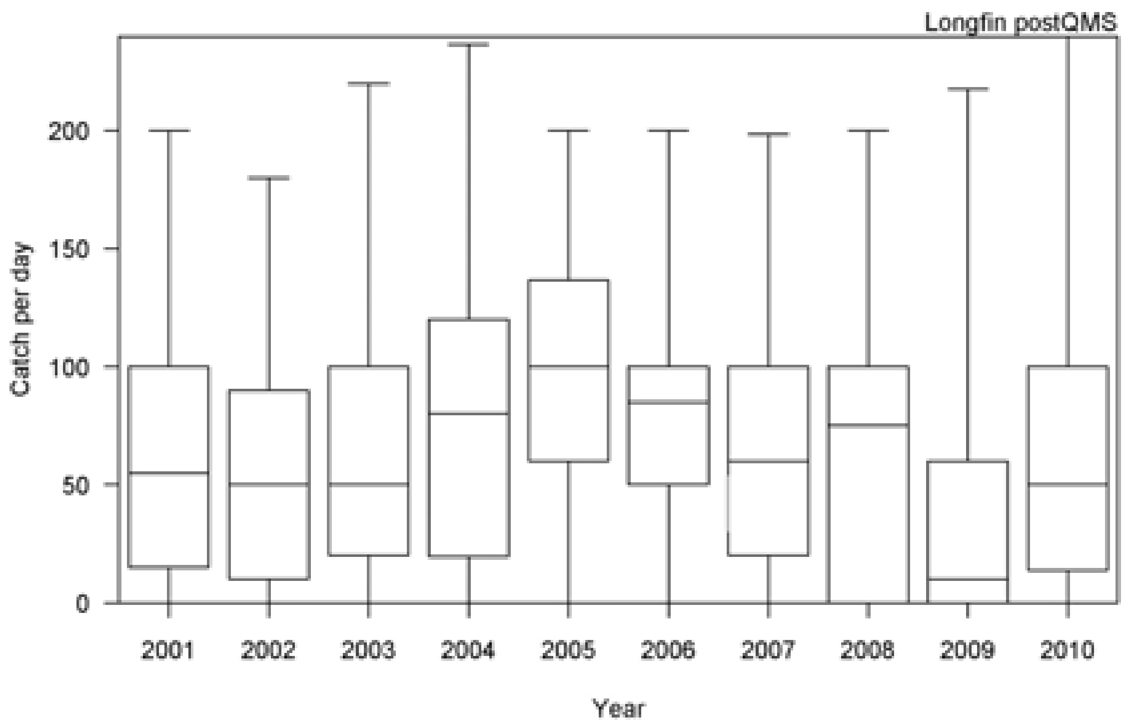

Figure G37: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA19 (AV)).

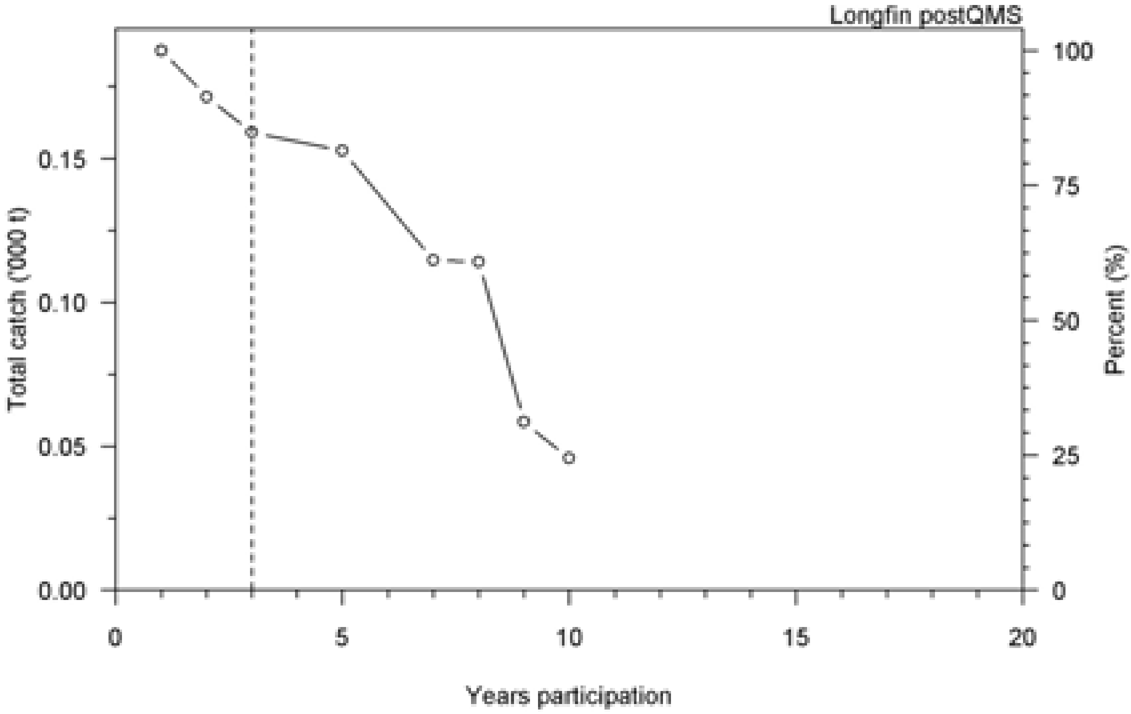

Figure G38: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA19 (AV)).

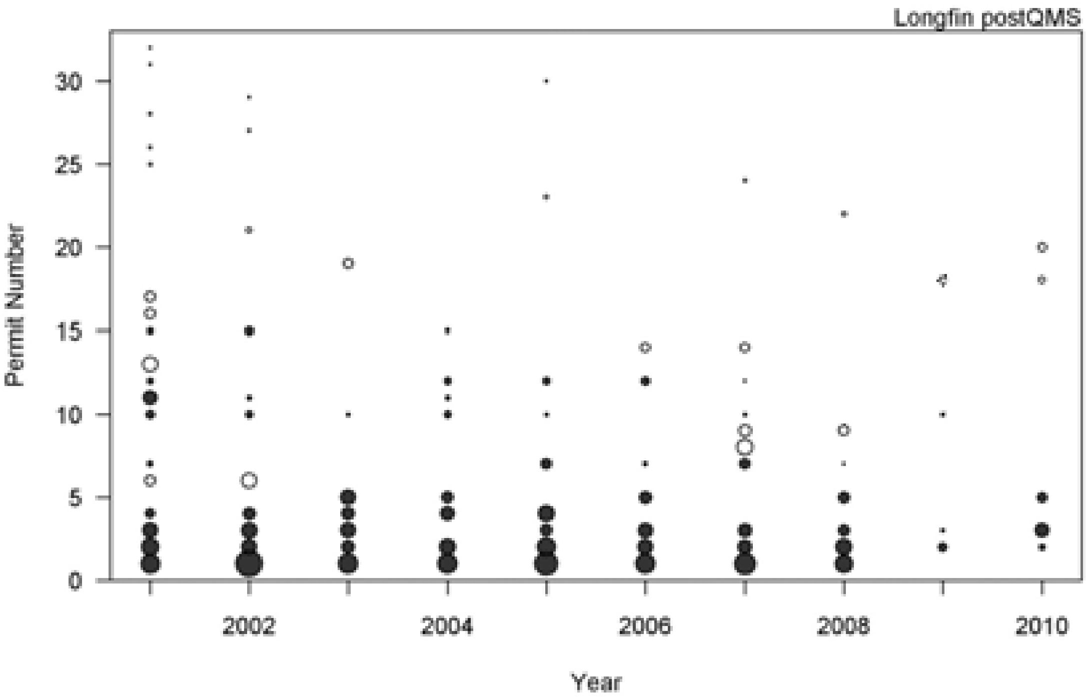

Figure G39: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA19 (AV)).

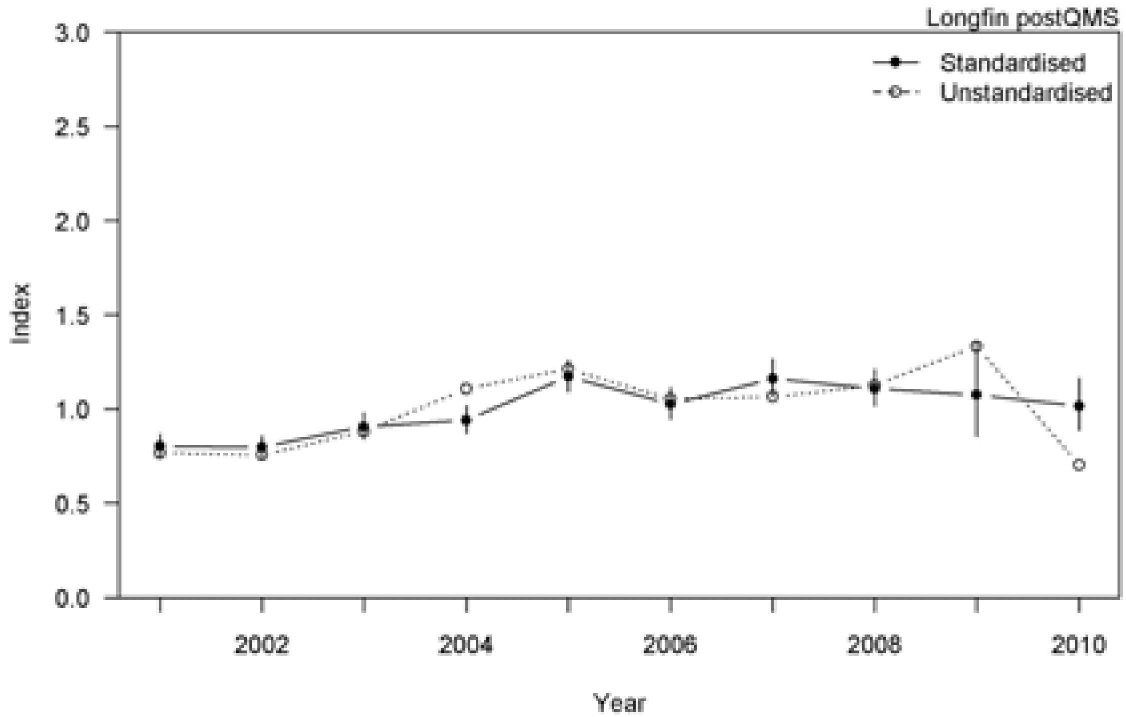

Figure G40: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers post-QMS eel CPUE model for the years 2000–01 to 2009–10 (ESA19 (AV)).

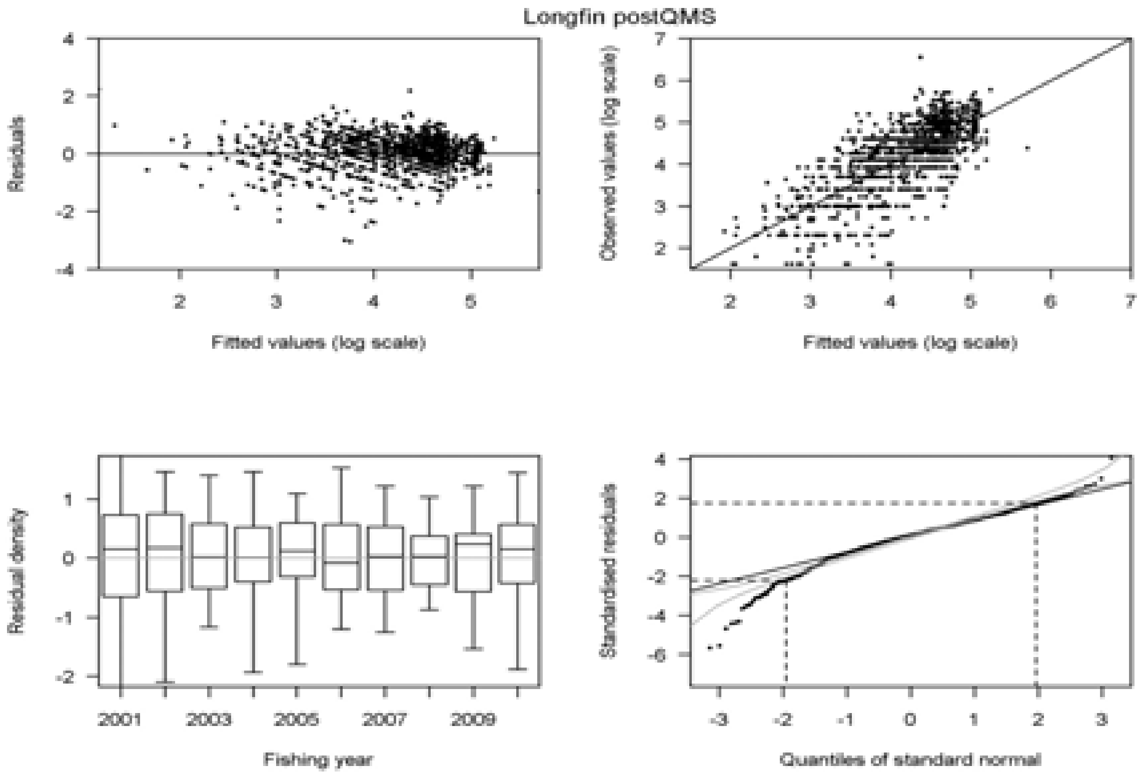

Figure G41: Residual diagnostic plots for the longfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA19 (AV)).

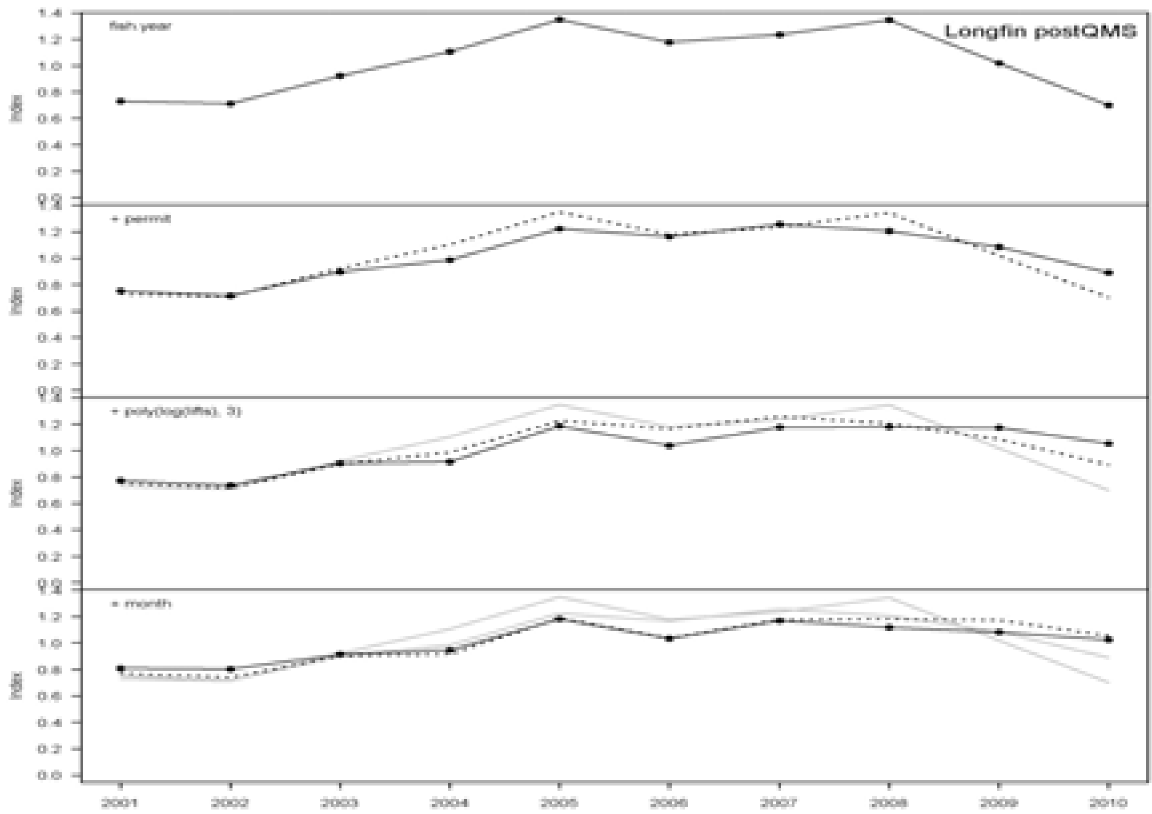

Figure G42: Step plot for the longfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA19 (AV)).

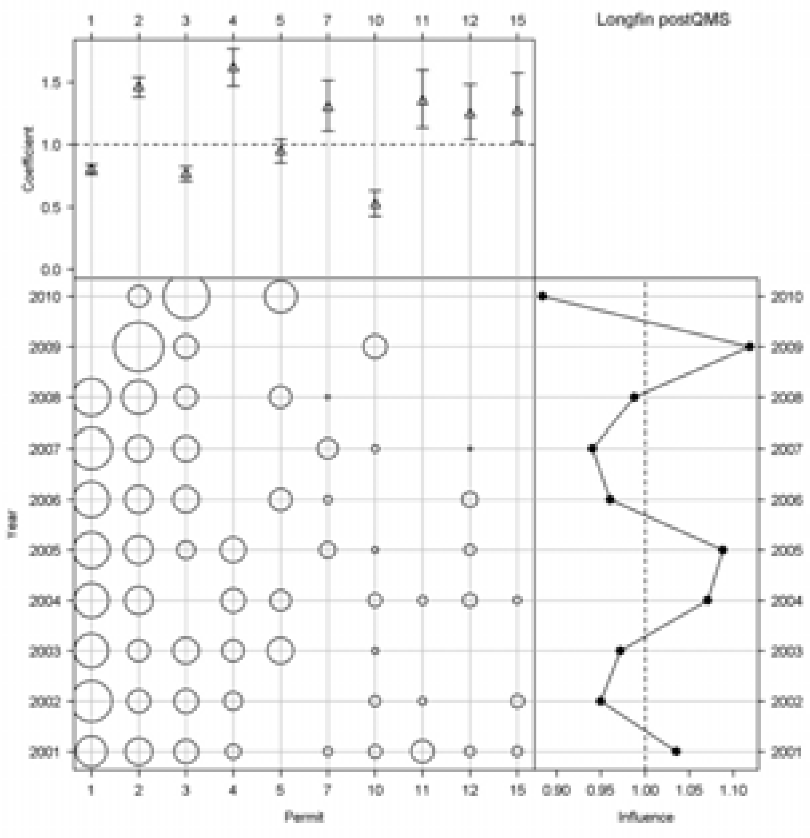

Figure G43: Influence of permit number for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

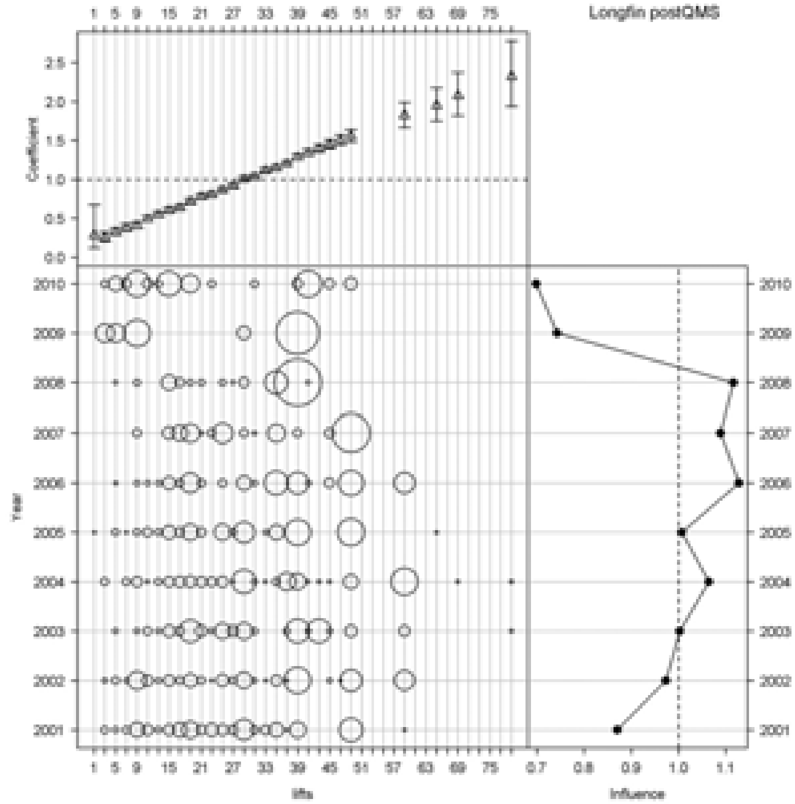

Figure G44: Influence of lifts for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

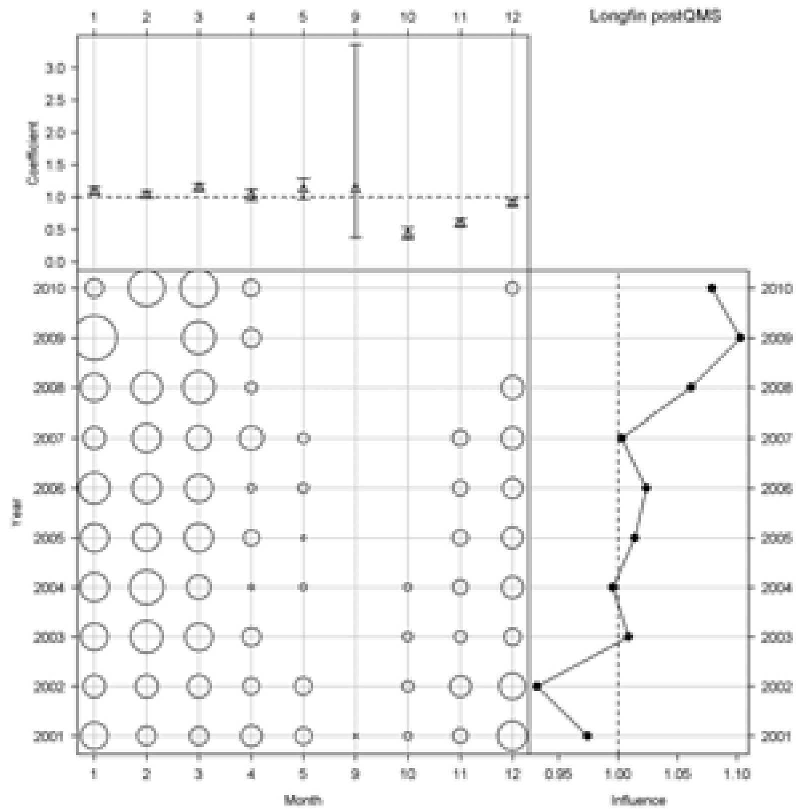

Figure G45: Influence of month for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA19 (AV)).

Appendix H: ESA 20 (AW).

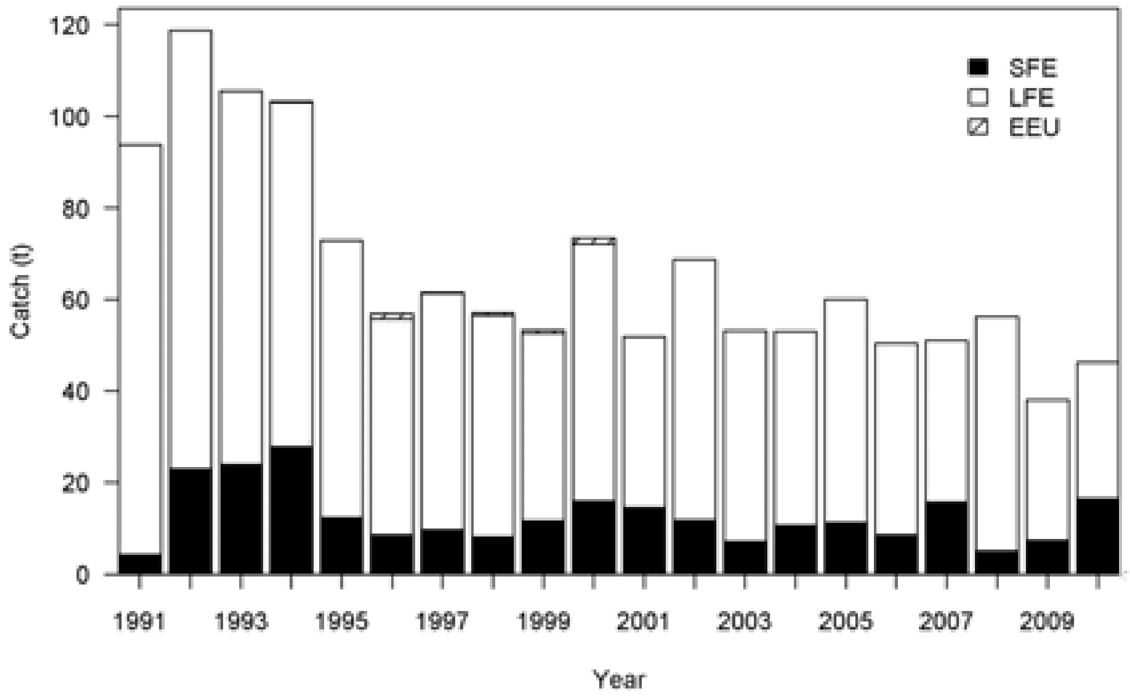

Figure H1: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 1990–91 to 2009–10 (ESA20 (AW)).

