



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

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Abstract

The updated standardized CPUE for Japanese offshore and distant water longline fishery was provided. The standardized method was same with former stock assessment. The estimated abundance trend in WCPO was fluctuated and the one in EPO showed increasing trend especially after 2005.

Introduction

The abundance indices of Japanese offshore and distant-water longline fishery in the Pacific were provided by Kimoto et al. (2014). The purpose of this document is to provide the updated information.

Materials and Methods

In this study, aggregated data by 5x5 degree grids, month, and gear configurations between 1975 and 2015 were used for the analysis. The operation area information was aggregated by same area separation with former analysis (Fig. 1). The five categories of the gear configurations arbitrarily were adopted 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. The analysis conducted separately for WCNPO and EPO (Fig. 1). Area 8, 9, 12, 14 and 16 were removed from analysis because of the small number of data set. The gear configurations 1 (HPB: 3-4) and 2(HPB:5-6) were combined in EPO because of the number of data set.

The standardized model was conducted as follow equation.

number of caught sword fish~ year + quarter + area + gear + year:area + year:quarter + offset(log(hooks)) + negative binomial error

Here, all exploitable variables are categorical factors except hooks and log function was used as link function. After estimating all coefficients of exploitable variables, least squared mean of each year was calculated as annual trend of stock abundance. Non parametric bootstrap with 100 trials was used to estimate standard error of least squared mean for each year, respectively.

Additional analysis by using set by set data in EPO was conducted. The model was same with the one using for aggregate data, i.e.

number of caught sword fish~ year + quarter + area + gear + year:area + year:quarter + offset(log(hooks)) + negative binomial error

Results and Discussions

Nominal CPUE, standardized CPUE and standard error were shown in Table 1. Scaled annual trends were shown in Fig 2. In WCPO, after 2012 the annual trend increased but generally be flat. In EPO, after 2005 the annual trend drastically increased and this caused problem on fitting to stock assessment model.

Residuals pattern and diagnostic figures and table were shown in appendix and any significant problem was not shown.

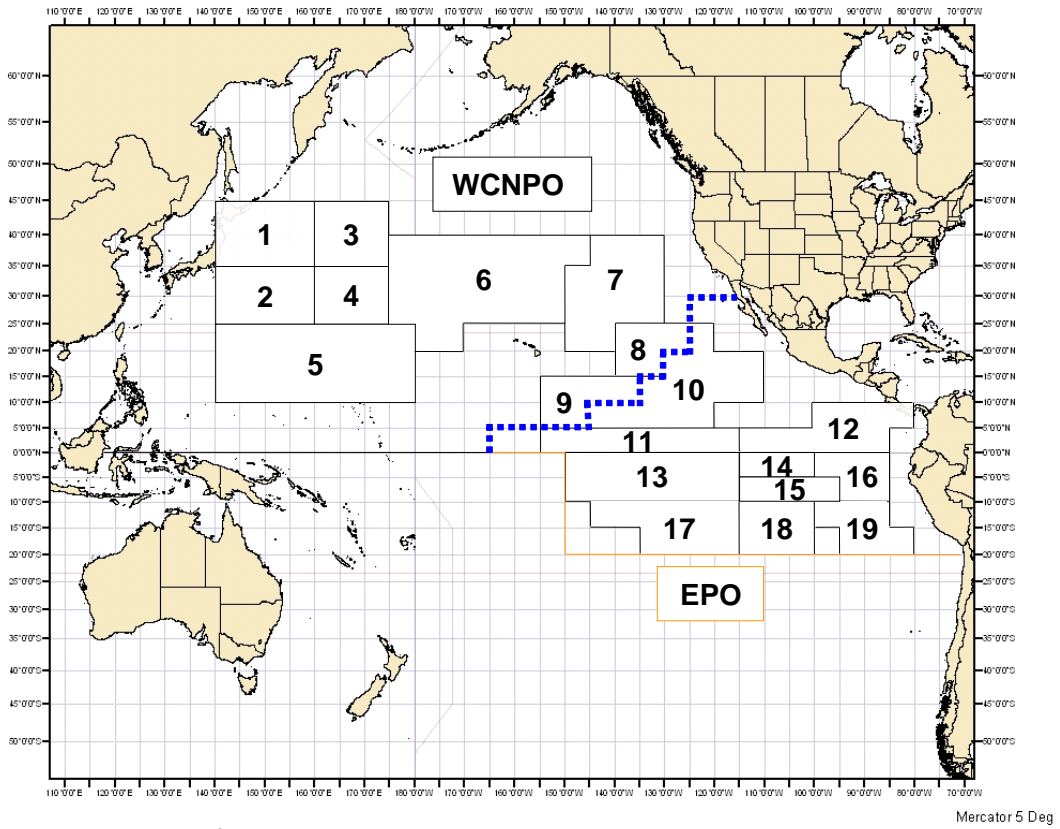
Using set-by-set data in EPO, there are no significant problem on model fitting and the standardized indices were almost same with the result by aggregated data (see Appendix 2).

References

- Ichinokawa, M. and J. Brodziak. 2010. Using adaptive area stratification to standardize catch rates with application to North Pacific swordfish (*Xiphias gladius*). Fisheries Research 106: 249-260.
- Kimoto, A., M. Kanaiwa and K. Yokawa. 2014. Update of the Catch per Unit Effort (CPUE) distribution of swordfish (*Xiphias gladius*) by the Japanese offshore and distantwater longline fishery in the Pacific. ISC/14/BILLWG-1/08.

Table 1. Nominal CPUE, standardized CPUE and standard error for each region.

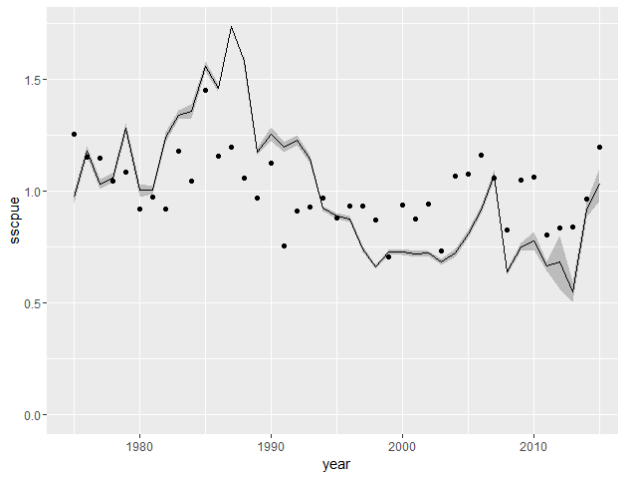
WCPO				EPO			
Year	nCPUE	sCPUE	SE	Year	nCPUE	sCPUE	SE
1975	1.477	0.471	0.076	1975	0.406	0.348	0.048
1976	1.355	0.570	0.061	1976	0.390	0.353	0.029
1977	1.350	0.499	0.055	1977	0.409	0.391	0.032
1978	1.228	0.513	0.051	1978	0.394	0.334	0.028
1979	1.279	0.620	0.061	1979	0.313	0.292	0.023
1980	1.085	0.486	0.078	1980	0.398	0.304	0.038
1981	1.145	0.487	0.047	1981	0.364	0.363	0.049
1982	1.083	0.601	0.057	1982	0.325	0.295	0.039
1983	1.390	0.649	0.051	1983	0.413	0.279	0.032
1984	1.228	0.656	0.073	1984	0.244	0.219	0.048
1985	1.709	0.753	0.045	1985	0.249	0.229	0.037
1986	1.364	0.707	0.041	1986	0.292	0.301	0.033
1987	1.407	0.840	0.061	1987	0.305	0.316	0.030
1988	1.247	0.764	0.047	1988	0.257	0.260	0.037
1989	1.142	0.569	0.036	1989	0.252	0.244	0.032
1990	1.325	0.607	0.069	1990	0.321	0.313	0.026
1991	0.887	0.579	0.046	1991	0.275	0.273	0.022
1992	1.071	0.594	0.047	1992	0.277	0.246	0.024
1993	1.095	0.553	0.038	1993	0.295	0.287	0.023
1994	1.142	0.447	0.029	1994	0.266	0.278	0.023
1995	1.036	0.430	0.035	1995	0.284	0.274	0.030
1996	1.100	0.423	0.036	1996	0.330	0.313	0.024
1997	1.101	0.359	0.047	1997	0.384	0.364	0.033
1998	1.025	0.320	0.035	1998	0.463	0.411	0.025
1999	0.830	0.352	0.032	1999	0.401	0.382	0.029
2000	1.106	0.353	0.036	2000	0.504	0.466	0.028
2001	1.029	0.349	0.041	2001	0.591	0.552	0.024
2002	1.107	0.350	0.033	2002	0.476	0.443	0.022
2003	0.863	0.331	0.037	2003	0.478	0.444	0.029
2004	1.257	0.350	0.060	2004	0.376	0.357	0.029
2005	1.265	0.392	0.055	2005	0.420	0.368	0.039
2006	1.367	0.444	0.045	2006	0.486	0.461	0.037
2007	1.245	0.519	0.064	2007	0.570	0.524	0.033
2008	0.973	0.309	0.046	2008	0.645	0.638	0.030
2009	1.236	0.364	0.055	2009	0.914	0.875	0.032
2010	1.251	0.377	0.105	2010	1.067	1.092	0.030
2011	0.947	0.321	0.058	2011	1.044	1.056	0.028
2012	0.984	0.330	1.797	2012	0.855	1.081	0.027
2013	0.990	0.266	0.653	2013	1.019	1.261	0.030
2014	1.133	0.444	0.096	2014	1.241	1.356	0.025
2015	1.411	0.499	0.157	2015	1.492	1.542	0.033



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 this analysis.

a) WCPO



b) EPO

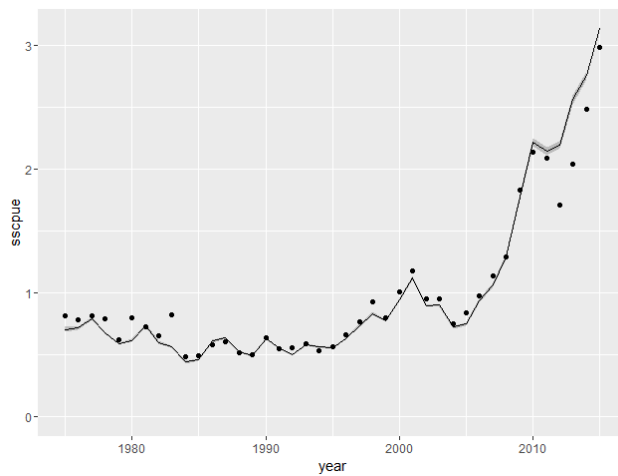


Figure 2. Scaled nominal and standardized CPUE for each region.

The solid lines show standardized CPUE and closed circle showed nominal CPUE scaled by each mean.

Gray areas showed standard error for each estimated standardized CPUE.

Appendix

Table A1 deviance table for WCPO

Factor	Df	Deviance	Resid. Df	Resid. Dev	LR Chisq	p
Null			43833	101880		
year	40	1654.3	43793	100226	1776.1	0.00
quarter	3	2412.8	43790	97813	1480.4	0.00
area	6	24607.4	43784	73205	7156.5	0.00
gear	4	19470.8	43780	53735	17445.6	0.00
year:area	240	2774.4	43540	50960	2664.5	0.00
year:quarter	120	1288.2	43420	49672	1288.2	0.00

Table A2 deviance table for EPO

Factor	Df	Deviance	Resid. Df	Resid. Dev	LR Chisq	p
Null			48121	92573		
year	40	22691.4	48081	69882	22613.6	0.00
quarter	3	2754.3	48078	67127	3147.1	0.00
area	6	5752.1	48072	61375	4761	0.00
gear	3	328.4	48069	61047	214.4	0.00
year:area	240	6252.3	47829	54794	5388.1	0.00
year:quarter	120	1327.1	47709	53467	1327.1	0.00

Table a3 summary table of GLM result for WCPO

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-5.882943	0.148071	-39.731	< 2e-16 ***
as.factor(year)1976	0.183171	0.189293	0.968	0.333215
as.factor(year)1977	0.039245	0.184481	0.213	0.831535
as.factor(year)1978	0.861781	0.194061	4.441	8.96e-06 ***
as.factor(year)1979	1.072227	0.189220	5.667	1.46e-08 ***
as.factor(year)1980	-0.093818	0.190271	-0.493	0.621959
as.factor(year)1981	-0.911027	0.189259	-4.814	1.48e-06 ***
as.factor(year)1982	-0.696715	0.186768	-3.730	0.000191 ***
as.factor(year)1983	-0.124841	0.192510	-0.648	0.516666
as.factor(year)1984	0.388482	0.187917	2.067	0.038706 *
as.factor(year)1985	0.403272	0.193302	2.086	0.036957 *
as.factor(year)1986	0.082048	0.194552	0.422	0.673222
as.factor(year)1987	0.177311	0.191676	0.925	0.354938
as.factor(year)1988	0.042083	0.191210	0.220	0.825804
as.factor(year)1989	0.058121	0.216972	0.268	0.788796
as.factor(year)1990	0.193856	0.209508	0.925	0.354813
as.factor(year)1991	0.252200	0.196767	1.282	0.199940
as.factor(year)1992	-0.269015	0.219568	-1.225	0.220500
as.factor(year)1993	-0.115395	0.203233	-0.568	0.570172
as.factor(year)1994	0.079662	0.189843	0.420	0.674761
as.factor(year)1995	-0.089229	0.192530	-0.463	0.643040
as.factor(year)1996	-0.347901	0.196670	-1.769	0.076901 .
as.factor(year)1997	0.164763	0.196101	0.840	0.400797
as.factor(year)1998	-0.642916	0.214522	-2.997	0.002727 **
as.factor(year)1999	-0.320523	0.206017	-1.556	0.119754
as.factor(year)2000	-0.492930	0.199069	-2.476	0.013280 *
as.factor(year)2001	-1.204548	0.196646	-6.125	9.04e-10 ***
as.factor(year)2002	-0.921078	0.209081	-4.405	1.06e-05 ***
as.factor(year)2003	-0.379721	0.205939	-1.844	0.065205 .
as.factor(year)2004	-0.809206	0.210019	-3.853	0.000117 ***
as.factor(year)2005	-0.736612	0.225266	-3.270	0.001076 **
as.factor(year)2006	-0.710605	0.208496	-3.408	0.000654 ***
as.factor(year)2007	0.130711	0.191938	0.681	0.495869
as.factor(year)2008	-0.548200	0.197006	-2.783	0.005391 **

as.factor(year)2009	-0.685685	0.203837	-3.364	0.000769	***
as.factor(year)2010	-0.804281	0.215044	-3.740	0.000184	***
as.factor(year)2011	-1.011649	0.242620	-4.170	3.05e-05	***
as.factor(year)2012	-0.680489	0.229047	-2.971	0.002969	**
as.factor(year)2013	-0.242731	0.226759	-1.070	0.284423	
as.factor(year)2014	-0.638078	0.209516	-3.045	0.002323	**
as.factor(year)2015	0.087595	0.227045	0.386	0.699642	
as.factor(qt)2	-0.064881	0.120347	-0.539	0.589808	
as.factor(qt)3	-0.838395	0.127177	-6.592	4.33e-11	***
as.factor(qt)4	-0.636095	0.091435	-6.957	3.48e-12	***
as.factor(ar09)2	1.035094	0.145957	7.092	1.32e-12	***
as.factor(ar09)3	0.605253	0.245271	2.468	0.013599	*
as.factor(ar09)4	0.606179	0.174456	3.475	0.000511	***
as.factor(ar09)5	-0.684510	0.142753	-4.795	1.63e-06	***
as.factor(ar09)6	-0.232535	0.182767	-1.272	0.203265	
as.factor(ar09)7	-2.574322	0.186836	-13.778	< 2e-16	***
as.factor(gear)2	-0.559965	0.022153	-25.277	< 2e-16	***
as.factor(gear)3	-1.148891	0.023840	-48.192	< 2e-16	***
as.factor(gear)4	-1.953058	0.016482	-118.495	< 2e-16	***
as.factor(gear)5	-2.412343	0.029639	-81.392	< 2e-16	***
as.factor(year)1976:as.factor(ar09)2	-0.548661	0.188632	-2.909	0.003630	**
as.factor(year)1977:as.factor(ar09)2	-0.566043	0.183658	-3.082	0.002056	**
as.factor(year)1978:as.factor(ar09)2	-0.838666	0.194419	-4.314	1.61e-05	***
as.factor(year)1979:as.factor(ar09)2	-1.383675	0.191604	-7.222	5.14e-13	***
as.factor(year)1980:as.factor(ar09)2	-0.495791	0.192145	-2.580	0.009872	**
as.factor(year)1981:as.factor(ar09)2	0.387558	0.190296	2.037	0.041690	*
as.factor(year)1982:as.factor(ar09)2	0.116667	0.188749	0.618	0.536503	
as.factor(year)1983:as.factor(ar09)2	-0.092821	0.192939	-0.481	0.630451	
as.factor(year)1984:as.factor(ar09)2	-0.731407	0.188807	-3.874	0.000107	***
as.factor(year)1985:as.factor(ar09)2	-0.519570	0.194709	-2.668	0.007620	**
as.factor(year)1986:as.factor(ar09)2	-0.504359	0.193886	-2.601	0.009287	**
as.factor(year)1987:as.factor(ar09)2	-0.716164	0.191224	-3.745	0.000180	***
as.factor(year)1988:as.factor(ar09)2	-0.383527	0.197415	-1.943	0.052047	.
as.factor(year)1989:as.factor(ar09)2	-0.409498	0.222574	-1.840	0.065793	.
as.factor(year)1990:as.factor(ar09)2	-0.454256	0.215750	-2.105	0.035250	*
as.factor(year)1991:as.factor(ar09)2	-0.652342	0.203039	-3.213	0.001314	**

as.factor(year)1992:as.factor(ar09)2	-0.135248	0.224472	-0.603	0.546833
as.factor(year)1993:as.factor(ar09)2	-0.678468	0.204177	-3.323	0.000891 ***
as.factor(year)1994:as.factor(ar09)2	-0.650651	0.190267	-3.420	0.000627 ***
as.factor(year)1995:as.factor(ar09)2	-0.880515	0.195436	-4.505	6.63e-06 ***
as.factor(year)1996:as.factor(ar09)2	-0.634405	0.201415	-3.150	0.001634 **
as.factor(year)1997:as.factor(ar09)2	-1.108520	0.197769	-5.605	2.08e-08 ***
as.factor(year)1998:as.factor(ar09)2	-0.379668	0.217045	-1.749	0.080247 .
as.factor(year)1999:as.factor(ar09)2	-0.671222	0.211391	-3.175	0.001497 **
as.factor(year)2000:as.factor(ar09)2	-0.390532	0.201897	-1.934	0.053075 .
as.factor(year)2001:as.factor(ar09)2	0.001753	0.199727	0.009	0.992999
as.factor(year)2002:as.factor(ar09)2	-0.683469	0.220251	-3.103	0.001915 **
as.factor(year)2003:as.factor(ar09)2	-1.467050	0.213505	-6.871	6.36e-12 ***
as.factor(year)2004:as.factor(ar09)2	-0.455792	0.220306	-2.069	0.038555 *
as.factor(year)2005:as.factor(ar09)2	-0.065915	0.227407	-0.290	0.771926
as.factor(year)2006:as.factor(ar09)2	-0.166562	0.213488	-0.780	0.435275
as.factor(year)2007:as.factor(ar09)2	-0.874698	0.190150	-4.600	4.22e-06 ***
as.factor(year)2008:as.factor(ar09)2	-0.617226	0.202898	-3.042	0.002350 **
as.factor(year)2009:as.factor(ar09)2	-0.858720	0.212084	-4.049	5.14e-05 ***
as.factor(year)2010:as.factor(ar09)2	-0.904362	0.218715	-4.135	3.55e-05 ***
as.factor(year)2011:as.factor(ar09)2	-0.852803	0.250812	-3.400	0.000673 ***
as.factor(year)2012:as.factor(ar09)2	-0.856881	0.227591	-3.765	0.000167 ***
as.factor(year)2013:as.factor(ar09)2	-1.414699	0.226863	-6.236	4.49e-10 ***
as.factor(year)2014:as.factor(ar09)2	-1.021335	0.217829	-4.689	2.75e-06 ***
as.factor(year)2015:as.factor(ar09)2	-1.267058	0.227409	-5.572	2.52e-08 ***
as.factor(year)1976:as.factor(ar09)3	-0.310270	0.325229	-0.954	0.340082
as.factor(year)1977:as.factor(ar09)3	-0.554586	0.333288	-1.664	0.096116 .
as.factor(year)1978:as.factor(ar09)3	-1.236247	0.313709	-3.941	8.12e-05 ***
as.factor(year)1979:as.factor(ar09)3	-1.534446	0.302114	-5.079	3.79e-07 ***
as.factor(year)1980:as.factor(ar09)3	-1.005630	0.304648	-3.301	0.000964 ***
as.factor(year)1981:as.factor(ar09)3	-0.046971	0.304376	-0.154	0.877359
as.factor(year)1982:as.factor(ar09)3	-0.911181	0.292483	-3.115	0.001837 **
as.factor(year)1983:as.factor(ar09)3	-0.460261	0.301876	-1.525	0.127342
as.factor(year)1984:as.factor(ar09)3	-1.000528	0.289981	-3.450	0.000560 ***
as.factor(year)1985:as.factor(ar09)3	-1.033666	0.299034	-3.457	0.000547 ***
as.factor(year)1986:as.factor(ar09)3	-0.729352	0.296420	-2.461	0.013873 *
as.factor(year)1987:as.factor(ar09)3	-0.562262	0.287842	-1.953	0.050776 .

as.factor(year)1988:as.factor(ar09)3	-0.692728	0.288786	-2.399	0.016451	*
as.factor(year)1989:as.factor(ar09)3	-0.312089	0.308045	-1.013	0.310998	
as.factor(year)1990:as.factor(ar09)3	-0.499532	0.301404	-1.657	0.097449	.
as.factor(year)1991:as.factor(ar09)3	-0.885708	0.289467	-3.060	0.002215	**
as.factor(year)1992:as.factor(ar09)3	-0.355137	0.310172	-1.145	0.252223	
as.factor(year)1993:as.factor(ar09)3	-0.195079	0.301277	-0.648	0.517303	
as.factor(year)1994:as.factor(ar09)3	-0.823228	0.275724	-2.986	0.002829	**
as.factor(year)1995:as.factor(ar09)3	-0.614285	0.283703	-2.165	0.030369	*
as.factor(year)1996:as.factor(ar09)3	-0.446679	0.288973	-1.546	0.122165	
as.factor(year)1997:as.factor(ar09)3	-0.650543	0.280448	-2.320	0.020359	*
as.factor(year)1998:as.factor(ar09)3	-0.441040	0.290914	-1.516	0.129507	
as.factor(year)1999:as.factor(ar09)3	-0.479281	0.285618	-1.678	0.093337	.
as.factor(year)2000:as.factor(ar09)3	-0.588928	0.281917	-2.089	0.036706	*
as.factor(year)2001:as.factor(ar09)3	-0.153936	0.281341	-0.547	0.584274	
as.factor(year)2002:as.factor(ar09)3	-0.987748	0.285957	-3.454	0.000552	***
as.factor(year)2003:as.factor(ar09)3	-1.044715	0.284632	-3.670	0.000242	***
as.factor(year)2004:as.factor(ar09)3	-0.745202	0.287308	-2.594	0.009494	**
as.factor(year)2005:as.factor(ar09)3	-0.394103	0.298044	-1.322	0.186069	
as.factor(year)2006:as.factor(ar09)3	-0.196262	0.289036	-0.679	0.497122	
as.factor(year)2007:as.factor(ar09)3	-0.560567	0.280987	-1.995	0.046044	*
as.factor(year)2008:as.factor(ar09)3	-0.338318	0.287302	-1.178	0.238968	
as.factor(year)2009:as.factor(ar09)3	-0.951913	0.287679	-3.309	0.000936	***
as.factor(year)2010:as.factor(ar09)3	-0.251235	0.294214	-0.854	0.393150	
as.factor(year)2011:as.factor(ar09)3	-0.508697	0.308396	-1.649	0.099047	.
as.factor(year)2012:as.factor(ar09)3	-0.148109	0.302429	-0.490	0.624324	
as.factor(year)2013:as.factor(ar09)3	-0.873772	0.309524	-2.823	0.004758	**
as.factor(year)2014:as.factor(ar09)3	-0.764805	0.303865	-2.517	0.011839	*
as.factor(year)2015:as.factor(ar09)3	-1.111293	0.324430	-3.425	0.000614	***
as.factor(year)1976:as.factor(ar09)4	-0.274064	0.220895	-1.241	0.214717	
as.factor(year)1977:as.factor(ar09)4	-0.322188	0.217682	-1.480	0.138850	
as.factor(year)1978:as.factor(ar09)4	-0.950205	0.223893	-4.244	2.20e-05	***
as.factor(year)1979:as.factor(ar09)4	-1.406303	0.217224	-6.474	9.55e-11	***
as.factor(year)1980:as.factor(ar09)4	-0.696159	0.221113	-3.148	0.001641	**
as.factor(year)1981:as.factor(ar09)4	0.387606	0.218132	1.777	0.075579	.
as.factor(year)1982:as.factor(ar09)4	-0.067415	0.216565	-0.311	0.755579	
as.factor(year)1983:as.factor(ar09)4	-0.217679	0.220969	-0.985	0.324570	

