# Update of the Catch per Unit Effort (CPUE) Distribution of Swordfish (*Xiphias gladius*) by the Japanese offshore and distant-water longline fishery in the Pacific*

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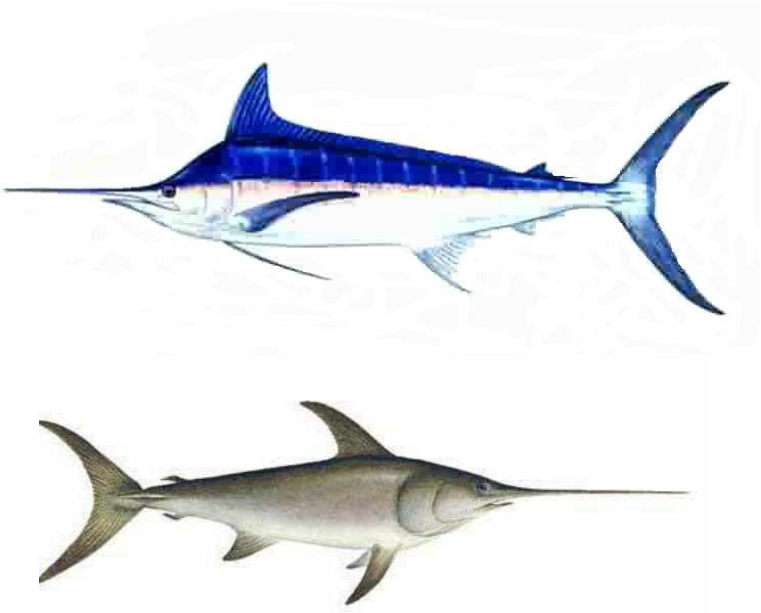

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## Introduction

In 2007 and 2009, Japan reported standardized CPUE of Swordfish caught by Japanese longliners as well as some biological information collected in the longline log book. This document describes the update the CPUE of the previous studies (Ishimura *et al*. 2008, Kimoto and Yokawa, 2009) with some additional analysis.

The abundance indices were estimated by standardizing CPUEs in the Western-Central North Pacific Ocean (WCNPO) and the Eastern Pacific Ocean (EPO) for a two stocks scenario (Figure 1, the WCNPO and EPO stocks), by the request from the Billfish Working Group. Additionally, this document addresses alternative trends of the standardized CPUE to improve these estimations.

## Materials and Methods

Generally, the similar data and method as in the previous study (Kimoto and Yokawa, 2009) was used in this study (base case). This study provides the updated CPUE series for a two stocks scenario with a boundary between the Western-Central North Pacific Ocean (WCNPO) and the Eastern Pacific Ocean (EPO).

This study adapted data compiled over 61 years from logbooks of the Japanese offshore and distant water longline fishery (1952-2012) compiled by the National Research Institute of Far Seas Fisheries, Japan (NRIFSF). These data included species-specific catch for tuna (e.g., bigeye tuna, bluefin tuna), tuna-like species (e.g., marlin), and sharks, and operational descriptions (e.g., number of hooks, gear configurations, locations) for each longline set. In this study, aggregated data by 5x5 degree grids, month, and gear configurations were used for the base case (Figure 2). Information about gear configuration is only available since 1975, which roughly coincide with the introduction of deeper setting in the Japanese distant water longliners to target bigeye tuna. Thus, this study analyzed two periods separately: 1952-1974 (calculation was done by 1979) and 1975-2012.

To improve the standardization of the CPUE, the operational catch and effort data (Figure 3) was used in these analyses, obtained from the Japanese offshore and distant longline fishery statistics compiled by NRIFSF. The analyzed period was between 1975 and 2012, because the information of the gear configuration started to be collected since 1975. Due to the change of the data reporting system in 1994 and the limitation in computer resources, the analyses were separately done for the periods between 1975 and 1993, and between 1994 and 2012.

The gear configuration of each set, as the proxy of targeting effect, is classified by the number of branch lines with baited hooks between float lines which often referred as hooks per basket (HPB). The gear deployment depth, which influences species specific catchability, is specified vertical down force by the total weight of a set defined by the number of branch lines. In a case of swordfish targeted effort by Japanese longline vessels mainly employ 3-4 HPB which is often referred as “night set” or “surface set” and intend to deploy hooks stay in surface at night. The five categories of the gear configurations

arbitrarily were employed in this study as follows; 1) 3-4, 2) 5-6, 3) 7-9, 4) 10-18, and 5) 19-22 HPB. Data of sets with its HPB is smaller than 2 or larger than 23 were excluded from the analysis as they are rather scarce. For the 5x5 aggregated data, observations which had less than 10,000 total hooks given time, spatial location and gear configurations were considered as minor fishing efforts and eliminated.

We spatially stratified the study area to articulate heterogeneity of the fishing grounds in model representations. This study followed the previous area stratifications by Kimoto and Yokawa (2009) which followed Ishimura *et al*., (2008). In the two stocks scenario, the entire north and east Pacific was stratified into 19 areas (Figure 1): areas 1-9 for the WCNPO stock, and areas 10-19 for the EPO stock. The areas 12, 14, and 16 in the EPO were deleted, due to the lack of data in recent years.

Because the trend of nominal CPUEs in areas 8 and 9 appeared not to be similar to those in other WCNPO areas but to those of EPO, alternative standardized CPUE was also calculated by removing these two areas.

**a) Standardized log-transformed CPUE (Base case) in the WCNPO and the EPO**

The CPUE for each grid cell (5x5) over time was calculated by the number of swordfish caught divided by the number of hooks as the unit of fishing effort (/1000 hooks). Standardized CPUE series of the Japanese distant-water longliners for the period between 1952 and 2012 are analyzed by GLM methods. The standardized CPUE values of each area was weighted by the approximate size of each area and summed up to the total CPUE. Two periods between 1952-1974 (calculation was done by 1979) and 1975-2012 were analyzed separately, because information for/of gear configuration is only available since 1975. Analysis was made through the GLM procedure of computer software, “SAS Ver. 9.3” and "Rx64 2.15.0".

*Period between 1952 and 1974 (calculated up to 1979) in the WCNPO and the EPO

The standardized log-transformed CPUE with Gaussian errors (glm.log) was fitted for three categorical explanatory variables, year (*year*), quarter (*qt*), area (*area*), and their interaction terms;

$$\ln(CPUE+\text{const}) = year + qt + area + qt*area + year*qt + Gaussian\ error\ term$$

where const 0.006 was chosen, and was close to the minimum observed positive CPUE.

It was already shown in the previous study that the longer period of the CPUE was adopted because the similar trend was obtained between the models with qt*area and with year*area (see detail: Kimoto and Yokawa, 2009). In the EPO area, the standardized CPUEs started in 1955 due to the lack of data.

*Period between 1975 and 2012 in the WCNPO and the EPO

The standardized log–transformed CPUE with Gaussian errors was fitted for four categorical explanatory variables, year (*year*), quarter (*qt*), area (*area*), gear (*gear*), and their interaction terms;

$$\ln(CPUE+\text{const}) = year + qt + gear + area + year*area + year*qt + Gaussian\ error\ term$$

where const 0.005 was chosen, and was close to the minimum observed positive CPUE.

*Period between 1952 and 2012 in the WCNPO and the EPO

The standardized CPUEs of two periods (1952-1979 and 1975-2012) were roughly combined into one period between 1952 and 2012, using the average ratio of the standardized CPUEs for the overlapping period between 1975 and 1979.

**b) Standardized log-transformed CPUE in the WCNPO without areas 8 and 9**

Since the late 2000s, the rapid increasing trends of the nominal CPUEs were observed in the WCNPO areas close to the stock boundary with EPO (areas 8 and 9 in Figure 1), and similar trends were obtained not in areas WCNPO but in the EPO stock (Figures 4 and 5). Because this was supposed to suggest the temporal change of the position of stock boundary, this study also provided the standardized CPUE for the WCNPO stock without areas 8 and 9. The CPUEs were calculated by all above methods.

**c) Standardized CPUE fitted negative binomial GLM in the WCNPO, in the EPO, in the WCNPO without areas 8 and 9**

To improve the standardized CPUE, this study attempted to fit a negative binomial GLM (glm.nb) applying to the operational data since 1975 in the WCNPO, in the EPO, and in the WCNPO without areas 8 and 9. The analyzed periods were 1975-1993 and 1994-2012 with the following equations by the computer software, "Rx64 2.15.0".

glm.nb(nswo~as.factor(year)+as.factor(qt)+as.factor(ar09)+as.factor(gear)+as.factor(year)*as.factor(area)+as.factor(year)*as.factor(qt)+offset(log(hooks)))

where nswo is the number of swordfish.

**Results and Discussion**

In the calculations, several data set were used. The number of observations in the 5x5 aggregated or in the operational data was shown in Figures 2 or 3 by year and area, and by year and quarter. For the 5x5 aggregated data, the total number of observations (Figure 2) was 117,194 (25,057 in 1952-1979 (15,250 in the WCNPO and 9,807 in the EPO), and 92,137 in 1975-2012 (46,140 in the WCNPO and 45,997 in the EPO). For the operational data (Figure 3), the total number of observations was 2,242,851 (1,453,247 in 1975-1993 (685,662 in the WCNPO and 767,585 in the EPO), and 789,604 in 1994-2012 (327,111 in the WCNPO and 462,493 in the EPO)).

The simple update of the standardized CPUEs in the WCNPO are shown in Figure 6-a, and the combined series for the period between 1952 and 2012 is available in Figure 7-a. The standardized CPUE showed stabilized trends in the period of 1952 and 1974 compared to those since 1975. In the standardized CPUE since 1975, a decreasing trend was observed for a decade which was followed by

the relatively higher level in the 80s. In the 2000s, it has been fluctuated in the small range, and the standardized CPUEs stayed in the smaller level than those before 1990.

The similar decreasing trend in the 90s was observed in the areas 1-6 (Figure 8), especially in the area 2 where showed continuously decreasing trend historically. The similar trend was also observed in the 2nd quarter (Figure 9). In the area 2, Japanese offshore night surface longliners used to target swordfish during their spawning season (quarter 2), but they have changed the target species to blue shark since the mid 2000s (Hiraoka et al., 2013 and Kai et al., 2014). The effect of such target shift would not be adjusted sufficiently in the standardization, and thus the level of standardized CPUE in recent years would underestimate the actual level of abundance to some extent.

In the study of blue shark in the Pacific (Hiraoka et al., 2013 and Kai et al., 2014), the target effect (Chang et al., 2009) was considered by using the percentile of the annual CPUE value of swordfish but they only use data of Japanese offshore surface longliners based on Kesennuma fishing port. In this study, we used all data of Japanese offshore and distant-water longliners operated in the designated area to cover main distribution area of swordfish, which has been targeted by more fleets than blue shark, and it makes difficult to filter simply the targeting fishery such as blue shark. Thus, the large change of the method should be necessary for the introduction of the target effect into the swordfish CPUE standardization model, such as to separate data into two sets (data of Japanese offshore and distant-water longliners and others). Such large change of the method should be considered as the future works.

In the EPO, it showed a slight increasing trend since the late 50s (Figures 6-b, and 7-b). The standardized CPUE was stabilized in the 80s and the 90s with slight decreasing in the mid-70s. The increase of the CPUE was observed in around 2000, and the standardized CPUE started increasing rapidly since 2006. This substantial increment in the recent years was observed in the all areas in the EPO, especially in the areas 10, 15, and 19 (Figure 10), though the coverage of Japanese data decreased in the recent years. The high values in the areas 15 and 19 possibly related to a strong year class in 2009, where good catch of the YOY (young of the year) was observed in the area 15 (Figure 12). The sings of higher level of recruitment were also seen in other areas and years in EPO (e.g., 2010 in area 19, 2006 in area 18), and these accumulation would contribute the increase of the productivity of the EPO stock and produce the quite high level of abundance indices in recent years.

Considering above, it seems obvious that the observed recent increase CPUEs in the areas 10 and 11 are the influences by the EPO stock. Temporal change of the position of stock boundary is reported in the Atlantic (ICCAT, 2006). Further investigations of this observation should be necessary for the appropriate stock assessment and management of swordfish stocks. Seasonal invasion of the EPO stock into the WCNPO stock area could be the reason but the increase of the distribution area of the EPO stock due to the increase of stock size could also be possible.

b) Standardized CPUE in the WCNPO without areas 8 and 9 modified the base case

In the areas 8 and 9 in the WCNPO, the historical trends of the CPUEs were rather similar to those in the areas 10 and 11 in the EPO than other areas in the WCNPO (Figures 4 and 5). As described in a), the recent trends of CPUE in areas 8 and 9 are influenced by the catch derived from the EPO stock. In addition, the unnatural large fluctuations are observed in the standardized CPUE in the area 8 supposed to be caused by the smaller number of data; especially the shortage of observation should be even serious for the 5x5 aggregated data used in the base case analysis. In this study, the alternative standardized CPUE in the WCNPO was also provided by eliminating data of these two areas. The comparison of the alternative CPUE with the base case is shown in Figure 13. The trends of both CPUE were mostly similar, except in the recent years except for the ones in the most recent years (2008 – 2012) when the level of the alternative CPUE becomes higher than the base case. Smaller . The lower CPUE values of the base case in the most recent years would be due to the quite small CPUEs observed in 2009 and 2012 in the area 8. In this point, the use of data in the areas 8 and 9 for the estimation of abundance index of the WCNPO stock would be questioned.

c) Standardized CPUE by negative binomial GLM

To improve the standardized CPUEs by Japanese longliners, alternative CPUEs were also provided by applying negative binomial GLM to the operational data set since 1975 (no adequate operational data is available for this purpose in the period before 1975). In the WCNPO (Figures 14-a, 15, and 16), the CPUE showed a convex curve with the peak in the mid-80s for the period between 1975 and 1993. The standardized CPUE since 1994 showed a slightly increasing trend, and a decreasing trend in the recent two years. This decrease would be due to the influence of the Great East Japan Earthquake. Many of Japanese offshore surface longliners targeting swordfish and blue shark switched their targets to swordfish and tunas due to the lost of shark meeting and fin processing facilities and reduction of market price of blue shark (personal comm., Kesennuma fishers union). In the tuna targeting sets, the bycatch ratio of swordfish is generally lower than that of blue shark targeting sets (Yokawa, 2009). In the EPO (Figures 14-b, 17, and 18), CPUE was once peaked in 2000 and decreased thereafter, and the rapid and substantial increases were observed since 2006.

The standardized CPUEs between in the WCNPO and in the WCNPO without areas 8 and 9 estimated by negative binomial GLM using the operational data were compared in Figure 19. Mostly similar values were obtained. In the recent years, the estimated value in the WCNPO without areas 8 and 9 was smaller than those in the WCNPO, but the differences were not large compared to those by log-transformed GLM (Figure 13).

This difference may be caused by the difference of the number of observations under the condition of limited number of data. The number of observation in the area 8 and 9 should be much larger for the operation data than the aggregated data. If sufficiently large number and coverage of data were existed in the area 8 and 9 in the recent years, two different models would produce similar trends but under the

condition of limited number of data, two models might produce some different results.

Finally, the results applied different models (log-transformed GLM versus negative binomial GLM) were compared in the WCNPO, the WCNPO without areas 8 and 9, and the EPO (Figure 20). Generally, the trends in the WCNPO and the EPO by both models were similar, and the values were smoother with negative binomial GLM using operational data than log-transformed GLM using the aggregated data. The smooth trends usually indicate better reflection of the actual abundance trend. However, this method can only be applied since 1975 due to the limited information of gear configuration. The analysis would be separately done because of the change in the data collecting system, and due to the limitation in computer resources.

In the WCNPO without areas 8 and 9, it showed a similar trend in early period between models (Figure 20-c). On the other hand, the trend was largely fluctuated with log-transformed GLM and relatively lower CPUE was estimated since 2007. It roughly seemed that the aggregated data affected these estimations, though the detailed check obviously is necessary in the future study.

In this study, the simple update of the standardized CPUE series was provided. Additionally, this study attempted to analyze some alternative CPUE series, considering the model improvement and the data quantities. Some alternative series showed similar trends with the base case, while some discrepancies were also found between models or data. It should be well-discussed in the BILLWG how to treat these standardized CPUEs by considering the pros and cons on each CPUE.

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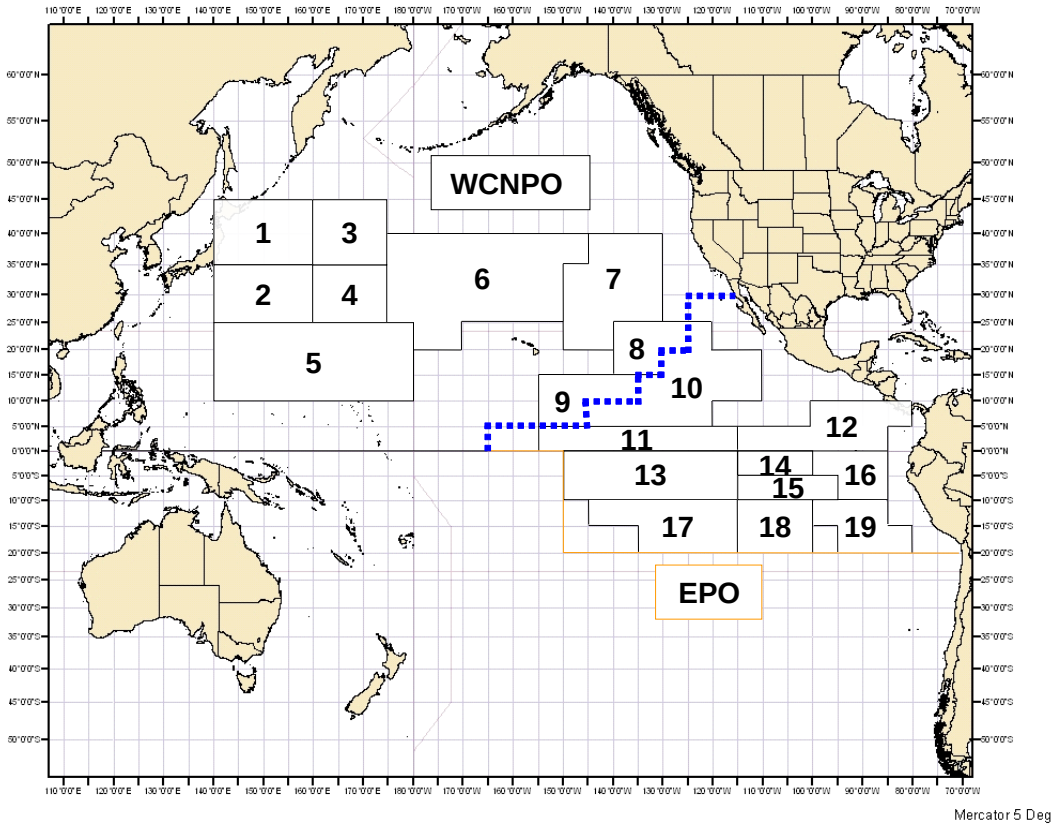



Adapted from Ichinokawa and Brodziak (2008; Figure 11d)

Figure 1. Area stratifications in the WCNPO and the EPO, adapted from Ichinokawa and Brodziak (2008), used for the CPUE analysis of swordfish caught by Japanese distant water longliners.

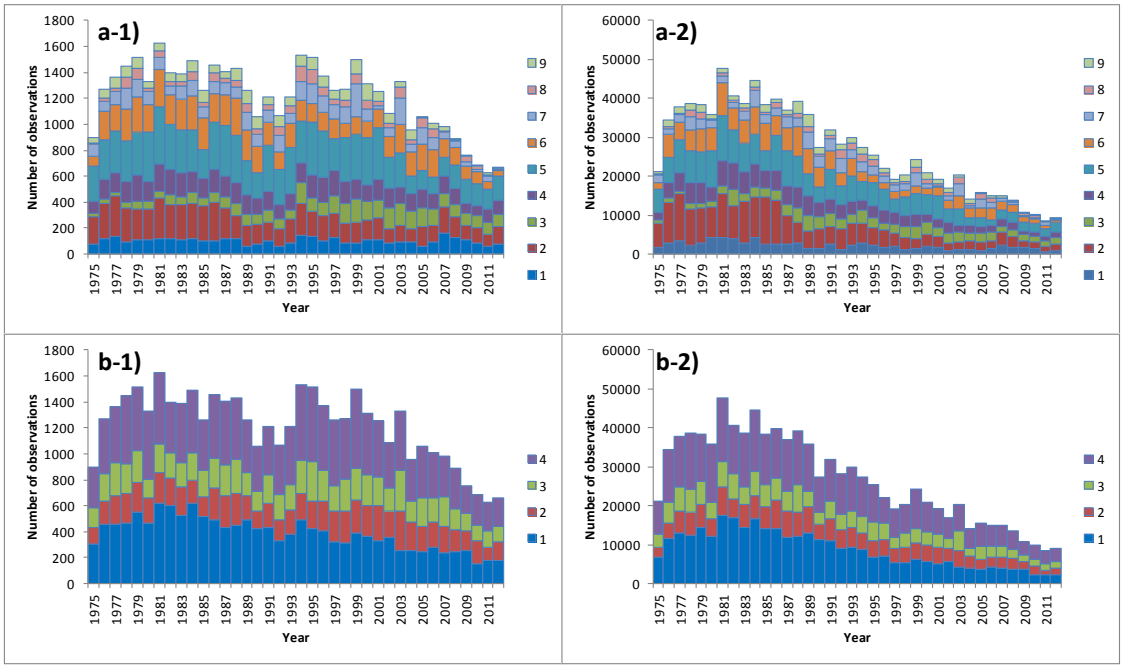



Figure 2. Number of observations in the WCNPO (1) in the 5x5 aggregated data, and (2) in the operational data (a) by year and area, and (b) by year and quarter.

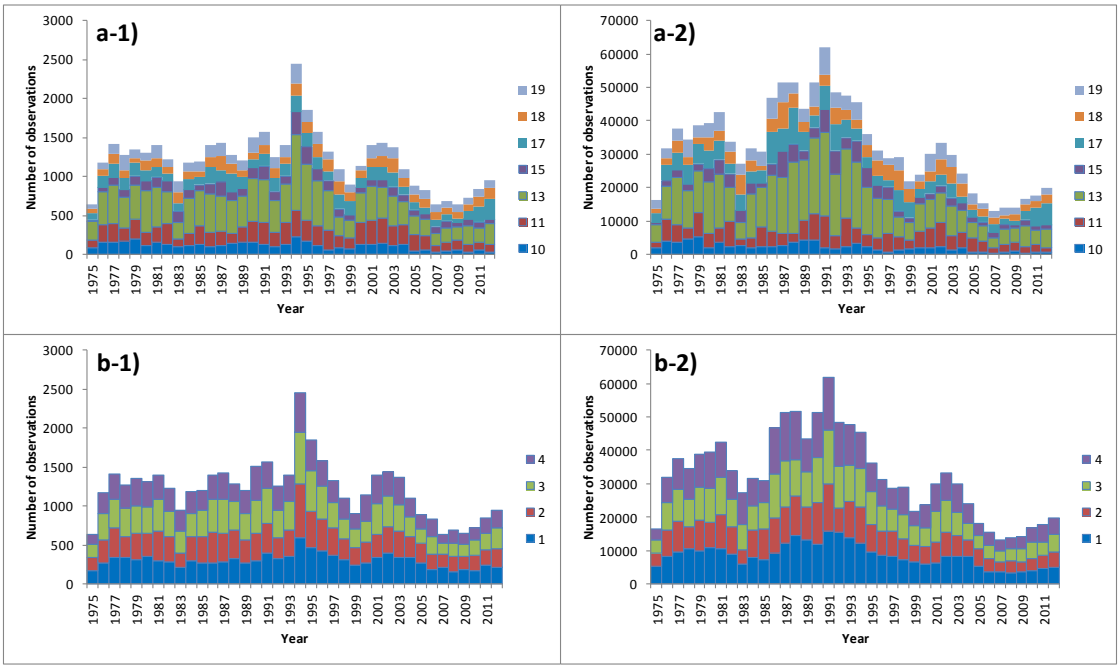



Figure 3. Number of observations in the EPO (1) in the 5x5 aggregated data, and (2) in the operational data (a) by year and area, and (b) by year and quarter.

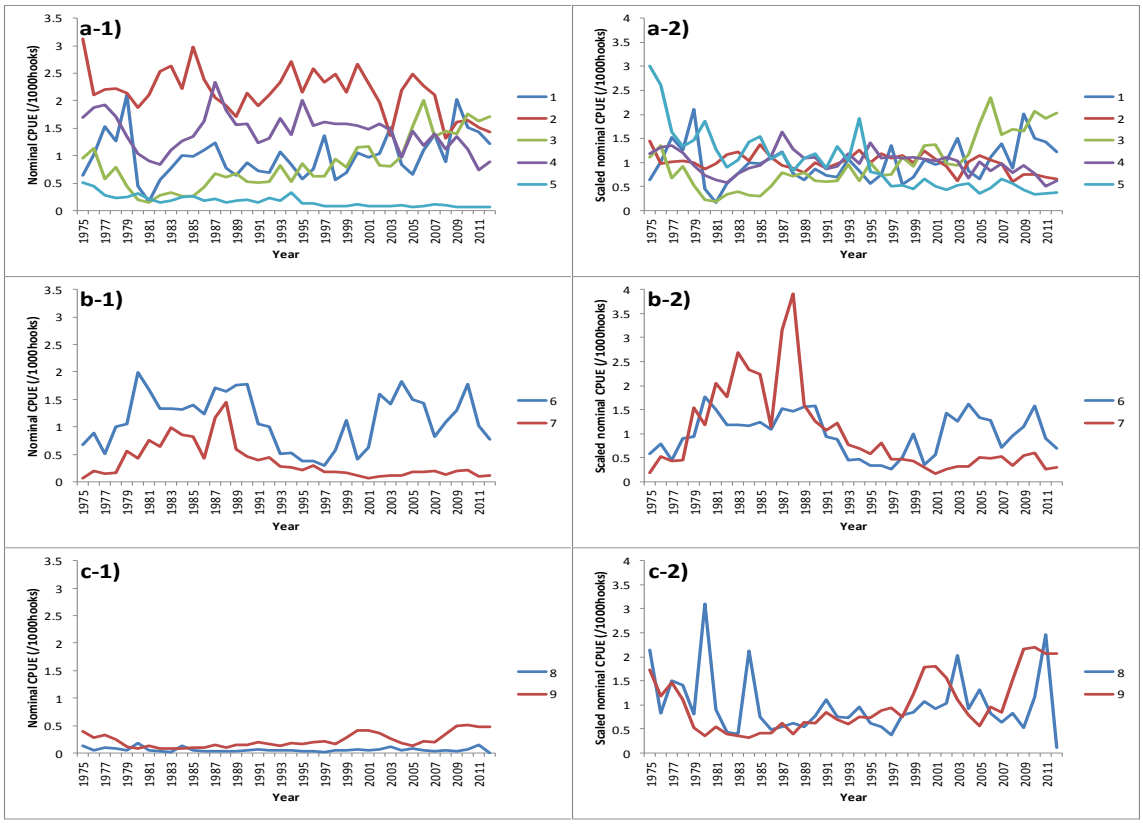



Figure 4. Trend of nominal CPUE in the WCNPO by area, using the 5x5 aggregated data.

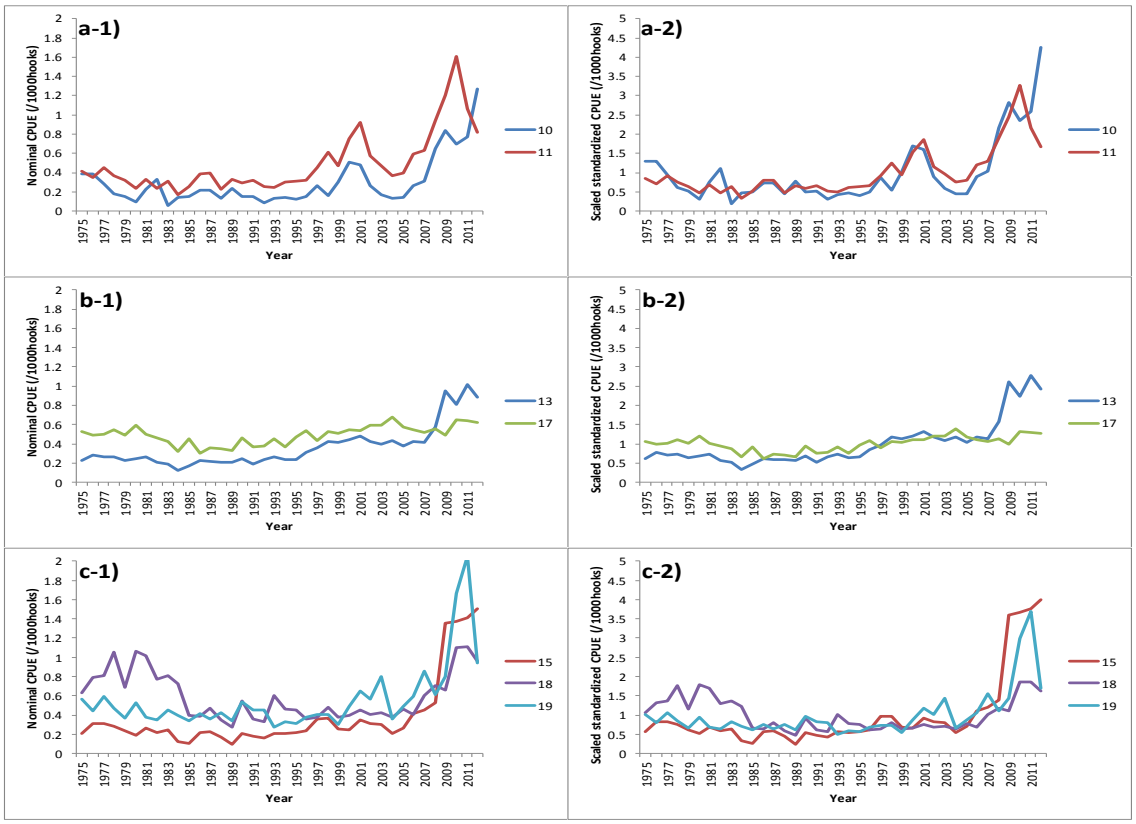



Figure 5. Trend of nominal CPUE in the WCNPO by area, using the 5x5 aggregated data.

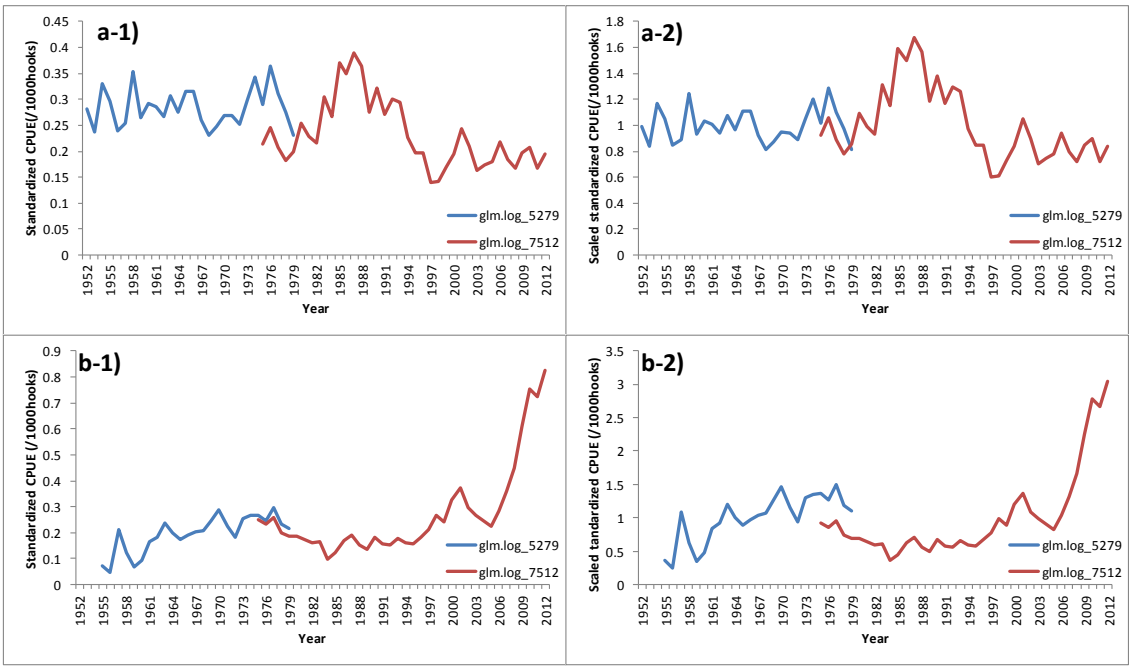



Figure 6. The standardized CPUEs (1) by log-transformed GLM or their scaled CPUEs (2) for the period between 1952 and 1979 (blue line), and between 1975 and 2012 (red line) with their confidence interval in (a) the WCNPO and (b) the EPO.

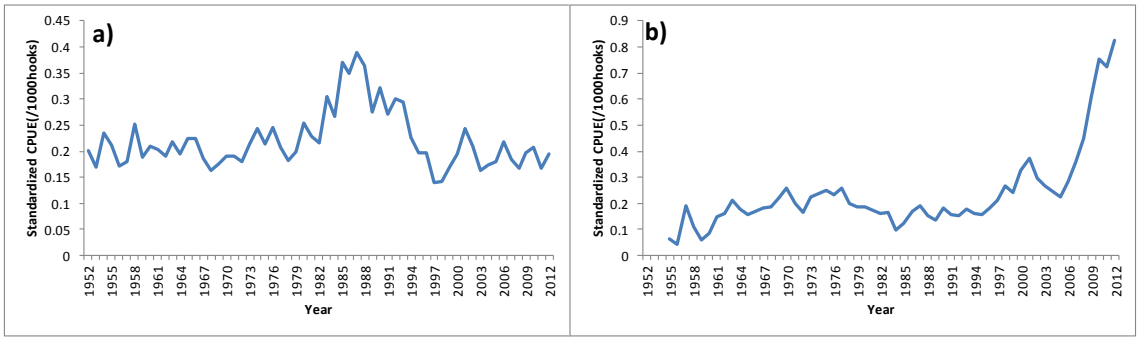



Figure 7. The combined standardized CPUEs by log-transformed GLM for the period between 1952 and 2012 with their confidence interval in (a) the WCNPO and (b) the EPO.

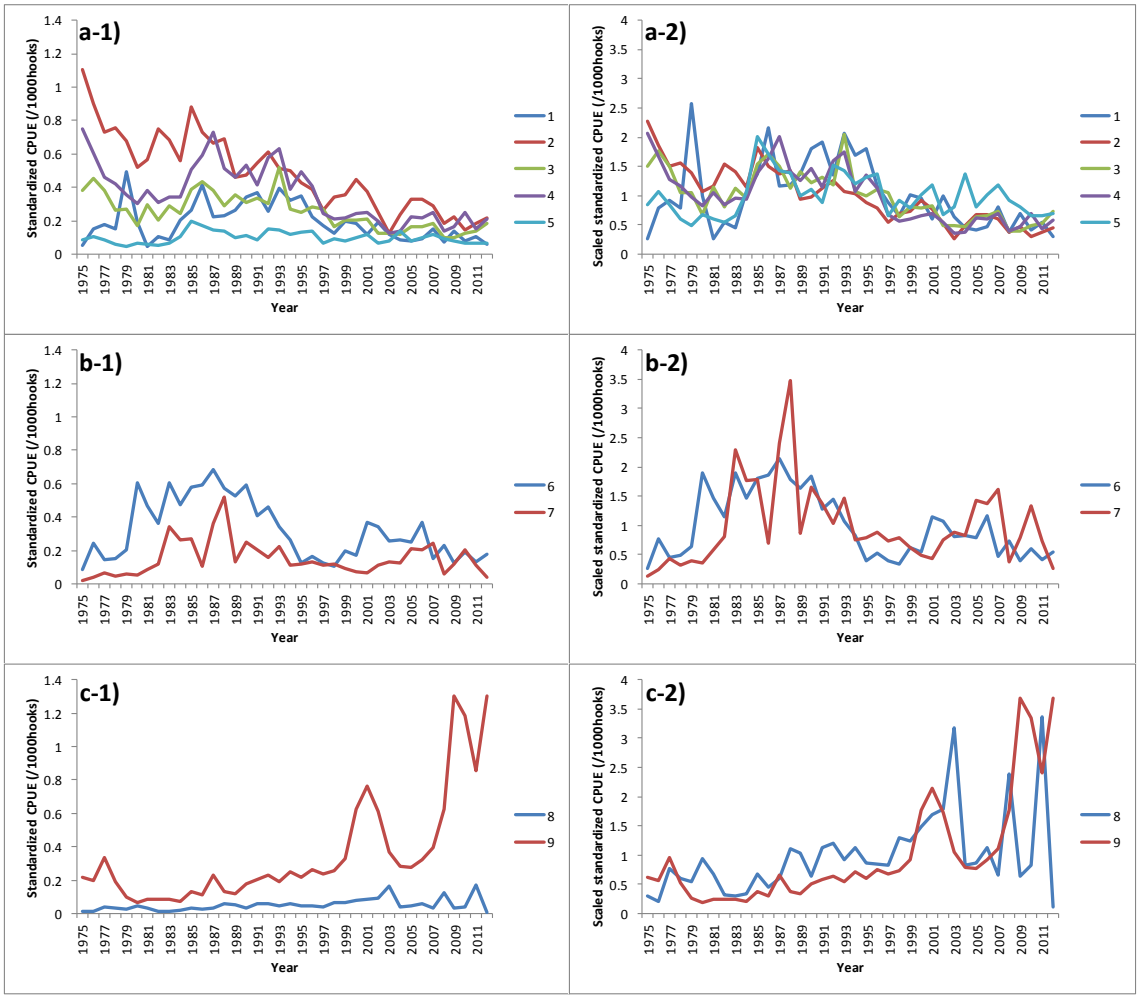



Figure 8. The standardized CPUEs by area (1) by log-transformed GLM or their scaled CPUEs (2) for the period between 1975 and 2012 in the WCNPO, areas (a) 1-5, (b) 6-7, and (c) 8-9.

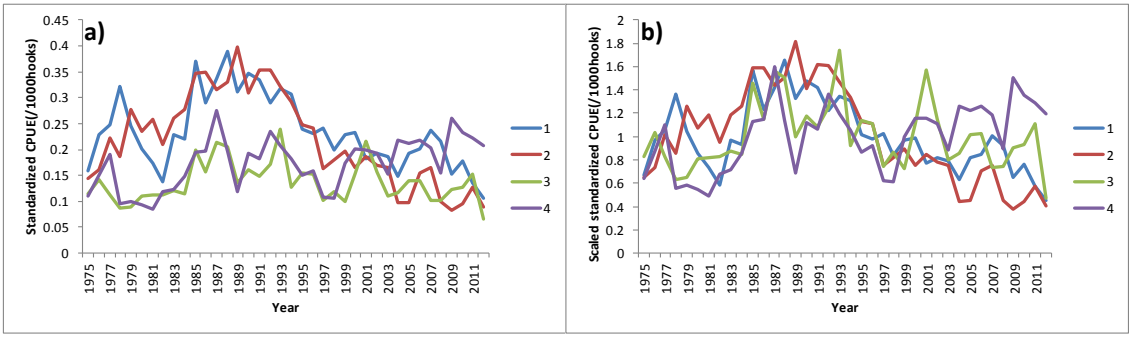



Figure 9. The standardized CPUEs by quarter (1) by log-transformed GLM or their scaled CPUEs (2) for the period between 1975 and 2012 in the WCNPO.

