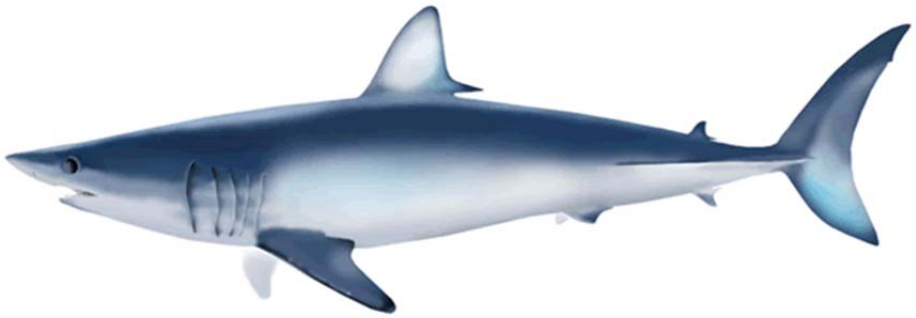
Re-estimation of abundance indices and catch amount for blue shark in the North Pacific [1]

Yuko Hiraoka[2], Minoru Kanaiwa[3], and Kotaro Yokawa[2]

[2]National Research Institute of Far Seas Fisheries, Fishery Research Agency
5-7-1 Orido, Shimizu-ku, Shizuoka 424-8633, JAPAN

[3]Tokyo University of Agriculture, Faculty of Aquatic bioscience
196 Yasaka, Abashiri, Hokkaido Japan 099-2493

Email: yhira415@affrc.go.jp



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Summary

The objective of this WP is to provide abundance indices by standardizing CPUE of blue shark caught by Japanese surface longliners registered in Tohoku and Hokkaido area and to estimate catch numbers using the standardized CPUE for the use of the stock assessment of blue shark. In order to clarify the most appropriate model for the abundance index and the catch estimations, three types of formulae were compared. It is considered that the negative binomial model would be the best formula from the perspective of the estimation of blue shark catch because the delta-lognormal model induced the under estimation. In addition, the filtering method, which was addressed by SPC and adopted by WCPFC SC in 2011, was introduced into this study to remove the data of the operations with unrealistic high zero catches, which was pointed out in the last ISC shark WG meeting in July 2012. The newly introduced filtering method seemed to be succeeded in reducing the number of unexpected data of 0 catch.

Introduction

Although it is necessary to estimate accurate abundance indices for stock assessment, there are many difficulties because of errors, biases insufficiencies in the data used for the estimation. In the last ISC shark meeting held in Sapporo in July 2012, the abundance indices of the north Pacific blue shark stock estimated by applying the negative binominal model on the catch and effort data of Japanese offshore surface longliners were submitted (Hiraoka et al., 2012b), however the statistical problem relating to unexpected high number of zero catch data for the negative binominal error distribution pattern were indicated by the WG. In this WP, the filtering method, which is addressed by Clarke et al. (2011) and adopted by WCPFC SC in 2011,was applied for estimating the abundance indices in 1976-1993, 1994-2010 in order to solve the previous problems.

The objective of this WP is to provide abundance indices by standardizing CPUE of blue shark and to estimate catch numbers using the standardized CPUE with confidence intervals for the use of the stock assessment of blue shark with improved method from the ones in the previous study caught by Japanese offshore surface longliners registered in Tohoku and Hokkaido area. The most appropriate model for the CPUE standardization for its use as abundance index as well as for its use of the catch estimations was discussed. Firstly the delta-lognormal model and negative binomial model were applied on the filtered data. The standardized CPUEs estimated by these two different models showed similar trends, but their levels were different. To investigate the reason for this difference and to decide the better model, further examinations were conducted by changing the value of response variables of the 2nd step formula for the delta-lognormal model. The newly formula of the response variable was the normal CPUE (not log CPUE) but log link function was introduced.

Materials and Methods

The same data sets described in Hiraoka et al. (2012a, 2012b) are used. They are filtered by applying the method described by Clarke et al. (2011) which select the data with individual vessels base of reporting rate being larger than 94.6%. i.e., the data of the vessels whose reporting ratio is lower than 94.6% were deleted from the analysis. The duration for estimation of the abundance indices and catch amount was shortened to 1976-2010 from the previous study because the code for individual vessels was available only since 1976. The models used for the offshore shallow fleet and distant-water shallow fleet registered in Tohoku and Hokkaido (fleets categorized into 1-1-1a and 2-1-1a in the previous study by Hiraoka et al. (2012a)) are improved

by using the new explanatory variable to account for the target effect. Following by the agreement in the last ISC Shark WG meeting in July 2012, the percentile of the annual CPUE value of swordfish is used as the target effect instead of that of blue shark. Each data of the year was divided into 10 categories by the order of swordfish catch ratio at every 10^{th} percentile. Other explanatory valuables than the CPUE rank of swordfish and the formula of CPUE standardization in the CPUE analysis of this study were the same as those in the previous studies by Hiraoka et al (2012a, 2012b).

In order to decide the most appropriate model for the CPUE standardization and catch estimation, the standardized CPUEs were calculated by three types of formulae,

1) Delta-lognormal model

2nd step

$\log CPUE = (\text{intercept}) + (\text{Main effects}) + (\text{Interactions}),\ \log CPUE \sim N(\mu, \sigma^2)$

2) Delta-lognormal model with log link function

2nd step

$CPUE = \exp\{(\text{intercept}) + (\text{Main effects}) + (\text{Interactions})\},\ CUPE \sim N(\mu, \sigma^2)$

3) Negative binomial model

$Catch = (Effort) * \exp\{(\text{intercept}) + (\text{Main effects}) + (\text{Interactions})\},\ Catch \sim NB(\alpha, \beta)$

The annual values of the standardized CPUE were calculated as the weighted mean of the area indices and they were proposed as the candidates of the abundance indices of blue shark. The weighting factor of each area is decided by their approximate sizes.

The total catch number of blue shark were estimated as the product of the total effort by the standardized CPUE of negative binominal model in each categories same as Hiraoka et al. (2012a, 2012b; Kinkai_shallow, Enyo_shallow, Kinkai_deep and Enyo deep), respectively. The catches in weight were calculated by multiplying the catch number by the average weight for each category (year, area and quarter). The area and quarter specific average weight were calculated using information in the log-book in 1994 – 2010 when the catch weight information available (Table 1). Conversion factor form the processed weight in the log-book to whole weight was 1.20.

Through the filtering process for data set in 1994-2010, almost of the operation conducted in area 5 (Fig. 1) were rejected and only two operations were remained. Thus the abundance index were estimated by the operations exclusive in the area 5, and because of this, the catch number in area 5 were estimated by multiplying the overall mean standardized CPUE in year *i* to total hooks of area 5 in year *i*.

Bootstrap method was used to calculate 95% confidence interval of standardized CPUE and coefficients of variation (CV) for estimated catch with 1000 times re-sampling. The calculations of GLM in this study were conducted using R 2.15.1.