as.factor(year)1984:as.factor(ar09)4	-0.995322	0.221134	-4.501	6.76e-06	***
as.factor(year)1985:as.factor(ar09)4	-0.624929	0.226995	-2.753	0.005904	**
as.factor(year)1986:as.factor(ar09)4	-0.268936	0.223263	-1.205	0.228370	
as.factor(year)1987:as.factor(ar09)4	-0.152075	0.221428	-0.687	0.492215	
as.factor(year)1988:as.factor(ar09)4	-0.176746	0.221749	-0.797	0.425420	
as.factor(year)1989:as.factor(ar09)4	-0.078361	0.244625	-0.320	0.748718	
as.factor(year)1990:as.factor(ar09)4	-0.219204	0.240638	-0.911	0.362333	
as.factor(year)1991:as.factor(ar09)4	-0.495766	0.226668	-2.187	0.028728	*
as.factor(year)1992:as.factor(ar09)4	0.085325	0.251461	0.339	0.734371	
as.factor(year)1993:as.factor(ar09)4	-0.141938	0.232877	-0.609	0.542195	
as.factor(year)1994:as.factor(ar09)4	-0.662650	0.219490	-3.019	0.002536	**
as.factor(year)1995:as.factor(ar09)4	-0.211995	0.221105	-0.959	0.337660	
as.factor(year)1996:as.factor(ar09)4	-0.261510	0.223182	-1.172	0.241304	
as.factor(year)1997:as.factor(ar09)4	-0.611561	0.218590	-2.798	0.005146	**
as.factor(year)1998:as.factor(ar09)4	-0.279849	0.235103	-1.190	0.233918	
as.factor(year)1999:as.factor(ar09)4	-0.473279	0.232271	-2.038	0.041589	*
as.factor(year)2000:as.factor(ar09)4	-0.307622	0.225831	-1.362	0.173143	
as.factor(year)2001:as.factor(ar09)4	0.248267	0.220610	1.125	0.260433	
as.factor(year)2002:as.factor(ar09)4	-0.225517	0.231291	-0.975	0.329542	
as.factor(year)2003:as.factor(ar09)4	-0.555287	0.231588	-2.398	0.016497	*
as.factor(year)2004:as.factor(ar09)4	-0.482434	0.233913	-2.062	0.039164	*
as.factor(year)2005:as.factor(ar09)4	0.020901	0.245644	0.085	0.932194	
as.factor(year)2006:as.factor(ar09)4	-0.006646	0.234823	-0.028	0.977422	
as.factor(year)2007:as.factor(ar09)4	-0.624319	0.216839	-2.879	0.003987	**
as.factor(year)2008:as.factor(ar09)4	-0.228883	0.227109	-1.008	0.313545	
as.factor(year)2009:as.factor(ar09)4	-0.467551	0.242139	-1.931	0.053492	.
as.factor(year)2010:as.factor(ar09)4	-0.098316	0.240684	-0.408	0.682917	
as.factor(year)2011:as.factor(ar09)4	-0.297381	0.259204	-1.147	0.251262	
as.factor(year)2012:as.factor(ar09)4	-0.207714	0.245768	-0.845	0.398020	
as.factor(year)2013:as.factor(ar09)4	-0.906842	0.240998	-3.763	0.000168	***
as.factor(year)2014:as.factor(ar09)4	-0.738021	0.226347	-3.261	0.001112	**
as.factor(year)2015:as.factor(ar09)4	-1.024994	0.239289	-4.283	1.84e-05	***
as.factor(year)1976:as.factor(ar09)5	-0.203981	0.186303	-1.095	0.273564	
as.factor(year)1977:as.factor(ar09)5	-0.227063	0.182163	-1.246	0.212587	
as.factor(year)1978:as.factor(ar09)5	-1.129588	0.192601	-5.865	4.49e-09	***
as.factor(year)1979:as.factor(ar09)5	-1.291869	0.188040	-6.870	6.41e-12	***

as.factor(year)1980:as.factor(ar09)5	-0.486324	0.188957	-2.574	0.010061	*
as.factor(year)1981:as.factor(ar09)5	0.406147	0.186514	2.178	0.029438	*
as.factor(year)1982:as.factor(ar09)5	-0.087835	0.187100	-0.469	0.638745	
as.factor(year)1983:as.factor(ar09)5	-0.021469	0.190682	-0.113	0.910357	
as.factor(year)1984:as.factor(ar09)5	-0.550327	0.188496	-2.920	0.003505	**
as.factor(year)1985:as.factor(ar09)5	-0.169243	0.197951	-0.855	0.392565	
as.factor(year)1986:as.factor(ar09)5	-0.189642	0.192587	-0.985	0.324767	
as.factor(year)1987:as.factor(ar09)5	-0.448714	0.186810	-2.402	0.016307	*
as.factor(year)1988:as.factor(ar09)5	-0.131439	0.188160	-0.699	0.484835	
as.factor(year)1989:as.factor(ar09)5	-0.177785	0.219377	-0.810	0.417704	
as.factor(year)1990:as.factor(ar09)5	-0.143459	0.213662	-0.671	0.501948	
as.factor(year)1991:as.factor(ar09)5	-0.631638	0.194629	-3.245	0.001173	**
as.factor(year)1992:as.factor(ar09)5	0.180163	0.215986	0.834	0.404200	
as.factor(year)1993:as.factor(ar09)5	-0.027016	0.198124	-0.136	0.891539	
as.factor(year)1994:as.factor(ar09)5	-0.140444	0.188699	-0.744	0.456709	
as.factor(year)1995:as.factor(ar09)5	-0.116525	0.186783	-0.624	0.532725	
as.factor(year)1996:as.factor(ar09)5	0.104677	0.193809	0.540	0.589125	
as.factor(year)1997:as.factor(ar09)5	-0.501660	0.197722	-2.537	0.011174	*
as.factor(year)1998:as.factor(ar09)5	0.249407	0.208029	1.199	0.230565	
as.factor(year)1999:as.factor(ar09)5	-0.255330	0.201915	-1.265	0.206036	
as.factor(year)2000:as.factor(ar09)5	0.035773	0.191548	0.187	0.851849	
as.factor(year)2001:as.factor(ar09)5	0.494617	0.188253	2.627	0.008604	**

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Table a4 summary table of GLM result for EPO

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-7.7532806	0.0927824	-83.564	< 2e-16 ***
as.factor(year)1976	0.1463662	0.1172911	1.248	0.212072
as.factor(year)1977	0.0695348	0.1151603	0.604	0.545971
as.factor(year)1978	-0.2791906	0.1165326	-2.396	0.016583 *
as.factor(year)1979	-0.6055772	0.1180539	-5.130	2.90e-07 ***
as.factor(year)1980	-1.4127656	0.1322520	-10.682	< 2e-16 ***
as.factor(year)1981	0.1629476	0.1204292	1.353	0.176037
as.factor(year)1982	-0.0999217	0.1223482	-0.817	0.414100
as.factor(year)1983	-0.8595981	0.1436827	-5.983	2.20e-09 ***
as.factor(year)1984	-0.2011689	0.1288145	-1.562	0.118360
as.factor(year)1985	-0.7220455	0.1262491	-5.719	1.07e-08 ***
as.factor(year)1986	-0.1577666	0.1297043	-1.216	0.223850
as.factor(year)1987	-0.0062325	0.1236781	-0.050	0.959809
as.factor(year)1988	-0.4836432	0.1222830	-3.955	7.65e-05 ***
as.factor(year)1989	0.0044102	0.1211089	0.036	0.970951
as.factor(year)1990	-0.6724503	0.1196703	-5.619	1.92e-08 ***
as.factor(year)1991	-0.5221385	0.1230223	-4.244	2.19e-05 ***
as.factor(year)1992	-1.2039953	0.1363560	-8.830	< 2e-16 ***
as.factor(year)1993	-0.8336272	0.1240372	-6.721	1.81e-11 ***
as.factor(year)1994	-0.7424519	0.1134318	-6.545	5.94e-11 ***
as.factor(year)1995	-0.8239092	0.1218668	-6.761	1.37e-11 ***
as.factor(year)1996	-0.7233428	0.1257774	-5.751	8.87e-09 ***
as.factor(year)1997	-0.3157151	0.1414352	-2.232	0.025600 *
as.factor(year)1998	-0.4609038	0.1307172	-3.526	0.000422 ***
as.factor(year)1999	-0.1310462	0.1355614	-0.967	0.333698
as.factor(year)2000	0.3268810	0.1227996	2.662	0.007770 **
as.factor(year)2001	0.6082961	0.1173549	5.183	2.18e-07 ***
as.factor(year)2002	0.0050742	0.1178811	0.043	0.965665
as.factor(year)2003	-0.4236828	0.1281850	-3.305	0.000949 ***
as.factor(year)2004	-0.7432315	0.1265091	-5.875	4.23e-09 ***
as.factor(year)2005	-0.7470043	0.1741815	-4.289	1.80e-05 ***
as.factor(year)2006	-0.0093868	0.1524727	-0.062	0.950910
as.factor(year)2007	0.2617189	0.1874011	1.397	0.162543
as.factor(year)2008	0.8419658	0.1518159	5.546	2.92e-08 ***

as.factor(year)2009	0.8934784	0.1373933	6.503	7.87e-11	***
as.factor(year)2010	0.9944871	0.1579047	6.298	3.01e-10	***
as.factor(year)2011	0.9036718	0.1372773	6.583	4.62e-11	***
as.factor(year)2012	1.7061305	0.1587646	10.746	< 2e-16	***
as.factor(year)2013	1.7469745	0.1418974	12.312	< 2e-16	***
as.factor(year)2014	1.1305049	0.1731738	6.528	6.66e-11	***
as.factor(year)2015	1.3757863	0.2545670	5.404	6.50e-08	***
as.factor(qt)2	-0.1153599	0.0805700	-1.432	0.152202	
as.factor(qt)3	-0.0413865	0.0801893	-0.516	0.605777	
as.factor(qt)4	0.7909579	0.0839782	9.419	< 2e-16	***
as.factor(ar09)11	0.0097901	0.1037736	0.094	0.924839	
as.factor(ar09)13	-0.5210959	0.0893798	-5.830	5.54e-09	***
as.factor(ar09)15	-0.6640081	0.1845947	-3.597	0.000322	***
as.factor(ar09)17	-0.1847908	0.1099618	-1.681	0.092860	.
as.factor(ar09)18	-0.0390911	0.1167975	-0.335	0.737858	
as.factor(ar09)19	0.0462997	0.1185350	0.391	0.696093	
as.factor(gear)3	-0.1443470	0.0182966	-7.889	3.04e-15	***
as.factor(gear)4	-0.2119475	0.0168346	-12.590	< 2e-16	***
as.factor(gear)5	-0.3439644	0.0247455	-13.900	< 2e-16	***
as.factor(year)1976:as.factor(ar09)11	-0.1332632	0.1266104	-1.053	0.292549	
as.factor(year)1977:as.factor(ar09)11	0.3229541	0.1261379	2.560	0.010457	*
as.factor(year)1978:as.factor(ar09)11	0.6238899	0.1306018	4.777	1.78e-06	***
as.factor(year)1979:as.factor(ar09)11	0.6244727	0.1256635	4.969	6.72e-07	***
as.factor(year)1980:as.factor(ar09)11	1.0403982	0.1463962	7.107	1.19e-12	***
as.factor(year)1981:as.factor(ar09)11	0.6085403	0.1294952	4.699	2.61e-06	***
as.factor(year)1982:as.factor(ar09)11	-0.0282904	0.1306129	-0.217	0.828522	
as.factor(year)1983:as.factor(ar09)11	1.4265001	0.1546862	9.222	< 2e-16	***
as.factor(year)1984:as.factor(ar09)11	0.2165752	0.1427927	1.517	0.129340	
as.factor(year)1985:as.factor(ar09)11	0.6066354	0.1339790	4.528	5.96e-06	***
as.factor(year)1986:as.factor(ar09)11	0.3511289	0.1371187	2.561	0.010444	*
as.factor(year)1987:as.factor(ar09)11	0.3919728	0.1341163	2.923	0.003471	**
as.factor(year)1988:as.factor(ar09)11	0.4243520	0.1391258	3.050	0.002287	**
as.factor(year)1989:as.factor(ar09)11	0.3811999	0.1288298	2.959	0.003087	**
as.factor(year)1990:as.factor(ar09)11	0.6438311	0.1283958	5.014	5.32e-07	***
as.factor(year)1991:as.factor(ar09)11	0.6056309	0.1325358	4.570	4.89e-06	***
as.factor(year)1992:as.factor(ar09)11	0.9125939	0.1492143	6.116	9.60e-10	***

as.factor(year)1993:as.factor(ar09)11	0.6404459	0.1337712	4.788	1.69e-06	***
as.factor(year)1994:as.factor(ar09)11	0.7364365	0.1247321	5.904	3.54e-09	***
as.factor(year)1995:as.factor(ar09)11	0.9643242	0.1326933	7.267	3.67e-13	***
as.factor(year)1996:as.factor(ar09)11	0.7710483	0.1385028	5.567	2.59e-08	***
as.factor(year)1997:as.factor(ar09)11	0.6943508	0.1522346	4.561	5.09e-06	***
as.factor(year)1998:as.factor(ar09)11	1.3106485	0.1440767	9.097	< 2e-16	***
as.factor(year)1999:as.factor(ar09)11	0.5414434	0.1451882	3.729	0.000192	***
as.factor(year)2000:as.factor(ar09)11	0.5094992	0.1274917	3.996	6.43e-05	***
as.factor(year)2001:as.factor(ar09)11	0.5770912	0.1255841	4.595	4.32e-06	***
as.factor(year)2002:as.factor(ar09)11	0.7051004	0.1265398	5.572	2.52e-08	***
as.factor(year)2003:as.factor(ar09)11	0.8664744	0.1371520	6.318	2.66e-10	***
as.factor(year)2004:as.factor(ar09)11	0.9046591	0.1345904	6.722	1.80e-11	***
as.factor(year)2005:as.factor(ar09)11	1.0642369	0.1823146	5.837	5.30e-09	***
as.factor(year)2006:as.factor(ar09)11	0.7661452	0.1581043	4.846	1.26e-06	***
as.factor(year)2007:as.factor(ar09)11	0.6454860	0.2014834	3.204	0.001357	**
as.factor(year)2008:as.factor(ar09)11	0.4347954	0.1584750	2.744	0.006077	**
as.factor(year)2009:as.factor(ar09)11	0.2783969	0.1478552	1.883	0.059714	.
as.factor(year)2010:as.factor(ar09)11	0.6565431	0.1712473	3.834	0.000126	***
as.factor(year)2011:as.factor(ar09)11	0.2181609	0.1521999	1.433	0.151748	
as.factor(year)2012:as.factor(ar09)11	-0.4794590	0.1681689	-2.851	0.004357	**
as.factor(year)2013:as.factor(ar09)11	-0.0398719	0.1518844	-0.263	0.792924	
as.factor(year)2014:as.factor(ar09)11	0.2154051	0.1801496	1.196	0.231813	
as.factor(year)2015:as.factor(ar09)11	0.0614484	0.2537708	0.242	0.808671	
as.factor(year)1976:as.factor(ar09)13	0.0266641	0.1122809	0.237	0.812287	
as.factor(year)1977:as.factor(ar09)13	0.1485789	0.1108863	1.340	0.180271	
as.factor(year)1978:as.factor(ar09)13	0.5115330	0.1136523	4.501	6.77e-06	***
as.factor(year)1979:as.factor(ar09)13	0.6547278	0.1132261	5.782	7.36e-09	***
as.factor(year)1980:as.factor(ar09)13	1.4988963	0.1278319	11.726	< 2e-16	***
as.factor(year)1981:as.factor(ar09)13	0.3148276	0.1139843	2.762	0.005744	**
as.factor(year)1982:as.factor(ar09)13	0.2101475	0.1179313	1.782	0.074758	.
as.factor(year)1983:as.factor(ar09)13	0.9996824	0.1445816	6.914	4.70e-12	***
as.factor(year)1984:as.factor(ar09)13	0.0699548	0.1248034	0.561	0.575125	
as.factor(year)1985:as.factor(ar09)13	0.6451611	0.1202998	5.363	8.19e-08	***
as.factor(year)1986:as.factor(ar09)13	0.3050582	0.1216510	2.508	0.012154	*
as.factor(year)1987:as.factor(ar09)13	0.2617371	0.1179478	2.219	0.026480	*
as.factor(year)1988:as.factor(ar09)13	0.7694983	0.1165309	6.603	4.02e-11	***

as.factor(year)1989:as.factor(ar09)13	0.3475508	0.1134871	3.062	0.002195	**
as.factor(year)1990:as.factor(ar09)13	0.9711371	0.1133252	8.569	< 2e-16	***
as.factor(year)1991:as.factor(ar09)13	0.6513620	0.1190186	5.473	4.43e-08	***
as.factor(year)1992:as.factor(ar09)13	1.4846368	0.1329118	11.170	< 2e-16	***
as.factor(year)1993:as.factor(ar09)13	1.2397132	0.1196847	10.358	< 2e-16	***
as.factor(year)1994:as.factor(ar09)13	0.9035969	0.1088658	8.300	< 2e-16	***
as.factor(year)1995:as.factor(ar09)13	1.1395461	0.1165198	9.780	< 2e-16	***
as.factor(year)1996:as.factor(ar09)13	1.2701068	0.1236201	10.274	< 2e-16	***
as.factor(year)1997:as.factor(ar09)13	0.9551839	0.1402766	6.809	9.81e-12	***
as.factor(year)1998:as.factor(ar09)13	1.4234793	0.1311342	10.855	< 2e-16	***
as.factor(year)1999:as.factor(ar09)13	0.7896033	0.1309830	6.028	1.66e-09	***
as.factor(year)2000:as.factor(ar09)13	0.4980142	0.1155909	4.308	1.64e-05	***
as.factor(year)2001:as.factor(ar09)13	0.3380785	0.1130611	2.990	0.002788	**
as.factor(year)2002:as.factor(ar09)13	0.8183880	0.1151206	7.109	1.17e-12	***
as.factor(year)2003:as.factor(ar09)13	1.1853646	0.1248043	9.498	< 2e-16	***
as.factor(year)2004:as.factor(ar09)13	1.5966518	0.1237273	12.905	< 2e-16	***
as.factor(year)2005:as.factor(ar09)13	1.4236452	0.1741872	8.173	3.01e-16	***
as.factor(year)2006:as.factor(ar09)13	0.9166141	0.1493289	6.138	8.34e-10	***
as.factor(year)2007:as.factor(ar09)13	0.8754206	0.1895602	4.618	3.87e-06	***
as.factor(year)2008:as.factor(ar09)13	0.2883144	0.1476168	1.953	0.050805	.
as.factor(year)2009:as.factor(ar09)13	0.6225844	0.1358305	4.584	4.57e-06	***
as.factor(year)2010:as.factor(ar09)13	0.7352552	0.1553996	4.731	2.23e-06	***
as.factor(year)2011:as.factor(ar09)13	0.8798937	0.1381597	6.369	1.91e-10	***
as.factor(year)2012:as.factor(ar09)13	0.0187513	0.1519453	0.123	0.901784	.
as.factor(year)2013:as.factor(ar09)13	0.0994403	0.1339324	0.742	0.457805	.
as.factor(year)2014:as.factor(ar09)13	0.5944439	0.1679668	3.539	0.000402	***
as.factor(year)2015:as.factor(ar09)13	0.5394728	0.2501319	2.157	0.031025	*
as.factor(year)1976:as.factor(ar09)15	-0.0326113	0.2160315	-0.151	0.880010	.
as.factor(year)1977:as.factor(ar09)15	0.3724913	0.2059094	1.809	0.070450	.
as.factor(year)1978:as.factor(ar09)15	0.6988959	0.2082070	3.357	0.000789	***
as.factor(year)1979:as.factor(ar09)15	0.8015943	0.2059177	3.893	9.91e-05	***
as.factor(year)1980:as.factor(ar09)15	1.4087514	0.2141136	6.579	4.72e-11	***
as.factor(year)1981:as.factor(ar09)15	0.3777244	0.2057724	1.836	0.066411	.
as.factor(year)1982:as.factor(ar09)15	0.3675446	0.2064556	1.780	0.075033	.
as.factor(year)1983:as.factor(ar09)15	1.5376004	0.2177541	7.061	1.65e-12	***
as.factor(year)1984:as.factor(ar09)15	0.4464869	0.2128926	2.097	0.035972	*

as.factor(year)1985:as.factor(ar09)15	0.3863259	0.2222707	1.738	0.082195	.
as.factor(year)1986:as.factor(ar09)15	0.3088558	0.2094816	1.474	0.140379	
as.factor(year)1987:as.factor(ar09)15	0.2903758	0.2033723	1.428	0.153348	
as.factor(year)1988:as.factor(ar09)15	0.3238248	0.2093433	1.547	0.121897	
as.factor(year)1989:as.factor(ar09)15	-0.4216479	0.2108341	-2.000	0.045511	*
as.factor(year)1990:as.factor(ar09)15	0.9077726	0.2051665	4.425	9.66e-06	***
as.factor(year)1991:as.factor(ar09)15	0.6893320	0.2055150	3.354	0.000796	***
as.factor(year)1992:as.factor(ar09)15	1.0631106	0.2177029	4.883	1.04e-06	***
as.factor(year)1993:as.factor(ar09)15	1.1959527	0.2109543	5.669	1.43e-08	***
as.factor(year)1994:as.factor(ar09)15	0.9086385	0.1983198	4.582	4.61e-06	***
as.factor(year)1995:as.factor(ar09)15	1.1203493	0.2035813	5.503	3.73e-08	***
as.factor(year)1996:as.factor(ar09)15	1.0123712	0.2094491	4.833	1.34e-06	***
as.factor(year)1997:as.factor(ar09)15	0.9780573	0.2203830	4.438	9.08e-06	***
as.factor(year)1998:as.factor(ar09)15	1.2632151	0.2156239	5.858	4.67e-09	***
as.factor(year)1999:as.factor(ar09)15	0.5267742	0.2231068	2.361	0.018222	*
as.factor(year)2000:as.factor(ar09)15	0.0171405	0.2140137	0.080	0.936165	
as.factor(year)2001:as.factor(ar09)15	0.1821420	0.2089614	0.872	0.383397	
as.factor(year)2002:as.factor(ar09)15	0.6852560	0.2093734	3.273	0.001065	**
as.factor(year)2003:as.factor(ar09)15	1.1228464	0.2117973	5.302	1.15e-07	***
as.factor(year)2004:as.factor(ar09)15	1.0654197	0.2152249	4.950	7.41e-07	***
as.factor(year)2005:as.factor(ar09)15	1.3933910	0.2473757	5.633	1.77e-08	***
as.factor(year)2006:as.factor(ar09)15	0.9149118	0.2331540	3.924	8.71e-05	***
as.factor(year)2007:as.factor(ar09)15	0.8228357	0.2544079	3.234	0.001219	**
as.factor(year)2008:as.factor(ar09)15	0.4310139	0.2256305	1.910	0.056099	.
as.factor(year)2009:as.factor(ar09)15	1.0061474	0.2238418	4.495	6.96e-06	***
as.factor(year)2010:as.factor(ar09)15	1.1893388	0.2302691	5.165	2.40e-07	***
as.factor(year)2011:as.factor(ar09)15	1.3377151	0.2207712	6.059	1.37e-09	***
as.factor(year)2012:as.factor(ar09)15	0.6766369	0.2373489	2.851	0.004361	**
as.factor(year)2013:as.factor(ar09)15	0.6643045	0.2256787	2.944	0.003244	**
as.factor(year)2014:as.factor(ar09)15	1.4147710	0.2468996	5.730	1.00e-08	***
as.factor(year)2015:as.factor(ar09)15	1.1784689	0.3088179	3.816	0.000136	***
as.factor(year)1976:as.factor(ar09)17	-0.0145914	0.1377846	-0.106	0.915662	
as.factor(year)1977:as.factor(ar09)17	0.1760637	0.1352706	1.302	0.193065	
as.factor(year)1978:as.factor(ar09)17	0.5340666	0.1383693	3.860	0.000114	***
as.factor(year)1979:as.factor(ar09)17	0.7684604	0.1379999	5.569	2.57e-08	***
as.factor(year)1980:as.factor(ar09)17	1.7858984	0.1511871	11.813	< 2e-16	***

as.factor(year)1981:as.factor(ar09)17	0.3802243	0.1415637	2.686	0.007234	**
as.factor(year)1982:as.factor(ar09)17	0.4347273	0.1486278	2.925	0.003445	**
as.factor(year)1983:as.factor(ar09)17	1.3502879	0.1654008	8.164	3.25e-16	***
as.factor(year)1984:as.factor(ar09)17	0.3840698	0.1495807	2.568	0.010239	*
as.factor(year)1985:as.factor(ar09)17	0.8998823	0.1498579	6.005	1.91e-09	***
as.factor(year)1986:as.factor(ar09)17	0.0532311	0.1426606	0.373	0.709051	
as.factor(year)1987:as.factor(ar09)17	0.2440628	0.1425293	1.712	0.086829	.
as.factor(year)1988:as.factor(ar09)17	0.5776174	0.1366120	4.228	2.36e-05	***
as.factor(year)1989:as.factor(ar09)17	0.1371176	0.1384851	0.990	0.322113	
as.factor(year)1990:as.factor(ar09)17	1.0775602	0.1441013	7.478	7.56e-14	***
as.factor(year)1991:as.factor(ar09)17	0.8157014	0.1429191	5.707	1.15e-08	***
as.factor(year)1992:as.factor(ar09)17	1.3958364	0.1525037	9.153	< 2e-16	***
as.factor(year)1993:as.factor(ar09)17	1.2210398	0.1440550	8.476	< 2e-16	***
as.factor(year)1994:as.factor(ar09)17	0.8784204	0.1341084	6.550	5.75e-11	***
as.factor(year)1995:as.factor(ar09)17	1.2122523	0.1412559	8.582	< 2e-16	***
as.factor(year)1996:as.factor(ar09)17	1.2036842	0.1483312	8.115	4.86e-16	***
as.factor(year)1997:as.factor(ar09)17	0.6163293	0.1659819	3.713	0.000205	***
as.factor(year)1998:as.factor(ar09)17	1.1888093	0.1479995	8.033	9.55e-16	***
as.factor(year)1999:as.factor(ar09)17	0.6256597	0.1470684	4.254	2.10e-05	***
as.factor(year)2000:as.factor(ar09)17	0.1691887	0.1412674	1.198	0.231054	
as.factor(year)2001:as.factor(ar09)17	0.0996547	0.1373952	0.725	0.468259	
as.factor(year)2002:as.factor(ar09)17	0.6902488	0.1390082	4.966	6.85e-07	***

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Figure A1 diagnostics for the standardized model of WCPO