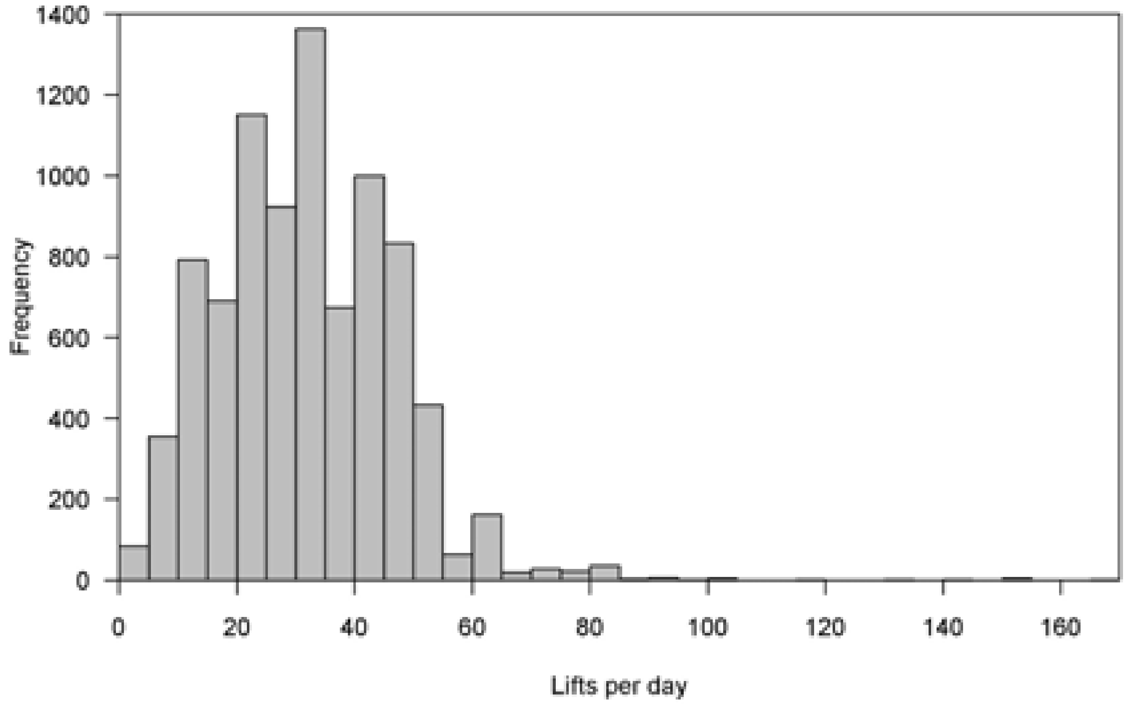

Figure H2: Frequency of total lifts per day for the years 1990–91 to 2009–10 (ESA20 (AW)).

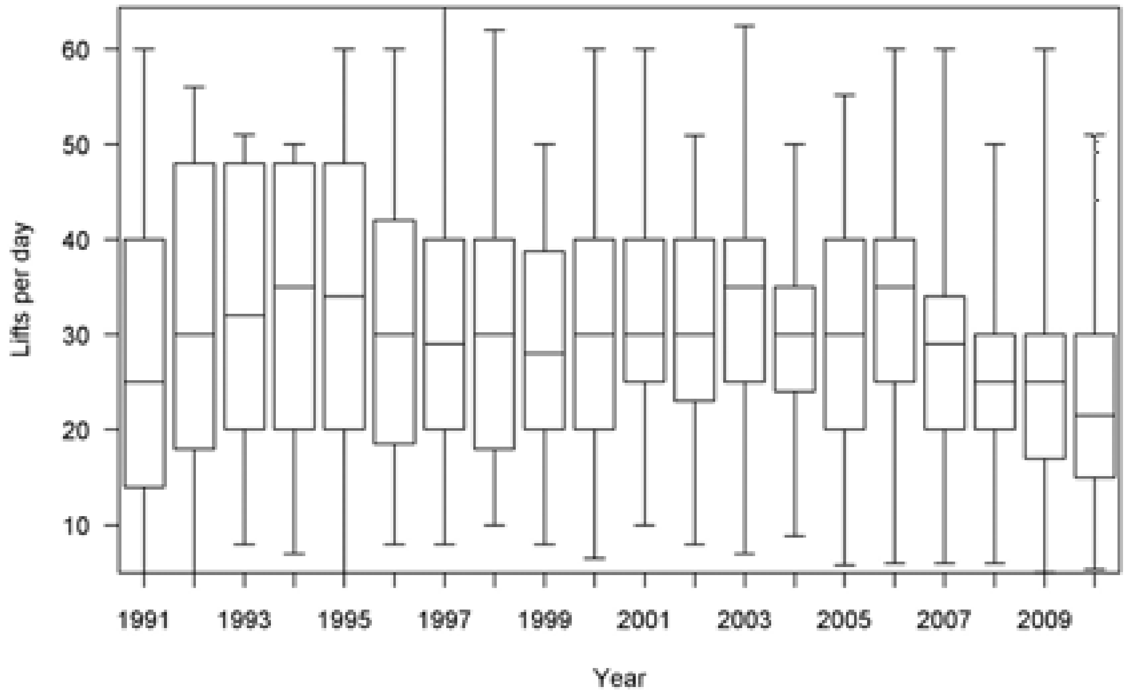

Figure H3: Total lifts per day for the years 1990–91 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA20 (AW)).

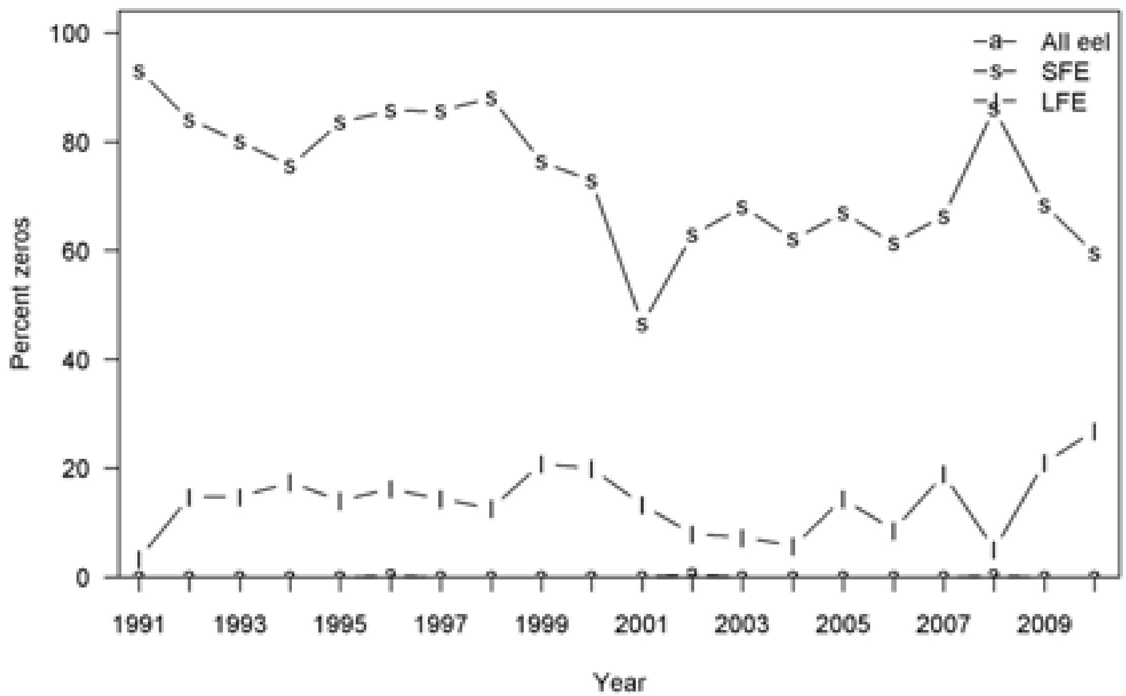

Figure H4: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 1990–91 to 2009–10 (ESA20 (AW)).

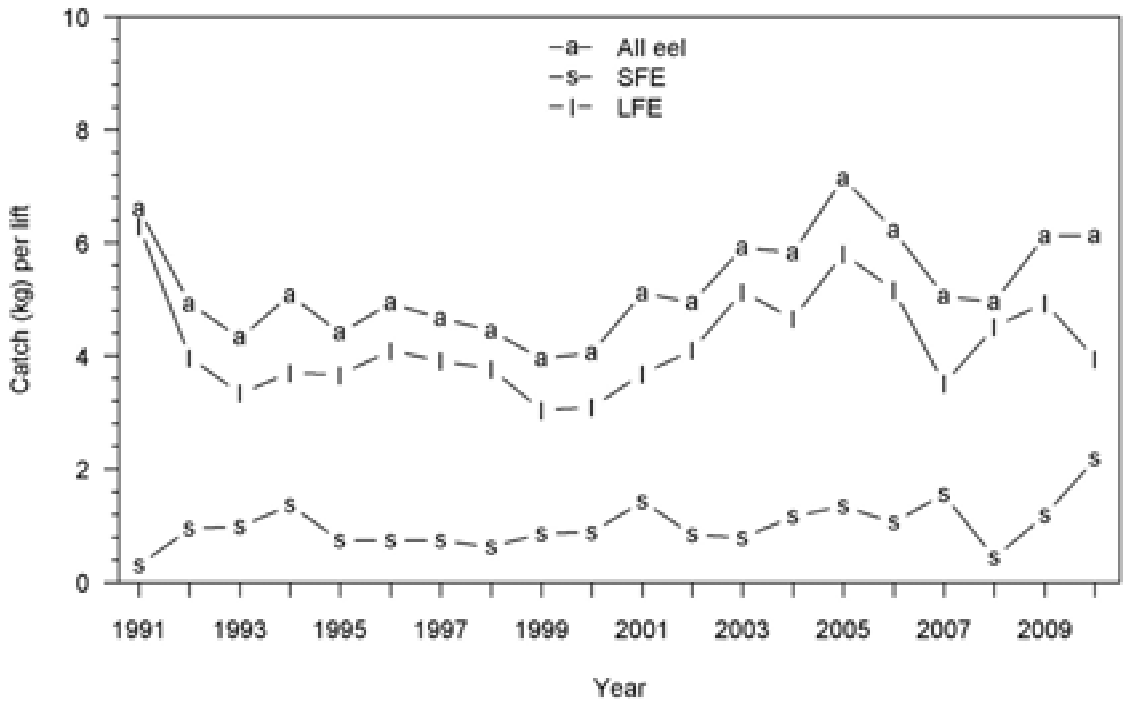

Figure H5: Unstandardised catch per lift (total kg/total lifts) for all eel, shortfin (SFE), and longfin (LFE) for the years 1990–91 to 2009–10 (ESA20 (AW)).

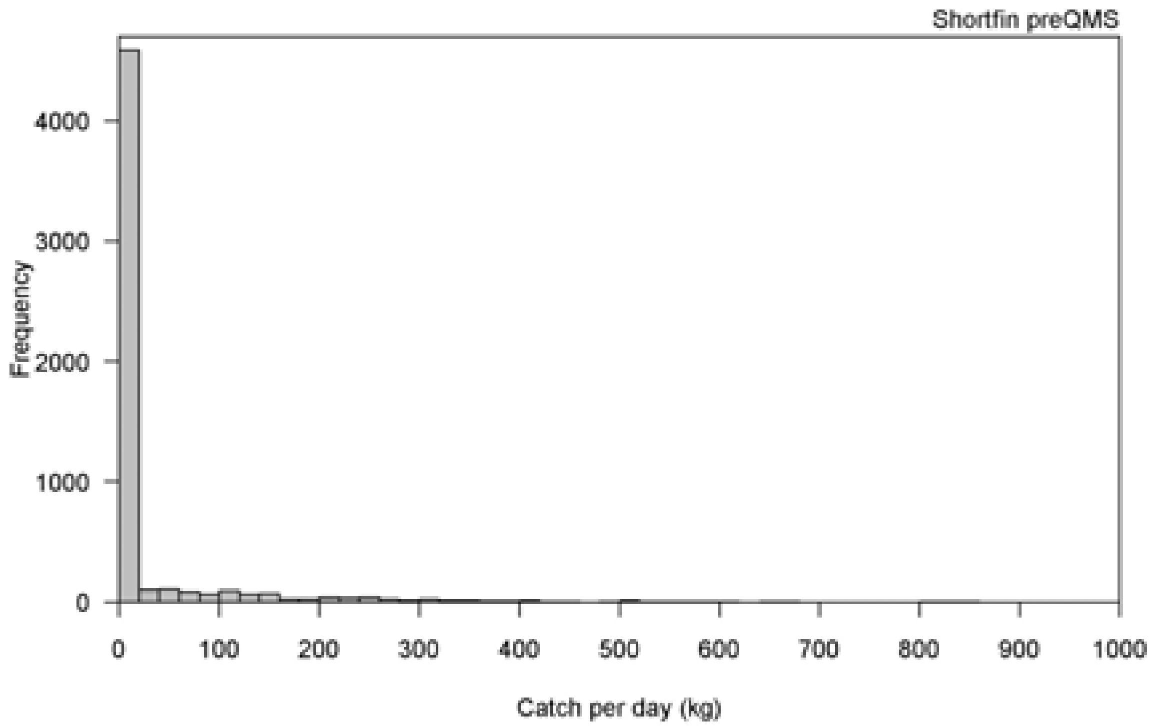

Figure H6: Frequency of shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

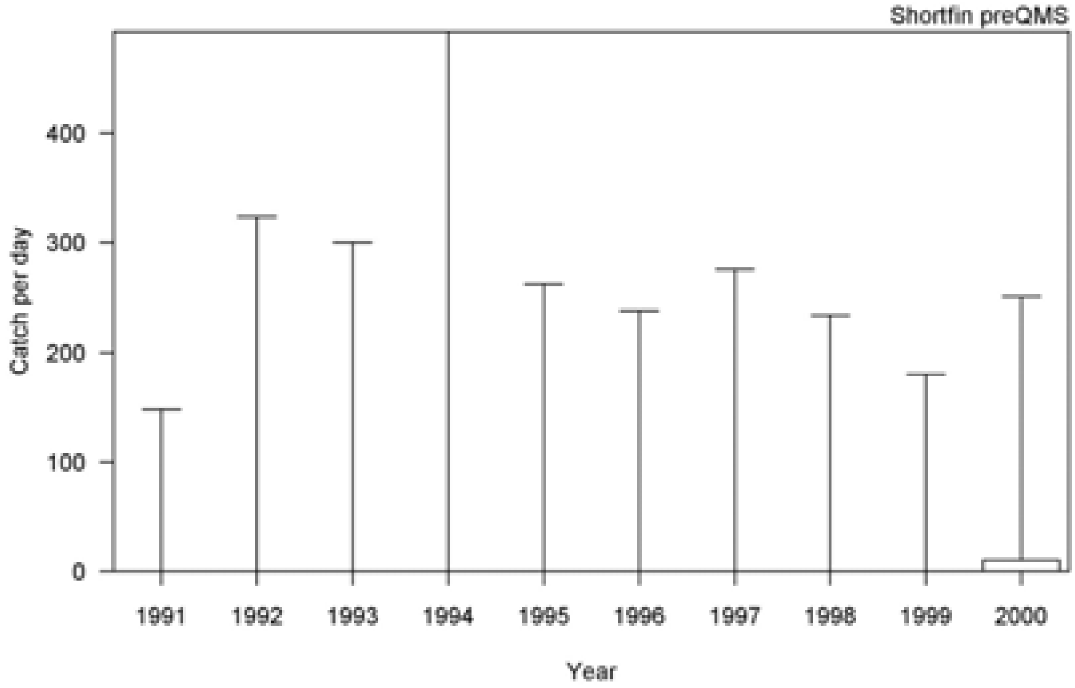

Figure H7: Shortfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA20 (AW)).

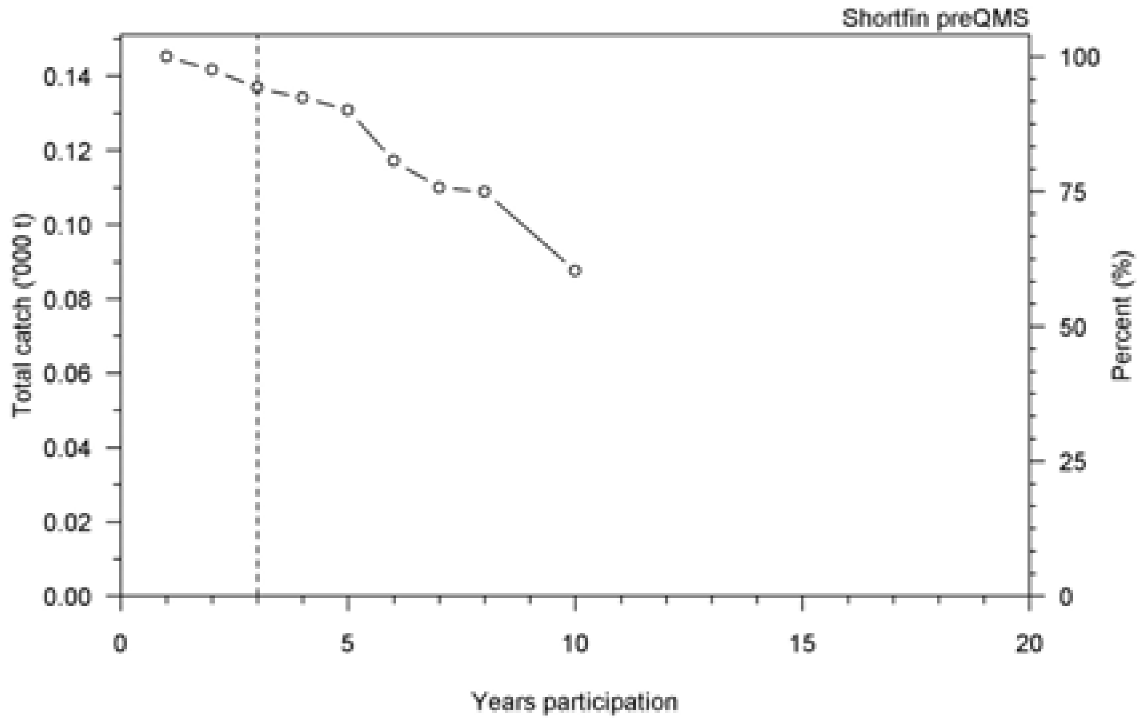

Figure H8: Relationship between years of participation in the fishery and shortfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA20 (AW)).

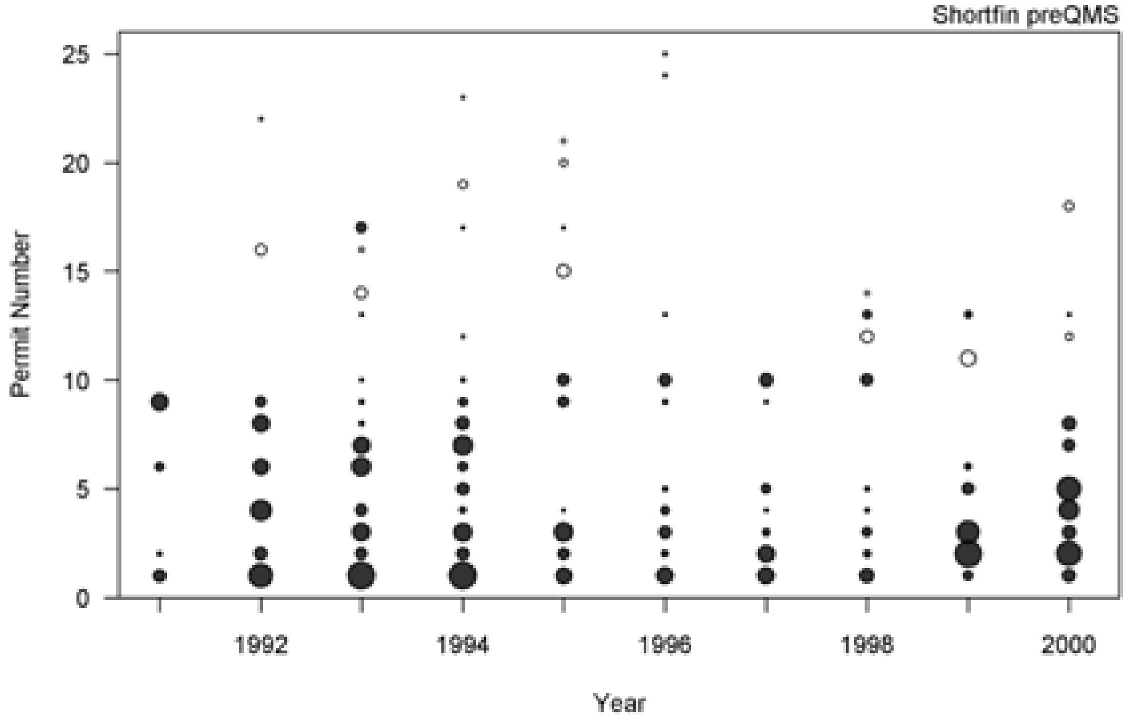

Figure H9: Relative shortfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA20 (AW)).

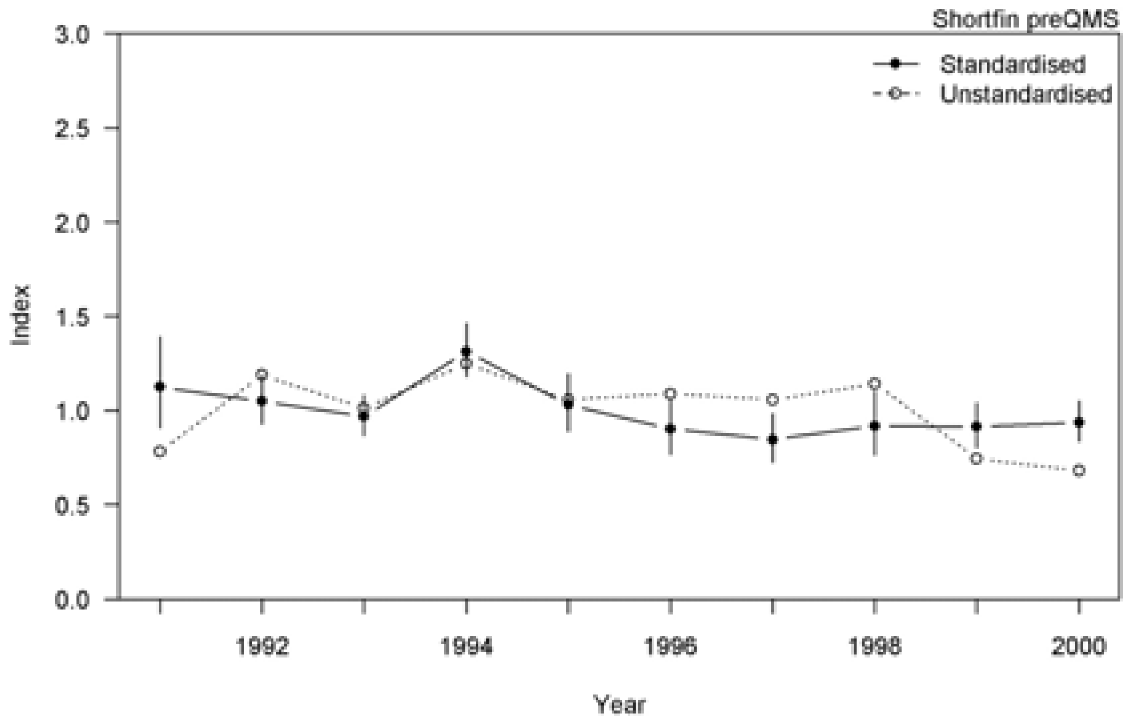

Figure H10: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA20 (AW)).

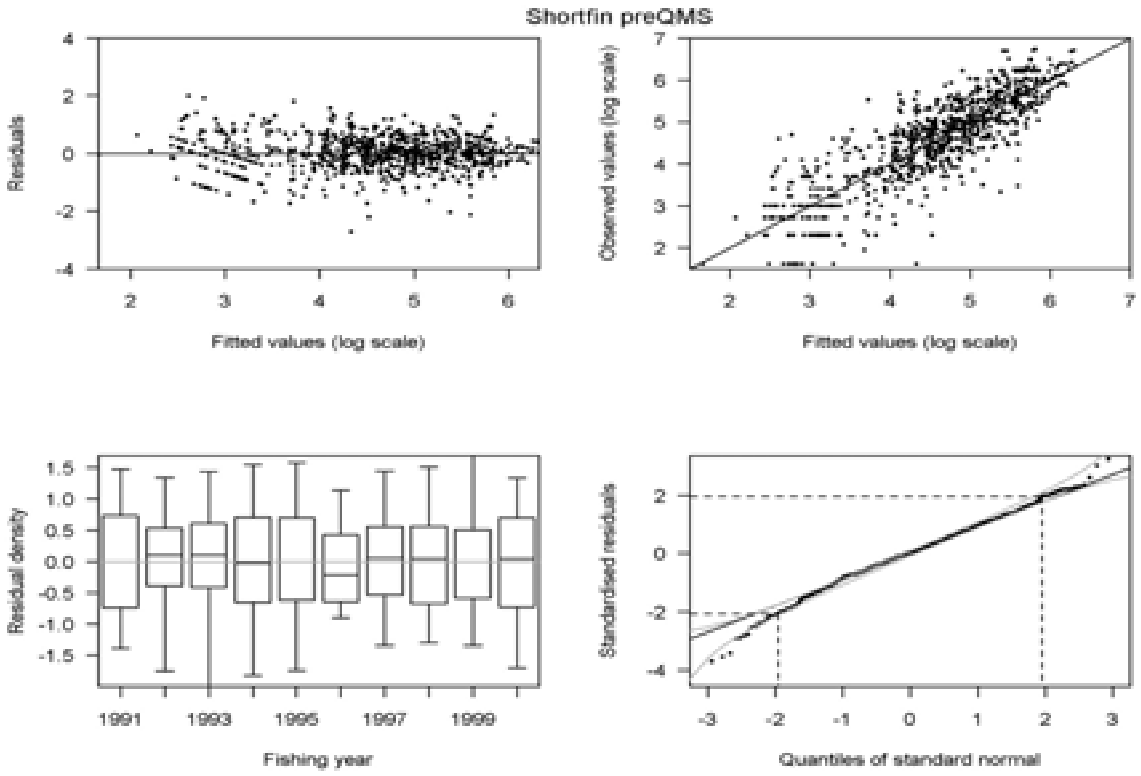

Figure H11: Residual diagnostic plots for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA20 (AW)).