Result

Table 2 shows the standardized CPUE and 95% confidence intervals estimated by the delta-lognormal model and negative binomial model. Although the absolute vales of standardize CPUE by delta-lognormal was lower than those by negative binomial, their normalized annual trends were roughly similar (Table 4, Fig. 2). They showed decreasing trend from 1976 to 1990 then continuously increased to 2006. In 2007 and 2008, the level of

standardized CPUE dropped to its in late 1990's but immediately recovered in 2009 and 2010.

The results of comparison between three formulae were shown in Tables 3-5 and Figs. 2 and 3. The AIC value of delta-lognormal model was much lower than that of log linked delta-lognormal model (Table 3). The trends of normalized CPUEs obtained by three methods were almost same in both two periods analyzed were similar to both periods (1976-1993, 1994-2010). The estimated annual catches for three formulae showed higher than nominal ones in the period before 1985 (Table 6, Fig. 3). Throughout the years analyzed, the estimated catches by the delta-lognormal model were lowest in the estimated catches by all formulae.

The comparison of residuals, estimated by observation value minus predict value, between two types of delta log-normal model was shown in Fig. 4. The residuals of delta-lognormal model were relatively lower than that of log linked delta-lognormal model in the both periods.

The general trend of the annual blue shark catches in number by Japanese offshore and distant-water longliners were similar with those in weight throughout the period analyzed (Tables 6 and 7, Fig. 5). The catches by Kinkai fleet with shallower set in 1970's were highest among all categories. The highest total catches both in number and in weight (number and weight) including releases and discards recorded in 1981 then they drastically decreased until 1987, but after that, the trends were relatively stable up to 2010.

Discussion

The filtering method would be essential for the selection of the reliable data set especially before the1980s. In the previous studies (Hiraoka et al., 2012a; 2012b), we assumed that Kinkai fleet belong to Hokkaido and Tohoku region with shallower setting data have negligible under reporting because this assumption were validated by the comparison of the catch ratio of blue shark between the log-book data of the fleet of Kinkai-shallow longliners in Hokkaido and Tohoku region and shallow sets of the research and the training longline data operated in the same area and season (Takahashi et al., 2012), as well as the comparison of the catch record between the log-book and the observer report (Yokawa and Kimoto, 2012). But in the ISC shark WG meeting in July 2012, the log-book data of this category (Kinkai_shallow_Hokkaido & Tohoku) was indicated to contain the too many zero catches especially in the 1970s. The data used for the validations were only after 2000 therefore the information relating to the shark dumping in the old days was collected. The interview with the retired fisherman in Kesennuma port were conducted and it is indicated that even though the Kesennuma fleets, which actively target blue shark, did not report all their catches of shark species before the 1980s due to many catches of swordfishes and tunas, which have higher market values than blue shark, sometimes occupied their tank. Thus the application of filtered data was supposed to be necessary for the estimation of abundance indices of shark species caught even by Kinkai-shallow longliners in Hokkaido and Tohoku region.

It is considered that the negative binomial model would be the most appropriate from the perspective of the estimation of blue shark catch. The level of estimated catch of the delta-lognormal with log link function was similar to catch estimated by not the delta-lognormal model but the negative binomial model (Table 4, Fig. 3). The difference between the delta-lognormal model and the delta-lognormal model with log link function is the residual distribution. The residuals from delta-lognormal model were relatively smaller than these from the log-linked delta-lognormal model (Fig. 4). It is suggested that the log-transformed residual distribution would not precisely predict the normal CPUE, and this would induce the under estimation of

total catches. Though the level of catch was bit small, the trends of standardized CPUEs for the delta-lognormal were similar to the ones by other two formulae, the negative binomial and delta-lognormal with log link in both the former and the later periods analyzed (Table 4, Fig2).

The estimated catch in the 1970s would be under estimation in the previous WP by Hiraoka et al. (2012a, 2012b). Through the filtering process, the higher value of standardized CPUE than previous study were used for the estimation of annual catch, and the annual catch in the 1970s of Kinkai fleets with shallower setting showed rather high catch amount than landing (observed catch) both in number and weight (Tables 6 and 7). This indicates that the dumping ratio of blue shark by Japanese surface longliner would be neither low nor negligible before the middle of the 1980s. The results suggested the necessity of further information relating to shark dumping before the 1980s (for all categories). For the Kinkai fleets with shallower setting discussed in this WP, the distribution of operations would be possible to be more south area where is considered to be lower density of blue shark than north if these fleets targeted the higher value fishes before the 1980's as retied fisherman indicate. Thus it is considered that the 94.6% of filtering criteria might overestimate the actual catch number of blue shark and it should be reviewed with the information of operation pattern before the 1980s, although the little information could be available at this moment. Consequently, the estimated annual catch in this WP is supposed to be the best available information at this moment.

In conclusion, the abundance indices and catch amount shown in this WP can be best input data for the stock assessment of the north Pacific blue shark.

Reference

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Table 1 Average weight (kg) by area I and season compiled within the year of 1994 - 2010

Area	Season	Catch number	Catch weight (kg)	Average weight (kg)
1	1	2112394	43494075	20.59
2	1	18223	468158	25.69
3	1	133384	3817282	28.62
4	1	78979	3233284	40.94
5	1	32714	898736	27.47
1	2	2809934	48387126	17.22
2	2	333508	5172216	15.51
3	2	402235	11597037	28.83
4	2	63589	2587959	40.70
5	2	42046	1180960	28.09
1	3	2717791	48350381	17.79
2	3	151114	2705509	17.90
3	3	65384	1921470	29.39
4	3	8945	346577	38.75
5	3	41259	1220596	29.58
1	4	1806861	35086170	19.42
2	4	50230	1156457	23.02
3	4	17799	507601	28.52
4	4	17860	690492	38.66
5	4	45893	1304058	28.42

Table 2 Annual standardized CPUEs (n/1000 hooks) and confidence intervals (95%) for the blue shark during 1975 to 2010 estimated by delta-lognormal and negative binomial model

	Delta-lognormal			Negative binomial		
Year	lcpue	cpue	ucpue	lcpue	cpue	ucpue
1976	10.430	10.827	11.226	12.107	12.566	13.083
1977	11.265	11.541	11.854	12.869	13.183	13.523
1978	9.351	9.663	10.026	11.093	11.427	11.764
1979	10.305	10.604	10.968	11.674	11.974	12.279
1980	11.615	11.964	12.305	12.470	12.797	13.131
1981	9.376	9.611	9.850	10.458	10.706	10.951
1982	9.212	9.455	9.708	10.337	10.583	10.848
1983	8.690	8.918	9.165	9.741	9.947	10.162
1984	7.482	7.669	7.868	8.621	8.819	9.020
1985	6.784	6.925	7.064	7.470	7.611	7.768
1986	7.469	7.642	7.822	8.689	8.869	9.051
1987	5.324	5.445	5.571	6.562	6.702	6.848
1988	5.571	5.718	5.882	6.876	7.033	7.193
1989	4.976	5.128	5.279	6.208	6.383	6.546
1990	5.404	5.559	5.719	6.568	6.747	6.903
1991	7.345	7.542	7.741	8.241	8.451	8.655
1992	7.464	7.673	7.866	8.522	8.761	9.009
1993	8.264	8.537	8.807	9.955	10.264	10.566
1994	5.201	5.392	5.597	8.000	8.308	8.631
1995	6.449	6.652	6.882	9.267	9.572	9.905
1996	6.048	6.275	6.486	8.694	9.001	9.295
1997	7.400	7.657	7.940	11.232	11.648	12.082
1998	7.318	7.567	7.822	11.275	11.685	12.119
1999	7.561	7.819	8.078	12.200	12.664	13.184
2000	8.576	8.846	9.107	12.075	12.524	12.959
2001	8.363	8.680	8.999	13.696	14.183	14.763
2002	8.393	8.704	8.993	13.746	14.256	14.799
2003	9.695	10.021	10.369	14.605	15.122	15.669
2004	9.603	9.906	10.207	13.607	14.061	14.534
2005	9.243	9.628	10.022	14.318	14.954	15.565
2006	8.572	8.924	9.270	13.854	14.534	15.218
2007	6.536	6.753	7.010	10.622	11.102	11.590
2008	6.137	6.379	6.643	10.533	11.077	11.664
2009	8.597	8.970	9.346	14.658	15.414	16.280
2010	8.805	9.160	9.529	14.755	15.452	16.196