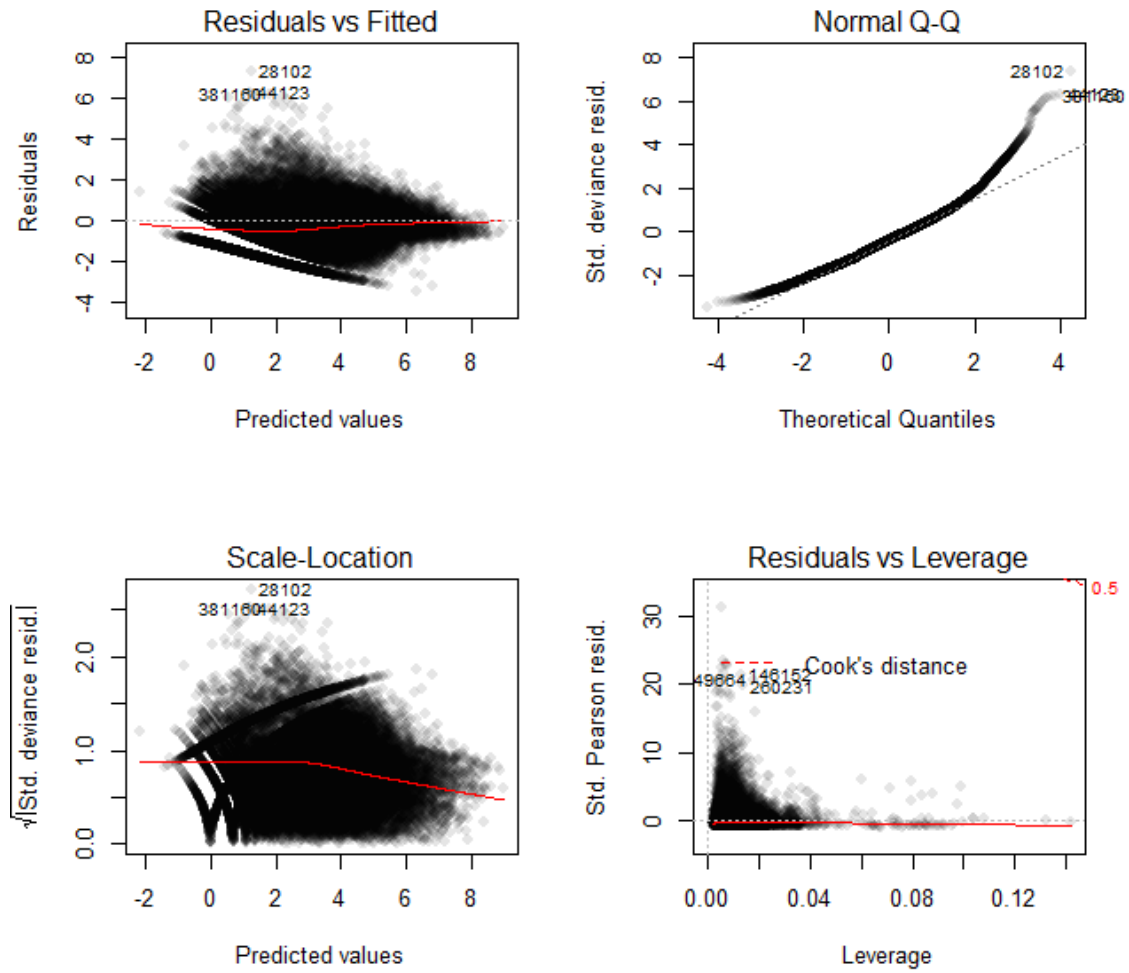


Figure A2 standardized residuals for the standardized model of WCPO

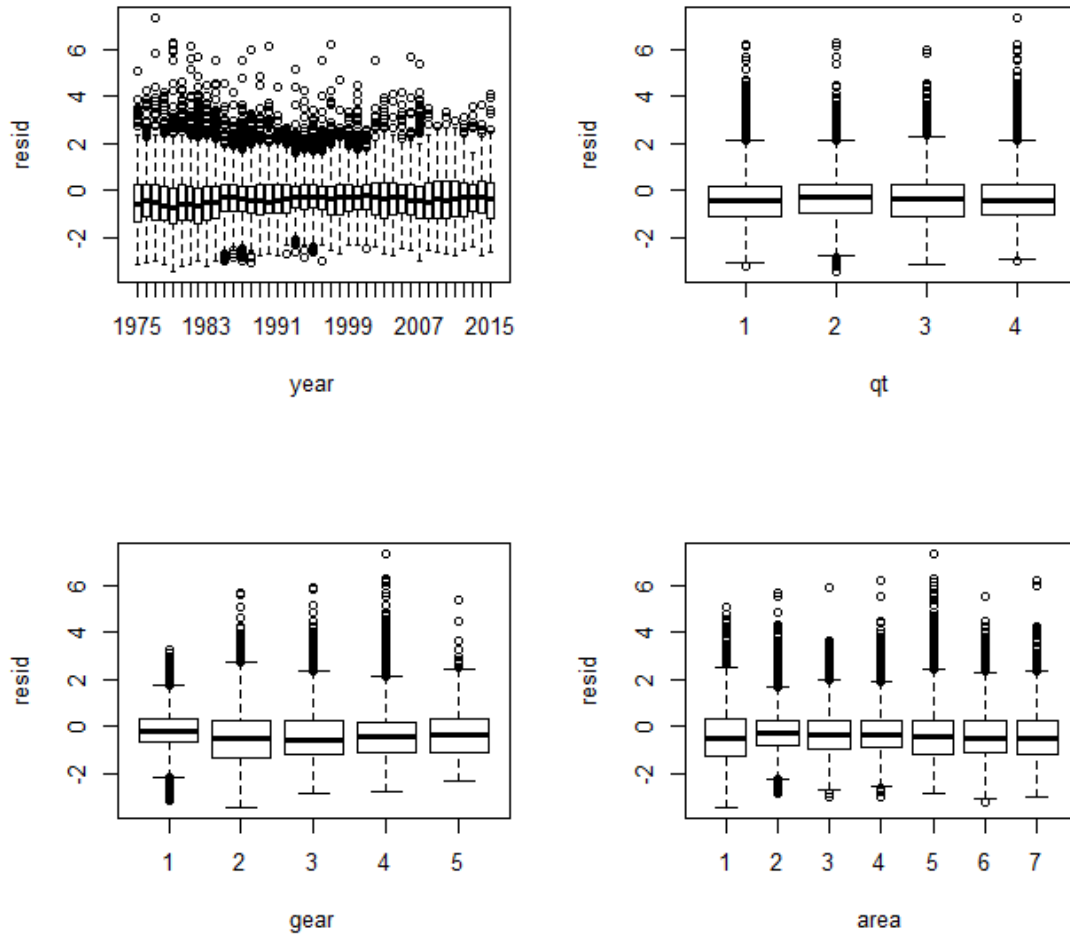


Figure A3 quantile residuals for the standardized model of WCPO

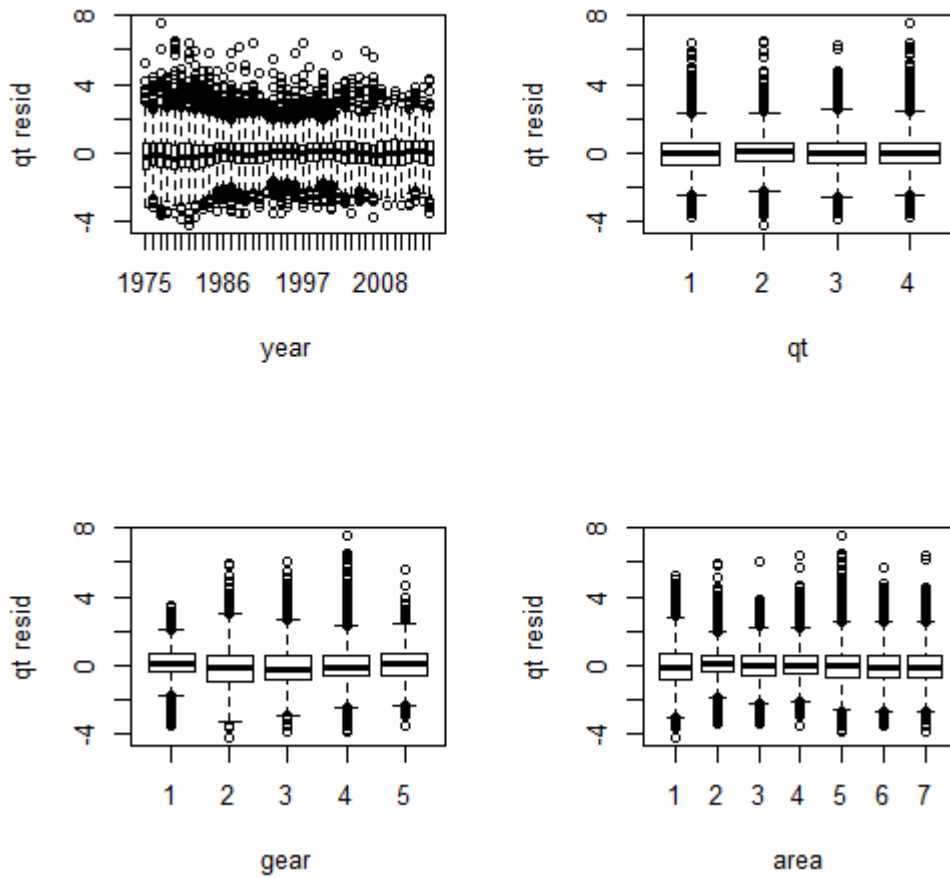


Figure A4 diagnostics for the standardized model of EPO

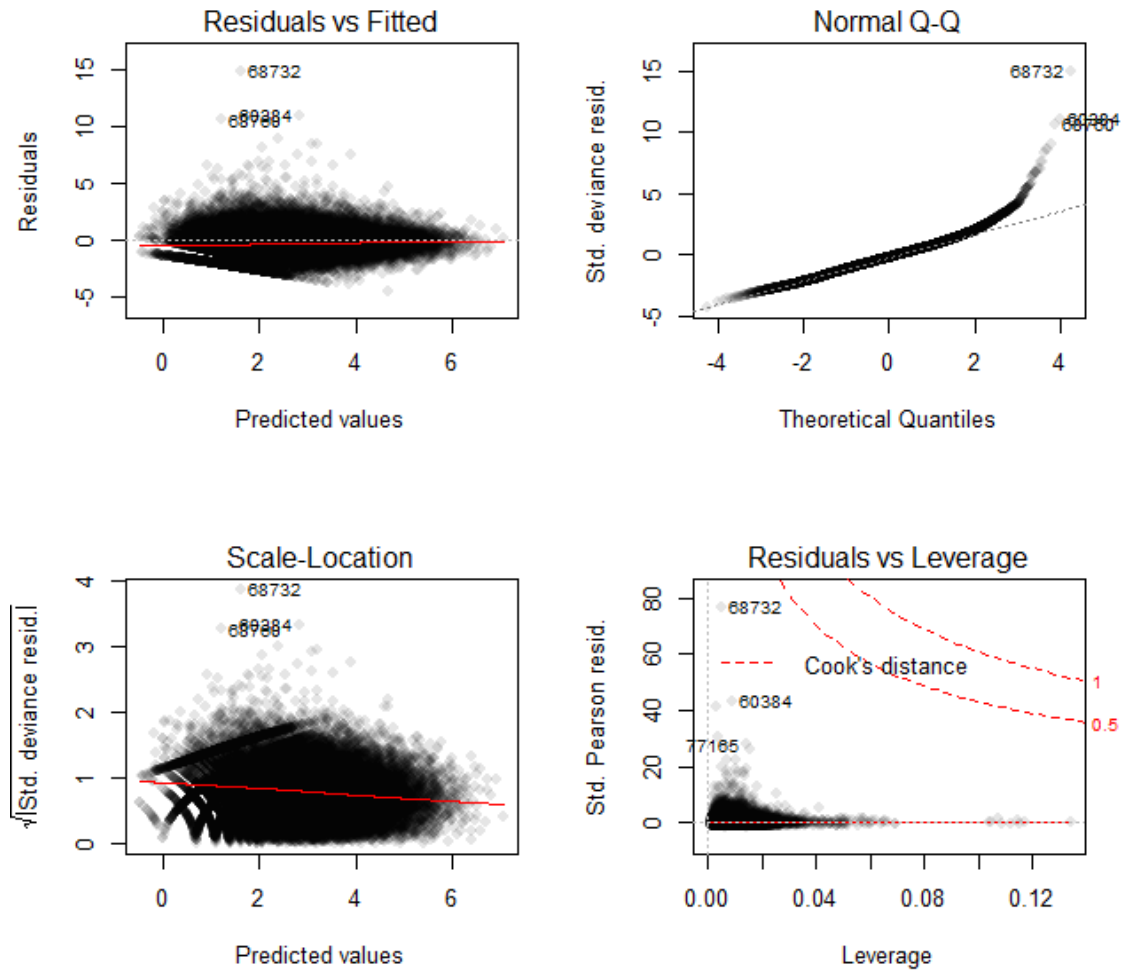


Figure A5 standardized residuals for the standardized model of EPO

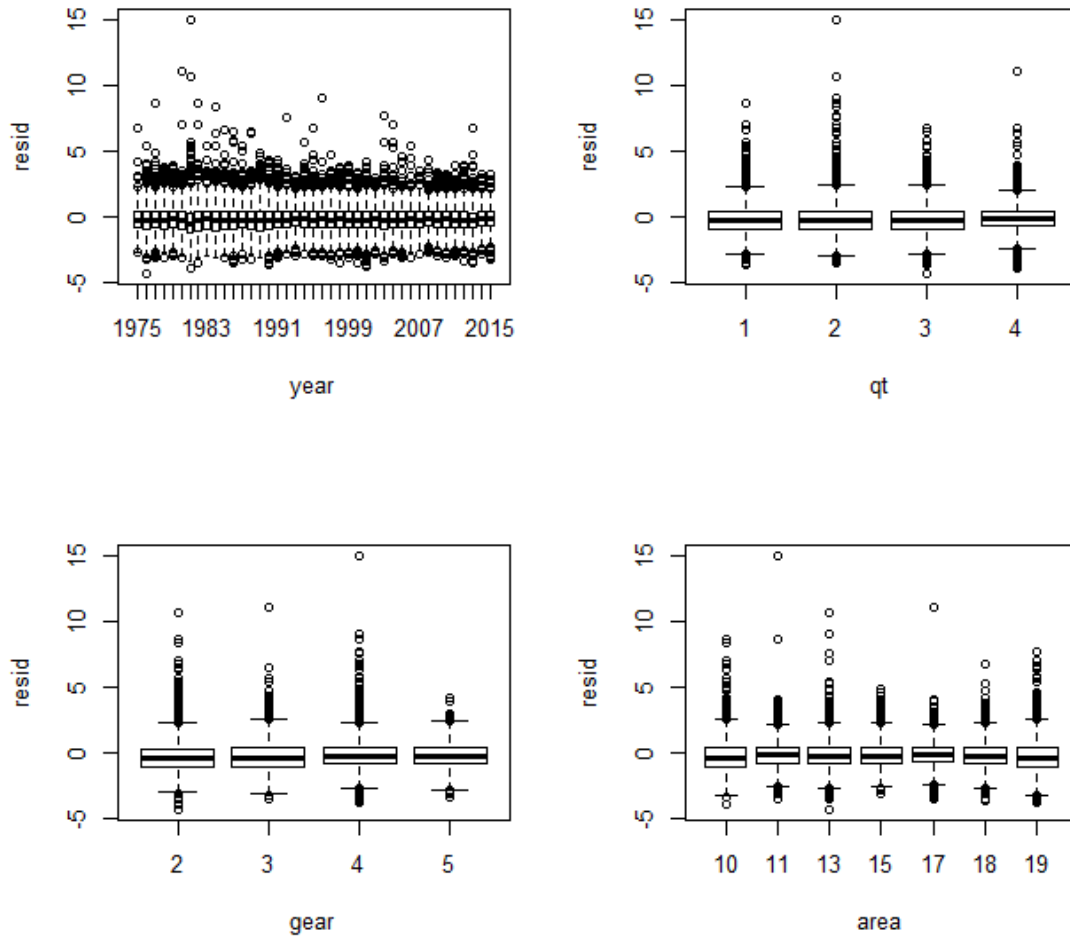
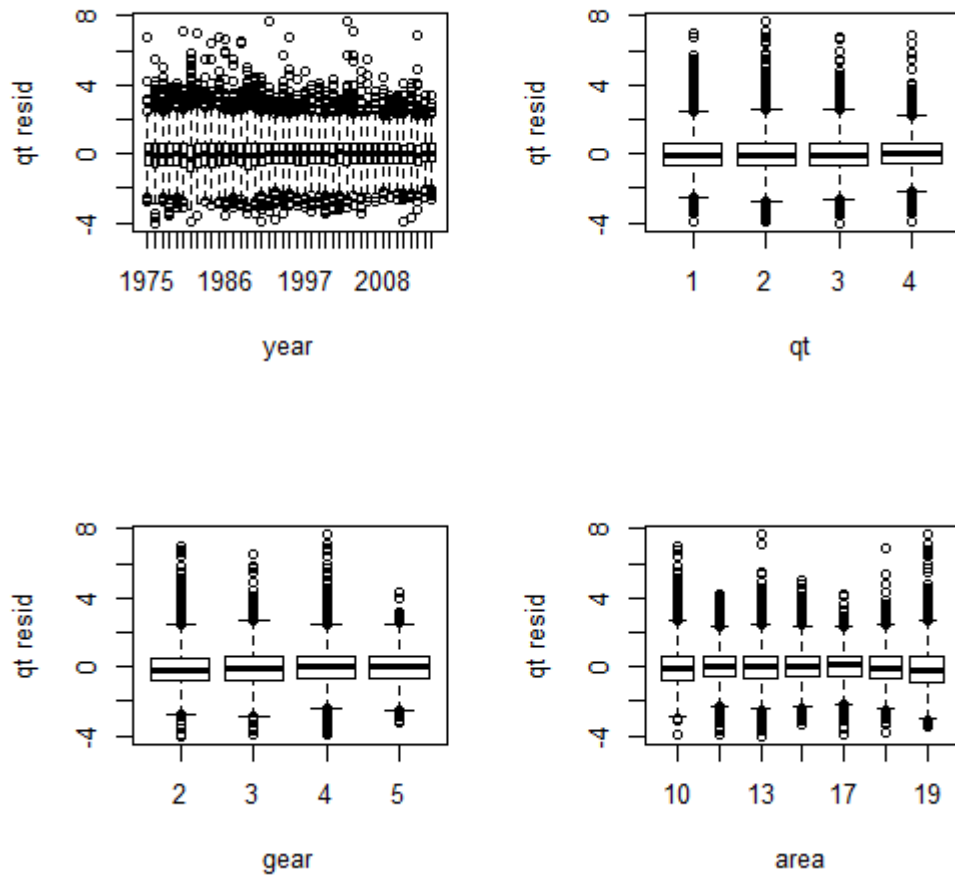


Figure A5 quantile residuals for the standardized model of EPO



Appendix 2: analysis by set by set data in EPO

Table B1 ANOVA table of GLM

	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)
NULL			507392	637868	
year	21	83693	507371	554175	2.20E-16
qt	3	2337	507368	551838	2.20E-16
area	6	10041	507362	541796	2.20E-16
gear	3	239	507359	541557	2.20E-16
year: area	126	18977	507233	522580	2.20E-16
year: qt	63	3353	507170	519227	2.20E-16

Table B2 summary table of GLM

Coefficients:

	Estimate	Std. Error	z value
Pr(> z)			
(Intercept)	-1.236918	0.070181	-17.6
25 < 2e-16 ***			
as. factor(yr) 1995	-0.112638	0.060741	-1.8
54 0.063682 .			
as. factor(yr) 1996	0.011726	0.064538	0.1
82 0.855828			
as. factor(yr) 1997	0.435104	0.070083	6.2
08 5.35e-10 ***			
as. factor(yr) 1998	0.253411	0.062404	4.0
61 4.89e-05 ***			
as. factor(yr) 1999	0.656472	0.055716	11.7
82 < 2e-16 ***			
as. factor(yr) 2000	1.089170	0.051261	21.2
47 < 2e-16 ***			
as. factor(yr) 2001	1.338091	0.047979	27.8
89 < 2e-16 ***			
as. factor(yr) 2002	0.742257	0.050543	14.6
86 < 2e-16 ***			
as. factor(yr) 2003	0.256574	0.064134	4.0
01 6.32e-05 ***			
as. factor(yr) 2004	-0.032135	0.060420	-0.5
32 0.594825			
as. factor(yr) 2005	0.068249	0.091930	0.7
42 0.457840			
as. factor(yr) 2006	0.774310	0.070865	10.9
27 < 2e-16 ***			
as. factor(yr) 2007	1.123999	0.093274	12.0
50 < 2e-16 ***			
as. factor(yr) 2008	1.759469	0.061773	28.4
83 < 2e-16 ***			
as. factor(yr) 2009	1.706629	0.055780	30.5
96 < 2e-16 ***			

as. factor(yr) 2010 93 < 2e-16 ***	1.716159	0.067584	25.3
as. factor(yr) 2011 62 < 2e-16 ***	1.731279	0.057022	30.3
as. factor(yr) 2012 41 < 2e-16 ***	2.449231	0.061168	40.0
as. factor(yr) 2013 84 < 2e-16 ***	2.448794	0.059029	41.4
as. factor(yr) 2014 98 < 2e-16 ***	1.974123	0.074220	26.5
as. factor(yr) 2015 24 < 2e-16 ***	2.110976	0.103864	20.3
as. factor(season) 1 872 < 2e-16 ***	-0.375190	0.022238	-16.
as. factor(season) 2 858 0.000114 ***	-0.085680	0.022208	-3.
as. factor(season) 3 20 < 2e-16 ***	0.188877	0.019841	9.5
as. factor(ar09) 11 53 < 2e-16 ***	0.748270	0.041450	18.0
as. factor(ar09) 13 37 < 2e-16 ***	0.405464	0.037416	10.8
as. factor(ar09) 15 47 8.49e-16 ***	0.333859	0.041489	8.0
as. factor(ar09) 17 26 < 2e-16 ***	0.765032	0.042440	18.0
as. factor(ar09) 18 51 < 2e-16 ***	1.042221	0.044066	23.6
as. factor(ar09) 19 93 < 2e-16 ***	0.836316	0.040611	20.5
as. factor(gear) 3 96 6.82e-08 ***	-0.400706	0.074263	-5.3
as. factor(gear) 4 43 < 2e-16 ***	-0.598603	0.059603	-10.0
as. factor(gear) 5 02 < 2e-16 ***	-0.704914	0.060239	-11.7

as. factor(yr) 1995: as. factor(ar09) 11	0. 255657	0. 065908	
3. 879 0. 000105 ***			
as. factor(yr) 1996: as. factor(ar09) 11	0. 089229	0. 070246	
1. 270 0. 203998			
as. factor(yr) 1997: as. factor(ar09) 11	0. 013438	0. 073887	
0. 182 0. 855686			
as. factor(yr) 1998: as. factor(ar09) 11	0. 664979	0. 066494	1
0. 001 < 2e- 16 ***			
as. factor(yr) 1999: as. factor(ar09) 11	-0. 261248	0. 060365	
-4. 328 1. 51e- 05 ***			
as. factor(yr) 2000: as. factor(ar09) 11	-0. 251824	0. 053111	
-4. 741 2. 12e- 06 ***			
as. factor(yr) 2001: as. factor(ar09) 11	-0. 117834	0. 051347	
-2. 295 0. 021742 *			
as. factor(yr) 2002: as. factor(ar09) 11	0. 005817	0. 053434	
0. 109 0. 913313			
as. factor(yr) 2003: as. factor(ar09) 11	0. 232065	0. 067553	
3. 435 0. 000592 ***			
as. factor(yr) 2004: as. factor(ar09) 11	0. 260470	0. 063504	
4. 102 4. 10e- 05 ***			
as. factor(yr) 2005: as. factor(ar09) 11	0. 268821	0. 094740	
2. 837 0. 004548 **			
as. factor(yr) 2006: as. factor(ar09) 11	-0. 020376	0. 072549	
-0. 281 0. 778819			
as. factor(yr) 2007: as. factor(ar09) 11	-0. 168097	0. 098041	
-1. 715 0. 086426 .			
as. factor(yr) 2008: as. factor(ar09) 11	-0. 464834	0. 063998	
-7. 263 3. 78e- 13 ***			
as. factor(yr) 2009: as. factor(ar09) 11	-0. 404849	0. 058982	
-6. 864 6. 70e- 12 ***			
as. factor(yr) 2010: as. factor(ar09) 11	0. 009683	0. 072052	
0. 134 0. 893100			
as. factor(yr) 2011: as. factor(ar09) 11	-0. 477952	0. 061636	
-7. 754 8. 87e- 15 ***			
as. factor(yr) 2012: as. factor(ar09) 11	-1. 175438	0. 066952	-
17. 557 < 2e- 16 ***			

as. factor(yr) 2013: as. factor(ar09) 11	-0.750292	0.064443	-
11.643 < 2e-16 ***			
as. factor(yr) 2014: as. factor(ar09) 11	-0.520219	0.077450	
-6.717 1.86e-11 ***			
as. factor(yr) 2015: as. factor(ar09) 11	-0.580906	0.103921	
-5.590 2.27e-08 ***			
as. factor(yr) 1995: as. factor(ar09) 13	0.217741	0.060214	
3.616 0.000299 ***			
as. factor(yr) 1996: as. factor(ar09) 13	0.324237	0.065105	
4.980 6.35e-07 ***			
as. factor(yr) 1997: as. factor(ar09) 13	0.017763	0.070927	
0.250 0.802244			
as. factor(yr) 1998: as. factor(ar09) 13	0.440924	0.063751	
6.916 4.63e-12 ***			
as. factor(yr) 1999: as. factor(ar09) 13	-0.156902	0.054658	
-2.871 0.004097 **			
as. factor(yr) 2000: as. factor(ar09) 13	-0.474233	0.049882	
-9.507 < 2e-16 ***			
as. factor(yr) 2001: as. factor(ar09) 13	-0.490686	0.048131	-
10.195 < 2e-16 ***			
as. factor(yr) 2002: as. factor(ar09) 13	-0.117080	0.050883	
-2.301 0.021393 *			
as. factor(yr) 2003: as. factor(ar09) 13	0.294230	0.064258	
4.579 4.68e-06 ***			
as. factor(yr) 2004: as. factor(ar09) 13	0.641196	0.060834	1
0.540 < 2e-16 ***			
as. factor(yr) 2005: as. factor(ar09) 13	0.496644	0.093001	
5.340 9.28e-08 ***			
as. factor(yr) 2006: as. factor(ar09) 13	-0.149142	0.070698	
-2.110 0.034895 *			
as. factor(yr) 2007: as. factor(ar09) 13	-0.302439	0.095086	
-3.181 0.001469 **			
as. factor(yr) 2008: as. factor(ar09) 13	-0.811753	0.061129	-
13.279 < 2e-16 ***			
as. factor(yr) 2009: as. factor(ar09) 13	-0.364213	0.056141	
-6.488 8.73e-11 ***			