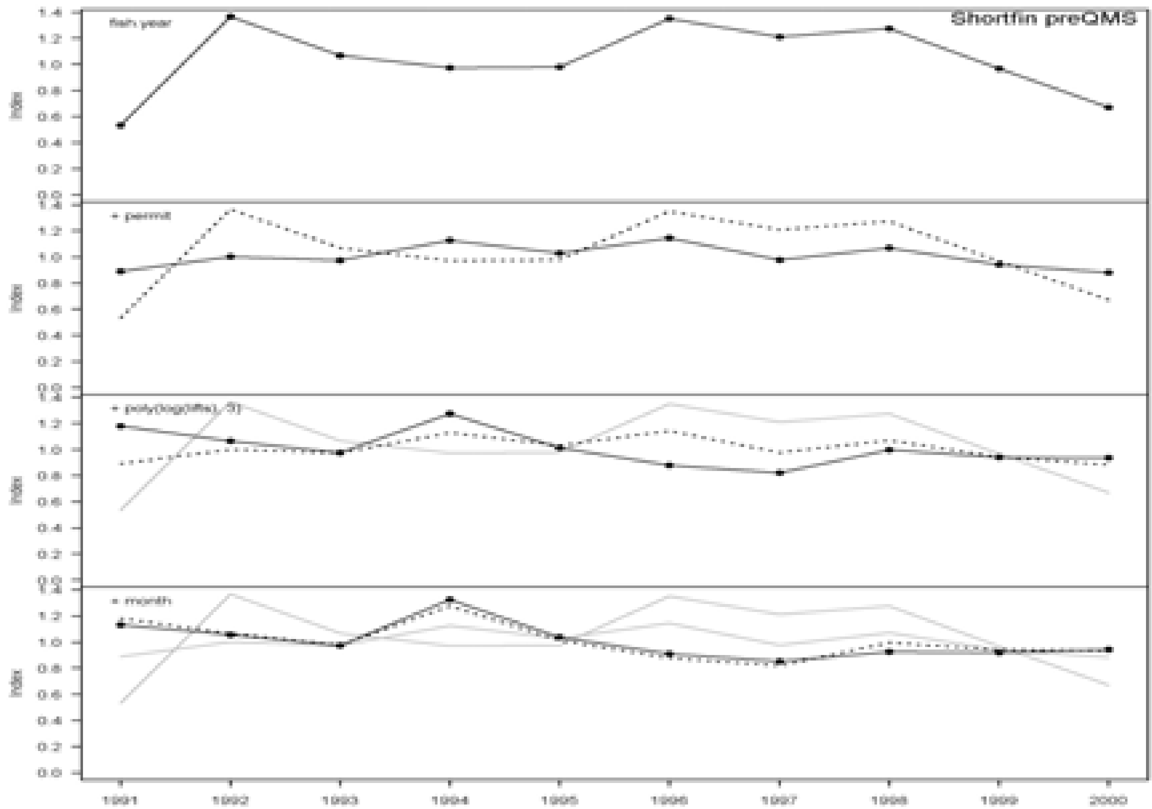

Figure H12: Step plot for the shortfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA20 (AW)).

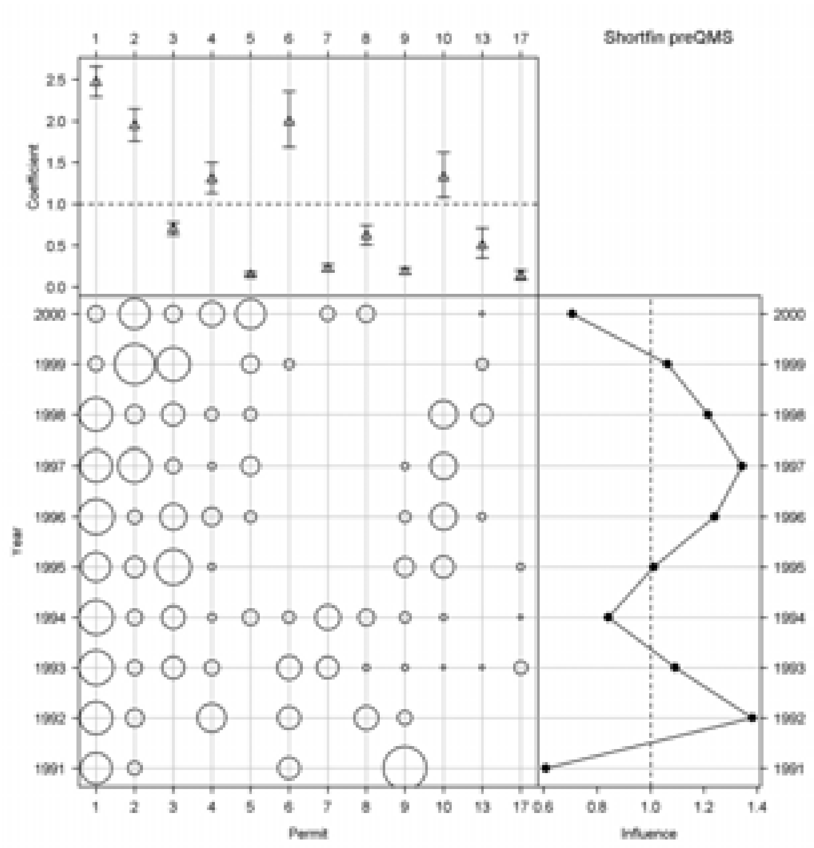

Figure H13: Influence of permit number for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

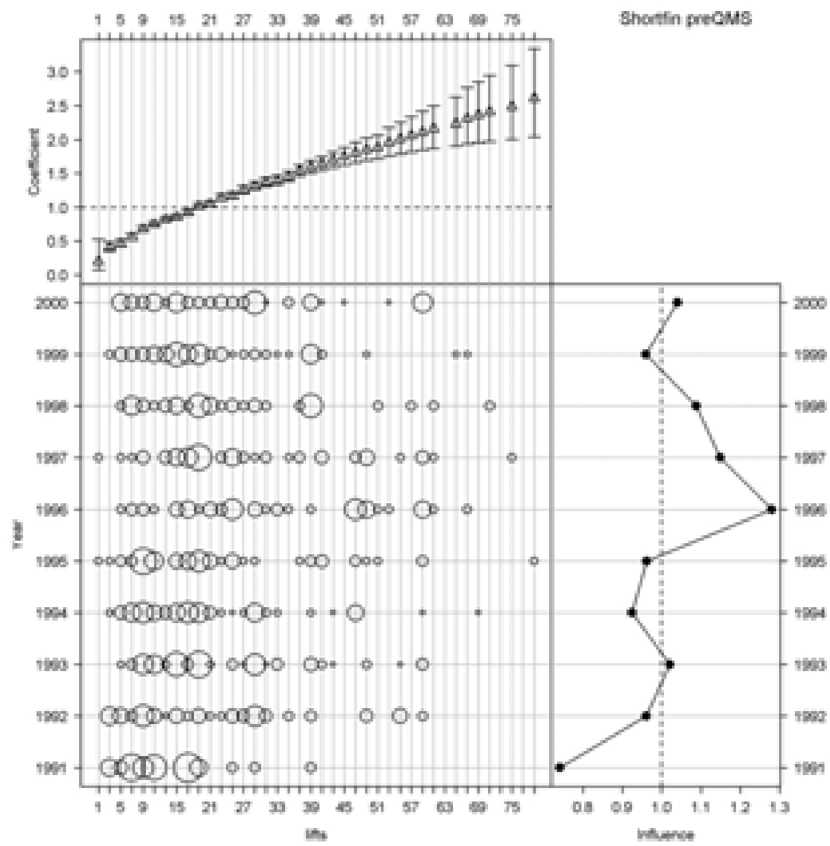

Figure H14: Influence of lifts for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

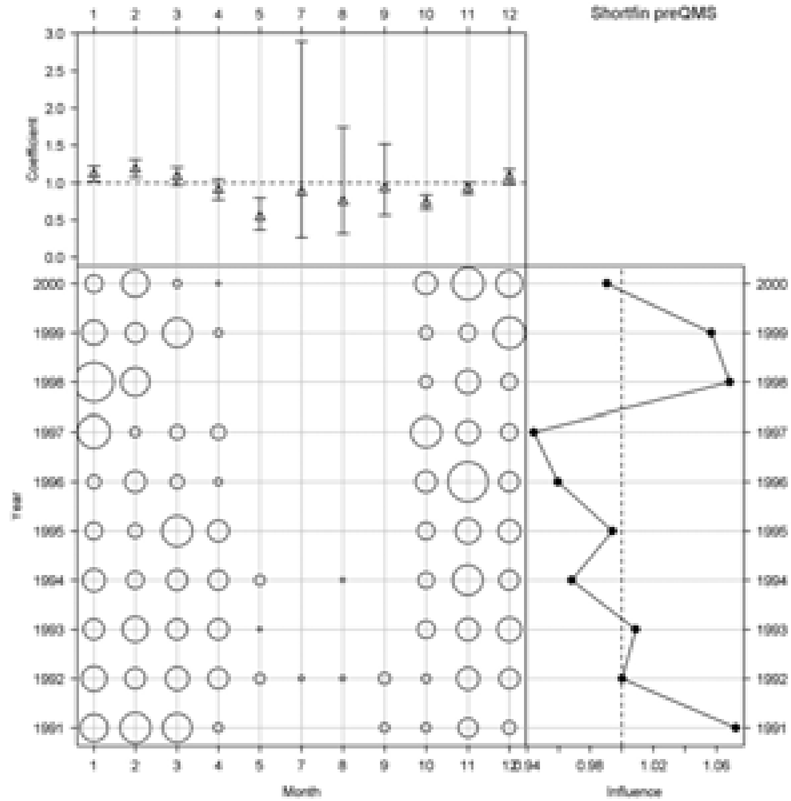

Figure H15: Influence of month for the shortfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

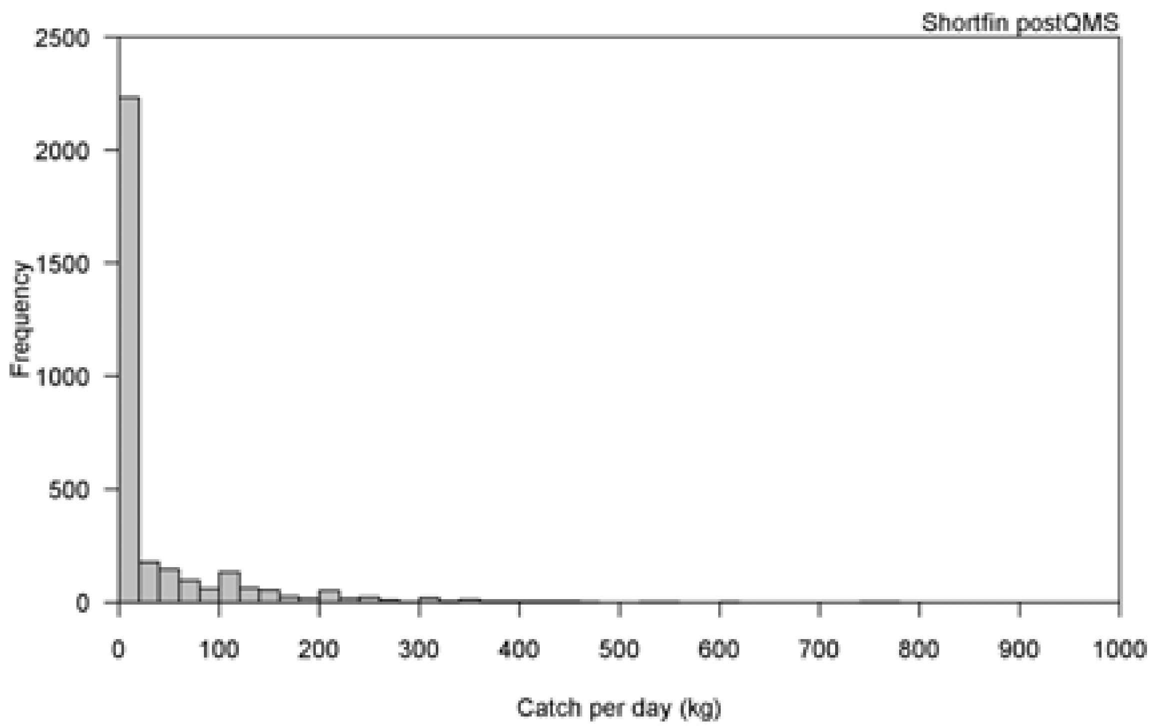

Figure H16: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

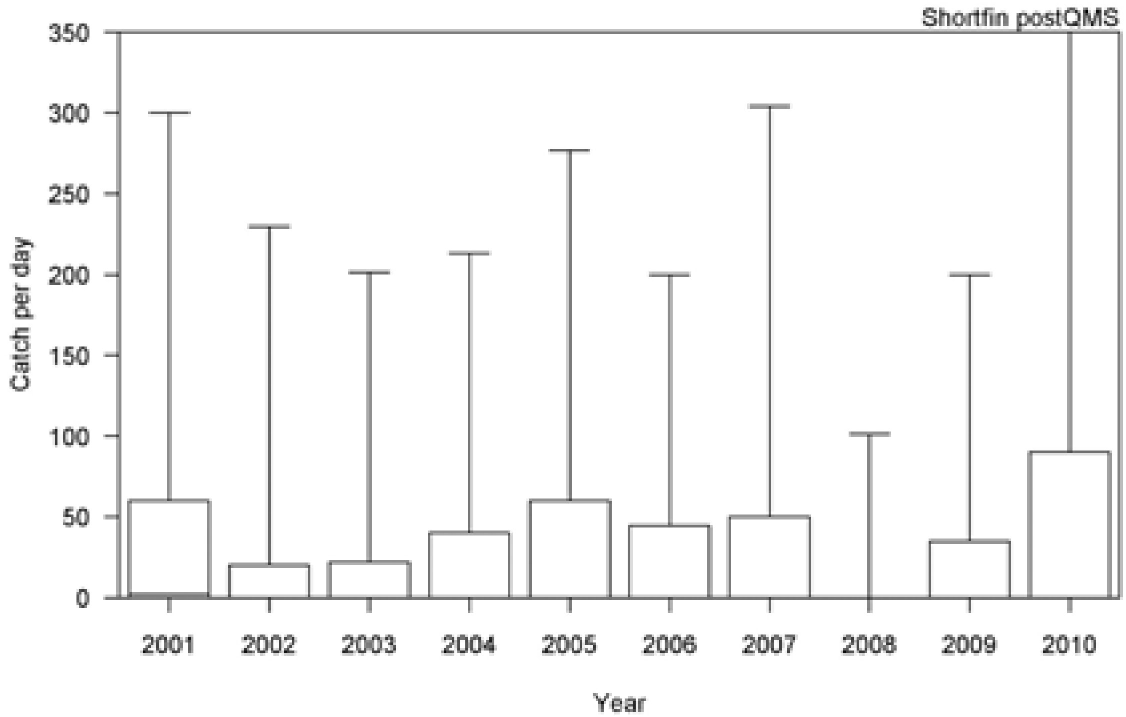

Figure H17: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA20 (AW)).

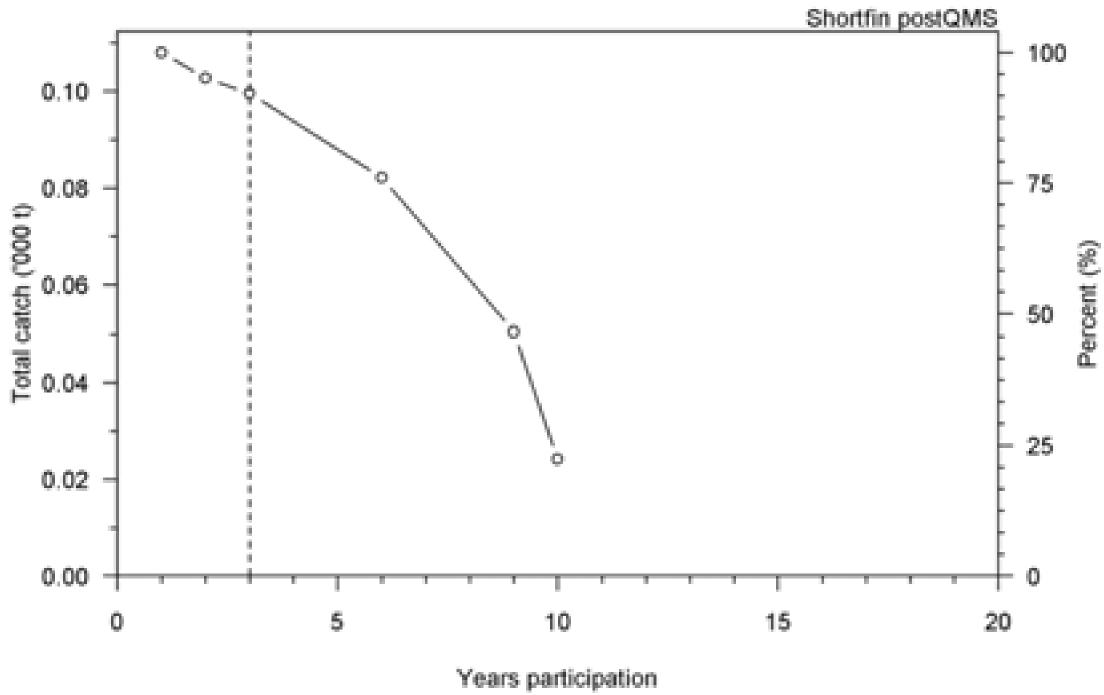

Figure H18: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA20 (AW)).

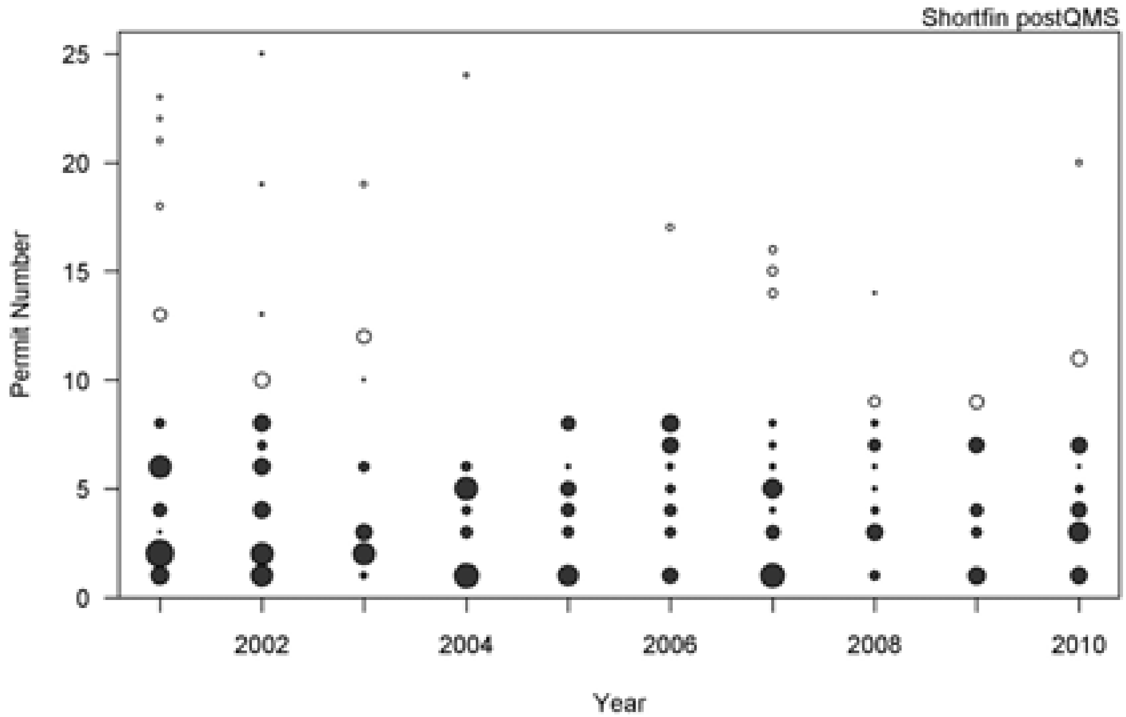

Figure H19: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA20 (AW)).

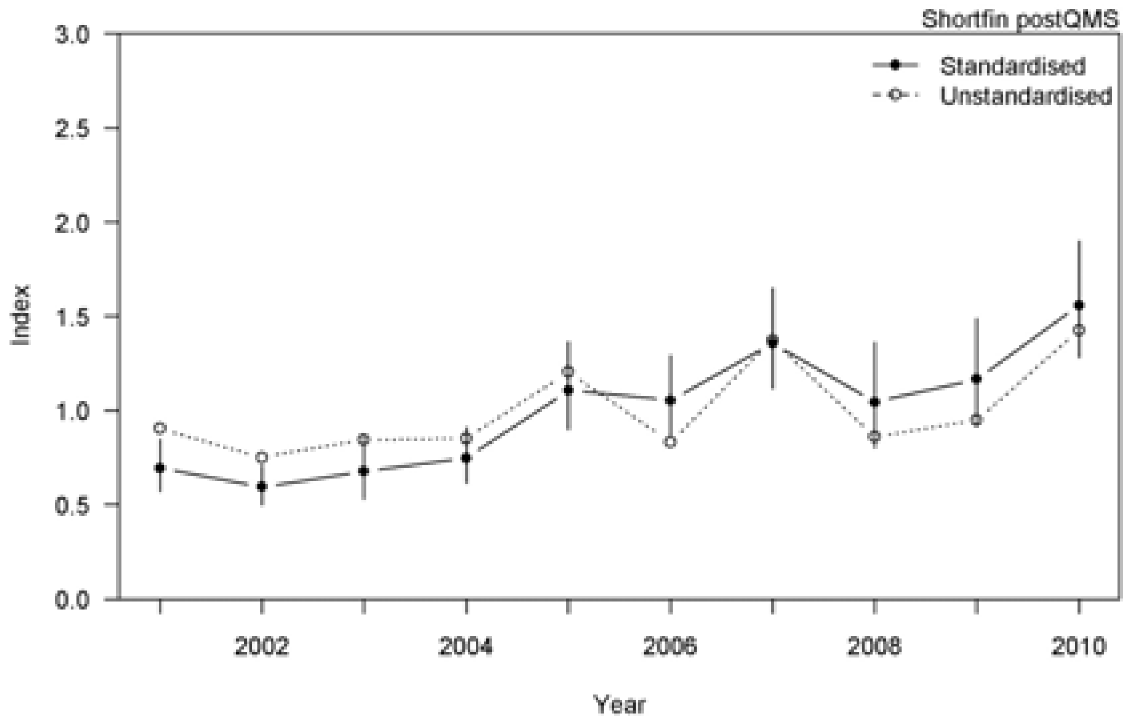

Figure H20: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers post-QMS eel CPUE model for the years 2000–01 to 2009–10 (ESA20 (AW)).

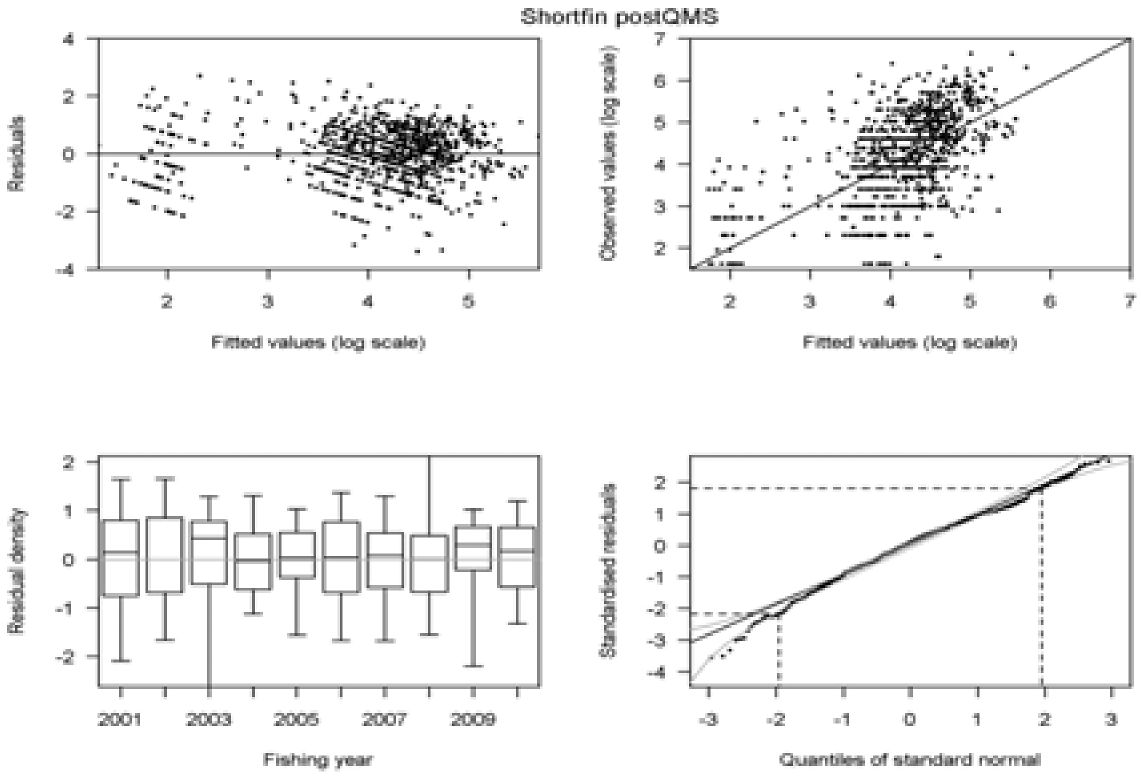

Figure H21: Residual diagnostic plots for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA20 (AW)).