Table 3 Comparison of AIC, Log-likelihood and DF for the Delta-lognormal, Delta-lognormal with log link function and Negative Binomial models

		CPUE model		Catch model
AIC		Delta-lognormal	Delta-normal + log link	Negative binomial
1976-1993	1st model	23093		1096885
	2nd model	827315	965990	
1994-2010	1st model	12079		878805
	2nd model	669780	813623	
log-likelihood				
1976-1993	1st model	-11599		-548258
	2nd model	-153700	-482810	
1994-2010	1st model	5835		-439197
	2nd model	-116255	-406606	
DF				
1976-1993	1st model	184		185
	2nd model	185	185	
1994-2010	1st model	204		205
	2nd model	205	205	

Table 4 The standardized and normalized CPUEs estimated by the four models and the area weighted nominal CPUE of 1-1-1a and 2-1-1a

Year	Delta-lognormal	Delta-lognormal + loglink	Negative binomial	Area weighted nominal
1976	1.269	1.441	1.312	1.236
1977	1.377	1.424	1.369	1.344
1978	1.151	1.216	1.192	1.153
1979	1.250	1.213	1.240	1.238
1980	1.452	1.417	1.338	1.348
1981	1.143	1.112	1.120	1.125
1982	1.122	1.123	1.101	1.095
1983	1.074	1.010	1.041	1.003
1984	0.926	0.893	0.922	0.921
1985	0.833	0.772	0.792	0.791
1986	0.920	0.871	0.918	0.943
1987	0.652	0.660	0.697	0.686
1988	0.690	0.684	0.733	0.725
1989	0.621	0.642	0.666	0.683
1990	0.663	0.656	0.700	0.715
1991	0.907	0.835	0.877	0.940
1992	0.917	0.941	0.913	0.937
1993	1.032	1.091	1.071	1.116
1994	0.673	0.524	0.660	0.468
1995	0.827	0.569	0.757	0.468
1996	0.778	0.618	0.710	0.477
1997	0.949	0.903	0.920	1.025
1998	0.941	0.889	0.929	0.629
1999	0.972	1.048	1.005	0.661
2000	1.094	1.038	0.987	0.627
2001	1.072	1.182	1.120	1.584
2002	1.072	1.243	1.122	1.344
2003	1.238	1.227	1.191	1.550
2004	1.224	1.104	1.107	1.137
2005	1.187	1.218	1.177	1.324
2006	1.106	1.147	1.143	1.390
2007	0.836	0.880	0.875	1.297
2008	0.788	0.890	0.871	0.673
2009	1.111	1.216	1.216	1.205
2010	1.133	1.303	1.210	1.140

Table 5 The catch series of Kinkai fleet with shallower setting estimated by the four models and nominal one

Year	Delta-lognormal	Delta-lognormal + loglink	Negative binomial	nominal
1976	597,232	854,807	914,738	297,594
1977	840,558	1,137,724	1,227,242	380,505
1978	647,287	933,406	997,161	305,841
1979	693,853	1,077,190	1,094,177	334,591
1980	778,806	1,029,910	1,040,383	324,247
1981	675,101	837,087	917,997	296,086
1982	413,120	553,866	587,281	266,507
1983	355,626	463,035	486,118	330,247
1984	272,167	366,689	382,290	300,624
1985	261,183	345,612	347,975	315,011
1986	295,063	399,296	417,060	380,512
1987	224,380	320,734	329,674	301,910
1988	205,217	294,218	303,202	278,583
1989	182,070	269,240	271,756	239,156
1990	170,607	244,123	248,488	221,247
1991	221,837	295,342	301,970	262,460
1992	223,748	331,517	317,901	298,283
1993	256,826	394,094	390,711	352,009
1994	218,040	264,565	341,404	265,983
1995	243,001	259,616	358,874	238,871
1996	228,833	289,009	334,199	276,778
1997	276,917	440,011	440,505	386,862
1998	264,342	412,561	428,304	377,760
1999	297,243	527,481	506,653	471,328
2000	459,460	691,940	663,216	607,837
2001	452,578	801,218	762,252	712,117
2002	392,088	713,564	660,914	628,499
2003	432,555	672,285	655,027	620,871
2004	406,825	575,626	580,126	532,358
2005	425,452	684,328	658,879	649,733
2006	376,359	597,948	590,038	547,435
2007	269,625	449,533	443,272	437,854
2008	238,817	408,642	399,295	386,265
2009	296,599	490,729	486,408	455,865
2010	254,344	435,180	417,096	382,087

Table 6 Re-estimated total blue shark catches in number including releases and discards Japanese longline fisheries during 1975 and 2010 in the North Pacific

Year	Kinkai_shallow	Enyo_shallow	Kinkai_deep	Enyo_deep	Total
1976	914,738	59,565	79,879	430,135	1,484,317
1977	1,227,242	45,355	118,022	526,465	1,917,084
1978	997,161	53,990	91,435	491,228	1,633,814
1979	1,094,177	27,587	96,861	752,520	1,971,144
1980	1,040,383	19,329	199,131	793,132	2,051,975
1981	917,997	16,895	287,827	806,361	2,029,080
1982	587,281	16,759	304,235	526,293	1,434,569
1983	486,118	23,354	315,583	573,779	1,398,834
1984	382,290	10,611	353,545	557,108	1,303,553
1985	347,975	15,366	261,870	589,136	1,214,347
1986	417,060	33,327	288,924	323,545	1,062,855
1987	329,674	18,066	148,415	351,850	848,005
1988	303,202	15,738	104,963	532,890	956,793
1989	271,756	9,743	131,681	613,561	1,026,740
1990	248,488	5,846	115,887	405,759	775,980
1991	301,970	9,084	178,910	376,645	866,608
1992	317,901	10,927	145,963	298,035	772,827
1993	390,711	14,493	162,502	398,817	966,523
1994	341,404	23,639	96,880	397,931	859,854
1995	358,874	35,544	51,330	511,462	957,210
1996	334,199	37,967	80,552	316,025	768,743
1997	440,505	46,784	43,583	354,871	885,741
1998	428,304	63,486	40,616	334,110	866,517
1999	506,653	76,432	21,885	228,005	832,975
2000	663,216	73,006	84,965	135,473	956,660
2001	762,252	94,741	37,657	147,219	1,041,869
2002	660,914	74,581	30,303	99,943	865,741
2003	655,027	88,101	120,826	113,218	977,172
2004	580,126	141,242	67,415	101,667	890,451
2005	658,879	127,998	64,686	131,016	982,579
2006	590,038	156,881	107,247	102,965	957,131
2007	443,272	138,570	101,306	116,064	799,211
2008	399,295	138,922	30,938	95,180	664,334
2009	486,408	134,236	11,832	80,903	713,378
2010	417,096	126,286	0	260,872	804,255