as. factor(yr) 2010: as. factor(ar09) 13	-0.241076	0.068060
-3.542	0.000397	***
as. factor(yr) 2011: as. factor(ar09) 13	-0.098273	0.057898
-1.697	0.089632	.
as. factor(yr) 2012: as. factor(ar09) 13	-0.912668	0.060075
15.192	< 2e-16	***
as. factor(yr) 2013: as. factor(ar09) 13	-0.783119	0.057512
13.617	< 2e-16	***
as. factor(yr) 2014: as. factor(ar09) 13	-0.303812	0.073500
-4.133	3.57e-05	***
as. factor(yr) 2015: as. factor(ar09) 13	-0.226714	0.103433
-2.192	0.028388	*
as. factor(yr) 1995: as. factor(ar09) 15	0.187417	0.065386
2.866	0.004153	**
as. factor(yr) 1996: as. factor(ar09) 15	0.078485	0.070867
1.108	0.268074	
as. factor(yr) 1997: as. factor(ar09) 15	-0.054804	0.075811
-0.723	0.469742	
as. factor(yr) 1998: as. factor(ar09) 15	0.267310	0.071140
3.758	0.000172	***
as. factor(yr) 1999: as. factor(ar09) 15	-0.562096	0.071445
-7.868	3.62e-15	***
as. factor(yr) 2000: as. factor(ar09) 15	-1.109769	0.062857
17.655	< 2e-16	***
as. factor(yr) 2001: as. factor(ar09) 15	-0.705361	0.059706
11.814	< 2e-16	***
as. factor(yr) 2002: as. factor(ar09) 15	-0.349896	0.061025
-5.734	9.83e-09	***
as. factor(yr) 2003: as. factor(ar09) 15	0.133190	0.070919
1.878	0.060374	.
as. factor(yr) 2004: as. factor(ar09) 15	-0.017473	0.070428
-0.248	0.804060	
as. factor(yr) 2005: as. factor(ar09) 15	0.201939	0.099113
2.037	0.041604	*
as. factor(yr) 2006: as. factor(ar09) 15	-0.195708	0.080256
-2.439	0.014746	*

as. factor(yr) 2007: as. factor(ar09) 15	-0.248561	0.099814
-2.490 0.012766 *		
as. factor(yr) 2008: as. factor(ar09) 15	-0.762756	0.068384 -
11.154 < 2e-16 ***		
as. factor(yr) 2009: as. factor(ar09) 15	0.055416	0.065777
0.842 0.399520		
as. factor(yr) 2010: as. factor(ar09) 15	0.240418	0.072423
3.320 0.000901 ***		
as. factor(yr) 2011: as. factor(ar09) 15	0.254408	0.064518
3.943 8.04e-05 ***		
as. factor(yr) 2012: as. factor(ar09) 15	-0.341112	0.068536
-4.977 6.45e-07 ***		
as. factor(yr) 2013: as. factor(ar09) 15	-0.303420	0.067410
-4.501 6.76e-06 ***		
as. factor(yr) 2014: as. factor(ar09) 15	0.452372	0.079819
5.667 1.45e-08 ***		
as. factor(yr) 2015: as. factor(ar09) 15	0.355433	0.107065
3.320 0.000901 ***		
as. factor(yr) 1995: as. factor(ar09) 17	0.365467	0.066720
5.478 4.31e-08 ***		
as. factor(yr) 1996: as. factor(ar09) 17	0.381422	0.071471
5.337 9.46e-08 ***		
as. factor(yr) 1997: as. factor(ar09) 17	-0.322615	0.078686
-4.100 4.13e-05 ***		
as. factor(yr) 1998: as. factor(ar09) 17	0.210483	0.066838
3.149 0.001637 **		
as. factor(yr) 1999: as. factor(ar09) 17	-0.328270	0.058474
-5.614 1.98e-08 ***		
as. factor(yr) 2000: as. factor(ar09) 17	-0.716822	0.057960 -
12.368 < 2e-16 ***		
as. factor(yr) 2001: as. factor(ar09) 17	-0.693116	0.054783 -
12.652 < 2e-16 ***		
as. factor(yr) 2002: as. factor(ar09) 17	-0.201235	0.057333
-3.510 0.000448 ***		
as. factor(yr) 2003: as. factor(ar09) 17	0.317815	0.068380
4.648 3.36e-06 ***		

as. factor(yr) 2004: as. factor(ar09) 17	0. 692916	0. 068057	1
0. 181 < 2e- 16 ***			
as. factor(yr) 2005: as. factor(ar09) 17	0. 600808	0. 097790	
6. 144 8. 06e- 10 ***			
as. factor(yr) 2006: as. factor(ar09) 17	-0. 334696	0. 077840	
-4. 300 1. 71e- 05 ***			
as. factor(yr) 2007: as. factor(ar09) 17	-0. 612438	0. 099035	
-6. 184 6. 25e- 10 ***			
as. factor(yr) 2008: as. factor(ar09) 17	-1. 286075	0. 070066	-
18. 355 < 2e- 16 ***			
as. factor(yr) 2009: as. factor(ar09) 17	-1. 375839	0. 067879	-
20. 269 < 2e- 16 ***			
as. factor(yr) 2010: as. factor(ar09) 17	-0. 794617	0. 074289	-
10. 696 < 2e- 16 ***			
as. factor(yr) 2011: as. factor(ar09) 17	-0. 813658	0. 062301	-
13. 060 < 2e- 16 ***			
as. factor(yr) 2012: as. factor(ar09) 17	-1. 645261	0. 064244	-
25. 610 < 2e- 16 ***			
as. factor(yr) 2013: as. factor(ar09) 17	-1. 428910	0. 062645	-
22. 810 < 2e- 16 ***			
as. factor(yr) 2014: as. factor(ar09) 17	-0. 873040	0. 077357	-
11. 286 < 2e- 16 ***			
as. factor(yr) 2015: as. factor(ar09) 17	-1. 056783	0. 106224	
-9. 949 < 2e- 16 ***			
as. factor(yr) 1995: as. factor(ar09) 18	0. 093680	0. 066894	
1. 400 0. 161387			
as. factor(yr) 1996: as. factor(ar09) 18	-0. 246101	0. 070887	
-3. 472 0. 000517 ***			
as. factor(yr) 1997: as. factor(ar09) 18	-0. 681354	0. 076239	
-8. 937 < 2e- 16 ***			
as. factor(yr) 1998: as. factor(ar09) 18	-0. 222660	0. 067869	
-3. 281 0. 001035 **			
as. factor(yr) 1999: as. factor(ar09) 18	-0. 921666	0. 062603	-
14. 722 < 2e- 16 ***			
as. factor(yr) 2000: as. factor(ar09) 18	-1. 347586	0. 060379	-
22. 319 < 2e- 16 ***			

as. factor(yr) 2001: as. factor(ar09) 18	- 1.155709	0.056721	-
20.375	< 2e-16	***	
as. factor(yr) 2002: as. factor(ar09) 18	-0.845550	0.058038	-
14.569	< 2e-16	***	
as. factor(yr) 2003: as. factor(ar09) 18	-0.300576	0.069392	
-4.332	1.48e-05	***	
as. factor(yr) 2004: as. factor(ar09) 18	-0.131843	0.067250	
-1.960	0.049938	*	
as. factor(yr) 2005: as. factor(ar09) 18	0.056391	0.098874	
0.570	0.568454		
as. factor(yr) 2006: as. factor(ar09) 18	-0.939572	0.077677	-
12.096	< 2e-16	***	
as. factor(yr) 2007: as. factor(ar09) 18	-0.826226	0.099654	
-8.291	< 2e-16	***	
as. factor(yr) 2008: as. factor(ar09) 18	-1.342357	0.071649	-
18.735	< 2e-16	***	
as. factor(yr) 2009: as. factor(ar09) 18	-1.377573	0.064174	-
21.466	< 2e-16	***	
as. factor(yr) 2010: as. factor(ar09) 18	-0.596357	0.074463	
-8.009	1.16e-15	***	
as. factor(yr) 2011: as. factor(ar09) 18	-0.714160	0.064472	-
11.077	< 2e-16	***	
as. factor(yr) 2012: as. factor(ar09) 18	-1.587458	0.066761	-
23.778	< 2e-16	***	
as. factor(yr) 2013: as. factor(ar09) 18	-1.575307	0.064961	-
24.250	< 2e-16	***	
as. factor(yr) 2014: as. factor(ar09) 18	-0.988222	0.079261	-
12.468	< 2e-16	***	
as. factor(yr) 2015: as. factor(ar09) 18	-1.154946	0.107524	-
10.741	< 2e-16	***	
as. factor(yr) 1995: as. factor(ar09) 19	0.134193	0.065850	
2.038	0.041565	*	
as. factor(yr) 1996: as. factor(ar09) 19	0.155546	0.071027	
2.190	0.028527	*	
as. factor(yr) 1997: as. factor(ar09) 19	-0.375878	0.078515	
-4.787	1.69e-06	***	

as. factor(yr) 1998: as. factor(ar09) 19	-0.036412	0.066465	
-0.548	0.583798		
as. factor(yr) 1999: as. factor(ar09) 19	-0.963030	0.061288	-
15.713	< 2e-16	***	
as. factor(yr) 2000: as. factor(ar09) 19	-0.943812	0.056636	-
16.665	< 2e-16	***	
as. factor(yr) 2001: as. factor(ar09) 19	-0.521475	0.051413	-
10.143	< 2e-16	***	
as. factor(yr) 2002: as. factor(ar09) 19	0.022945	0.053738	
0.427	0.669392		
as. factor(yr) 2003: as. factor(ar09) 19	0.720334	0.066902	1
0.767	< 2e-16	***	
as. factor(yr) 2004: as. factor(ar09) 19	0.265304	0.064529	
4.111	3.93e-05	***	
as. factor(yr) 2005: as. factor(ar09) 19	0.612509	0.095450	
6.417	1.39e-10	***	
as. factor(yr) 2006: as. factor(ar09) 19	-0.065497	0.074637	
-0.878	0.380191		
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1.635	0.102140		
as. factor(yr) 2008: as. factor(ar09) 19	-0.984290	0.064825	-
15.184	< 2e-16	***	
as. factor(yr) 2009: as. factor(ar09) 19	-0.860465	0.060211	-
14.291	< 2e-16	***	
as. factor(yr) 2010: as. factor(ar09) 19	0.269217	0.073071	
3.684	0.000229	***	
as. factor(yr) 2011: as. factor(ar09) 19	0.278965	0.061421	
4.542	5.58e-06	***	
as. factor(yr) 2012: as. factor(ar09) 19	-1.095598	0.064874	-
16.888	< 2e-16	***	
as. factor(yr) 2013: as. factor(ar09) 19	-0.331800	0.064249	
-5.164	2.41e-07	***	
as. factor(yr) 2014: as. factor(ar09) 19	0.126548	0.080025	
1.581	0.113800		
as. factor(yr) 2015: as. factor(ar09) 19	-0.344834	0.111410	
-3.095	0.001967	**	

as. factor(yr) 1995: as. factor(season) 1	-0.074303	0.033905
-2.192	0.028413	*
as. factor(yr) 1996: as. factor(season) 1	0.097584	0.033215
2.938	0.003304	**
as. factor(yr) 1997: as. factor(season) 1	0.079048	0.032156
2.458	0.013963	*
as. factor(yr) 1998: as. factor(season) 1	-0.033637	0.034507
-0.975	0.329666	
as. factor(yr) 1999: as. factor(season) 1	0.068443	0.036789
1.860	0.062825	.
as. factor(yr) 2000: as. factor(season) 1	0.138330	0.034531
4.006	6.18e-05	***
as. factor(yr) 2001: as. factor(season) 1	0.062707	0.031203
2.010	0.044468	*
as. factor(yr) 2002: as. factor(season) 1	0.137127	0.031694
4.327	1.51e-05	***
as. factor(yr) 2003: as. factor(season) 1	0.038401	0.032148
1.195	0.232280	
as. factor(yr) 2004: as. factor(season) 1	0.142848	0.035884
3.981	6.87e-05	***
as. factor(yr) 2005: as. factor(season) 1	0.187455	0.035471
5.285	1.26e-07	***
as. factor(yr) 2006: as. factor(season) 1	0.058615	0.038386
1.527	0.126759	
as. factor(yr) 2007: as. factor(season) 1	-0.203745	0.039003
-5.224	1.75e-07	***
as. factor(yr) 2008: as. factor(season) 1	0.062626	0.036786
1.702	0.088676	.
as. factor(yr) 2009: as. factor(season) 1	0.338456	0.036013
9.398	< 2e-16	***
as. factor(yr) 2010: as. factor(season) 1	0.105628	0.032450
3.255	0.001134	**
as. factor(yr) 2011: as. factor(season) 1	0.302721	0.032974
9.181	< 2e-16	***
as. factor(yr) 2012: as. factor(season) 1	-0.145487	0.032427
-4.487	7.24e-06	***

as. factor(yr) 2013: as. factor(season) 1	-0.315962	0.033308
-9.486	< 2e-16	***
as. factor(yr) 2014: as. factor(season) 1	0.018591	0.037807
0.492	0.622906	
as. factor(yr) 2015: as. factor(season) 1	0.104811	0.041087
2.551	0.010744	*
as. factor(yr) 1995: as. factor(season) 2	-0.163431	0.032942
-4.961	7.01e-07	***
as. factor(yr) 1996: as. factor(season) 2	-0.104244	0.033064
-3.153	0.001617	**
as. factor(yr) 1997: as. factor(season) 2	-0.038606	0.032543
-1.186	0.235490	
as. factor(yr) 1998: as. factor(season) 2	-0.201269	0.032481
-6.196	5.77e-10	***
as. factor(yr) 1999: as. factor(season) 2	0.127210	0.035462
3.587	0.000334	***
as. factor(yr) 2000: as. factor(season) 2	0.191160	0.034474
5.545	2.94e-08	***
as. factor(yr) 2001: as. factor(season) 2	-0.125019	0.030086
-4.155	3.25e-05	***
as. factor(yr) 2002: as. factor(season) 2	-0.304740	0.031550
-9.659	< 2e-16	***
as. factor(yr) 2003: as. factor(season) 2	-0.076261	0.031934
-2.388	0.016938	*
as. factor(yr) 2004: as. factor(season) 2	-0.163741	0.035882
-4.563	5.03e-06	***
as. factor(yr) 2005: as. factor(season) 2	-0.442099	0.039859
11.092	< 2e-16	***
as. factor(yr) 2006: as. factor(season) 2	-0.176525	0.039254
-4.497	6.89e-06	***
as. factor(yr) 2007: as. factor(season) 2	-0.389039	0.040886
-9.515	< 2e-16	***
as. factor(yr) 2008: as. factor(season) 2	-0.321944	0.038194
-8.429	< 2e-16	***
as. factor(yr) 2009: as. factor(season) 2	-0.019045	0.036077
-0.528	0.597575	

```

as. factor(yr) 2010: as. factor(season) 2 -0.470154 0.034432 -
13.654 < 2e-16 ***
as. factor(yr) 2011: as. factor(season) 2 -0.498605 0.033267 -
14.988 < 2e-16 ***
as. factor(yr) 2012: as. factor(season) 2 -0.269350 0.032685
-8.241 < 2e-16 ***
as. factor(yr) 2013: as. factor(season) 2 -0.610342 0.033045 -
18.470 < 2e-16 ***
[ reached getOption("max.print") -- omitted 23 rows ]
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
1

```

(Dispersion parameter for Negative Binomial (1.4101) family taken to be 1)

Null deviance: 637868 on 507392 degrees of freedom
Residual deviance: 519227 on 507170 degrees of freedom
AIC: 1553948

Number of Fisher Scoring iterations: 1

Theta: 1.41012
Std. Err.: 0.00660

2 x log-likelihood: -1553499.88800

Figure B1 diagnostics

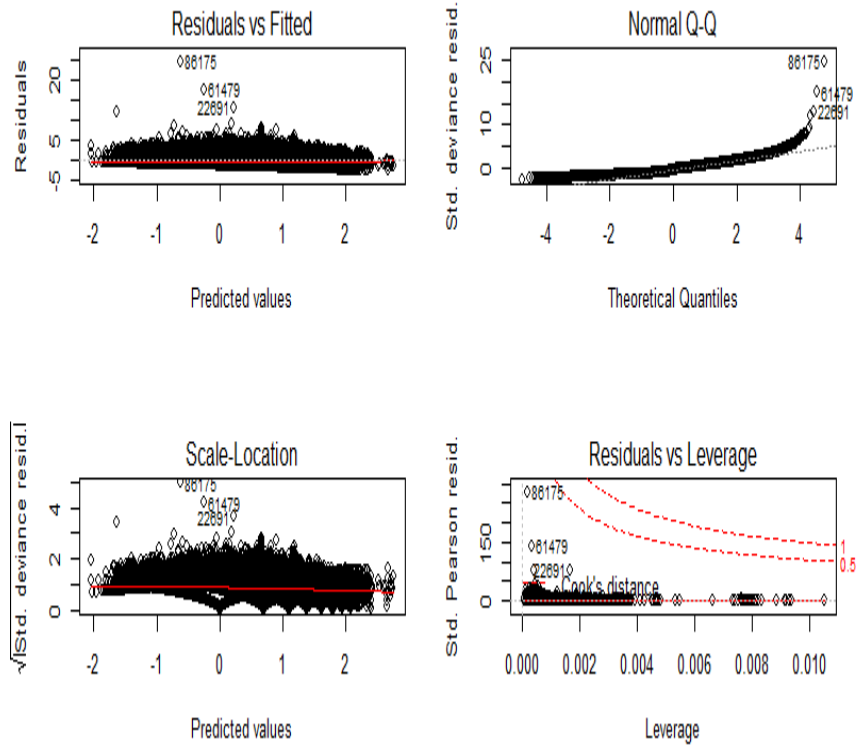


Figure B2 quantile residuals

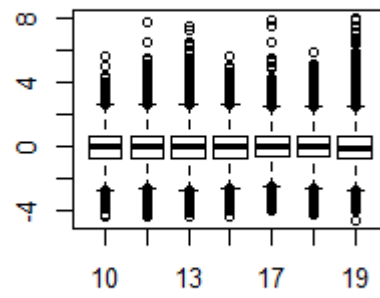
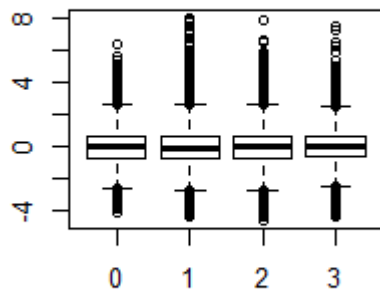
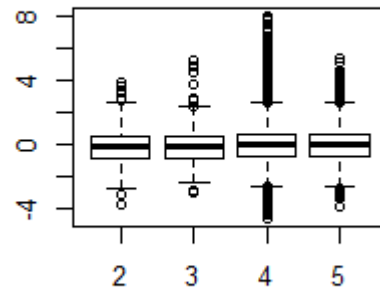
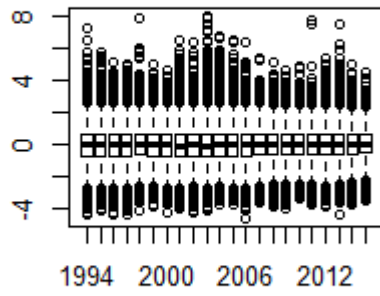
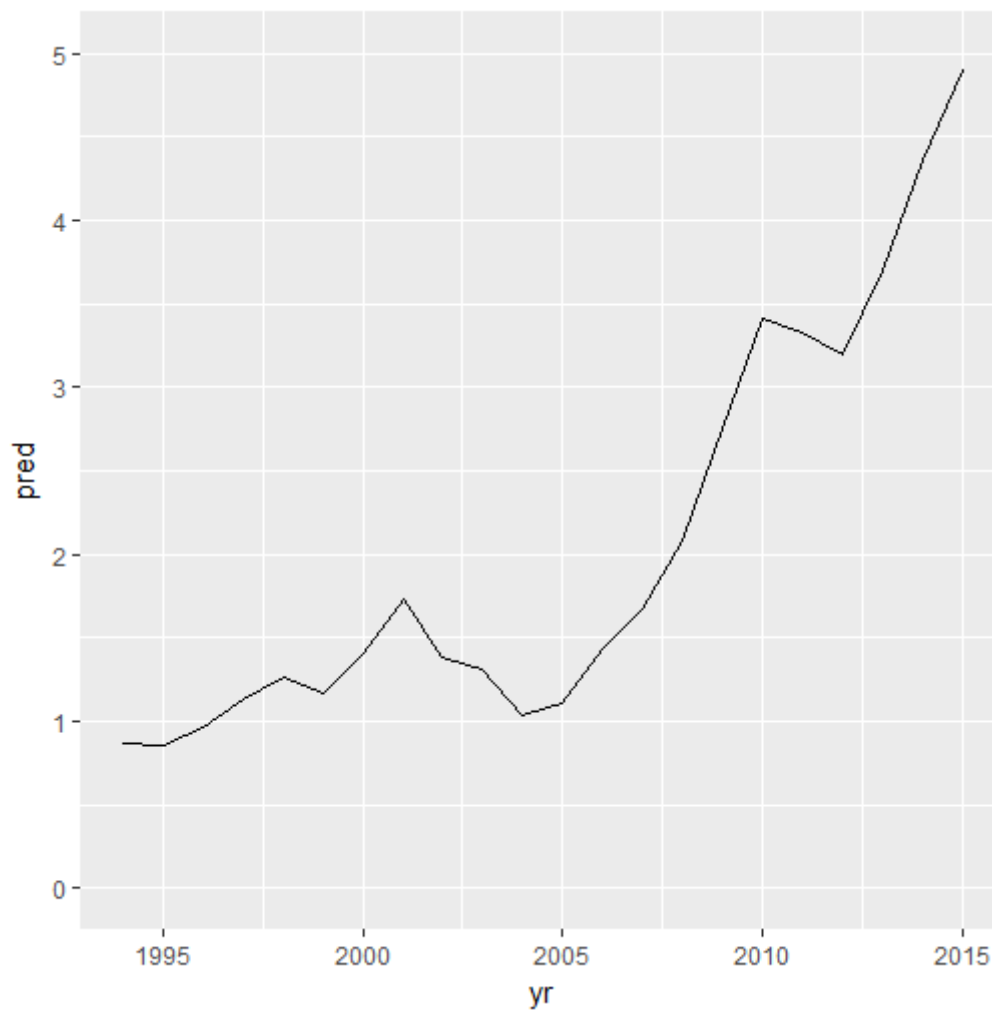


Figure B3 standardized CPUE for EPO



Appendix 3 additional information of nominal CPUE and catch by aggregated data.