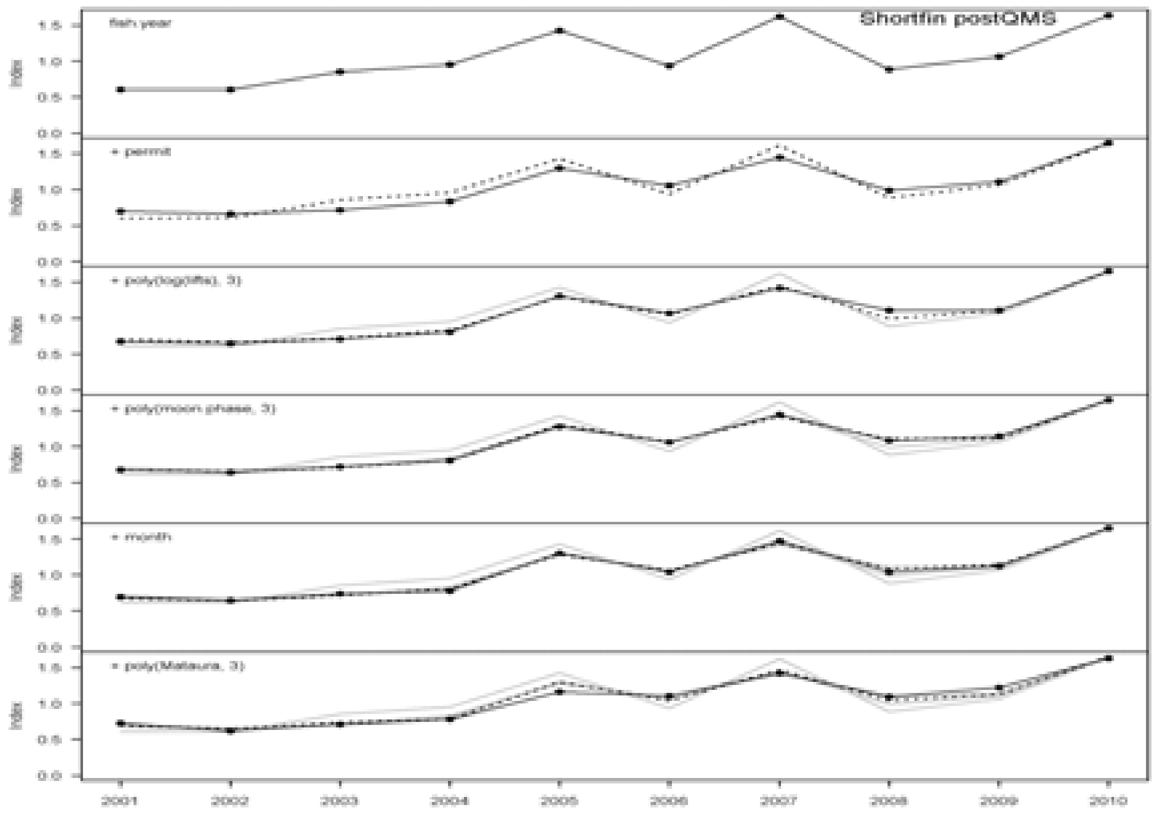

Figure H22: Step plot for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA20 (AW)).

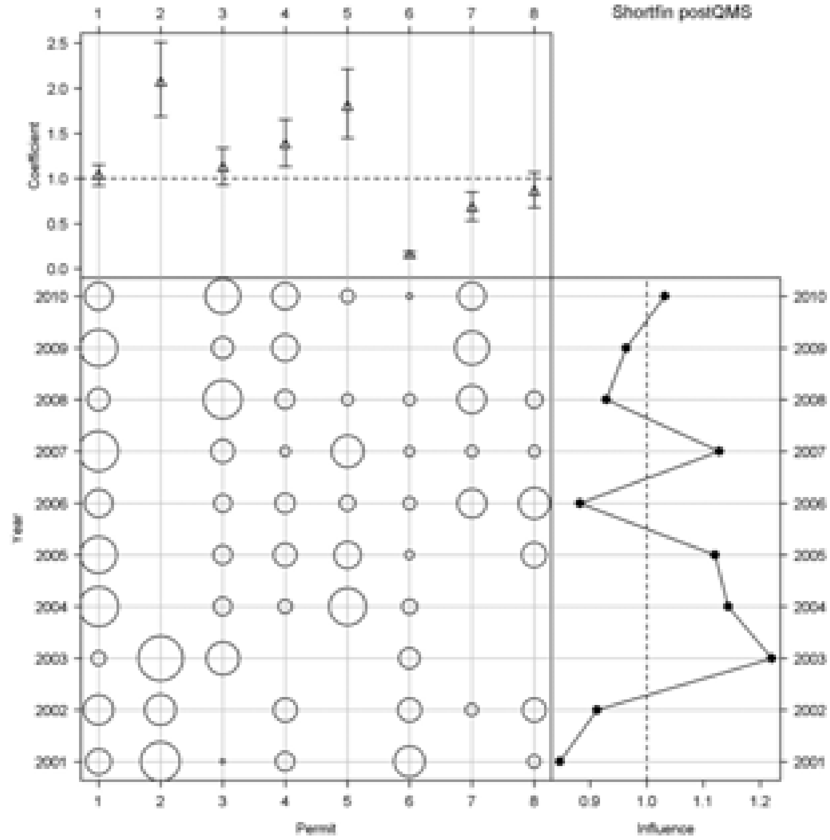

Figure H23: Influence of permit number for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

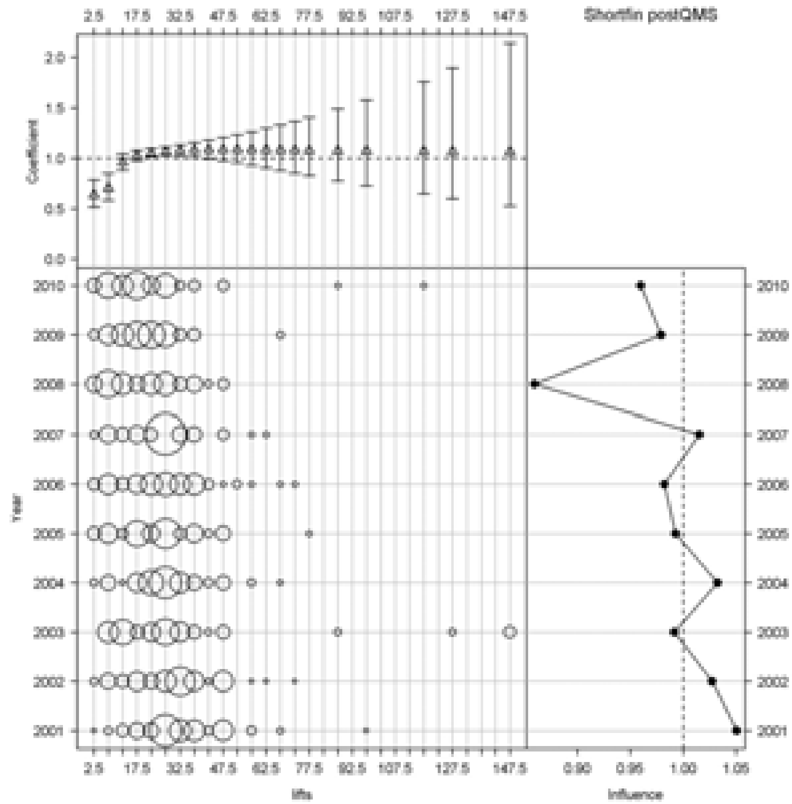

Figure H24: Influence of lifts for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

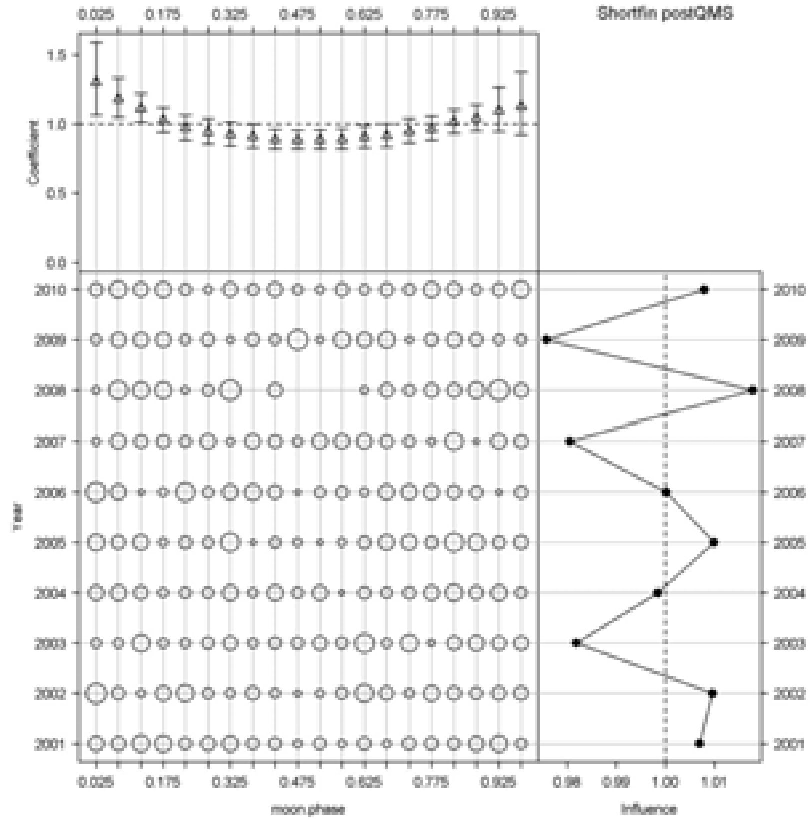

Figure H25: Influence of moon phase for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

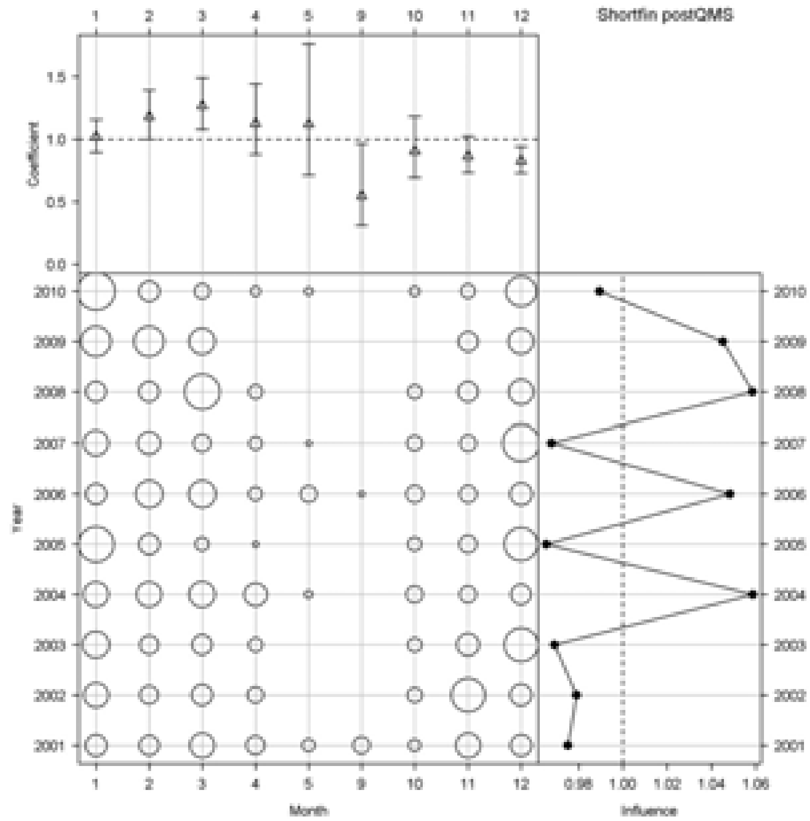

Figure H26: Influence of month for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

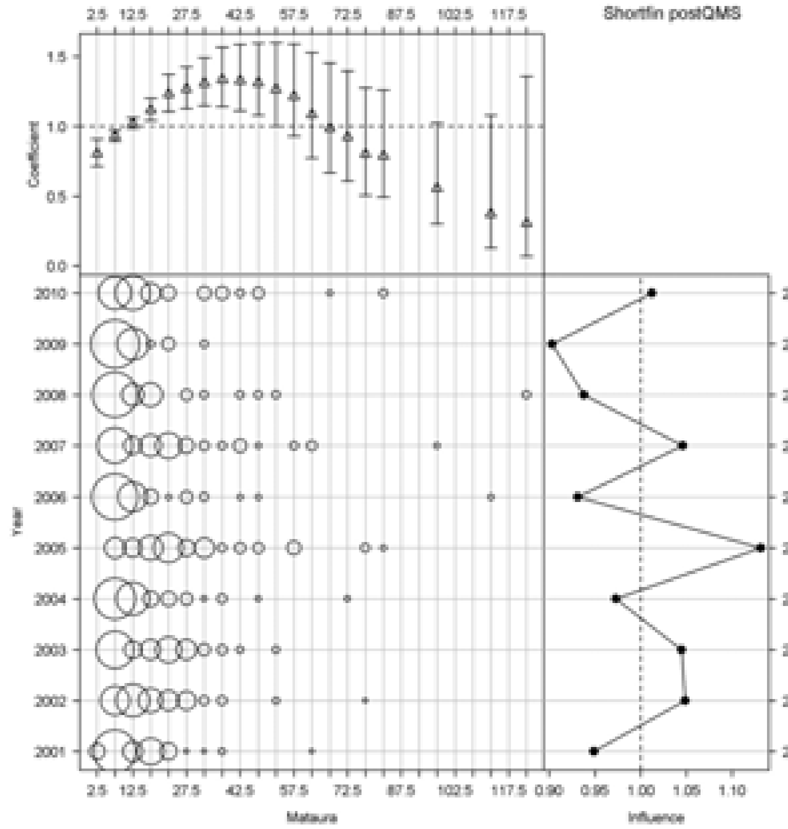

Figure H27: Influence of Mataura River flow for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

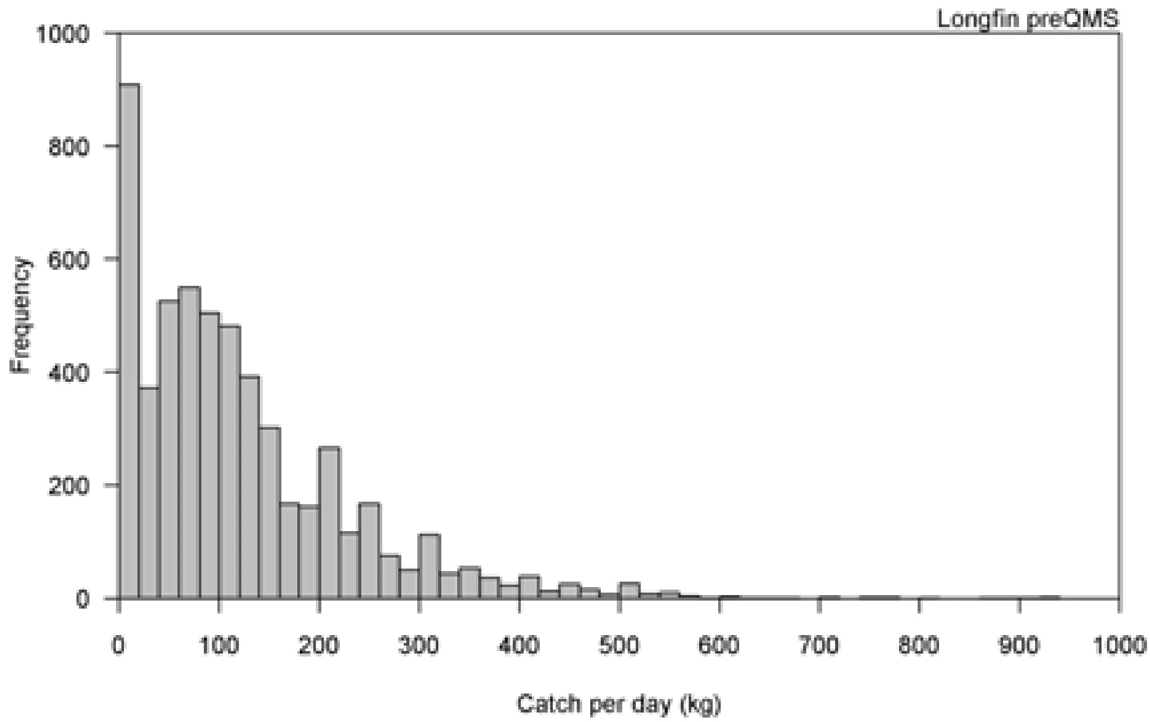

Figure H28: Frequency of longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

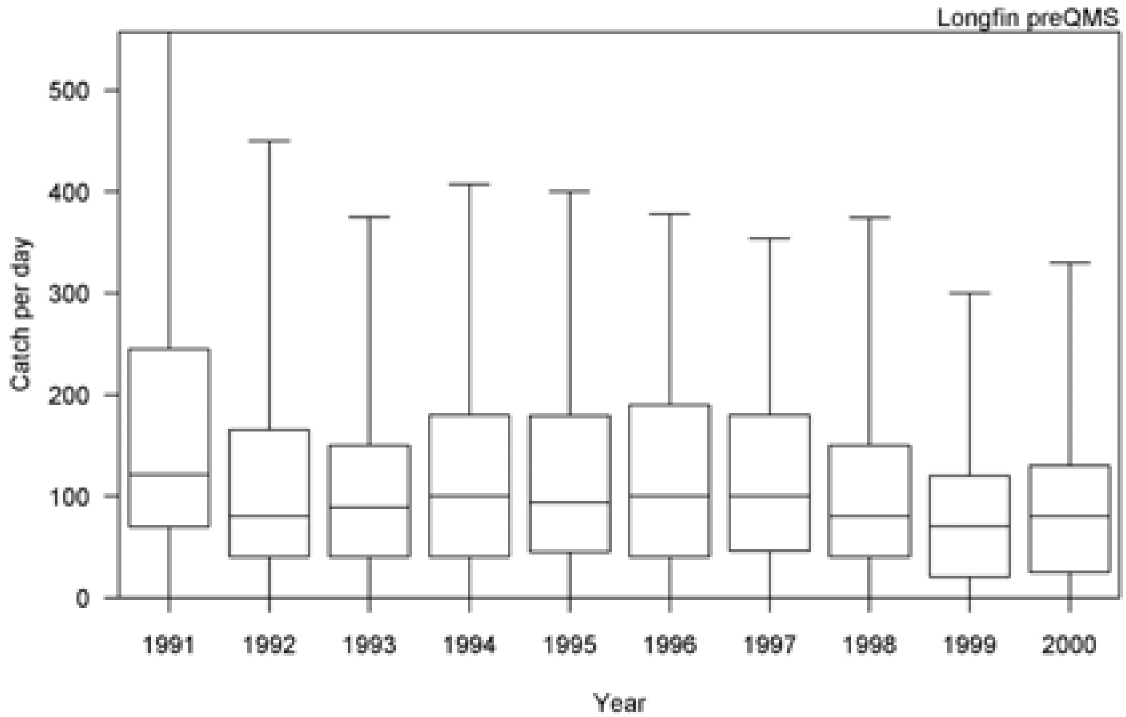

Figure H29: Longfin eel catch per day for the years 1990–91 to 1999–2000 (pre-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA20 (AW)).

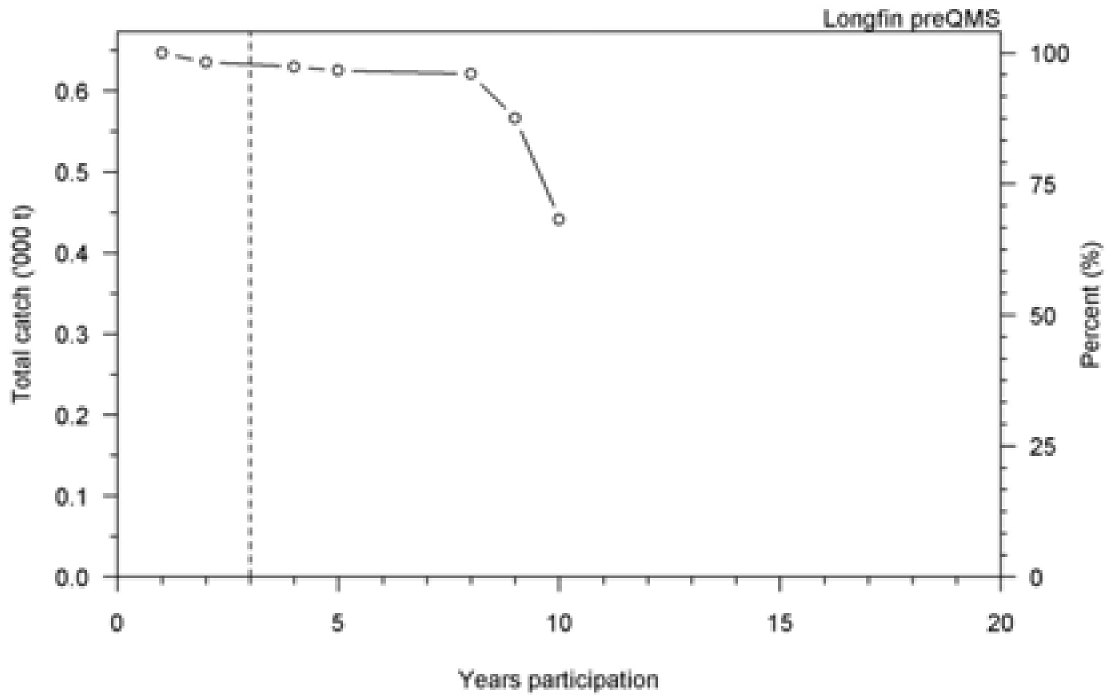

Figure H30: Relationship between years of participation in the fishery and longfin catch for the years 1990–91 to 1999–2000 (pre-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA20 (AW)).

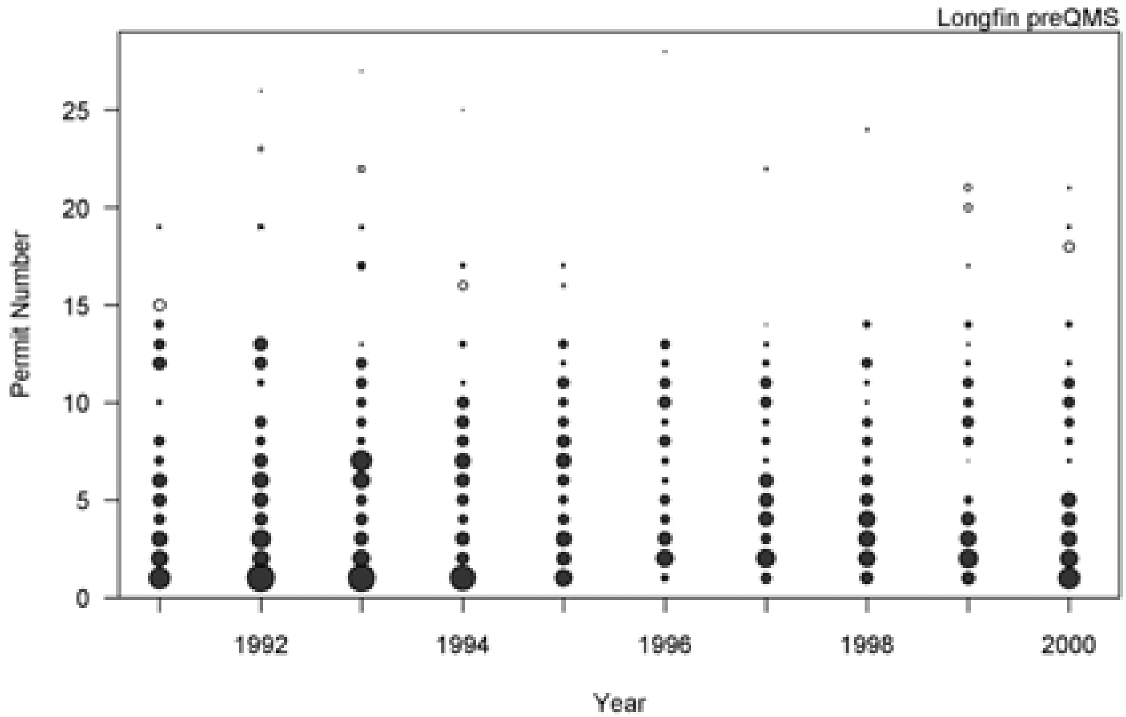

Figure H31: Relative longfin catch from all fishers (all circles) for the years 1990–91 to 1999–2000 (pre-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA20 (AW)).

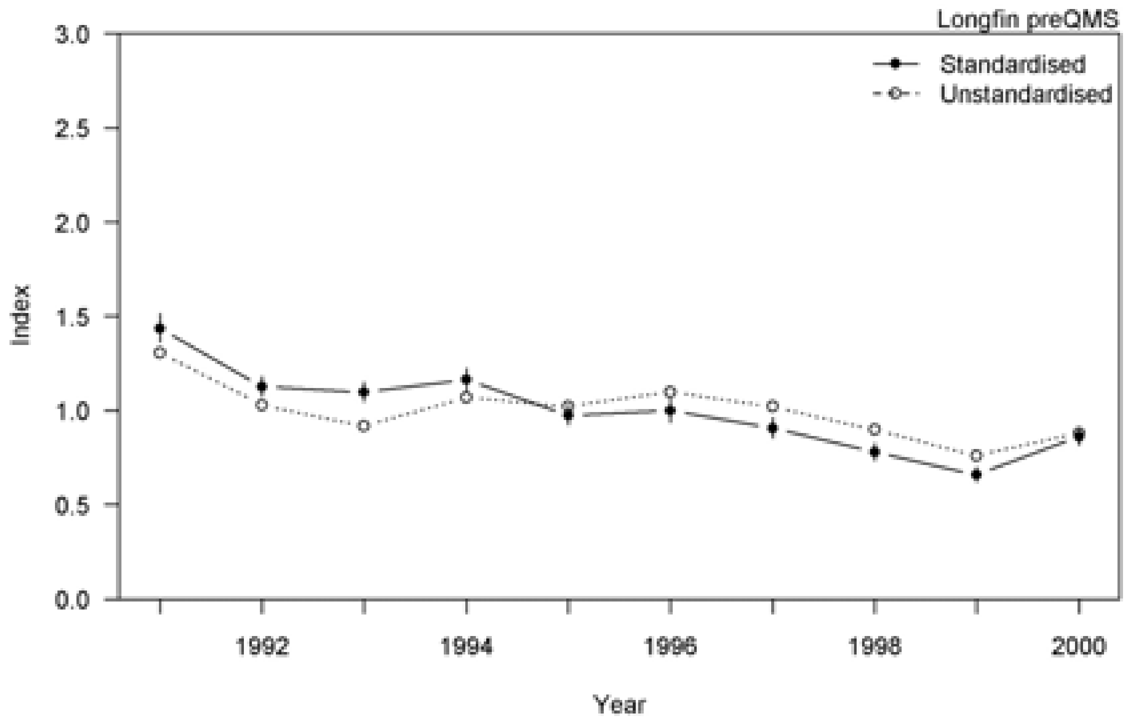

Figure H32: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers pre-QMS eel CPUE model for the years 1990–91 to 1999–2000 (ESA20 (AW)).