Table 7 Re-estimated total blue shark catches in weight (metric tons) and coefficients of variation (C.V.) including releases and discards Japanese longline fisheries during 1975 and 2010 in the North Pacific

Year	Kinkai_ shallow	Enyo_ shallow	Kinkai_ deep	Enyo_ deep	Total	C.V.(%)
1976	23,056	1,431	1,826	10,328	36,641	1.99
1977	31,868	1,098	2,831	13,608	49,405	2.36
1978	25,542	1,308	2,253	13,314	42,417	2.50
1979	27,913	676	2,277	19,666	50,533	3.04
1980	26,704	511	4,657	21,646	53,517	1.90
1981	23,789	426	6,748	23,859	54,822	1.81
1982	14,216	442	6,969	15,136	36,764	1.68
1983	11,122	557	7,297	16,414	35,389	1.59
1984	8,775	266	8,234	15,428	32,703	1.71
1985	7,700	380	6,080	15,610	29,770	1.86
1986	9,174	710	6,622	9,387	25,892	1.48
1987	7,280	430	3,572	10,230	21,512	2.07
1988	6,510	342	2,343	15,837	25,032	3.19
1989	5,910	208	3,063	18,012	27,193	2.83
1990	5,374	141	2,725	11,738	19,979	2.36
1991	6,448	221	4,092	10,181	20,942	2.19
1992	6,901	265	3,462	8,504	19,132	1.81
1993	8,506	352	3,742	11,183	23,783	1.89
1994	6,993	469	2,085	10,661	20,208	1.65
1995	7,464	940	1,134	14,539	24,078	1.66
1996	6,666	807	1,775	8,959	18,208	2.14
1997	8,662	1,017	983	9,596	20,257	1.74
1998	8,485	1,407	858	9,458	20,207	2.04
1999	9,714	1,472	445	6,573	18,204	1.69
2000	12,222	1,397	1,711	4,070	19,401	3.69
2001	14,022	1,746	816	4,175	20,759	1.54
2002	12,417	1,436	604	2,948	17,405	1.64
2003	12,035	1,654	2,351	3,079	19,119	2.27
2004	10,683	2,680	1,391	2,837	17,590	1.83
2005	11,952	2,373	1,253	3,510	19,088	2.06
2006	10,654	2,871	2,076	2,707	18,309	2.17
2007	8,144	2,581	1,927	3,052	15,703	2.52
2008	7,302	2,538	595	2,581	13,015	2.33
2009	8,756	2,470	266	2,197	13,690	2.37
2010	7,667	2,357	0	7,288	17,311	2.64

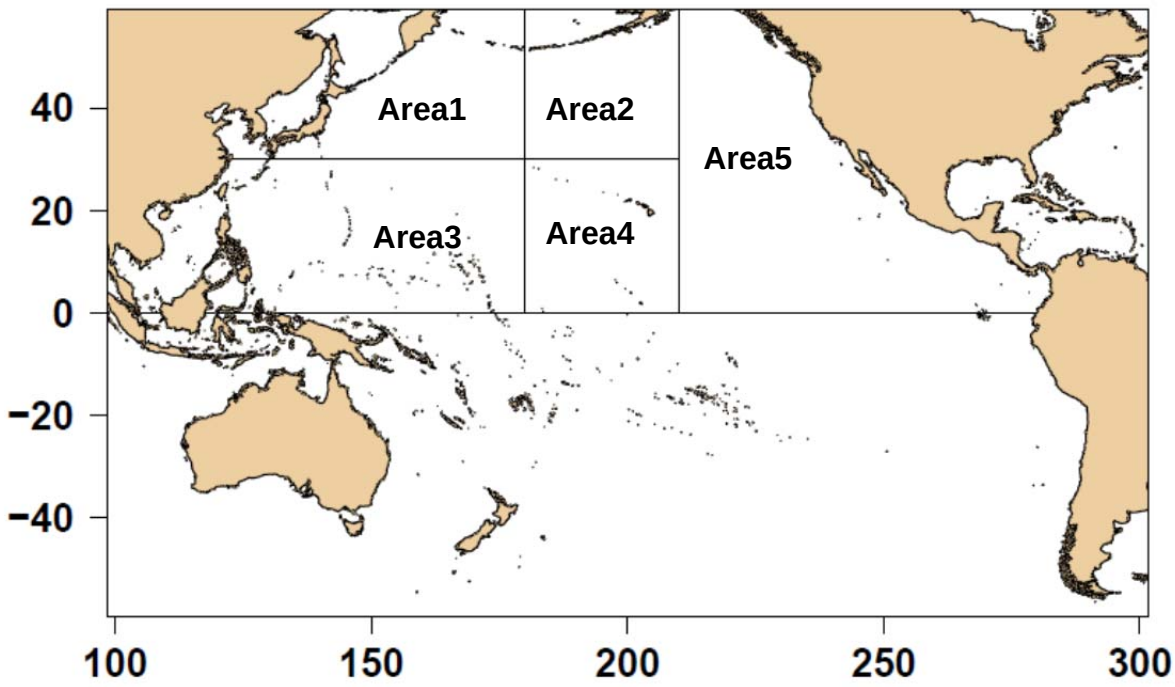

Figure 1. Area classification designated by the shark WG.