Figure C1 annual trend of Nominal CPUE in WCPO for each area

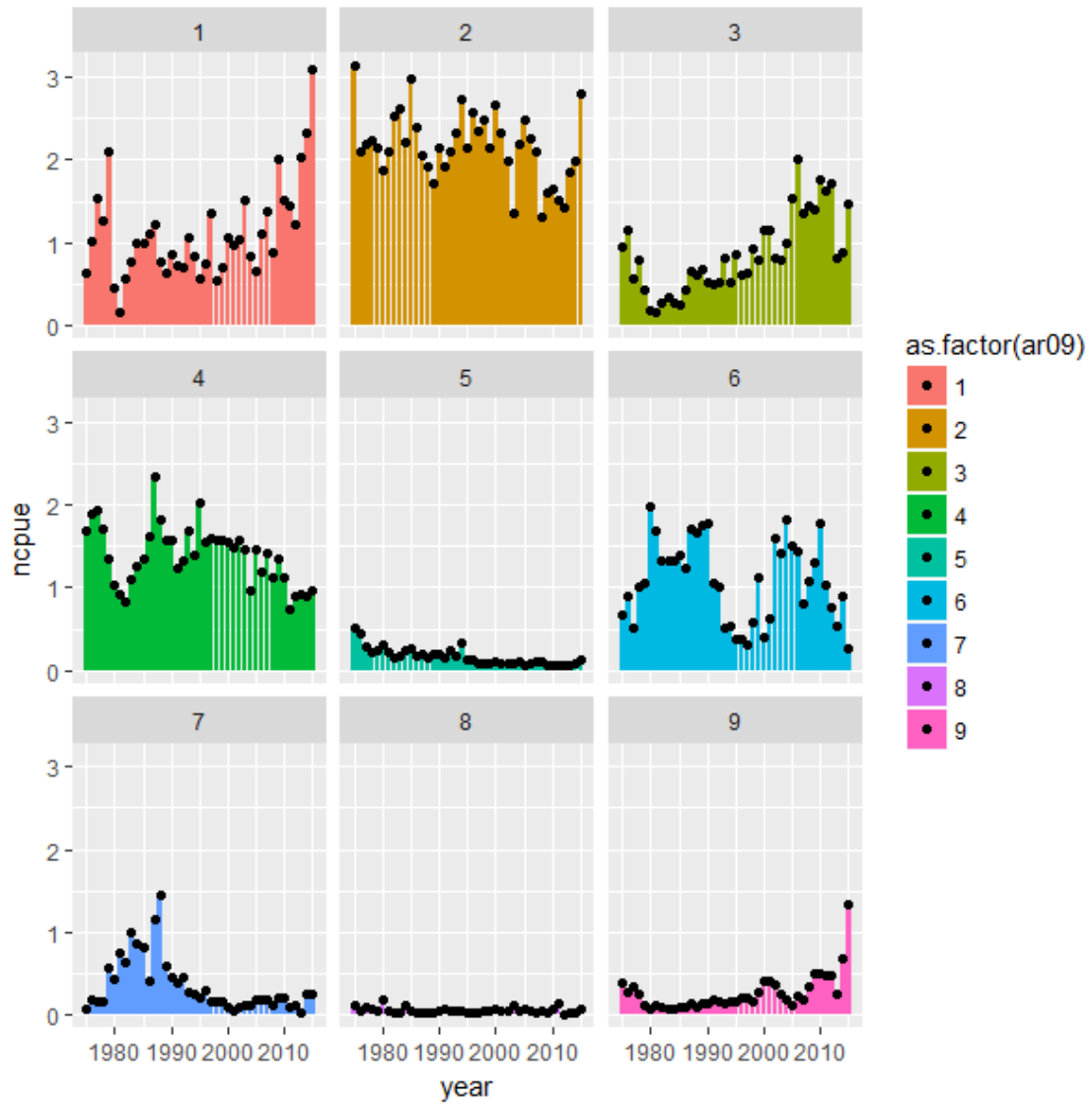


Figure C2 Annual trend of zero-catch ratio in WCPO for each area

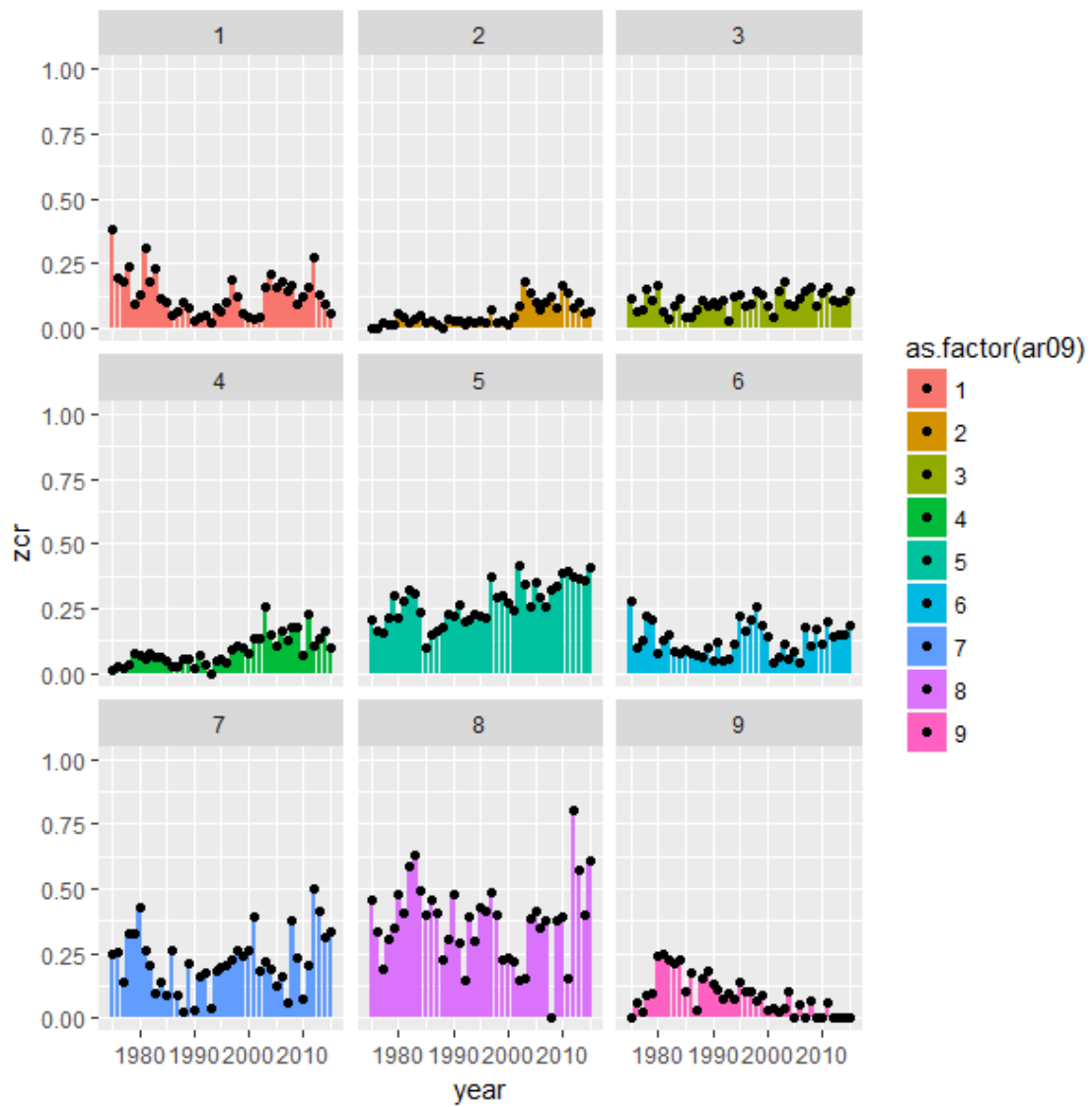


Figure C3 Histogram of log nominal CPUE in WCPO for each area

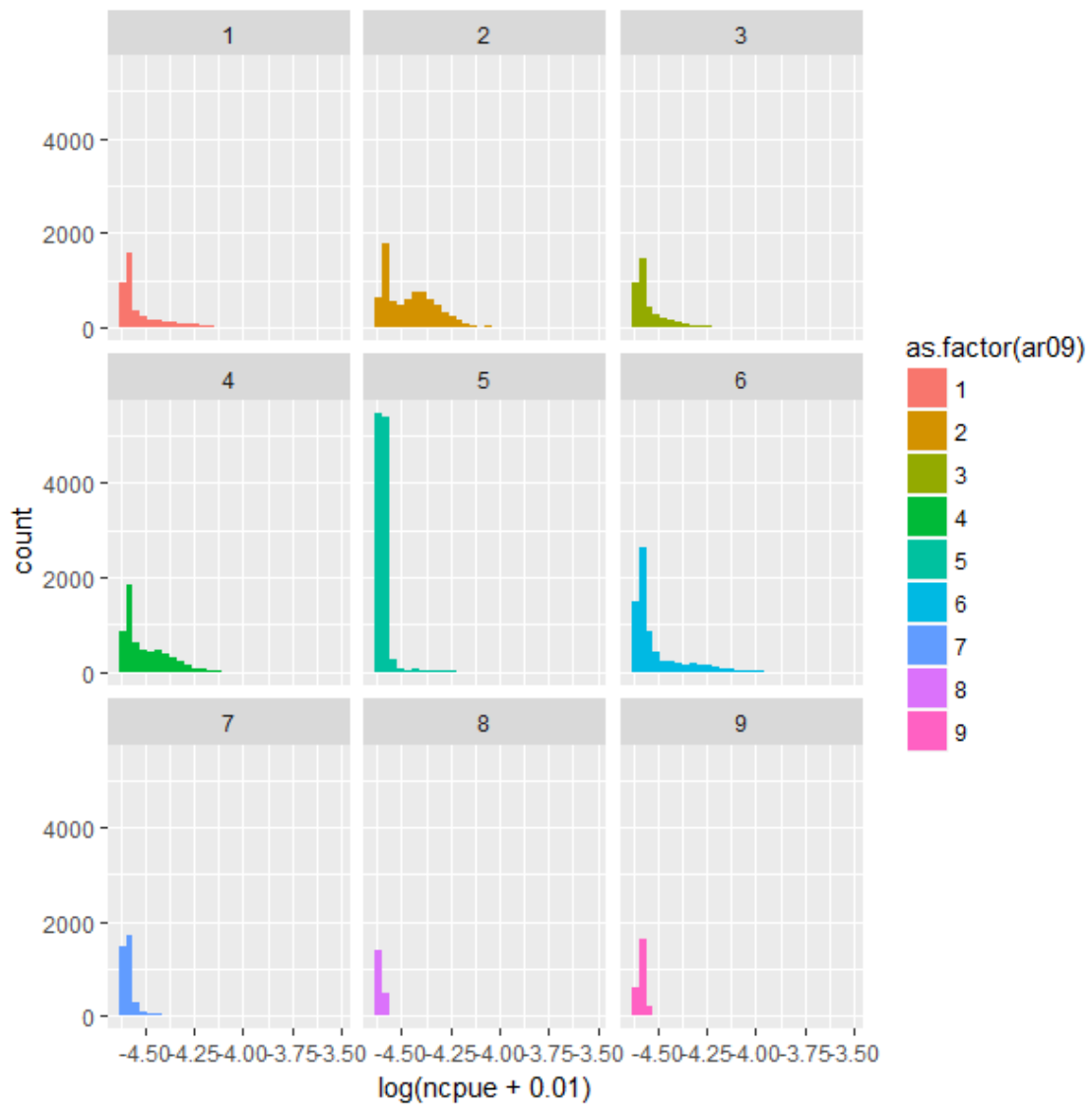


Figure C4 Annual trend of catch in WCPO for each area

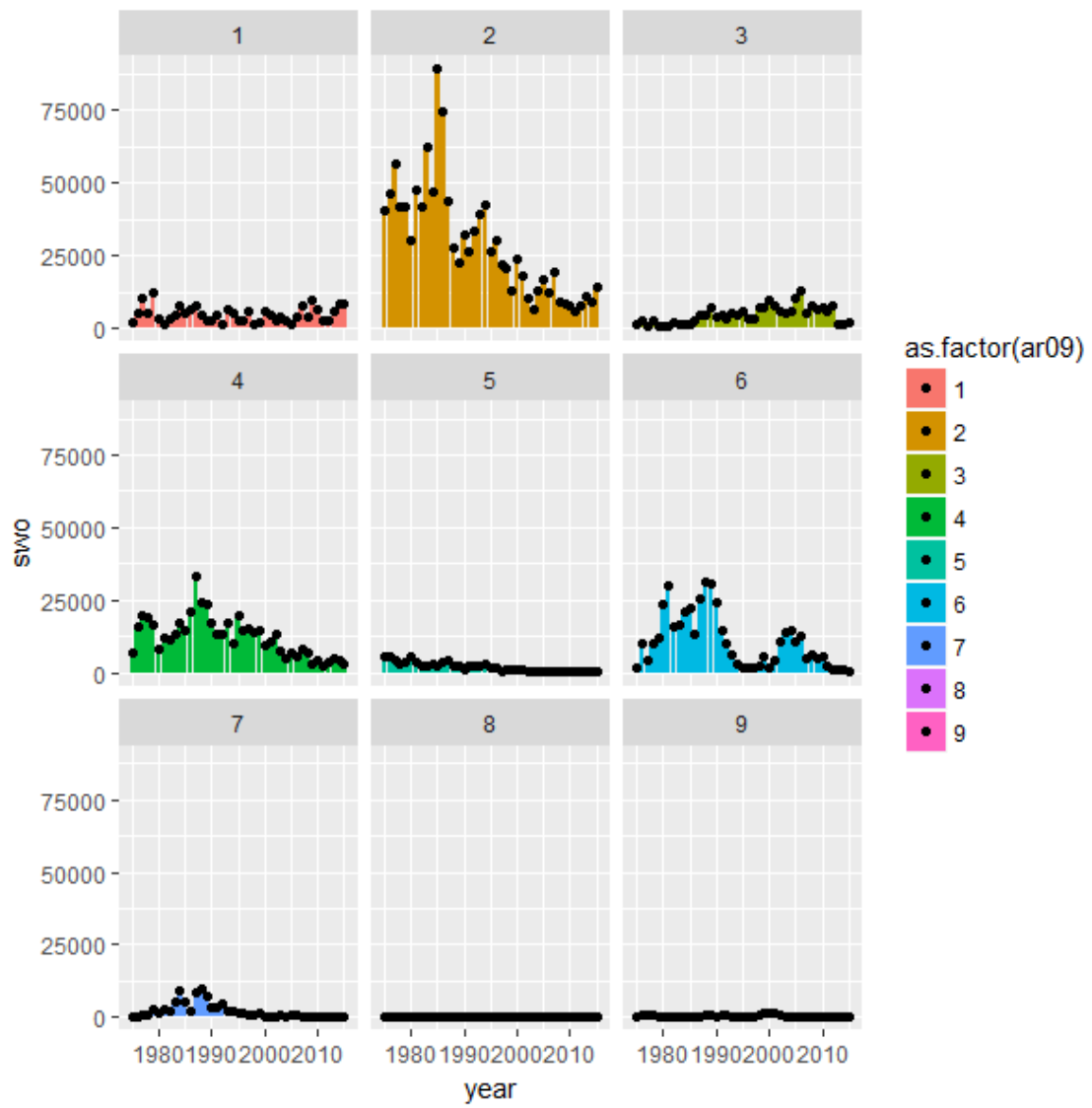


Figure C5 annual trend of Nominal CPUE in WCPO for each gear

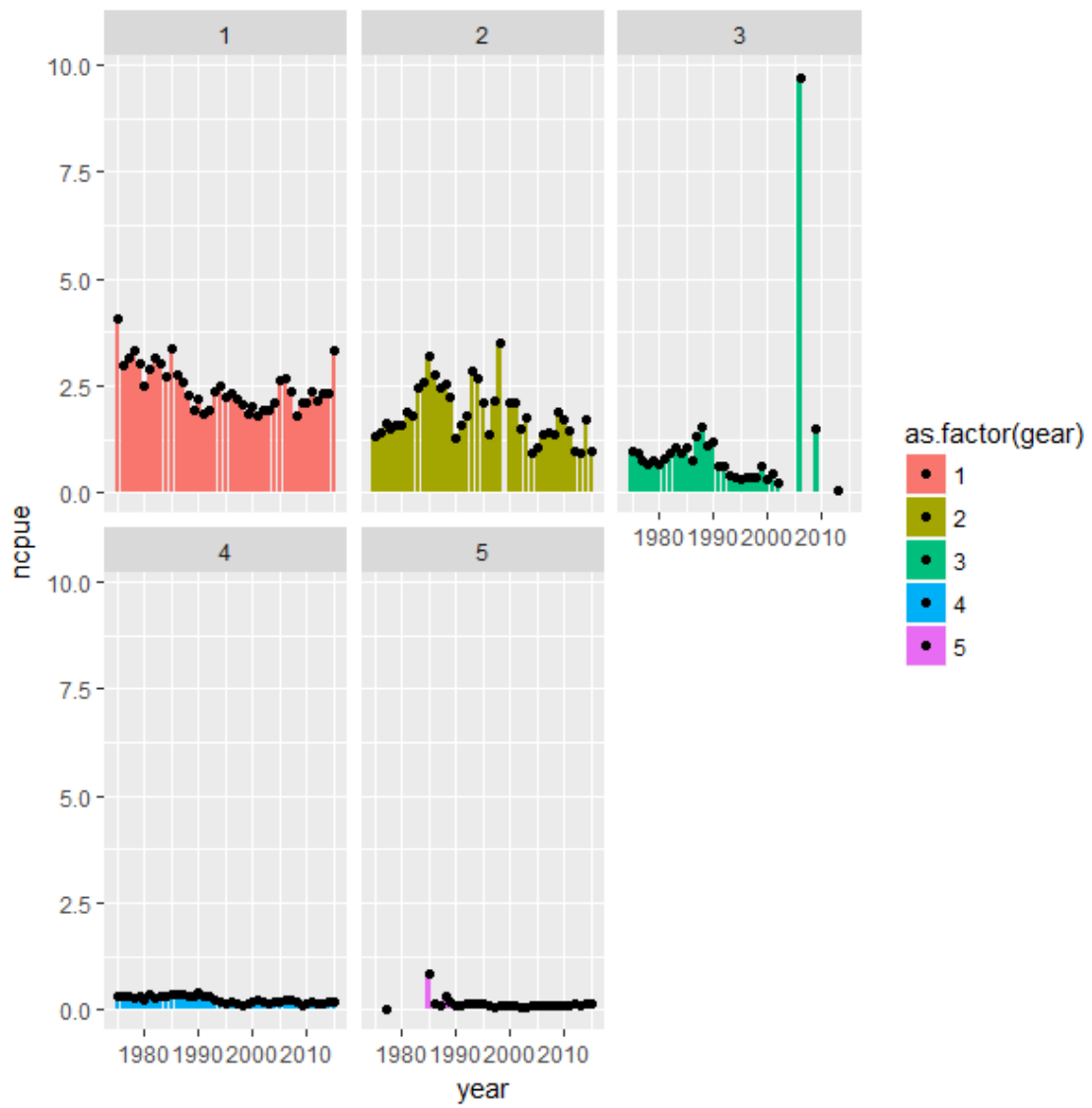


Figure C5b same information with C5 but different Y-axis

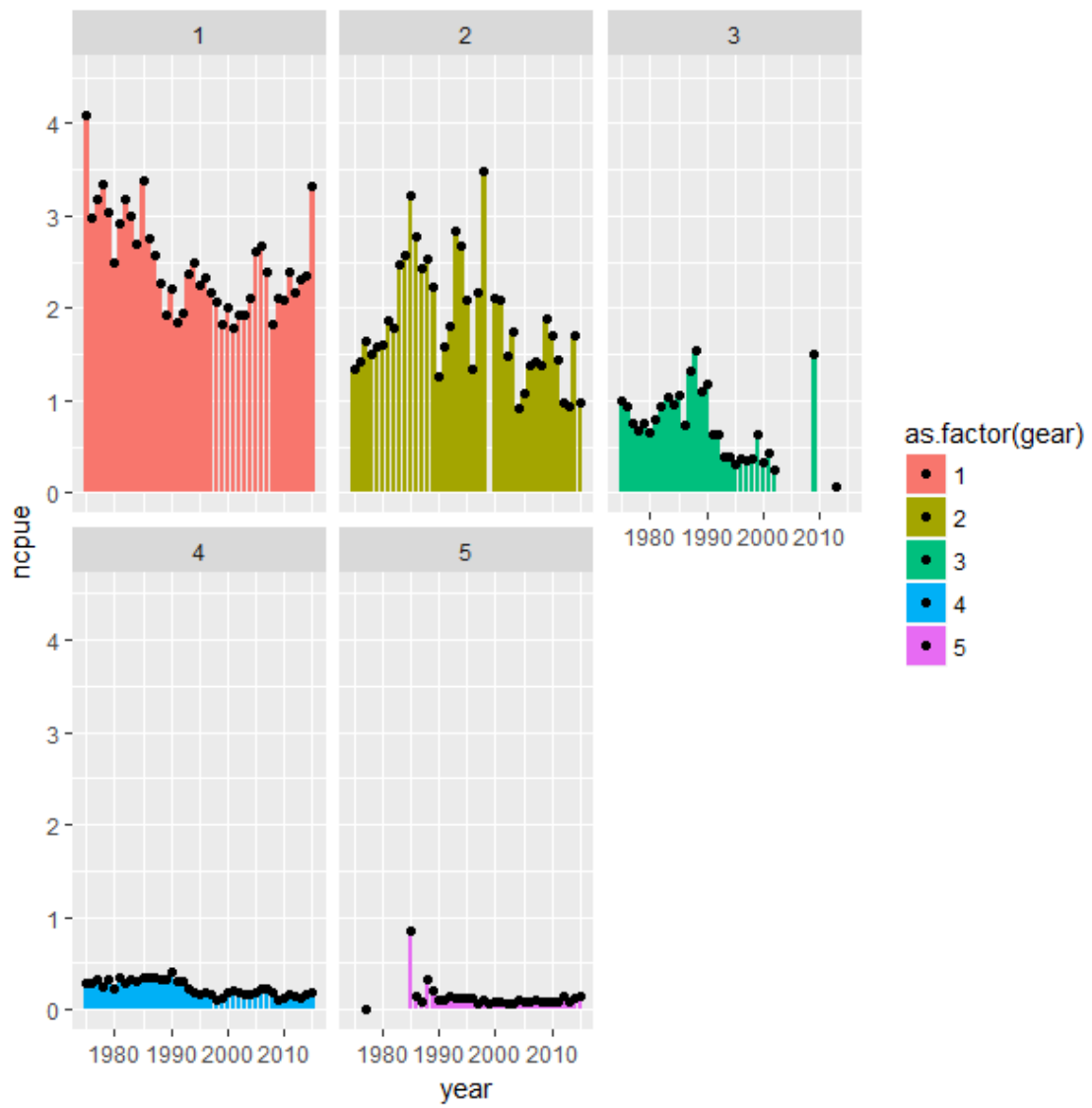


Figure C6 Annual trend of zero-catch ratio in WCPO for each gear

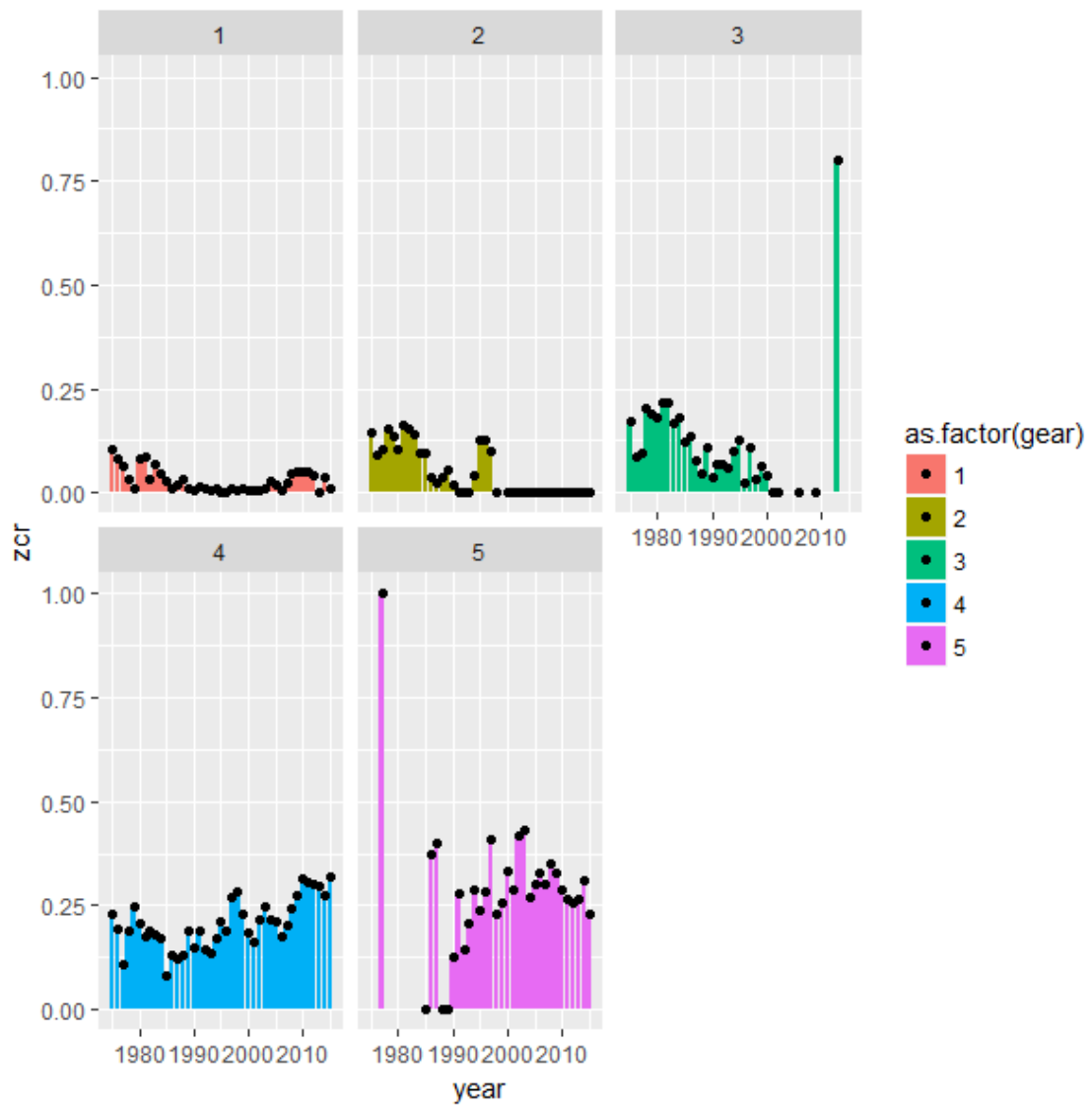


Figure C7 Histogram of log nominal CPUE in WCPO for each gear

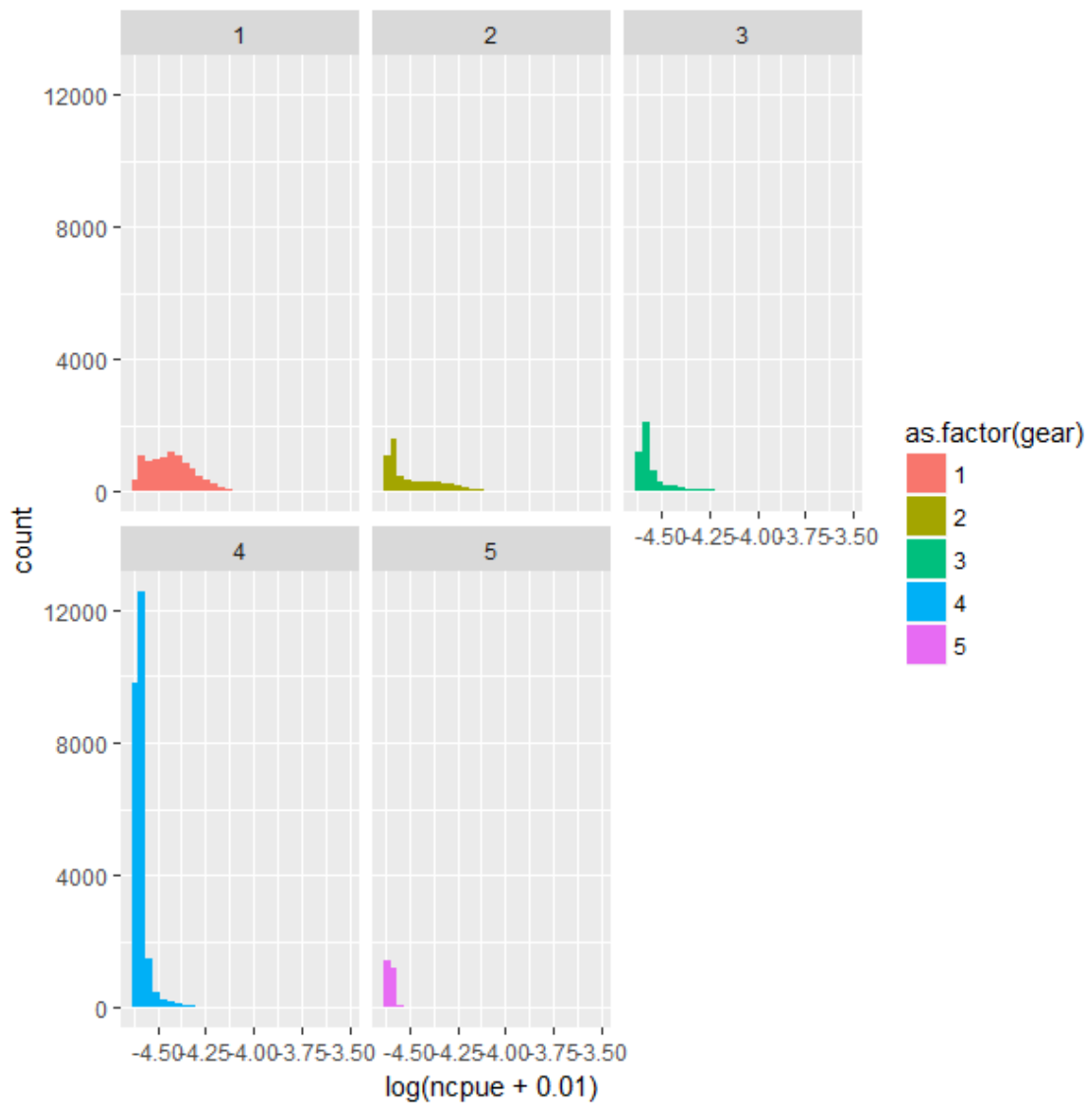


Figure C8 Annual trend of catch in WCPO for each gear

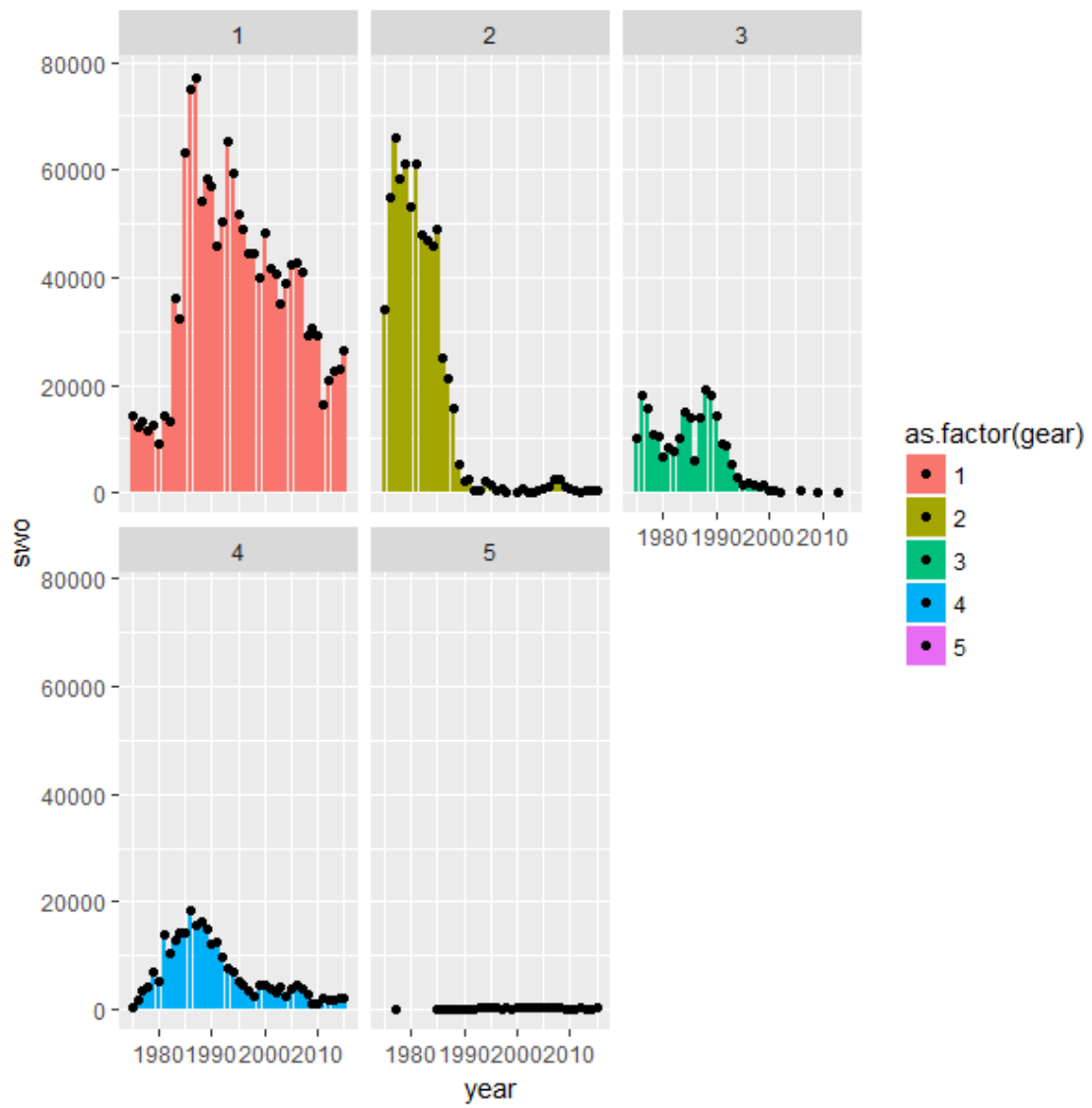


Figure C9 annual trend of Nominal CPUE in WCPO for each quarter

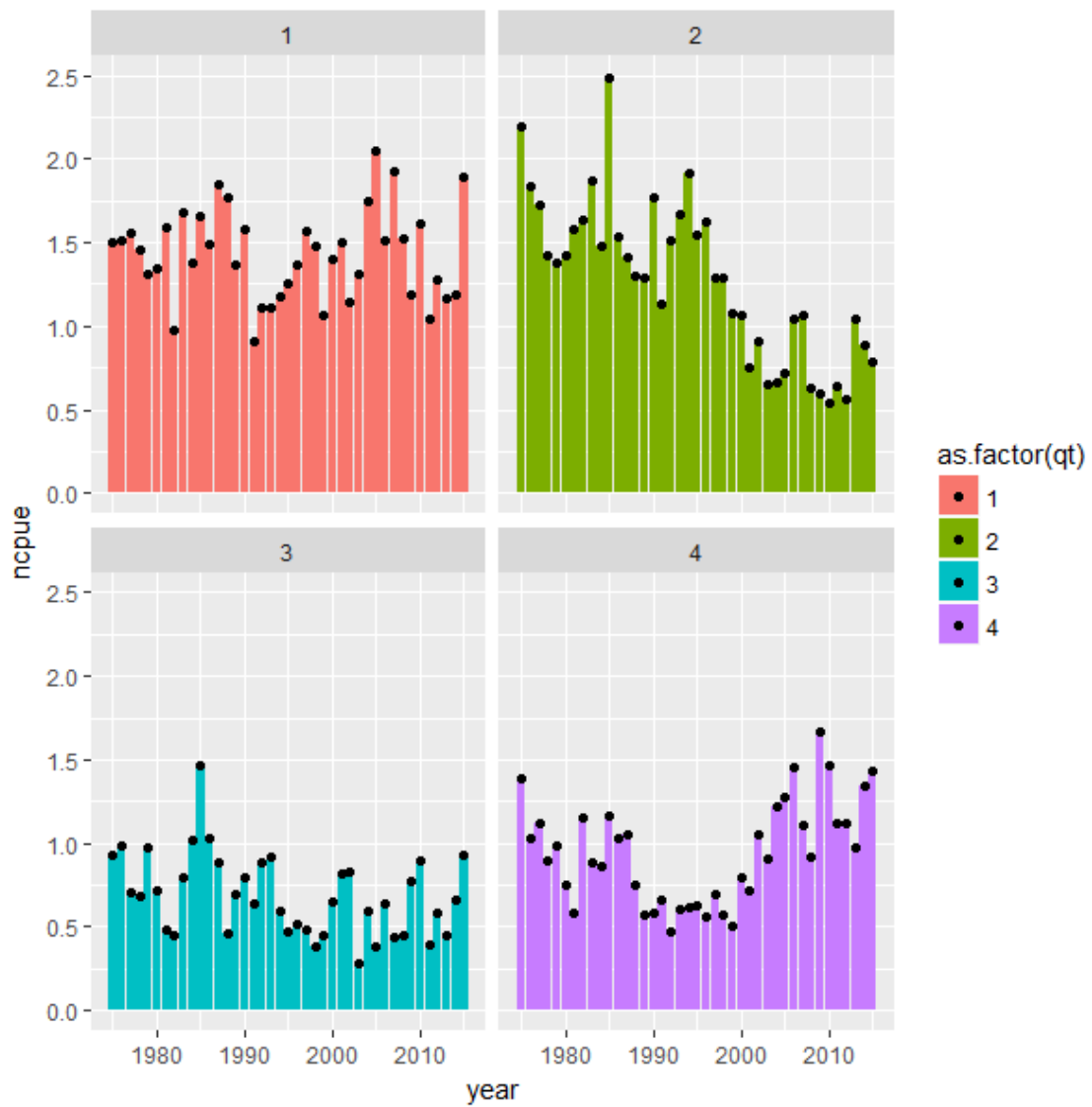


Figure C10 Annual trend of zero-catch ratio in WCPO for each quarter

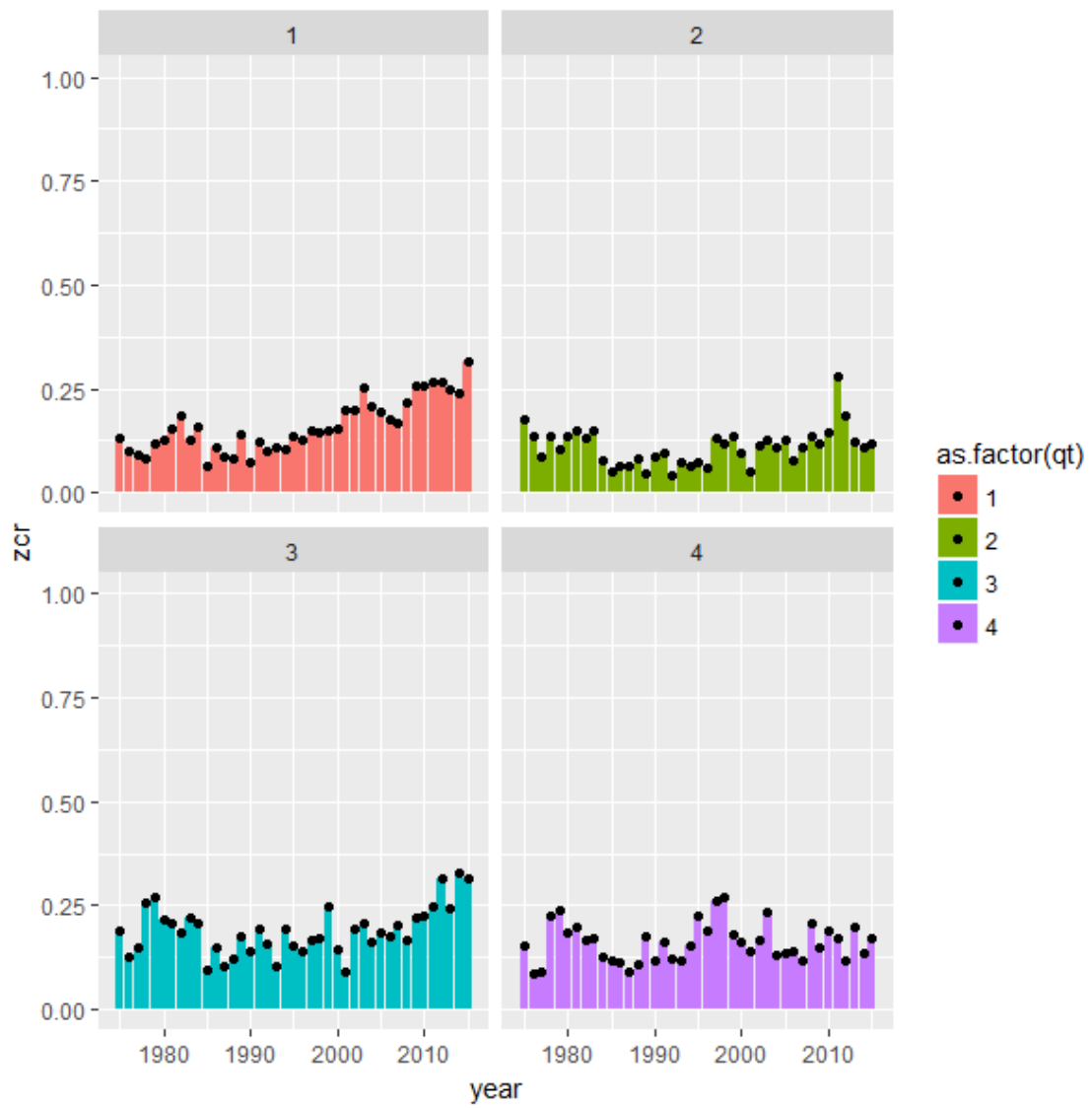


Figure C11 Histogram of log nominal CPUE in WCPO for each quarter

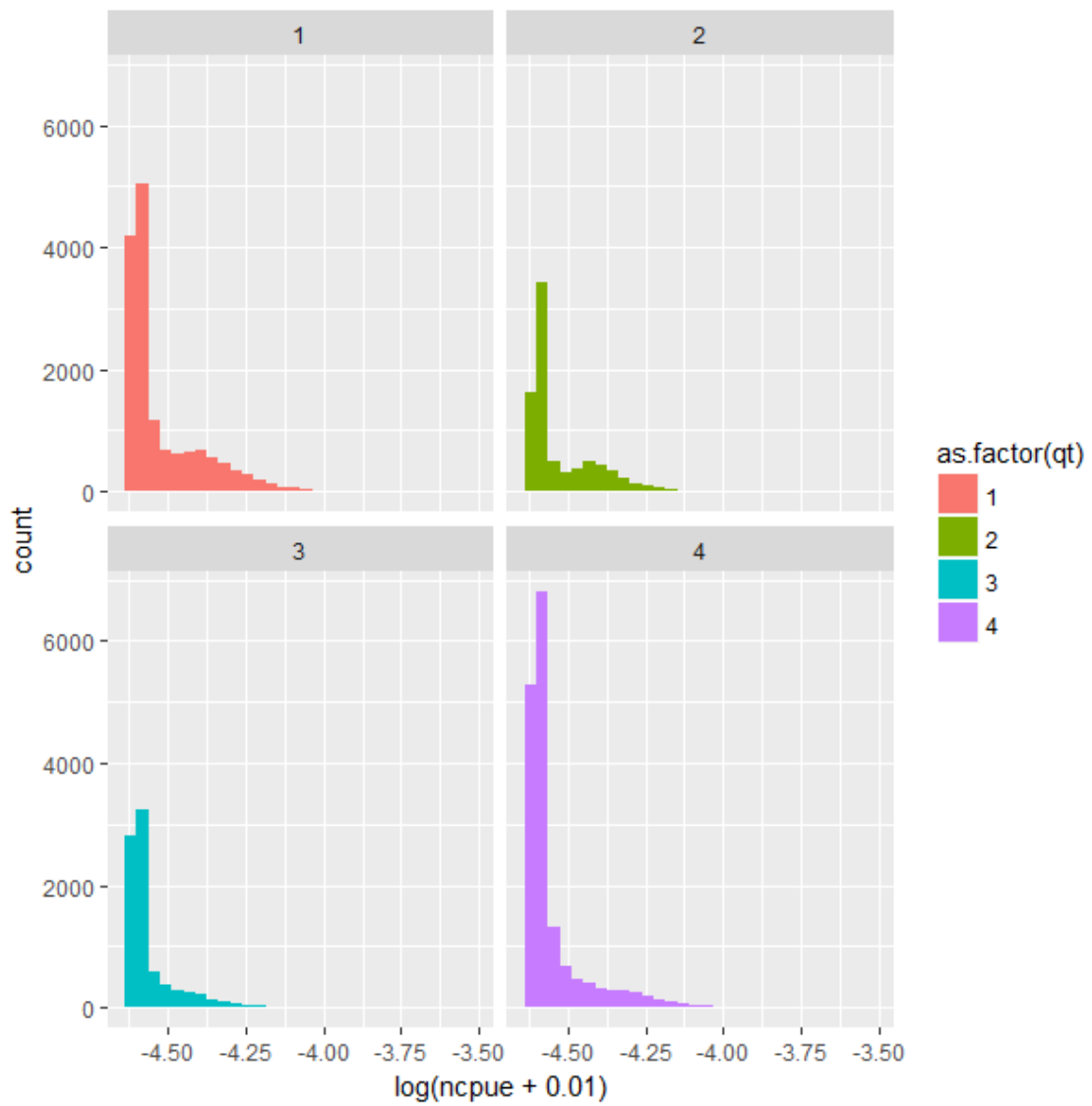


Figure C12 Annual trend of catch in WCPO for each quarter

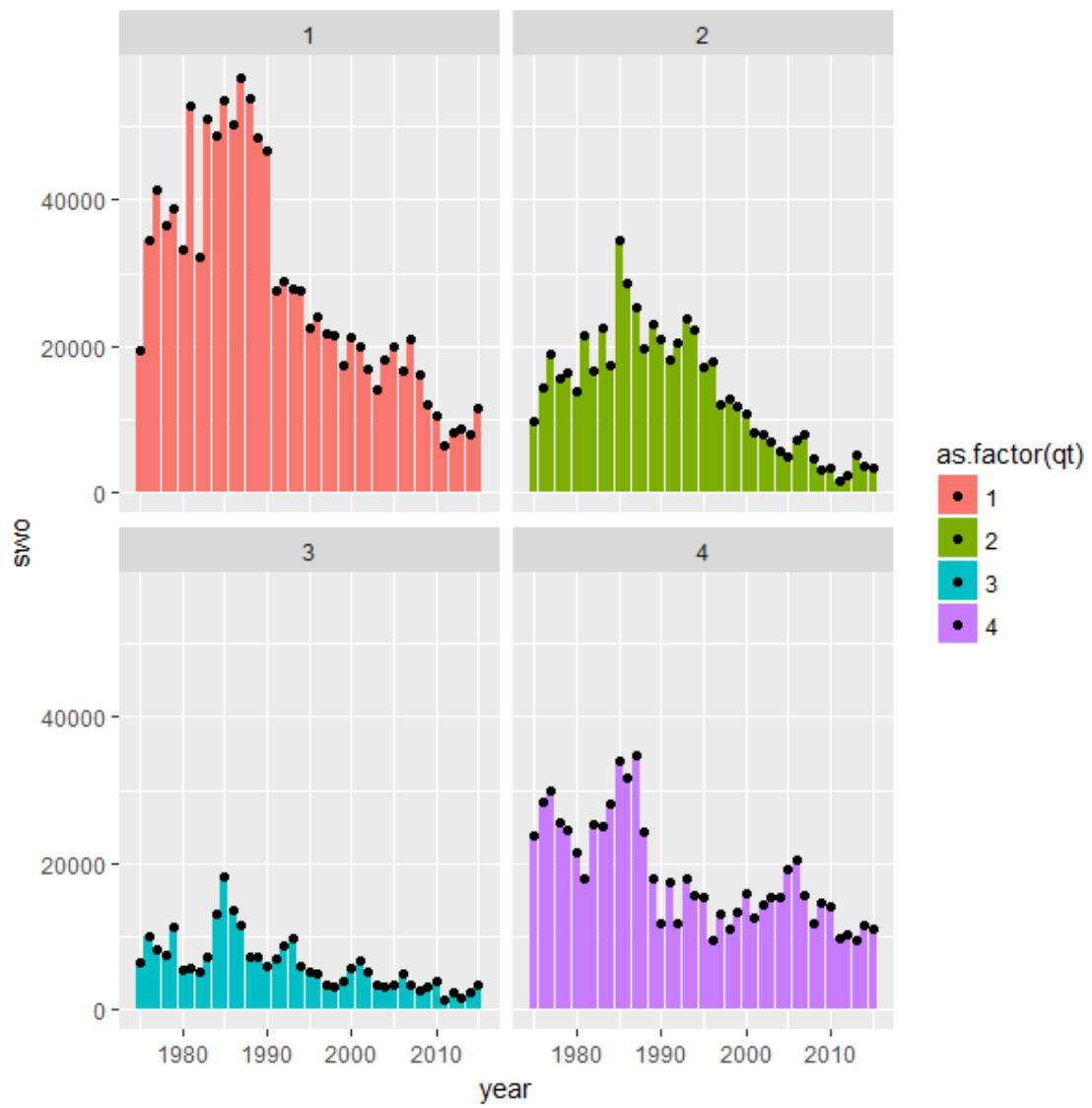


Figure C13 annual trend of Nominal CPUE in EPO for each area

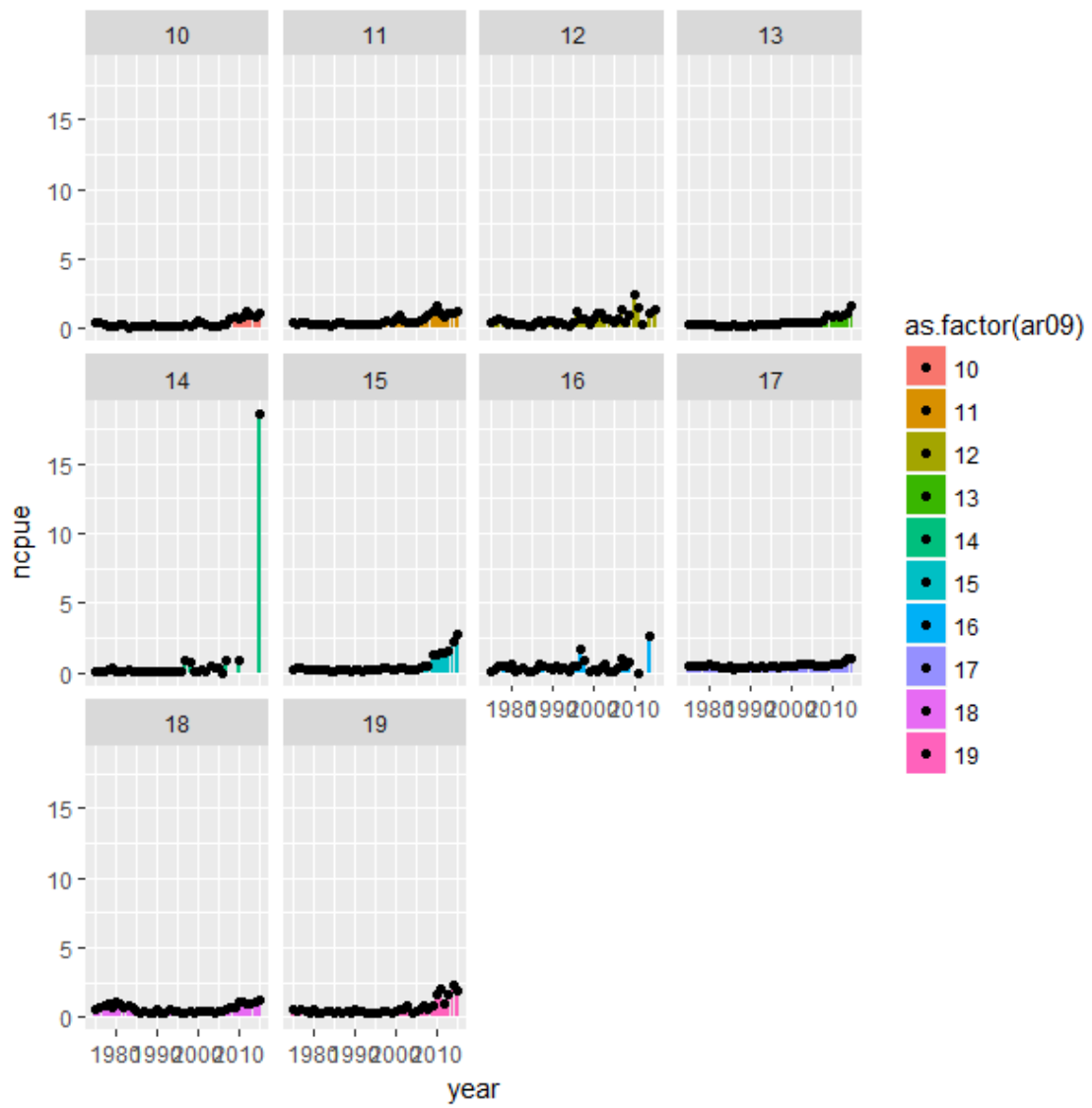


Figure C13b same information with C13 but different Y-axis

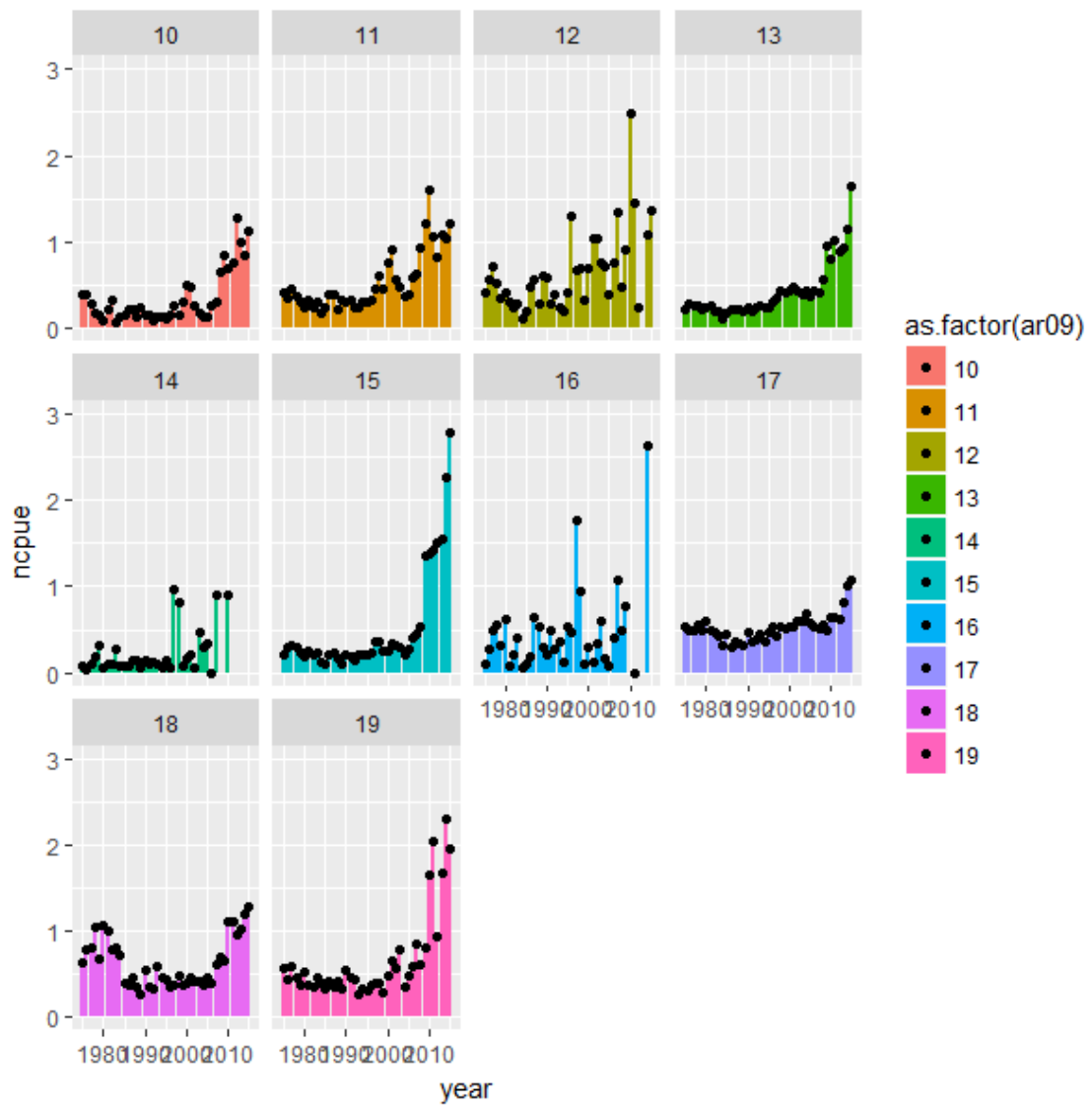


Figure C14 Annual trend of zero-catch ratio in EPO for each area

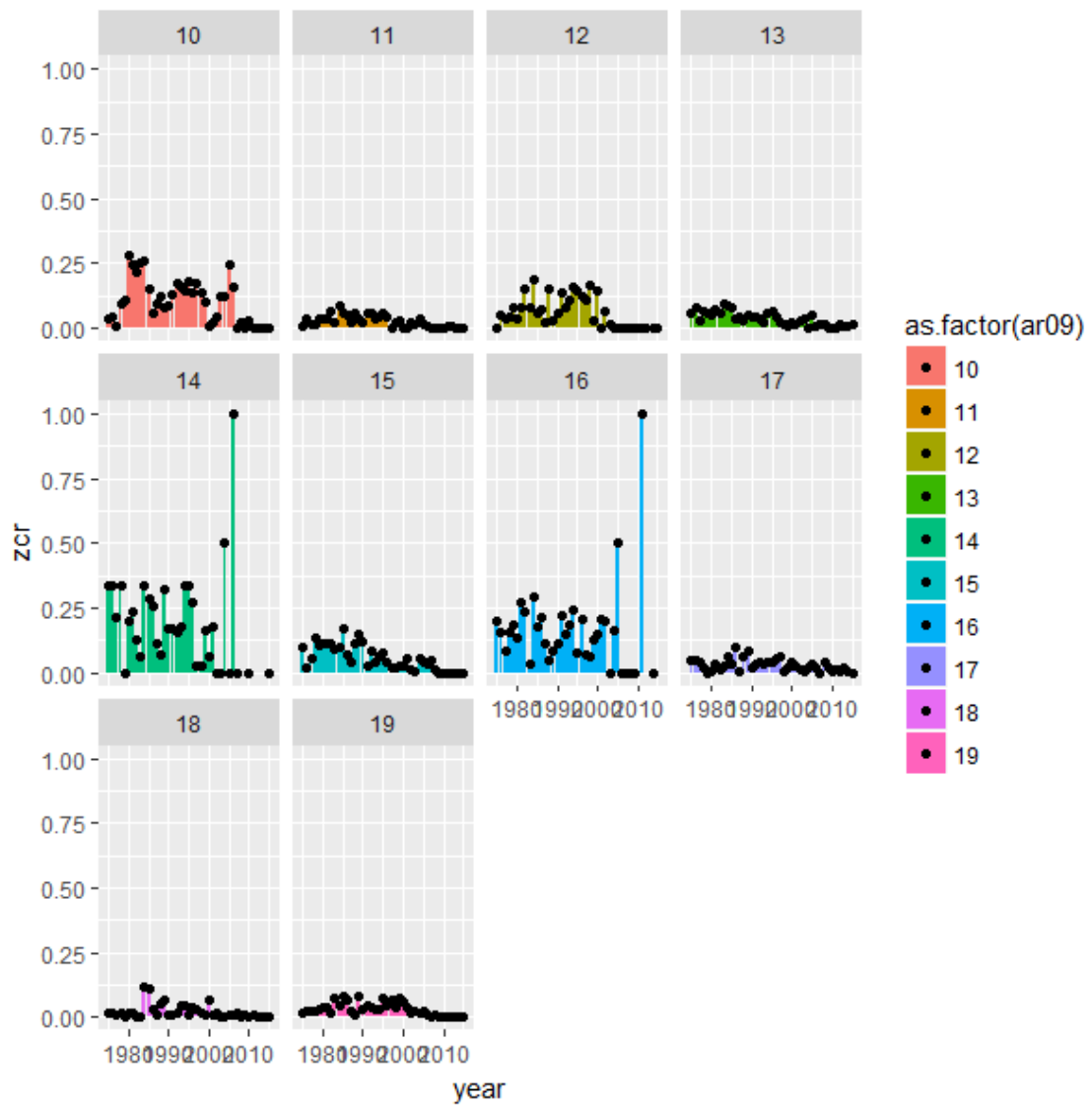


Figure C15 Histogram of log nominal CPUE in EPO for each area

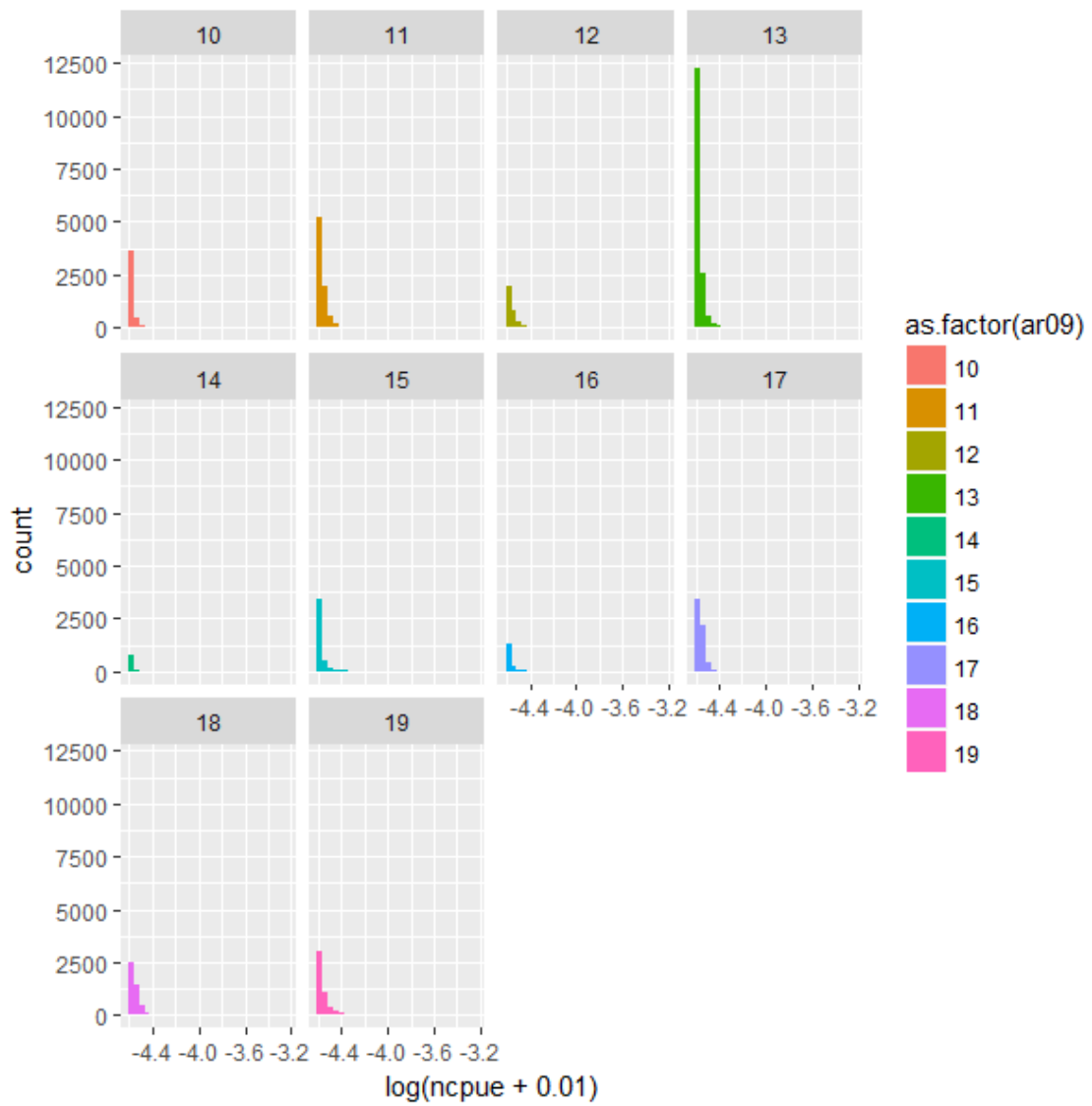


Figure C16 Annual trend of catch in EPO for each area

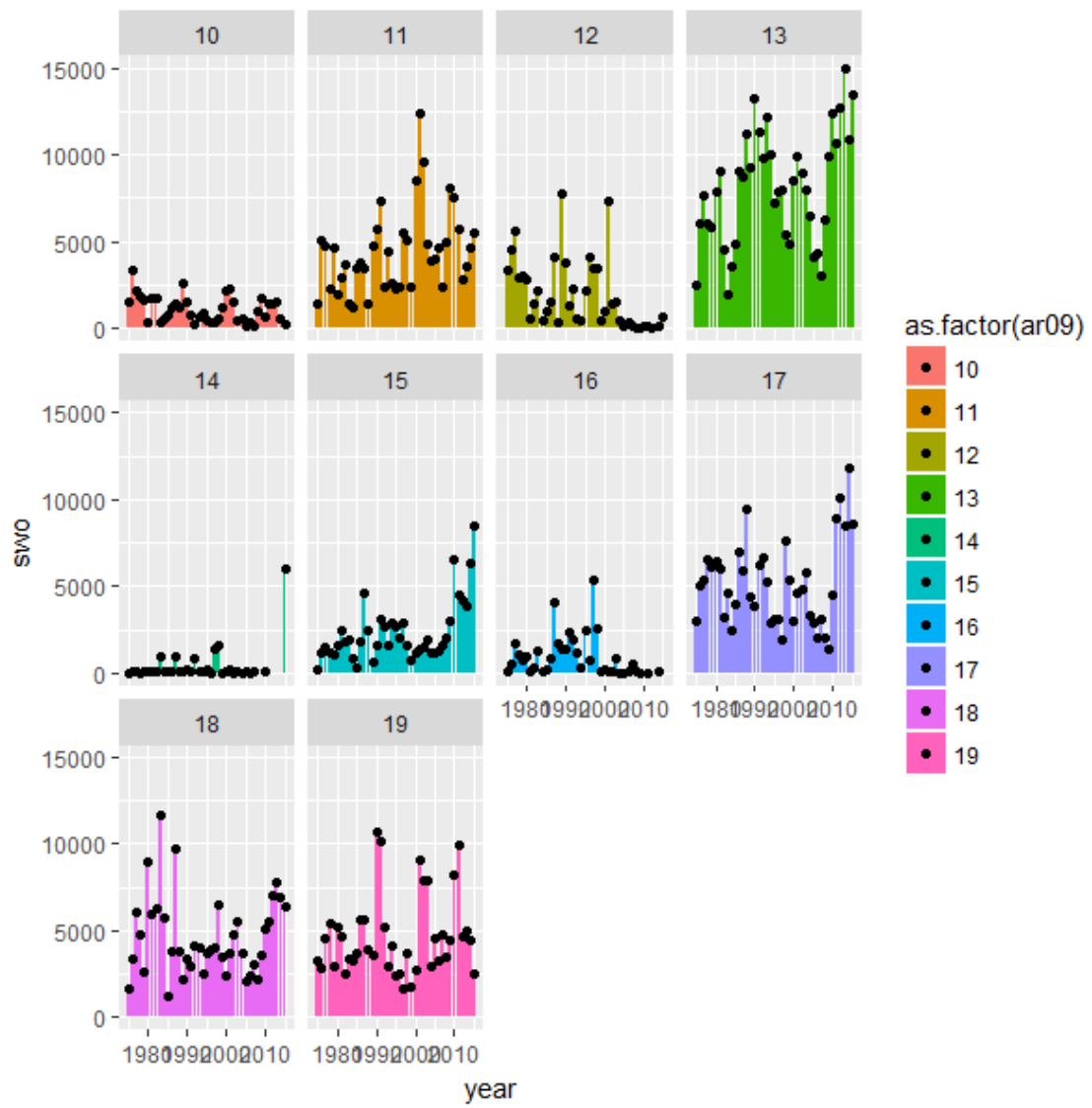


Figure C17 annual trend of Nominal CPUE in EPO for each gear

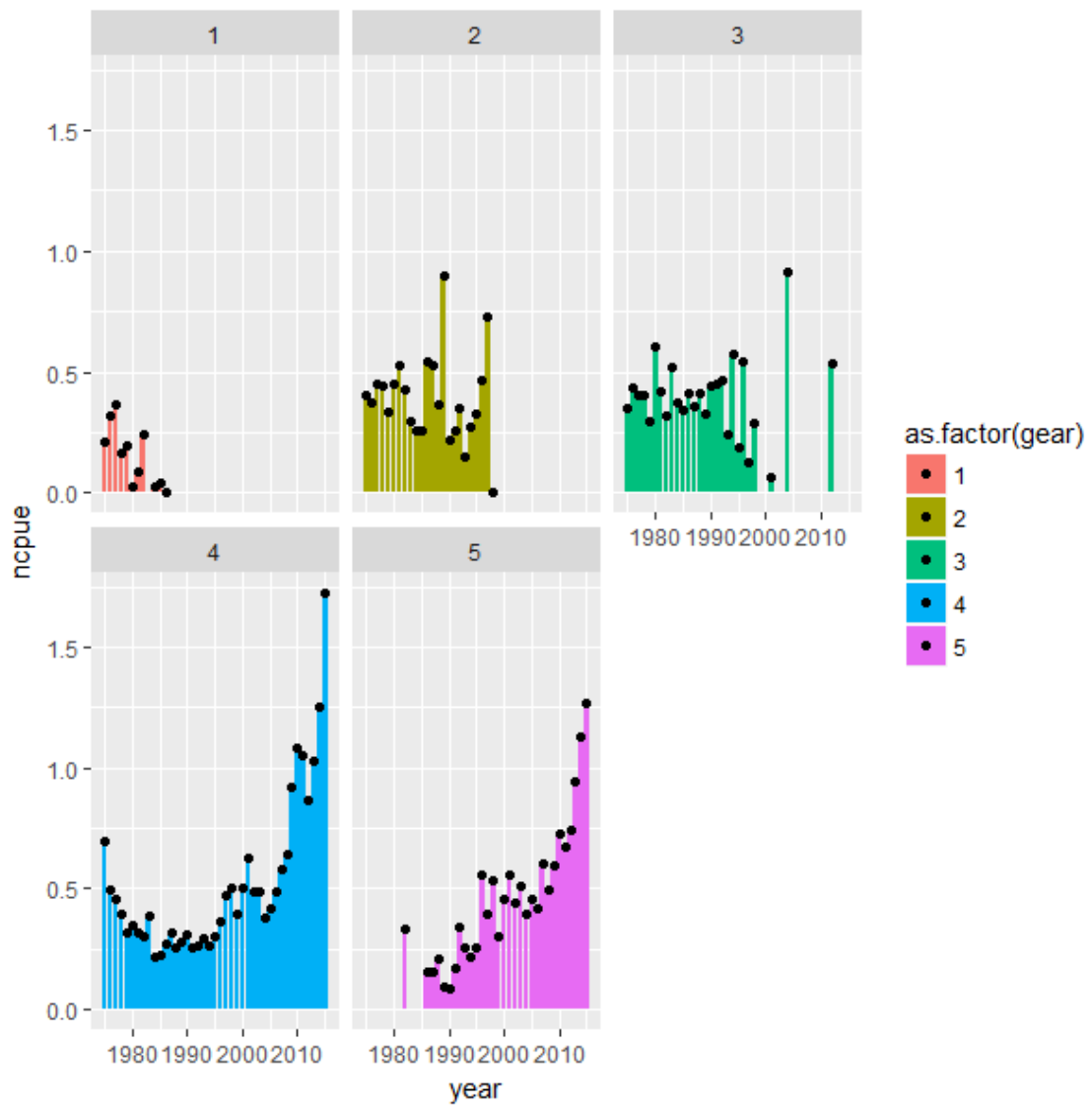


Figure C18 Annual trend of zero-catch ratio in EPO for each gear

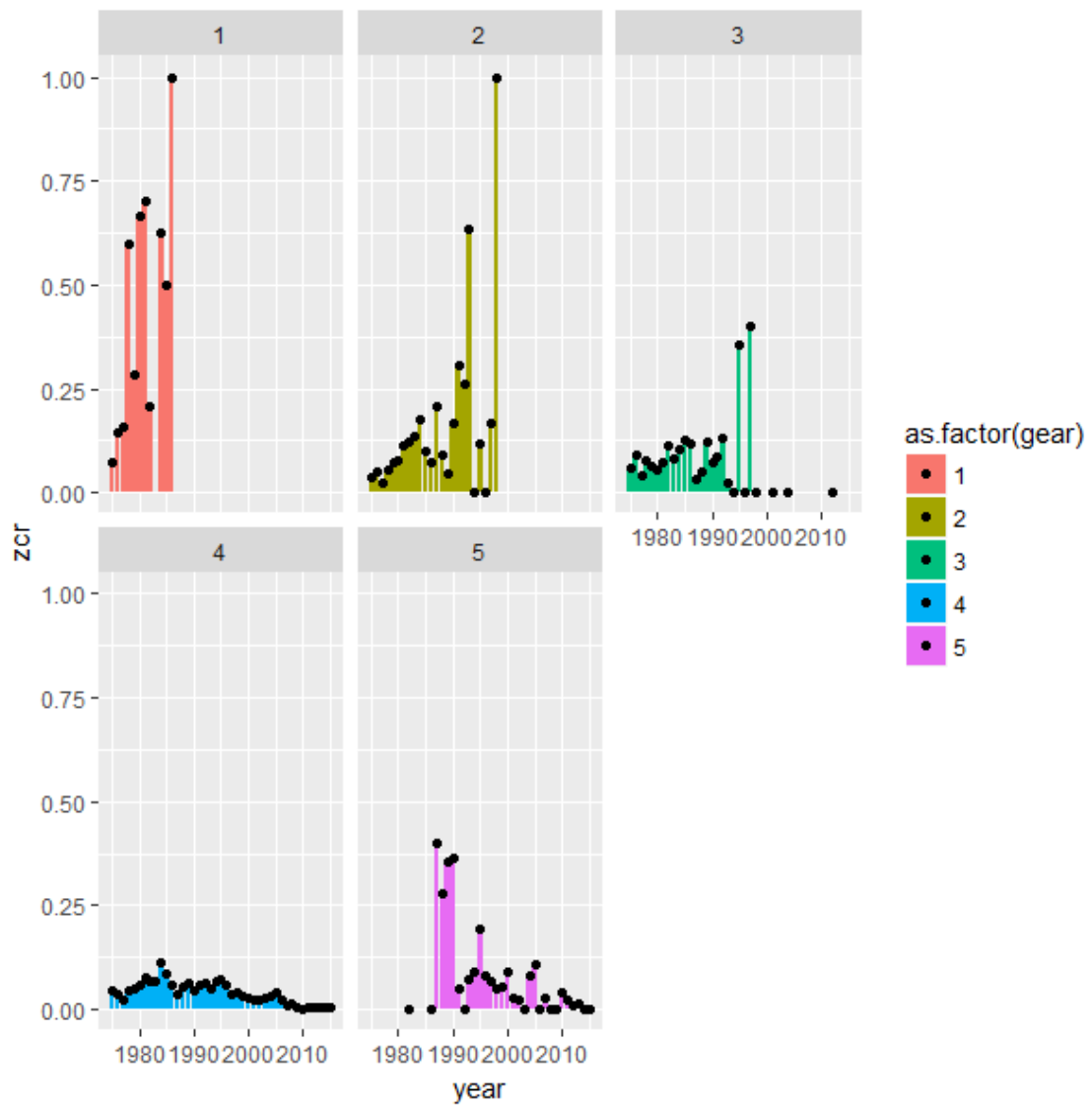


Figure C19 Histogram of log nominal CPUE in EPO for each gear

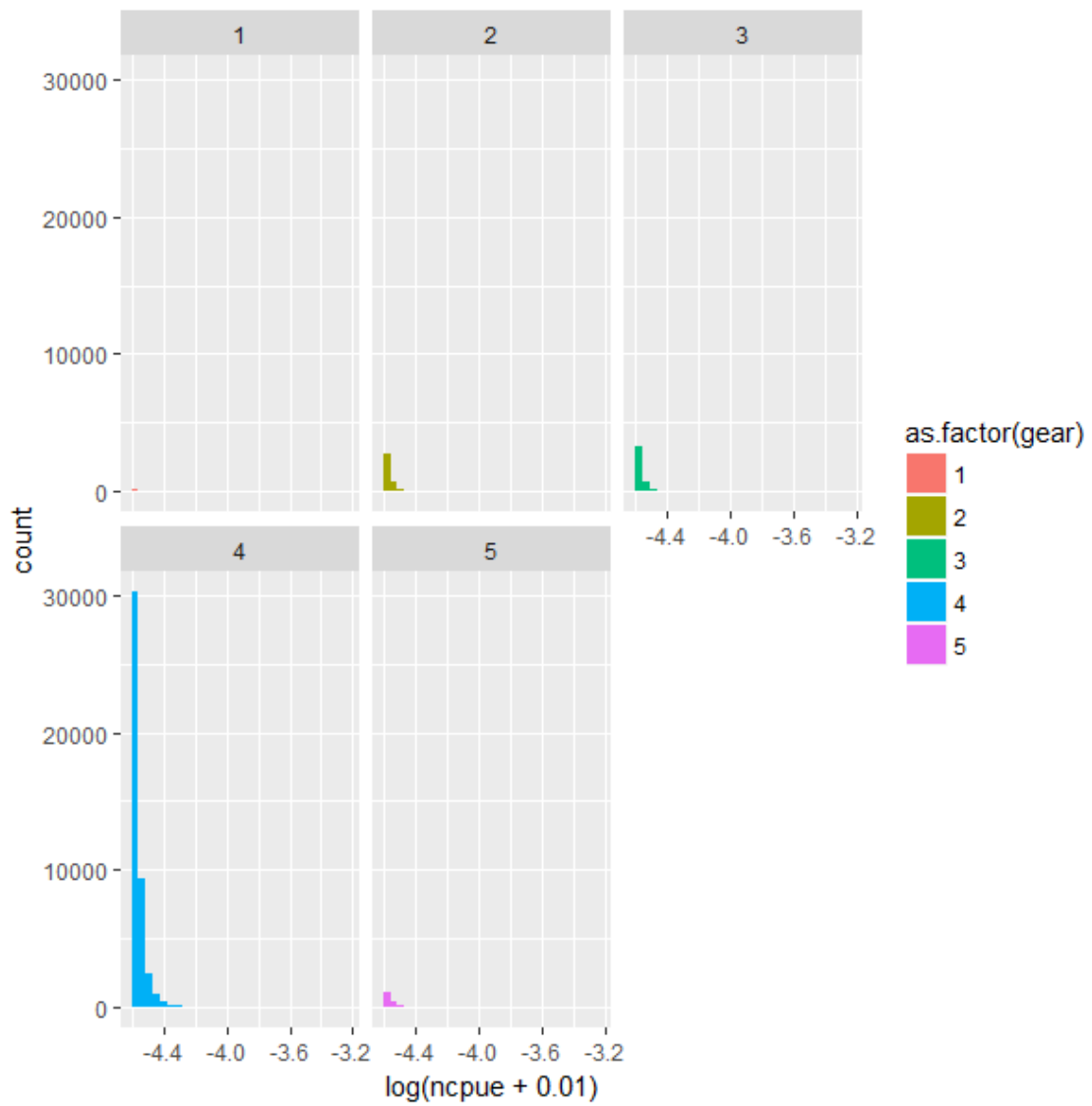


Figure C20 Annual trend of catch in EPO for each gear

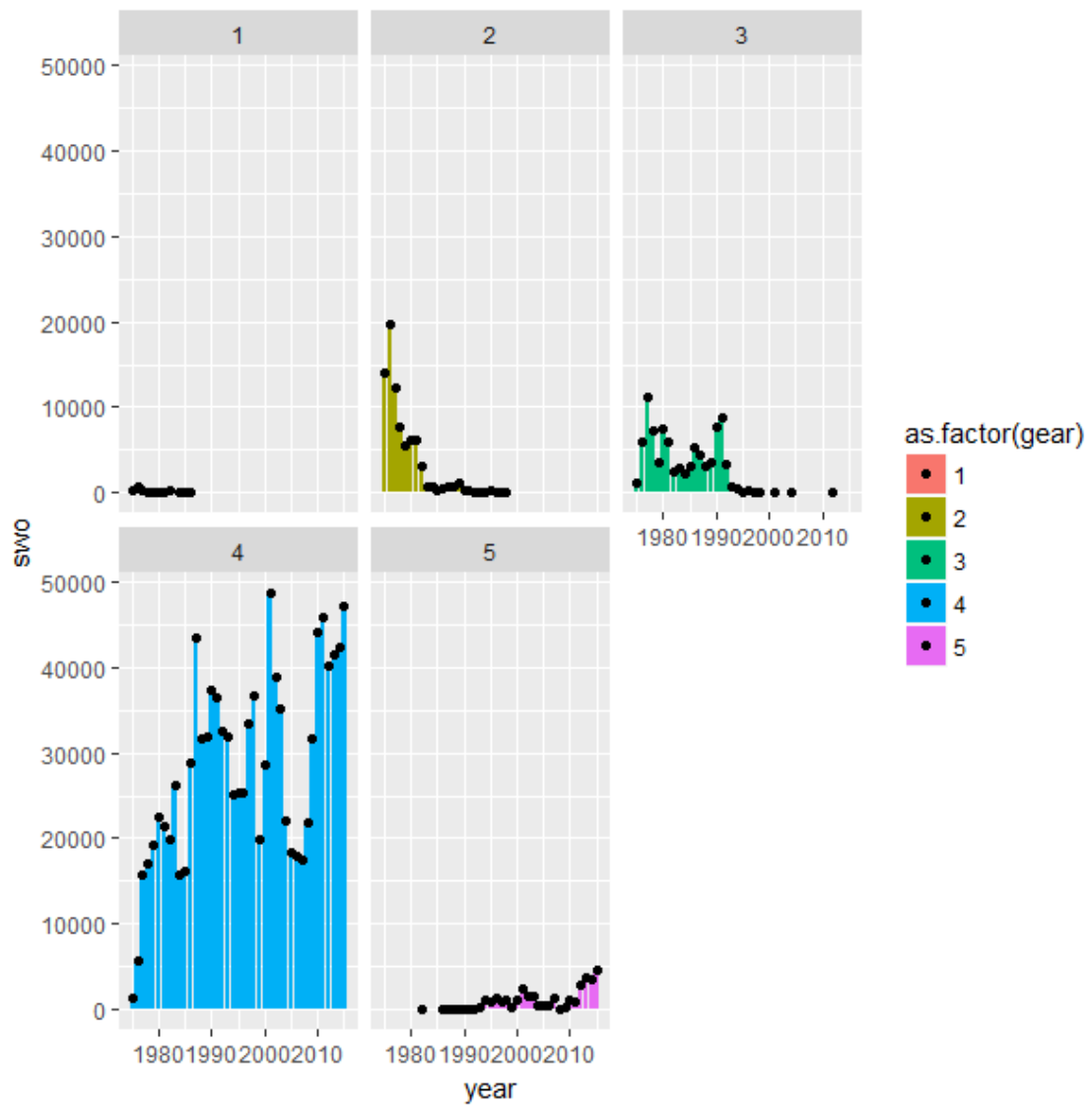


Figure C21 annual trend of Nominal CPUE in EPO for each quarter

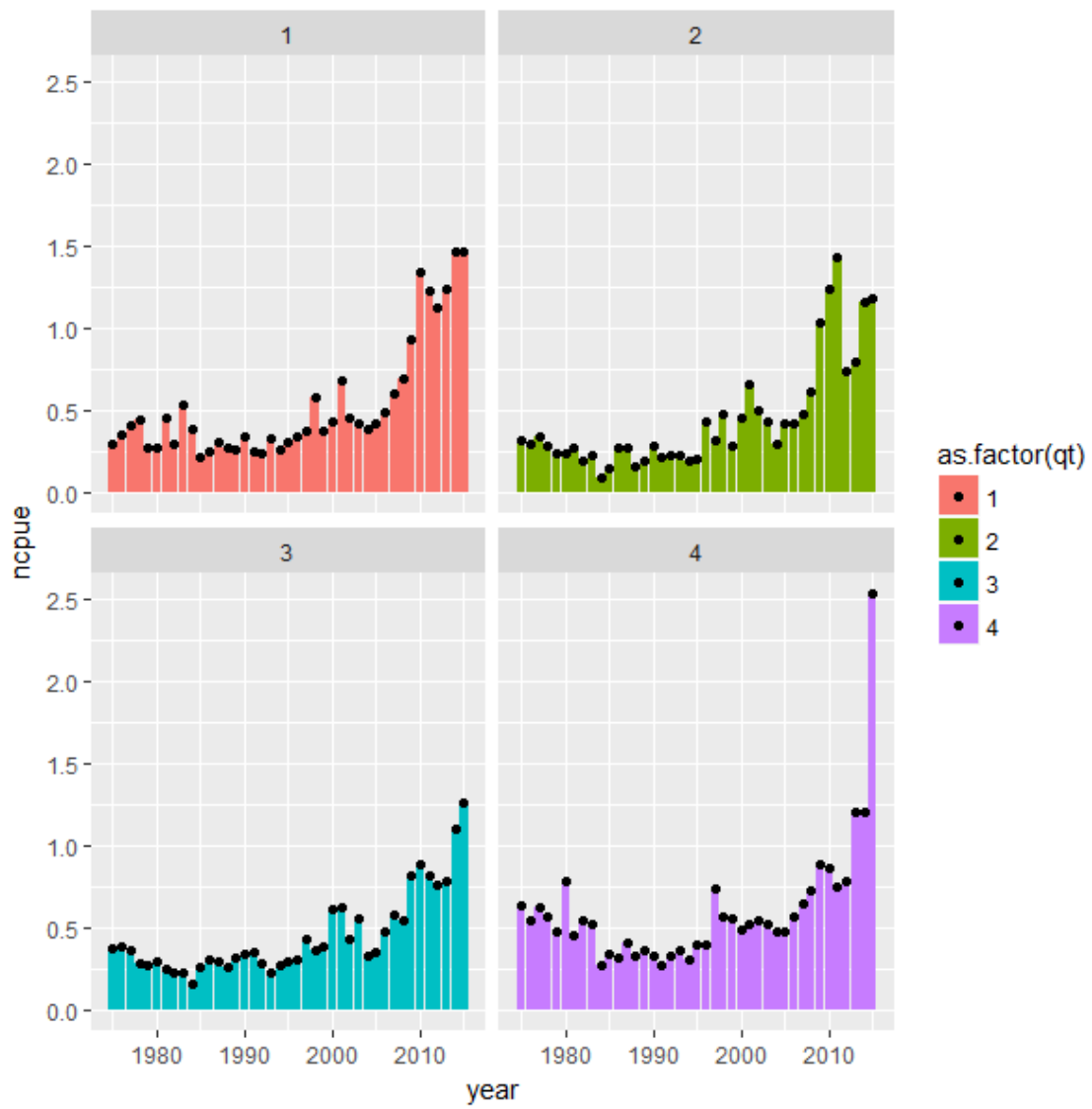


Figure C22 Annual trend of zero-catch ratio in EPO for each quarter