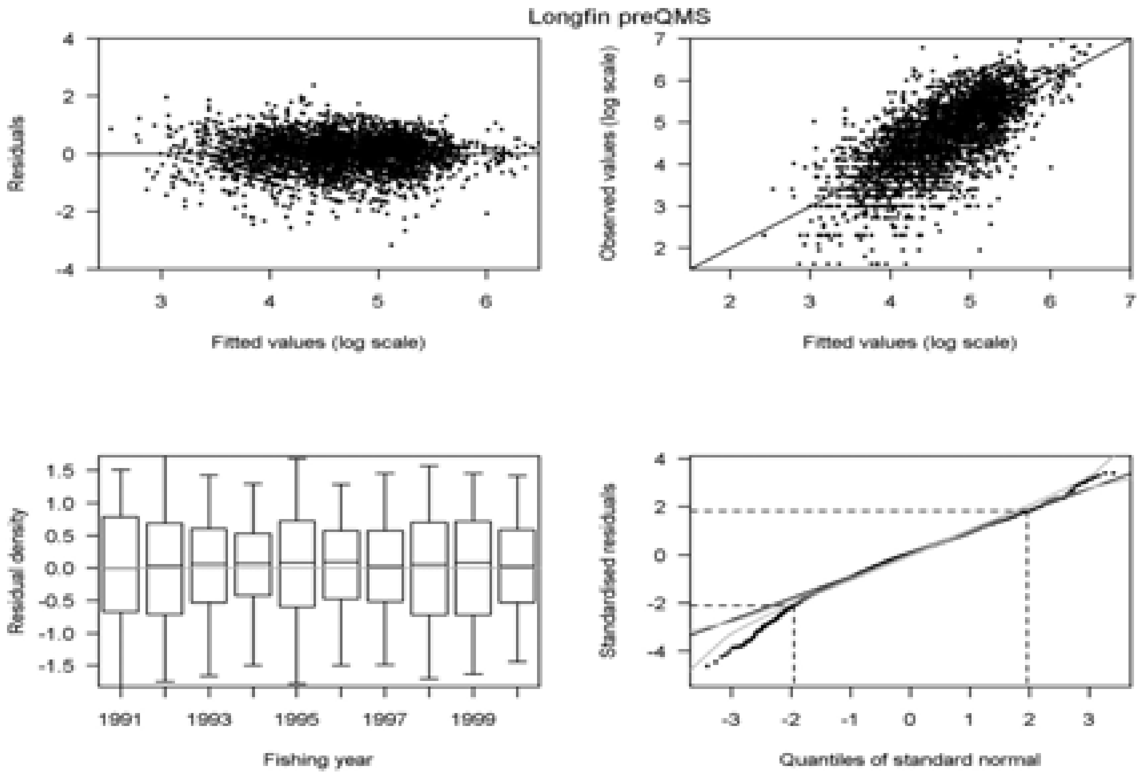

Figure H33: Residual diagnostic plots for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA20 (AW)).

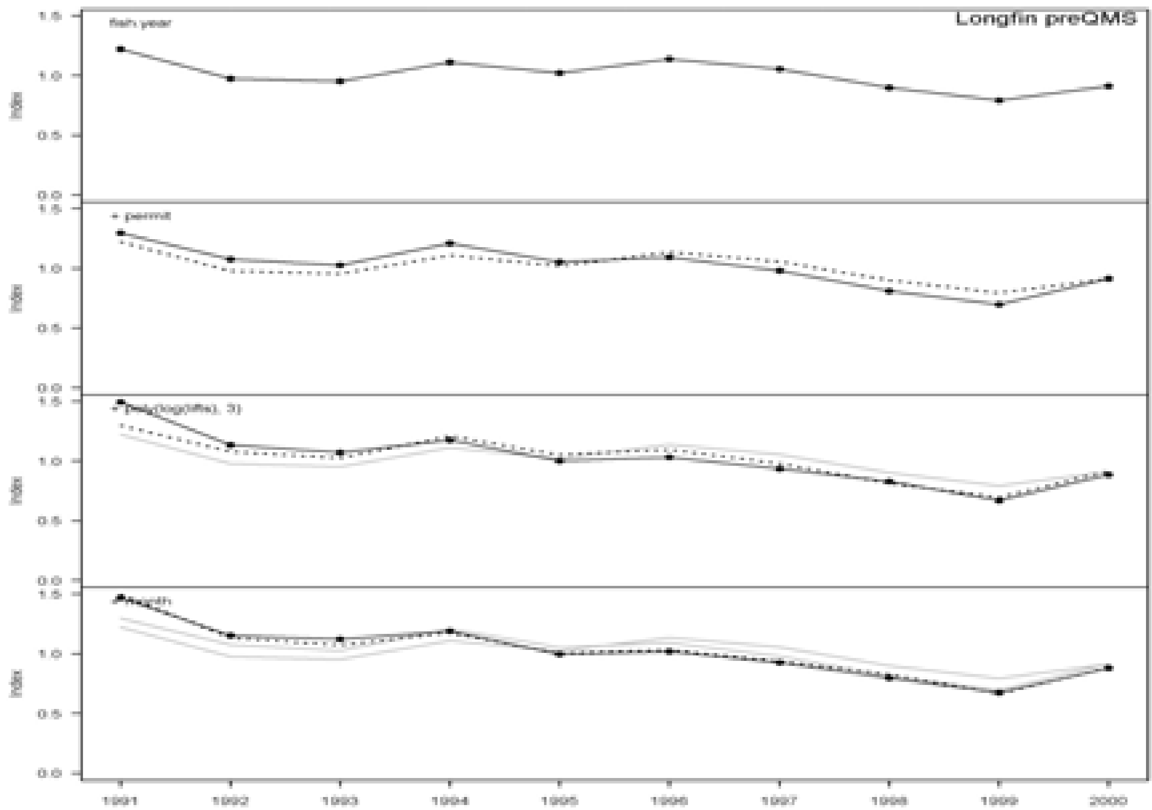

Figure H34: Step plot for the longfin eel CPUE model for the years 1990–91 to 1999–2000 (pre-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA20 (AW)).

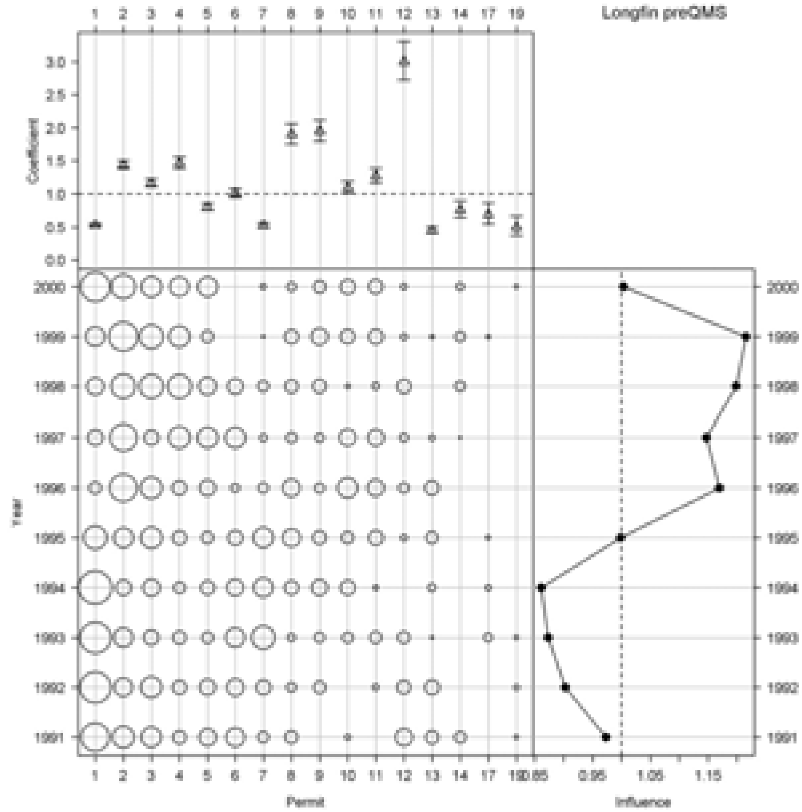

Figure H35: Influence of permit number for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

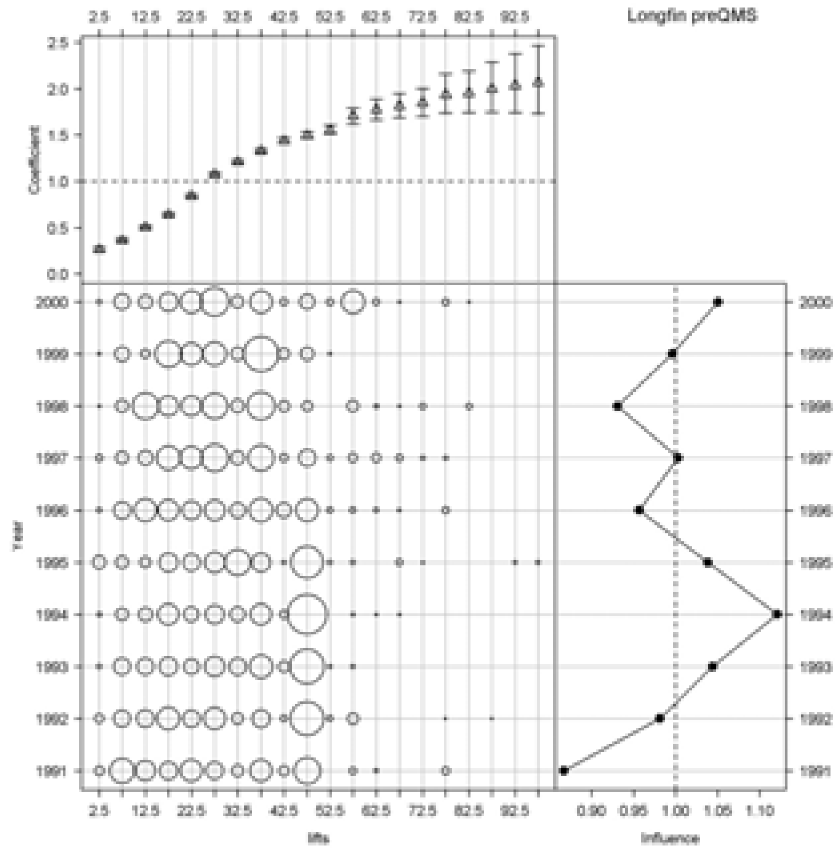

Figure H36: Influence of lifts for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

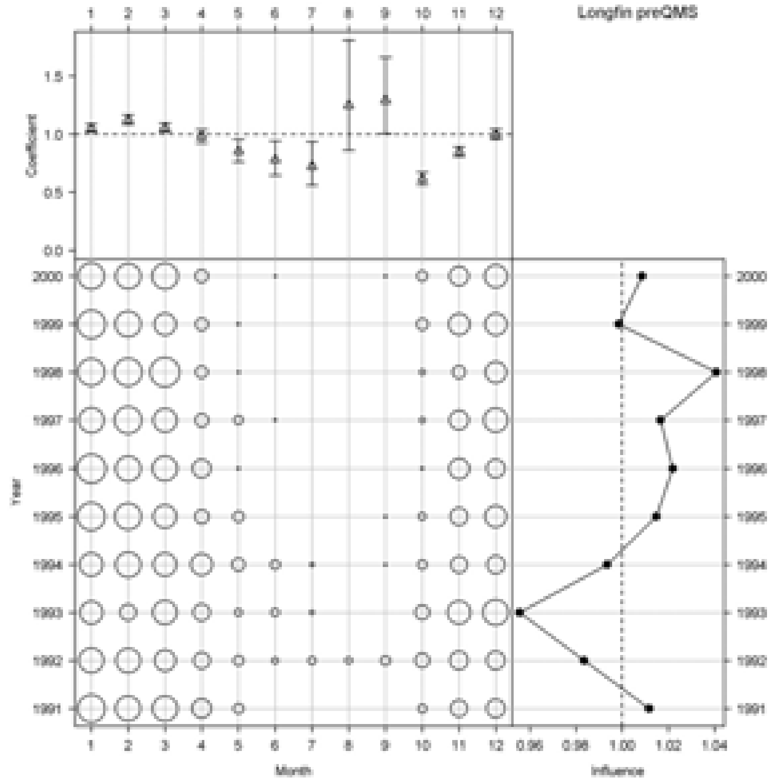

Figure H37: Influence of month for the longfin CPUE model for the years 1990–91 to 1999–2000 (pre-QMS) (ESA20 (AW)).

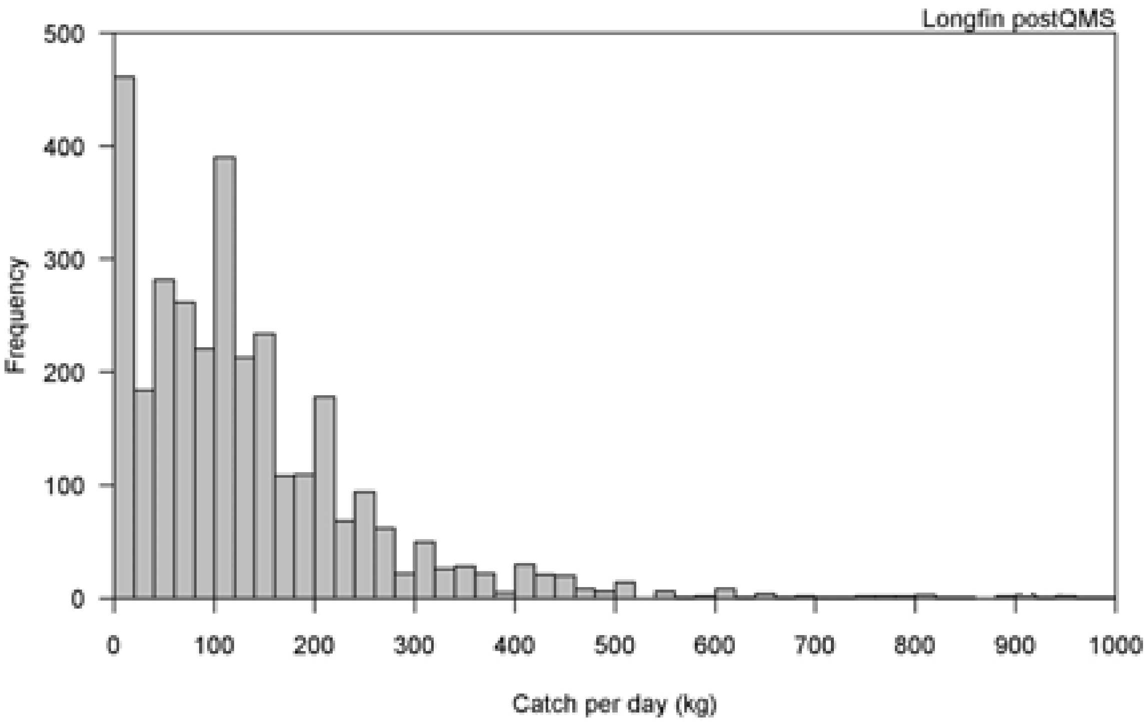

Figure H38: Frequency of longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

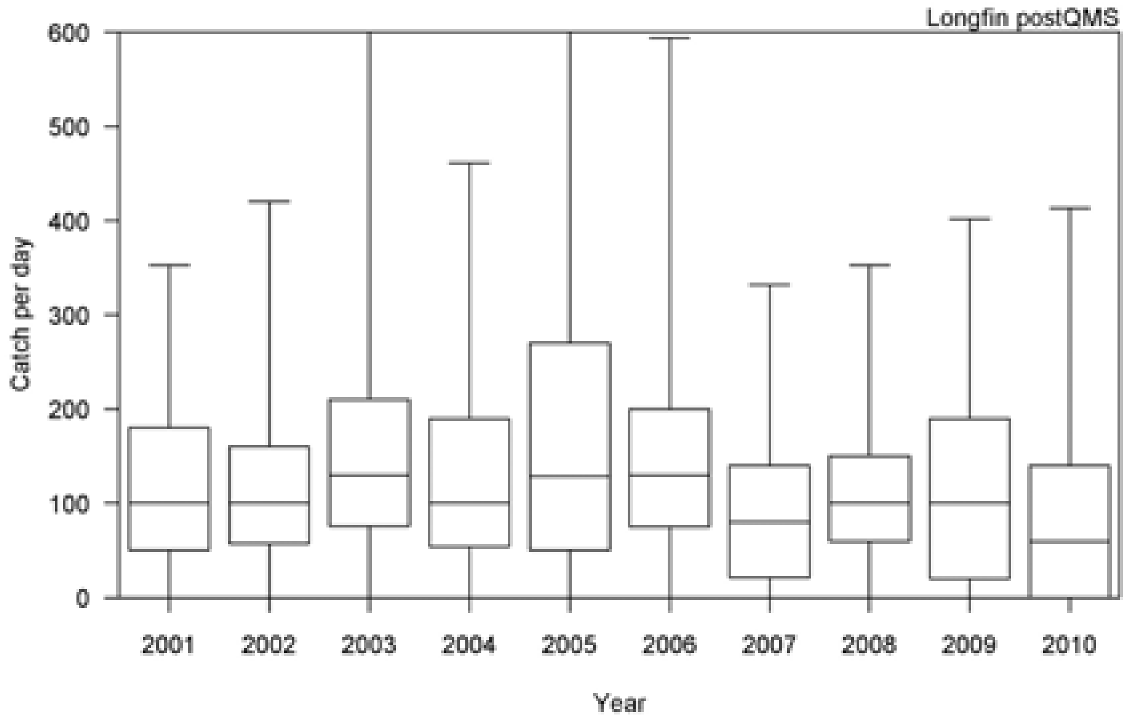

Figure H39: Longfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA20 (AW)).

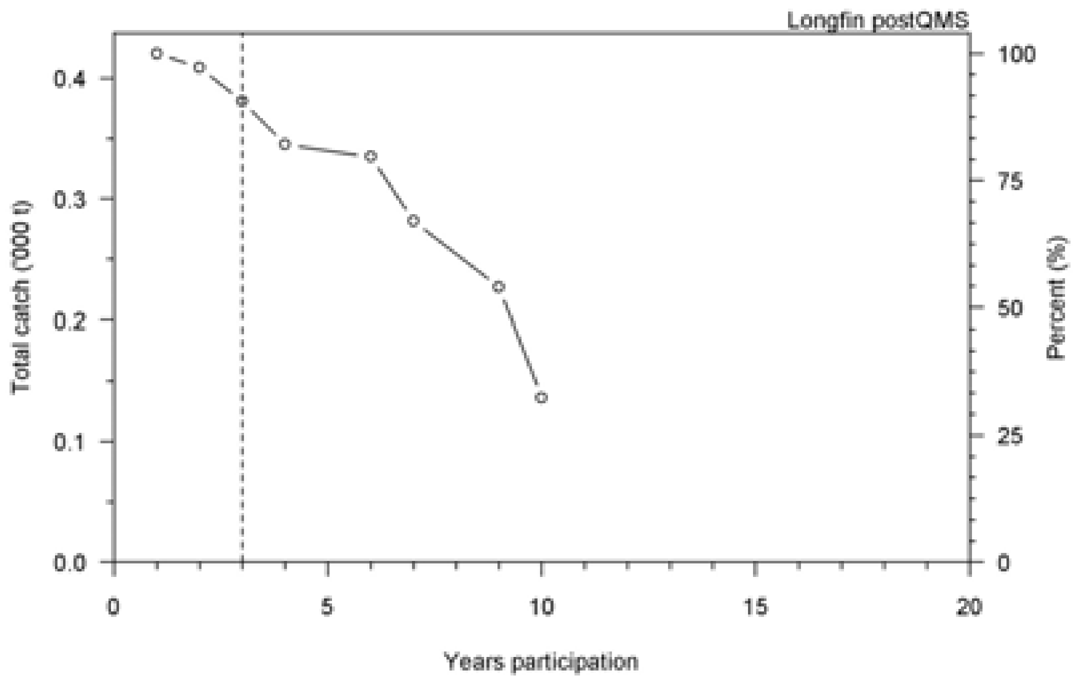

Figure H40: Relationship between years of participation in the fishery and longfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total longfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA20 (AW)).

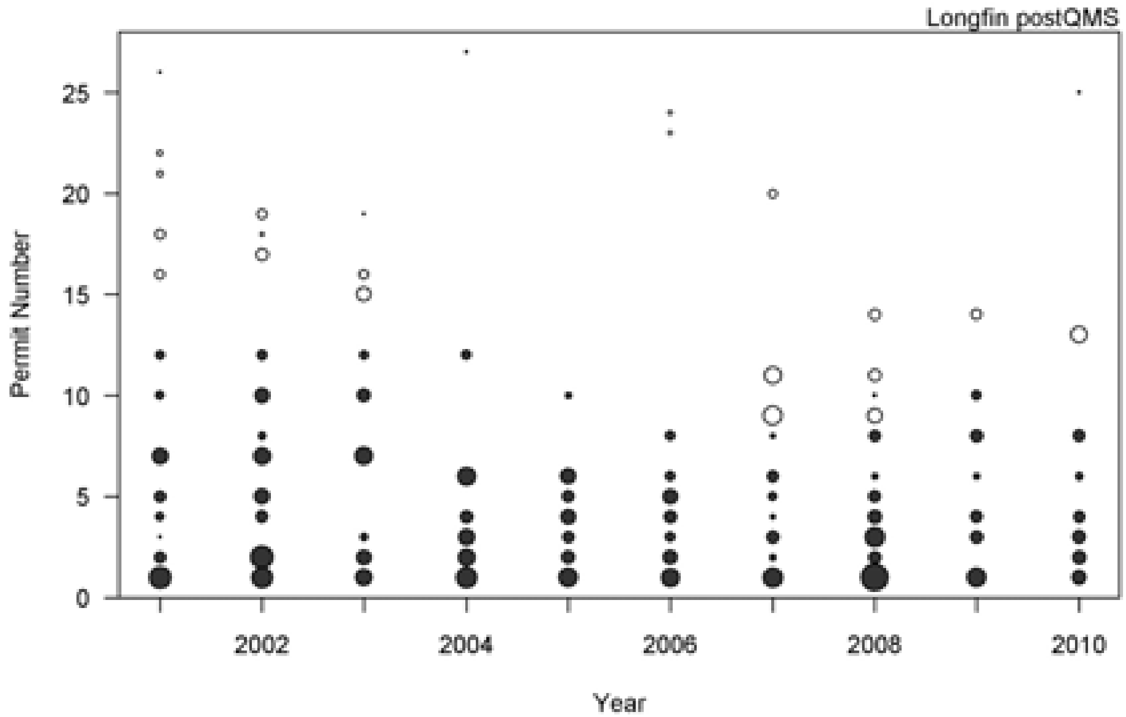

Figure H41: Relative longfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA20 (AW)).

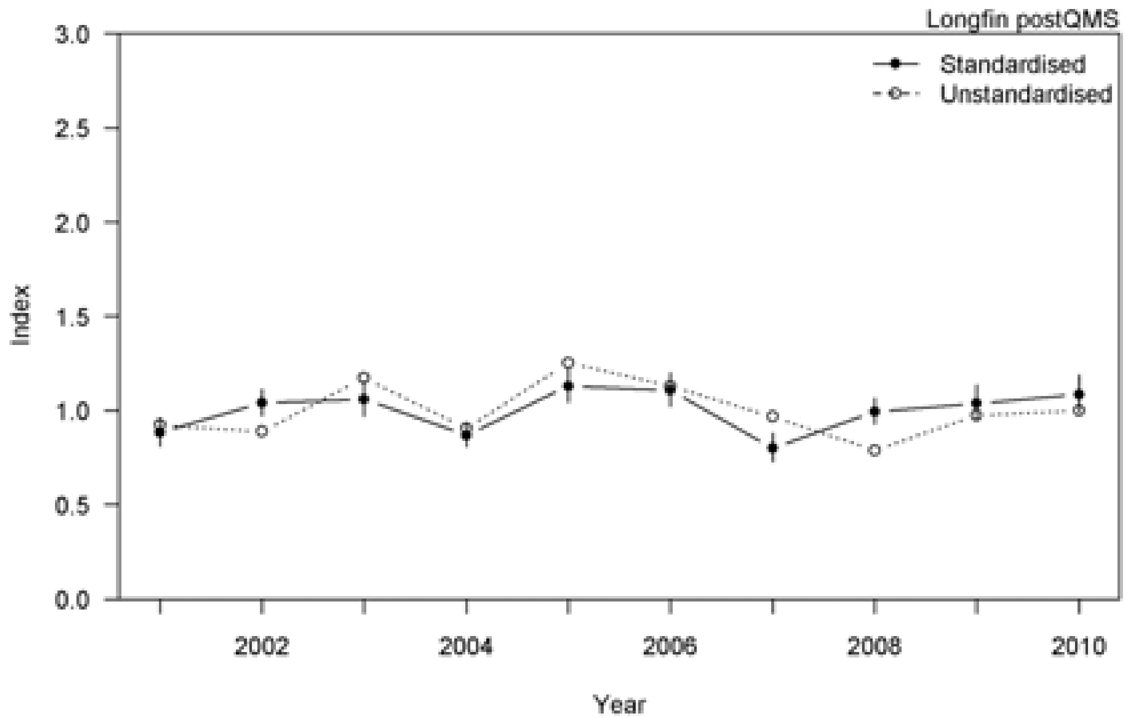

Figure H42: Indices of unstandardised catch per day and standardised CPUE for longfin core fishers post-QMS eel CPUE model for the years 2000–01 to 2009–10 (ESA20 (AW)).