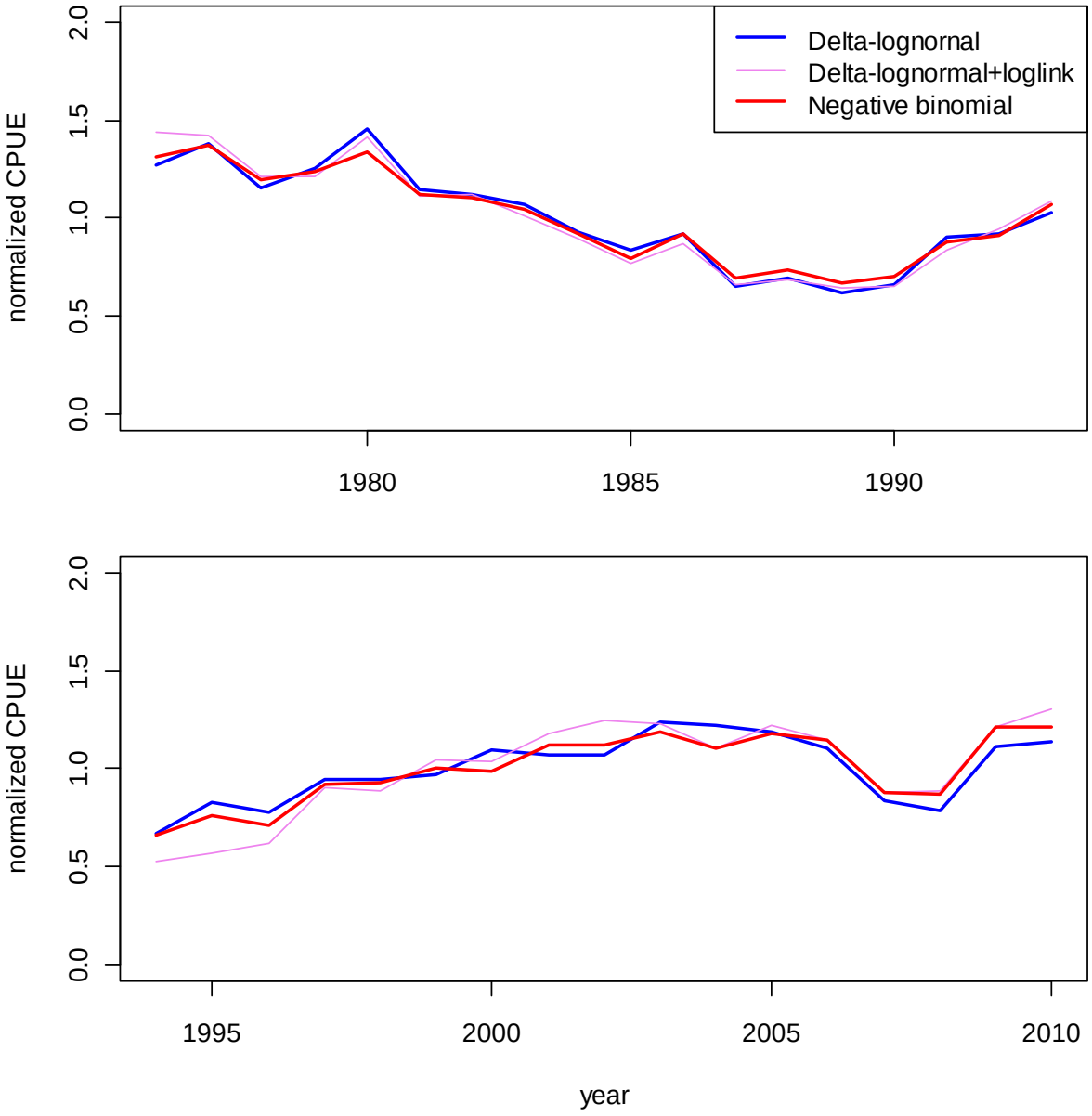

Figure 2 The standardized CPUEs estimated by four models in 1976-1993, 1994-2010. All the values of standardized CPUEs were normalized to their average which set at 1.0.

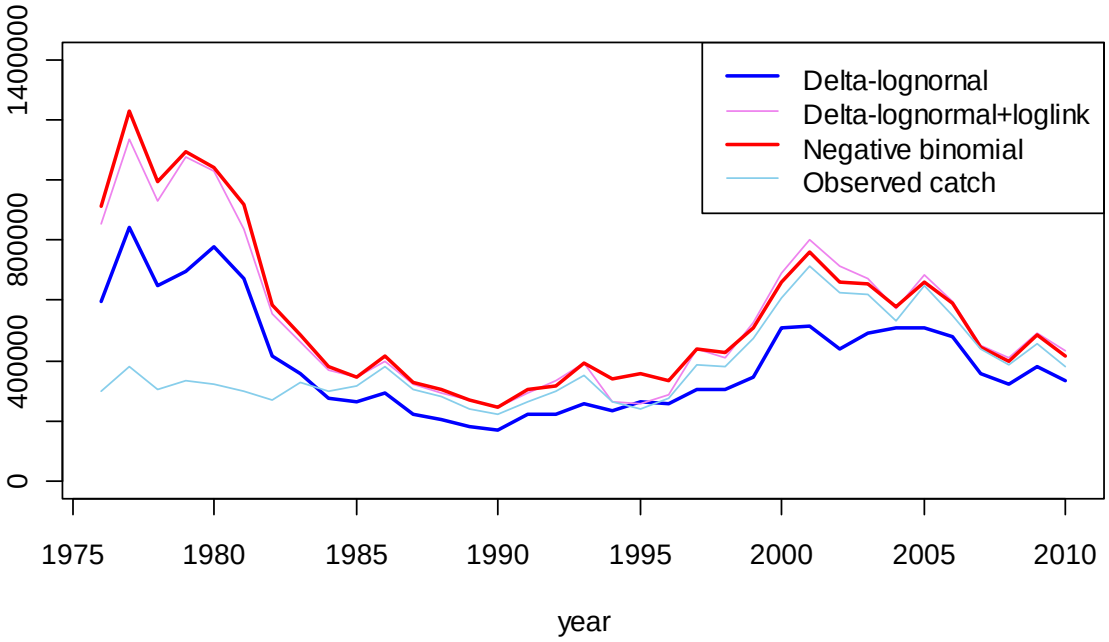

Figure 3 Annual estimated blue shark catch in number by using standardized CPUEs from three formulae and observed catch.

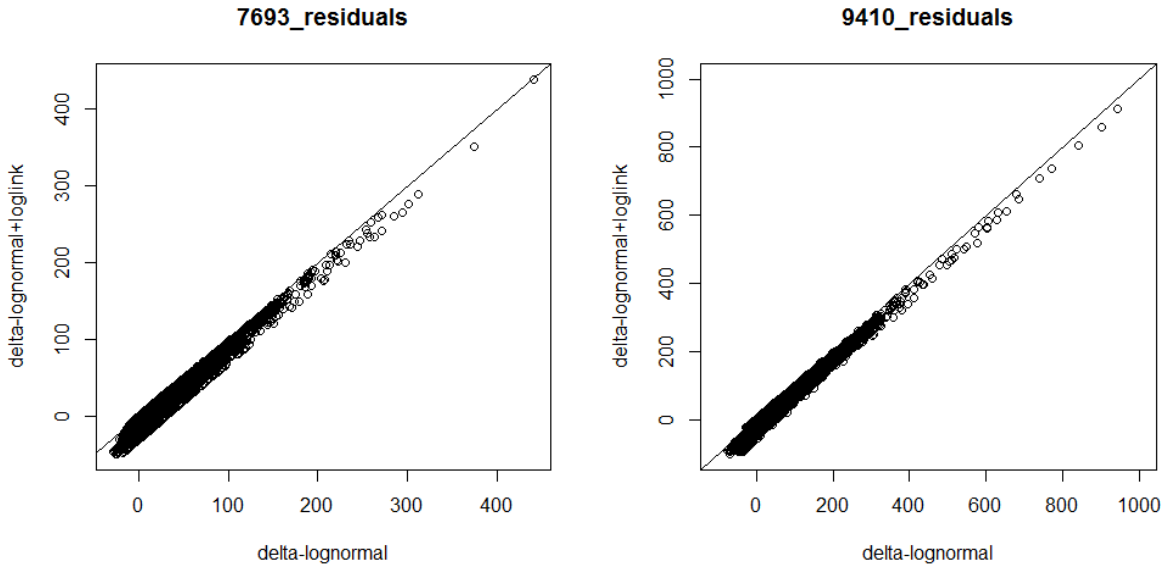

Figure 4 Comparison of residuals between 2nd step formula of the delta-lognormal model and delta-lognormal model with log link function in 1976-1993 (left), 1994-2010 (right). Solid line is given by y=x.