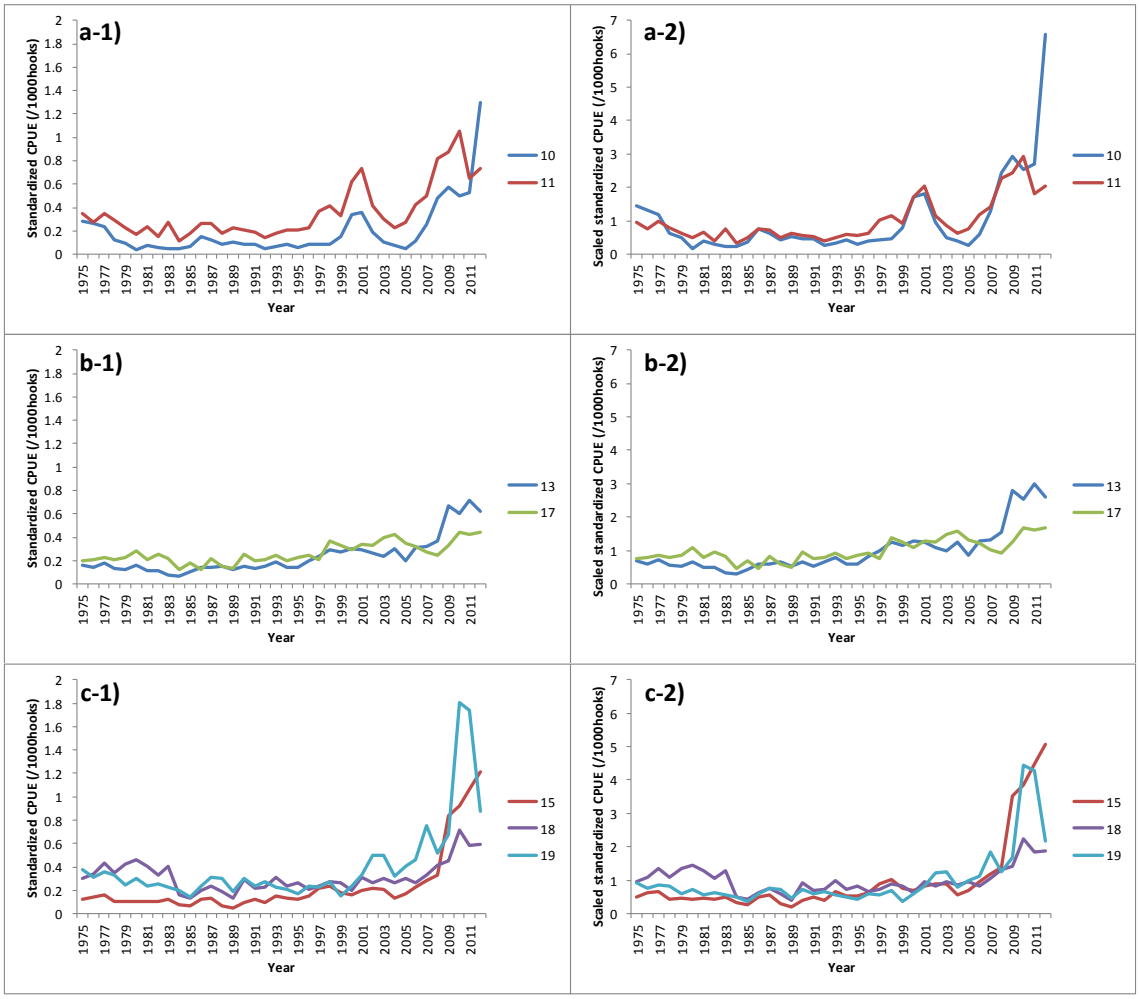



Figure 10. The standardized CPUEs by area (1) by log-transformed GLM or their scaled CPUEs (2) for the period between 1975 and 2012 in the EPO, areas (a) 10 and 11, (b) 13 and 17, and (c)15, 18, and 19.

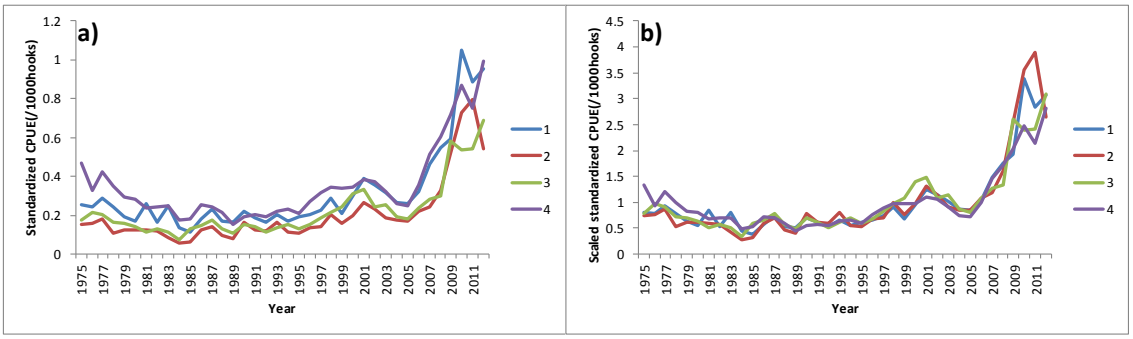



Figure 11. The standardized CPUEs by quarter (1) by log-transformed GLM or their scaled CPUEs (2) for the period between 1975 and 2012 in the EPO.

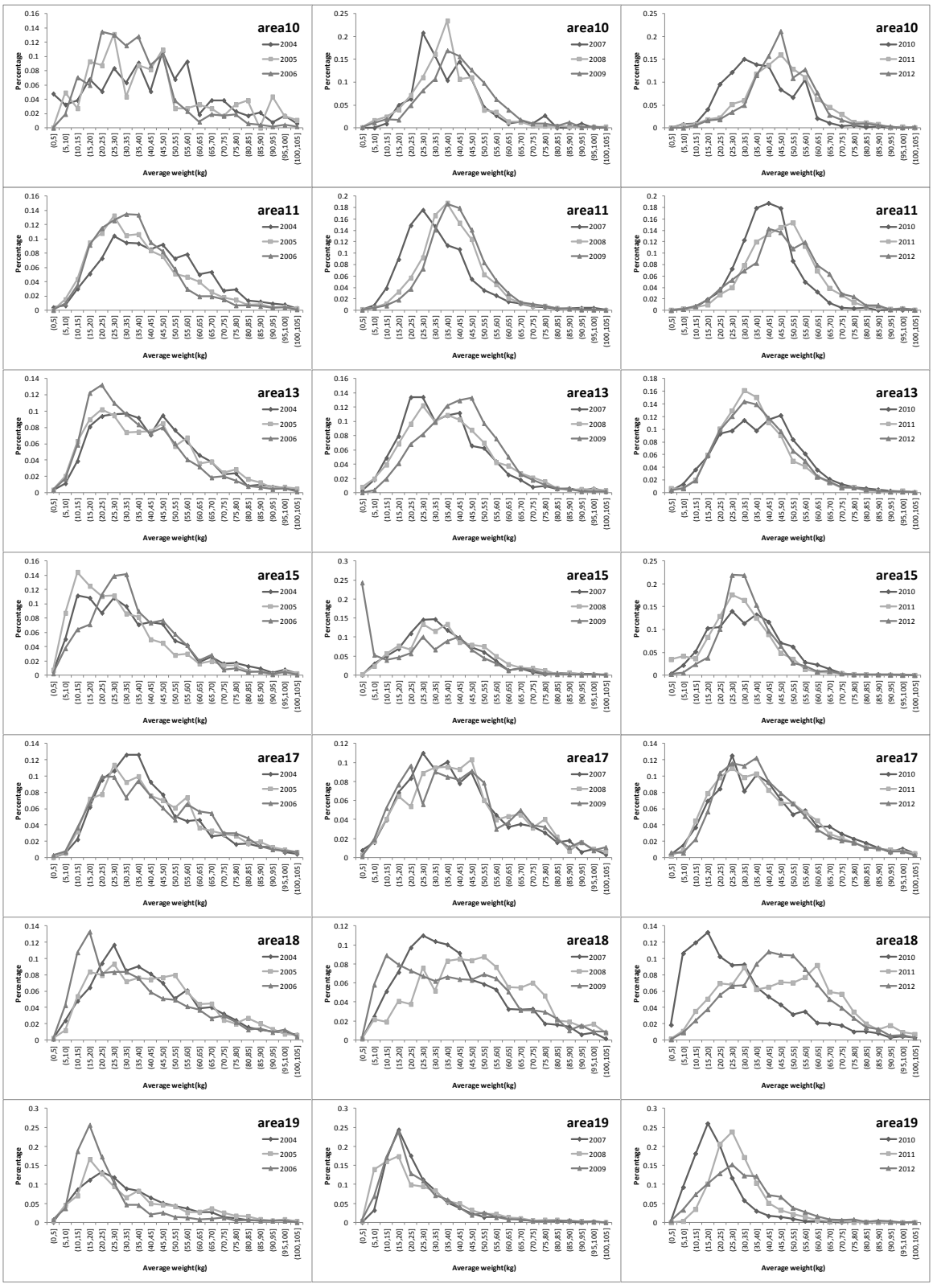



Figure 12. The weight frequency (kg) of swordfish in the EPO, obtained from the estimated average weight in each operational data in the logbook by area for the period between 2004 and 2012.

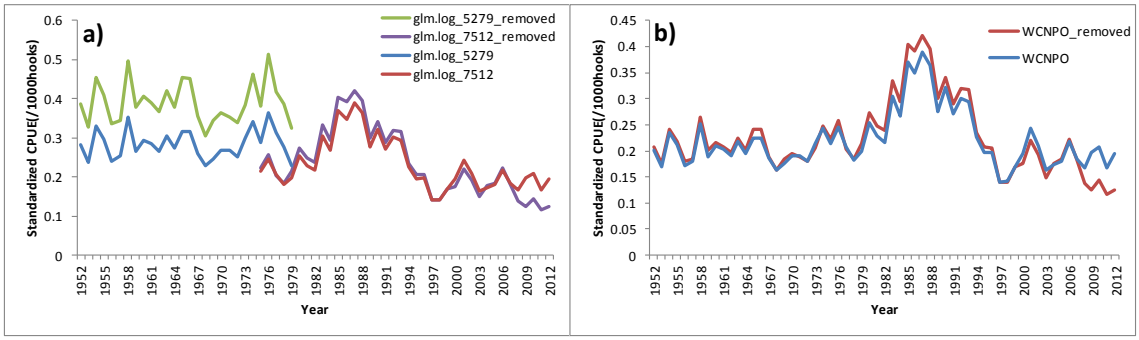



Figure 13. The comparison of the standardized CPUEs by log-transformed GLM between those in the WCNPO and in the WCNPO without areas 8 and 9 (removed). a) the standardized CPUEs for the period between 1952 and 1979, and between 1975 and 2012, and b) the combined standardized CPUEs for the period between 1952 and 2012.

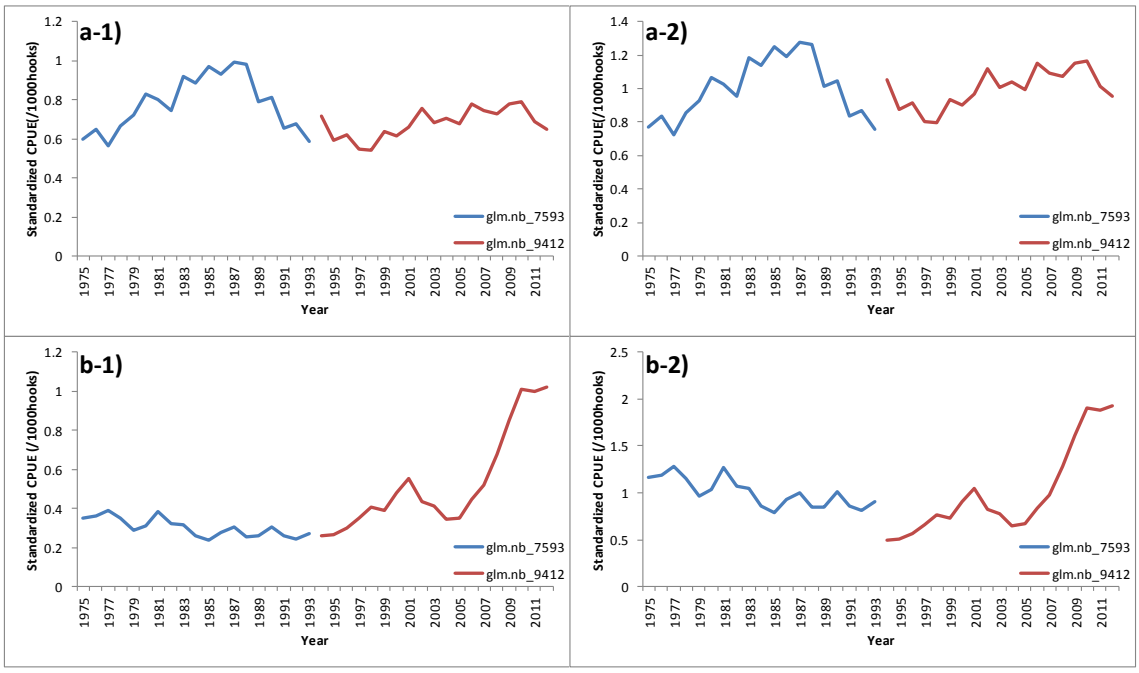



Figure 14. The standardized CPUEs (1) by negative binomial GLM or their scaled CPUEs (2) for the period between 1975 and 1993 (blue line), and between 1994 and 2012 (red line) with their confidence interval of swordfish caught by Japanese longliners in (a) the WCNPO and (b) the EPO.

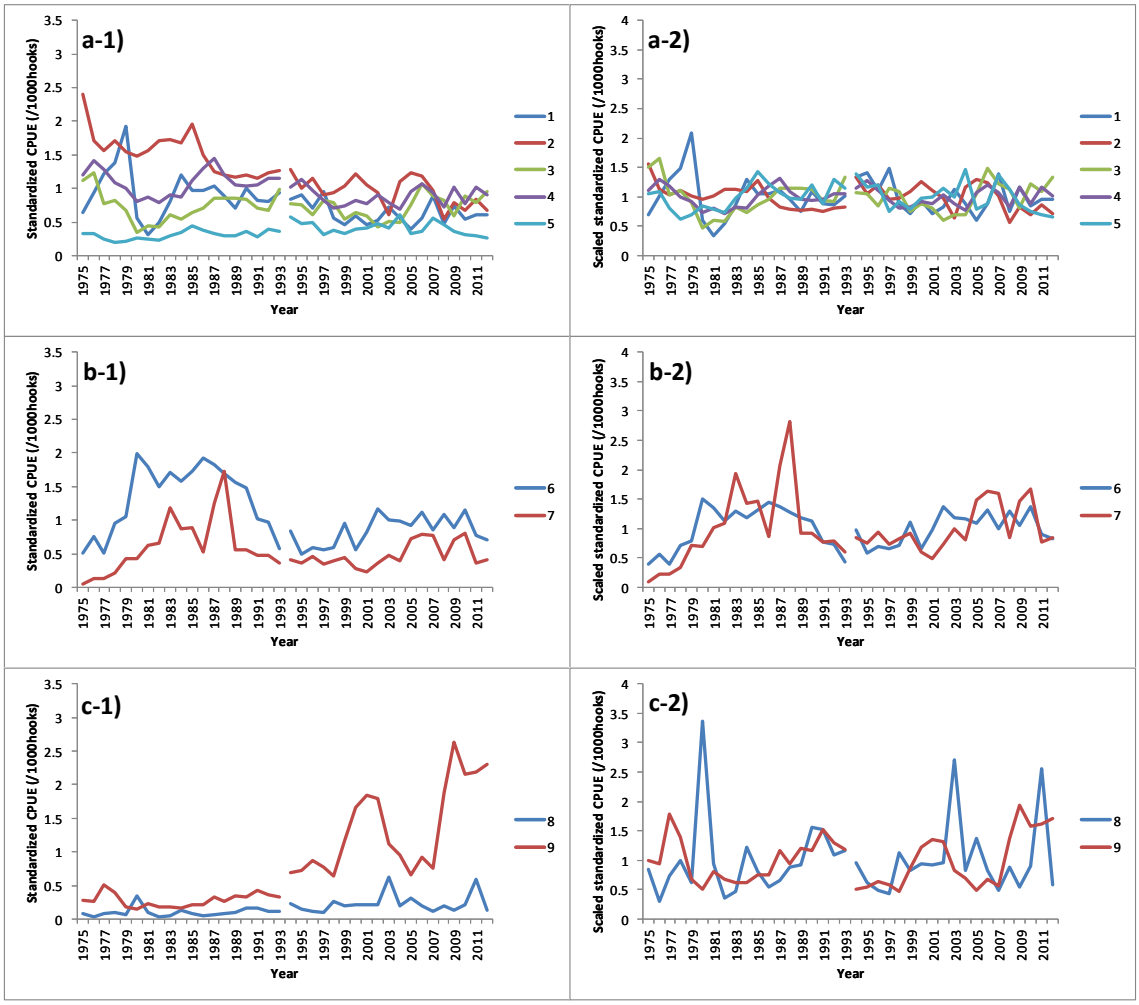



Figure 15. The standardized CPUEs (1) by negative binomial GLM or their scaled CPUEs (2) by area for the period between 1975 and 2012 in the WCNPO, areas (a) 1-5, (b) 6-7, and (c) 8-9.

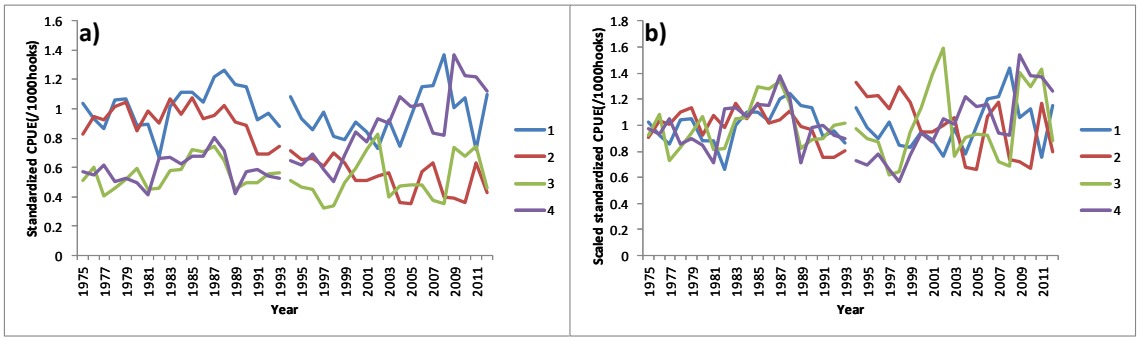



Figure 16. The standardized CPUEs (1) by negative binomial GLM or their scaled CPUEs (2) by quarter for the period between 1975 and 2012 in the WCNPO.

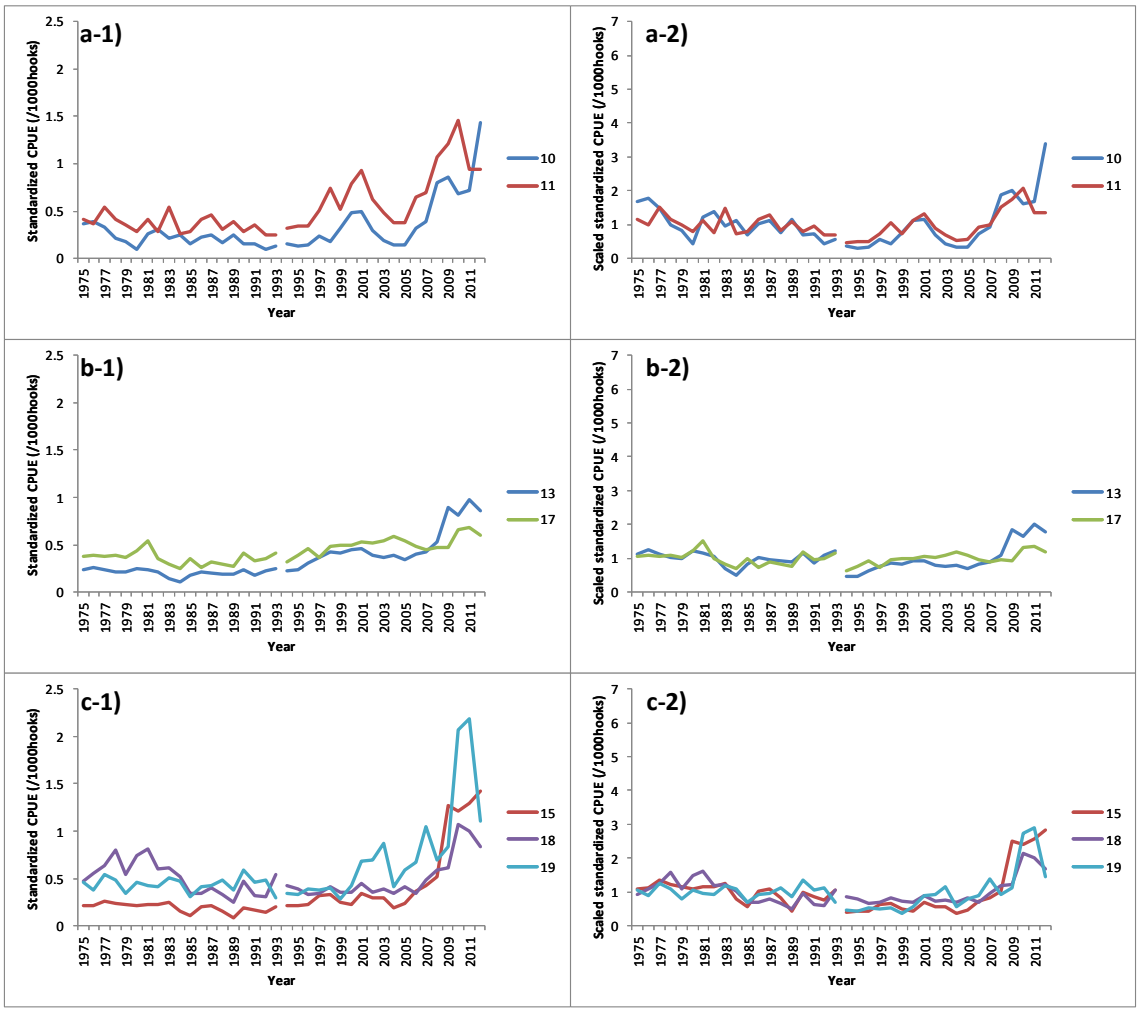



Figure 17. The standardized CPUEs (1) by negative binomial GLM or their scaled CPUEs (2) by area for the period between 1975 and 2012 in the EPO, areas (a) 10 and 11, (b) 13 and 17, and (c)15, 18, and 19.

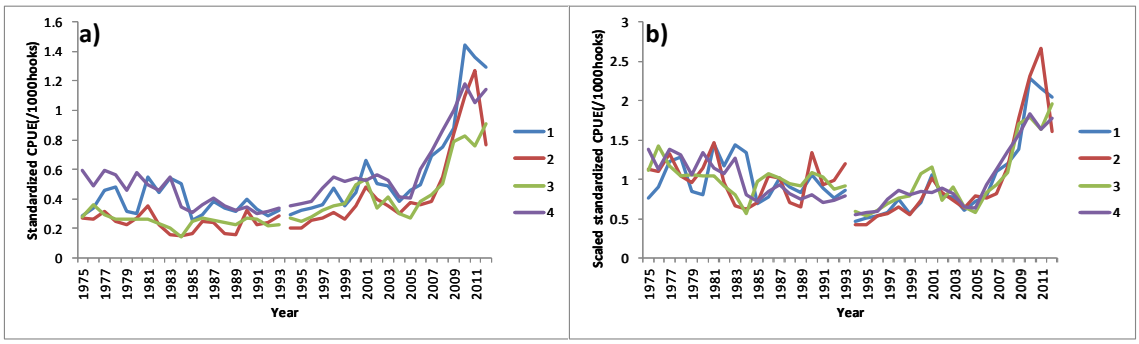



Figure 18. The standardized CPUEs (1) by negative binomial GLM or their scaled CPUEs (2) by quarter for the period between 1975 and 2012 in the ENPO.

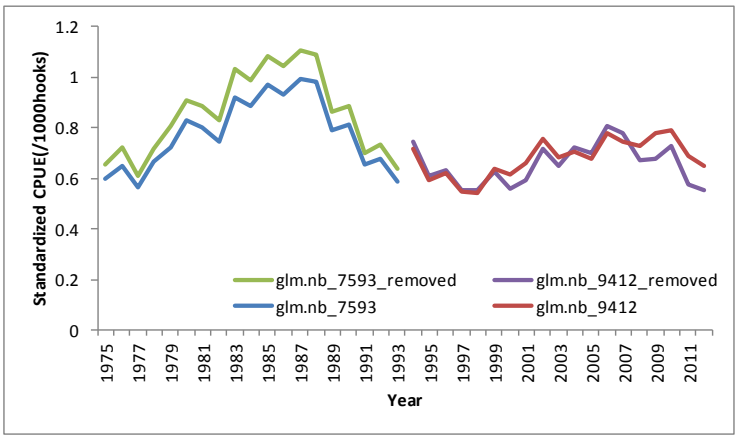



Figure 19. Comparison of the standardized CPUEs by negative binomial GLM between those in the WCNPO and in the WCNPO without areas 8 and 9 for the period between 1975 and 1993, and between 1994 and 2012.

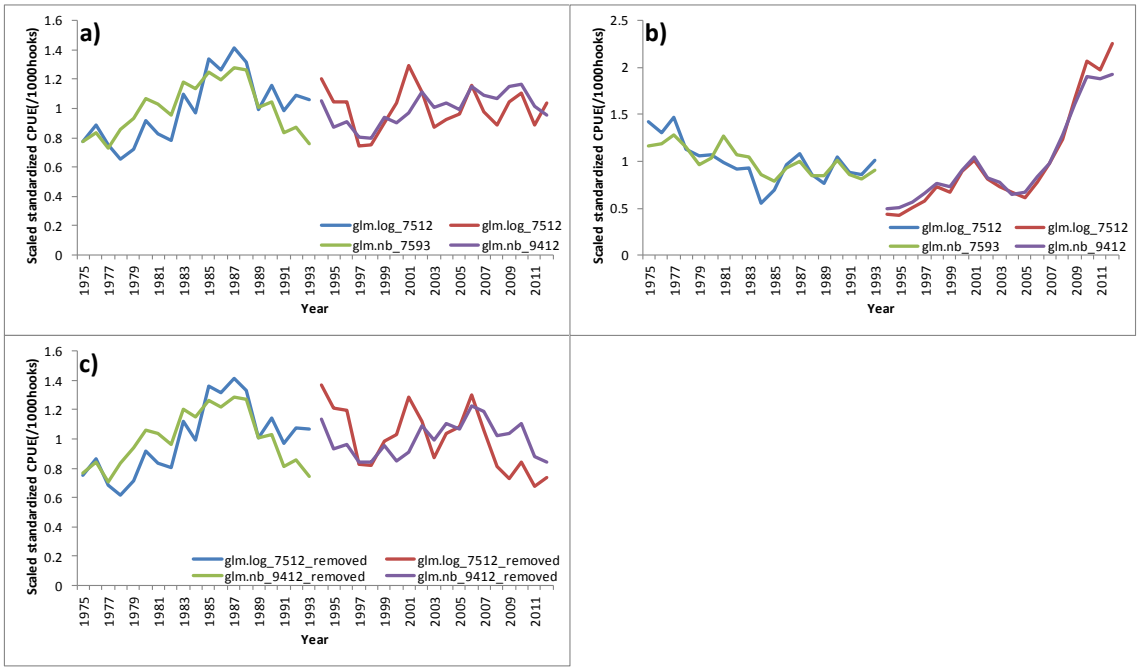



Figure 20. Model comparisons of the scaled standardized CPUEs between log-transformed GLM and negative binomial GLM in the WCNPO (a), in the WCNPO without areas 8 and 9 (b), and in the EPO (c). The standardized CPUE was scaled for the period between 1975 and 1993 or between 1994 and 2012.

**Appendix Diagnostics and predicted values**

**WCNPO for the period between 1952 and 1979, fitted simple GLM (log-transformed) to the 5x5 aggregated data**

| | Df | Deviance | Resid. Df | Resid. Dev |
|---|---|---|---|---|
| NULL | | | 12334 | 54322 |
| as.factor(year) | 27 | 966.4 | 12307 | 53356 |
| as.factor(qt) | 3 | 1778.1 | 12304 | 51578 |
| as.factor(ar09) | 8 | 16881.4 | 12296 | 34696 |
| as.factor(qt):as.factor(ar09) | 24 | 5223.1 | 12272 | 29473 |
| as.factor(year):as.factor(qt) | 81 | 375.1 | 12191 | 29098 |

Call:

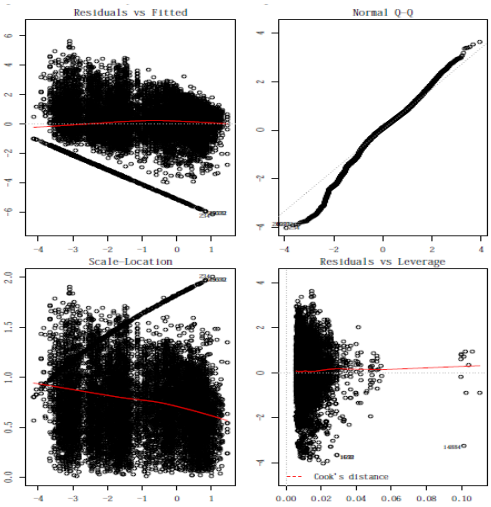
```
glm(formula = lcpue ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(qt) * as.factor(area) + as.factor(year) * as.factor(qt),
    family = gaussian, data = awcpob)
```

Deviance Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -6.1506 | -0.8137 | 0.1549 | 0.9232 | 5.5967 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|
| (Intercept) | 0.335058 | 0.224780 | 1.491 | 0.136091 | |
| as.factor(year)1953 | -0.274198 | 0.270506 | -1.014 | 0.310770 | |
| as.factor(year)1954 | -0.015124 | 0.277321 | -0.055 | 0.956508 | |
| as.factor(year)1955 | 0.001268 | 0.252298 | 0.005 | 0.995990 | |
| as.factor(year)1956 | -0.039466 | 0.252307 | -0.156 | 0.875703 | |
| as.factor(year)1957 | -0.004001 | 0.250028 | -0.016 | 0.987232 | |
| as.factor(year)1958 | -0.088981 | 0.258114 | -0.345 | 0.730299 | |
| as.factor(year)1959 | -0.208265 | 0.251073 | -0.829 | 0.406839 | |
| as.factor(year)1960 | -0.167692 | 0.245870 | -0.682 | 0.495231 | |
| as.factor(year)1961 | -0.048036 | 0.250053 | -0.192 | 0.847664 | |
| as.factor(year)1962 | -0.164174 | 0.244748 | -0.671 | 0.502369 | |
| as.factor(year)1963 | 0.103193 | 0.241452 | 0.427 | 0.669107 | |
| as.factor(year)1964 | -0.215295 | 0.240887 | -0.894 | 0.371469 | |
| as.factor(year)1965 | -0.159693 | 0.241114 | -0.662 | 0.507782 | |
| as.factor(year)1966 | -0.027899 | 0.242996 | -0.115 | 0.908597 | |
| as.factor(year)1967 | -0.033873 | 0.236882 | -0.143 | 0.886297 | |
| as.factor(year)1968 | -0.386837 | 0.239292 | -1.617 | 0.105993 | |
| as.factor(year)1969 | -0.255107 | 0.239592 | -1.065 | 0.287008 | |
| as.factor(year)1970 | -0.023039 | 0.237999 | -0.097 | 0.922885 | |
| as.factor(year)1971 | -0.218822 | 0.235737 | -0.928 | 0.353299 | |
| as.factor(year)1972 | -0.169014 | 0.239269 | -0.706 | 0.479967 | |
| as.factor(year)1973 | 0.142682 | 0.239043 | 0.597 | 0.550591 | |
| as.factor(year)1974 | 0.012033 | 0.241307 | 0.050 | 0.960230 | |
| as.factor(year)1975 | -0.275093 | 0.242915 | -1.132 | 0.257461 | |
| as.factor(year)1976 | -0.064652 | 0.236389 | -0.273 | 0.784476 | |
| as.factor(year)1977 | -0.136921 | 0.238001 | -0.575 | 0.565102 | |
| as.factor(year)1978 | 0.065259 | 0.237879 | 0.274 | 0.783831 | |
| as.factor(year)1979 | -0.213015 | 0.235711 | -0.904 | 0.366165 | |
| as.factor(qt)2 | -3.189286 | 0.320484 | -9.951 | < 2e-16 | *** |
| as.factor(qt)3 | -1.374550 | 0.334027 | -4.115 | 3.90e-05 | *** |
| as.factor(qt)4 | -0.030500 | 0.306264 | -0.100 | 0.920674 | |
| as.factor(area)2 | 0.319704 | 0.122315 | 2.614 | 0.008966 | ** |
| as.factor(area)3 | 0.875457 | 0.226906 | 3.858 | 0.000115 | *** |
| as.factor(area)4 | 0.548651 | 0.128319 | 4.276 | 1.92e-05 | *** |
| as.factor(area)5 | -2.581285 | 0.116960 | -22.070 | < 2e-16 | *** |
| as.factor(area)6 | -0.451141 | 0.120446 | -3.746 | 0.000181 | *** |
| as.factor(area)7 | -2.185505 | 0.140292 | -15.578 | < 2e-16 | *** |
| as.factor(area)8 | -3.535055 | 0.185588 | -19.048 | < 2e-16 | *** |
| as.factor(area)9 | -1.660264 | 0.176123 | -9.427 | < 2e-16 | *** |
| as.factor(qt)2:as.factor(area)2 | 3.569119 | 0.164321 | 21.720 | < 2e-16 | *** |
| as.factor(qt)3:as.factor(area)2 | 0.662635 | 0.168687 | 3.928 | 8.61e-05 | *** |
| as.factor(qt)4:as.factor(area)2 | -0.542203 | 0.159999 | -3.389 | 0.000704 | *** |
| as.factor(qt)2:as.factor(area)3 | 2.029409 | 0.528223 | 3.842 | 0.000123 | *** |
| as.factor(qt)3:as.factor(area)3 | -0.671974 | 0.257848 | -2.606 | 0.009170 | ** |
| as.factor(qt)4:as.factor(area)3 | -0.725466 | 0.258577 | -2.806 | 0.005030 | ** |
| as.factor(qt)2:as.factor(area)4 | 3.552043 | 0.195332 | 18.185 | < 2e-16 | *** |
| as.factor(qt)3:as.factor(area)4 | -1.250463 | 0.216019 | -5.789 | 7.27e-09 | *** |
| as.factor(qt)4:as.factor(area)4 | -1.599075 | 0.173089 | -9.238 | < 2e-16 | *** |
| as.factor(qt)2:as.factor(area)5 | 4.066760 | 0.155574 | 26.140 | < 2e-16 | *** |
| as.factor(qt)3:as.factor(area)5 | 0.303491 | 0.153715 | 1.974 | 0.048362 | * |
| as.factor(qt)4:as.factor(area)5 | -1.055515 | 0.150652 | -7.006 | 2.58e-12 | *** |
| as.factor(qt)2:as.factor(area)6 | 3.328839 | 0.185556 | 17.940 | < 2e-16 | *** |
| as.factor(qt)3:as.factor(area)6 | -1.540597 | 0.163898 | -9.400 | < 2e-16 | *** |
| as.factor(qt)4:as.factor(area)6 | -1.643085 | 0.150122 | -10.945 | < 2e-16 | *** |
| as.factor(qt)2:as.factor(area)7 | 3.511044 | 0.288512 | 12.169 | < 2e-16 | *** |
| as.factor(qt)3:as.factor(area)7 | -0.309224 | 0.187665 | -1.648 | 0.099431 | . |
| as.factor(qt)4:as.factor(area)7 | -1.329126 | 0.176781 | -7.518 | 5.93e-14 | *** |
| as.factor(qt)2:as.factor(area)8 | 4.367681 | 0.380756 | 11.471 | < 2e-16 | *** |
| as.factor(qt)3:as.factor(area)8 | 0.667307 | 0.344646 | 1.936 | 0.052865 | . |
| as.factor(qt)4:as.factor(area)8 | 0.037087 | 0.250753 | 0.148 | 0.882421 | |
| as.factor(qt)2:as.factor(area)9 | 3.312417 | 0.229220 | 14.451 | < 2e-16 | *** |



```
as.factor(qt)3:as.factor(area)9          0.750782   0.223660    3.357 0.000791 ***
as.factor(qt)4:as.factor(area)9         -0.552465   0.253378   -2.180 0.029247 *
as.factor(year)1953:as.factor(qt)2 -0.204393   0.414596   -0.493 0.622026
as.factor(year)1954:as.factor(qt)2 -0.152580   0.423068   -0.361 0.718367
as.factor(year)1955:as.factor(qt)2  0.034830   0.389344    0.089 0.928720
as.factor(year)1956:as.factor(qt)2  0.004657   0.388399    0.012 0.990433
as.factor(year)1957:as.factor(qt)2 -0.022444   0.387807   -0.058 0.953850
as.factor(year)1958:as.factor(qt)2  0.304246   0.388451    0.783 0.433507
as.factor(year)1959:as.factor(qt)2 -0.014140   0.379080   -0.037 0.970245
as.factor(year)1960:as.factor(qt)2 -0.158163   0.367287   -0.431 0.666749
as.factor(year)1961:as.factor(qt)2 -0.139134   0.373783   -0.372 0.709728
as.factor(year)1962:as.factor(qt)2 -0.198512   0.370674   -0.536 0.592284
as.factor(year)1963:as.factor(qt)2 -0.540027   0.373237   -1.447 0.147957
as.factor(year)1964:as.factor(qt)2  0.047207   0.377579    0.125 0.900505
as.factor(year)1965:as.factor(qt)2  0.029632   0.364065    0.081 0.935131
as.factor(year)1966:as.factor(qt)2  0.078756   0.363762    0.217 0.828598
as.factor(year)1967:as.factor(qt)2 -0.299987   0.353185   -0.849 0.395689
as.factor(year)1968:as.factor(qt)2 -0.252977   0.360481   -0.702 0.482833
as.factor(year)1969:as.factor(qt)2 -0.161386   0.365879   -0.441 0.659155
as.factor(year)1970:as.factor(qt)2 -0.524514   0.358522   -1.463 0.143496
as.factor(year)1971:as.factor(qt)2 -0.429196   0.364203   -1.178 0.238640
as.factor(year)1972:as.factor(qt)2 -0.394334   0.371823   -1.061 0.288919
as.factor(year)1973:as.factor(qt)2 -0.707846   0.368847   -1.919 0.054998 .
as.factor(year)1974:as.factor(qt)2 -0.206059   0.366138   -0.563 0.573588
as.factor(year)1975:as.factor(qt)2  0.162889   0.372068    0.438 0.661543
as.factor(year)1976:as.factor(qt)2  0.037199   0.361057    0.103 0.917943
as.factor(year)1977:as.factor(qt)2 -0.118251   0.363599   -0.325 0.745017
as.factor(year)1978:as.factor(qt)2 -0.239117   0.363025   -0.659 0.510114
as.factor(year)1979:as.factor(qt)2 -0.141247   0.355745   -0.397 0.691340
as.factor(year)1953:as.factor(qt)3  0.224692   0.431680    0.521 0.602721
as.factor(year)1954:as.factor(qt)3  0.511267   0.445001    1.149 0.250614
as.factor(year)1955:as.factor(qt)3  0.086515   0.420526    0.206 0.837005
as.factor(year)1956:as.factor(qt)3 -0.483888   0.417114   -1.160 0.246036
as.factor(year)1957:as.factor(qt)3 -0.596043   0.406415   -1.467 0.142514
as.factor(year)1958:as.factor(qt)3  0.544565   0.403750    1.349 0.177437
as.factor(year)1959:as.factor(qt)3  0.372195   0.391312    0.951 0.341549
as.factor(year)1960:as.factor(qt)3  0.502076   0.397024    1.265 0.206040
as.factor(year)1961:as.factor(qt)3 -0.013045   0.389065   -0.034 0.973253
as.factor(year)1962:as.factor(qt)3  0.187656   0.390240    0.481 0.630616
as.factor(year)1963:as.factor(qt)3 -0.084562   0.385303   -0.219 0.826288
as.factor(year)1964:as.factor(qt)3  0.401107   0.383664    1.045 0.295829
as.factor(year)1965:as.factor(qt)3  0.719781   0.374683    1.921 0.054750 .
as.factor(year)1966:as.factor(qt)3  0.300017   0.380008    0.790 0.429835
as.factor(year)1967:as.factor(qt)3  0.268045   0.368855    0.727 0.467427
as.factor(year)1968:as.factor(qt)3  0.488617   0.372968    1.310 0.190195
as.factor(year)1969:as.factor(qt)3  0.372181   0.371840    1.001 0.316886
as.factor(year)1970:as.factor(qt)3  0.499846   0.369234    1.354 0.175845
as.factor(year)1971:as.factor(qt)3  0.675484   0.371424    1.819 0.068992 .
as.factor(year)1972:as.factor(qt)3  0.307659   0.386351    0.796 0.425862
as.factor(year)1973:as.factor(qt)3  0.393170   0.381602    1.030 0.302883
as.factor(year)1974:as.factor(qt)3  0.813289   0.381918    2.129 0.033234 *
as.factor(year)1975:as.factor(qt)3  0.385534   0.389846    0.989 0.322712
as.factor(year)1976:as.factor(qt)3  0.848464   0.372190    2.280 0.022646 *
as.factor(year)1977:as.factor(qt)3  0.577922   0.374008    1.545 0.122321
as.factor(year)1978:as.factor(qt)3  0.165770   0.376321    0.441 0.659581
as.factor(year)1979:as.factor(qt)3  0.319405   0.371659    0.859 0.390134
as.factor(year)1953:as.factor(qt)4  0.414281   0.382265    1.084 0.278496
as.factor(year)1954:as.factor(qt)4  0.330977   0.382985    0.864 0.387492
as.factor(year)1955:as.factor(qt)4  0.084465   0.355414    0.238 0.812155
as.factor(year)1956:as.factor(qt)4  0.010261   0.350022    0.029 0.976613
as.factor(year)1957:as.factor(qt)4  0.219263   0.354351    0.619 0.536077
as.factor(year)1958:as.factor(qt)4  0.394461   0.357344    1.104 0.269672
as.factor(year)1959:as.factor(qt)4  0.233019   0.348387    0.669 0.503603
as.factor(year)1960:as.factor(qt)4  0.487311   0.344941    1.413 0.157759
as.factor(year)1961:as.factor(qt)4  0.402078   0.351969    1.142 0.253324
as.factor(year)1962:as.factor(qt)4  0.453911   0.341159    1.330 0.183379
as.factor(year)1963:as.factor(qt)4  0.542634   0.336630    1.612 0.106996
as.factor(year)1964:as.factor(qt)4  0.313496   0.337152    0.930 0.352473
as.factor(year)1965:as.factor(qt)4  0.342461   0.335107    1.022 0.306826
as.factor(year)1966:as.factor(qt)4  0.184439   0.339801    0.543 0.587287
as.factor(year)1967:as.factor(qt)4 -0.122348   0.333903   -0.366 0.714060
as.factor(year)1968:as.factor(qt)4  0.523650   0.334395    1.566 0.117384
as.factor(year)1969:as.factor(qt)4  0.298345   0.335060    0.890 0.373257
as.factor(year)1970:as.factor(qt)4 -0.062327   0.332203   -0.188 0.851180
as.factor(year)1971:as.factor(qt)4  0.440539   0.332693    1.324 0.185475
as.factor(year)1972:as.factor(qt)4  0.336667   0.338110    0.996 0.319400
as.factor(year)1973:as.factor(qt)4 -0.014150   0.336634   -0.042 0.966473
as.factor(year)1974:as.factor(qt)4  0.112206   0.338545    0.331 0.740321
as.factor(year)1975:as.factor(qt)4  0.657141   0.340882    1.928 0.053907 .
as.factor(year)1976:as.factor(qt)4  0.392313   0.332343    1.180 0.237846
as.factor(year)1977:as.factor(qt)4  0.495900   0.336600    1.473 0.140706
as.factor(year)1978:as.factor(qt)4 -0.257203   0.331985   -0.775 0.438507
as.factor(year)1979:as.factor(qt)4 -0.114619   0.328786   -0.349 0.727387
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 2.386857)

    Null deviance: 54322  on 12334  degrees of freedom
Residual deviance: 29098  on 12191  degrees of freedom
AIC: 45882
Number of Fisher Scoring iterations: 2
```