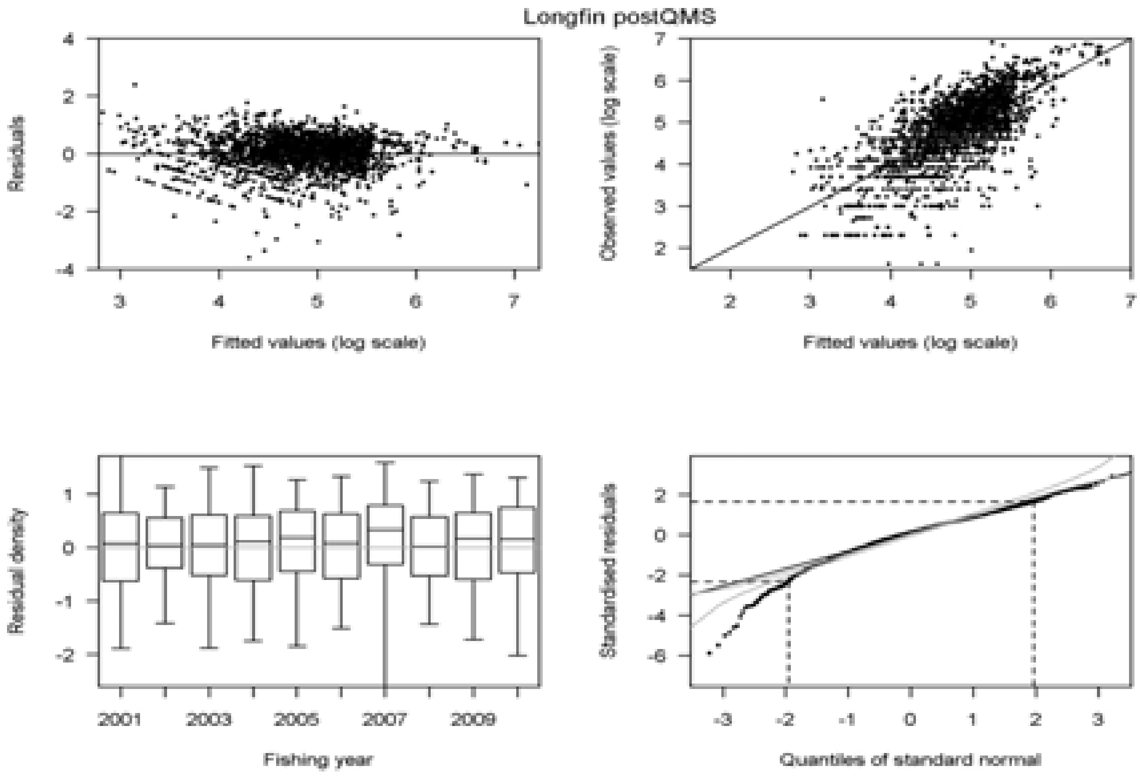

Figure H43: Residual diagnostic plots for the longfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA20 (AW)).

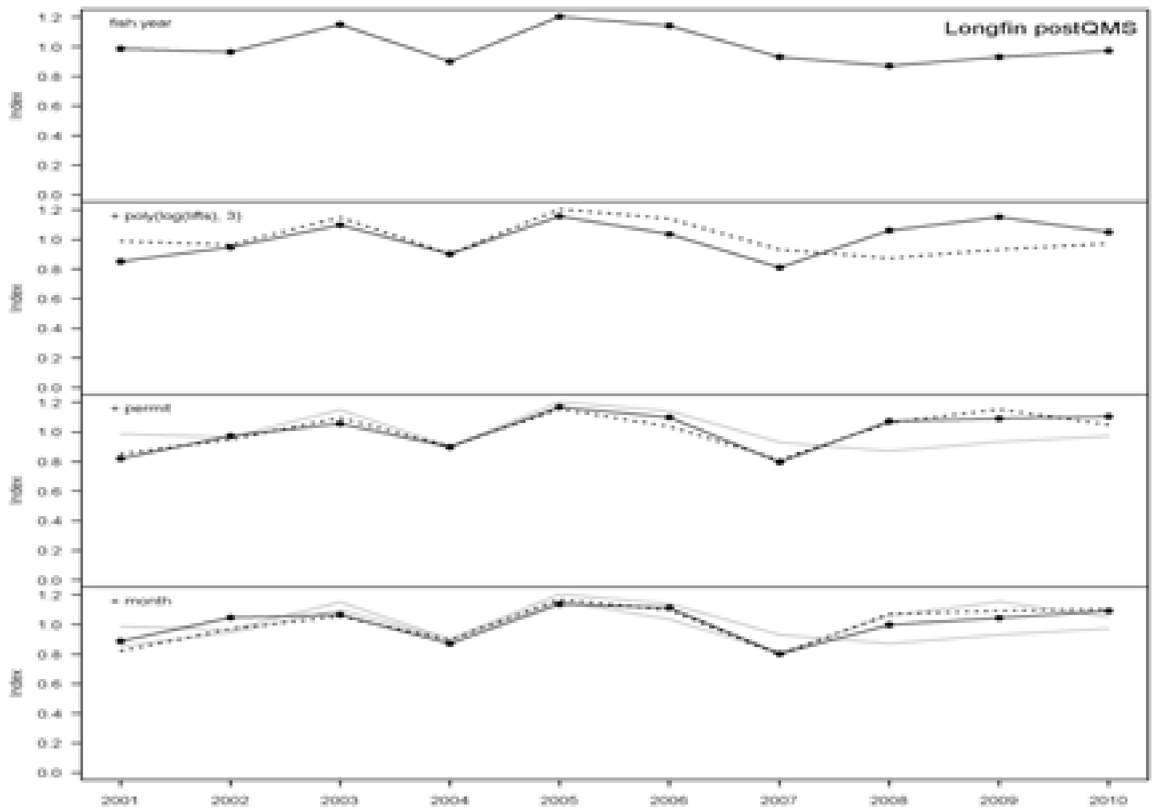

Figure H44: Step plot for the longfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA20 (AW)).

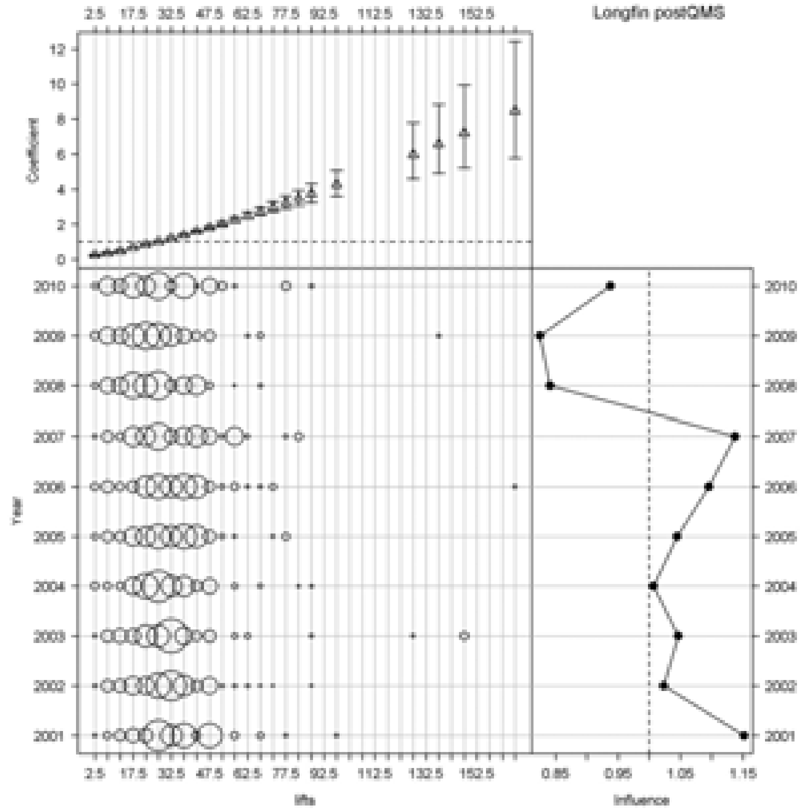

Figure H45: Influence of lifts for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

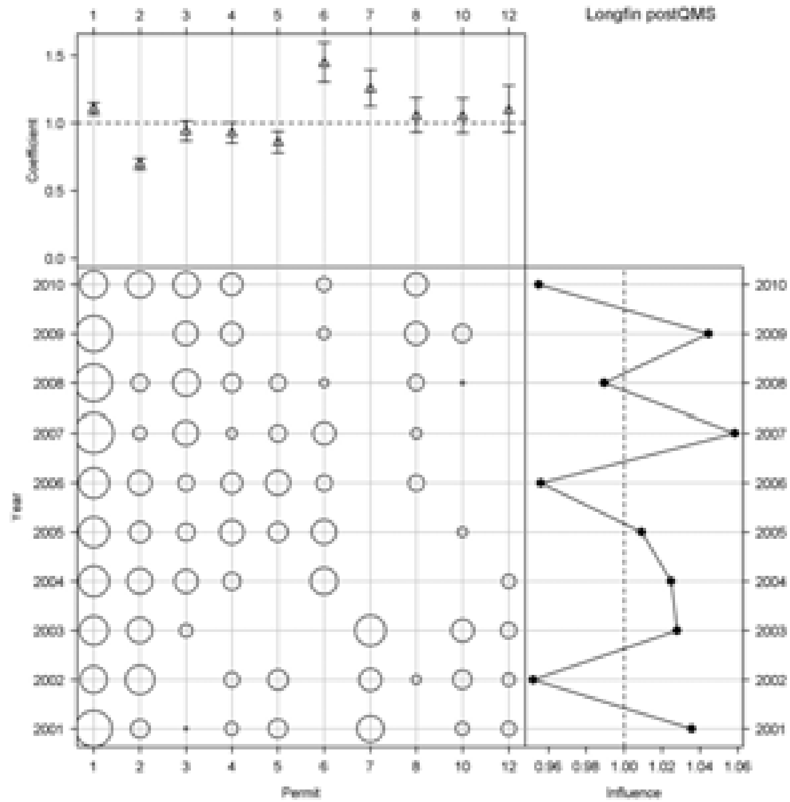

Figure H46: Influence of permit number for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

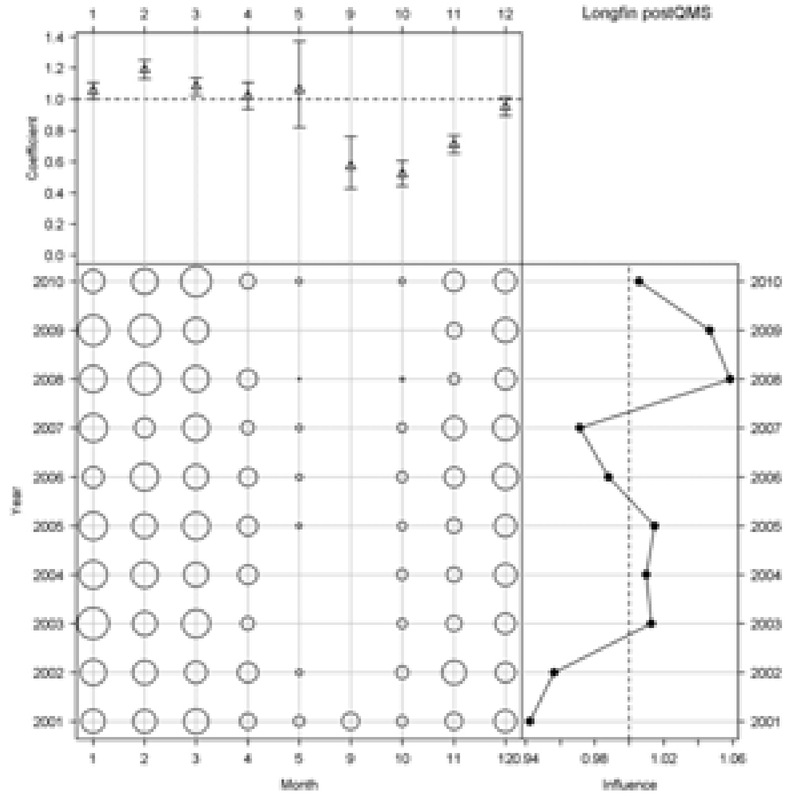

Figure H47: Influence of month for the longfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA20 (AW)).

Appendix I: ESA 21 (AS).

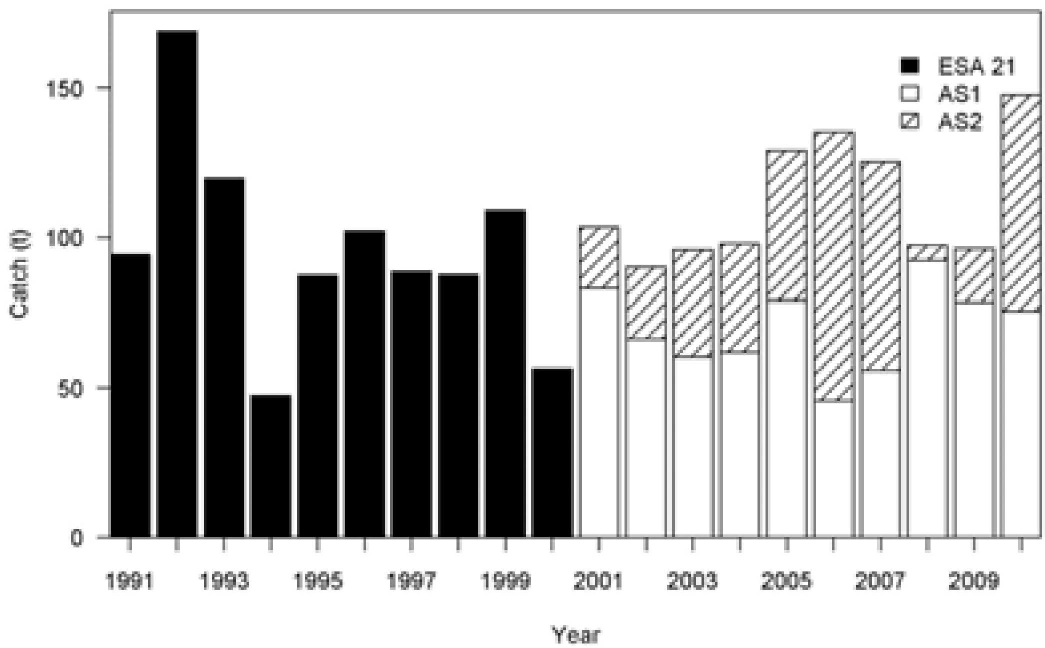

Figure I1: Total estimated commercial catch of all eels (shortfin and longfin) by area for the years 1990–91 to 2009–10. Shortfin is more than 99% of total catch. ESA 21, entire lake; AS1, entire lake outside migration area; AS2, migration area.

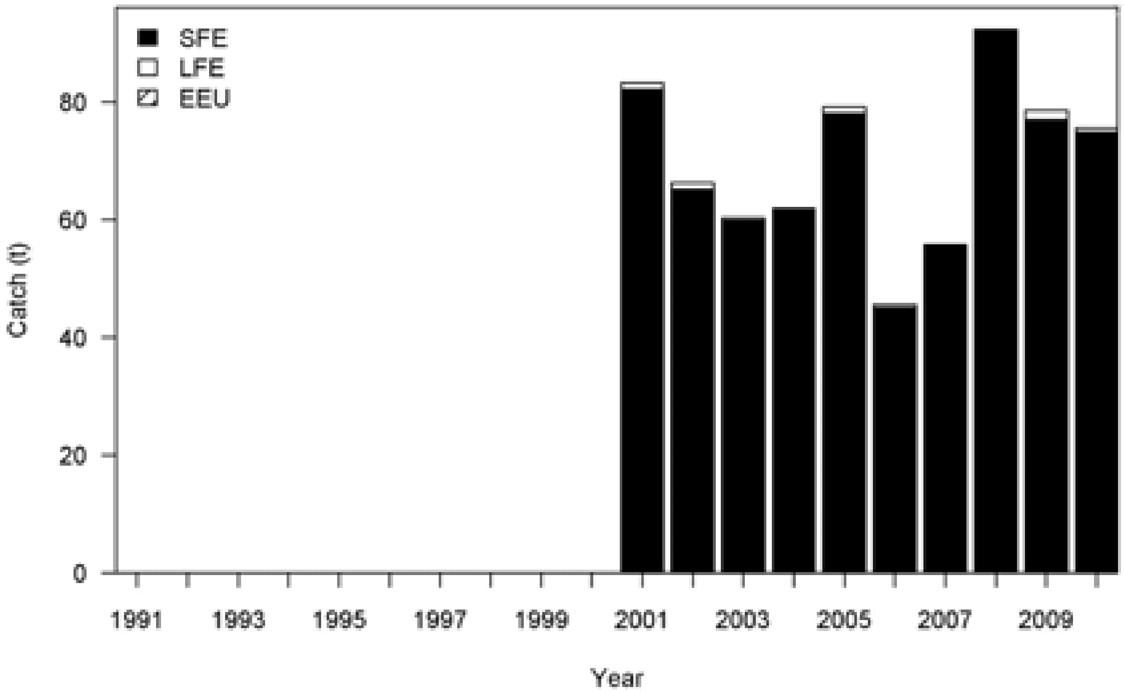

Figure I2: Total estimated commercial catch of shortfin (SFE), longfin (LFE), and unclassified eel catch (EEU) for the years 2000–01 to 2009–10 (ESA21 (AS1)).

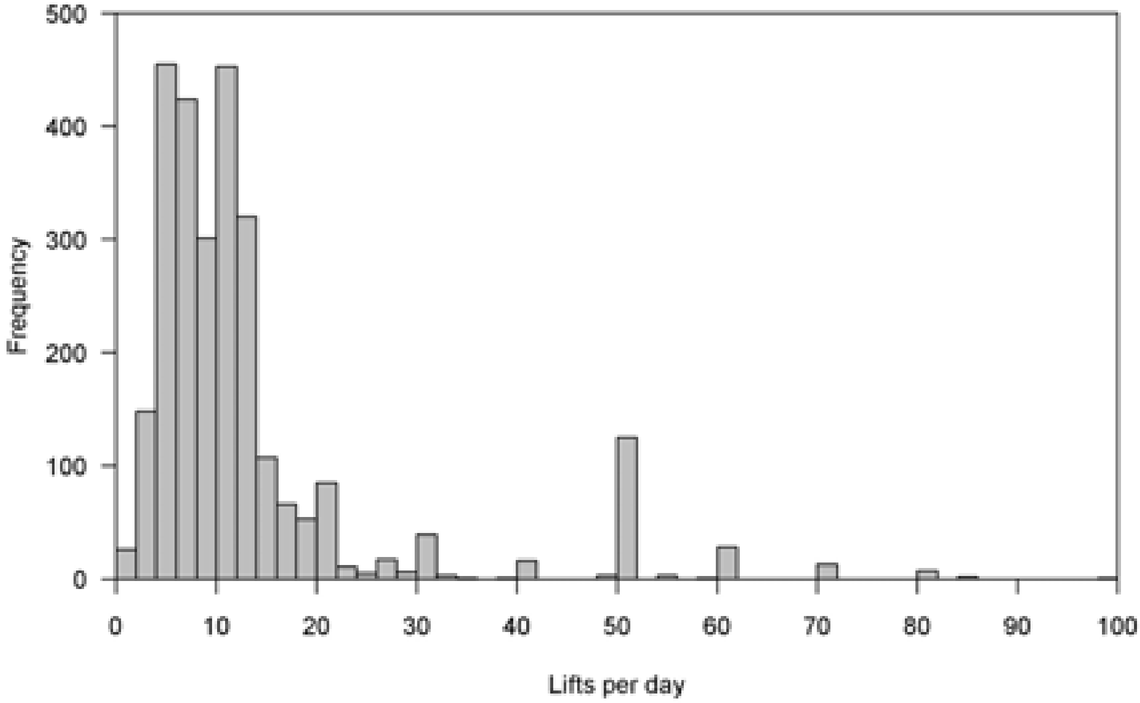

Figure I3: Frequency of total lifts per day for the years 2000–01 to 2009–10 (ESA21 (AS1)).

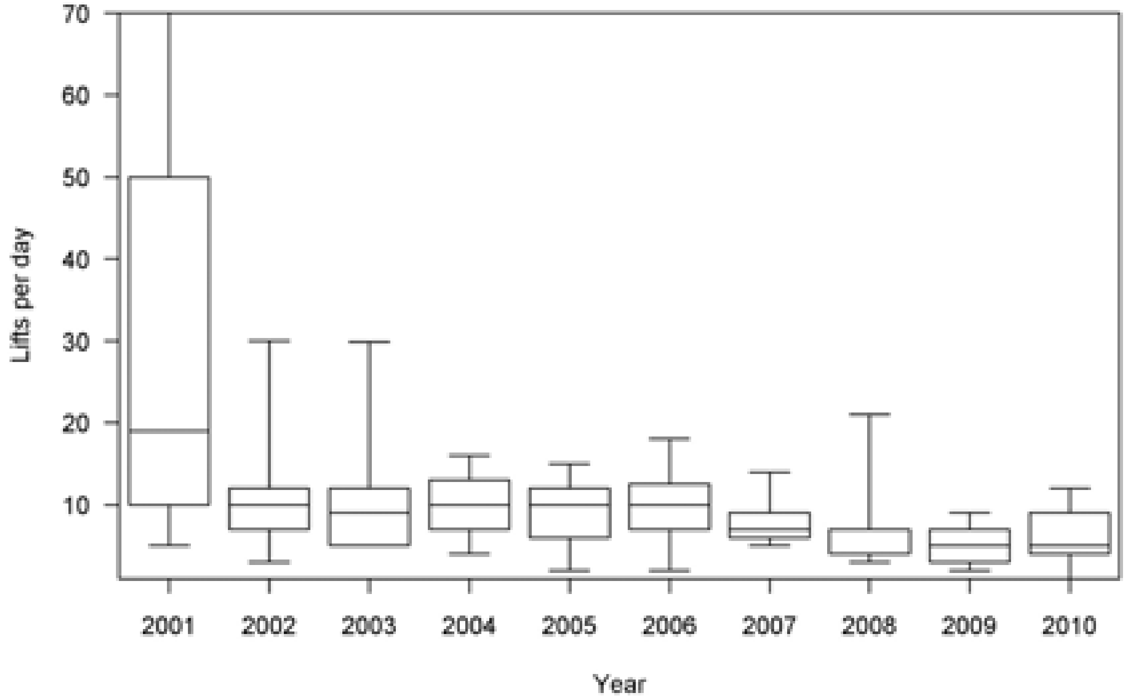

Figure I4: Total lifts per day for the years 2000–01 to 2009–10. The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA21 (AS1)).

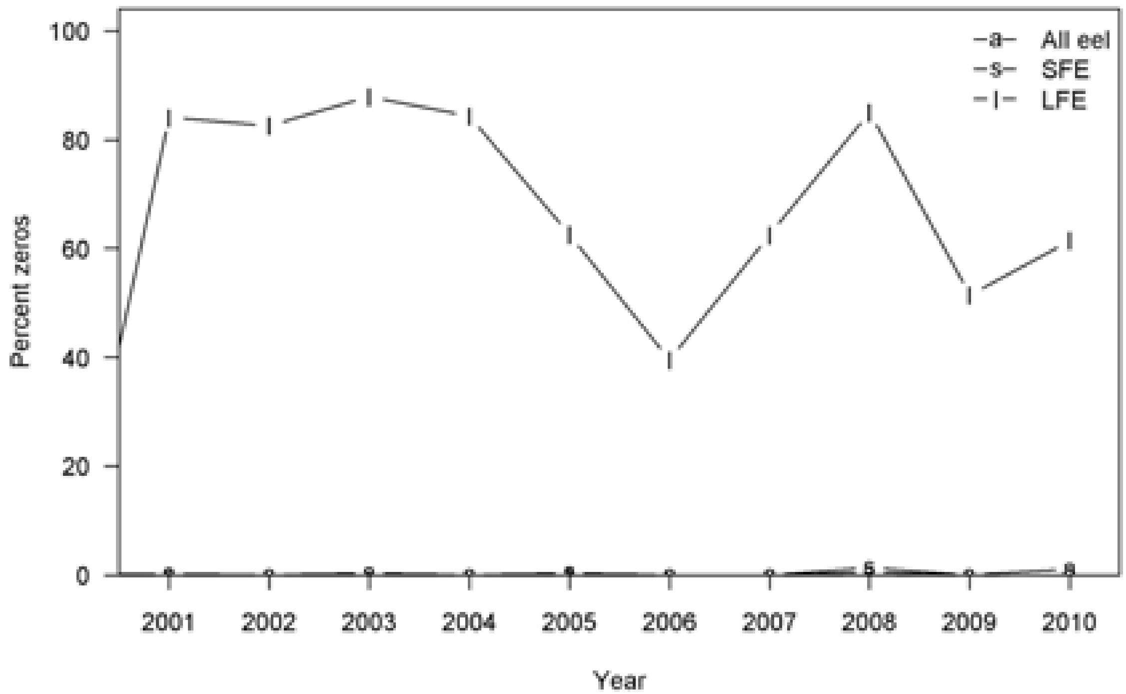

Figure I5: Proportion of zero records for all eel, shortfin (SFE), and longfin (LFE) catch for the years 2000–01 to 2009–10 (ESA21 (AS1)).