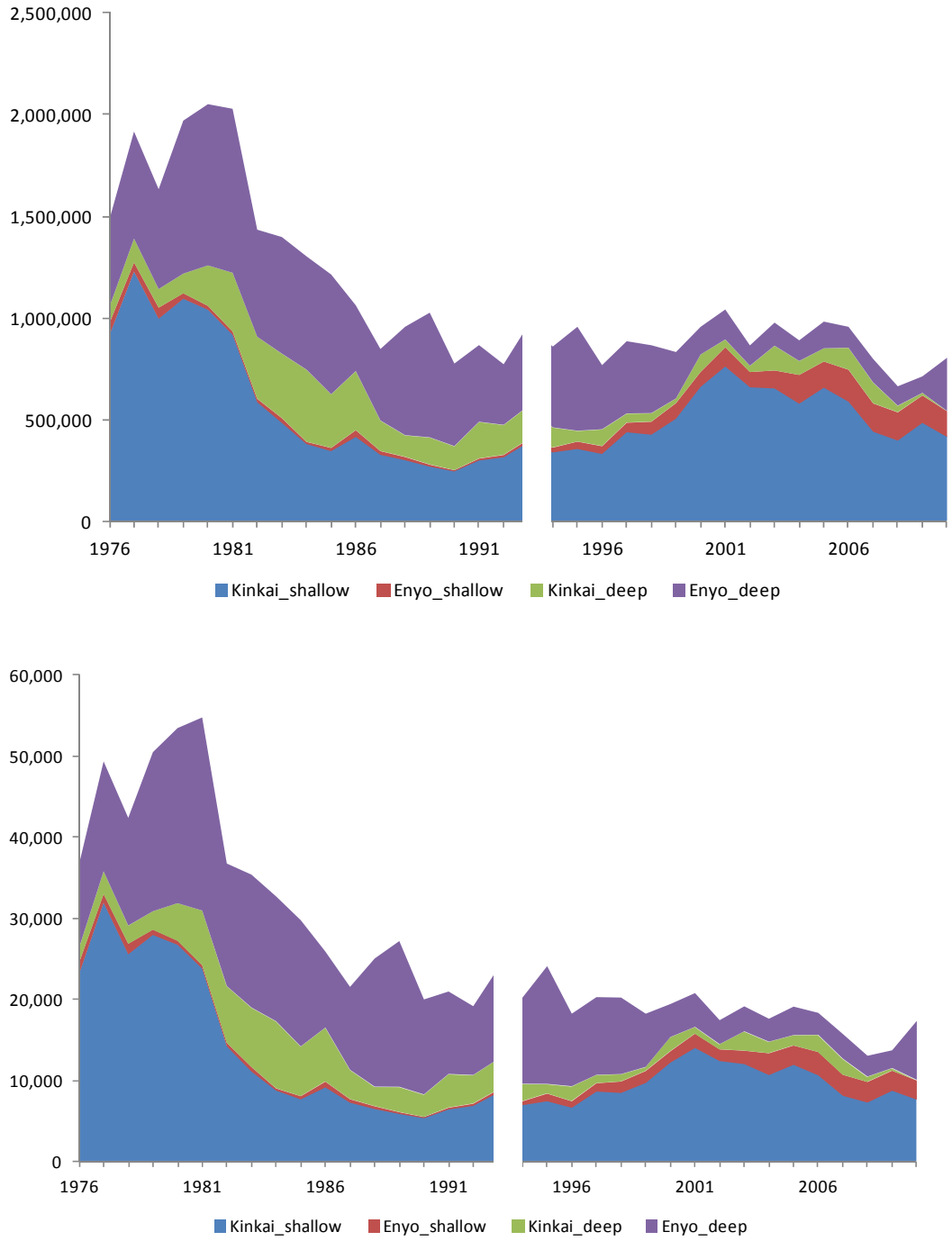

Figure 5 Re-estimated total blue shark catches in number (upper) and weight (metric tons; lower) including releases and discards Japanese longline fisheries in 1976-1993, 1994-2010.