**EPO for the period between 1955 and 1979, fitted simple GLM (log-transformed) to the 5x5 aggregated data**

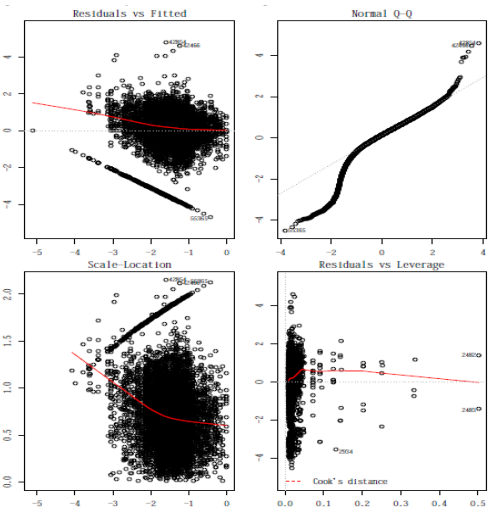
| | Df | Deviance | Resid. Df | Resid. Dev |
|---|---|---|---|---|
| NULL | | | 7636 | 10333.2 |
| as.factor(year) | 24 | 558.99 | 7612 | 9774.3 |
| as.factor(qt) | 3 | 346.38 | 7609 | 9427.9 |
| as.factor(ar09) | 6 | 769.92 | 7603 | 8658.0 |
| as.factor(qt):as.factor(ar09) | 18 | 266.27 | 7585 | 8391.7 |
| as.factor(year):as.factor(qt) | 72 | 187.41 | 7513 | 8204.3 |

Call:

```
glm(formula = lcpue ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(qt) * as.factor(area) + as.factor(year) * as.factor(qt),
    family = gaussian, data = aepob)
```

Deviance Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -4.6908 | -0.3676 | 0.1506 | 0.6185 | 4.7764 |




Coefficients:

| | Estimate | Std. Error | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|
| (Intercept) | -2.322128 | 0.606978 | -3.826 | 0.000131 | *** |
| as.factor(year)1956 | 0.901826 | 1.207113 | 0.747 | 0.455031 | |
| as.factor(year)1957 | 0.432347 | 0.683023 | 0.633 | 0.526759 | |
| as.factor(year)1958 | 0.123048 | 0.638355 | 0.193 | 0.847154 | |
| as.factor(year)1959 | 0.037627 | 0.634029 | 0.059 | 0.952678 | |
| as.factor(year)1960 | -0.985147 | 0.635977 | -1.549 | 0.121417 | |
| as.factor(year)1961 | 0.516846 | 0.621221 | 0.832 | 0.405444 | |
| as.factor(year)1962 | 0.838813 | 0.615567 | 1.363 | 0.173028 | |
| as.factor(year)1963 | 0.896141 | 0.613115 | 1.462 | 0.143887 | |
| as.factor(year)1964 | 0.795008 | 0.611710 | 1.300 | 0.193761 | |
| as.factor(year)1965 | 0.865058 | 0.612652 | 1.412 | 0.157994 | |
| as.factor(year)1966 | 0.812579 | 0.615008 | 1.321 | 0.186458 | |
| as.factor(year)1967 | 0.803278 | 0.613816 | 1.309 | 0.190688 | |
| as.factor(year)1968 | 1.038769 | 0.614791 | 1.690 | 0.091140 | . |
| as.factor(year)1969 | 0.986006 | 0.615867 | 1.601 | 0.109418 | |
| as.factor(year)1970 | 1.312301 | 0.615802 | 2.131 | 0.033118 | * |
| as.factor(year)1971 | 1.031873 | 0.615893 | 1.675 | 0.093895 | . |
| as.factor(year)1972 | 0.717286 | 0.616190 | 1.164 | 0.244435 | |
| as.factor(year)1973 | 0.953546 | 0.615368 | 1.550 | 0.121291 | |
| as.factor(year)1974 | 1.242841 | 0.613433 | 2.026 | 0.042796 | * |
| as.factor(year)1975 | 0.880368 | 0.614167 | 1.433 | 0.151776 | |
| as.factor(year)1976 | 1.075104 | 0.613396 | 1.753 | 0.079693 | . |
| as.factor(year)1977 | 1.161223 | 0.613720 | 1.892 | 0.058515 | . |
| as.factor(year)1978 | 1.055923 | 0.614704 | 1.718 | 0.085879 | . |
| as.factor(year)1979 | 0.843972 | 0.614099 | 1.374 | 0.169382 | |
| as.factor(qt)2 | -0.443497 | 0.959314 | -0.462 | 0.643875 | |
| as.factor(qt)3 | -0.657298 | 0.801121 | -0.820 | 0.411972 | |
| as.factor(qt)4 | 0.561315 | 0.710686 | 0.790 | 0.429657 | |
| as.factor(area)11 | 0.277099 | 0.099656 | 2.781 | 0.005440 | ** |
| as.factor(area)13 | -0.076035 | 0.084856 | -0.896 | 0.370256 | |
| as.factor(area)15 | -0.333953 | 0.107053 | -3.120 | 0.001818 | ** |
| as.factor(area)17 | -0.311889 | 0.099710 | -3.128 | 0.001767 | ** |
| as.factor(area)18 | 0.840960 | 0.117887 | 7.134 | 1.07e-12 | *** |
| as.factor(area)19 | 0.130530 | 0.140764 | 0.927 | 0.353803 | |
| as.factor(qt)2:as.factor(area)11 | 0.087011 | 0.126064 | 0.690 | 0.490079 | |
| as.factor(qt)3:as.factor(area)11 | -0.353114 | 0.125820 | -2.807 | 0.005021 | ** |
| as.factor(qt)4:as.factor(area)11 | -0.164100 | 0.139827 | -1.174 | 0.240596 | |
| as.factor(qt)2:as.factor(area)13 | -0.295314 | 0.110777 | -2.666 | 0.007696 | ** |
| as.factor(qt)3:as.factor(area)13 | -0.635458 | 0.111284 | -5.710 | 1.17e-08 | *** |
| as.factor(qt)4:as.factor(area)13 | -0.167808 | 0.118780 | -1.413 | 0.157767 | |
| as.factor(qt)2:as.factor(area)15 | -0.589229 | 0.147552 | -3.993 | 6.58e-05 | *** |
| as.factor(qt)3:as.factor(area)15 | -0.468012 | 0.143712 | -3.257 | 0.001133 | ** |
| as.factor(qt)4:as.factor(area)15 | -0.030386 | 0.150123 | -0.202 | 0.839605 | |
| as.factor(qt)2:as.factor(area)17 | -1.002330 | 0.146546 | -6.840 | 8.56e-12 | *** |
| as.factor(qt)3:as.factor(area)17 | -0.496786 | 0.141159 | -3.519 | 0.000435 | *** |
| as.factor(qt)4:as.factor(area)17 | 0.239595 | 0.134461 | 1.782 | 0.074808 | . |
| as.factor(qt)2:as.factor(area)18 | -1.097658 | 0.166095 | -6.609 | 4.14e-11 | *** |
| as.factor(qt)3:as.factor(area)18 | -0.904757 | 0.154067 | -5.872 | 4.48e-09 | *** |
| as.factor(qt)4:as.factor(area)18 | -0.110656 | 0.152773 | -0.724 | 0.468894 | |
| as.factor(qt)2:as.factor(area)19 | -0.367518 | 0.176415 | -2.083 | 0.037261 | * |
| as.factor(qt)3:as.factor(area)19 | -0.198375 | 0.166570 | -1.191 | 0.233716 | |
| as.factor(qt)4:as.factor(area)19 | 0.309145 | 0.175148 | 1.765 | 0.077596 | . |
| as.factor(year)1956:as.factor(qt)2 | -2.880847 | 1.759997 | -1.637 | 0.101704 | |
| as.factor(year)1957:as.factor(qt)2 | 1.442599 | 1.045495 | 1.380 | 0.167682 | |
| as.factor(year)1958:as.factor(qt)2 | 0.446939 | 0.994673 | 0.449 | 0.653205 | |
| as.factor(year)1959:as.factor(qt)2 | 0.054002 | 0.996081 | 0.054 | 0.956766 | |
| as.factor(year)1960:as.factor(qt)2 | 1.675451 | 0.989953 | 1.692 | 0.090601 | . |
| as.factor(year)1961:as.factor(qt)2 | 0.482452 | 0.975151 | 0.495 | 0.620794 | |
| as.factor(year)1962:as.factor(qt)2 | 0.186010 | 0.968915 | 0.192 | 0.847765 | |
| as.factor(year)1963:as.factor(qt)2 | 0.483186 | 0.965181 | 0.501 | 0.616656 | |
| as.factor(year)1964:as.factor(qt)2 | 0.349961 | 0.965443 | 0.362 | 0.716998 | |
| as.factor(year)1965:as.factor(qt)2 | 0.249469 | 0.966490 | 0.258 | 0.796322 | |
| as.factor(year)1966:as.factor(qt)2 | 0.361636 | 0.967014 | 0.374 | 0.708436 | |
| as.factor(year)1967:as.factor(qt)2 | 0.529071 | 0.967656 | 0.547 | 0.584563 | |

```
as.factor(year)1968:as.factor(qt)2 -0.003017     0.969187   -0.003 0.997516
as.factor(year)1969:as.factor(qt)2  0.352405     0.968193    0.364 0.715882
as.factor(year)1970:as.factor(qt)2 -0.058363     0.969528   -0.060 0.952000
as.factor(year)1971:as.factor(qt)2  0.531141     0.969760    0.548 0.583912
as.factor(year)1972:as.factor(qt)2  0.617733     0.970488    0.637 0.524458
as.factor(year)1973:as.factor(qt)2  0.463564     0.969615    0.478 0.632600
as.factor(year)1974:as.factor(qt)2  0.215949     0.966746    0.223 0.823248
as.factor(year)1975:as.factor(qt)2  0.486934     0.968386    0.503 0.615098
as.factor(year)1976:as.factor(qt)2  0.214143     0.966299    0.222 0.824622
as.factor(year)1977:as.factor(qt)2  0.277456     0.966265    0.287 0.774011
as.factor(year)1978:as.factor(qt)2 -0.034489     0.968136   -0.036 0.971583
as.factor(year)1979:as.factor(qt)2  0.383759     0.967450    0.397 0.691621
as.factor(year)1956:as.factor(qt)3 -0.998810     1.373926   -0.727 0.467264
as.factor(year)1957:as.factor(qt)3  1.243732     0.878750    1.415 0.157010
as.factor(year)1958:as.factor(qt)3  1.025787     0.847441    1.210 0.226144
as.factor(year)1959:as.factor(qt)3  0.606994     0.838343    0.724 0.469064
as.factor(year)1960:as.factor(qt)3  2.541236     0.845211    3.007 0.002650 **
as.factor(year)1961:as.factor(qt)3  1.047809     0.824710    1.271 0.203939
as.factor(year)1962:as.factor(qt)3  0.800554     0.817435    0.979 0.327439
as.factor(year)1963:as.factor(qt)3  1.044428     0.811889    1.286 0.198337
as.factor(year)1964:as.factor(qt)3  0.874993     0.812077    1.077 0.281303
as.factor(year)1965:as.factor(qt)3  0.763916     0.812519    0.940 0.347154
as.factor(year)1966:as.factor(qt)3  0.755640     0.816283    0.926 0.354627
as.factor(year)1967:as.factor(qt)3  0.665473     0.814080    0.817 0.413695
as.factor(year)1968:as.factor(qt)3  0.604596     0.815680    0.741 0.458585
as.factor(year)1969:as.factor(qt)3  0.879174     0.815448    1.078 0.281002
as.factor(year)1970:as.factor(qt)3  0.788553     0.814952    0.968 0.333272
as.factor(year)1971:as.factor(qt)3  0.536625     0.818808    0.655 0.512247
as.factor(year)1972:as.factor(qt)3  0.633253     0.816478    0.776 0.438015
as.factor(year)1973:as.factor(qt)3  0.990886     0.816714    1.213 0.225069
as.factor(year)1974:as.factor(qt)3  0.763648     0.813887    0.938 0.348134
as.factor(year)1975:as.factor(qt)3  1.084881     0.814018    1.333 0.182655
as.factor(year)1976:as.factor(qt)3  0.871984     0.812536    1.073 0.283233
as.factor(year)1977:as.factor(qt)3  0.935261     0.812675    1.151 0.249833
as.factor(year)1978:as.factor(qt)3  0.791639     0.813397    0.973 0.330460
as.factor(year)1979:as.factor(qt)3  0.805258     0.813089    0.990 0.322026
as.factor(year)1956:as.factor(qt)4 -1.244874     1.346674   -0.924 0.355305
as.factor(year)1957:as.factor(qt)4 -0.088192     0.801677   -0.110 0.912404
as.factor(year)1958:as.factor(qt)4  0.257217     0.760869    0.338 0.735330
as.factor(year)1959:as.factor(qt)4 -0.784171     0.766210   -1.023 0.306132
as.factor(year)1960:as.factor(qt)4  0.938045     0.754367    1.243 0.213728
as.factor(year)1961:as.factor(qt)4 -0.236460     0.735880   -0.321 0.747969
as.factor(year)1962:as.factor(qt)4 -0.598838     0.729714   -0.821 0.411873
as.factor(year)1963:as.factor(qt)4 -0.363227     0.724116   -0.502 0.615954
as.factor(year)1964:as.factor(qt)4 -0.337136     0.724101   -0.466 0.641520
as.factor(year)1965:as.factor(qt)4 -0.883065     0.726458   -1.216 0.224185
as.factor(year)1966:as.factor(qt)4 -0.445316     0.732728   -0.608 0.543371
as.factor(year)1967:as.factor(qt)4 -0.228321     0.727477   -0.314 0.753641
as.factor(year)1968:as.factor(qt)4 -0.493144     0.728633   -0.677 0.498549
as.factor(year)1969:as.factor(qt)4 -0.249788     0.727276   -0.343 0.731264
as.factor(year)1970:as.factor(qt)4 -0.454864     0.727682   -0.625 0.531934
as.factor(year)1971:as.factor(qt)4 -0.634530     0.731447   -0.867 0.385696
as.factor(year)1972:as.factor(qt)4 -0.366056     0.731776   -0.500 0.616928
as.factor(year)1973:as.factor(qt)4 -0.239094     0.728283   -0.328 0.742696
as.factor(year)1974:as.factor(qt)4 -0.755979     0.725816   -1.042 0.297651
as.factor(year)1975:as.factor(qt)4  0.145034     0.728502    0.199 0.842202
as.factor(year)1976:as.factor(qt)4 -0.459849     0.724912   -0.634 0.525871
as.factor(year)1977:as.factor(qt)4 -0.237775     0.725929   -0.328 0.743264
as.factor(year)1978:as.factor(qt)4 -0.309293     0.727047   -0.425 0.670550
as.factor(year)1979:as.factor(qt)4 -0.135025     0.725883   -0.186 0.852438
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 1.092012)

    Null deviance: 10333.2  on 7636  degrees of freedom
Residual deviance:  8204.3  on 7513  degrees of freedom
AIC: 22470

Number of Fisher Scoring iterations: 2
```

**WCNPO for the period between 1975 and 2012, fitted simple GLM (log-transformed) to the 5x5 aggregated data**

| | Df | Deviance | Resid. Df | Resid. Dev |
|---|---|---|---|---|
| NULL | | | 46139 | 189402 |
| as.factor(year) | 37 | 3438 | 46102 | 185965 |
| as.factor(qt) | 3 | 3665 | 46099 | 182300 |
| as.factor(ar09) | 8 | 47403 | 46091 | 134897 |
| as.factor(gear) | 4 | 26131 | 46087 | 108766 |
| as.factor(year):as.factor(ar09) | 296 | 6928 | 45791 | 101838 |
| as.factor(year):as.factor(qt) | 111 | 1889 | 45680 | 99949 |

Call:

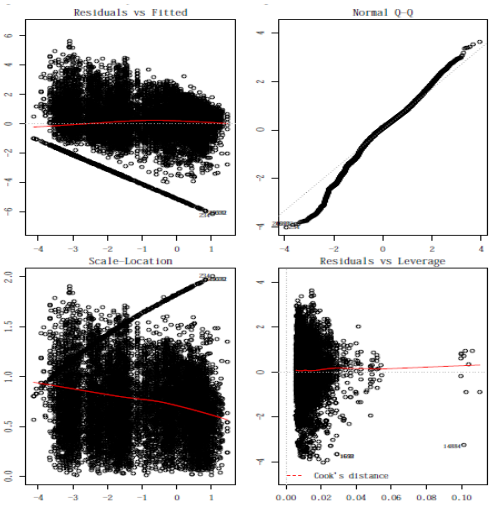
```
glm(formula = lcpue ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(gear) + as.factor(year) * as.factor(area) + as.factor(year) *
    as.factor(qt), family = gaussian, data = wcpo)
```

Deviance Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -6.4544 | -0.6963 | 0.2420 | 0.9680 | 5.1903 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|
| (Intercept) | -1.1551018 | 0.2027874 | -5.696 | 1.23e-08 | *** |
| as.factor(year)1976 | 1.1280550 | 0.2607797 | 4.326 | 1.52e-05 | *** |
| as.factor(year)1977 | 1.2789807 | 0.2533443 | 5.048 | 4.47e-07 | *** |
| as.factor(year)1978 | 1.5934069 | 0.2664675 | 5.980 | 2.25e-09 | *** |
| as.factor(year)1979 | 2.4289507 | 0.2595978 | 9.357 | < 2e-16 | *** |
| as.factor(year)1980 | 1.3575108 | 0.2606568 | 5.208 | 1.92e-07 | *** |
| as.factor(year)1981 | -0.0443929 | 0.2569997 | -0.173 | 0.862860 | |
| as.factor(year)1982 | 0.4639091 | 0.2556335 | 1.815 | 0.069570 | . |
| as.factor(year)1983 | 0.5765187 | 0.2628315 | 2.193 | 0.028277 | * |
| as.factor(year)1984 | 1.3267042 | 0.2568307 | 5.166 | 2.41e-07 | *** |
| as.factor(year)1985 | 1.6973907 | 0.2643658 | 6.421 | 1.37e-10 | *** |
| as.factor(year)1986 | 2.0184880 | 0.2667261 | 7.568 | 3.87e-14 | *** |
| as.factor(year)1987 | 1.3845577 | 0.2627838 | 5.269 | 1.38e-07 | *** |
| as.factor(year)1988 | 1.6061480 | 0.2610602 | 6.152 | 7.69e-10 | *** |
| as.factor(year)1989 | 1.7402390 | 0.2924278 | 5.951 | 2.68e-09 | *** |
| as.factor(year)1990 | 1.9987988 | 0.2828365 | 7.067 | 1.61e-12 | *** |
| as.factor(year)1991 | 2.0350198 | 0.2670978 | 7.619 | 2.61e-14 | *** |
| as.factor(year)1992 | 1.4781683 | 0.2970394 | 4.976 | 6.50e-07 | *** |
| as.factor(year)1993 | 1.9501657 | 0.2740565 | 7.116 | 1.13e-12 | *** |
| as.factor(year)1994 | 1.9448503 | 0.2550734 | 7.625 | 2.49e-14 | *** |
| as.factor(year)1995 | 1.8556907 | 0.2573527 | 7.211 | 5.65e-13 | *** |
| as.factor(year)1996 | 1.4043048 | 0.2646674 | 5.306 | 1.13e-07 | *** |
| as.factor(year)1997 | 1.4519139 | 0.2635486 | 5.509 | 3.63e-08 | *** |
| as.factor(year)1998 | 0.9680464 | 0.2831841 | 3.418 | 0.000630 | *** |
| as.factor(year)1999 | 1.3918507 | 0.2740672 | 5.079 | 3.82e-07 | *** |
| as.factor(year)2000 | 1.2525766 | 0.2663355 | 4.703 | 2.57e-06 | *** |
| as.factor(year)2001 | 0.5243411 | 0.2650135 | 1.979 | 0.047873 | * |
| as.factor(year)2002 | 1.1460855 | 0.2805369 | 4.085 | 4.41e-05 | *** |
| as.factor(year)2003 | 0.8232639 | 0.2766971 | 2.975 | 0.002928 | ** |
| as.factor(year)2004 | 0.3660737 | 0.2807739 | 1.304 | 0.192308 | |
| as.factor(year)2005 | 0.4489571 | 0.3002669 | 1.495 | 0.134871 | |
| as.factor(year)2006 | 0.4576236 | 0.2768096 | 1.653 | 0.098296 | . |
| as.factor(year)2007 | 1.1883571 | 0.2609103 | 4.555 | 5.26e-06 | *** |
| as.factor(year)2008 | 0.5906165 | 0.2660822 | 2.220 | 0.026446 | * |
| as.factor(year)2009 | 0.8002133 | 0.2738439 | 2.922 | 0.003478 | ** |
| as.factor(year)2010 | 0.3949992 | 0.2896521 | 1.364 | 0.172668 | |
| as.factor(year)2011 | 0.3329288 | 0.3211166 | 1.037 | 0.299842 | |
| as.factor(year)2012 | -0.0543106 | 0.3038280 | -0.179 | 0.858131 | |
| as.factor(qt)2 | -0.1028507 | 0.1615302 | -0.637 | 0.524306 | |
| as.factor(qt)3 | -0.3205711 | 0.1623572 | -1.974 | 0.048333 | * |
| as.factor(qt)4 | -0.3386240 | 0.1235646 | -2.740 | 0.006138 | ** |
| as.factor(area)2 | 2.9869513 | 0.2034863 | 14.679 | < 2e-16 | *** |
| as.factor(area)3 | 1.8916409 | 0.3434230 | 5.508 | 3.64e-08 | *** |
| as.factor(area)4 | 2.5920699 | 0.2428753 | 10.672 | < 2e-16 | *** |
| as.factor(area)5 | 0.4674394 | 0.1964640 | 2.379 | 0.017351 | * |
| as.factor(area)6 | 0.4565332 | 0.2523732 | 1.809 | 0.070464 | . |
| as.factor(area)7 | -0.7612047 | 0.2395313 | -3.178 | 0.001484 | ** |
| as.factor(area)8 | -1.0858179 | 0.4843319 | -2.242 | 0.024973 | * |
| as.factor(area)9 | 1.3718825 | 0.2887748 | 4.751 | 2.03e-06 | *** |
| as.factor(gear)2 | -1.0030759 | 0.0308225 | -32.544 | < 2e-16 | *** |
| as.factor(gear)3 | -1.6158057 | 0.0322639 | -50.081 | < 2e-16 | *** |
| as.factor(gear)4 | -2.3329436 | 0.0231020 | -100.984 | < 2e-16 | *** |
| as.factor(gear)5 | -2.7701975 | 0.0377857 | -73.313 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)2 | -1.2199917 | 0.2639836 | -4.621 | 3.82e-06 | *** |
| as.factor(year)1977:as.factor(area)2 | -1.5975732 | 0.2564784 | -6.229 | 4.74e-10 | *** |
| as.factor(year)1978:as.factor(area)2 | -1.4074752 | 0.2718901 | -5.177 | 2.27e-07 | *** |
| as.factor(year)1979:as.factor(area)2 | -2.6695431 | 0.2680209 | -9.960 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)2 | -1.9956312 | 0.2676382 | -7.456 | 9.05e-14 | *** |
| as.factor(year)1981:as.factor(area)2 | -0.6299205 | 0.2623048 | -2.401 | 0.016333 | * |
| as.factor(year)1982:as.factor(area)2 | -1.0508498 | 0.2629076 | -3.997 | 6.42e-05 | *** |
| as.factor(year)1983:as.factor(area)2 | -0.9661524 | 0.2679812 | -3.605 | 0.000312 | *** |
| as.factor(year)1984:as.factor(area)2 | -1.9965978 | 0.2631357 | -7.588 | 3.32e-14 | *** |
| as.factor(year)1985:as.factor(area)2 | -1.7791753 | 0.2711882 | -6.561 | 5.41e-11 | *** |
| as.factor(year)1986:as.factor(area)2 | -2.4189794 | 0.2701540 | -8.954 | < 2e-16 | *** |
| as.factor(year)1987:as.factor(area)2 | -1.9028393 | 0.2669870 | -7.127 | 1.04e-12 | *** |
| as.factor(year)1988:as.factor(area)2 | -1.8957802 | 0.2743986 | -6.909 | 4.95e-12 | *** |
| as.factor(year)1989:as.factor(area)2 | -2.4200962 | 0.3052124 | -7.929 | 2.26e-15 | *** |
| as.factor(year)1990:as.factor(area)2 | -2.6588497 | 0.2968092 | -8.958 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)2 | -2.5864950 | 0.2819173 | -9.175 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)2 | -2.1251372 | 0.3100842 | -6.853 | 7.30e-12 | *** |
| as.factor(year)1993:as.factor(area)2 | -2.7192706 | 0.2815384 | -9.659 | < 2e-16 | *** |
| as.factor(year)1994:as.factor(area)2 | -2.5617639 | 0.2623777 | -9.764 | < 2e-16 | *** |
| as.factor(year)1995:as.factor(area)2 | -2.7722034 | 0.2677626 | -10.353 | < 2e-16 | *** |
| as.factor(year)1996:as.factor(area)2 | -2.4507039 | 0.2766423 | -8.859 | < 2e-16 | *** |
| as.factor(year)1997:as.factor(area)2 | -2.5621935 | 0.2711648 | -9.449 | < 2e-16 | *** |
| as.factor(year)1998:as.factor(area)2 | -2.0246414 | 0.2941009 | -6.884 | 5.89e-12 | *** |
| as.factor(year)1999:as.factor(area)2 | -2.3999763 | 0.2883082 | -8.324 | < 2e-16 | *** |
| as.factor(year)2000:as.factor(area)2 | -2.1178123 | 0.2797188 | -7.571 | 3.77e-14 | *** |
| as.factor(year)2001:as.factor(area)2 | -1.8547197 | 0.2763293 | -6.712 | 1.94e-11 | *** |
| as.factor(year)2002:as.factor(area)2 | -2.7227186 | 0.3026092 | -8.997 | < 2e-16 | *** |



| | | | | |
|---|---|---|---|---|
| as.factor(year)2003:as.factor(area)2 | -2.9380423 | 0.2899312 | -10.134 | < 2e-16 *** |
| as.factor(year)2004:as.factor(area)2 | -2.0044945 | 0.3005882 | -6.669 | 2.61e-11 *** |
| as.factor(year)2005:as.factor(area)2 | -1.6232089 | 0.3085224 | -5.261 | 1.44e-07 *** |
| as.factor(year)2006:as.factor(area)2 | -1.7265932 | 0.2904223 | -5.945 | 2.78e-09 *** |
| as.factor(year)2007:as.factor(area)2 | -2.3691900 | 0.2628938 | -9.012 | < 2e-16 *** |
| as.factor(year)2008:as.factor(area)2 | -2.1035688 | 0.2765553 | -7.606 | 2.87e-14 *** |
| as.factor(year)2009:as.factor(area)2 | -2.4952919 | 0.2914214 | -8.562 | < 2e-16 *** |
| as.factor(year)2010:as.factor(area)2 | -2.4365508 | 0.2993023 | -8.141 | 4.03e-16 *** |
| as.factor(year)2011:as.factor(area)2 | -2.4341982 | 0.3375973 | -7.210 | 5.67e-13 *** |
| as.factor(year)2012:as.factor(area)2 | -1.7295230 | 0.3070063 | -5.634 | 1.78e-08 *** |
| as.factor(year)1976:as.factor(area)3 | -0.8409565 | 0.4566191 | -1.842 | 0.065525 . |
| as.factor(year)1977:as.factor(area)3 | -1.1780242 | 0.4648655 | -2.534 | 0.011276 * |
| as.factor(year)1978:as.factor(area)3 | -1.3652556 | 0.4363968 | -3.128 | 0.001758 ** |
| as.factor(year)1979:as.factor(area)3 | -2.4995090 | 0.4217895 | -5.926 | 3.13e-09 *** |
| as.factor(year)1980:as.factor(area)3 | -2.0169754 | 0.4212102 | -4.789 | 1.69e-06 *** |
| as.factor(year)1981:as.factor(area)3 | -0.1973566 | 0.4194487 | -0.471 | 0.637990 |
| as.factor(year)1982:as.factor(area)3 | -1.2484917 | 0.4074847 | -3.064 | 0.002186 ** |
| as.factor(year)1983:as.factor(area)3 | -0.7426666 | 0.4197687 | -1.769 | 0.076863 . |
| as.factor(year)1984:as.factor(area)3 | -1.7274112 | 0.4037282 | -4.279 | 1.88e-05 *** |
| as.factor(year)1985:as.factor(area)3 | -1.5091014 | 0.4165773 | -3.623 | 0.000292 *** |
| as.factor(year)1986:as.factor(area)3 | -1.8474251 | 0.4132346 | -4.471 | 7.82e-06 *** |
| as.factor(year)1987:as.factor(area)3 | -1.3670857 | 0.4032549 | -3.390 | 0.000699 *** |
| as.factor(year)1988:as.factor(area)3 | -1.6713051 | 0.4019036 | -4.158 | 3.21e-05 *** |
| as.factor(year)1989:as.factor(area)3 | -1.5810167 | 0.4268483 | -3.704 | 0.000213 *** |
| as.factor(year)1990:as.factor(area)3 | -1.9951386 | 0.4183512 | -4.769 | 1.86e-06 *** |
| as.factor(year)1991:as.factor(area)3 | -1.9767059 | 0.4028705 | -4.907 | 9.30e-07 *** |
| as.factor(year)1992:as.factor(area)3 | -1.7359249 | 0.4303176 | -4.034 | 5.49e-05 *** |
| as.factor(year)1993:as.factor(area)3 | -1.6262369 | 0.4193106 | -3.878 | 0.000105 *** |
| as.factor(year)1994:as.factor(area)3 | -2.0688594 | 0.3833129 | -5.397 | 6.80e-08 *** |
| as.factor(year)1995:as.factor(area)3 | -2.2035000 | 0.3930151 | -5.607 | 2.07e-08 *** |
| as.factor(year)1996:as.factor(area)3 | -1.6734474 | 0.4003489 | -4.180 | 2.92e-05 *** |
| as.factor(year)1997:as.factor(area)3 | -1.4448461 | 0.3886677 | -3.717 | 0.000201 *** |
| as.factor(year)1998:as.factor(area)3 | -1.6422599 | 0.3994603 | -4.111 | 3.94e-05 *** |
| as.factor(year)1999:as.factor(area)3 | -1.8434749 | 0.3945848 | -4.672 | 2.99e-06 *** |
| as.factor(year)2000:as.factor(area)3 | -1.8004377 | 0.3921821 | -4.591 | 4.43e-06 *** |
| as.factor(year)2001:as.factor(area)3 | -1.3269493 | 0.3922106 | -3.383 | 0.000717 *** |
| as.factor(year)2002:as.factor(area)3 | -2.3084691 | 0.3969891 | -5.815 | 6.11e-09 *** |
| as.factor(year)2003:as.factor(area)3 | -1.8679512 | 0.3938360 | -4.743 | 2.11e-06 *** |
| as.factor(year)2004:as.factor(area)3 | -1.5681866 | 0.3979434 | -3.941 | 8.14e-05 *** |
| as.factor(year)2005:as.factor(area)3 | -1.2149409 | 0.4108475 | -2.957 | 0.003106 ** |
| as.factor(year)2006:as.factor(area)3 | -1.2814540 | 0.3992197 | -3.210 | 0.001329 ** |
| as.factor(year)2007:as.factor(area)3 | -1.7251710 | 0.3910738 | -4.411 | 1.03e-05 *** |
| as.factor(year)2008:as.factor(area)3 | -1.5790579 | 0.3972336 | -3.975 | 7.04e-05 *** |
| as.factor(year)2009:as.factor(area)3 | -2.1963621 | 0.4006564 | -5.482 | 4.23e-08 *** |
| as.factor(year)2010:as.factor(area)3 | -1.4653405 | 0.4094570 | -3.579 | 0.000346 *** |
| as.factor(year)2011:as.factor(area)3 | -1.6351010 | 0.4253085 | -3.845 | 0.000121 *** |
| as.factor(year)2012:as.factor(area)3 | -0.8011527 | 0.4168459 | -1.922 | 0.054620 . |
| as.factor(year)1976:as.factor(area)4 | -1.2232860 | 0.3085974 | -3.964 | 7.38e-05 *** |
| as.factor(year)1977:as.factor(area)4 | -1.6558245 | 0.3037530 | -5.451 | 5.03e-08 *** |
| as.factor(year)1978:as.factor(area)4 | -1.5916137 | 0.3121801 | -5.098 | 3.44e-07 *** |
| as.factor(year)1979:as.factor(area)4 | -2.9122650 | 0.3026963 | -9.621 | < 2e-16 *** |
| as.factor(year)1980:as.factor(area)4 | -2.1483714 | 0.3065053 | -7.009 | 2.43e-12 *** |
| as.factor(year)1981:as.factor(area)4 | -0.6234716 | 0.3008634 | -2.072 | 0.038245 * |
| as.factor(year)1982:as.factor(area)4 | -1.5354206 | 0.3010709 | -5.100 | 3.41e-07 *** |
| as.factor(year)1983:as.factor(area)4 | -1.2489620 | 0.3062144 | -4.079 | 4.54e-05 *** |
| as.factor(year)1984:as.factor(area)4 | -2.0860524 | 0.3069250 | -6.797 | 1.08e-11 *** |
| as.factor(year)1985:as.factor(area)4 | -1.9430013 | 0.3149430 | -6.169 | 6.91e-10 *** |
| as.factor(year)1986:as.factor(area)4 | -2.2311171 | 0.3105560 | -7.184 | 6.86e-13 *** |
| as.factor(year)1987:as.factor(area)4 | -1.4180763 | 0.3088218 | -4.592 | 4.40e-06 *** |
| as.factor(year)1988:as.factor(area)4 | -1.7947216 | 0.3075194 | -5.836 | 5.38e-09 *** |
| as.factor(year)1989:as.factor(area)4 | -2.0312457 | 0.3356068 | -6.052 | 1.44e-09 *** |
| as.factor(year)1990:as.factor(area)4 | -2.1559112 | 0.3315806 | -6.502 | 8.01e-11 *** |
| as.factor(year)1991:as.factor(area)4 | -2.4675468 | 0.3140156 | -7.858 | 3.99e-15 *** |
| as.factor(year)1992:as.factor(area)4 | -1.7903425 | 0.3470085 | -5.159 | 2.49e-07 *** |
| as.factor(year)1993:as.factor(area)4 | -2.1307141 | 0.3213888 | -6.630 | 3.40e-11 *** |
| as.factor(year)1994:as.factor(area)4 | -2.4191413 | 0.3024032 | -8.000 | 1.28e-15 *** |
| as.factor(year)1995:as.factor(area)4 | -2.2443902 | 0.3034049 | -7.397 | 1.41e-13 *** |
| as.factor(year)1996:as.factor(area)4 | -2.0071843 | 0.3068395 | -6.541 | 6.16e-11 *** |
| as.factor(year)1997:as.factor(area)4 | -2.2344930 | 0.3012262 | -7.418 | 1.21e-13 *** |
| as.factor(year)1998:as.factor(area)4 | -2.1141355 | 0.3199221 | -6.608 | 3.93e-11 *** |
| as.factor(year)1999:as.factor(area)4 | -2.4812378 | 0.3181544 | -7.799 | 6.38e-15 *** |
| as.factor(year)2000:as.factor(area)4 | -2.3315823 | 0.3124300 | -7.463 | 8.62e-14 *** |
| as.factor(year)2001:as.factor(area)4 | -1.8556005 | 0.3051152 | -6.082 | 1.20e-09 *** |
| as.factor(year)2002:as.factor(area)4 | -2.5718553 | 0.3188530 | -8.066 | 7.44e-16 *** |
| as.factor(year)2003:as.factor(area)4 | -2.5513970 | 0.3181168 | -8.020 | 1.08e-15 *** |
| as.factor(year)2004:as.factor(area)4 | -2.1386593 | 0.3201314 | -6.681 | 2.41e-11 *** |
| as.factor(year)2005:as.factor(area)4 | -1.6005312 | 0.3353173 | -4.773 | 1.82e-06 *** |
| as.factor(year)2006:as.factor(area)4 | -1.7165679 | 0.3203333 | -5.359 | 8.42e-08 *** |
| as.factor(year)2007:as.factor(area)4 | -2.1283339 | 0.3002460 | -7.089 | 1.37e-12 *** |
| as.factor(year)2008:as.factor(area)4 | -1.9695603 | 0.3111529 | -6.330 | 2.48e-10 *** |
| as.factor(year)2009:as.factor(area)4 | -2.3937047 | 0.3331469 | -7.185 | 6.82e-13 *** |
| as.factor(year)2010:as.factor(area)4 | -1.5008388 | 0.3339355 | -4.494 | 6.99e-06 *** |
| as.factor(year)2011:as.factor(area)4 | -2.2051253 | 0.3527435 | -6.251 | 4.10e-10 *** |
| as.factor(year)2012:as.factor(area)4 | -1.3849183 | 0.3354833 | -4.128 | 3.66e-05 *** |
| as.factor(year)1976:as.factor(area)5 | -0.7871745 | 0.2571767 | -3.061 | 0.002209 ** |
| as.factor(year)1977:as.factor(area)5 | -1.1793500 | 0.2506588 | -4.705 | 2.55e-06 *** |
| as.factor(year)1978:as.factor(area)5 | -1.3501345 | 0.2645006 | -5.104 | 3.33e-07 *** |
| as.factor(year)1979:as.factor(area)5 | -2.6893067 | 0.2580866 | -10.420 | < 2e-16 *** |
| as.factor(year)1980:as.factor(area)5 | -1.4665367 | 0.2583753 | -5.676 | 1.39e-08 *** |
| as.factor(year)1981:as.factor(area)5 | -0.2764157 | 0.2528026 | -1.093 | 0.274222 |
| as.factor(year)1982:as.factor(area)5 | -1.0577132 | 0.2557295 | -4.136 | 3.54e-05 *** |
| as.factor(year)1983:as.factor(area)5 | -0.7085041 | 0.2594762 | -2.731 | 0.006326 ** |