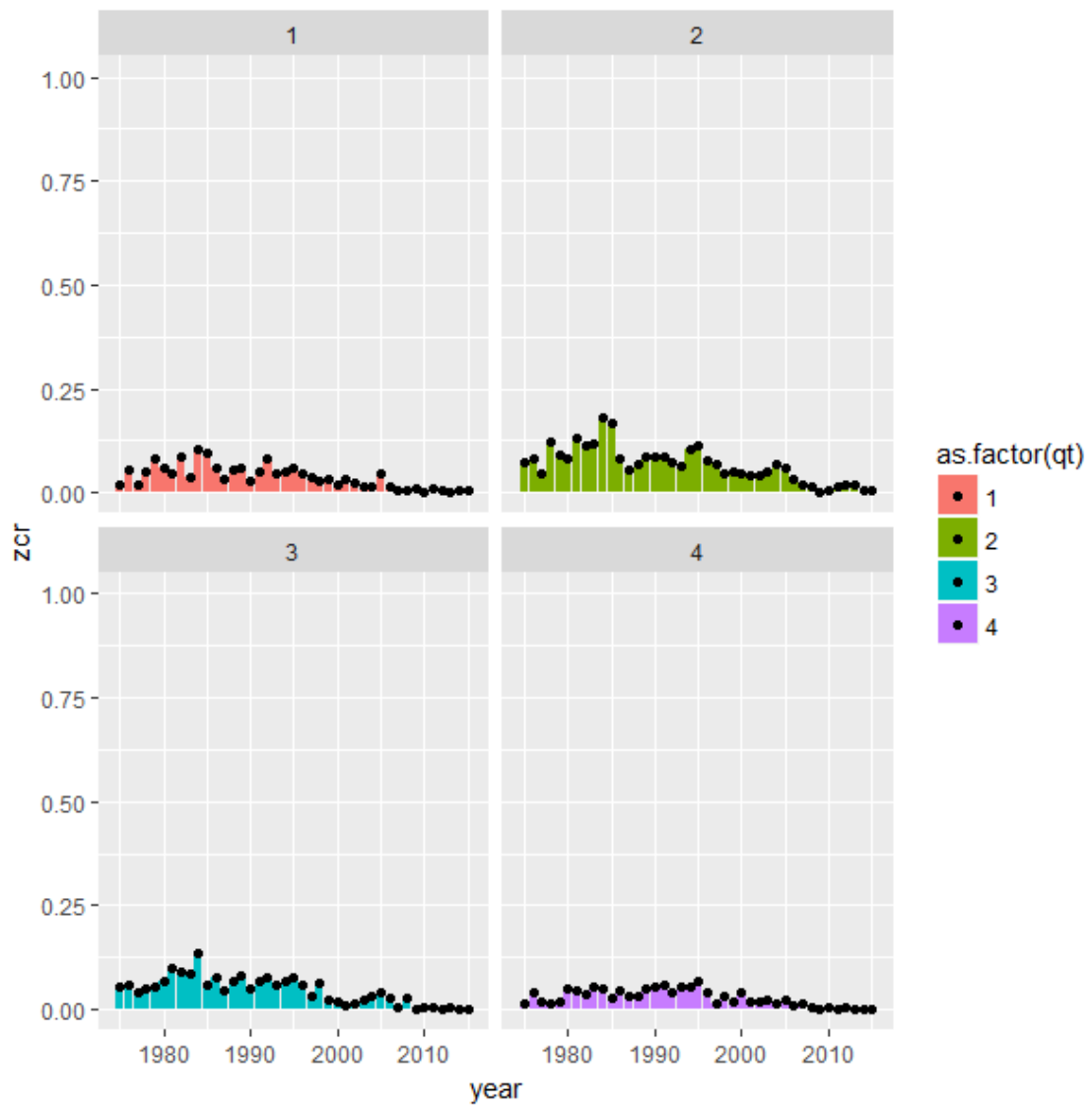


Figure C23 Histogram of log nominal CPUE in EPO for each quarter

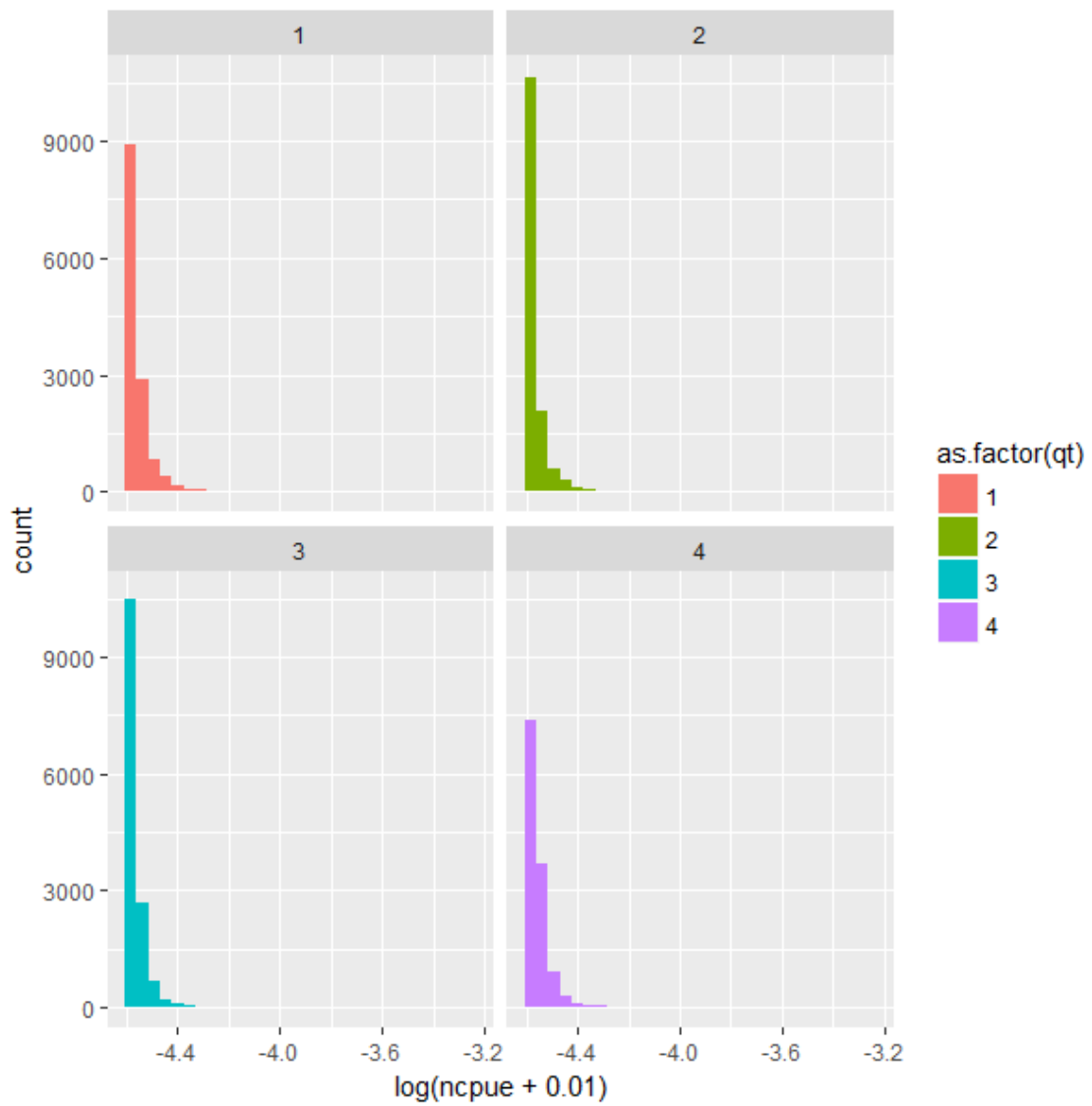
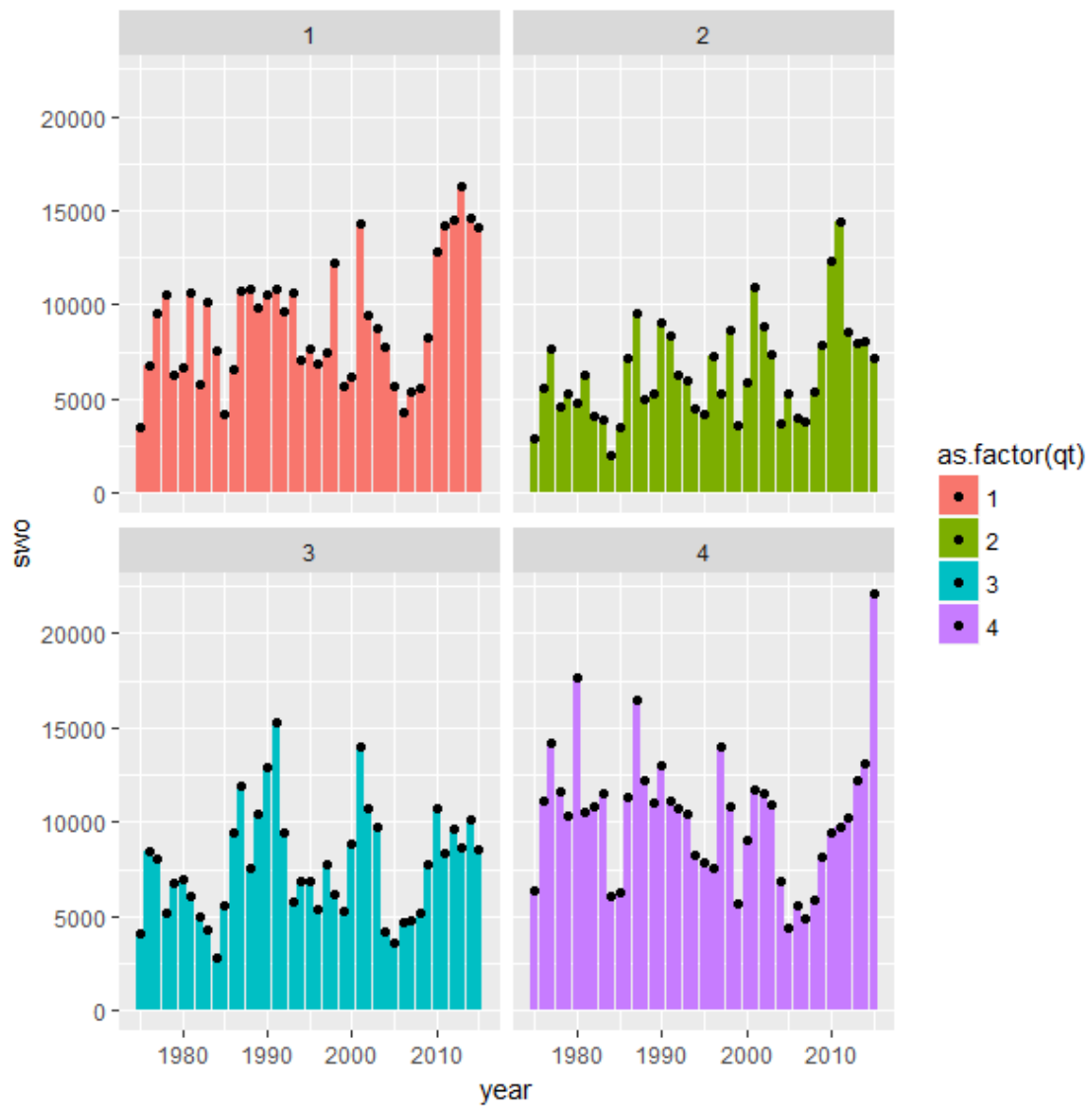


Figure C24 Annual trend of catch in EPO for each quarter



Appendix D data number table for aggregate data set

Table D1 data number in each area and year in WCPO

	1	2	3	4	5	6	7	8	9
1975	79	212	25	90	274	76	88	11	40
1976	116	277	31	148	306	226	71	30	67
1977	136	313	27	147	325	205	98	31	79
1978	95	262	45	160	306	246	168	78	87
1979	112	238	55	205	328	270	138	83	83
1980	113	235	55	153	381	211	106	21	54
1981	116	312	58	205	440	295	91	47	60
1982	118	264	78	189	346	231	73	34	66
1983	109	271	59	185	336	230	104	35	57
1984	118	275	84	155	328	259	119	67	83
1985	101	270	65	148	224	245	79	40	86
1986	98	302	73	180	362	223	95	64	57
1987	115	243	86	154	391	236	93	32	59
1988	115	180	92	164	360	295	83	48	92
1989	62	162	78	156	264	234	135	65	102
1990	74	153	80	122	196	205	94	44	92
1991	105	144	94	141	351	181	95	38	64
1992	59	138	74	107	277	136	126	68	82
1993	89	182	66	126	362	179	76	59	71
1994	143	243	165	154	320	160	145	113	92
1995	135	193	108	170	407	150	148	110	94
1996	105	191	104	192	352	151	127	61	86
1997	125	185	142	188	250	152	110	41	70
1998	81	153	156	165	341	109	129	50	88
1999	87	158	181	152	343	137	250	76	112
2000	109	152	145	131	363	126	88	73	123
2001	114	164	133	165	396	149	18	37	76
2002	84	107	162	155	235	161	66	40	77
2003	96	125	167	127	265	222	197	86	48
2004	91	107	136	135	128	190	57	39	75
2005	62	150	148	136	147	205	128	73	10
2006	92	128	128	122	123	208	98	69	40
2007	164	197	103	134	147	148	49	8	36
2008	127	159	99	122	176	142	45	8	15
2009	114	108	95	74	184	101	34	40	6
2010	89	113	92	82	169	94	13	28	7
2011	56	99	94	95	156	61	39	13	16
2012	73	137	92	113	183	43	12	5	3
2013	77	140	60	135	210	72	12	7	3
2014	103	107	63	142	216	41	16	10	3
2015	69	103	49	118	221	48	12	18	2

Table D1 data number in each area and year in EPO

	10	11	12	13	14	15	16	17	18	19
1975	86	95	98	241	3	20	15	82	60	53
1976	149	233	158	421	15	57	44	155	72	89
1977	160	233	219	491	23	102	95	182	122	125
1978	177	165	145	392	9	97	58	152	102	185
1979	197	259	172	438	13	111	59	167	66	114
1980	107	171	125	541	25	124	37	142	115	112
1981	153	199	63	515	17	121	37	135	116	161
1982	124	265	118	420	31	131	47	96	92	97
1983	100	96	125	218	50	139	58	107	143	140
1984	115	148	95	455	33	112	34	135	104	115
1985	127	243	121	450	38	70	39	107	64	137