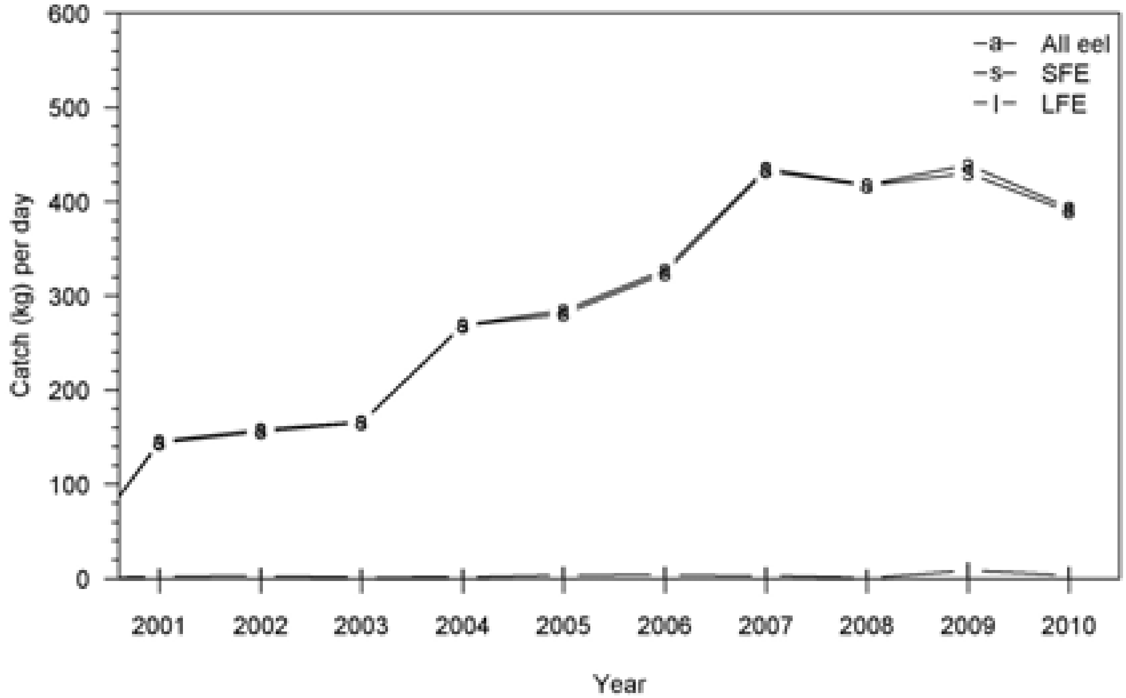

Figure I6: Unstandardised catch per day (total kg/total days) for all eel, shortfin (SFE), and longfin (LFE) for the years 2000–01 to 2009–10 (ESA21 (AS1)).

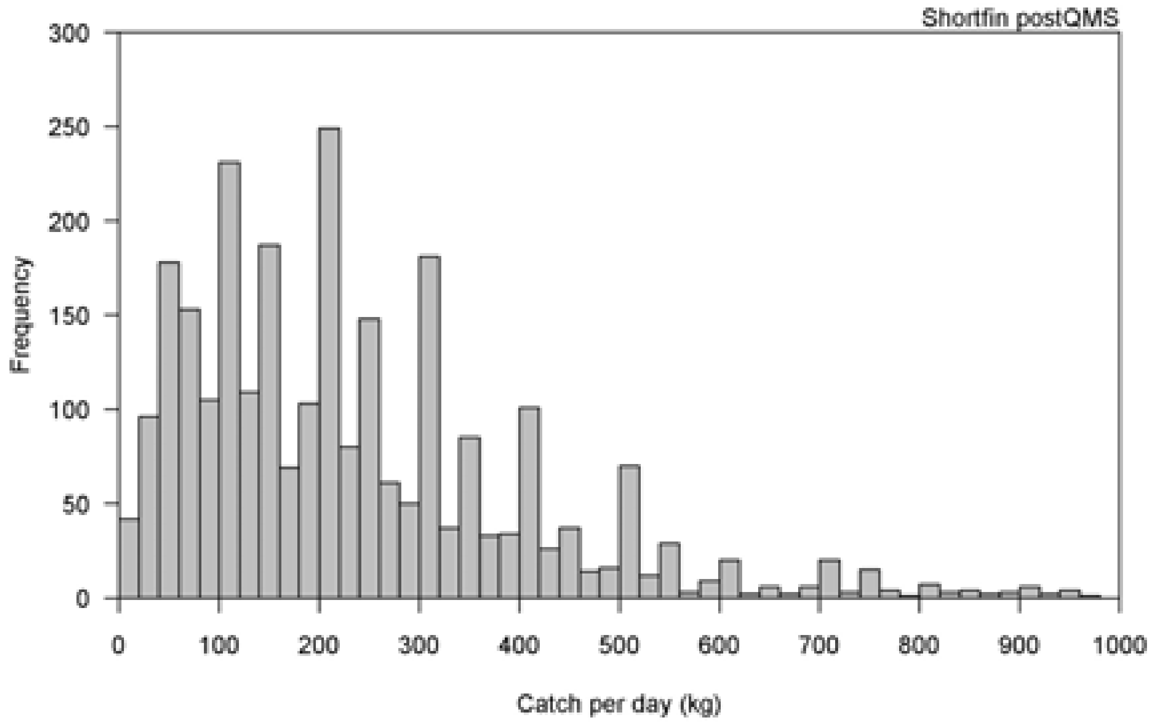

Figure I7: Frequency of shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS) (ESA21 (AS1)).

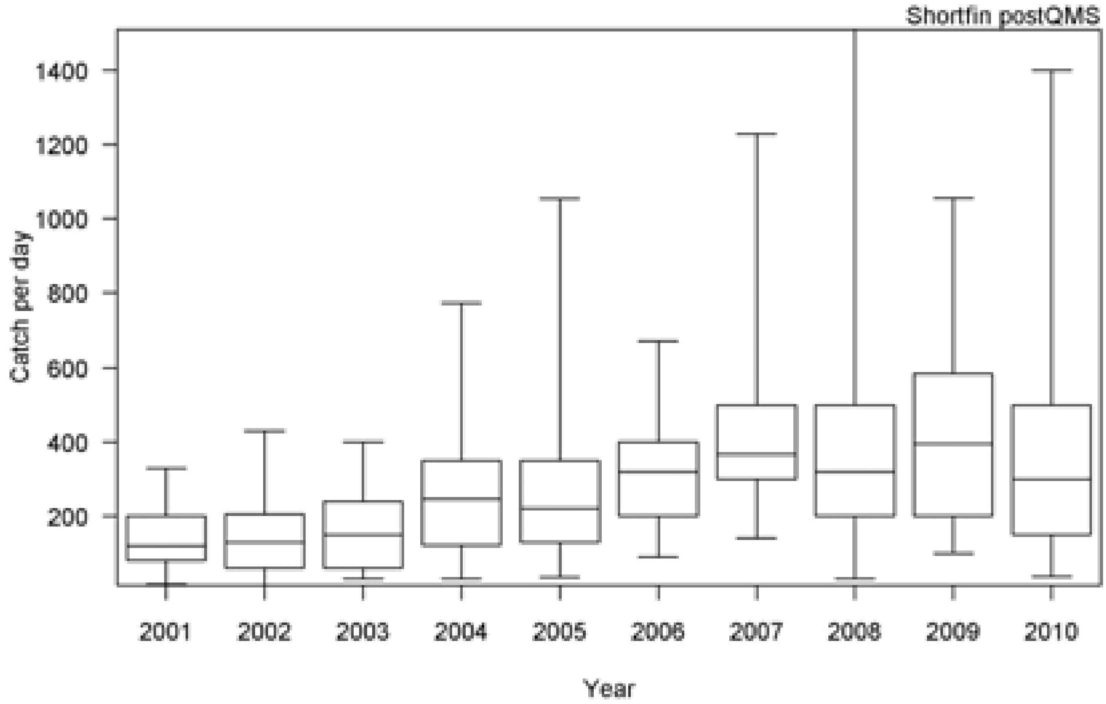

Figure I8: Shortfin eel catch per day for the years 2000–01 to 2009–10 (post-QMS). The horizontal line is the median, the top and bottom of the box are the interquartiles (25th and 75th), and error bars are the 95th percentile range (ESA21 (AS1)).

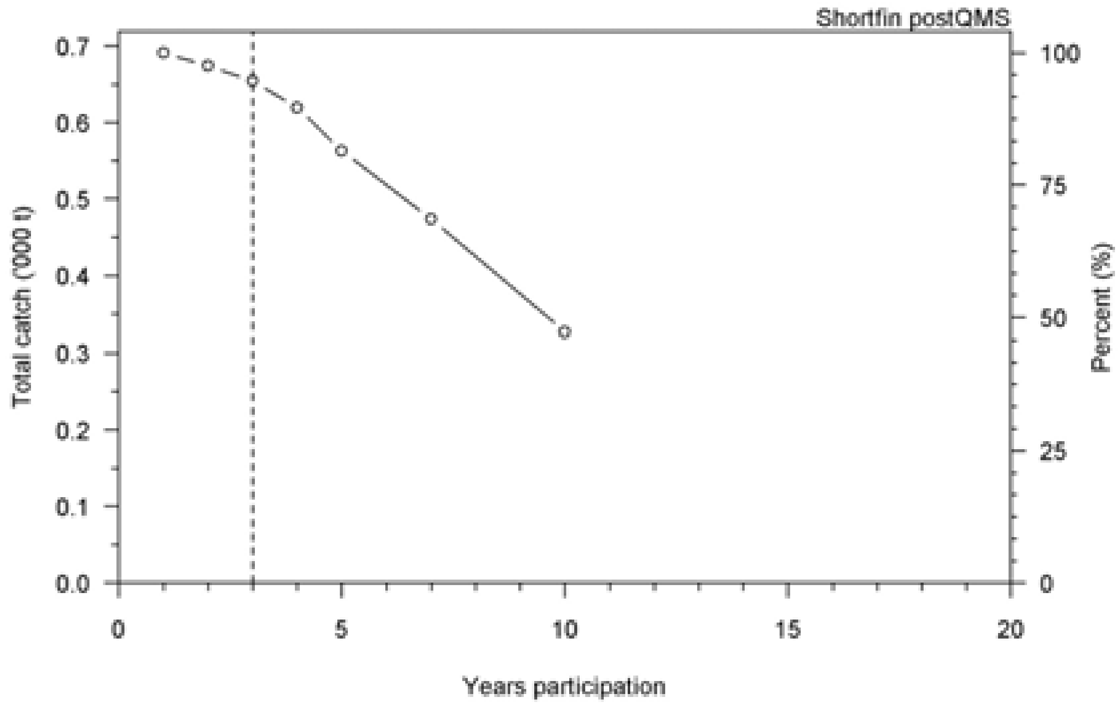

Figure I9: Relationship between years of participation in the fishery and shortfin catch for the years 2000–01 to 2009–10 (post-QMS) for fishers recording a total shortfin catch of more than 1000 kg over all years. Dotted vertical line represents three years participation and indicates the data included in the core fisher data (ESA21 (AS1)).

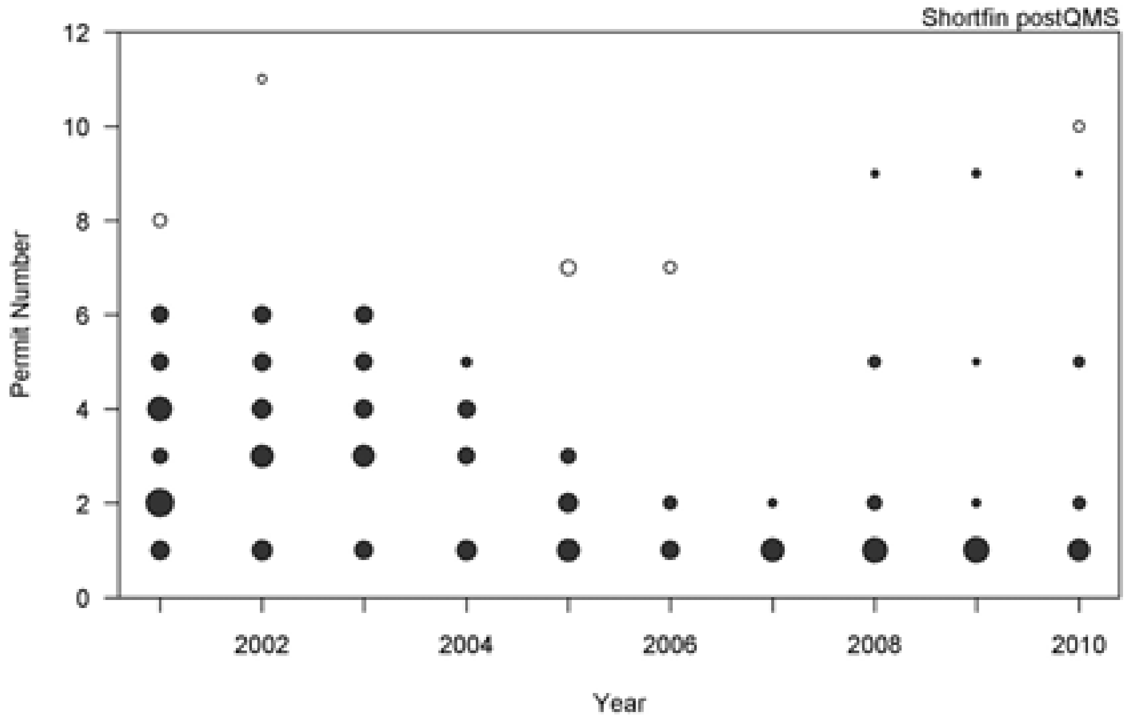

Figure I10: Relative shortfin catch from all fishers (all circles) for the years 2000–01 to 2009–10 (post-QMS), and for core fishers (dark shaded circles) included in the catch per unit effort analyses (ESA21 (AS1)).

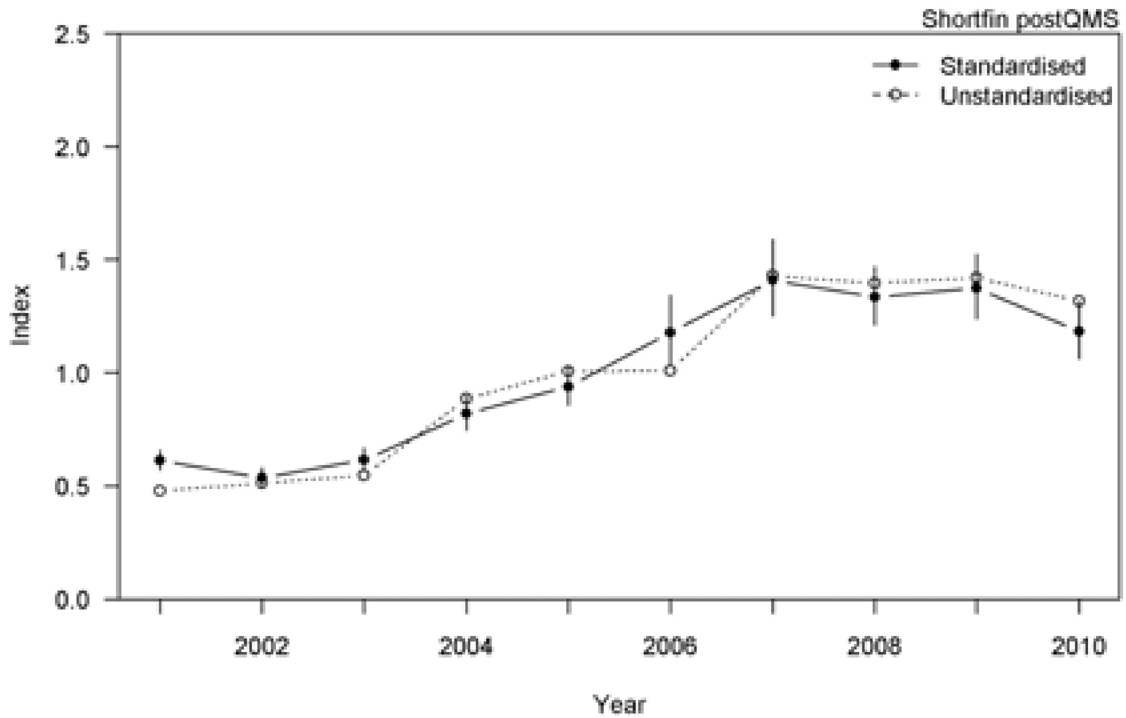

Figure I11: Indices of unstandardised catch per day and standardised CPUE for shortfin core fishers post-QMS eel CPUE model for the years 2000–01 to 2009–10 (ESA21 (AS1)).

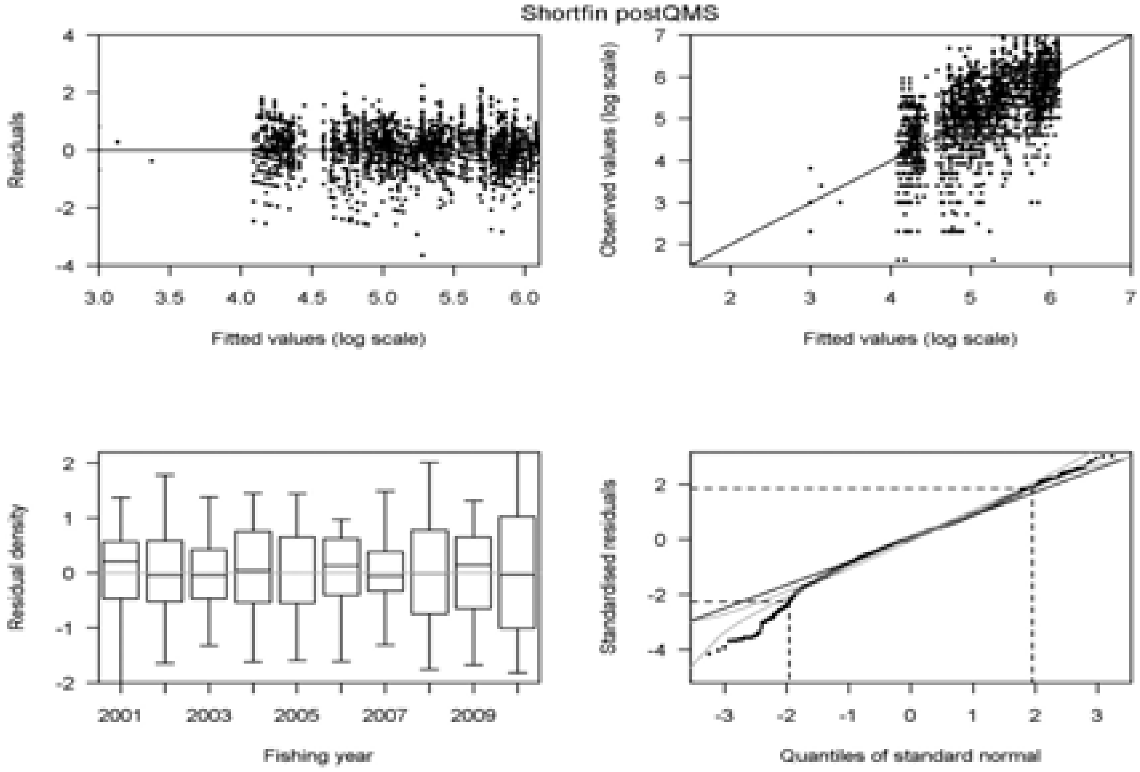

Figure I12: Residual diagnostic plots for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). The grey lines on the quantile-quantile plot represent the 95% confidence envelopes of a standard normal distribution (ESA21 (AS1)).

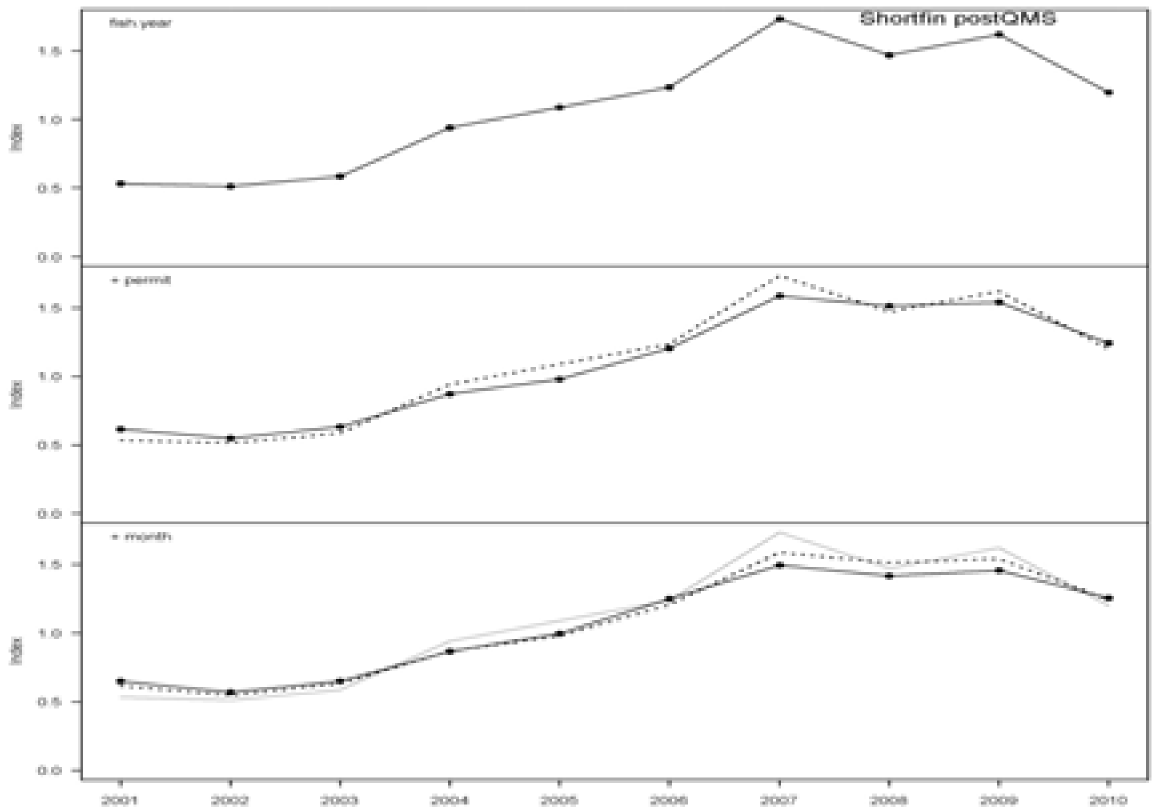

Figure I13: Step plot for the shortfin eel CPUE model for the years 2000–01 to 2009–10 (post-QMS). Each panel shows the standardised CPUE index as each explanatory variable is added to the model with the previous index shown by the dotted line and the grey lines for steps before that (ESA21 (AS1)).

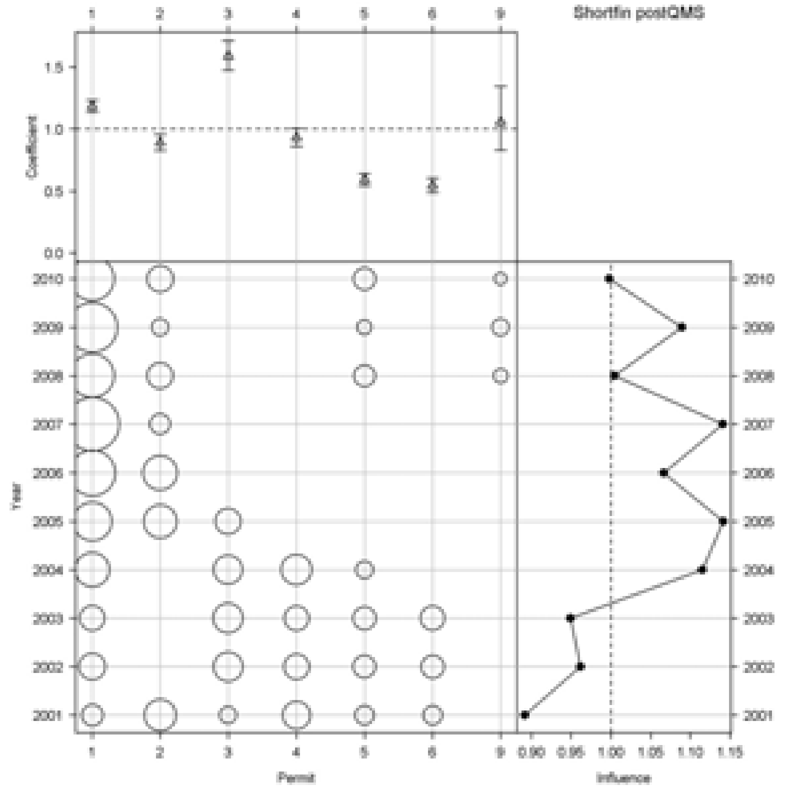

Figure I14: Influence of permit number for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA21 (AS1)).