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|---|---|---|---|---|---|
| as.factor(year)1984:as.factor(area)5 | -1.1162767 | 0.2567028 | -4.349 | 1.37e-05 | *** |
| as.factor(year)1985:as.factor(area)5 | -0.7304367 | 0.2703826 | -2.701 | 0.006905 | ** |
| as.factor(year)1986:as.factor(area)5 | -1.3350356 | 0.2636902 | -5.063 | 4.15e-07 | *** |
| as.factor(year)1987:as.factor(area)5 | -0.8905639 | 0.2561532 | -3.477 | 0.000508 | *** |
| as.factor(year)1988:as.factor(area)5 | -0.9497422 | 0.2562335 | -3.707 | 0.000210 | *** |
| as.factor(year)1989:as.factor(area)5 | -1.4022594 | 0.2939167 | -4.771 | 1.84e-06 | *** |
| as.factor(year)1990:as.factor(area)5 | -1.5604419 | 0.2856798 | -5.462 | 4.73e-08 | *** |
| as.factor(year)1991:as.factor(area)5 | -1.8432767 | 0.2632434 | -7.002 | 2.55e-12 | *** |
| as.factor(year)1992:as.factor(area)5 | -0.9692414 | 0.2922884 | -3.316 | 0.000914 | *** |
| as.factor(year)1993:as.factor(area)5 | -1.4561862 | 0.2677375 | -5.439 | 5.39e-08 | *** |
| as.factor(year)1994:as.factor(area)5 | -1.4404155 | 0.2535591 | -5.681 | 1.35e-08 | *** |
| as.factor(year)1995:as.factor(area)5 | -1.4115735 | 0.2500444 | -5.645 | 1.66e-08 | *** |
| as.factor(year)1996:as.factor(area)5 | -0.9520887 | 0.2603862 | -3.656 | 0.000256 | *** |
| as.factor(year)1997:as.factor(area)5 | -1.3703304 | 0.2607217 | -5.256 | 1.48e-07 | *** |
| as.factor(year)1998:as.factor(area)5 | -0.7732847 | 0.2740628 | -2.822 | 0.004781 | ** |
| as.factor(year)1999:as.factor(area)5 | -1.3472387 | 0.2679599 | -5.028 | 4.98e-07 | *** |
| as.factor(year)2000:as.factor(area)5 | -1.0371137 | 0.2579798 | -4.020 | 5.83e-05 | *** |
| as.factor(year)2001:as.factor(area)5 | -0.4548377 | 0.2544358 | -1.788 | 0.073842 | . |
| as.factor(year)2002:as.factor(area)5 | -1.4567478 | 0.2801472 | -5.200 | 2.00e-07 | *** |
| as.factor(year)2003:as.factor(area)5 | -0.8410023 | 0.2671180 | -3.148 | 0.001643 | ** |
| as.factor(year)2004:as.factor(area)5 | -0.0279536 | 0.2892449 | -0.097 | 0.923010 | |
| as.factor(year)2005:as.factor(area)5 | -0.4621508 | 0.3026508 | -1.527 | 0.126765 | |
| as.factor(year)2006:as.factor(area)5 | -0.3466485 | 0.2887373 | -1.201 | 0.229925 | |
| as.factor(year)2007:as.factor(area)5 | -0.7225739 | 0.2660428 | -2.716 | 0.006610 | ** |
| as.factor(year)2008:as.factor(area)5 | -0.2479636 | 0.2638081 | -0.940 | 0.347254 | |
| as.factor(year)2009:as.factor(area)5 | -0.9495542 | 0.2715711 | -3.497 | 0.000472 | *** |
| as.factor(year)2010:as.factor(area)5 | -0.6585557 | 0.2807445 | -2.346 | 0.018993 | * |
| as.factor(year)2011:as.factor(area)5 | -0.8854292 | 0.3151632 | -2.809 | 0.004965 | ** |
| as.factor(year)2012:as.factor(area)5 | -0.3194749 | 0.2921770 | -1.093 | 0.274211 | |
| as.factor(year)1976:as.factor(area)6 | 0.0300058 | 0.3096099 | 0.097 | 0.922794 | |
| as.factor(year)1977:as.factor(area)6 | -0.6483148 | 0.3030862 | -2.139 | 0.032437 | * |
| as.factor(year)1978:as.factor(area)6 | -0.4422280 | 0.3117134 | -1.419 | 0.155993 | |
| as.factor(year)1979:as.factor(area)6 | -1.3124164 | 0.3047855 | -4.306 | 1.67e-05 | *** |
| as.factor(year)1980:as.factor(area)6 | 0.6822338 | 0.3082929 | 2.213 | 0.026907 | * |
| as.factor(year)1981:as.factor(area)6 | 1.7137370 | 0.3040017 | 5.637 | 1.74e-08 | *** |
| as.factor(year)1982:as.factor(area)6 | 0.7647514 | 0.3062220 | 2.497 | 0.012515 | * |
| as.factor(year)1983:as.factor(area)6 | 1.4480695 | 0.3114318 | 4.650 | 3.33e-06 | *** |
| as.factor(year)1984:as.factor(area)6 | 0.3678447 | 0.3054762 | 1.204 | 0.228531 | |
| as.factor(year)1985:as.factor(area)6 | 0.3305346 | 0.3135036 | 1.054 | 0.291740 | |
| as.factor(year)1986:as.factor(area)6 | -0.0920111 | 0.3151702 | -0.292 | 0.770333 | |
| as.factor(year)1987:as.factor(area)6 | 0.6535768 | 0.3076702 | 2.124 | 0.033652 | * |
| as.factor(year)1988:as.factor(area)6 | 0.4501670 | 0.3052945 | 1.475 | 0.140345 | |
| as.factor(year)1989:as.factor(area)6 | 0.2412692 | 0.3339305 | 0.723 | 0.469983 | |
| as.factor(year)1990:as.factor(area)6 | 0.0844016 | 0.3284231 | 0.257 | 0.797187 | |
| as.factor(year)1991:as.factor(area)6 | -0.3518757 | 0.3144122 | -1.119 | 0.263080 | |
| as.factor(year)1992:as.factor(area)6 | 0.1217844 | 0.3473135 | 0.351 | 0.725855 | |
| as.factor(year)1993:as.factor(area)6 | -0.5977449 | 0.3211130 | -1.861 | 0.062683 | . |
| as.factor(year)1994:as.factor(area)6 | -0.6632401 | 0.3085858 | -2.149 | 0.031617 | * |
| as.factor(year)1995:as.factor(area)6 | -1.4365968 | 0.3106575 | -4.624 | 3.77e-06 | *** |
| as.factor(year)1996:as.factor(area)6 | -0.7456326 | 0.3186113 | -2.340 | 0.019275 | * |
| as.factor(year)1997:as.factor(area)6 | -0.7514965 | 0.3134446 | -2.398 | 0.016509 | * |
| as.factor(year)1998:as.factor(area)6 | -0.6163237 | 0.3379258 | -1.824 | 0.068182 | . |
| as.factor(year)1999:as.factor(area)6 | -0.4370657 | 0.3246263 | -1.346 | 0.178191 | |
| as.factor(year)2000:as.factor(area)6 | -0.5224597 | 0.3211675 | -1.627 | 0.103797 | |
| as.factor(year)2001:as.factor(area)6 | 0.6644109 | 0.3153829 | 2.107 | 0.035151 | * |
| as.factor(year)2002:as.factor(area)6 | 0.1193738 | 0.3257009 | 0.367 | 0.713984 | |
| as.factor(year)2003:as.factor(area)6 | 0.2780849 | 0.3114759 | 0.893 | 0.371970 | |
| as.factor(year)2004:as.factor(area)6 | 0.6277718 | 0.3172148 | 1.979 | 0.047821 | * |
| as.factor(year)2005:as.factor(area)6 | 0.6456370 | 0.3325825 | 1.941 | 0.052230 | . |
| as.factor(year)2006:as.factor(area)6 | 0.9341405 | 0.3141854 | 2.973 | 0.002949 | ** |
| as.factor(year)2007:as.factor(area)6 | -0.4692083 | 0.3037560 | -1.545 | 0.122429 | |
| as.factor(year)2008:as.factor(area)6 | 0.6667430 | 0.3127606 | 2.132 | 0.033029 | * |
| as.factor(year)2009:as.factor(area)6 | -0.5419400 | 0.3240585 | -1.672 | 0.094462 | . |
| as.factor(year)2010:as.factor(area)6 | 0.3784917 | 0.3351001 | 1.129 | 0.258698 | |
| as.factor(year)2011:as.factor(area)6 | -0.2283107 | 0.3730202 | -0.612 | 0.540501 | |
| as.factor(year)2012:as.factor(area)6 | 0.5658445 | 0.3832398 | 1.476 | 0.139823 | |
| as.factor(year)1976:as.factor(area)7 | -0.5367280 | 0.3310791 | -1.621 | 0.104993 | |
| as.factor(year)1977:as.factor(area)7 | -0.1970345 | 0.3128565 | -0.630 | 0.528834 | |
| as.factor(year)1978:as.factor(area)7 | -0.3394634 | 0.3078241 | -1.103 | 0.270127 | |
| as.factor(year)1979:as.factor(area)7 | -1.2737661 | 0.3080437 | -4.135 | 3.56e-05 | *** |
| as.factor(year)1980:as.factor(area)7 | -0.4546648 | 0.3139326 | -1.448 | 0.147543 | |
| as.factor(year)1981:as.factor(area)7 | 1.3042847 | 0.3200772 | 4.075 | 4.61e-05 | *** |
| as.factor(year)1982:as.factor(area)7 | 0.9019980 | 0.3285307 | 2.746 | 0.006043 | ** |
| as.factor(year)1983:as.factor(area)7 | 2.0960037 | 0.3205320 | 6.539 | 6.25e-11 | *** |
| as.factor(year)1984:as.factor(area)7 | 1.0096976 | 0.3137703 | 3.218 | 0.001292 | ** |
| as.factor(year)1985:as.factor(area)7 | 0.7751179 | 0.3344601 | 2.318 | 0.020480 | * |
| as.factor(year)1986:as.factor(area)7 | -0.5892291 | 0.3271187 | -1.801 | 0.071667 | . |
| as.factor(year)1987:as.factor(area)7 | 1.2353814 | 0.3236776 | 3.817 | 0.000135 | *** |
| as.factor(year)1988:as.factor(area)7 | 1.5704878 | 0.3274147 | 4.797 | 1.62e-06 | *** |
| as.factor(year)1989:as.factor(area)7 | 0.0867613 | 0.3359383 | 0.258 | 0.796203 | |
| as.factor(year)1990:as.factor(area)7 | 0.4354522 | 0.3404039 | 1.279 | 0.200825 | |
| as.factor(year)1991:as.factor(area)7 | 0.1929008 | 0.3237001 | 0.596 | 0.551229 | |
| as.factor(year)1992:as.factor(area)7 | 0.2733137 | 0.3386468 | 0.807 | 0.419627 | |
| as.factor(year)1993:as.factor(area)7 | 0.1858499 | 0.3389324 | 0.548 | 0.583462 | |
| as.factor(year)1994:as.factor(area)7 | -0.2698049 | 0.3016704 | -0.894 | 0.371129 | |
| as.factor(year)1995:as.factor(area)7 | -0.2841434 | 0.3005106 | -0.946 | 0.344391 | |
| as.factor(year)1996:as.factor(area)7 | 0.2441556 | 0.3138735 | 0.778 | 0.436644 | |
| as.factor(year)1997:as.factor(area)7 | 0.3434176 | 0.3131247 | 1.097 | 0.272759 | |
| as.factor(year)1998:as.factor(area)7 | 0.6853312 | 0.3271253 | 2.095 | 0.036175 | * |
| as.factor(year)1999:as.factor(area)7 | 0.0517273 | 0.3064557 | 0.169 | 0.865961 | |
| as.factor(year)2000:as.factor(area)7 | -0.1403402 | 0.3259006 | -0.431 | 0.666745 | |
| as.factor(year)2001:as.factor(area)7 | 0.1422866 | 0.4486613 | 0.317 | 0.751142 | |

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|---|---|---|---|---|
| as.factor(year)2002:as.factor(area)7 | 0.2421075 | 0.3454138 | 0.701 | 0.483356 |
| as.factor(year)2003:as.factor(area)7 | 0.8522245 | 0.3049201 | 2.795 | 0.005194 ** |
| as.factor(year)2004:as.factor(area)7 | 1.1049917 | 0.3511850 | 3.146 | 0.001654 ** |
| as.factor(year)2005:as.factor(area)7 | 1.7023268 | 0.3338240 | 5.099 | 3.42e-07 *** |
| as.factor(year)2006:as.factor(area)7 | 1.5647811 | 0.3251139 | 4.813 | 1.49e-06 *** |
| as.factor(year)2007:as.factor(area)7 | 1.1816397 | 0.3406729 | 3.469 | 0.000524 *** |
| as.factor(year)2008:as.factor(area)7 | 0.5282411 | 0.3549956 | 1.488 | 0.136752 |
| as.factor(year)2009:as.factor(area)7 | 0.6121977 | 0.3769520 | 1.624 | 0.104367 |
| as.factor(year)2010:as.factor(area)7 | 1.5683656 | 0.5012979 | 3.129 | 0.001757 ** |
| as.factor(year)2011:as.factor(area)7 | 0.8158268 | 0.3935308 | 2.073 | 0.038169 * |
| as.factor(year)2012:as.factor(area)7 | 0.3264487 | 0.5223465 | 0.625 | 0.531997 |
| as.factor(year)1976:as.factor(area)8 | -1.2551098 | 0.5761113 | -2.179 | 0.029367 * |
| as.factor(year)1977:as.factor(area)8 | -0.3473425 | 0.5699542 | -0.609 | 0.542248 |
| as.factor(year)1978:as.factor(area)8 | -0.3973684 | 0.5361677 | -0.741 | 0.458620 |
| as.factor(year)1979:as.factor(area)8 | -1.6205551 | 0.5310655 | -3.052 | 0.002278 ** |
| as.factor(year)1980:as.factor(area)8 | -0.2612776 | 0.5999054 | -0.436 | 0.663179 |
| as.factor(year)1981:as.factor(area)8 | 0.7735809 | 0.5485802 | 1.410 | 0.158502 |
| as.factor(year)1982:as.factor(area)8 | -0.5720536 | 0.5655788 | -1.011 | 0.311807 |
| as.factor(year)1983:as.factor(area)8 | -0.4116430 | 0.5667196 | -0.726 | 0.467621 |
| as.factor(year)1984:as.factor(area)8 | -1.1477919 | 0.5383496 | -2.132 | 0.033007 * |
| as.factor(year)1985:as.factor(area)8 | -0.8469338 | 0.5622536 | -1.506 | 0.131992 |
| as.factor(year)1986:as.factor(area)8 | -1.6098068 | 0.5439561 | -2.959 | 0.003084 ** |
| as.factor(year)1987:as.factor(area)8 | -0.7897112 | 0.5691078 | -1.388 | 0.165256 |
| as.factor(year)1988:as.factor(area)8 | -0.2619523 | 0.5505153 | -0.476 | 0.634197 |
| as.factor(year)1989:as.factor(area)8 | -0.4310412 | 0.5539521 | -0.778 | 0.436502 |
| as.factor(year)1990:as.factor(area)8 | -1.1529597 | 0.5626988 | -2.049 | 0.040470 * |
| as.factor(year)1991:as.factor(area)8 | -0.7042224 | 0.5614779 | -1.254 | 0.209765 |
| as.factor(year)1992:as.factor(area)8 | -0.2769256 | 0.5542714 | -0.500 | 0.617344 |
| as.factor(year)1993:as.factor(area)8 | -0.9484850 | 0.5453640 | -1.739 | 0.082010 . |
| as.factor(year)1994:as.factor(area)8 | -0.5794113 | 0.5210760 | -1.112 | 0.266165 |
| as.factor(year)1995:as.factor(area)8 | -0.8768283 | 0.5216039 | -1.681 | 0.092765 . |
| as.factor(year)1996:as.factor(area)8 | -0.4751271 | 0.5416800 | -0.877 | 0.380417 |
| as.factor(year)1997:as.factor(area)8 | -0.2415009 | 0.5555898 | -0.435 | 0.663801 |
| as.factor(year)1998:as.factor(area)8 | 0.4568696 | 0.5554825 | 0.822 | 0.410812 |
| as.factor(year)1999:as.factor(area)8 | 0.0155445 | 0.5391771 | 0.029 | 0.977000 |
| as.factor(year)2000:as.factor(area)8 | 0.2365680 | 0.5357577 | 0.442 | 0.658811 |
| as.factor(year)2001:as.factor(area)8 | 0.7781300 | 0.5636647 | 1.380 | 0.167445 |
| as.factor(year)2002:as.factor(area)8 | 0.3617699 | 0.5626862 | 0.643 | 0.520270 |
| as.factor(year)2003:as.factor(area)8 | 1.3734959 | 0.5321910 | 2.581 | 0.009859 ** |
| as.factor(year)2004:as.factor(area)8 | 0.4219568 | 0.5647333 | 0.747 | 0.454959 |
| as.factor(year)2005:as.factor(area)8 | 0.5412462 | 0.5501231 | 0.984 | 0.325188 |
| as.factor(year)2006:as.factor(area)8 | 0.6810841 | 0.5409023 | 1.259 | 0.207978 |
| as.factor(year)2007:as.factor(area)8 | -0.4692085 | 0.7317057 | -0.641 | 0.521361 |
| as.factor(year)2008:as.factor(area)8 | 1.4533576 | 0.7275084 | 1.998 | 0.045753 * |
| as.factor(year)2009:as.factor(area)8 | -0.2377804 | 0.5635275 | -0.422 | 0.673063 |
| as.factor(year)2010:as.factor(area)8 | 0.4605554 | 0.5823658 | 0.791 | 0.429044 |
| as.factor(year)2011:as.factor(area)8 | 1.5110687 | 0.6674095 | 2.264 | 0.023574 * |
| as.factor(year)2012:as.factor(area)8 | -0.9491654 | 0.8439242 | -1.125 | 0.260720 |
| as.factor(year)1976:as.factor(area)9 | -1.0998981 | 0.3686969 | -2.983 | 0.002854 ** |
| as.factor(year)1977:as.factor(area)9 | -0.7517833 | 0.3605536 | -2.085 | 0.037068 * |
| as.factor(year)1978:as.factor(area)9 | -1.1668771 | 0.3654573 | -3.193 | 0.001409 ** |
| as.factor(year)1979:as.factor(area)9 | -2.9647539 | 0.3623073 | -8.183 | 2.84e-16 *** |
| as.factor(year)1980:as.factor(area)9 | -2.4147536 | 0.3829238 | -6.306 | 2.89e-10 *** |
| as.factor(year)1981:as.factor(area)9 | -0.8735136 | 0.3730776 | -2.341 | 0.019217 * |
| as.factor(year)1982:as.factor(area)9 | -1.5489982 | 0.3688464 | -4.200 | 2.68e-05 *** |
| as.factor(year)1983:as.factor(area)9 | -1.3844807 | 0.3801290 | -3.642 | 0.000271 *** |
| as.factor(year)1984:as.factor(area)9 | -2.3353148 | 0.3606733 | -6.475 | 9.59e-11 *** |
| as.factor(year)1985:as.factor(area)9 | -2.0477818 | 0.3636171 | -5.632 | 1.79e-08 *** |
| as.factor(year)1986:as.factor(area)9 | -2.6777329 | 0.3838302 | -6.976 | 3.07e-12 *** |
| as.factor(year)1987:as.factor(area)9 | -1.3322057 | 0.3789359 | -3.516 | 0.000439 *** |
| as.factor(year)1988:as.factor(area)9 | -1.9121804 | 0.3576088 | -5.347 | 8.98e-08 *** |
| as.factor(year)1989:as.factor(area)9 | -2.1248325 | 0.3800610 | -5.591 | 2.27e-08 *** |
| as.factor(year)1990:as.factor(area)9 | -2.0196749 | 0.3747824 | -5.389 | 7.12e-08 *** |
| as.factor(year)1991:as.factor(area)9 | -1.9446501 | 0.3774393 | -5.152 | 2.58e-07 *** |
| as.factor(year)1992:as.factor(area)9 | -1.4831613 | 0.3894602 | -3.808 | 0.000140 *** |
| as.factor(year)1993:as.factor(area)9 | -2.0919563 | 0.3761682 | -5.561 | 2.69e-08 *** |
| as.factor(year)1994:as.factor(area)9 | -1.6260073 | 0.3534342 | -4.601 | 4.22e-06 *** |
| as.factor(year)1995:as.factor(area)9 | -1.8413881 | 0.3540072 | -5.202 | 1.98e-07 *** |
| as.factor(year)1996:as.factor(area)9 | -1.2125046 | 0.3646932 | -3.325 | 0.000886 *** |
| as.factor(year)1997:as.factor(area)9 | -1.0438520 | 0.3698253 | -2.823 | 0.004766 ** |
| as.factor(year)1998:as.factor(area)9 | -0.6888452 | 0.3709767 | -1.857 | 0.063340 . |
| as.factor(year)1999:as.factor(area)9 | -0.8656747 | 0.3599782 | -2.405 | 0.016185 * |
| as.factor(year)2000:as.factor(area)9 | -0.1755173 | 0.3507862 | -0.500 | 0.616828 |
| as.factor(year)2001:as.factor(area)9 | 0.4586937 | 0.3661558 | 1.253 | 0.210311 |
| as.factor(year)2002:as.factor(area)9 | -0.2371284 | 0.3765299 | -0.630 | 0.528846 |
| as.factor(year)2003:as.factor(area)9 | -0.2917422 | 0.3932341 | -0.742 | 0.458149 |
| as.factor(year)2004:as.factor(area)9 | -0.2372226 | 0.3719231 | -0.638 | 0.523589 |
| as.factor(year)2005:as.factor(area)9 | -0.2784158 | 0.5837220 | -0.477 | 0.633388 |
| as.factor(year)2006:as.factor(area)9 | -0.1369213 | 0.4085652 | -0.335 | 0.737531 |
| as.factor(year)2007:as.factor(area)9 | -0.4750582 | 0.4020565 | -1.182 | 0.237382 |
| as.factor(year)2008:as.factor(area)9 | 0.6596284 | 0.4971163 | 1.327 | 0.184545 |
| as.factor(year)2009:as.factor(area)9 | 0.6873075 | 0.6872483 | 1.000 | 0.317274 |
| as.factor(year)2010:as.factor(area)9 | 1.1144739 | 0.6502525 | 1.714 | 0.086552 . |
| as.factor(year)2011:as.factor(area)9 | 0.6407008 | 0.5152868 | 1.243 | 0.213732 |
| as.factor(year)2012:as.factor(area)9 | 1.2841959 | 0.9296453 | 1.381 | 0.167168 |
| as.factor(year)1976:as.factor(qt)2 | -0.2378422 | 0.2134324 | -1.114 | 0.265127 |
| as.factor(year)1977:as.factor(qt)2 | -0.0036484 | 0.2072792 | -0.018 | 0.985957 |
| as.factor(year)1978:as.factor(qt)2 | -0.4334821 | 0.2054399 | -2.110 | 0.034862 * |
| as.factor(year)1979:as.factor(qt)2 | 0.2138680 | 0.2018429 | 1.060 | 0.289343 |
| as.factor(year)1980:as.factor(qt)2 | 0.2481642 | 0.2080785 | 1.193 | 0.233014 |
| as.factor(year)1981:as.factor(qt)2 | 0.4943958 | 0.1997347 | 2.475 | 0.013317 * |
| as.factor(year)1982:as.factor(qt)2 | 0.5039587 | 0.2028747 | 2.484 | 0.012992 * |

| | | | | |
|---|---|---|---|---|
| as.factor(year)1983:as.factor(qt)2 | 0.2236761 | 0.2049703 | 1.091 | 0.275164 |
| as.factor(year)1984:as.factor(qt)2 | 0.3241458 | 0.2076257 | 1.561 | 0.118483 |
| as.factor(year)1985:as.factor(qt)2 | 0.0323765 | 0.2142907 | 0.151 | 0.879908 |
| as.factor(year)1986:as.factor(qt)2 | 0.2801452 | 0.2036296 | 1.376 | 0.168903 |
| as.factor(year)1987:as.factor(qt)2 | 0.0371149 | 0.2025140 | 0.183 | 0.854586 |
| as.factor(year)1988:as.factor(qt)2 | -0.0649579 | 0.2032608 | -0.320 | 0.749289 |
| as.factor(year)1989:as.factor(qt)2 | 0.3385237 | 0.2084632 | 1.624 | 0.104404 |
| as.factor(year)1990:as.factor(qt)2 | -0.0208767 | 0.2234026 | -0.093 | 0.925547 |
| as.factor(year)1991:as.factor(qt)2 | 0.1511800 | 0.2096483 | 0.721 | 0.470844 |
| as.factor(year)1992:as.factor(qt)2 | 0.2950512 | 0.2229405 | 1.323 | 0.185692 |
| as.factor(year)1993:as.factor(qt)2 | 0.1106215 | 0.2124570 | 0.521 | 0.602594 |
| as.factor(year)1994:as.factor(qt)2 | 0.0469507 | 0.2069867 | 0.227 | 0.820557 |
| as.factor(year)1995:as.factor(qt)2 | 0.1360585 | 0.2062660 | 0.660 | 0.509497 |
| as.factor(year)1996:as.factor(qt)2 | 0.1429050 | 0.2049861 | 0.697 | 0.485716 |
| as.factor(year)1997:as.factor(qt)2 | -0.2798251 | 0.2081213 | -1.345 | 0.178784 |
| as.factor(year)1998:as.factor(qt)2 | 0.0041983 | 0.2066136 | 0.020 | 0.983788 |
| as.factor(year)1999:as.factor(qt)2 | -0.0441882 | 0.2036339 | -0.217 | 0.828211 |
| as.factor(year)2000:as.factor(qt)2 | -0.2275892 | 0.2064240 | -1.103 | 0.270236 |
| as.factor(year)2001:as.factor(qt)2 | 0.1164964 | 0.2035992 | 0.572 | 0.567200 |
| as.factor(year)2002:as.factor(qt)2 | -0.0204634 | 0.2091408 | -0.098 | 0.922056 |
| as.factor(year)2003:as.factor(qt)2 | -0.0083458 | 0.2080858 | -0.040 | 0.968007 |
| as.factor(year)2004:as.factor(qt)2 | -0.3068646 | 0.2164098 | -1.418 | 0.156204 |
| as.factor(year)2005:as.factor(qt)2 | -0.5492487 | 0.2170085 | -2.531 | 0.011377 * |
| as.factor(year)2006:as.factor(qt)2 | -0.1553489 | 0.2161017 | -0.719 | 0.472225 |
| as.factor(year)2007:as.factor(qt)2 | -0.2458603 | 0.2168699 | -1.134 | 0.256936 |
| as.factor(year)2008:as.factor(qt)2 | -0.6559858 | 0.2205009 | -2.975 | 0.002932 ** |
| as.factor(year)2009:as.factor(qt)2 | -0.4948559 | 0.2288987 | -2.162 | 0.030631 * |
| as.factor(year)2010:as.factor(qt)2 | -0.4905344 | 0.2350565 | -2.087 | 0.036905 * |
| as.factor(year)2011:as.factor(qt)2 | 0.0335530 | 0.2543413 | 0.132 | 0.895047 |
| as.factor(year)2012:as.factor(qt)2 | -0.0813825 | 0.2338976 | -0.348 | 0.727886 |
| as.factor(year)1976:as.factor(qt)3 | -0.1405781 | 0.2112992 | -0.665 | 0.505860 |
| as.factor(year)1977:as.factor(qt)3 | -0.4404094 | 0.2047441 | -2.151 | 0.031480 * |
| as.factor(year)1978:as.factor(qt)3 | -0.9604592 | 0.2049256 | -4.687 | 2.78e-06 *** |
| as.factor(year)1979:as.factor(qt)3 | -0.6681089 | 0.2015695 | -3.315 | 0.000919 *** |
| as.factor(year)1980:as.factor(qt)3 | -0.2660556 | 0.2208672 | -1.205 | 0.228366 |
| as.factor(year)1981:as.factor(qt)3 | -0.0975361 | 0.2046808 | -0.477 | 0.633701 |
| as.factor(year)1982:as.factor(qt)3 | 0.1242683 | 0.2094659 | 0.593 | 0.553008 |
| as.factor(year)1983:as.factor(qt)3 | -0.3075654 | 0.2124662 | -1.448 | 0.147737 |
| as.factor(year)1984:as.factor(qt)3 | -0.3066894 | 0.2078776 | -1.475 | 0.140129 |
| as.factor(year)1985:as.factor(qt)3 | -0.2887316 | 0.2123131 | -1.360 | 0.173858 |
| as.factor(year)1986:as.factor(qt)3 | -0.2808182 | 0.2072794 | -1.355 | 0.175494 |
| as.factor(year)1987:as.factor(qt)3 | -0.1229047 | 0.2087648 | -0.589 | 0.556050 |
| as.factor(year)1988:as.factor(qt)3 | -0.3126863 | 0.2057611 | -1.520 | 0.128604 |
| as.factor(year)1989:as.factor(qt)3 | -0.4893066 | 0.2131317 | -2.296 | 0.021692 * |
| as.factor(year)1990:as.factor(qt)3 | -0.4371435 | 0.2225682 | -1.964 | 0.049526 * |
| as.factor(year)1991:as.factor(qt)3 | -0.4786878 | 0.2102108 | -2.277 | 0.022780 * |
| as.factor(year)1992:as.factor(qt)3 | -0.1952386 | 0.2172646 | -0.899 | 0.368859 |
| as.factor(year)1993:as.factor(qt)3 | 0.0348644 | 0.2138690 | 0.163 | 0.870505 |
| as.factor(year)1994:as.factor(qt)3 | -0.5484395 | 0.2052898 | -2.672 | 0.007553 ** |
| as.factor(year)1995:as.factor(qt)3 | -0.0996431 | 0.2029164 | -0.491 | 0.623390 |
| as.factor(year)1996:as.factor(qt)3 | -0.0907582 | 0.2074163 | -0.438 | 0.661703 |
| as.factor(year)1997:as.factor(qt)3 | -0.5241571 | 0.2218281 | -2.363 | 0.018137 * |
| as.factor(year)1998:as.factor(qt)3 | -0.1810931 | 0.2138319 | -0.847 | 0.397058 |
| as.factor(year)1999:as.factor(qt)3 | -0.4904509 | 0.2107261 | -2.327 | 0.019947 * |
| as.factor(year)2000:as.factor(qt)3 | -0.0911136 | 0.2102948 | -0.433 | 0.664823 |
| as.factor(year)2001:as.factor(qt)3 | 0.4778384 | 0.2127015 | 2.247 | 0.024675 * |
| as.factor(year)2002:as.factor(qt)3 | 0.1167452 | 0.2213261 | 0.527 | 0.597863 |
| as.factor(year)2003:as.factor(qt)3 | -0.1875207 | 0.2138141 | -0.877 | 0.380477 |
| as.factor(year)2004:as.factor(qt)3 | 0.0883429 | 0.2340771 | 0.377 | 0.705871 |
| as.factor(year)2005:as.factor(qt)3 | 0.0005394 | 0.2255486 | 0.002 | 0.998092 |
| as.factor(year)2006:as.factor(qt)3 | -0.0293423 | 0.2220184 | -0.132 | 0.894857 |
| as.factor(year)2007:as.factor(qt)3 | -0.5049849 | 0.2233251 | -2.261 | 0.023751 * |
| as.factor(year)2008:as.factor(qt)3 | -0.4080226 | 0.2328155 | -1.753 | 0.079685 . |
| as.factor(year)2009:as.factor(qt)3 | 0.1075545 | 0.2421902 | 0.444 | 0.656979 |
| as.factor(year)2010:as.factor(qt)3 | -0.0079437 | 0.2590843 | -0.031 | 0.975540 |
| as.factor(year)2011:as.factor(qt)3 | 0.4340219 | 0.2545992 | 1.705 | 0.088252 . |
| as.factor(year)2012:as.factor(qt)3 | -0.1510865 | 0.2600997 | -0.581 | 0.561325 |
| as.factor(year)1976:as.factor(qt)4 | -0.0594686 | 0.1609918 | -0.369 | 0.711840 |
| as.factor(year)1977:as.factor(qt)4 | 0.0814248 | 0.1604345 | 0.508 | 0.611788 |
| as.factor(year)1978:as.factor(qt)4 | -0.8416909 | 0.1572987 | -5.351 | 8.79e-08 *** |
| as.factor(year)1979:as.factor(qt)4 | -0.5279444 | 0.1559379 | -3.386 | 0.000711 *** |
| as.factor(year)1980:as.factor(qt)4 | -0.3994298 | 0.1600734 | -2.495 | 0.012589 * |
| as.factor(year)1981:as.factor(qt)4 | -0.3513335 | 0.1526926 | -2.301 | 0.021401 * |
| as.factor(year)1982:as.factor(qt)4 | 0.1858310 | 0.1599912 | 1.162 | 0.245442 |
| as.factor(year)1983:as.factor(qt)4 | -0.2630043 | 0.1576339 | -1.668 | 0.095233 . |
| as.factor(year)1984:as.factor(qt)4 | -0.0457783 | 0.1553164 | -0.295 | 0.768192 |
| as.factor(year)1985:as.factor(qt)4 | -0.2884240 | 0.1608443 | -1.793 | 0.072950 . |
| as.factor(year)1986:as.factor(qt)4 | -0.0370610 | 0.1569101 | -0.236 | 0.813284 |
| as.factor(year)1987:as.factor(qt)4 | 0.1458085 | 0.1605367 | 0.908 | 0.363748 |
| as.factor(year)1988:as.factor(qt)4 | -0.3322911 | 0.1604667 | -2.071 | 0.038385 * |
| as.factor(year)1989:as.factor(qt)4 | -0.6016235 | 0.1622583 | -3.708 | 0.000209 *** |
| as.factor(year)1990:as.factor(qt)4 | -0.2380328 | 0.1666948 | -1.428 | 0.153312 |
| as.factor(year)1991:as.factor(qt)4 | -0.2535573 | 0.1676651 | -1.512 | 0.130469 |
| as.factor(year)1992:as.factor(qt)4 | 0.1393381 | 0.1688894 | 0.825 | 0.409361 |
| as.factor(year)1993:as.factor(qt)4 | -0.0834674 | 0.1645996 | -0.507 | 0.612092 |
| as.factor(year)1994:as.factor(qt)4 | -0.1773753 | 0.1580273 | -1.122 | 0.261684 |
| as.factor(year)1995:as.factor(qt)4 | -0.1104512 | 0.1593897 | -0.693 | 0.488336 |
| as.factor(year)1996:as.factor(qt)4 | -0.0230777 | 0.1627352 | -0.142 | 0.887230 |
| as.factor(year)1997:as.factor(qt)4 | -0.4437591 | 0.1671421 | -2.655 | 0.007934 ** |
| as.factor(year)1998:as.factor(qt)4 | -0.2610906 | 0.1695316 | -1.540 | 0.123550 |
| as.factor(year)1999:as.factor(qt)4 | 0.0705463 | 0.1601827 | 0.440 | 0.659641 |
| as.factor(year)2000:as.factor(qt)4 | 0.1955884 | 0.1645505 | 1.189 | 0.234594 |

```
as.factor(year)2001:as.factor(qt)4  0.4258217  0.1699362   2.506 0.012222 *
as.factor(year)2002:as.factor(qt)4  0.3361519  0.1744998   1.926 0.054064 .
as.factor(year)2003:as.factor(qt)4  0.1477191  0.1778858   0.830 0.406308
as.factor(year)2004:as.factor(qt)4  0.7075187  0.1803394   3.923 8.75e-05 ***
as.factor(year)2005:as.factor(qt)4  0.4260133  0.1815590   2.346 0.018959 *
as.factor(year)2006:as.factor(qt)4  0.4186361  0.1768210   2.368 0.017909 *
as.factor(year)2007:as.factor(qt)4  0.1960742  0.1855206   1.057 0.290569
as.factor(year)2008:as.factor(qt)4  0.0092082  0.1831278   0.050 0.959897
as.factor(year)2009:as.factor(qt)4  0.8557648  0.1992707   4.294 1.75e-05 ***
as.factor(year)2010:as.factor(qt)4  0.6052998  0.2047514   2.956 0.003115 **
as.factor(year)2011:as.factor(qt)4  0.8295396  0.2136177   3.883 0.000103 ***
as.factor(year)2012:as.factor(qt)4  0.9826147  0.2096502   4.687 2.78e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 2.188025)

    Null deviance: 189402  on 46139  degrees of freedom
Residual deviance:  99949  on 45680  degrees of freedom
AIC: 167527

Number of Fisher Scoring iterations: 2
```