1986	98	178	79	503	23	131	71	208	136	146
1987	118	178	116	447	99	190	98	147	177	173
1988	140	126	39	428	14	107	62	231	128	120
1989	156	192	185	400	28	98	84	151	87	121
1990	152	268	116	559	35	134	115	105	84	202
1991	121	292	101	543	41	179	107	163	108	166
1992	96	181	98	410	88	120	107	179	117	152
1993	126	277	65	505	33	100	76	152	91	150
1994	225	341	86	978	30	287	65	203	153	261
1995	163	269	175	730	39	222	127	174	141	152
1996	117	257	74	569	11	156	44	143	169	163
1997	58	260	84	494	35	139	42	112	152	107
1998	92	154	97	235	41	98	67	193	170	153
1999	76	139	33	222	6	67	8	183	110	103
2000	128	278	55	378	16	72	20	131	87	65
2001	132	310	133	429	33	85	24	162	114	171
2002	142	324	48	401	3	90	5	164	146	168
2003	111	259	59	380	4	111	23	197	175	140
2004	128	258	25	297	4	85	6	101	111	119
2005	41	219	10	233	3	74	4	109	90	119
2006	51	185	13	219	1	61	6	89	114	107
2007	22	89	6	159	4	85	10	93	97	96
2008	44	117	6	184	0	81	4	94	78	93
2009	62	116	1	179	0	52	1	53	87	97
2010	33	93	4	237	4	85	0	110	88	77
2011	55	104	2	187	0	67	1	208	116	104
2012	33	100	1	266	0	50	0	271	136	91
2013	55	104	0	291	0	54	0	208	147	63
2014	27	103	4	181	0	51	2	161	90	42
2015	9	89	9	158	7	49	0	147	74	21

Table D3 data number in each quarter and year in WCPO (left) and EPO (right)

	1	2	3	4			1	2	3	4
1975	304	130	147	314		1975	197	179	216	161
1976	458	176	212	426		1976	309	324	401	359
1977	461	217	252	431		1977	437	456	455	404
1978	469	225	226	527		1978	380	331	430	341
1979	552	225	244	491		1979	371	415	416	394
1980	468	193	142	526		1980	386	376	399	338
1981	619	239	218	548		1981	313	438	434	332
1982	599	213	193	394		1982	312	380	415	314
1983	527	218	185	456		1983	281	280	332	283
1984	615	184	207	482		1984	330	339	351	326
1985	515	154	204	385		1985	329	401	361	305
1986	494	240	228	492		1986	324	438	454	357
1987	432	247	238	492		1987	347	473	518	405
1988	452	240	263	474		1988	367	384	395	249
1989	488	192	176	402		1989	322	376	418	386
1990	420	136	156	348		1990	342	384	480	564
1991	429	193	213	378		1991	467	454	493	407
1992	333	161	190	383		1992	382	397	421	348
1993	381	183	198	448		1993	388	399	395	393
1994	492	201	251	591		1994	625	728	691	585
1995	423	216	297	579		1995	573	562	600	457
1996	407	228	238	496		1996	455	450	441	357
1997	325	233	194	511		1997	389	367	378	349
1998	313	243	251	465		1998	424	332	280	264
1999	392	248	248	608		1999	243	271	236	197
2000	363	236	243	468		2000	276	298	282	374
2001	327	272	221	432		2001	428	344	401	420
2002	356	206	177	348		2002	400	351	394	346