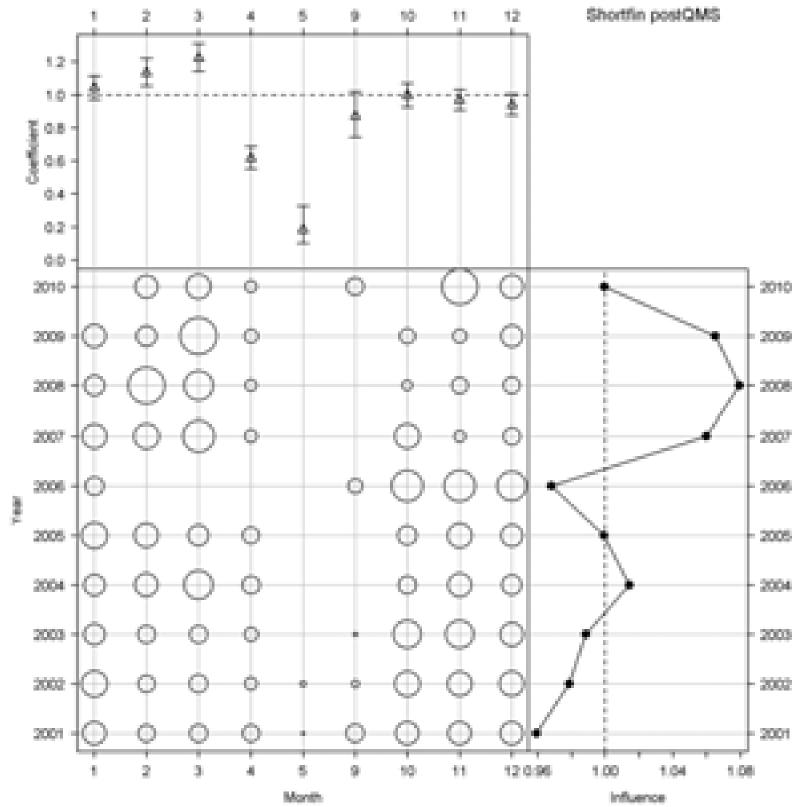

Figure I15: Influence of month for the shortfin CPUE model for the years 2000–01 to 2009–10 (post-QMS) (ESA21 (AS1)).

Appendix 1 Table 2: Daily river flow data used in the standardised CPUE analyses.

ESA	River	Location	Source
13 (AN)	Wairau River	Site 60109 Wairau at Barnetts Bank	NIWA
	Buller River	Site 93203 Buller at Te Kuha	NIWA
14 (AP–AQ)	Wairau River	Site 60109 Wairau at Barnetts Bank	NIWA
15 (AX)	Buller River	Site 93203 Buller at Te Kuha	NIWA
16 (AR)	Wairau River	Site 60109 Wairau at Barnetts Bank	NIWA
	Rakaia River	Site 68526 Rakaia at Fighting Hill	NIWA
17 (AT)	Waitaki River	Site 71104 Waitaki at Kurow	Environment Canterbury
	Rakaia River	Site 68526 Rakaia at Fighting Hill	NIWA
18 (AU)	Waitaki River	Site 71104 Waitaki at Kurow	Environment Canterbury
19 (AV)	Clutha River	Site 75207 Clutha at Balclutha	NIWA
20 (AW)	Mataura River	Site 77505, Parawa	Environment Southland

Appendix 2: Number of records, fishers (catches over zero), and catch in all and core shortfin, and all and core longfin, pre- and post QMS used in the CPUE analyses. Records do not include those with zero catch. SFE, shortfin; LFE, longfin; QMS, quota management system; ESA, eel statistical area.

		Pre-QMS			Post-QMS		
Area	Dataset	Records	Fishers	Catch (kg)	Records	Fishers	Catch (kg)
ESA 13 (AN)	All SFE	270	6	17 399	445	16	28 839
	Core SFE	246	1	14 651	164	3	15 001
	All LFE	899	6	98 692	565	14	42 707
	Core LFE	773	4	87 496	154	2	15 015
ESA 14 (AP_AQ)	All SFE	779	6	72 324	538	15	64 106
	Core SFE	771	3	72 014	390	2	50 464
	All LFE	694	7	53 480	369	12	34 762
	Core LFE	659	3	50 112	204	2	24 670
ESA 15 (AX)	All SFE	1 031	15	123 459	996	14	143 430
	Core SFE	952	6	118 713	889	7	133 704
	All LFE	4 683	16	434 499	2 211	18	230 240
	Core LFE	4 561	11	409 067	1 971	8	212 936
ESA 16 (AR)	All SFE	1 737	17	213 679	377	17	36 915
	Core SFE	1 663	9	202 534	221	6	26 934
	All LFE	1 270	22	132 914	650	19	68 559

Appendix 2 – *continued*

Area	Dataset	Pre-QMS Records	Pre-QMS Fishers	Pre-QMS Catch (kg)	Post-QMS Records	Post-QMS Fishers	Post-QMS Catch (kg)
	Core LFE	1 146	8	126 191	443	6	54 150
ESA 17 (AT)	All SFE	1 389	11	112 109	593	19	48 748
	Core SFE	1 360	9	109 494	409	5	30 903
	All LFE	1 431	17	109 044	596	20	45 823
	Core LFE	1 376	8	100 824	426	6	31 864
ESA 18 (AU)	All SFE	390	13	39 653	87	11	10 193
	Core SFE	357	7	36 201	41	2	7 272
	All LFE	729	17	79 025	264	17	31 295
	Core LFE	682	9	75 604	124	3	17 208
ESA 19 (AV)	All SFE	2 105	22	131 162	971	25	71 020
	Core SFE	2 038	17	128 687	722	7	49 179
	All LFE	4 236	26	425 538	2 154	32	187 510
	Core LFE	4 159	19	420 895	1 806	10	159 144
ESA 20 (AW)	All SFE	984	25	145 257	1 092	25	107 992
	Core SFE	901	12	135 826	961	8	99 469
	All LFE	4 661	28	646 876	2 780	27	420 435
	Core LFE	4 527	16	629 689	2 318	10	380 946
ESA 21 (AS1)	All SFE	–	–	–	2 712	11	691 151
	Core SFE	–	–	–	2 552	7	653 941

Appendix 3: Predictor variables and R^2 values from GLM stepwise regression analysis for pre- and post QMS CPUE analyses. Variables are shown in order of acceptance by the model with associated cumulative R^2 value. Only variables entered into the model are shown.

Region	Species	Variable	R^2 Pre-QMS	Variable	R^2 Post-QMS
ESA 13 (AN)	SFE	Fishing year	0.05	–	–
		Month	0.05	–	–
		Buller R.	0.10	–	–
		Lifts	0.14	–	–
		Moon	0.16	–	–
	LFE	Fishing year	0.16	–	–
		Lifts	0.27	–	–
		Permit	0.35	–	–
		Month	0.39	–	–
		Buller R.	0.39	–	–
ESA 14 (AP/AQ)	SFE	Fishing year	0.50	–	–
		Permit	0.55	–	–
		Lifts	0.60	–	–
		Month	0.63	–	–
		Wairau R.	0.64	–	–
	LFE	Fishing year	0.23	–	–
		Permit	0.35	–	–
		Month	0.42	–	–
		Lifts	0.44	–	–
		moon	0.45		
ESA 16 (AR)	SFE	Fishing year	0.06	–	–
		Permit	0.46	–	–
		Lifts	0.57	–	–
		Month	0.58	–	–
	LFE	Fishing year	0.15	–	–
		Permit	0.39	–	–
		Lifts	0.44	–	–
		Month	0.48	–	–
ESA 17 (AT)	SFE	Fishing year	0.09	–	–
		Permit	0.38	–	–
		Lifts	0.45	–	–
		Month	0.46	–	–
	LFE	Fishing year	0.18	–	–
		Permit	0.29	–	–
		Lifts	0.42	–	–
		Month	0.44	–	–

Appendix 3 –*continued*

Region	Species	Variable	R^2 Pre-QMS	Variable	R^2 Post-QMS
ESA 18 (AU)	SFE	Fishing year	0.17	–	–
		Permit	0.52	–	–
		Lifts	0.59	–	–
		Month	0.63	–	–
				–	–
	LFE	Fishing year	0.21	–	–
		Lifts	0.41	–	–
		Permit	0.46	–	–
		Month	0.50	–	–
		Moon	0.51	–	–
ESA 15 (AX)	SFE	Fishing year	0.13	Fishing year	0.26
		Permit	0.64	Permit	0.65
		Lifts	0.66	Lifts	0.69
		Month	0.68	Buller R.	0.71
	LFE	Fishing year	0.06	Fishing year	0.16
		Permit	0.51	Permit	0.46
		Lifts	0.59	Lifts	0.58
		Month	0.60	Month	0.59
ESA 19 (AV)	SFE	Fishing year	0.05	Fishing year	0.12
		Permit	0.44	Permit	0.48
		Lifts	0.48	Lifts	0.54
		Month	0.49	Month	0.55
	LFE	Fishing year	0.06	Fishing year	0.10
		Permit	0.37	Permit	0.38
		Lifts	0.50	Lifts	0.51
		Month	0.53	Month	0.56
ESA 20 (AW)	SFE	Fishing year	0.05	Fishing year	0.09
		Permit	0.60	Permit	0.37
		Lifts	0.70	Lifts	0.39
		month	0.72	Moon	0.40
				Month	0.41
				Mataura R.	0.42
	LFE	Fishing year	0.02	Fishing year	0.02
		Permit	0.25	Permit	0.39
		Lifts	0.46	Lifts	0.43
		month	0.49	Month	0.47
ESA 21 (AS1)	SFE	–	–	Fishing year	0.25
		–	–	Permit	0.37
		–	–	Month	0.40

Appendix 4: CPUE indices by ESA for shortfin and longfin, pre- and post QMS. CI, 95% confidence intervals; s.e., standard error; c.v., coefficient of variation; –, insufficient data or not done. 1991 represents 1990–91 fishing year.

ESA AN

Shortfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	–	–	–	–	–	2001	–	–	–	–	–
1992	–	–	–	–	–	2002	–	–	–	–	–
1993	1.63	0.65	4.13	0.46	0.49	2003	–	–	–	–	–
1994	–	–	–	–	–	2004	–	–	–	–	–
1995	0.90	0.45	1.80	0.34	0.36	2005	–	–	–	–	–
1996	0.78	0.60	1.01	0.13	0.13	2006	–	–	–	–	–
1997	1.01	0.76	1.33	0.14	0.14	2007	–	–	–	–	–
1998	0.82	0.63	1.05	0.13	0.13	2008	–	–	–	–	–
1999	1.07	0.79	1.47	0.16	0.16	2009	–	–	–	–	–
2000	0.99	0.72	1.35	0.16	0.16	2010	–	–	–	–	–

Longfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	2.55	2.06	3.15	0.11	0.11	2001	–	–	–	–	–
1992	1.09	0.94	1.25	0.07	0.07	2002	–	–	–	–	–
1993	0.81	0.72	0.91	0.06	0.06	2003	–	–	–	–	–
1994	1.09	0.90	1.32	0.10	0.10	2004	–	–	–	–	–
1995	0.78	0.68	0.88	0.06	0.06	2005	–	–	–	–	–
1996	0.76	0.68	0.84	0.05	0.05	2006	–	–	–	–	–
1997	0.75	0.61	0.94	0.11	0.11	2007	–	–	–	–	–
1998	0.70	0.60	0.81	0.07	0.07	2008	–	–	–	–	–
1999	1.02	0.87	1.21	0.08	0.08	2009	–	–	–	–	–
2000	1.30	1.08	1.55	0.09	0.09	2010	–	–	–	–	–

ESA AP-AQ

											Shortfin
					Pre-QMS						Post-QMS
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	2.38	2.05	2.76	0.07	0.08	2001	–	–	–	–	–
1992	2.13	1.80	2.52	0.08	0.08	2002	–	–	–	–	–
1993	1.82	1.54	2.15	0.08	0.08	2003	–	–	–	–	–
1994	1.50	1.33	1.70	0.06	0.06	2004	–	–	–	–	–
1995	1.34	1.20	1.49	0.05	0.05	2005	–	–	–	–	–
1996	0.82	0.75	0.90	0.05	0.05	2006	–	–	–	–	–
1997	0.70	0.60	0.80	0.07	0.07	2007	–	–	–	–	–
1998	0.26	0.23	0.29	0.06	0.06	2008	–	–	–	–	–
1999	0.54	0.48	0.60	0.06	0.06	2009	–	–	–	–	–
2000	0.67	0.59	0.77	0.07	0.07	2010	–	–	–	–	–

											Longfin
					Pre-QMS						Post-QMS
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.82	1.50	2.21	0.10	0.10	2001	–	–	–	–	–
1992	1.13	0.84	1.53	0.15	0.15	2002	–	–	–	–	–
1993	0.97	0.45	2.07	0.38	0.40	2003	–	–	–	–	–
1994	1.38	1.11	1.71	0.11	0.11	2004	–	–	–	–	–
1995	1.44	1.21	1.71	0.09	0.09	2005	–	–	–	–	–
1996	1.50	1.28	1.75	0.08	0.08	2006	–	–	–	–	–
1997	0.90	0.77	1.07	0.08	0.08	2007	–	–	–	–	–
1998	0.71	0.61	0.82	0.08	0.08	2008	–	–	–	–	–
1999	0.69	0.59	0.80	0.07	0.08	2009	–	–	–	–	–
2000	0.38	0.33	0.45	0.08	0.08	2010	–	–	–	–	–

ESA AR

Shortfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.19	1.03	1.36	0.07	0.07	2001	–	–	–	–	–
1992	1.11	1.01	1.21	0.05	0.05	2002	–	–	–	–	–
1993	0.94	0.83	1.06	0.06	0.06	2003	–	–	–	–	–
1994	0.95	0.88	1.03	0.04	0.04	2004	–	–	–	–	–
1995	0.86	0.80	0.93	0.04	0.04	2005	–	–	–	–	–
1996	1.05	0.96	1.15	0.04	0.04	2006	–	–	–	–	–
1997	0.96	0.88	1.05	0.04	0.04	2007	–	–	–	–	–
1998	1.05	0.95	1.16	0.05	0.05	2008	–	–	–	–	–
1999	1.17	1.03	1.34	0.07	0.07	2009	–	–	–	–	–
2000	0.80	0.58	1.11	0.16	0.16	2010	–	–	–	–	–

Longfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.51	1.27	1.79	0.09	0.09	2001	–	–	–	–	–
1992	0.63	0.55	0.72	0.07	0.07	2002	–	–	–	–	–
1993	0.75	0.62	0.91	0.09	0.09	2003	–	–	–	–	–
1994	0.81	0.72	0.91	0.06	0.06	2004	–	–	–	–	–
1995	0.56	0.50	0.63	0.06	0.06	2005	–	–	–	–	–
1996	1.46	1.28	1.66	0.07	0.07	2006	–	–	–	–	–
1997	1.30	1.14	1.49	0.07	0.07	2007	–	–	–	–	–
1998	0.99	0.84	1.17	0.08	0.08	2008	–	–	–	–	–
1999	1.10	0.94	1.30	0.08	0.08	2009	–	–	–	–	–
2000	1.47	1.19	1.81	0.10	0.10	2010	–	–	–	–	–

ESA AT

Shortfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.86	1.57	2.21	0.09	0.09	2001	–	–	–	–	–
1992	1.03	0.92	1.15	0.05	0.05	2002	–	–	–	–	–
1993	0.77	0.69	0.87	0.06	0.06	2003	–	–	–	–	–
1994	0.84	0.75	0.95	0.06	0.06	2004	–	–	–	–	–
1995	0.79	0.71	0.89	0.06	0.06	2005	–	–	–	–	–
1996	1.10	0.98	1.24	0.06	0.06	2006	–	–	–	–	–
1997	0.95	0.84	1.08	0.06	0.06	2007	–	–	–	–	–
1998	1.31	1.11	1.54	0.08	0.08	2008	–	–	–	–	–
1999	0.71	0.58	0.88	0.11	0.11	2009	–	–	–	–	–
2000	1.03	0.89	1.18	0.07	0.07	2010	–	–	–	–	–

Longfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.82	1.54	2.16	0.09	0.09	2001	–	–	–	–	–
1992	0.57	0.51	0.63	0.05	0.05	2002	–	–	–	–	–
1993	0.72	0.64	0.82	0.06	0.06	2003	–	–	–	–	–
1994	1.10	0.98	1.24	0.06	0.06	2004	–	–	–	–	–
1995	0.92	0.82	1.04	0.06	0.06	2005	–	–	–	–	–
1996	0.91	0.81	1.03	0.06	0.06	2006	–	–	–	–	–
1997	1.03	0.89	1.19	0.07	0.07	2007	–	–	–	–	–
1998	0.94	0.78	1.14	0.09	0.09	2008	–	–	–	–	–
1999	0.86	0.67	1.10	0.12	0.12	2009	–	–	–	–	–
2000	1.71	1.46	1.99	0.08	0.08	2010	–	–	–	–	–

ESA AU

Shortfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.79	1.08	2.99	0.25	0.26	2001	–	–	–	–	–
1992	1.23	0.79	1.91	0.22	0.22	2002	–	–	–	–	–
1993	0.65	0.53	0.79	0.10	0.10	2003	–	–	–	–	–
1994	1.18	0.77	1.79	0.21	0.21	2004	–	–	–	–	–
1995	0.82	0.65	1.04	0.12	0.12	2005	–	–	–	–	–
1996	1.30	1.01	1.69	0.13	0.13	2006	–	–	–	–	–
1997	0.76	0.59	0.97	0.13	0.13	2007	–	–	–	–	–
1998	0.95	0.70	1.30	0.15	0.15	2008	–	–	–	–	–
1999	0.79	0.60	1.05	0.14	0.14	2009	–	–	–	–	–
2000	0.96	0.72	1.29	0.15	0.15	2010	–	–	–	–	–

Longfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.38	1.10	1.72	0.11	0.11	2001	–	–	–	–	–
1992	1.50	1.24	1.82	0.10	0.10	2002	–	–	–	–	–
1993	0.73	0.63	0.85	0.08	0.08	2003	–	–	–	–	–
1994	0.87	0.72	1.06	0.10	0.10	2004	–	–	–	–	–
1995	0.66	0.58	0.76	0.07	0.07	2005	–	–	–	–	–
1996	1.11	0.87	1.42	0.12	0.12	2006	–	–	–	–	–
1997	1.01	0.86	1.19	0.08	0.08	2007	–	–	–	–	–
1998	0.87	0.74	1.04	0.09	0.09	2008	–	–	–	–	–
1999	1.16	0.97	1.41	0.09	0.09	2009	–	–	–	–	–
2000	1.00	0.78	1.29	0.13	0.13	2010	–	–	–	–	–

ESA AX

Shortfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.00	0.87	1.15	0.07	0.07	2001	0.68	0.54	0.87	0.12	0.12
1992	0.78	0.58	1.05	0.15	0.15	2002	0.80	0.70	0.92	0.07	0.07
1993	1.27	1.10	1.46	0.07	0.07	2003	0.64	0.52	0.78	0.10	0.10
1994	0.97	0.86	1.09	0.06	0.06	2004	0.98	0.82	1.17	0.09	0.09
1995	1.01	0.88	1.16	0.07	0.07	2005	0.94	0.79	1.11	0.08	0.08
1996	0.57	0.48	0.67	0.08	0.08	2006	1.05	0.89	1.22	0.08	0.08
1997	0.54	0.46	0.63	0.08	0.08	2007	1.02	0.90	1.15	0.06	0.06
1998	1.41	1.17	1.70	0.09	0.09	2008	0.99	0.86	1.13	0.07	0.07
1999	1.72	1.48	2.00	0.08	0.08	2009	1.80	1.55	2.08	0.07	0.07
2000	1.39	1.15	1.68	0.09	0.09	2010	1.64	1.43	1.88	0.07	0.07

Longfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.02	0.95	1.09	0.03	0.03	2001	0.96	0.87	1.05	0.05	0.05
1992	1.06	0.99	1.13	0.03	0.03	2002	0.80	0.73	0.87	0.04	0.04
1993	0.78	0.73	0.84	0.03	0.03	2003	0.86	0.79	0.94	0.04	0.04
1994	0.83	0.78	0.88	0.03	0.03	2004	0.94	0.86	1.03	0.05	0.05
1995	1.05	0.98	1.12	0.03	0.03	2005	1.08	1.00	1.16	0.04	0.04
1996	1.01	0.94	1.09	0.04	0.04	2006	1.05	0.96	1.15	0.04	0.04
1997	0.98	0.91	1.04	0.03	0.03	2007	0.95	0.89	1.02	0.03	0.03
1998	0.96	0.89	1.05	0.04	0.04	2008	0.98	0.91	1.06	0.04	0.04
1999	1.08	1.00	1.16	0.04	0.04	2009	1.10	1.00	1.22	0.05	0.05
2000	1.33	1.22	1.46	0.04	0.04	2010	1.37	1.25	1.50	0.05	0.05

ESA AV

Shortfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.63	1.35	1.97	0.10	0.10	2001	1.03	0.89	1.18	0.07	0.07
1992	1.21	1.04	1.42	0.08	0.08	2002	0.82	0.72	0.94	0.07	0.07
1993	0.91	0.82	1.01	0.05	0.05	2003	0.88	0.76	1.03	0.08	0.08
1994	0.89	0.81	0.99	0.05	0.05	2004	0.93	0.78	1.10	0.09	0.09
1995	0.94	0.85	1.04	0.05	0.05	2005	1.13	0.96	1.35	0.09	0.09
1996	0.91	0.82	1.01	0.05	0.05	2006	1.15	0.93	1.42	0.10	0.11
1997	0.96	0.85	1.08	0.06	0.06	2007	1.45	1.16	1.82	0.11	0.11
1998	0.86	0.75	0.99	0.07	0.07	2008	0.42	0.32	0.54	0.13	0.13
1999	0.80	0.71	0.90	0.06	0.06	2009	1.33	1.00	1.79	0.15	0.15
2000	1.09	0.99	1.21	0.05	0.05	2010	1.36	1.07	1.73	0.12	0.12

Longfin

Pre-QMS						Post-QMS					
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.41	1.32	1.51	0.03	0.03	2001	0.81	0.75	0.87	0.04	0.04
1992	1.22	1.14	1.30	0.03	0.03	2002	0.80	0.75	0.86	0.04	0.04
1993	1.09	1.03	1.16	0.03	0.03	2003	0.91	0.85	0.99	0.04	0.04
1994	1.28	1.20	1.36	0.03	0.03	2004	0.95	0.88	1.03	0.04	0.04
1995	0.89	0.84	0.94	0.03	0.03	2005	1.18	1.10	1.27	0.04	0.04
1996	0.81	0.76	0.87	0.03	0.03	2006	1.03	0.95	1.12	0.04	0.04
1997	0.88	0.82	0.94	0.04	0.04	2007	1.17	1.07	1.28	0.04	0.04
1998	0.90	0.84	0.97	0.04	0.04	2008	1.12	1.02	1.22	0.04	0.04
1999	0.84	0.78	0.91	0.04	0.04	2009	1.08	0.86	1.36	0.12	0.12
2000	0.86	0.80	0.93	0.04	0.04	2010	1.02	0.89	1.17	0.07	0.07

ESA AW

											Shortfin
					Pre-QMS						Post-QMS
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.13	0.91	1.40	0.11	0.11	2001	0.73	0.60	0.89	0.10	0.10
1992	1.06	0.93	1.20	0.06	0.06	2002	0.62	0.52	0.74	0.09	0.09
1993	0.97	0.87	1.09	0.06	0.06	2003	0.71	0.55	0.91	0.12	0.12
1994	1.32	1.19	1.47	0.05	0.05	2004	0.78	0.64	0.95	0.10	0.10
1995	1.04	0.90	1.20	0.07	0.07	2005	1.16	0.94	1.43	0.11	0.11
1996	0.91	0.77	1.07	0.08	0.08	2006	1.10	0.90	1.35	0.10	0.10
1997	0.85	0.73	0.99	0.08	0.08	2007	1.42	1.17	1.73	0.10	0.10
1998	0.93	0.77	1.11	0.09	0.09	2008	1.09	0.84	1.43	0.13	0.13
1999	0.92	0.81	1.05	0.07	0.07	2009	1.22	0.96	1.56	0.12	0.12
2000	0.94	0.84	1.06	0.06	0.06	2010	1.63	1.34	1.99	0.10	0.10

											Longfin
					Pre-QMS						Post-QMS
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	1.47	1.39	1.55	0.03	0.03	2001	0.89	0.81	0.97	0.04	0.04
1992	1.15	1.10	1.20	0.02	0.02	2002	1.05	0.98	1.12	0.03	0.03
1993	1.12	1.07	1.18	0.02	0.02	2003	1.07	0.97	1.17	0.04	0.04
1994	1.19	1.13	1.25	0.03	0.03	2004	0.87	0.81	0.94	0.04	0.04
1995	1.00	0.94	1.05	0.03	0.03	2005	1.14	1.05	1.23	0.04	0.04
1996	1.02	0.96	1.09	0.03	0.03	2006	1.11	1.03	1.21	0.04	0.04
1997	0.93	0.87	0.98	0.03	0.03	2007	0.80	0.73	0.88	0.05	0.05
1998	0.80	0.75	0.84	0.03	0.03	2008	1.00	0.93	1.07	0.03	0.03
1999	0.67	0.63	0.71	0.03	0.03	2009	1.04	0.95	1.14	0.05	0.05
2000	0.88	0.83	0.93	0.03	0.03	2010	1.09	1.00	1.20	0.05	0.05

ESA AS1

											Shortfin
					Pre-QMS						Post-QMS
		Confidence intervals						Confidence intervals			
Year	Index	Lower	Upper	s.e.	c.v.	Year	Index	Lower	Upper	s.e.	c.v.
1991	–	–	–	–	–	2001	0.65	0.61	0.70	0.04	0.04
1992	–	–	–	–	–	2002	0.57	0.53	0.61	0.04	0.04
1993	–	–	–	–	–	2003	0.65	0.60	0.71	0.04	0.04
1994	–	–	–	–	–	2004	0.87	0.79	0.95	0.05	0.05
1995	–	–	–	–	–	2005	1.00	0.91	1.09	0.05	0.05
1996	–	–	–	–	–	2006	1.25	1.10	1.42	0.07	0.07
1997	–	–	–	–	–	2007	1.49	1.33	1.69	0.06	0.06
1998	–	–	–	–	–	2008	1.41	1.28	1.56	0.05	0.05
1999	–	–	–	–	–	2009	1.46	1.31	1.62	0.05	0.05
2000	–	–	–	–	–	2010	1.25	1.13	1.40	0.05	0.05