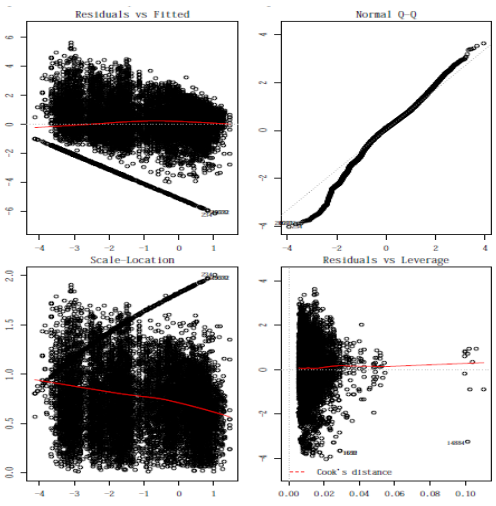
**EPO for the period between 1975 and 2012, fitted simple GLM (log-transformed) to the 5x5 aggregated data**

| | Df | Deviance | Resid. Df | Resid. Dev |
|---|---|---|---|---|
| NULL | | | 45996 | 66239 |
| as.factor(year) | 37 | 8853.5 | 45959 | 57386 |
| as.factor(qt) | 3 | 2428.2 | 45956 | 54957 |
| as.factor(ar09) | 6 | 3474.0 | 45950 | 51483 |
| as.factor(gear) | 4 | 136.0 | 45946 | 51347 |
| as.factor(year):as.factor(ar09) | 222 | 3113.1 | 45724 | 48234 |
| as.factor(year):as.factor(qt) | 111 | 571.8 | 45613 | 47663 |

```
Call:
glm(formula = lcpue ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(gear) + as.factor(year) * as.factor(area) + as.factor(year) *
    as.factor(qt), family = gaussian, data = epo)

Deviance Residuals:
      Min         1Q     Median         3Q        Max
-5.1888    -0.3586     0.1469     0.5901     4.9461

Coefficients:
                                Estimate Std. Error t value Pr(>|t|)
(Intercept)                    -1.459556   0.170335  -8.569  < 2e-16 ***
as.factor(year)1976            -0.089528   0.172861  -0.518 0.604517
as.factor(year)1977            -0.151515   0.168902  -0.897 0.369691
as.factor(year)1978            -0.657485   0.168415  -3.904 9.48e-05 ***
as.factor(year)1979            -1.041211   0.168453  -6.181 6.42e-10 ***
as.factor(year)1980            -2.058983   0.177301 -11.613  < 2e-16 ***
as.factor(year)1981            -0.921438   0.174517  -5.280 1.30e-07 ***
as.factor(year)1982            -1.505416   0.176894  -8.510  < 2e-16 ***
as.factor(year)1983            -1.412909   0.193895  -7.287 3.22e-13 ***
as.factor(year)1984            -1.552334   0.179629  -8.642  < 2e-16 ***
as.factor(year)1985            -1.431039   0.176951  -8.087 6.25e-16 ***
as.factor(year)1986            -0.635950   0.187693  -3.388 0.000704 ***
as.factor(year)1987            -0.696222   0.179558  -3.877 0.000106 ***
as.factor(year)1988            -1.117609   0.174851  -6.392 1.66e-10 ***
as.factor(year)1989            -0.765048   0.176751  -4.328 1.51e-05 ***
as.factor(year)1990            -0.997159   0.171423  -5.817 6.03e-09 ***
as.factor(year)1991            -1.033083   0.174176  -5.931 3.03e-09 ***
as.factor(year)1992            -1.612300   0.181041  -8.906  < 2e-16 ***
as.factor(year)1993            -1.318272   0.173498  -7.598 3.06e-14 ***
as.factor(year)1994            -1.216860   0.159923  -7.609 2.81e-14 ***
as.factor(year)1995            -1.344661   0.167318  -8.037 9.46e-16 ***
as.factor(year)1996            -1.176939   0.171889  -6.847 7.63e-12 ***
as.factor(year)1997            -1.125046   0.196653  -5.721 1.07e-08 ***
as.factor(year)1998            -1.084867   0.182939  -5.930 3.05e-09 ***
as.factor(year)1999            -0.748703   0.196169  -3.817 0.000135 ***
as.factor(year)2000             0.162476   0.180645   0.899 0.368434
as.factor(year)2001             0.290669   0.173597   1.674 0.094062 .
as.factor(year)2002            -0.274012   0.171013  -1.602 0.109099
as.factor(year)2003            -0.902206   0.178140  -5.065 4.11e-07 ***
as.factor(year)2004            -1.134917   0.176820  -6.418 1.39e-10 ***
as.factor(year)2005            -1.535729   0.218905  -7.016 2.32e-12 ***
as.factor(year)2006            -0.812125   0.214496  -3.786 0.000153 ***
as.factor(year)2007             0.056024   0.265212   0.211 0.832701
as.factor(year)2008             0.705801   0.226274   3.119 0.001814 **
as.factor(year)2009             0.624724   0.206678   3.023 0.002507 **
as.factor(year)2010             0.792342   0.237167   3.341 0.000836 ***
as.factor(year)2011             0.737716   0.206037   3.581 0.000343 ***
as.factor(year)2012             1.642625   0.243085   6.757 1.42e-11 ***
as.factor(qt)2                 -0.493722   0.115520  -4.274 1.92e-05 ***
as.factor(qt)3                 -0.352510   0.114228  -3.086 0.002030 **
```



| | | | | |
|---|---|---|---|---|
| as.factor(qt)4 | 0.616103 | 0.125763 | 4.899 | 9.67e-07 *** |
| as.factor(area)11 | 0.190771 | 0.153460 | 1.243 | 0.213827 |
| as.factor(area)13 | -0.546414 | 0.130634 | -4.183 | 2.88e-05 *** |
| as.factor(area)15 | -0.869229 | 0.256220 | -3.393 | 0.000693 *** |
| as.factor(area)17 | -0.344412 | 0.164206 | -2.097 | 0.035960 * |
| as.factor(area)18 | 0.038317 | 0.175715 | 0.218 | 0.827380 |
| as.factor(area)19 | 0.270602 | 0.180231 | 1.501 | 0.133256 |
| as.factor(gear)2 | 0.476340 | 0.113944 | 4.180 | 2.91e-05 *** |
| as.factor(gear)3 | 0.354427 | 0.114169 | 3.104 | 0.001908 ** |
| as.factor(gear)4 | 0.405595 | 0.113552 | 3.572 | 0.000355 *** |
| as.factor(gear)5 | 0.135955 | 0.117022 | 1.162 | 0.245327 |
| as.factor(year)1976:as.factor(area)11 | -0.137337 | 0.187076 | -0.734 | 0.462877 |
| as.factor(year)1977:as.factor(area)11 | 0.206514 | 0.185737 | 1.112 | 0.266202 |
| as.factor(year)1978:as.factor(area)11 | 0.616243 | 0.189318 | 3.255 | 0.001134 ** |
| as.factor(year)1979:as.factor(area)11 | 0.618818 | 0.181141 | 3.416 | 0.000636 *** |
| as.factor(year)1980:as.factor(area)11 | 1.317321 | 0.198945 | 6.622 | 3.59e-11 *** |
| as.factor(year)1981:as.factor(area)11 | 0.889680 | 0.188592 | 4.717 | 2.39e-06 *** |
| as.factor(year)1982:as.factor(area)11 | 0.653389 | 0.189289 | 3.452 | 0.000557 *** |
| as.factor(year)1983:as.factor(area)11 | 1.568674 | 0.212264 | 7.390 | 1.49e-13 *** |
| as.factor(year)1984:as.factor(area)11 | 0.707119 | 0.199463 | 3.545 | 0.000393 *** |
| as.factor(year)1985:as.factor(area)11 | 0.728783 | 0.190099 | 3.834 | 0.000126 *** |
| as.factor(year)1986:as.factor(area)11 | 0.377553 | 0.200239 | 1.886 | 0.059367 . |
| as.factor(year)1987:as.factor(area)11 | 0.546116 | 0.195843 | 2.789 | 0.005297 ** |
| as.factor(year)1988:as.factor(area)11 | 0.540862 | 0.198414 | 2.726 | 0.006415 ** |
| as.factor(year)1989:as.factor(area)11 | 0.539683 | 0.188986 | 2.856 | 0.004296 ** |
| as.factor(year)1990:as.factor(area)11 | 0.612197 | 0.185303 | 3.304 | 0.000955 *** |
| as.factor(year)1991:as.factor(area)11 | 0.565717 | 0.189284 | 2.989 | 0.002803 ** |
| as.factor(year)1992:as.factor(area)11 | 0.826563 | 0.200954 | 4.113 | 3.91e-05 *** |
| as.factor(year)1993:as.factor(area)11 | 0.714152 | 0.188740 | 3.784 | 0.000155 *** |
| as.factor(year)1994:as.factor(area)11 | 0.720053 | 0.176906 | 4.070 | 4.70e-05 *** |
| as.factor(year)1995:as.factor(area)11 | 0.986695 | 0.184211 | 5.356 | 8.53e-08 *** |
| as.factor(year)1996:as.factor(area)11 | 0.812305 | 0.191290 | 4.246 | 2.18e-05 *** |
| as.factor(year)1997:as.factor(area)11 | 1.224216 | 0.213738 | 5.728 | 1.02e-08 *** |
| as.factor(year)1998:as.factor(area)11 | 1.304827 | 0.204985 | 6.365 | 1.97e-10 *** |
| as.factor(year)1999:as.factor(area)11 | 0.551678 | 0.211840 | 2.604 | 0.009211 ** |
| as.factor(year)2000:as.factor(area)11 | 0.404262 | 0.188677 | 2.143 | 0.032150 * |
| as.factor(year)2001:as.factor(area)11 | 0.530083 | 0.186731 | 2.839 | 0.004531 ** |
| as.factor(year)2002:as.factor(area)11 | 0.588560 | 0.184885 | 3.183 | 0.001457 ** |
| as.factor(year)2003:as.factor(area)11 | 0.899876 | 0.192362 | 4.678 | 2.90e-06 *** |
| as.factor(year)2004:as.factor(area)11 | 0.838095 | 0.189786 | 4.416 | 1.01e-05 *** |
| as.factor(year)2005:as.factor(area)11 | 1.445984 | 0.232238 | 6.226 | 4.82e-10 *** |
| as.factor(year)2006:as.factor(area)11 | 1.089034 | 0.223755 | 4.867 | 1.14e-06 *** |
| as.factor(year)2007:as.factor(area)11 | 0.504134 | 0.287784 | 1.752 | 0.079818 . |
| as.factor(year)2008:as.factor(area)11 | 0.335708 | 0.237344 | 1.414 | 0.157240 |
| as.factor(year)2009:as.factor(area)11 | 0.224876 | 0.223583 | 1.006 | 0.314525 |
| as.factor(year)2010:as.factor(area)11 | 0.556670 | 0.258348 | 2.155 | 0.031188 * |
| as.factor(year)2011:as.factor(area)11 | 0.015973 | 0.229377 | 0.070 | 0.944482 |
| as.factor(year)2012:as.factor(area)11 | -0.752121 | 0.256891 | -2.928 | 0.003416 ** |
| as.factor(year)1976:as.factor(area)13 | -0.061369 | 0.163920 | -0.374 | 0.708121 |
| as.factor(year)1977:as.factor(area)13 | 0.270321 | 0.161324 | 1.676 | 0.093815 . |
| as.factor(year)1978:as.factor(area)13 | 0.581835 | 0.162091 | 3.590 | 0.000332 *** |
| as.factor(year)1979:as.factor(area)13 | 0.789864 | 0.159992 | 4.937 | 7.97e-07 *** |
| as.factor(year)1980:as.factor(area)13 | 1.949366 | 0.169478 | 11.502 | < 2e-16 *** |
| as.factor(year)1981:as.factor(area)13 | 0.945400 | 0.163107 | 5.796 | 6.83e-09 *** |
| as.factor(year)1982:as.factor(area)13 | 1.157777 | 0.168408 | 6.875 | 6.29e-12 *** |
| as.factor(year)1983:as.factor(area)13 | 1.116546 | 0.191343 | 5.835 | 5.40e-09 *** |
| as.factor(year)1984:as.factor(area)13 | 0.999864 | 0.171046 | 5.846 | 5.08e-09 *** |
| as.factor(year)1985:as.factor(area)13 | 0.925134 | 0.167268 | 5.531 | 3.20e-08 *** |
| as.factor(year)1986:as.factor(area)13 | 0.479891 | 0.174996 | 2.742 | 0.006103 ** |
| as.factor(year)1987:as.factor(area)13 | 0.686695 | 0.169849 | 4.043 | 5.29e-05 *** |
| as.factor(year)1988:as.factor(area)13 | 1.144909 | 0.165563 | 6.915 | 4.73e-12 *** |
| as.factor(year)1989:as.factor(area)13 | 0.733684 | 0.164087 | 4.471 | 7.79e-06 *** |
| as.factor(year)1990:as.factor(area)13 | 1.069232 | 0.161293 | 6.629 | 3.41e-11 *** |
| as.factor(year)1991:as.factor(area)13 | 0.903909 | 0.166877 | 5.417 | 6.10e-08 *** |
| as.factor(year)1992:as.factor(area)13 | 1.632083 | 0.174795 | 9.337 | < 2e-16 *** |
| as.factor(year)1993:as.factor(area)13 | 1.506714 | 0.166011 | 9.076 | < 2e-16 *** |
| as.factor(year)1994:as.factor(area)13 | 1.085808 | 0.151797 | 7.153 | 8.62e-13 *** |
| as.factor(year)1995:as.factor(area)13 | 1.369368 | 0.158277 | 8.652 | < 2e-16 *** |
| as.factor(year)1996:as.factor(area)13 | 1.403413 | 0.167451 | 8.381 | < 2e-16 *** |
| as.factor(year)1997:as.factor(area)13 | 1.520554 | 0.193756 | 7.848 | 4.33e-15 *** |
| as.factor(year)1998:as.factor(area)13 | 1.715027 | 0.183044 | 9.369 | < 2e-16 *** |
| as.factor(year)1999:as.factor(area)13 | 1.120600 | 0.189502 | 5.913 | 3.38e-09 *** |
| as.factor(year)2000:as.factor(area)13 | 0.443091 | 0.169304 | 2.617 | 0.008870 ** |
| as.factor(year)2001:as.factor(area)13 | 0.370113 | 0.166299 | 2.226 | 0.026047 * |
| as.factor(year)2002:as.factor(area)13 | 0.856083 | 0.165982 | 5.158 | 2.51e-07 *** |
| as.factor(year)2003:as.factor(area)13 | 1.371760 | 0.171814 | 7.984 | 1.45e-15 *** |
| as.factor(year)2004:as.factor(area)13 | 1.867658 | 0.172079 | 10.853 | < 2e-16 *** |
| as.factor(year)2005:as.factor(area)13 | 1.886009 | 0.217572 | 8.668 | < 2e-16 *** |
| as.factor(year)2006:as.factor(area)13 | 1.512699 | 0.208776 | 7.246 | 4.37e-13 *** |
| as.factor(year)2007:as.factor(area)13 | 0.787486 | 0.267964 | 2.939 | 0.003297 ** |
| as.factor(year)2008:as.factor(area)13 | 0.281483 | 0.219420 | 1.283 | 0.199551 |
| as.factor(year)2009:as.factor(area)13 | 0.694097 | 0.204485 | 3.394 | 0.000688 *** |
| as.factor(year)2010:as.factor(area)13 | 0.744365 | 0.232548 | 3.201 | 0.001371 ** |
| as.factor(year)2011:as.factor(area)13 | 0.850584 | 0.207582 | 4.098 | 4.18e-05 *** |
| as.factor(year)2012:as.factor(area)13 | -0.170809 | 0.232300 | -0.735 | 0.462163 |
| as.factor(year)1976:as.factor(area)15 | 0.302469 | 0.303503 | 0.997 | 0.318967 |
| as.factor(year)1977:as.factor(area)15 | 0.491412 | 0.287580 | 1.709 | 0.087498 . |
| as.factor(year)1978:as.factor(area)15 | 0.680331 | 0.287934 | 2.363 | 0.018141 * |
| as.factor(year)1979:as.factor(area)15 | 0.967745 | 0.283837 | 3.410 | 0.000651 *** |
| as.factor(year)1980:as.factor(area)15 | 1.894237 | 0.289399 | 6.545 | 6.00e-11 *** |
| as.factor(year)1981:as.factor(area)15 | 1.192389 | 0.285455 | 4.177 | 2.96e-05 *** |
| as.factor(year)1982:as.factor(area)15 | 1.377328 | 0.286544 | 4.807 | 1.54e-06 *** |

| | | | | | |
|---|---|---|---|---|---|
| as.factor(year)1983:as.factor(area)15 | 1.838544 | 0.293700 | 6.260 | 3.89e-10 | *** |
| as.factor(year)1984:as.factor(area)15 | 1.431886 | 0.290141 | 4.935 | 8.04e-07 | *** |
| as.factor(year)1985:as.factor(area)15 | 0.798013 | 0.298252 | 2.676 | 0.007462 | ** |
| as.factor(year)1986:as.factor(area)15 | 0.667094 | 0.291364 | 2.290 | 0.022051 | * |
| as.factor(year)1987:as.factor(area)15 | 0.945839 | 0.283393 | 3.338 | 0.000846 | *** |
| as.factor(year)1988:as.factor(area)15 | 0.678598 | 0.288872 | 2.349 | 0.018822 | * |
| as.factor(year)1989:as.factor(area)15 | 0.055795 | 0.289046 | 0.193 | 0.846934 | |
| as.factor(year)1990:as.factor(area)15 | 0.959819 | 0.283731 | 3.383 | 0.000718 | *** |
| as.factor(year)1991:as.factor(area)15 | 1.165035 | 0.283339 | 4.112 | 3.93e-05 | *** |
| as.factor(year)1992:as.factor(area)15 | 1.444783 | 0.292337 | 4.942 | 7.75e-07 | *** |
| as.factor(year)1993:as.factor(area)15 | 1.651714 | 0.290598 | 5.684 | 1.32e-08 | *** |
| as.factor(year)1994:as.factor(area)15 | 1.307099 | 0.272266 | 4.801 | 1.59e-06 | *** |
| as.factor(year)1995:as.factor(area)15 | 1.550966 | 0.277474 | 5.590 | 2.29e-08 | *** |
| as.factor(year)1996:as.factor(area)15 | 1.454989 | 0.285219 | 5.101 | 3.39e-07 | *** |
| as.factor(year)1997:as.factor(area)15 | 1.748388 | 0.303513 | 5.761 | 8.44e-09 | *** |
| as.factor(year)1998:as.factor(area)15 | 1.827454 | 0.297710 | 6.138 | 8.41e-10 | *** |
| as.factor(year)1999:as.factor(area)15 | 1.009883 | 0.310888 | 3.248 | 0.001161 | ** |
| as.factor(year)2000:as.factor(area)15 | 0.154095 | 0.299887 | 0.514 | 0.607364 | |
| as.factor(year)2001:as.factor(area)15 | 0.293152 | 0.293582 | 0.999 | 0.318024 | |
| as.factor(year)2002:as.factor(area)15 | 0.977786 | 0.292581 | 3.342 | 0.000833 | *** |
| as.factor(year)2003:as.factor(area)15 | 1.591791 | 0.291005 | 5.470 | 4.52e-08 | *** |
| as.factor(year)2004:as.factor(area)15 | 1.381522 | 0.295987 | 4.668 | 3.06e-06 | *** |
| as.factor(year)2005:as.factor(area)15 | 2.024866 | 0.325303 | 6.225 | 4.87e-10 | *** |
| as.factor(year)2006:as.factor(area)15 | 1.537927 | 0.323425 | 4.755 | 1.99e-06 | *** |
| as.factor(year)2007:as.factor(area)15 | 0.987719 | 0.354961 | 2.783 | 0.005395 | ** |
| as.factor(year)2008:as.factor(area)15 | 0.497379 | 0.322057 | 1.544 | 0.122503 | |
| as.factor(year)2009:as.factor(area)15 | 1.243454 | 0.322665 | 3.854 | 0.000117 | *** |
| as.factor(year)2010:as.factor(area)15 | 1.480922 | 0.331425 | 4.468 | 7.90e-06 | *** |
| as.factor(year)2011:as.factor(area)15 | 1.561817 | 0.317394 | 4.921 | 8.65e-07 | *** |
| as.factor(year)2012:as.factor(area)15 | 0.804447 | 0.347390 | 2.316 | 0.020580 | * |
| as.factor(year)1976:as.factor(area)17 | 0.121529 | 0.204821 | 0.593 | 0.552954 | |
| as.factor(year)1977:as.factor(area)17 | 0.328239 | 0.200264 | 1.639 | 0.101213 | |
| as.factor(year)1978:as.factor(area)17 | 0.821784 | 0.202771 | 4.053 | 5.07e-05 | *** |
| as.factor(year)1979:as.factor(area)17 | 1.168764 | 0.201232 | 5.808 | 6.36e-09 | *** |
| as.factor(year)1980:as.factor(area)17 | 2.336161 | 0.211050 | 11.069 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)17 | 1.310208 | 0.207471 | 6.315 | 2.72e-10 | *** |
| as.factor(year)1982:as.factor(area)17 | 1.713554 | 0.219346 | 7.812 | 5.74e-15 | *** |
| as.factor(year)1983:as.factor(area)17 | 1.862594 | 0.230075 | 8.096 | 5.84e-16 | *** |
| as.factor(year)1984:as.factor(area)17 | 1.310545 | 0.212142 | 6.178 | 6.56e-10 | *** |
| as.factor(year)1985:as.factor(area)17 | 1.275175 | 0.215983 | 5.904 | 3.57e-09 | *** |
| as.factor(year)1986:as.factor(area)17 | 0.178504 | 0.209248 | 0.853 | 0.393623 | |
| as.factor(year)1987:as.factor(area)17 | 0.873772 | 0.209709 | 4.167 | 3.10e-05 | *** |
| as.factor(year)1988:as.factor(area)17 | 0.952492 | 0.198732 | 4.793 | 1.65e-06 | *** |
| as.factor(year)1989:as.factor(area)17 | 0.546184 | 0.203839 | 2.679 | 0.007376 | ** |
| as.factor(year)1990:as.factor(area)17 | 1.353229 | 0.211316 | 6.404 | 1.53e-10 | *** |
| as.factor(year)1991:as.factor(area)17 | 1.134221 | 0.206752 | 5.486 | 4.14e-08 | *** |
| as.factor(year)1992:as.factor(area)17 | 1.725750 | 0.209550 | 8.235 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)17 | 1.577895 | 0.206456 | 7.643 | 2.17e-14 | *** |
| as.factor(year)1994:as.factor(area)17 | 1.189937 | 0.192765 | 6.173 | 6.76e-10 | *** |
| as.factor(year)1995:as.factor(area)17 | 1.613476 | 0.199811 | 8.075 | 6.91e-16 | *** |
| as.factor(year)1996:as.factor(area)17 | 1.420163 | 0.208967 | 6.796 | 1.09e-11 | *** |
| as.factor(year)1997:as.factor(area)17 | 1.170405 | 0.235206 | 4.976 | 6.51e-07 | *** |
| as.factor(year)1998:as.factor(area)17 | 1.730291 | 0.211841 | 8.168 | 3.22e-16 | *** |
| as.factor(year)1999:as.factor(area)17 | 1.106248 | 0.216512 | 5.109 | 3.24e-07 | *** |
| as.factor(year)2000:as.factor(area)17 | 0.194499 | 0.209913 | 0.927 | 0.354156 | |
| as.factor(year)2001:as.factor(area)17 | 0.292325 | 0.205190 | 1.425 | 0.154264 | |
| as.factor(year)2002:as.factor(area)17 | 0.897055 | 0.204757 | 4.381 | 1.18e-05 | *** |
| as.factor(year)2003:as.factor(area)17 | 1.685378 | 0.204860 | 8.227 | < 2e-16 | *** |
| as.factor(year)2004:as.factor(area)17 | 1.996573 | 0.218232 | 9.149 | < 2e-16 | *** |
| as.factor(year)2005:as.factor(area)17 | 2.219181 | 0.252797 | 8.778 | < 2e-16 | *** |
| as.factor(year)2006:as.factor(area)17 | 1.357755 | 0.247855 | 5.478 | 4.32e-08 | *** |
| as.factor(year)2007:as.factor(area)17 | 0.432070 | 0.297622 | 1.452 | 0.146581 | |
| as.factor(year)2008:as.factor(area)17 | -0.307947 | 0.253258 | -1.216 | 0.224012 | |
| as.factor(year)2009:as.factor(area)17 | -0.200138 | 0.256966 | -0.779 | 0.436073 | |
| as.factor(year)2010:as.factor(area)17 | 0.237422 | 0.268601 | 0.884 | 0.376743 | |
| as.factor(year)2011:as.factor(area)17 | 0.132786 | 0.232606 | 0.571 | 0.568097 | |
| as.factor(year)2012:as.factor(area)17 | -0.710356 | 0.254447 | -2.792 | 0.005244 | ** |
| as.factor(year)1976:as.factor(area)18 | 0.230518 | 0.229790 | 1.003 | 0.315784 | |
| as.factor(year)1977:as.factor(area)18 | 0.566636 | 0.216388 | 2.619 | 0.008832 | ** |
| as.factor(year)1978:as.factor(area)18 | 0.946409 | 0.219324 | 4.315 | 1.60e-05 | *** |
| as.factor(year)1979:as.factor(area)18 | 1.381221 | 0.231096 | 5.977 | 2.29e-09 | *** |
| as.factor(year)1980:as.factor(area)18 | 2.419064 | 0.224901 | 10.756 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)18 | 1.579022 | 0.218711 | 7.220 | 5.29e-13 | *** |
| as.factor(year)1982:as.factor(area)18 | 1.593875 | 0.228277 | 6.982 | 2.95e-12 | *** |
| as.factor(year)1983:as.factor(area)18 | 2.098788 | 0.229209 | 9.157 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)18 | 1.169057 | 0.224888 | 5.198 | 2.02e-07 | *** |
| as.factor(year)1985:as.factor(area)18 | 0.593068 | 0.236322 | 2.510 | 0.012091 | * |
| as.factor(year)1986:as.factor(area)18 | 0.231072 | 0.223940 | 1.032 | 0.302150 | |
| as.factor(year)1987:as.factor(area)18 | 0.593927 | 0.215197 | 2.760 | 0.005784 | ** |
| as.factor(year)1988:as.factor(area)18 | 0.760527 | 0.216210 | 3.518 | 0.000436 | *** |
| as.factor(year)1989:as.factor(area)18 | 0.165520 | 0.224543 | 0.737 | 0.461040 | |
| as.factor(year)1990:as.factor(area)18 | 1.119481 | 0.225565 | 4.963 | 6.97e-07 | *** |
| as.factor(year)1991:as.factor(area)18 | 0.827960 | 0.222949 | 3.714 | 0.000205 | *** |
| as.factor(year)1992:as.factor(area)18 | 1.404501 | 0.225611 | 6.225 | 4.85e-10 | *** |
| as.factor(year)1993:as.factor(area)18 | 1.421413 | 0.226237 | 6.283 | 3.35e-10 | *** |
| as.factor(year)1994:as.factor(area)18 | 0.969468 | 0.206458 | 4.696 | 2.66e-06 | *** |
| as.factor(year)1995:as.factor(area)18 | 1.373365 | 0.212230 | 6.471 | 9.83e-11 | *** |
| as.factor(year)1996:as.factor(area)18 | 0.869302 | 0.215288 | 4.038 | 5.40e-05 | *** |
| as.factor(year)1997:as.factor(area)18 | 0.917245 | 0.237478 | 3.862 | 0.000112 | *** |
| as.factor(year)1998:as.factor(area)18 | 1.067342 | 0.222215 | 4.803 | 1.57e-06 | *** |
| as.factor(year)1999:as.factor(area)18 | 0.495327 | 0.238164 | 2.080 | 0.037552 | * |
| as.factor(year)2000:as.factor(area)18 | -0.566231 | 0.229496 | -2.467 | 0.013618 | * |