AppendixI: Summary outputs of GLM analyses from R

I. 1976 -1993

I-(1) delta-lognormal model

<1stStep>

Call:

```
glm(formula = pocatch ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(target3) + as.factor(year):as.factor(target3),
    family = binomial, data = temp)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.6307   0.1287   0.1777   0.2256   0.9660

Coefficients:
                                                Estimate Std. Error z value Pr(>|z|)
(Intercept)                                      1.21888    0.11249  10.835  < 2e-16 ***
as.factor(year)1977                              1.16960    0.17636   6.632 3.31e-11 ***
as.factor(year)1978                              0.68996    0.15952   4.325 1.52e-05 ***
as.factor(year)1979                              1.03301    0.16911   6.109 1.01e-09 ***
as.factor(year)1980                              2.21161    0.23975   9.225  < 2e-16 ***
as.factor(year)1981                              2.18562    0.22724   9.618  < 2e-16 ***
as.factor(year)1982                              2.97984    0.39390   7.565 3.88e-14 ***
as.factor(year)1983                              2.93441    0.35091   8.362  < 2e-16 ***
as.factor(year)1984                              3.37910    0.42273   7.994 1.31e-15 ***
as.factor(year)1985                              3.62858    0.42291   8.580  < 2e-16 ***
as.factor(year)1986                              2.37638    0.24437   9.725  < 2e-16 ***
as.factor(year)1987                              2.63394    0.28866   9.125  < 2e-16 ***
as.factor(year)1988                              1.72593    0.21120   8.172 3.03e-16 ***
as.factor(year)1989                              2.04203    0.23253   8.782  < 2e-16 ***
as.factor(year)1990                              1.05717    0.17485   6.046 1.48e-09 ***
as.factor(year)1991                              3.24265    0.42333   7.660 1.86e-14 ***
as.factor(year)1992                              2.52679    0.31006   8.149 3.66e-16 ***
as.factor(year)1993                              2.13960    0.27434   7.799 6.24e-15 ***
as.factor(qt)2                                   0.54167    0.05722   9.467  < 2e-16 ***
as.factor(qt)3                                   0.19761    0.06206   3.184 0.001452 **
as.factor(qt)4                                  -0.17490    0.06389  -2.738 0.006191 **
as.factor(area)3                                -0.52401    0.04881 -10.737  < 2e-16 ***
as.factor(target3)2                              0.67979    0.15961   4.259 2.05e-05 ***
as.factor(target3)3                              3.12814    0.35222   8.881  < 2e-16 ***
as.factor(target3)4                              2.70000    0.29067   9.289  < 2e-16 ***
as.factor(target3)5                              2.87968    0.31033   9.279  < 2e-16 ***
as.factor(target3)6                              2.08526    0.22664   9.201  < 2e-16 ***
as.factor(target3)7                              2.08045    0.22707   9.162  < 2e-16 ***
as.factor(target3)8                              3.01351    0.33579   8.974  < 2e-16 ***
as.factor(target3)9                              2.40233    0.26130   9.194  < 2e-16 ***
as.factor(target3)10                             2.72444    0.29945   9.098  < 2e-16 ***
as.factor(year)1977:as.factor(target3)2         -0.16570    0.26913  -0.616 0.538095
as.factor(year)1978:as.factor(target3)2          0.30963    0.26111   1.186 0.235693
as.factor(year)1979:as.factor(target3)2         -0.68980    0.24328  -2.835 0.004577 **
as.factor(year)1980:as.factor(target3)2          1.13833    0.63858   1.783 0.074651 .
as.factor(year)1981:as.factor(target3)2         -0.23512    0.44101  -0.533 0.593932
as.factor(year)1982:as.factor(target3)2         -0.91138    0.53212  -1.713 0.086762 .
as.factor(year)1983:as.factor(target3)2         -0.64894    0.48957  -1.326 0.184994
as.factor(year)1984:as.factor(target3)2         -0.59862    0.58136  -1.030 0.303157
as.factor(year)1985:as.factor(target3)2         -1.98272    0.49070  -4.041 5.33e-05 ***
as.factor(year)1986:as.factor(target3)2         -0.88329    0.33850  -2.609 0.009070 **
as.factor(year)1987:as.factor(target3)2         -0.70703    0.39783  -1.777 0.075534 .
as.factor(year)1988:as.factor(target3)2         -0.51525    0.31088  -1.657 0.097437 .
as.factor(year)1989:as.factor(target3)2         -0.22752    0.36469  -0.624 0.532713
as.factor(year)1990:as.factor(target3)2          0.60943    0.33766   1.805 0.071097 .
as.factor(year)1991:as.factor(target3)2         -1.77115    0.49881  -3.551 0.000384 ***
as.factor(year)1992:as.factor(target3)2         -1.64484    0.37839  -4.347 1.38e-05 ***
as.factor(year)1993:as.factor(target3)2         -0.72604    0.38438  -1.889 0.058914 .
as.factor(year)1977:as.factor(target3)3         -0.96481    0.52028  -1.854 0.063681 .
as.factor(year)1978:as.factor(target3)3         -1.66412    0.42662  -3.901 9.59e-05 ***
as.factor(year)1979:as.factor(target3)3         -1.81266    0.43436  -4.173 3.00e-05 ***
as.factor(year)1980:as.factor(target3)3         -2.97912    0.46650  -6.386 1.70e-10 ***
as.factor(year)1981:as.factor(target3)3         -2.66438    0.48248  -5.522 3.35e-08 ***
as.factor(year)1982:as.factor(target3)3         -1.56014    0.87750  -1.778 0.075413 .
as.factor(year)1983:as.factor(target3)3         -2.29859    0.66184  -3.473 0.000515 ***
as.factor(year)1984:as.factor(target3)3          9.91053  147.63872   0.067 0.946481
as.factor(year)1985:as.factor(target3)3         -2.39146    0.79210  -3.019 0.002535 **
as.factor(year)1986:as.factor(target3)3         -1.63027    0.61209  -2.663 0.007734 **
as.factor(year)1987:as.factor(target3)3         -3.32726    0.49545  -6.716 1.87e-11 ***
as.factor(year)1988:as.factor(target3)3         -2.26853    0.48090  -4.717 2.39e-06 ***
as.factor(year)1989:as.factor(target3)3         -3.47509    0.44463  -7.816 5.47e-15 ***
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[1]Working document submitted to the ISC Shark Working Group Workshop, 7 January – 14 January 2013, NOAA Southwest Fisheries Science Center, La Jolla, California U.S.A.

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as.factor(year)1990:as.factor(target3)3	-1.30822	0.50723	-2.579	0.009905	**
as.factor(year)1991:as.factor(target3)3	-3.76145	0.62122	-6.055	1.40e-09	***
as.factor(year)1992:as.factor(target3)3	-3.19510	0.53731	-5.946	2.74e-09	***
as.factor(year)1993:as.factor(target3)3	-2.53922	0.53930	-4.708	2.50e-06	***
as.factor(year)1977:as.factor(target3)4	-1.44740	0.39527	-3.662	0.000250	***
as.factor(year)1978:as.factor(target3)4	-1.00837	0.39162	-2.575	0.010027	*
as.factor(year)1979:as.factor(target3)4	-0.65097	0.45148	-1.442	0.149341	
as.factor(year)1980:as.factor(target3)4	-1.90074	0.48257	-3.939	8.19e-05	***