2003	255	303	315	460		2003	352	382	358	367
2004	256	222	158	322		2004	355	285	249	245
2005	243	196	224	396		2005	282	257	177	186
2006	281	192	189	346		2006	189	208	226	223
2007	237	203	226	320		2007	209	188	139	125
2008	244	175	154	320		2008	158	199	180	164
2009	251	159	128	218		2009	192	156	160	140
2010	156	178	115	238		2010	176	205	187	163
2011	181	97	130	221		2011	236	207	203	198
2012	179	142	118	222		2012	208	251	267	222
2013	180	155	123	258		2013	237	245	253	187
2014	195	139	134	233		2014	167	169	169	156
2015	164	143	127	206		2015	157	129	149	128

Table D4 data number in each gear and year in WCPO (left) and EPO (right)

	1	2	3	4	5		1	2	3	4	5
1975	86	496	230	83	0	1975	14	562	114	63	0
1976	122	613	330	207	0	1976	28	703	373	289	0
1977	92	564	393	310	2	1977	25	509	640	578	0
1978	86	547	387	427	0	1978	5	353	477	647	0
1979	105	516	356	535	0	1979	21	371	392	812	0
1980	84	432	287	526	0	1980	9	298	316	876	0
1981	94	492	306	732	0	1981	10	268	333	906	0
1982	95	415	223	666	0	1982	24	162	178	1056	1
1983	143	305	220	718	0	1983	0	73	149	954	0
1984	135	310	243	800	0	1984	8	90	104	1144	0
1985	174	197	189	696	2	1985	8	50	118	1220	0
1986	185	158	167	936	8	1986	2	27	146	1397	1
1987	247	170	167	820	5	1987	0	34	157	1547	5
1988	203	136	166	923	1	1988	0	33	96	1248	18
1989	199	56	174	828	1	1989	0	44	132	1312	14
1990	189	48	163	644	16	1990	0	60	236	1463	11
1991	188	40	143	817	25	1991	0	46	199	1556	20
1992	185	13	157	671	41	1992	0	19	91	1435	3
1993	214	9	171	725	91	1993	0	11	46	1491	27
1994	358	23	168	893	93	1994	0	2	24	2437	166
1995	308	24	104	949	130	1995	0	25	14	2024	129
1996	320	16	117	789	127	1996	0	6	17	1594	86
1997	344	20	100	689	110	1997	0	6	5	1386	86
1998	336	4	62	748	122	1998	0	1	10	1209	80
1999	345	0	48	983	120	1999	0	0	0	910	37
2000	374	4	25	759	148	2000	0	0	0	1122	108
2001	425	17	19	561	230	2001	0	0	1	1457	135
2002	366	4	6	560	151	2002	0	0	0	1349	142
2003	348	2	0	816	167	2003	0	0	0	1365	94
2004	352	5	0	504	97	2004	0	0	2	1095	37
2005	337	13	0	597	112	2005	0	0	0	865	37
2006	281	14	2	586	125	2006	0	0	0	815	31
2007	354	27	0	470	135	2007	0	0	0	592	69
2008	280	25	0	471	117	2008	0	0	0	695	6
2009	285	18	1	388	64	2009	0	0	0	630	18
2010	277	14	0	330	66	2010	0	0	0	680	51
2011	164	8	0	393	64	2011	0	0	0	800	44
2012	220	4	0	351	86	2012	0	0	1	836	111
2013	222	5	5	420	64	2013	0	0	0	790	132
2014	234	5	0	401	61	2014	0	0	0	594	67
2015	164	5	0	375	96	2015	0	0	0	486	77
total	9520	5774	5129	25097	2677		154	3753	4371	43725	1843