| | | | | |
|---|---|---|---|---|
| as.factor(year)2001:as.factor(area)18 | -0.184844 | 0.221215 | -0.836 | 0.403393 |
| as.factor(year)2002:as.factor(area)18 | 0.288562 | 0.215804 | 1.337 | 0.181182 |
| as.factor(year)2003:as.factor(area)18 | 1.037636 | 0.216421 | 4.795 | 1.64e-06 *** |
| as.factor(year)2004:as.factor(area)18 | 1.163010 | 0.224532 | 5.180 | 2.23e-07 *** |
| as.factor(year)2005:as.factor(area)18 | 1.686347 | 0.262832 | 6.416 | 1.41e-10 *** |
| as.factor(year)2006:as.factor(area)18 | 0.762608 | 0.250713 | 3.042 | 0.002353 ** |
| as.factor(year)2007:as.factor(area)18 | 0.252025 | 0.303007 | 0.832 | 0.405557 |
| as.factor(year)2008:as.factor(area)18 | -0.182870 | 0.268364 | -0.681 | 0.495605 |
| as.factor(year)2009:as.factor(area)18 | -0.277135 | 0.249237 | -1.112 | 0.266173 |
| as.factor(year)2010:as.factor(area)18 | 0.319760 | 0.274444 | 1.165 | 0.243977 |
| as.factor(year)2011:as.factor(area)18 | 0.064314 | 0.244567 | 0.263 | 0.792574 |
| as.factor(year)2012:as.factor(area)18 | -0.797273 | 0.268409 | -2.970 | 0.002976 ** |
| as.factor(year)1976:as.factor(area)19 | -0.088551 | 0.226352 | -0.391 | 0.695646 |
| as.factor(year)1977:as.factor(area)19 | 0.142109 | 0.218951 | 0.649 | 0.516312 |
| as.factor(year)1978:as.factor(area)19 | 0.678299 | 0.211023 | 3.214 | 0.001308 ** |
| as.factor(year)1979:as.factor(area)19 | 0.603490 | 0.217116 | 2.780 | 0.005445 ** |
| as.factor(year)1980:as.factor(area)19 | 1.759207 | 0.227855 | 7.721 | 1.18e-14 *** |
| as.factor(year)1981:as.factor(area)19 | 0.792754 | 0.214043 | 3.704 | 0.000213 *** |
| as.factor(year)1982:as.factor(area)19 | 1.096614 | 0.228441 | 4.800 | 1.59e-06 *** |
| as.factor(year)1983:as.factor(area)19 | 1.316322 | 0.230368 | 5.714 | 1.11e-08 *** |
| as.factor(year)1984:as.factor(area)19 | 1.188987 | 0.225715 | 5.268 | 1.39e-07 *** |
| as.factor(year)1985:as.factor(area)19 | 0.446302 | 0.220602 | 2.023 | 0.043068 * |
| as.factor(year)1986:as.factor(area)19 | 0.173514 | 0.224559 | 0.773 | 0.439712 |
| as.factor(year)1987:as.factor(area)19 | 0.621580 | 0.218727 | 2.842 | 0.004488 ** |
| as.factor(year)1988:as.factor(area)19 | 0.982572 | 0.221642 | 4.433 | 9.31e-06 *** |
| as.factor(year)1989:as.factor(area)19 | 0.290610 | 0.220054 | 1.321 | 0.186632 |
| as.factor(year)1990:as.factor(area)19 | 0.903037 | 0.213110 | 4.237 | 2.27e-05 *** |
| as.factor(year)1991:as.factor(area)19 | 0.693949 | 0.218845 | 3.171 | 0.001520 ** |
| as.factor(year)1992:as.factor(area)19 | 1.366357 | 0.226166 | 6.041 | 1.54e-09 *** |
| as.factor(year)1993:as.factor(area)19 | 0.879545 | 0.219797 | 4.002 | 6.30e-05 *** |
| as.factor(year)1994:as.factor(area)19 | 0.607244 | 0.203168 | 2.989 | 0.002802 ** |
| as.factor(year)1995:as.factor(area)19 | 0.716188 | 0.214414 | 3.340 | 0.000838 *** |
| as.factor(year)1996:as.factor(area)19 | 0.768579 | 0.221422 | 3.471 | 0.000519 *** |
| as.factor(year)1997:as.factor(area)19 | 0.661046 | 0.248387 | 2.661 | 0.007785 ** |
| as.factor(year)1998:as.factor(area)19 | 0.832220 | 0.225558 | 3.690 | 0.000225 *** |
| as.factor(year)1999:as.factor(area)19 | -0.285193 | 0.238538 | -1.196 | 0.231864 |
| as.factor(year)2000:as.factor(area)19 | -0.613756 | 0.239020 | -2.568 | 0.010238 * |
| as.factor(year)2001:as.factor(area)19 | -0.340725 | 0.216663 | -1.573 | 0.115818 |
| as.factor(year)2002:as.factor(area)19 | 0.672387 | 0.215658 | 3.118 | 0.001823 ** |
| as.factor(year)2003:as.factor(area)19 | 1.312342 | 0.223114 | 5.882 | 4.08e-09 *** |
| as.factor(year)2004:as.factor(area)19 | 1.111458 | 0.223773 | 4.967 | 6.83e-07 *** |
| as.factor(year)2005:as.factor(area)19 | 1.756122 | 0.260055 | 6.753 | 1.47e-11 *** |
| as.factor(year)2006:as.factor(area)19 | 1.085422 | 0.253113 | 4.288 | 1.80e-05 *** |
| as.factor(year)2007:as.factor(area)19 | 0.826415 | 0.305447 | 2.706 | 0.006821 ** |
| as.factor(year)2008:as.factor(area)19 | -0.204935 | 0.260631 | -0.786 | 0.431692 |
| as.factor(year)2009:as.factor(area)19 | -0.101789 | 0.246536 | -0.413 | 0.679698 |
| as.factor(year)2010:as.factor(area)19 | 1.015866 | 0.283138 | 3.588 | 0.000334 *** |
| as.factor(year)2011:as.factor(area)19 | 0.916406 | 0.249822 | 3.668 | 0.000245 *** |
| as.factor(year)2012:as.factor(area)19 | -0.648068 | 0.276022 | -2.348 | 0.018885 * |
| as.factor(year)1976:as.factor(qt)2 | 0.065475 | 0.146277 | 0.448 | 0.654438 |
| as.factor(year)1977:as.factor(qt)2 | 0.030118 | 0.140056 | 0.215 | 0.829737 |
| as.factor(year)1978:as.factor(qt)2 | -0.282318 | 0.145195 | -1.944 | 0.051853 . |
| as.factor(year)1979:as.factor(qt)2 | 0.082942 | 0.144738 | 0.573 | 0.566614 |
| as.factor(year)1980:as.factor(qt)2 | 0.211940 | 0.142432 | 1.488 | 0.136754 |
| as.factor(year)1981:as.factor(qt)2 | -0.233049 | 0.142305 | -1.638 | 0.101497 |
| as.factor(year)1982:as.factor(qt)2 | 0.190923 | 0.145585 | 1.311 | 0.189723 |
| as.factor(year)1983:as.factor(qt)2 | -0.518304 | 0.165004 | -3.141 | 0.001684 ** |
| as.factor(year)1984:as.factor(qt)2 | -0.367730 | 0.142866 | -2.574 | 0.010058 * |
| as.factor(year)1985:as.factor(qt)2 | -0.058081 | 0.143701 | -0.404 | 0.686083 |
| as.factor(year)1986:as.factor(qt)2 | 0.135879 | 0.144298 | 0.942 | 0.346373 |
| as.factor(year)1987:as.factor(qt)2 | 0.028728 | 0.143473 | 0.200 | 0.841298 |
| as.factor(year)1988:as.factor(qt)2 | -0.027116 | 0.140997 | -0.192 | 0.847495 |
| as.factor(year)1989:as.factor(qt)2 | -0.163522 | 0.146578 | -1.116 | 0.264600 |
| as.factor(year)1990:as.factor(qt)2 | 0.205815 | 0.142170 | 1.448 | 0.147716 |
| as.factor(year)1991:as.factor(qt)2 | 0.087454 | 0.137601 | 0.636 | 0.525064 |
| as.factor(year)1992:as.factor(qt)2 | 0.198077 | 0.143483 | 1.380 | 0.167444 |
| as.factor(year)1993:as.factor(qt)2 | 0.284177 | 0.139828 | 2.032 | 0.042125 * |
| as.factor(year)1994:as.factor(qt)2 | 0.090396 | 0.129323 | 0.699 | 0.484562 |
| as.factor(year)1995:as.factor(qt)2 | -0.078452 | 0.134303 | -0.584 | 0.559126 |
| as.factor(year)1996:as.factor(qt)2 | 0.124328 | 0.135866 | 0.915 | 0.360154 |
| as.factor(year)1997:as.factor(qt)2 | 0.022459 | 0.138836 | 0.162 | 0.871492 |
| as.factor(year)1998:as.factor(qt)2 | 0.160629 | 0.146875 | 1.094 | 0.274116 |
| as.factor(year)1999:as.factor(qt)2 | 0.218190 | 0.152240 | 1.433 | 0.151807 |
| as.factor(year)2000:as.factor(qt)2 | 0.099487 | 0.147717 | 0.673 | 0.500637 |
| as.factor(year)2001:as.factor(qt)2 | 0.127278 | 0.142928 | 0.891 | 0.373199 |
| as.factor(year)2002:as.factor(qt)2 | 0.079698 | 0.140340 | 0.568 | 0.570109 |
| as.factor(year)2003:as.factor(qt)2 | -0.025347 | 0.140811 | -0.180 | 0.857145 |
| as.factor(year)2004:as.factor(qt)2 | 0.084584 | 0.145848 | 0.580 | 0.561954 |
| as.factor(year)2005:as.factor(qt)2 | 0.082913 | 0.148599 | 0.558 | 0.576874 |
| as.factor(year)2006:as.factor(qt)2 | 0.128435 | 0.158370 | 0.811 | 0.417383 |
| as.factor(year)2007:as.factor(qt)2 | -0.143176 | 0.159226 | -0.899 | 0.368551 |
| as.factor(year)2008:as.factor(qt)2 | -0.006638 | 0.162765 | -0.041 | 0.967470 |
| as.factor(year)2009:as.factor(qt)2 | 0.356044 | 0.163288 | 2.180 | 0.029228 * |
| as.factor(year)2010:as.factor(qt)2 | 0.126744 | 0.158084 | 0.802 | 0.422702 |
| as.factor(year)2011:as.factor(qt)2 | 0.392580 | 0.154686 | 2.538 | 0.011155 * |
| as.factor(year)2012:as.factor(qt)2 | -0.065612 | 0.152994 | -0.429 | 0.668034 |
| as.factor(year)1976:as.factor(qt)3 | 0.240771 | 0.143775 | 1.675 | 0.094012 . |
| as.factor(year)1977:as.factor(qt)3 | 0.023929 | 0.139022 | 0.172 | 0.863341 |
| as.factor(year)1978:as.factor(qt)3 | -0.028889 | 0.139945 | -0.206 | 0.836455 |
| as.factor(year)1979:as.factor(qt)3 | 0.150767 | 0.142679 | 1.057 | 0.290659 |
| as.factor(year)1980:as.factor(qt)3 | 0.179688 | 0.140347 | 1.280 | 0.200443 |
| as.factor(year)1981:as.factor(qt)3 | -0.437393 | 0.142128 | -3.077 | 0.002089 ** |

```
as.factor(year)1982:as.factor(qt)3     0.132116   0.144166    0.916 0.359455
as.factor(year)1983:as.factor(qt)3    -0.407757   0.151278   -2.695 0.007033 **
as.factor(year)1984:as.factor(qt)3    -0.217457   0.146108   -1.488 0.136670
as.factor(year)1985:as.factor(qt)3     0.484036   0.144368    3.353 0.000801 ***
as.factor(year)1986:as.factor(qt)3     0.165102   0.142314    1.160 0.246004
as.factor(year)1987:as.factor(qt)3     0.091311   0.139796    0.653 0.513647
as.factor(year)1988:as.factor(qt)3     0.093570   0.140720    0.665 0.506095
as.factor(year)1989:as.factor(qt)3    -0.020632   0.146720   -0.141 0.888171
as.factor(year)1990:as.factor(qt)3     0.018645   0.140943    0.132 0.894756
as.factor(year)1991:as.factor(qt)3     0.054877   0.136293    0.403 0.687216
as.factor(year)1992:as.factor(qt)3     0.010489   0.141591    0.074 0.940949
as.factor(year)1993:as.factor(qt)3    -0.015756   0.138704   -0.114 0.909562
as.factor(year)1994:as.factor(qt)3     0.263333   0.129427    2.035 0.041896 *
as.factor(year)1995:as.factor(qt)3    -0.016252   0.133115   -0.122 0.902831
as.factor(year)1996:as.factor(qt)3     0.069598   0.136230    0.511 0.609434
as.factor(year)1997:as.factor(qt)3     0.151936   0.140264    1.083 0.278718
as.factor(year)1998:as.factor(qt)3     0.083781   0.145872    0.574 0.565738
as.factor(year)1999:as.factor(qt)3     0.489774   0.153489    3.191 0.001419 **
as.factor(year)2000:as.factor(qt)3     0.400112   0.149825    2.671 0.007576 **
as.factor(year)2001:as.factor(qt)3     0.201222   0.138977    1.448 0.147657
as.factor(year)2002:as.factor(qt)3    -0.015287   0.138540   -0.110 0.912139
as.factor(year)2003:as.factor(qt)3     0.138672   0.141516    0.980 0.327140
as.factor(year)2004:as.factor(qt)3     0.036107   0.147828    0.244 0.807038
as.factor(year)2005:as.factor(qt)3    -0.004151   0.156669   -0.026 0.978865
as.factor(year)2006:as.factor(qt)3     0.067165   0.157665    0.426 0.670114
as.factor(year)2007:as.factor(qt)3    -0.122346   0.168507   -0.726 0.467805
as.factor(year)2008:as.factor(qt)3    -0.242143   0.166093   -1.458 0.144882
as.factor(year)2009:as.factor(qt)3     0.331064   0.166920    1.983 0.047332 *
as.factor(year)2010:as.factor(qt)3    -0.319925   0.164755   -1.942 0.052165 .
as.factor(year)2011:as.factor(qt)3    -0.137766   0.154038   -0.894 0.371130
as.factor(year)2012:as.factor(qt)3     0.031250   0.152208    0.205 0.837330
as.factor(year)1976:as.factor(qt)4    -0.315430   0.153531   -2.054 0.039933 *
as.factor(year)1977:as.factor(qt)4    -0.235110   0.149844   -1.569 0.116647
as.factor(year)1978:as.factor(qt)4    -0.243095   0.151126   -1.609 0.107718
as.factor(year)1979:as.factor(qt)4    -0.211552   0.149859   -1.412 0.158052
as.factor(year)1980:as.factor(qt)4    -0.115328   0.150734   -0.765 0.444209
as.factor(year)1981:as.factor(qt)4    -0.699940   0.152325   -4.595 4.34e-06 ***
as.factor(year)1982:as.factor(qt)4    -0.223246   0.153168   -1.458 0.144979
as.factor(year)1983:as.factor(qt)4    -0.617641   0.158786   -3.890 0.000100 ***
as.factor(year)1984:as.factor(qt)4    -0.388627   0.152427   -2.550 0.010788 *
as.factor(year)1985:as.factor(qt)4    -0.172218   0.155547   -1.107 0.268223
as.factor(year)1986:as.factor(qt)4    -0.265425   0.151882   -1.748 0.080544 .
as.factor(year)1987:as.factor(qt)4    -0.554216   0.150884   -3.673 0.000240 ***
as.factor(year)1988:as.factor(qt)4    -0.387889   0.155349   -2.497 0.012532 *
as.factor(year)1989:as.factor(qt)4    -0.651498   0.153049   -4.257 2.08e-05 ***
as.factor(year)1990:as.factor(qt)4    -0.736448   0.148026   -4.975 6.54e-07 ***
as.factor(year)1991:as.factor(qt)4    -0.553290   0.147090   -3.762 0.000169 ***
as.factor(year)1992:as.factor(qt)4    -0.467386   0.151206   -3.091 0.001996 **
as.factor(year)1993:as.factor(qt)4    -0.522883   0.148404   -3.523 0.000426 ***
as.factor(year)1994:as.factor(qt)4    -0.308316   0.140453   -2.195 0.028158 *
as.factor(year)1995:as.factor(qt)4    -0.529996   0.144744   -3.662 0.000251 ***
as.factor(year)1996:as.factor(qt)4    -0.333547   0.148361   -2.248 0.024567 *
as.factor(year)1997:as.factor(qt)4    -0.303007   0.151965   -1.994 0.046166 *
as.factor(year)1998:as.factor(qt)4    -0.427120   0.154946   -2.757 0.005843 **
as.factor(year)1999:as.factor(qt)4    -0.140744   0.159956   -0.880 0.378923
as.factor(year)2000:as.factor(qt)4    -0.469326   0.152412   -3.079 0.002076 **
as.factor(year)2001:as.factor(qt)4    -0.622175   0.148644   -4.186 2.85e-05 ***
as.factor(year)2002:as.factor(qt)4    -0.557288   0.148687   -3.748 0.000178 ***
as.factor(year)2003:as.factor(qt)4    -0.590413   0.148208   -3.984 6.80e-05 ***
as.factor(year)2004:as.factor(qt)4    -0.641198   0.153870   -4.167 3.09e-05 ***
as.factor(year)2005:as.factor(qt)4    -0.660125   0.162256   -4.068 4.74e-05 ***
as.factor(year)2006:as.factor(qt)4    -0.516462   0.162741   -3.174 0.001507 **
as.factor(year)2007:as.factor(qt)4    -0.507026   0.175696   -2.886 0.003906 **
as.factor(year)2008:as.factor(qt)4    -0.515587   0.172397   -2.991 0.002785 **
as.factor(year)2009:as.factor(qt)4    -0.430529   0.171408   -2.512 0.012018 *
as.factor(year)2010:as.factor(qt)4    -0.802425   0.175003   -4.585 4.55e-06 ***
as.factor(year)2011:as.factor(qt)4    -0.775946   0.163884   -4.735 2.20e-06 ***
as.factor(year)2012:as.factor(qt)4    -0.576820   0.163568   -3.526 0.000422 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 1.044933)

    Null deviance: 66239  on 45996  degrees of freedom
Residual deviance: 47663  on 45613  degrees of freedom
AIC: 132940

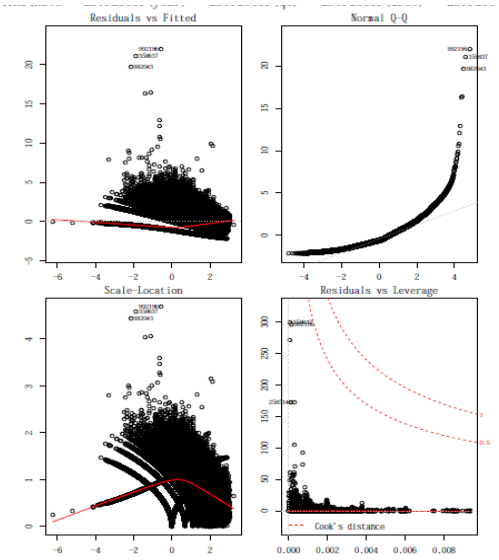
Number of Fisher Scoring iterations: 2
```

## WCNPO for the period between 1975 and 1993, fitted negative binomial GLM to the operational data

| | Df | Deviance | Resid. Df | Resid. Dev | Pr(>Chi) | |
|---|---|---|---|---|---|---|
| NULL | | | 685661 | 1047023 | | |
| as.factor(year) | 18 | 10121 | 685643 | 1036902 | < 2.2e-16 | *** |
| as.factor(qt) | 3 | 30094 | 685640 | 1006808 | < 2.2e-16 | *** |
| as.factor(ar09) | 8 | 240484 | 685632 | 766323 | < 2.2e-16 | *** |
| as.factor(gear) | 4 | 98385 | 685628 | 667939 | < 2.2e-16 | *** |
| as.factor(year):as.factor(ar09) | 144 | 25246 | 685484 | 642693 | < 2.2e-16 | *** |
| as.factor(year):as.factor(qt) | 54 | 2990 | 685430 | 639702 | < 2.2e-16 | *** |

Call:

```
glm.nb(formula = nswo ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(gear) + as.factor(year) * as.factor(area) + as.factor(year) *
    as.factor(qt) + offset(log(hooks)), data = owcpo1, init.theta = 0.7259278712,
    link = log)
```




Deviance Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -2.1749 | -0.9870 | -0.6109 | 0.1346 | 21.9429 |

Coefficients:

| | Estimate | Std. Error | z value | Pr(>\|z\|) | |
|---|---|---|---|---|---|
| (Intercept) | -6.307511 | 0.044201 | -142.700 | < 2e-16 | *** |
| as.factor(year)1976 | 0.235358 | 0.054382 | 4.328 | 1.51e-05 | *** |
| as.factor(year)1977 | 0.488480 | 0.052469 | 9.310 | < 2e-16 | *** |
| as.factor(year)1978 | 0.741341 | 0.054610 | 13.575 | < 2e-16 | *** |
| as.factor(year)1979 | 1.045894 | 0.052822 | 19.800 | < 2e-16 | *** |
| as.factor(year)1980 | -0.257349 | 0.053568 | -4.804 | 1.55e-06 | *** |
| as.factor(year)1981 | -0.816998 | 0.054422 | -15.012 | < 2e-16 | *** |
| as.factor(year)1982 | -0.614711 | 0.054399 | -11.300 | < 2e-16 | *** |
| as.factor(year)1983 | 0.073579 | 0.055184 | 1.333 | 0.182418 | |
| as.factor(year)1984 | 0.572836 | 0.051837 | 11.051 | < 2e-16 | *** |
| as.factor(year)1985 | 0.280150 | 0.055327 | 5.063 | 4.12e-07 | *** |
| as.factor(year)1986 | 0.278284 | 0.056478 | 4.927 | 8.34e-07 | *** |
| as.factor(year)1987 | 0.386642 | 0.055501 | 6.966 | 3.25e-12 | *** |
| as.factor(year)1988 | 0.297929 | 0.055818 | 5.338 | 9.42e-08 | *** |
| as.factor(year)1989 | 0.191661 | 0.062438 | 3.070 | 0.002143 | ** |
| as.factor(year)1990 | 0.486645 | 0.063020 | 7.722 | 1.14e-14 | *** |
| as.factor(year)1991 | 0.204184 | 0.057843 | 3.530 | 0.000416 | *** |
| as.factor(year)1992 | 0.214499 | 0.067477 | 3.179 | 0.001479 | ** |
| as.factor(year)1993 | 0.282579 | 0.058304 | 4.847 | 1.26e-06 | *** |
| as.factor(qt)2 | -0.229854 | 0.034008 | -6.759 | 1.39e-11 | *** |
| as.factor(qt)3 | -0.713092 | 0.038576 | -18.485 | < 2e-16 | *** |
| as.factor(qt)4 | -0.602177 | 0.025431 | -23.679 | < 2e-16 | *** |
| as.factor(area)2 | 1.308053 | 0.041654 | 31.403 | < 2e-16 | *** |
| as.factor(area)3 | 0.545453 | 0.062888 | 8.673 | < 2e-16 | *** |
| as.factor(area)4 | 0.617334 | 0.050048 | 12.335 | < 2e-16 | *** |
| as.factor(area)5 | -0.682931 | 0.044323 | -15.408 | < 2e-16 | *** |
| as.factor(area)6 | -0.224595 | 0.056511 | -3.974 | 7.06e-05 | *** |
| as.factor(area)7 | -2.519913 | 0.073392 | -34.335 | < 2e-16 | *** |
| as.factor(area)8 | -2.005738 | 0.189465 | -10.586 | < 2e-16 | *** |
| as.factor(area)9 | -0.840116 | 0.070649 | -11.891 | < 2e-16 | *** |
| as.factor(gear)2 | -0.281966 | 0.006432 | -43.836 | < 2e-16 | *** |
| as.factor(gear)3 | -0.903379 | 0.007565 | -119.416 | < 2e-16 | *** |
| as.factor(gear)4 | -1.610726 | 0.006274 | -256.750 | < 2e-16 | *** |
| as.factor(gear)5 | -1.868785 | 0.044111 | -42.365 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)2 | -0.706495 | 0.051746 | -13.653 | < 2e-16 | *** |
| as.factor(year)1977:as.factor(area)2 | -1.049105 | 0.049816 | -21.060 | < 2e-16 | *** |
| as.factor(year)1978:as.factor(area)2 | -1.091829 | 0.052255 | -20.894 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)2 | -1.529341 | 0.050738 | -30.142 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)2 | -0.337029 | 0.051192 | -6.584 | 4.59e-11 | *** |
| as.factor(year)1981:as.factor(area)2 | 0.308228 | 0.052570 | 5.863 | 4.54e-09 | *** |
| as.factor(year)1982:as.factor(area)2 | -0.070067 | 0.052284 | -1.340 | 0.180207 | |
| as.factor(year)1983:as.factor(area)2 | -0.549844 | 0.052907 | -10.393 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)2 | -0.971005 | 0.049464 | -19.631 | < 2e-16 | *** |
| as.factor(year)1985:as.factor(area)2 | -0.609180 | 0.053144 | -11.463 | < 2e-16 | *** |
| as.factor(year)1986:as.factor(area)2 | -0.881801 | 0.053952 | -16.344 | < 2e-16 | *** |
| as.factor(year)1987:as.factor(area)2 | -1.108363 | 0.053307 | -20.792 | < 2e-16 | *** |
| as.factor(year)1988:as.factor(area)2 | -1.010171 | 0.054946 | -18.385 | < 2e-16 | *** |
| as.factor(year)1989:as.factor(area)2 | -0.794182 | 0.061616 | -12.889 | < 2e-16 | *** |
| as.factor(year)1990:as.factor(area)2 | -1.128737 | 0.062231 | -18.138 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)2 | -0.975140 | 0.056700 | -17.198 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)2 | -0.883478 | 0.066053 | -13.375 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)2 | -1.000082 | 0.056232 | -17.785 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)3 | -0.278982 | 0.079158 | -3.524 | 0.000425 | *** |
| as.factor(year)1977:as.factor(area)3 | -0.988823 | 0.089122 | -11.095 | < 2e-16 | *** |
| as.factor(year)1978:as.factor(area)3 | -1.063085 | 0.077811 | -13.662 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)3 | -1.607292 | 0.082304 | -19.529 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)3 | -1.021473 | 0.087375 | -11.691 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)3 | -0.185090 | 0.084099 | -2.201 | 0.027746 | * |
| as.factor(year)1982:as.factor(area)3 | -0.692508 | 0.075356 | -9.190 | < 2e-16 | *** |
| as.factor(year)1983:as.factor(area)3 | -0.818925 | 0.081027 | -10.107 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)3 | -1.322925 | 0.076683 | -17.252 | < 2e-16 | *** |
| as.factor(year)1985:as.factor(area)3 | -0.956936 | 0.079334 | -12.062 | < 2e-16 | *** |
| as.factor(year)1986:as.factor(area)3 | -0.861311 | 0.076952 | -11.193 | < 2e-16 | *** |
| as.factor(year)1987:as.factor(area)3 | -0.731138 | 0.074659 | -9.793 | < 2e-16 | *** |
| as.factor(year)1988:as.factor(area)3 | -0.585144 | 0.074370 | -7.868 | 3.60e-15 | *** |
| as.factor(year)1989:as.factor(area)3 | -0.342181 | 0.078238 | -4.374 | 1.22e-05 | *** |
| as.factor(year)1990:as.factor(area)3 | -0.722356 | 0.079980 | -9.032 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)3 | -0.702244 | 0.074966 | -9.367 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)3 | -0.717561 | 0.083391 | -8.605 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)3 | -0.486419 | 0.076810 | -6.333 | 2.41e-10 | *** |
| as.factor(year)1976:as.factor(area)4 | -0.212715 | 0.061296 | -3.470 | 0.000520 | *** |
| as.factor(year)1977:as.factor(area)4 | -0.554513 | 0.059423 | -9.332 | < 2e-16 | *** |
| as.factor(year)1978:as.factor(area)4 | -0.856964 | 0.060842 | -14.085 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)4 | -1.270888 | 0.059624 | -21.315 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)4 | -0.260575 | 0.061375 | -4.246 | 2.18e-05 | *** |
| as.factor(year)1981:as.factor(area)4 | 0.422013 | 0.061382 | 6.875 | 6.19e-12 | *** |
| as.factor(year)1982:as.factor(area)4 | -0.160340 | 0.060661 | -2.643 | 0.008212 | ** |
| as.factor(year)1983:as.factor(area)4 | -0.501469 | 0.061584 | -8.143 | 3.86e-16 | *** |
| as.factor(year)1984:as.factor(area)4 | -0.929680 | 0.058804 | -15.810 | < 2e-16 | *** |

| | | | | | |
|---|---|---|---|---|---|
| as.factor(year)1985:as.factor(area)4 | -0.480889 | 0.062941 | -7.640 | 2.17e-14 | *** |
| as.factor(year)1986:as.factor(area)4 | -0.325561 | 0.062954 | -5.171 | 2.32e-07 | *** |
| as.factor(year)1987:as.factor(area)4 | -0.279339 | 0.061419 | -4.548 | 5.41e-06 | *** |
| as.factor(year)1988:as.factor(area)4 | -0.320093 | 0.061921 | -5.169 | 2.35e-07 | *** |
| as.factor(year)1989:as.factor(area)4 | -0.215498 | 0.068036 | -3.167 | 0.001538 | ** |
| as.factor(year)1990:as.factor(area)4 | -0.591254 | 0.069298 | -8.532 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)4 | -0.366488 | 0.064182 | -5.710 | 1.13e-08 | *** |
| as.factor(year)1992:as.factor(area)4 | -0.266939 | 0.073057 | -3.654 | 0.000258 | *** |
| as.factor(year)1993:as.factor(area)4 | -0.414818 | 0.064756 | -6.406 | 1.50e-10 | *** |
| as.factor(year)1976:as.factor(area)5 | -0.344797 | 0.056193 | -6.136 | 8.46e-10 | *** |
| as.factor(year)1977:as.factor(area)5 | -0.892486 | 0.054620 | -16.340 | < 2e-16 | *** |
| as.factor(year)1978:as.factor(area)5 | -1.280167 | 0.057323 | -22.333 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)5 | -1.515120 | 0.055730 | -27.187 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)5 | -0.082579 | 0.055780 | -1.480 | 0.138757 | |
| as.factor(year)1981:as.factor(area)5 | 0.435857 | 0.056515 | 7.712 | 1.24e-14 | *** |
| as.factor(year)1982:as.factor(area)5 | -0.100491 | 0.058173 | -1.727 | 0.084084 | . |
| as.factor(year)1983:as.factor(area)5 | -0.304359 | 0.059095 | -5.150 | 2.60e-07 | *** |
| as.factor(year)1984:as.factor(area)5 | -0.536566 | 0.055798 | -9.616 | < 2e-16 | *** |
| as.factor(year)1985:as.factor(area)5 | -0.109468 | 0.060578 | -1.807 | 0.070752 | . |
| as.factor(year)1986:as.factor(area)5 | -0.259053 | 0.058945 | -4.395 | 1.11e-05 | *** |
| as.factor(year)1987:as.factor(area)5 | -0.456798 | 0.058080 | -7.865 | 3.69e-15 | *** |
| as.factor(year)1988:as.factor(area)5 | -0.398494 | 0.059238 | -6.727 | 1.73e-11 | *** |
| as.factor(year)1989:as.factor(area)5 | -0.177034 | 0.067625 | -2.618 | 0.008848 | ** |
| as.factor(year)1990:as.factor(area)5 | -0.320181 | 0.069341 | -4.618 | 3.88e-06 | *** |
| as.factor(year)1991:as.factor(area)5 | -0.413440 | 0.061528 | -6.720 | 1.82e-11 | *** |
| as.factor(year)1992:as.factor(area)5 | -0.017428 | 0.071542 | -0.244 | 0.807536 | |
| as.factor(year)1993:as.factor(area)5 | -0.286959 | 0.061723 | -4.649 | 3.33e-06 | *** |
| as.factor(year)1976:as.factor(area)6 | 0.001341 | 0.066382 | 0.020 | 0.983877 | |
| as.factor(year)1977:as.factor(area)6 | -0.627876 | 0.065996 | -9.514 | < 2e-16 | *** |
| as.factor(year)1978:as.factor(area)6 | -0.148470 | 0.066573 | -2.230 | 0.025734 | * |
| as.factor(year)1979:as.factor(area)6 | -0.381271 | 0.064818 | -5.882 | 4.05e-09 | *** |
| as.factor(year)1980:as.factor(area)6 | 1.487808 | 0.064819 | 22.953 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)6 | 1.983544 | 0.065906 | 30.097 | < 2e-16 | *** |
| as.factor(year)1982:as.factor(area)6 | 1.319630 | 0.066323 | 19.897 | < 2e-16 | *** |
| as.factor(year)1983:as.factor(area)6 | 0.976645 | 0.066806 | 14.619 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)6 | 0.500118 | 0.063785 | 7.841 | 4.48e-15 | *** |
| as.factor(year)1985:as.factor(area)6 | 0.799307 | 0.066986 | 11.932 | < 2e-16 | *** |
| as.factor(year)1986:as.factor(area)6 | 0.904718 | 0.068322 | 13.242 | < 2e-16 | *** |
| as.factor(year)1987:as.factor(area)6 | 0.794905 | 0.066320 | 11.986 | < 2e-16 | *** |
| as.factor(year)1988:as.factor(area)6 | 0.866658 | 0.066461 | 13.040 | < 2e-16 | *** |
| as.factor(year)1989:as.factor(area)6 | 1.028173 | 0.072133 | 14.254 | < 2e-16 | *** |
| as.factor(year)1990:as.factor(area)6 | 0.612333 | 0.073220 | 8.363 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)6 | 0.442114 | 0.068353 | 6.468 | 9.92e-11 | *** |
| as.factor(year)1992:as.factor(area)6 | 0.401394 | 0.077941 | 5.150 | 2.61e-07 | *** |
| as.factor(year)1993:as.factor(area)6 | -0.247056 | 0.069777 | -3.541 | 0.000399 | *** |
| as.factor(year)1976:as.factor(area)7 | 0.619049 | 0.095846 | 6.459 | 1.06e-10 | *** |
| as.factor(year)1977:as.factor(area)7 | 0.325117 | 0.091468 | 3.554 | 0.000379 | *** |
| as.factor(year)1978:as.factor(area)7 | 0.638283 | 0.087343 | 7.308 | 2.72e-13 | *** |
| as.factor(year)1979:as.factor(area)7 | 1.031247 | 0.084052 | 12.269 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)7 | 2.233803 | 0.086370 | 25.863 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)7 | 3.213285 | 0.087692 | 36.643 | < 2e-16 | *** |
| as.factor(year)1982:as.factor(area)7 | 2.798236 | 0.088915 | 31.471 | < 2e-16 | *** |
| as.factor(year)1983:as.factor(area)7 | 2.899349 | 0.084601 | 34.271 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)7 | 2.192821 | 0.080693 | 27.175 | < 2e-16 | *** |
| as.factor(year)1985:as.factor(area)7 | 2.430140 | 0.085288 | 28.493 | < 2e-16 | *** |
| as.factor(year)1986:as.factor(area)7 | 1.912107 | 0.088246 | 21.668 | < 2e-16 | *** |
| as.factor(year)1987:as.factor(area)7 | 2.721226 | 0.084031 | 32.384 | < 2e-16 | *** |
| as.factor(year)1988:as.factor(area)7 | 3.180124 | 0.084312 | 37.719 | < 2e-16 | *** |
| as.factor(year)1989:as.factor(area)7 | 2.286898 | 0.088098 | 25.959 | < 2e-16 | *** |
| as.factor(year)1990:as.factor(area)7 | 1.926976 | 0.089829 | 21.452 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)7 | 1.970765 | 0.085834 | 22.960 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)7 | 2.002487 | 0.092011 | 21.764 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)7 | 1.576093 | 0.087916 | 17.927 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)8 | -1.377730 | 0.226690 | -6.078 | 1.22e-09 | *** |
| as.factor(year)1977:as.factor(area)8 | -0.769211 | 0.227869 | -3.376 | 0.000736 | *** |
| as.factor(year)1978:as.factor(area)8 | -0.578432 | 0.201172 | -2.875 | 0.004036 | ** |
| as.factor(year)1979:as.factor(area)8 | -1.399291 | 0.207136 | -6.755 | 1.42e-11 | *** |
| as.factor(year)1980:as.factor(area)8 | 1.532843 | 0.226121 | 6.779 | 1.21e-11 | *** |
| as.factor(year)1981:as.factor(area)8 | 0.845427 | 0.221889 | 3.810 | 0.000139 | *** |
| as.factor(year)1982:as.factor(area)8 | -0.565594 | 0.261243 | -2.165 | 0.030387 | * |
| as.factor(year)1983:as.factor(area)8 | -0.780104 | 0.248486 | -3.139 | 0.001693 | ** |
| as.factor(year)1984:as.factor(area)8 | -0.243253 | 0.205891 | -1.181 | 0.237417 | |
| as.factor(year)1985:as.factor(area)8 | -0.440887 | 0.229265 | -1.923 | 0.054475 | . |
| as.factor(year)1986:as.factor(area)8 | -0.837116 | 0.216494 | -3.867 | 0.000110 | *** |
| as.factor(year)1987:as.factor(area)8 | -0.695172 | 0.256683 | -2.708 | 0.006763 | ** |
| as.factor(year)1988:as.factor(area)8 | -0.271817 | 0.217143 | -1.252 | 0.210647 | |
| as.factor(year)1989:as.factor(area)8 | 0.013772 | 0.213949 | 0.064 | 0.948673 | |
| as.factor(year)1990:as.factor(area)8 | 0.184498 | 0.213986 | 0.862 | 0.388579 | |
| as.factor(year)1991:as.factor(area)8 | 0.357453 | 0.210222 | 1.700 | 0.089063 | . |
| as.factor(year)1992:as.factor(area)8 | 0.038429 | 0.205961 | 0.187 | 0.851986 | |
| as.factor(year)1993:as.factor(area)8 | -0.036313 | 0.205664 | -0.177 | 0.859850 | |
| as.factor(year)1976:as.factor(area)9 | -0.431950 | 0.086945 | -4.968 | 6.76e-07 | *** |
| as.factor(year)1977:as.factor(area)9 | -0.033403 | 0.086595 | -0.386 | 0.699689 | |
| as.factor(year)1978:as.factor(area)9 | -0.420905 | 0.089207 | -4.718 | 2.38e-06 | *** |
| as.factor(year)1979:as.factor(area)9 | -1.478992 | 0.091891 | -16.095 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)9 | -0.515452 | 0.113869 | -4.527 | 5.99e-06 | *** |
| as.factor(year)1981:as.factor(area)9 | 0.528406 | 0.101852 | 5.188 | 2.13e-07 | *** |
| as.factor(year)1982:as.factor(area)9 | -0.132992 | 0.108576 | -1.225 | 0.220620 | |
| as.factor(year)1983:as.factor(area)9 | -0.686568 | 0.109341 | -6.279 | 3.40e-10 | *** |
| as.factor(year)1984:as.factor(area)9 | -1.092843 | 0.098134 | -11.136 | < 2e-16 | *** |
| as.factor(year)1985:as.factor(area)9 | -0.688358 | 0.094603 | -7.276 | 3.43e-13 | *** |
| as.factor(year)1986:as.factor(area)9 | -0.688985 | 0.110412 | -6.240 | 4.37e-10 | *** |

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as.factor(year)1987:as.factor(area)9 -0.303139  0.094798  -3.198 0.001385 **
as.factor(year)1988:as.factor(area)9 -0.371310  0.087703  -4.234 2.30e-05 ***
as.factor(year)1989:as.factor(area)9  0.115441  0.090948   1.269 0.204329
as.factor(year)1990:as.factor(area)9 -0.284290  0.097692  -2.910 0.003613 **
as.factor(year)1991:as.factor(area)9  0.193767  0.092892   2.086 0.036985 *
as.factor(year)1992:as.factor(area)9  0.050801  0.099519   0.510 0.609726
as.factor(year)1993:as.factor(area)9 -0.197471  0.095120  -2.076 0.037891 *
as.factor(year)1976:as.factor(qt)2     0.245860  0.043851   5.607 2.06e-08 ***
as.factor(year)1977:as.factor(qt)2     0.296488  0.041603   7.127 1.03e-12 ***
as.factor(year)1978:as.factor(qt)2     0.183728  0.041955   4.379 1.19e-05 ***
as.factor(year)1979:as.factor(qt)2     0.208720  0.041390   5.043 4.59e-07 ***
as.factor(year)1980:as.factor(qt)2     0.179396  0.043138   4.159 3.20e-05 ***
as.factor(year)1981:as.factor(qt)2     0.323881  0.040473   8.002 1.22e-15 ***
as.factor(year)1982:as.factor(qt)2     0.529979  0.042538  12.459  < 2e-16 ***
as.factor(year)1983:as.factor(qt)2     0.284387  0.041330   6.881 5.95e-12 ***
as.factor(year)1984:as.factor(qt)2     0.085244  0.041299   2.064 0.039014 *
as.factor(year)1985:as.factor(qt)2     0.194614  0.040940   4.754 2.00e-06 ***
as.factor(year)1986:as.factor(qt)2     0.114693  0.040479   2.833 0.004605 **
as.factor(year)1987:as.factor(qt)2    -0.014146  0.041290  -0.343 0.731904
as.factor(year)1988:as.factor(qt)2     0.015193  0.041442   0.367 0.713905
as.factor(year)1989:as.factor(qt)2    -0.021946  0.041848  -0.524 0.599989
as.factor(year)1990:as.factor(qt)2    -0.029255  0.043120  -0.678 0.497488
as.factor(year)1991:as.factor(qt)2    -0.055624  0.043110  -1.290 0.196951
as.factor(year)1992:as.factor(qt)2    -0.102975  0.044032  -2.339 0.019355 *
as.factor(year)1993:as.factor(qt)2     0.057729  0.043264   1.334 0.182092
as.factor(year)1976:as.factor(qt)3     0.271023  0.048045   5.641 1.69e-08 ***
as.factor(year)1977:as.factor(qt)3    -0.051780  0.047112  -1.099 0.271728
as.factor(year)1978:as.factor(qt)3    -0.118493  0.047578  -2.490 0.012757 *
as.factor(year)1979:as.factor(qt)3    -0.006142  0.047137  -0.130 0.896337
as.factor(year)1980:as.factor(qt)3     0.303578  0.049829   6.092 1.11e-09 ***
as.factor(year)1981:as.factor(qt)3     0.023488  0.047555   0.494 0.621377
as.factor(year)1982:as.factor(qt)3     0.332979  0.049499   6.727 1.73e-11 ***
as.factor(year)1983:as.factor(qt)3     0.156223  0.049164   3.178 0.001485 **
as.factor(year)1984:as.factor(qt)3     0.074885  0.046507   1.610 0.107361
as.factor(year)1985:as.factor(qt)3     0.278705  0.046641   5.976 2.29e-09 ***
as.factor(year)1986:as.factor(qt)3     0.326276  0.047542   6.863 6.75e-12 ***
as.factor(year)1987:as.factor(qt)3     0.215462  0.048309   4.460 8.19e-06 ***
as.factor(year)1988:as.factor(qt)3     0.043415  0.047952   0.905 0.365254
as.factor(year)1989:as.factor(qt)3    -0.228476  0.049907  -4.578 4.69e-06 ***
as.factor(year)1990:as.factor(qt)3    -0.130364  0.051766  -2.518 0.011791 *
as.factor(year)1991:as.factor(qt)3     0.091742  0.050233   1.826 0.067798 .
as.factor(year)1992:as.factor(qt)3     0.155400  0.050103   3.102 0.001925 **
as.factor(year)1993:as.factor(qt)3     0.271697  0.050339   5.397 6.76e-08 ***
as.factor(year)1976:as.factor(qt)4     0.069654  0.031481   2.213 0.026928 *
as.factor(year)1977:as.factor(qt)4     0.258877  0.031566   8.201 2.38e-16 ***
as.factor(year)1978:as.factor(qt)4    -0.142554  0.031824  -4.479 7.49e-06 ***
as.factor(year)1979:as.factor(qt)4    -0.100545  0.031929  -3.149 0.001638 **
as.factor(year)1980:as.factor(qt)4     0.013615  0.032305   0.421 0.673416
as.factor(year)1981:as.factor(qt)4    -0.166296  0.030711  -5.415 6.13e-08 ***
as.factor(year)1982:as.factor(qt)4     0.594030  0.031817  18.670  < 2e-16 ***
as.factor(year)1983:as.factor(qt)4     0.182730  0.031387   5.822 5.82e-09 ***
as.factor(year)1984:as.factor(qt)4     0.021210  0.030697   0.691 0.489591
as.factor(year)1985:as.factor(qt)4     0.106437  0.031183   3.413 0.000642 ***
as.factor(year)1986:as.factor(qt)4     0.163888  0.031744   5.163 2.43e-07 ***
as.factor(year)1987:as.factor(qt)4     0.187874  0.032188   5.837 5.32e-09 ***
as.factor(year)1988:as.factor(qt)4     0.026617  0.032046   0.831 0.406197
as.factor(year)1989:as.factor(qt)4    -0.420579  0.033417 -12.586  < 2e-16 ***
as.factor(year)1990:as.factor(qt)4    -0.091307  0.034234  -2.667 0.007650 **
as.factor(year)1991:as.factor(qt)4     0.141934  0.034380   4.128 3.65e-05 ***
as.factor(year)1992:as.factor(qt)4     0.016641  0.034856   0.477 0.633063
as.factor(year)1993:as.factor(qt)4     0.087172  0.035069   2.486 0.012928 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for Negative Binomial(0.7259) family taken to be 1)

    Null deviance: 1047023  on 685661  degrees of freedom
Residual deviance:  639702  on 685430  degrees of freedom
AIC: 2361082

Number of Fisher Scoring iterations: 1


              Theta:  0.72593
          Std. Err.:  0.00224

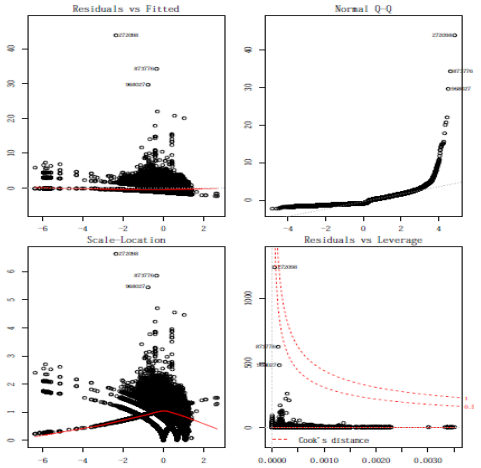
 2 x log-likelihood:  -2360616.18100
```

**WCNPO for the period between 1994 and 2012, fitted negative binomial GLM to the operational data**

| | Df | Deviance | Resid. Df | Resid. Dev | Pr(>Chi) | |
|---|---|---|---|---|---|---|
| NULL | | | 327110 | 703485 | | |
| as.factor(year) | 18 | 4908 | 327092 | 698577 | < 2.2e-16 | *** |
| as.factor(qt) | 3 | 28693 | 327089 | 669884 | < 2.2e-16 | *** |
| as.factor(ar09) | 8 | 201083 | 327081 | 468801 | < 2.2e-16 | *** |
| as.factor(gear) | 4 | 153538 | 327077 | 315263 | < 2.2e-16 | *** |
| as.factor(year):as.factor(ar09) | 144 | 8511 | 326933 | 306752 | < 2.2e-16 | *** |
| as.factor(year):as.factor(qt) | 54 | 6090 | 326879 | 300662 | < 2.2e-16 | *** |

Call:

```
glm.nb(formula = nswo ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(gear) + as.factor(year) * as.factor(area) + as.factor(year) *
    as.factor(qt) + offset(log(hooks)), data = owcpo2, init.theta = 1.375492183,
    link = log)
```




Deviance Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -2.6661 | -0.8404 | -0.5875 | 0.1511 | 16.5541 |

Coefficients:

| | Estimate | Std. Error | z value | Pr(>\|z\|) | |
|---|---|---|---|---|---|
| (Intercept) | -5.8232823 | 0.0328136 | -177.465 | < 2e-16 | *** |
| as.factor(year)1995 | 0.0100404 | 0.0501156 | 0.200 | 0.841212 | |
| as.factor(year)1996 | -0.3129251 | 0.0503008 | -6.221 | 4.94e-10 | *** |
| as.factor(year)1997 | 0.1781391 | 0.0490321 | 3.633 | 0.000280 | *** |
| as.factor(year)1998 | -0.4723621 | 0.0586290 | -8.057 | 7.83e-16 | *** |
| as.factor(year)1999 | -0.8130371 | 0.0527471 | -15.414 | < 2e-16 | *** |
| as.factor(year)2000 | -0.4953750 | 0.0467436 | -10.598 | < 2e-16 | *** |
| as.factor(year)2001 | -0.8259593 | 0.0487072 | -16.958 | < 2e-16 | *** |
| as.factor(year)2002 | -0.8986029 | 0.0552607 | -16.261 | < 2e-16 | *** |
| as.factor(year)2003 | -0.2602158 | 0.0543624 | -4.787 | 1.70e-06 | *** |
| as.factor(year)2004 | -0.6864449 | 0.0555147 | -12.365 | < 2e-16 | *** |
| as.factor(year)2005 | -0.8629553 | 0.0639611 | -13.492 | < 2e-16 | *** |
| as.factor(year)2006 | -0.4465171 | 0.0540618 | -8.259 | < 2e-16 | *** |
| as.factor(year)2007 | 0.0962700 | 0.0476769 | 2.019 | 0.043464 | * |
| as.factor(year)2008 | -0.3422313 | 0.0499234 | -6.855 | 7.13e-12 | *** |
| as.factor(year)2009 | -0.3691042 | 0.0483024 | -7.642 | 2.15e-14 | *** |
| as.factor(year)2010 | -0.5752260 | 0.0561216 | -10.250 | < 2e-16 | *** |
| as.factor(year)2011 | -0.8543044 | 0.0716125 | -11.930 | < 2e-16 | *** |
| as.factor(year)2012 | -0.3586575 | 0.0658861 | -5.444 | 5.22e-08 | *** |
| as.factor(qt)2 | -0.4130170 | 0.0231947 | -17.807 | < 2e-16 | *** |
| as.factor(qt)3 | -0.7562110 | 0.0297185 | -25.446 | < 2e-16 | *** |
| as.factor(qt)4 | -0.5168596 | 0.0225508 | -22.920 | < 2e-16 | *** |
| as.factor(area)2 | 0.4152604 | 0.0318513 | 13.037 | < 2e-16 | *** |
| as.factor(area)3 | -0.0954373 | 0.0361657 | -2.639 | 0.008318 | ** |
| as.factor(area)4 | 0.1867974 | 0.0358606 | 5.209 | 1.90e-07 | *** |
| as.factor(area)5 | -0.3929074 | 0.0390695 | -10.057 | < 2e-16 | *** |
| as.factor(area)6 | -0.0127760 | 0.0392772 | -0.325 | 0.744971 | |
| as.factor(area)7 | -0.7268279 | 0.0426451 | -17.044 | < 2e-16 | *** |
| as.factor(area)8 | -1.3229747 | 0.0627182 | -21.094 | < 2e-16 | *** |
| as.factor(area)9 | -0.2075746 | 0.0553842 | -3.748 | 0.000178 | *** |
| as.factor(gear)2 | -0.4027197 | 0.0181012 | -22.248 | < 2e-16 | *** |
| as.factor(gear)3 | -1.3264416 | 0.0169246 | -78.374 | < 2e-16 | *** |
| as.factor(gear)4 | -2.2865163 | 0.0073197 | -312.378 | < 2e-16 | *** |
| as.factor(gear)5 | -2.7541139 | 0.0150432 | -183.080 | < 2e-16 | *** |
| as.factor(year)1995:as.factor(area)2 | -0.3080390 | 0.0488375 | -6.307 | 2.84e-10 | *** |
| as.factor(year)1996:as.factor(area)2 | 0.0739535 | 0.0496964 | 1.488 | 0.136723 | |
| as.factor(year)1997:as.factor(area)2 | -0.4539783 | 0.0481951 | -9.420 | < 2e-16 | *** |
| as.factor(year)1998:as.factor(area)2 | 0.0940650 | 0.0580236 | 1.621 | 0.104986 | |
| as.factor(year)1999:as.factor(area)2 | 0.4158074 | 0.0535082 | 7.771 | 7.79e-15 | *** |
| as.factor(year)2000:as.factor(area)2 | 0.2983214 | 0.0453164 | 6.583 | 4.61e-11 | *** |
| as.factor(year)2001:as.factor(area)2 | 0.4226586 | 0.0486017 | 8.696 | < 2e-16 | *** |
| as.factor(year)2002:as.factor(area)2 | 0.1667069 | 0.0569184 | 2.929 | 0.003402 | ** |
| as.factor(year)2003:as.factor(area)2 | -0.5853297 | 0.0567058 | -10.322 | < 2e-16 | *** |
| as.factor(year)2004:as.factor(area)2 | 0.2711217 | 0.0562985 | 4.816 | 1.47e-06 | *** |
| as.factor(year)2005:as.factor(area)2 | 0.7464691 | 0.0637223 | 11.714 | < 2e-16 | *** |
| as.factor(year)2006:as.factor(area)2 | 0.3369834 | 0.0549742 | 6.130 | 8.80e-10 | *** |
| as.factor(year)2007:as.factor(area)2 | -0.3160461 | 0.0468901 | -6.740 | 1.58e-11 | *** |
| as.factor(year)2008:as.factor(area)2 | -0.2712431 | 0.0521884 | -5.197 | 2.02e-07 | *** |
| as.factor(year)2009:as.factor(area)2 | -0.3603650 | 0.0510507 | -7.059 | 1.68e-12 | *** |
| as.factor(year)2010:as.factor(area)2 | -0.1954098 | 0.0572970 | -3.410 | 0.000649 | *** |
| as.factor(year)2011:as.factor(area)2 | -0.0978185 | 0.0728200 | -1.343 | 0.179177 | |
| as.factor(year)2012:as.factor(area)2 | -0.3117394 | 0.0647095 | -4.818 | 1.45e-06 | *** |
| as.factor(year)1995:as.factor(area)3 | -0.0655014 | 0.0547737 | -1.196 | 0.231754 | |
| as.factor(year)1996:as.factor(area)3 | -0.0419484 | 0.0579024 | -0.724 | 0.468779 | |
| as.factor(year)1997:as.factor(area)3 | -0.0405033 | 0.0545185 | -0.743 | 0.457526 | |
| as.factor(year)1998:as.factor(area)3 | 0.4282282 | 0.0610323 | 7.016 | 2.28e-12 | *** |
| as.factor(year)1999:as.factor(area)3 | 0.2834215 | 0.0556636 | 5.092 | 3.55e-07 | *** |
| as.factor(year)2000:as.factor(area)3 | 0.1783096 | 0.0498551 | 3.577 | 0.000348 | *** |
| as.factor(year)2001:as.factor(area)3 | 0.3436476 | 0.0508066 | 6.764 | 1.34e-11 | *** |
| as.factor(year)2002:as.factor(area)3 | -0.1039663 | 0.0577084 | -1.802 | 0.071611 | . |
| as.factor(year)2003:as.factor(area)3 | -0.2509587 | 0.0563161 | -4.456 | 8.34e-06 | *** |
| as.factor(year)2004:as.factor(area)3 | -0.0193477 | 0.0578648 | -0.334 | 0.738107 | |
| as.factor(year)2005:as.factor(area)3 | 0.7744248 | 0.0647142 | 11.967 | < 2e-16 | *** |
| as.factor(year)2006:as.factor(area)3 | 0.7450716 | 0.0552648 | 13.482 | < 2e-16 | *** |
| as.factor(year)2007:as.factor(area)3 | 0.0989762 | 0.0534773 | 1.851 | 0.064197 | . |
| as.factor(year)2008:as.factor(area)3 | 0.6456259 | 0.0541111 | 11.931 | < 2e-16 | *** |
| as.factor(year)2009:as.factor(area)3 | -0.1346420 | 0.0536242 | -2.511 | 0.012044 | * |
| as.factor(year)2010:as.factor(area)3 | 0.5855622 | 0.0561162 | 10.435 | < 2e-16 | *** |
| as.factor(year)2011:as.factor(area)3 | 0.3477407 | 0.0670720 | 5.185 | 2.16e-07 | *** |
| as.factor(year)2012:as.factor(area)3 | 0.5448563 | 0.0645762 | 8.437 | < 2e-16 | *** |
| as.factor(year)1995:as.factor(area)4 | 0.0416839 | 0.0526374 | 0.792 | 0.428415 | |
| as.factor(year)1996:as.factor(area)4 | 0.1391688 | 0.0536309 | 2.595 | 0.009461 | ** |
| as.factor(year)1997:as.factor(area)4 | -0.3203970 | 0.0503964 | -6.358 | 2.05e-10 | *** |
| as.factor(year)1998:as.factor(area)4 | 0.0530265 | 0.0592931 | 0.894 | 0.371155 | |
| as.factor(year)1999:as.factor(area)4 | 0.2949379 | 0.0547191 | 5.390 | 7.04e-08 | *** |
| as.factor(year)2000:as.factor(area)4 | 0.1420556 | 0.0506421 | 2.805 | 0.005030 | ** |
| as.factor(year)2001:as.factor(area)4 | 0.3421966 | 0.0507124 | 6.748 | 1.50e-11 | *** |
| as.factor(year)2002:as.factor(area)4 | 0.3616886 | 0.0566997 | 6.379 | 1.78e-10 | *** |
| as.factor(year)2003:as.factor(area)4 | -0.0952331 | 0.0576259 | -1.653 | 0.098411 | . |

| | | | | |
|---|---|---|---|---|
| as.factor(year)2004:as.factor(area)4 | 0.0249110 | 0.0592127 | 0.421 | 0.673971 |
| as.factor(year)2005:as.factor(area)4 | 0.7144384 | 0.0661964 | 10.793 | < 2e-16 *** |
| as.factor(year)2006:as.factor(area)4 | 0.4606751 | 0.0574663 | 8.016 | 1.09e-15 *** |
| as.factor(year)2007:as.factor(area)4 | -0.1203392 | 0.0514410 | -2.339 | 0.019317 * |
| as.factor(year)2008:as.factor(area)4 | 0.2499686 | 0.0545489 | 4.582 | 4.60e-06 *** |
| as.factor(year)2009:as.factor(area)4 | 0.1346343 | 0.0595210 | 2.262 | 0.023700 * |
| as.factor(year)2010:as.factor(area)4 | 0.1735943 | 0.0568193 | 3.055 | 0.002249 ** |
| as.factor(year)2011:as.factor(area)4 | 0.3365056 | 0.0689943 | 4.877 | 1.08e-06 *** |
| as.factor(year)2012:as.factor(area)4 | 0.2013018 | 0.0651834 | 3.088 | 0.002013 ** |
| as.factor(year)1995:as.factor(area)5 | -0.2300035 | 0.0577967 | -3.980 | 6.91e-05 *** |
| as.factor(year)1996:as.factor(area)5 | 0.0423656 | 0.0590970 | 0.717 | 0.473446 |
| as.factor(year)1997:as.factor(area)5 | -0.7220615 | 0.0659775 | -10.944 | < 2e-16 *** |
| as.factor(year)1998:as.factor(area)5 | -0.0006334 | 0.0676236 | -0.009 | 0.992526 |
| as.factor(year)1999:as.factor(area)5 | 0.0614856 | 0.0633291 | 0.971 | 0.331603 |
| as.factor(year)2000:as.factor(area)5 | 0.0060180 | 0.0568846 | 0.106 | 0.915747 |
| as.factor(year)2001:as.factor(area)5 | 0.2856507 | 0.0578142 | 4.941 | 7.78e-07 *** |
| as.factor(year)2002:as.factor(area)5 | 0.2809511 | 0.0691430 | 4.063 | 4.84e-05 *** |
| as.factor(year)2003:as.factor(area)5 | -0.1605749 | 0.0635817 | -2.525 | 0.011554 * |
| as.factor(year)2004:as.factor(area)5 | 0.4756693 | 0.0741027 | 6.419 | 1.37e-10 *** |
| as.factor(year)2005:as.factor(area)5 | 0.2293500 | 0.0844795 | 2.715 | 0.006630 ** |
| as.factor(year)2006:as.factor(area)5 | -0.0232152 | 0.0809006 | -0.287 | 0.774143 |
| as.factor(year)2007:as.factor(area)5 | -0.0501866 | 0.0660624 | -0.760 | 0.447443 |
| as.factor(year)2008:as.factor(area)5 | 0.3808276 | 0.0671340 | 5.673 | 1.41e-08 *** |
| as.factor(year)2009:as.factor(area)5 | -0.3336725 | 0.0694165 | -4.807 | 1.53e-06 *** |
| as.factor(year)2010:as.factor(area)5 | -0.1518268 | 0.0783244 | -1.938 | 0.052570 . |
| as.factor(year)2011:as.factor(area)5 | -0.3487298 | 0.0890582 | -3.916 | 9.01e-05 *** |
| as.factor(year)2012:as.factor(area)5 | -0.4232617 | 0.0801806 | -5.279 | 1.30e-07 *** |
| as.factor(year)1995:as.factor(area)6 | -0.5747299 | 0.0638880 | -8.996 | < 2e-16 *** |
| as.factor(year)1996:as.factor(area)6 | -0.1518094 | 0.0624507 | -2.431 | 0.015063 * |
| as.factor(year)1997:as.factor(area)6 | -0.5050135 | 0.0598642 | -8.436 | < 2e-16 *** |
| as.factor(year)1998:as.factor(area)6 | 0.0803729 | 0.0690691 | 1.164 | 0.244562 |
| as.factor(year)1999:as.factor(area)6 | 0.7472324 | 0.0601893 | 12.415 | < 2e-16 *** |
| as.factor(year)2000:as.factor(area)6 | -0.0399631 | 0.0595117 | -0.672 | 0.501891 |
| as.factor(year)2001:as.factor(area)6 | 0.6076017 | 0.0551874 | 11.010 | < 2e-16 *** |
| as.factor(year)2002:as.factor(area)6 | 0.8114928 | 0.0594242 | 13.656 | < 2e-16 *** |
| as.factor(year)2003:as.factor(area)6 | 0.3494083 | 0.0551593 | 6.335 | 2.38e-10 *** |
| as.factor(year)2004:as.factor(area)6 | 0.5850214 | 0.0577171 | 10.136 | < 2e-16 *** |
| as.factor(year)2005:as.factor(area)6 | 0.8810033 | 0.0660876 | 13.331 | < 2e-16 *** |
| as.factor(year)2006:as.factor(area)6 | 0.7074250 | 0.0557324 | 12.693 | < 2e-16 *** |
| as.factor(year)2007:as.factor(area)6 | -0.0216726 | 0.0537011 | -0.404 | 0.686523 |
| as.factor(year)2008:as.factor(area)6 | 0.8498223 | 0.0567752 | 14.968 | < 2e-16 *** |
| as.factor(year)2009:as.factor(area)6 | 0.1938345 | 0.0573503 | 3.380 | 0.000725 *** |
| as.factor(year)2010:as.factor(area)6 | 0.7732746 | 0.0593308 | 13.033 | < 2e-16 *** |
| as.factor(year)2011:as.factor(area)6 | 0.2460458 | 0.0748031 | 3.289 | 0.001005 ** |
| as.factor(year)2012:as.factor(area)6 | 0.1485762 | 0.0841764 | 1.765 | 0.077554 . |
| as.factor(year)1995:as.factor(area)7 | -0.1666025 | 0.0637815 | -2.612 | 0.008999 ** |
| as.factor(year)1996:as.factor(area)7 | 0.2898722 | 0.0648218 | 4.472 | 7.76e-06 *** |
| as.factor(year)1997:as.factor(area)7 | -0.2583333 | 0.0681637 | -3.790 | 0.000151 *** |
| as.factor(year)1998:as.factor(area)7 | 0.3955290 | 0.0737892 | 5.360 | 8.31e-08 *** |
| as.factor(year)1999:as.factor(area)7 | 0.7012061 | 0.0634602 | 11.050 | < 2e-16 *** |
| as.factor(year)2000:as.factor(area)7 | 0.0025793 | 0.0777036 | 0.033 | 0.973520 |
| as.factor(year)2001:as.factor(area)7 | 0.0615632 | 0.1746961 | 0.352 | 0.724537 |
| as.factor(year)2002:as.factor(area)7 | 0.3437721 | 0.0859722 | 3.999 | 6.37e-05 *** |
| as.factor(year)2003:as.factor(area)7 | 0.3277388 | 0.0656687 | 4.991 | 6.01e-07 *** |
| as.factor(year)2004:as.factor(area)7 | 0.3841134 | 0.0965008 | 3.980 | 6.88e-05 *** |
| as.factor(year)2005:as.factor(area)7 | 1.3450868 | 0.0736554 | 18.262 | < 2e-16 *** |
| as.factor(year)2006:as.factor(area)7 | 1.0729569 | 0.0718396 | 14.935 | < 2e-16 *** |
| as.factor(year)2007:as.factor(area)7 | 0.5970746 | 0.0735712 | 8.116 | 4.83e-16 *** |
| as.factor(year)2008:as.factor(area)7 | 0.5867750 | 0.0951790 | 6.165 | 7.05e-10 *** |
| as.factor(year)2009:as.factor(area)7 | 0.6816601 | 0.0881043 | 7.737 | 1.02e-14 *** |
| as.factor(year)2010:as.factor(area)7 | 1.1281382 | 0.0976228 | 11.556 | < 2e-16 *** |
| as.factor(year)2011:as.factor(area)7 | 0.2288947 | 0.0990392 | 2.311 | 0.020824 * |
| as.factor(year)2012:as.factor(area)7 | 0.3354919 | 0.1721477 | 1.949 | 0.051312 . |
| as.factor(year)1995:as.factor(area)8 | -0.4989136 | 0.1021693 | -4.883 | 1.04e-06 *** |
| as.factor(year)1996:as.factor(area)8 | -0.4931453 | 0.1400214 | -3.522 | 0.000428 *** |
| as.factor(year)1997:as.factor(area)8 | -0.9109763 | 0.1669980 | -5.455 | 4.90e-08 *** |
| as.factor(year)1998:as.factor(area)8 | 0.5559907 | 0.1349601 | 4.120 | 3.79e-05 *** |
| as.factor(year)1999:as.factor(area)8 | 0.4683592 | 0.1030242 | 4.546 | 5.46e-06 *** |
| as.factor(year)2000:as.factor(area)8 | 0.3352939 | 0.1033398 | 3.245 | 0.001176 ** |
| as.factor(year)2001:as.factor(area)8 | 0.5598386 | 0.1210794 | 4.624 | 3.77e-06 *** |
| as.factor(year)2002:as.factor(area)8 | 0.4589895 | 0.1157681 | 3.965 | 7.35e-05 *** |
| as.factor(year)2003:as.factor(area)8 | 1.1928064 | 0.0858551 | 13.893 | < 2e-16 *** |
| as.factor(year)2004:as.factor(area)8 | 0.2679359 | 0.1365425 | 1.962 | 0.049729 * |
| as.factor(year)2005:as.factor(area)8 | 1.1346596 | 0.1060841 | 10.696 | < 2e-16 *** |
| as.factor(year)2006:as.factor(area)8 | 0.2570933 | 0.1119977 | 2.296 | 0.021703 * |
| as.factor(year)2007:as.factor(area)8 | -0.7267876 | 0.3235099 | -2.247 | 0.024668 * |
| as.factor(year)2008:as.factor(area)8 | 0.4856391 | 0.2578593 | 1.883 | 0.059653 . |
| as.factor(year)2009:as.factor(area)8 | -0.4520743 | 0.1484172 | -3.046 | 0.002319 ** |
| as.factor(year)2010:as.factor(area)8 | 0.3861198 | 0.1369499 | 2.819 | 0.004811 ** |
| as.factor(year)2011:as.factor(area)8 | 1.3010273 | 0.1360826 | 9.561 | < 2e-16 *** |
| as.factor(year)2012:as.factor(area)8 | -0.1948786 | 0.3938994 | -0.495 | 0.620782 |
| as.factor(year)1995:as.factor(area)9 | 0.0035425 | 0.0846347 | 0.042 | 0.966613 |
| as.factor(year)1996:as.factor(area)9 | 0.4293363 | 0.0808070 | 5.313 | 1.08e-07 *** |
| as.factor(year)1997:as.factor(area)9 | 0.0136119 | 0.0831314 | 0.164 | 0.869936 |
| as.factor(year)1998:as.factor(area)9 | 0.3492126 | 0.0831017 | 4.202 | 2.64e-05 *** |
| as.factor(year)1999:as.factor(area)9 | 1.1535654 | 0.0739086 | 15.608 | < 2e-16 *** |
| as.factor(year)2000:as.factor(area)9 | 1.2339363 | 0.0682668 | 18.075 | < 2e-16 *** |
| as.factor(year)2001:as.factor(area)9 | 1.5999772 | 0.0724128 | 22.095 | < 2e-16 *** |
| as.factor(year)2002:as.factor(area)9 | 1.4298699 | 0.0799762 | 17.879 | < 2e-16 *** |
| as.factor(year)2003:as.factor(area)9 | 0.6535464 | 0.0917364 | 7.124 | 1.05e-12 *** |
| as.factor(year)2004:as.factor(area)9 | 0.7479949 | 0.0849619 | 8.804 | < 2e-16 *** |
| as.factor(year)2005:as.factor(area)9 | 0.7301189 | 0.1610186 | 4.534 | 5.78e-06 *** |

```
as.factor(year)2006:as.factor(area)9  0.7160800  0.0948741    7.548 4.43e-14 ***
as.factor(year)2007:as.factor(area)9  0.0528692  0.0921240    0.574 0.566041
as.factor(year)2008:as.factor(area)9  1.5823896  0.1428029   11.081  < 2e-16 ***
as.factor(year)2009:as.factor(area)9  1.4714373  0.1586997    9.272  < 2e-16 ***
as.factor(year)2010:as.factor(area)9  1.5866958  0.1649854    9.617  < 2e-16 ***
as.factor(year)2011:as.factor(area)9  1.4912390  0.1197619   12.452  < 2e-16 ***
as.factor(year)2012:as.factor(area)9  1.5359631  0.1647350    9.324  < 2e-16 ***
as.factor(year)1995:as.factor(qt)2    0.0611559  0.0334176    1.830 0.067242 .
as.factor(year)1996:as.factor(qt)2    0.1515556  0.0328138    4.619 3.86e-06 ***
as.factor(year)1997:as.factor(qt)2   -0.0658881  0.0347545   -1.896 0.057985 .
as.factor(year)1998:as.factor(qt)2    0.2667212  0.0353368    7.548 4.42e-14 ***
as.factor(year)1999:as.factor(qt)2    0.1952111  0.0350583    5.568 2.57e-08 ***
as.factor(year)2000:as.factor(qt)2   -0.1644407  0.0351876   -4.673 2.96e-06 ***
as.factor(year)2001:as.factor(qt)2   -0.0931357  0.0361648   -2.575 0.010015 *
as.factor(year)2002:as.factor(qt)2    0.1139170  0.0370239    3.077 0.002092 **
as.factor(year)2003:as.factor(qt)2   -0.0789846  0.0389168   -2.030 0.042399 *
as.factor(year)2004:as.factor(qt)2   -0.3088473  0.0391891   -7.881 3.25e-15 ***
as.factor(year)2005:as.factor(qt)2   -0.5613578  0.0411912  -13.628  < 2e-16 ***
as.factor(year)2006:as.factor(qt)2   -0.2840878  0.0411017   -6.912 4.78e-12 ***
as.factor(year)2007:as.factor(qt)2   -0.1935843  0.0388803   -4.979 6.39e-07 ***
as.factor(year)2008:as.factor(qt)2   -0.8241633  0.0402260  -20.488  < 2e-16 ***
as.factor(year)2009:as.factor(qt)2   -0.5395865  0.0462905  -11.657  < 2e-16 ***
as.factor(year)2010:as.factor(qt)2   -0.6841676  0.0495934  -13.796  < 2e-16 ***
as.factor(year)2011:as.factor(qt)2    0.2796084  0.0638914    4.376 1.21e-05 ***
as.factor(year)2012:as.factor(qt)2   -0.5339077  0.0505377  -10.565  < 2e-16 ***
as.factor(year)1995:as.factor(qt)3    0.0637038  0.0428594    1.486 0.137188
as.factor(year)1996:as.factor(qt)3    0.1200547  0.0428920    2.799 0.005126 **
as.factor(year)1997:as.factor(qt)3   -0.3469920  0.0468893   -7.400 1.36e-13 ***
as.factor(year)1998:as.factor(qt)3   -0.1195704  0.0473566   -2.525 0.011573 *
as.factor(year)1999:as.factor(qt)3    0.2923218  0.0451297    6.477 9.33e-11 ***
as.factor(year)2000:as.factor(qt)3    0.3300075  0.0444306    7.427 1.11e-13 ***
as.factor(year)2001:as.factor(qt)3    0.6016498  0.0447630   13.441  < 2e-16 ***
as.factor(year)2002:as.factor(qt)3    0.8866856  0.0465255   19.058  < 2e-16 ***
as.factor(year)2003:as.factor(qt)3   -0.0933036  0.0483129   -1.931 0.053454 .
as.factor(year)2004:as.factor(qt)3    0.3009887  0.0512912    5.868 4.40e-09 ***
as.factor(year)2005:as.factor(qt)3    0.0881680  0.0508253    1.735 0.082789 .
as.factor(year)2006:as.factor(qt)3   -0.1118427  0.0495099   -2.259 0.023884 *
as.factor(year)2007:as.factor(qt)3   -0.3751222  0.0480536   -7.806 5.89e-15 ***
as.factor(year)2008:as.factor(qt)3   -0.5883076  0.0518367  -11.349  < 2e-16 ***
as.factor(year)2009:as.factor(qt)3    0.4381353  0.0557202    7.863 3.75e-15 ***
as.factor(year)2010:as.factor(qt)3    0.2918668  0.0597231    4.887 1.02e-06 ***
as.factor(year)2011:as.factor(qt)3    0.7896220  0.0689401   11.454  < 2e-16 ***
as.factor(year)2012:as.factor(qt)3   -0.1136020  0.0652745   -1.740 0.081793 .
as.factor(year)1995:as.factor(qt)4    0.1023094  0.0329140    3.108 0.001881 **
as.factor(year)1996:as.factor(qt)4    0.3014908  0.0338862    8.897  < 2e-16 ***
as.factor(year)1997:as.factor(qt)4    0.0089525  0.0344115    0.260 0.794740
as.factor(year)1998:as.factor(qt)4    0.0397087  0.0365500    1.086 0.277292
as.factor(year)1999:as.factor(qt)4    0.3781995  0.0339620   11.136  < 2e-16 ***
as.factor(year)2000:as.factor(qt)4    0.4385737  0.0336480   13.034  < 2e-16 ***
as.factor(year)2001:as.factor(qt)4    0.4274154  0.0353547   12.089  < 2e-16 ***
as.factor(year)2002:as.factor(qt)4    0.7646339  0.0350052   21.843  < 2e-16 ***
as.factor(year)2003:as.factor(qt)4    0.4843676  0.0387583   12.497  < 2e-16 ***
as.factor(year)2004:as.factor(qt)4    0.8874515  0.0365501   24.280  < 2e-16 ***
as.factor(year)2005:as.factor(qt)4    0.5892475  0.0378741   15.558  < 2e-16 ***
as.factor(year)2006:as.factor(qt)4    0.4072069  0.0371665   10.956  < 2e-16 ***
as.factor(year)2007:as.factor(qt)4    0.1869413  0.0360916    5.180 2.22e-07 ***
as.factor(year)2008:as.factor(qt)4    0.0012142  0.0385853    0.031 0.974895
as.factor(year)2009:as.factor(qt)4    0.8216300  0.0424601   19.351  < 2e-16 ***
as.factor(year)2010:as.factor(qt)4    0.6481099  0.0447723   14.476  < 2e-16 ***
as.factor(year)2011:as.factor(qt)4    1.0442624  0.0538028   19.409  < 2e-16 ***
as.factor(year)2012:as.factor(qt)4    0.5336113  0.0494092   10.800  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for Negative Binomial(1.3755) family taken to be 1)

    Null deviance: 703485  on 327110  degrees of freedom
Residual deviance: 300662  on 326879  degrees of freedom
AIC: 999482

Number of Fisher Scoring iterations: 1
              Theta:  1.37549
          Std. Err.:  0.00758

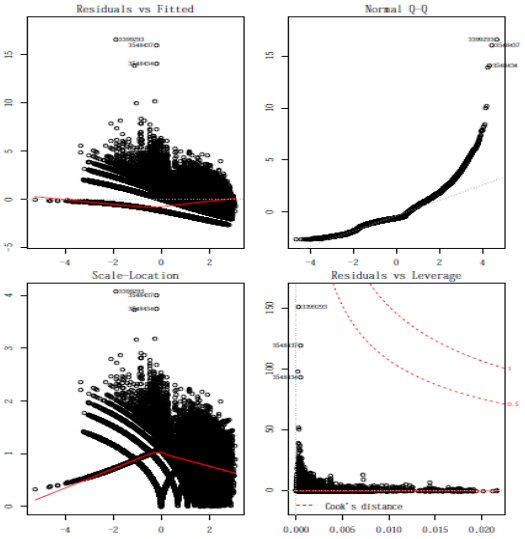
 2 x log-likelihood:  -999016.48400
```

**EPO for the period between 1975 and 1993, fitted negative binomial GLM to the operational data**

| | Df | Deviance | Resid. Df | Resid. Dev | Pr(>Chi) | |
|---|---|---|---|---|---|---|
| NULL | | | 767584 | 762324 | | |
| as.factor(year) | 18 | 10148 | 767566 | 752176 | < 2.2e-16 | *** |
| as.factor(qt) | 3 | 15823 | 767563 | 736352 | < 2.2e-16 | *** |
| as.factor(ar09) | 6 | 37968 | 767557 | 698385 | < 2.2e-16 | *** |
| as.factor(gear) | 4 | 735 | 767553 | 697650 | < 2.2e-16 | *** |
| as.factor(year):as.factor(ar09) | 108 | 10844 | 767445 | 686806 | < 2.2e-16 | *** |
| as.factor(year):as.factor(qt) | 54 | 5580 | 767391 | 681225 | < 2.2e-16 | *** |

Call:

```
glm.nb(formula = nswo ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(gear) + as.factor(year) * as.factor(area) + as.factor(year) *
    as.factor(qt) + offset(log(hooks)), data = oepo1, init.theta = 0.9572046732,
    link = log)
```




Deviance Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -2.311 | -0.998 | -0.808 | 0.332 | 43.783 |

Coefficients:

| | Estimate | Std. Error | z value | Pr(>\|z\|) | |
|---|---|---|---|---|---|
| (Intercept) | -8.134743 | 0.051217 | -158.829 | < 2e-16 | *** |
| as.factor(year)1976 | 0.207515 | 0.052641 | 3.942 | 8.08e-05 | *** |
| as.factor(year)1977 | 0.210468 | 0.054377 | 3.871 | 0.000109 | *** |
| as.factor(year)1978 | -0.103898 | 0.055110 | -1.885 | 0.059390 | . |
| as.factor(year)1979 | -0.500270 | 0.056803 | -8.807 | < 2e-16 | *** |
| as.factor(year)1980 | -1.283061 | 0.071832 | -17.862 | < 2e-16 | *** |
| as.factor(year)1981 | 0.168792 | 0.056743 | 2.975 | 0.002933 | ** |
| as.factor(year)1982 | 0.293171 | 0.057621 | 5.088 | 3.62e-07 | *** |
| as.factor(year)1983 | 0.046388 | 0.066303 | 0.700 | 0.484154 | |
| as.factor(year)1984 | 0.395161 | 0.064567 | 6.120 | 9.35e-10 | *** |
| as.factor(year)1985 | -0.596026 | 0.064592 | -9.228 | < 2e-16 | *** |
| as.factor(year)1986 | -0.277233 | 0.060866 | -4.555 | 5.24e-06 | *** |
| as.factor(year)1987 | -0.015758 | 0.058894 | -0.268 | 0.789039 | |
| as.factor(year)1988 | -0.337881 | 0.058226 | -5.803 | 6.52e-09 | *** |
| as.factor(year)1989 | 0.045878 | 0.055053 | 0.833 | 0.404645 | |
| as.factor(year)1990 | -0.489387 | 0.055842 | -8.764 | < 2e-16 | *** |
| as.factor(year)1991 | -0.443542 | 0.062311 | -7.118 | 1.09e-12 | *** |
| as.factor(year)1992 | -1.075328 | 0.075481 | -14.246 | < 2e-16 | *** |
| as.factor(year)1993 | -0.764579 | 0.063256 | -12.087 | < 2e-16 | *** |
| as.factor(qt)2 | -0.053907 | 0.036759 | -1.467 | 0.142509 | |
| as.factor(qt)3 | -0.023817 | 0.037346 | -0.638 | 0.523645 | |
| as.factor(qt)4 | 0.735315 | 0.034737 | 21.168 | < 2e-16 | *** |
| as.factor(area)11 | 0.105945 | 0.050684 | 2.090 | 0.036589 | * |
| as.factor(area)13 | -0.463556 | 0.043874 | -10.566 | < 2e-16 | *** |
| as.factor(area)15 | -0.571790 | 0.088982 | -6.426 | 1.31e-10 | *** |
| as.factor(area)17 | 0.004872 | 0.047481 | 0.103 | 0.918279 | |
| as.factor(area)18 | 0.234911 | 0.053352 | 4.403 | 1.07e-05 | *** |
| as.factor(area)19 | 0.206814 | 0.044684 | 4.628 | 3.69e-06 | *** |
| as.factor(gear)2 | 0.215157 | 0.036558 | 5.885 | 3.97e-09 | *** |
| as.factor(gear)3 | 0.100449 | 0.036872 | 2.724 | 0.006444 | ** |
| as.factor(gear)4 | 0.034631 | 0.036719 | 0.943 | 0.345608 | |
| as.factor(gear)5 | -0.439876 | 0.063203 | -6.960 | 3.41e-12 | *** |
| as.factor(year)1976:as.factor(area)11 | -0.178831 | 0.058383 | -3.063 | 0.002191 | ** |
| as.factor(year)1977:as.factor(area)11 | 0.401435 | 0.060429 | 6.643 | 3.07e-11 | *** |
| as.factor(year)1978:as.factor(area)11 | 0.542721 | 0.063762 | 8.512 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)11 | 0.598198 | 0.060866 | 9.828 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)11 | 0.968875 | 0.079081 | 12.252 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)11 | 0.323563 | 0.063393 | 5.104 | 3.32e-07 | *** |
| as.factor(year)1982:as.factor(area)11 | -0.198102 | 0.063494 | -3.120 | 0.001808 | ** |
| as.factor(year)1983:as.factor(area)11 | 0.851326 | 0.073631 | 11.562 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)11 | -0.052536 | 0.073714 | -0.713 | 0.476028 | |
| as.factor(year)1985:as.factor(area)11 | 0.516738 | 0.068587 | 7.534 | 4.92e-14 | *** |
| as.factor(year)1986:as.factor(area)11 | 0.496051 | 0.065396 | 7.585 | 3.32e-14 | *** |
| as.factor(year)1987:as.factor(area)11 | 0.539886 | 0.065221 | 8.278 | < 2e-16 | *** |
| as.factor(year)1988:as.factor(area)11 | 0.470464 | 0.068701 | 6.848 | 7.49e-12 | *** |
| as.factor(year)1989:as.factor(area)11 | 0.324234 | 0.060072 | 5.397 | 6.76e-08 | *** |
| as.factor(year)1990:as.factor(area)11 | 0.534083 | 0.061165 | 8.732 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)11 | 0.681794 | 0.067559 | 10.092 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)11 | 0.896759 | 0.082325 | 10.893 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)11 | 0.557580 | 0.068738 | 8.112 | 4.99e-16 | *** |
| as.factor(year)1976:as.factor(area)13 | 0.062827 | 0.052469 | 1.197 | 0.231146 | |
| as.factor(year)1977:as.factor(area)13 | 0.132554 | 0.053872 | 2.461 | 0.013873 | * |
| as.factor(year)1978:as.factor(area)13 | 0.456246 | 0.055509 | 8.219 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)13 | 0.616772 | 0.056041 | 11.006 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)13 | 1.422956 | 0.071203 | 19.984 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)13 | 0.370321 | 0.055580 | 6.663 | 2.69e-11 | *** |
| as.factor(year)1982:as.factor(area)13 | 0.127348 | 0.057689 | 2.207 | 0.027280 | * |
| as.factor(year)1983:as.factor(area)13 | 0.104943 | 0.069494 | 1.510 | 0.131016 | |
| as.factor(year)1984:as.factor(area)13 | -0.410403 | 0.064965 | -6.317 | 2.66e-10 | *** |
| as.factor(year)1985:as.factor(area)13 | 0.574138 | 0.063123 | 9.096 | < 2e-16 | *** |
| as.factor(year)1986:as.factor(area)13 | 0.412503 | 0.058750 | 7.021 | 2.20e-12 | *** |
| as.factor(year)1987:as.factor(area)13 | 0.249134 | 0.058044 | 4.292 | 1.77e-05 | *** |
| as.factor(year)1988:as.factor(area)13 | 0.572911 | 0.057108 | 10.032 | < 2e-16 | *** |
| as.factor(year)1989:as.factor(area)13 | 0.157132 | 0.053592 | 2.932 | 0.003368 | ** |
| as.factor(year)1990:as.factor(area)13 | 0.909684 | 0.054380 | 16.728 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)13 | 0.580213 | 0.061833 | 9.384 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)13 | 1.354564 | 0.074886 | 18.088 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)13 | 1.154287 | 0.062552 | 18.453 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)15 | -0.015306 | 0.100434 | -0.152 | 0.878875 | |
| as.factor(year)1977:as.factor(area)15 | 0.332848 | 0.099086 | 3.359 | 0.000782 | *** |
| as.factor(year)1978:as.factor(area)15 | 0.678903 | 0.101059 | 6.718 | 1.84e-11 | *** |
| as.factor(year)1979:as.factor(area)15 | 0.807162 | 0.100841 | 8.004 | 1.20e-15 | *** |
| as.factor(year)1980:as.factor(area)15 | 1.349032 | 0.108413 | 12.443 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)15 | 0.415597 | 0.097878 | 4.246 | 2.18e-05 | *** |
| as.factor(year)1982:as.factor(area)15 | 0.267231 | 0.098818 | 2.704 | 0.006845 | ** |
| as.factor(year)1983:as.factor(area)15 | 0.738782 | 0.104253 | 7.086 | 1.38e-12 | *** |
| as.factor(year)1984:as.factor(area)15 | 0.094356 | 0.106009 | 0.890 | 0.373430 | |
| as.factor(year)1985:as.factor(area)15 | 0.246070 | 0.116544 | 2.111 | 0.034739 | * |
| as.factor(year)1986:as.factor(area)15 | 0.434928 | 0.100556 | 4.325 | 1.52e-05 | *** |

| | | | | | |
|---|---|---|---|---|---|
| as.factor(year)1987:as.factor(area)15 | 0.430161 | 0.097515 | 4.411 | 1.03e-05 | *** |
| as.factor(year)1988:as.factor(area)15 | 0.507536 | 0.098919 | 5.131 | 2.89e-07 | *** |
| as.factor(year)1989:as.factor(area)15 | -0.504376 | 0.102720 | -4.910 | 9.10e-07 | *** |
| as.factor(year)1990:as.factor(area)15 | 0.816055 | 0.098717 | 8.267 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)15 | 0.628389 | 0.100748 | 6.237 | 4.45e-10 | *** |
| as.factor(year)1992:as.factor(area)15 | 1.027689 | 0.109682 | 9.370 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)15 | 1.069336 | 0.103165 | 10.365 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)17 | 0.006820 | 0.058066 | 0.117 | 0.906505 | |
| as.factor(year)1977:as.factor(area)17 | 0.129709 | 0.059294 | 2.188 | 0.028701 | * |
| as.factor(year)1978:as.factor(area)17 | 0.578714 | 0.059954 | 9.653 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)17 | 0.718195 | 0.060640 | 11.844 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)17 | 1.518403 | 0.074932 | 20.264 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)17 | 0.708302 | 0.060777 | 11.654 | < 2e-16 | *** |
| as.factor(year)1982:as.factor(area)17 | 0.144126 | 0.063999 | 2.252 | 0.024322 | * |
| as.factor(year)1983:as.factor(area)17 | 0.341046 | 0.071479 | 4.771 | 1.83e-06 | *** |
| as.factor(year)1984:as.factor(area)17 | 0.011401 | 0.070498 | 0.162 | 0.871529 | |
| as.factor(year)1985:as.factor(area)17 | 0.822923 | 0.069088 | 11.911 | < 2e-16 | *** |
| as.factor(year)1986:as.factor(area)17 | 0.157502 | 0.062393 | 2.524 | 0.011591 | * |
| as.factor(year)1987:as.factor(area)17 | 0.257991 | 0.062389 | 4.135 | 3.55e-05 | *** |
| as.factor(year)1988:as.factor(area)17 | 0.557675 | 0.060691 | 9.189 | < 2e-16 | *** |
| as.factor(year)1989:as.factor(area)17 | 0.086678 | 0.058927 | 1.471 | 0.141309 | |
| as.factor(year)1990:as.factor(area)17 | 1.006745 | 0.061574 | 16.350 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)17 | 0.745715 | 0.066237 | 11.258 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)17 | 1.323064 | 0.077981 | 16.967 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)17 | 1.173447 | 0.067507 | 17.383 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)18 | 0.121490 | 0.065290 | 1.861 | 0.062776 | . |
| as.factor(year)1977:as.factor(area)18 | 0.426295 | 0.064400 | 6.620 | 3.60e-11 | *** |
| as.factor(year)1978:as.factor(area)18 | 1.077750 | 0.066653 | 16.170 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)18 | 0.889698 | 0.068786 | 12.934 | < 2e-16 | *** |
| as.factor(year)1980:as.factor(area)18 | 1.808866 | 0.079073 | 22.876 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)18 | 0.880403 | 0.066172 | 13.305 | < 2e-16 | *** |
| as.factor(year)1982:as.factor(area)18 | 0.442266 | 0.067373 | 6.564 | 5.22e-11 | *** |
| as.factor(year)1983:as.factor(area)18 | 0.842843 | 0.073030 | 11.541 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)18 | 0.512637 | 0.072770 | 7.045 | 1.86e-12 | *** |
| as.factor(year)1985:as.factor(area)18 | 0.565088 | 0.078754 | 7.175 | 7.21e-13 | *** |
| as.factor(year)1986:as.factor(area)18 | 0.187568 | 0.068834 | 2.725 | 0.006431 | ** |
| as.factor(year)1987:as.factor(area)18 | 0.274931 | 0.066206 | 4.153 | 3.29e-05 | *** |
| as.factor(year)1988:as.factor(area)18 | 0.442646 | 0.067426 | 6.565 | 5.21e-11 | *** |
| as.factor(year)1989:as.factor(area)18 | -0.272504 | 0.067121 | -4.060 | 4.91e-05 | *** |
| as.factor(year)1990:as.factor(area)18 | 0.906538 | 0.067433 | 13.444 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)18 | 0.465177 | 0.072761 | 6.393 | 1.62e-10 | *** |
| as.factor(year)1992:as.factor(area)18 | 0.960137 | 0.082864 | 11.587 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)18 | 1.223728 | 0.073159 | 16.727 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(area)19 | -0.218882 | 0.056370 | -3.883 | 0.000103 | *** |
| as.factor(year)1977:as.factor(area)19 | 0.301370 | 0.057639 | 5.229 | 1.71e-07 | *** |
| as.factor(year)1978:as.factor(area)19 | 0.593463 | 0.056593 | 10.487 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(area)19 | 0.453382 | 0.058520 | 7.747 | 9.38e-15 | *** |
| as.factor(year)1980:as.factor(area)19 | 1.366938 | 0.073839 | 18.513 | < 2e-16 | *** |
| as.factor(year)1981:as.factor(area)19 | 0.252503 | 0.057206 | 4.414 | 1.01e-05 | *** |
| as.factor(year)1982:as.factor(area)19 | 0.086056 | 0.061697 | 1.395 | 0.163070 | |
| as.factor(year)1983:as.factor(area)19 | 0.698112 | 0.069334 | 10.069 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(area)19 | 0.436794 | 0.066763 | 6.542 | 6.05e-11 | *** |
| as.factor(year)1985:as.factor(area)19 | 0.473197 | 0.065003 | 7.280 | 3.35e-13 | *** |
| as.factor(year)1986:as.factor(area)19 | 0.387919 | 0.059955 | 6.470 | 9.79e-11 | *** |
| as.factor(year)1987:as.factor(area)19 | 0.340231 | 0.059724 | 5.697 | 1.22e-08 | *** |
| as.factor(year)1988:as.factor(area)19 | 0.840118 | 0.060992 | 13.774 | < 2e-16 | *** |
| as.factor(year)1989:as.factor(area)19 | 0.185021 | 0.056935 | 3.250 | 0.001155 | ** |
| as.factor(year)1990:as.factor(area)19 | 1.145548 | 0.056729 | 20.193 | < 2e-16 | *** |
| as.factor(year)1991:as.factor(area)19 | 0.844851 | 0.063771 | 13.248 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(area)19 | 1.450121 | 0.077632 | 18.679 | < 2e-16 | *** |
| as.factor(year)1993:as.factor(area)19 | 0.665289 | 0.067158 | 9.906 | < 2e-16 | *** |
| as.factor(year)1976:as.factor(qt)2 | -0.200561 | 0.045539 | -4.404 | 1.06e-05 | *** |
| as.factor(year)1977:as.factor(qt)2 | -0.320108 | 0.044185 | -7.245 | 4.33e-13 | *** |
| as.factor(year)1978:as.factor(qt)2 | -0.601360 | 0.047196 | -12.742 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(qt)2 | -0.280692 | 0.047160 | -5.952 | 2.65e-09 | *** |
| as.factor(year)1980:as.factor(qt)2 | -0.047481 | 0.046389 | -1.024 | 0.306054 | |
| as.factor(year)1981:as.factor(qt)2 | -0.382409 | 0.043798 | -8.731 | < 2e-16 | *** |
| as.factor(year)1982:as.factor(qt)2 | -0.604716 | 0.046633 | -12.967 | < 2e-16 | *** |
| as.factor(year)1983:as.factor(qt)2 | -1.183199 | 0.056682 | -20.874 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(qt)2 | -1.172346 | 0.048482 | -24.181 | < 2e-16 | *** |
| as.factor(year)1985:as.factor(qt)2 | -0.373817 | 0.047628 | -7.849 | 4.20e-15 | *** |
| as.factor(year)1986:as.factor(qt)2 | -0.096576 | 0.045002 | -2.146 | 0.031871 | * |
| as.factor(year)1987:as.factor(qt)2 | -0.402423 | 0.043781 | -9.192 | < 2e-16 | *** |
| as.factor(year)1988:as.factor(qt)2 | -0.650283 | 0.043717 | -14.875 | < 2e-16 | *** |
| as.factor(year)1989:as.factor(qt)2 | -0.644763 | 0.045075 | -14.304 | < 2e-16 | *** |
| as.factor(year)1990:as.factor(qt)2 | -0.163088 | 0.042512 | -3.836 | 0.000125 | *** |
| as.factor(year)1991:as.factor(qt)2 | -0.353238 | 0.042289 | -8.353 | < 2e-16 | *** |
| as.factor(year)1992:as.factor(qt)2 | -0.137194 | 0.044723 | -3.068 | 0.002158 | ** |
| as.factor(year)1993:as.factor(qt)2 | -0.059611 | 0.042900 | -1.390 | 0.164664 | |
| as.factor(year)1976:as.factor(qt)3 | 0.078503 | 0.045306 | 1.733 | 0.083149 | . |
| as.factor(year)1977:as.factor(qt)3 | -0.428090 | 0.044518 | -9.616 | < 2e-16 | *** |
| as.factor(year)1978:as.factor(qt)3 | -0.587748 | 0.045619 | -12.884 | < 2e-16 | *** |
| as.factor(year)1979:as.factor(qt)3 | -0.163789 | 0.046596 | -3.515 | 0.000440 | *** |
| as.factor(year)1980:as.factor(qt)3 | -0.116391 | 0.045518 | -2.557 | 0.010557 | * |
| as.factor(year)1981:as.factor(qt)3 | -0.705088 | 0.045026 | -15.660 | < 2e-16 | *** |
| as.factor(year)1982:as.factor(qt)3 | -0.625045 | 0.046668 | -13.393 | < 2e-16 | *** |
| as.factor(year)1983:as.factor(qt)3 | -0.960201 | 0.047622 | -20.163 | < 2e-16 | *** |
| as.factor(year)1984:as.factor(qt)3 | -1.244842 | 0.051162 | -24.331 | < 2e-16 | *** |
| as.factor(year)1985:as.factor(qt)3 | -0.027056 | 0.048913 | -0.553 | 0.580159 | |
| as.factor(year)1986:as.factor(qt)3 | -0.060985 | 0.044744 | -1.363 | 0.172893 | |
| as.factor(year)1987:as.factor(qt)3 | -0.386019 | 0.043165 | -8.943 | < 2e-16 | *** |
| as.factor(year)1988:as.factor(qt)3 | -0.336294 | 0.043991 | -7.645 | 2.10e-14 | *** |

```
as.factor(year)1989:as.factor(qt)3  -0.292400   0.045609   -6.411 1.45e-10 ***
as.factor(year)1990:as.factor(qt)3  -0.358216   0.043513   -8.232  < 2e-16 ***
as.factor(year)1991:as.factor(qt)3  -0.226749   0.042784   -5.300 1.16e-07 ***
as.factor(year)1992:as.factor(qt)3  -0.244779   0.044233   -5.534 3.13e-08 ***
as.factor(year)1993:as.factor(qt)3  -0.319602   0.043844   -7.289 3.11e-13 ***
as.factor(year)1976:as.factor(qt)4  -0.372074   0.042697   -8.714  < 2e-16 ***
as.factor(year)1977:as.factor(qt)4  -0.483424   0.041018  -11.786  < 2e-16 ***
as.factor(year)1978:as.factor(qt)4  -0.577373   0.041253  -13.996  < 2e-16 ***
as.factor(year)1979:as.factor(qt)4  -0.380374   0.041741   -9.113  < 2e-16 ***
as.factor(year)1980:as.factor(qt)4  -0.082468   0.041815   -1.972 0.048587 *
as.factor(year)1981:as.factor(qt)4  -0.834873   0.041586  -20.076  < 2e-16 ***
as.factor(year)1982:as.factor(qt)4  -0.691959   0.042575  -16.253  < 2e-16 ***
as.factor(year)1983:as.factor(qt)4  -0.722685   0.042729  -16.913  < 2e-16 ***
as.factor(year)1984:as.factor(qt)4  -1.112549   0.043379  -25.647  < 2e-16 ***
as.factor(year)1985:as.factor(qt)4  -0.550663   0.046289  -11.896  < 2e-16 ***
as.factor(year)1986:as.factor(qt)4  -0.513773   0.041096  -12.502  < 2e-16 ***
as.factor(year)1987:as.factor(qt)4  -0.682280   0.039778  -17.152  < 2e-16 ***
as.factor(year)1988:as.factor(qt)4  -0.704283   0.040339  -17.459  < 2e-16 ***
as.factor(year)1989:as.factor(qt)4  -0.708032   0.040969  -17.282  < 2e-16 ***
as.factor(year)1990:as.factor(qt)4  -0.867917   0.040208  -21.586  < 2e-16 ***
as.factor(year)1991:as.factor(qt)4  -0.833883   0.039520  -21.101  < 2e-16 ***
as.factor(year)1992:as.factor(qt)4  -0.649006   0.040869  -15.880  < 2e-16 ***
as.factor(year)1993:as.factor(qt)4  -0.683605   0.040070  -17.060  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(0.9572) family taken to be 1)

    Null deviance: 762324  on 767584  degrees of freedom
Residual deviance: 681225  on 767391  degrees of freedom
AIC: 1765253

Number of Fisher Scoring iterations: 1
              Theta:  0.95720
          Std. Err.:  0.00436

 2 x log-likelihood:  -1764862.56700
```

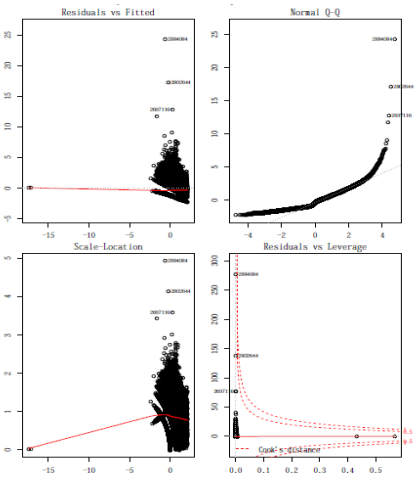
**EPO for the period between 1994 and 2012, fitted negative binomial GLM to the operational data**

| | Df | Deviance | Resid. Df | Resid. Dev | Pr(>Chi) | |
|---|---|---|---|---|---|---|
| NULL | | | 462492 | 545213 | | |
| as.factor(year) | 18 | 49650 | 462474 | 495563 | < 2.2e-16 | *** |
| as.factor(qt) | 3 | 1559 | 462471 | 494003 | < 2.2e-16 | *** |
| as.factor(ar09) | 6 | 9335 | 462465 | 484668 | < 2.2e-16 | *** |
| as.factor(gear) | 4 | 202 | 462461 | 484466 | < 2.2e-16 | *** |
| as.factor(year):as.factor(ar09) | 108 | 15103 | 462353 | 469363 | < 2.2e-16 | *** |
| as.factor(year):as.factor(qt) | 54 | 2669 | 462299 | 466694 | < 2.2e-16 | *** |

Call:

```
glm.nb(formula = nswo ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(gear) + as.factor(year) * as.factor(area) + as.factor(year) *
    as.factor(qt) + offset(log(hooks)), data = oepo2, init.theta = 1.3451281,
    link = log)

Deviance Residuals:
     Min       1Q   Median       3Q      Max
-2.3123  -1.1432  -0.4007   0.3536  24.2672
Coefficients:
                                Estimate Std. Error z value Pr(>|z|)
(Intercept)                   -2.500e+01  2.438e+03  -0.010 0.991818
as.factor(year)1995           -1.076e-01  6.096e-02  -1.765 0.077531 .
as.factor(year)1996            1.394e-02  6.484e-02   0.215 0.829809
as.factor(year)1997            4.439e-01  7.041e-02   6.304 2.90e-10 ***
as.factor(year)1998            2.551e-01  6.273e-02   4.067 4.76e-05 ***
as.factor(year)1999            6.567e-01  5.609e-02  11.708  < 2e-16 ***
as.factor(year)2000            1.091e+00  5.165e-02  21.126  < 2e-16 ***
as.factor(year)2001            1.341e+00  4.833e-02  27.748  < 2e-16 ***
as.factor(year)2002            7.433e-01  5.086e-02  14.614  < 2e-16 ***
as.factor(year)2003            2.586e-01  6.448e-02   4.010 6.06e-05 ***
as.factor(year)2004           -3.216e-02  6.073e-02  -0.530 0.596339
as.factor(year)2005            6.944e-02  9.238e-02   0.752 0.452260
as.factor(year)2006            7.749e-01  7.137e-02  10.858  < 2e-16 ***
as.factor(year)2007            1.127e+00  9.404e-02  11.979  < 2e-16 ***
as.factor(year)2008            1.761e+00  6.238e-02  28.226  < 2e-16 ***
as.factor(year)2009            1.707e+00  5.634e-02  30.305  < 2e-16 ***
as.factor(year)2010            1.717e+00  6.832e-02  25.135  < 2e-16 ***
as.factor(year)2011            1.732e+00  5.759e-02  30.076  < 2e-16 ***
as.factor(year)2012            2.454e+00  6.188e-02  39.658  < 2e-16 ***
as.factor(qt)2                -3.735e-01  2.238e-02 -16.686  < 2e-16 ***
as.factor(qt)3                -8.240e-02  2.237e-02  -3.684 0.000230 ***
as.factor(qt)4                 1.923e-01  2.001e-02   9.609  < 2e-16 ***
as.factor(area)11              7.472e-01  4.166e-02  17.936  < 2e-16 ***
as.factor(area)13              4.035e-01  3.758e-02  10.737  < 2e-16 ***
as.factor(area)15              3.316e-01  4.168e-02   7.955 1.79e-15 ***
as.factor(area)17              7.638e-01  4.267e-02  17.900  < 2e-16 ***
```



| | | | | | |
|---|---|---|---|---|---|
| as.factor(area)18 | 1.037e+00 | 4.435e-02 | 23.371 | < 2e-16 | *** |
| as.factor(area)19 | 8.302e-01 | 4.081e-02 | 20.343 | < 2e-16 | *** |
| as.factor(gear)2 | 1.680e+01 | 2.438e+03 | 0.007 | 0.994500 | |
| as.factor(gear)3 | 1.649e+01 | 2.438e+03 | 0.007 | 0.994603 | |
| as.factor(gear)4 | 1.626e+01 | 2.438e+03 | 0.007 | 0.994680 | |
| as.factor(gear)5 | 1.613e+01 | 2.438e+03 | 0.007 | 0.994720 | |
| as.factor(year)1995:as.factor(area)11 | 2.530e-01 | 6.620e-02 | 3.821 | 0.000133 | *** |
| as.factor(year)1996:as.factor(area)11 | 8.891e-02 | 7.062e-02 | 1.259 | 0.208019 | |
| as.factor(year)1997:as.factor(area)11 | 2.219e-03 | 7.428e-02 | 0.030 | 0.976166 | |
| as.factor(year)1998:as.factor(area)11 | 6.661e-01 | 6.687e-02 | 9.961 | < 2e-16 | *** |
| as.factor(year)1999:as.factor(area)11 | -2.595e-01 | 6.079e-02 | -4.269 | 1.97e-05 | *** |
| as.factor(year)2000:as.factor(area)11 | -2.511e-01 | 5.352e-02 | -4.692 | 2.70e-06 | *** |
| as.factor(year)2001:as.factor(area)11 | -1.173e-01 | 5.173e-02 | -2.268 | 0.023318 | * |
| as.factor(year)2002:as.factor(area)11 | 6.201e-03 | 5.378e-02 | 0.115 | 0.908197 | |
| as.factor(year)2003:as.factor(area)11 | 2.326e-01 | 6.794e-02 | 3.423 | 0.000619 | *** |
| as.factor(year)2004:as.factor(area)11 | 2.617e-01 | 6.384e-02 | 4.100 | 4.13e-05 | *** |
| as.factor(year)2005:as.factor(area)11 | 2.696e-01 | 9.522e-02 | 2.831 | 0.004639 | ** |
| as.factor(year)2006:as.factor(area)11 | -1.894e-02 | 7.307e-02 | -0.259 | 0.795481 | |
| as.factor(year)2007:as.factor(area)11 | -1.679e-01 | 9.887e-02 | -1.698 | 0.089459 | . |
| as.factor(year)2008:as.factor(area)11 | -4.639e-01 | 6.463e-02 | -7.179 | 7.04e-13 | *** |
| as.factor(year)2009:as.factor(area)11 | -4.037e-01 | 5.956e-02 | -6.778 | 1.22e-11 | *** |
| as.factor(year)2010:as.factor(area)11 | 1.094e-02 | 7.285e-02 | 0.150 | 0.880675 | |
| as.factor(year)2011:as.factor(area)11 | -4.770e-01 | 6.226e-02 | -7.662 | 1.83e-14 | *** |
| as.factor(year)2012:as.factor(area)11 | -1.176e+00 | 6.772e-02 | -17.366 | < 2e-16 | *** |
| as.factor(year)1995:as.factor(area)13 | 2.153e-01 | 6.044e-02 | 3.562 | 0.000368 | *** |
| as.factor(year)1996:as.factor(area)13 | 3.248e-01 | 6.542e-02 | 4.965 | 6.88e-07 | *** |
| as.factor(year)1997:as.factor(area)13 | 1.095e-02 | 7.127e-02 | 0.154 | 0.877879 | |
| as.factor(year)1998:as.factor(area)13 | 4.416e-01 | 6.409e-02 | 6.891 | 5.53e-12 | *** |
| as.factor(year)1999:as.factor(area)13 | -1.548e-01 | 5.501e-02 | -2.814 | 0.004895 | ** |
| as.factor(year)2000:as.factor(area)13 | -4.725e-01 | 5.025e-02 | -9.404 | < 2e-16 | *** |
| as.factor(year)2001:as.factor(area)13 | -4.899e-01 | 4.847e-02 | -10.109 | < 2e-16 | *** |
| as.factor(year)2002:as.factor(area)13 | -1.150e-01 | 5.120e-02 | -2.247 | 0.024623 | * |
| as.factor(year)2003:as.factor(area)13 | 2.953e-01 | 6.460e-02 | 4.572 | 4.84e-06 | *** |
| as.factor(year)2004:as.factor(area)13 | 6.433e-01 | 6.114e-02 | 10.522 | < 2e-16 | *** |
| as.factor(year)2005:as.factor(area)13 | 4.978e-01 | 9.346e-02 | 5.327 | 1.00e-07 | *** |
| as.factor(year)2006:as.factor(area)13 | -1.477e-01 | 7.119e-02 | -2.075 | 0.037981 | * |
| as.factor(year)2007:as.factor(area)13 | -3.029e-01 | 9.587e-02 | -3.160 | 0.001579 | ** |
| as.factor(year)2008:as.factor(area)13 | -8.102e-01 | 6.171e-02 | -13.129 | < 2e-16 | *** |
| as.factor(year)2009:as.factor(area)13 | -3.623e-01 | 5.670e-02 | -6.390 | 1.65e-10 | *** |
| as.factor(year)2010:as.factor(area)13 | -2.399e-01 | 6.879e-02 | -3.487 | 0.000489 | *** |
| as.factor(year)2011:as.factor(area)13 | -9.683e-02 | 5.848e-02 | -1.656 | 0.097767 | . |
| as.factor(year)2012:as.factor(area)13 | -9.140e-01 | 6.076e-02 | -15.044 | < 2e-16 | *** |
| as.factor(year)1995:as.factor(area)15 | 1.853e-01 | 6.565e-02 | 2.822 | 0.004767 | ** |
| as.factor(year)1996:as.factor(area)15 | 7.918e-02 | 7.122e-02 | 1.112 | 0.266224 | |
| as.factor(year)1997:as.factor(area)15 | -6.083e-02 | 7.621e-02 | -0.798 | 0.424717 | |
| as.factor(year)1998:as.factor(area)15 | 2.689e-01 | 7.155e-02 | 3.758 | 0.000172 | *** |
| as.factor(year)1999:as.factor(area)15 | -5.600e-01 | 7.192e-02 | -7.786 | 6.94e-15 | *** |
| as.factor(year)2000:as.factor(area)15 | -1.108e+00 | 6.332e-02 | -17.505 | < 2e-16 | *** |
| as.factor(year)2001:as.factor(area)15 | -7.047e-01 | 6.015e-02 | -11.715 | < 2e-16 | *** |
| as.factor(year)2002:as.factor(area)15 | -3.483e-01 | 6.144e-02 | -5.669 | 1.44e-08 | *** |
| as.factor(year)2003:as.factor(area)15 | 1.342e-01 | 7.133e-02 | 1.881 | 0.059975 | . |
| as.factor(year)2004:as.factor(area)15 | -1.542e-02 | 7.081e-02 | -0.218 | 0.827634 | |
| as.factor(year)2005:as.factor(area)15 | 2.034e-01 | 9.963e-02 | 2.042 | 0.041159 | * |
| as.factor(year)2006:as.factor(area)15 | -1.938e-01 | 8.086e-02 | -2.397 | 0.016542 | * |
| as.factor(year)2007:as.factor(area)15 | -2.458e-01 | 1.007e-01 | -2.442 | 0.014602 | * |
| as.factor(year)2008:as.factor(area)15 | -7.608e-01 | 6.904e-02 | -11.020 | < 2e-16 | *** |
| as.factor(year)2009:as.factor(area)15 | 5.720e-02 | 6.651e-02 | 0.860 | 0.389801 | |
| as.factor(year)2010:as.factor(area)15 | 2.420e-01 | 7.321e-02 | 3.306 | 0.000948 | *** |
| as.factor(year)2011:as.factor(area)15 | 2.566e-01 | 6.521e-02 | 3.935 | 8.32e-05 | *** |
| as.factor(year)2012:as.factor(area)15 | -3.424e-01 | 6.937e-02 | -4.936 | 7.97e-07 | *** |
| as.factor(year)1995:as.factor(area)17 | 3.620e-01 | 6.705e-02 | 5.400 | 6.68e-08 | *** |
| as.factor(year)1996:as.factor(area)17 | 3.811e-01 | 7.188e-02 | 5.301 | 1.15e-07 | *** |
| as.factor(year)1997:as.factor(area)17 | -3.318e-01 | 7.914e-02 | -4.192 | 2.77e-05 | *** |
| as.factor(year)1998:as.factor(area)17 | 2.107e-01 | 6.722e-02 | 3.134 | 0.001725 | ** |
| as.factor(year)1999:as.factor(area)17 | -3.266e-01 | 5.888e-02 | -5.547 | 2.91e-08 | *** |
| as.factor(year)2000:as.factor(area)17 | -7.183e-01 | 5.843e-02 | -12.294 | < 2e-16 | *** |
| as.factor(year)2001:as.factor(area)17 | -6.933e-01 | 5.521e-02 | -12.558 | < 2e-16 | *** |
| as.factor(year)2002:as.factor(area)17 | -2.008e-01 | 5.774e-02 | -3.478 | 0.000506 | *** |
| as.factor(year)2003:as.factor(area)17 | 3.184e-01 | 6.879e-02 | 4.628 | 3.69e-06 | *** |
| as.factor(year)2004:as.factor(area)17 | 6.939e-01 | 6.849e-02 | 10.131 | < 2e-16 | *** |
| as.factor(year)2005:as.factor(area)17 | 6.007e-01 | 9.833e-02 | 6.109 | 1.00e-09 | *** |
| as.factor(year)2006:as.factor(area)17 | -3.339e-01 | 7.844e-02 | -4.257 | 2.07e-05 | *** |
| as.factor(year)2007:as.factor(area)17 | -6.135e-01 | 9.987e-02 | -6.143 | 8.10e-10 | *** |
| as.factor(year)2008:as.factor(area)17 | -1.285e+00 | 7.076e-02 | -18.164 | < 2e-16 | *** |
| as.factor(year)2009:as.factor(area)17 | -1.374e+00 | 6.856e-02 | -20.038 | < 2e-16 | *** |
| as.factor(year)2010:as.factor(area)17 | -7.933e-01 | 7.509e-02 | -10.564 | < 2e-16 | *** |
| as.factor(year)2011:as.factor(area)17 | -8.126e-01 | 6.292e-02 | -12.916 | < 2e-16 | *** |
| as.factor(year)2012:as.factor(area)17 | -1.647e+00 | 6.496e-02 | -25.359 | < 2e-16 | *** |
| as.factor(year)1995:as.factor(area)18 | 9.455e-02 | 6.725e-02 | 1.406 | 0.159725 | |
| as.factor(year)1996:as.factor(area)18 | -2.414e-01 | 7.130e-02 | -3.386 | 0.000710 | *** |
| as.factor(year)1997:as.factor(area)18 | -6.837e-01 | 7.668e-02 | -8.917 | < 2e-16 | *** |
| as.factor(year)1998:as.factor(area)18 | -2.182e-01 | 6.828e-02 | -3.195 | 0.001397 | ** |
| as.factor(year)1999:as.factor(area)18 | -9.154e-01 | 6.308e-02 | -14.512 | < 2e-16 | *** |
| as.factor(year)2000:as.factor(area)18 | -1.343e+00 | 6.089e-02 | -22.055 | < 2e-16 | *** |
| as.factor(year)2001:as.factor(area)18 | -1.151e+00 | 5.719e-02 | -20.130 | < 2e-16 | *** |
| as.factor(year)2002:as.factor(area)18 | -8.398e-01 | 5.847e-02 | -14.363 | < 2e-16 | *** |
| as.factor(year)2003:as.factor(area)18 | -2.952e-01 | 6.983e-02 | -4.228 | 2.36e-05 | *** |
| as.factor(year)2004:as.factor(area)18 | -1.253e-01 | 6.767e-02 | -1.851 | 0.064158 | . |
| as.factor(year)2005:as.factor(area)18 | 6.223e-02 | 9.945e-02 | 0.626 | 0.531472 | |
| as.factor(year)2006:as.factor(area)18 | -9.334e-01 | 7.828e-02 | -11.924 | < 2e-16 | *** |
| as.factor(year)2007:as.factor(area)18 | -8.203e-01 | 1.005e-01 | -8.160 | 3.35e-16 | *** |
| as.factor(year)2008:as.factor(area)18 | -1.337e+00 | 7.241e-02 | -18.469 | < 2e-16 | *** |

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as.factor(year)2009:as.factor(area)18 -1.373e+00  6.484e-02 -21.167  < 2e-16 ***
as.factor(year)2010:as.factor(area)18 -5.913e-01  7.530e-02  -7.853 4.07e-15 ***
as.factor(year)2011:as.factor(area)18 -7.090e-01  6.516e-02 -10.881  < 2e-16 ***
as.factor(year)2012:as.factor(area)18 -1.587e+00  6.755e-02 -23.489  < 2e-16 ***
as.factor(year)1995:as.factor(area)19  1.346e-01  6.618e-02   2.034 0.041970 *
as.factor(year)1996:as.factor(area)19  1.583e-01  7.142e-02   2.217 0.026656 *
as.factor(year)1997:as.factor(area)19 -3.793e-01  7.901e-02  -4.800 1.58e-06 ***
as.factor(year)1998:as.factor(area)19 -3.183e-02  6.684e-02  -0.476 0.633923
as.factor(year)1999:as.factor(area)19 -9.564e-01  6.171e-02 -15.499  < 2e-16 ***
as.factor(year)2000:as.factor(area)19 -9.387e-01  5.710e-02 -16.441  < 2e-16 ***
as.factor(year)2001:as.factor(area)19 -5.159e-01  5.180e-02  -9.961  < 2e-16 ***
as.factor(year)2002:as.factor(area)19  2.782e-02  5.409e-02   0.514 0.607031
as.factor(year)2003:as.factor(area)19  7.268e-01  6.730e-02  10.799  < 2e-16 ***
as.factor(year)2004:as.factor(area)19  2.711e-01  6.488e-02   4.179 2.93e-05 ***
as.factor(year)2005:as.factor(area)19  6.182e-01  9.595e-02   6.442 1.18e-10 ***
as.factor(year)2006:as.factor(area)19 -5.981e-02  7.520e-02  -0.795 0.426401
as.factor(year)2007:as.factor(area)19  1.666e-01  9.862e-02   1.690 0.091102 .
as.factor(year)2008:as.factor(area)19 -9.788e-01  6.546e-02 -14.954  < 2e-16 ***
as.factor(year)2009:as.factor(area)19 -8.546e-01  6.082e-02 -14.052  < 2e-16 ***
as.factor(year)2010:as.factor(area)19  2.741e-01  7.390e-02   3.709 0.000208 ***
as.factor(year)2011:as.factor(area)19  2.840e-01  6.207e-02   4.576 4.74e-06 ***
as.factor(year)2012:as.factor(area)19 -1.094e+00  6.563e-02 -16.676  < 2e-16 ***
as.factor(year)1995:as.factor(qt)2     -7.614e-02  3.412e-02  -2.231 0.025665 *
as.factor(year)1996:as.factor(qt)2      9.562e-02  3.345e-02   2.858 0.004261 **
as.factor(year)1997:as.factor(qt)2      7.790e-02  3.241e-02   2.403 0.016239 *
as.factor(year)1998:as.factor(qt)2     -3.625e-02  3.481e-02  -1.041 0.297672
as.factor(year)1999:as.factor(qt)2      6.661e-02  3.708e-02   1.796 0.072472 .
as.factor(year)2000:as.factor(qt)2      1.362e-01  3.484e-02   3.909 9.28e-05 ***
as.factor(year)2001:as.factor(qt)2      5.905e-02  3.150e-02   1.874 0.060870 .
as.factor(year)2002:as.factor(qt)2      1.351e-01  3.197e-02   4.225 2.38e-05 ***
as.factor(year)2003:as.factor(qt)2      3.476e-02  3.242e-02   1.072 0.283695
as.factor(year)2004:as.factor(qt)2      1.411e-01  3.618e-02   3.900 9.61e-05 ***
as.factor(year)2005:as.factor(qt)2      1.848e-01  3.578e-02   5.166 2.39e-07 ***
as.factor(year)2006:as.factor(qt)2      5.664e-02  3.875e-02   1.462 0.143798
as.factor(year)2007:as.factor(qt)2     -2.068e-01  3.938e-02  -5.252 1.51e-07 ***
as.factor(year)2008:as.factor(qt)2      5.976e-02  3.717e-02   1.607 0.107960
as.factor(year)2009:as.factor(qt)2      3.364e-01  3.645e-02   9.229  < 2e-16 ***
as.factor(year)2010:as.factor(qt)2      1.041e-01  3.284e-02   3.171 0.001520 **
as.factor(year)2011:as.factor(qt)2      3.009e-01  3.337e-02   9.018  < 2e-16 ***
as.factor(year)2012:as.factor(qt)2     -1.476e-01  3.278e-02  -4.503 6.71e-06 ***
as.factor(year)1995:as.factor(qt)3     -1.669e-01  3.318e-02  -5.031 4.88e-07 ***
as.factor(year)1996:as.factor(qt)3     -1.079e-01  3.331e-02  -3.241 0.001192 **
as.factor(year)1997:as.factor(qt)3     -4.127e-02  3.282e-02  -1.258 0.208534
as.factor(year)1998:as.factor(qt)3     -2.048e-01  3.276e-02  -6.250 4.11e-10 ***
as.factor(year)1999:as.factor(qt)3      1.239e-01  3.578e-02   3.463 0.000535 ***
as.factor(year)2000:as.factor(qt)3      1.870e-01  3.481e-02   5.374 7.72e-08 ***
as.factor(year)2001:as.factor(qt)3     -1.296e-01  3.038e-02  -4.265 2.00e-05 ***
as.factor(year)2002:as.factor(qt)3     -3.069e-01  3.183e-02  -9.642  < 2e-16 ***
as.factor(year)2003:as.factor(qt)3     -8.032e-02  3.222e-02  -2.493 0.012679 *
as.factor(year)2004:as.factor(qt)3     -1.662e-01  3.619e-02  -4.593 4.38e-06 ***
as.factor(year)2005:as.factor(qt)3     -4.447e-01  4.021e-02 -11.060  < 2e-16 ***
as.factor(year)2006:as.factor(qt)3     -1.792e-01  3.964e-02  -4.522 6.13e-06 ***
as.factor(year)2007:as.factor(qt)3     -3.932e-01  4.131e-02  -9.519  < 2e-16 ***
as.factor(year)2008:as.factor(qt)3     -3.260e-01  3.861e-02  -8.444  < 2e-16 ***
as.factor(year)2009:as.factor(qt)3     -2.256e-02  3.651e-02  -0.618 0.536604
as.factor(year)2010:as.factor(qt)3     -4.729e-01  3.484e-02 -13.573  < 2e-16 ***
as.factor(year)2011:as.factor(qt)3     -5.015e-01  3.365e-02 -14.904  < 2e-16 ***
as.factor(year)2012:as.factor(qt)3     -2.713e-01  3.305e-02  -8.207 2.27e-16 ***
as.factor(year)1995:as.factor(qt)4     -5.636e-02  3.037e-02  -1.856 0.063505 .
as.factor(year)1996:as.factor(qt)4     -6.977e-02  3.060e-02  -2.280 0.022615 *
as.factor(year)1997:as.factor(qt)4      8.065e-02  3.049e-02   2.645 0.008168 **
as.factor(year)1998:as.factor(qt)4     -3.509e-02  2.942e-02  -1.192 0.233114
as.factor(year)1999:as.factor(qt)4      1.825e-01  3.255e-02   5.607 2.06e-08 ***
as.factor(year)2000:as.factor(qt)4      4.233e-03  3.082e-02   0.137 0.890748
as.factor(year)2001:as.factor(qt)4     -4.188e-01  2.888e-02 -14.504  < 2e-16 ***
as.factor(year)2002:as.factor(qt)4     -7.332e-02  2.819e-02  -2.601 0.009289 **
as.factor(year)2003:as.factor(qt)4     -1.271e-01  2.833e-02  -4.489 7.16e-06 ***
as.factor(year)2004:as.factor(qt)4     -1.139e-01  3.081e-02  -3.697 0.000218 ***
as.factor(year)2005:as.factor(qt)4     -3.094e-01  3.607e-02  -8.578  < 2e-16 ***
as.factor(year)2006:as.factor(qt)4     -5.064e-03  3.497e-02  -0.145 0.884861
as.factor(year)2007:as.factor(qt)4     -1.516e-01  3.782e-02  -4.008 6.12e-05 ***
as.factor(year)2008:as.factor(qt)4     -5.606e-02  3.545e-02  -1.582 0.113758
as.factor(year)2009:as.factor(qt)4     -6.192e-02  3.329e-02  -1.860 0.062919 .
as.factor(year)2010:as.factor(qt)4     -3.911e-01  3.339e-02 -11.713  < 2e-16 ***
as.factor(year)2011:as.factor(qt)4     -4.543e-01  3.159e-02 -14.380  < 2e-16 ***
as.factor(year)2012:as.factor(qt)4     -3.172e-01  3.165e-02 -10.023  < 2e-16 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for Negative Binomial(1.3451) family taken to be 1)

    Null deviance: 545213  on 462492  degrees of freedom
Residual deviance: 466694  on 462299  degrees of freedom
AIC: 1355068

Number of Fisher Scoring iterations: 1

              Theta:  1.34513
          Std. Err.:  0.00685

 2 x log-likelihood:  -1354677.87300
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