as.factor(year)1981:as.factor(target3)4	-3.35354	0.38909	-8.619	< 2e-16	***
as.factor(year)1982:as.factor(target3)4	-2.12663	0.65616	-3.241	0.001191	**
as.factor(year)1983:as.factor(target3)4	-0.99286	0.83571	-1.188	0.234814	
as.factor(year)1984:as.factor(target3)4	-2.04567	0.70998	-2.881	0.003961	**
as.factor(year)1985:as.factor(target3)4	-1.97168	0.76677	-2.571	0.010129	*
as.factor(year)1986:as.factor(target3)4	-2.38534	0.44435	-5.368	7.96e-08	***
as.factor(year)1987:as.factor(target3)4	-2.70286	0.46236	-5.846	5.04e-09	***
as.factor(year)1988:as.factor(target3)4	-2.09535	0.41590	-5.038	4.70e-07	***
as.factor(year)1989:as.factor(target3)4	-2.29481	0.43388	-5.289	1.23e-07	***
as.factor(year)1990:as.factor(target3)4	-1.21024	0.43629	-2.774	0.005539	**
as.factor(year)1991:as.factor(target3)4	-1.97542	0.76727	-2.575	0.010035	*
as.factor(year)1992:as.factor(target3)4	-2.76367	0.49943	-5.534	3.14e-08	***
as.factor(year)1993:as.factor(target3)4	-1.83481	0.54292	-3.380	0.000726	***
as.factor(year)1977:as.factor(target3)5	-0.77931	0.47858	-1.628	0.103440	
as.factor(year)1978:as.factor(target3)5	-0.30579	0.48734	-0.627	0.530353	
as.factor(year)1979:as.factor(target3)5	-1.41575	0.41369	-3.422	0.000621	***
as.factor(year)1980:as.factor(target3)5	-0.87005	0.69146	-1.258	0.208291	
as.factor(year)1981:as.factor(target3)5	-2.52114	0.44848	-5.622	1.89e-08	***
as.factor(year)1982:as.factor(target3)5	-3.09961	0.57769	-5.366	8.07e-08	***
as.factor(year)1983:as.factor(target3)5	-0.49471	1.10013	-0.450	0.652937	
as.factor(year)1984:as.factor(target3)5	-2.94149	0.62515	-4.705	2.54e-06	***
as.factor(year)1985:as.factor(target3)5	-3.15126	0.62544	-5.038	4.69e-07	***
as.factor(year)1986:as.factor(target3)5	-2.83769	0.44088	-6.436	1.22e-10	***
as.factor(year)1987:as.factor(target3)5	-2.50149	0.50335	-4.970	6.71e-07	***
as.factor(year)1988:as.factor(target3)5	-0.96741	0.57614	-1.679	0.093130	.
as.factor(year)1989:as.factor(target3)5	-2.28246	0.46120	-4.949	7.46e-07	***
as.factor(year)1990:as.factor(target3)5	-0.42351	0.56442	-0.750	0.453040	
as.factor(year)1991:as.factor(target3)5	-2.63345	0.68343	-3.853	0.000117	***
as.factor(year)1992:as.factor(target3)5	-2.86593	0.51737	-5.539	3.04e-08	***
as.factor(year)1993:as.factor(target3)5	-1.37938	0.64267	-2.146	0.031847	*
as.factor(year)1977:as.factor(target3)6	0.34735	0.48963	0.709	0.478072	
as.factor(year)1978:as.factor(target3)6	-0.17922	0.36070	-0.497	0.619281	
as.factor(year)1979:as.factor(target3)6	-0.83694	0.34409	-2.432	0.015002	*
as.factor(year)1980:as.factor(target3)6	0.26695	0.77461	0.345	0.730376	
as.factor(year)1981:as.factor(target3)6	-0.99995	0.46759	-2.139	0.032476	*
as.factor(year)1982:as.factor(target3)6	-2.17176	0.54546	-3.982	6.85e-05	***
as.factor(year)1983:as.factor(target3)6	-2.28209	0.49207	-4.638	3.52e-06	***
as.factor(year)1984:as.factor(target3)6	-1.87940	0.62242	-3.019	0.002532	**
as.factor(year)1985:as.factor(target3)6	-1.61797	0.68620	-2.358	0.018381	*
as.factor(year)1986:as.factor(target3)6	-1.75786	0.40525	-4.338	1.44e-05	***
as.factor(year)1987:as.factor(target3)6	-2.16794	0.41830	-5.183	2.19e-07	***
as.factor(year)1988:as.factor(target3)6	-0.64031	0.46069	-1.390	0.164564	
as.factor(year)1989:as.factor(target3)6	-1.03174	0.45542	-2.265	0.023484	*
as.factor(year)1990:as.factor(target3)6	-0.43706	0.40570	-1.077	0.281350	
as.factor(year)1991:as.factor(target3)6	-0.95503	0.84981	-1.124	0.261094	
as.factor(year)1992:as.factor(target3)6	-0.67979	0.68749	-0.989	0.322764	
as.factor(year)1993:as.factor(target3)6	-0.30325	0.67219	-0.451	0.651895	
as.factor(year)1977:as.factor(target3)7	-0.21160	0.40492	-0.523	0.601275	
as.factor(year)1978:as.factor(target3)7	-0.50344	0.33944	-1.483	0.138042	
as.factor(year)1979:as.factor(target3)7	0.01322	0.42664	0.031	0.975273	
as.factor(year)1980:as.factor(target3)7	1.02402	1.04868	0.976	0.328824	
as.factor(year)1981:as.factor(target3)7	-1.23448	0.44001	-2.806	0.005022	**
as.factor(year)1982:as.factor(target3)7	-2.72063	0.50620	-5.375	7.67e-08	***
as.factor(year)1983:as.factor(target3)7	-1.62820	0.55503	-2.934	0.003351	**
as.factor(year)1984:as.factor(target3)7	-3.37960	0.50766	-6.657	2.79e-11	***
as.factor(year)1985:as.factor(target3)7	-2.58430	0.56664	-4.561	5.10e-06	***
as.factor(year)1986:as.factor(target3)7	-1.35872	0.43910	-3.094	0.001973	**
as.factor(year)1987:as.factor(target3)7	-1.08968	0.51768	-2.105	0.035296	*
as.factor(year)1988:as.factor(target3)7	-1.16457	0.39799	-2.926	0.003432	**
as.factor(year)1989:as.factor(target3)7	-0.81352	0.48929	-1.663	0.096384	.
as.factor(year)1990:as.factor(target3)7	1.19932	0.75747	1.583	0.113349	
as.factor(year)1991:as.factor(target3)7	-1.93161	0.64985	-2.972	0.002955	**
as.factor(year)1992:as.factor(target3)7	-0.95456	0.62394	-1.530	0.126043	
as.factor(year)1993:as.factor(target3)7	-0.58690	0.60661	-0.967	0.333296	
as.factor(year)1977:as.factor(target3)8	0.56688	0.79645	0.712	0.476619	
as.factor(year)1978:as.factor(target3)8	-1.19935	0.43333	-2.768	0.005644	**
as.factor(year)1979:as.factor(target3)8	-0.62021	0.52430	-1.183	0.236844	
as.factor(year)1980:as.factor(target3)8	-1.51264	0.60084	-2.518	0.011818	*
as.factor(year)1981:as.factor(target3)8	-2.38120	0.48146	-4.946	7.58e-07	***
as.factor(year)1982:as.factor(target3)8	-2.87470	0.61943	-4.641	3.47e-06	***

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as.factor(year)1983:as.factor(target3)8   -2.17980    0.65310  -3.338 0.000845 ***
as.factor(year)1984:as.factor(target3)8   -3.32053    0.61059  -5.438 5.38e-08 ***
as.factor(year)1985:as.factor(target3)8   -3.57066    0.61082  -5.846 5.04e-09 ***
as.factor(year)1986:as.factor(target3)8   -1.92125    0.53689  -3.579 0.000346 ***
as.factor(year)1987:as.factor(target3)8   -3.75364    0.46061  -8.149 3.66e-16 ***
as.factor(year)1988:as.factor(target3)8   -2.26217    0.45933  -4.925 8.44e-07 ***
as.factor(year)1989:as.factor(target3)8   -1.85551    0.53168  -3.490 0.000483 ***
as.factor(year)1990:as.factor(target3)8   -1.89943    0.43653  -4.351 1.35e-05 ***
as.factor(year)1991:as.factor(target3)8   -1.22103    1.13279  -1.078 0.281081
as.factor(year)1992:as.factor(target3)8   -1.20240    0.83697  -1.437 0.150830
as.factor(year)1993:as.factor(target3)8   -1.20581    0.71599  -1.684 0.092160 .
as.factor(year)1977:as.factor(target3)9   -0.55914    0.42524  -1.315 0.188549
as.factor(year)1978:as.factor(target3)9   -0.80189    0.36344  -2.206 0.027356 *
as.factor(year)1979:as.factor(target3)9   -0.74267    0.39900  -1.861 0.062697 .
as.factor(year)1980:as.factor(target3)9    0.73926    1.05660   0.700 0.484139
as.factor(year)1981:as.factor(target3)9   -1.44700    0.45883  -3.154 0.001612 **
as.factor(year)1982:as.factor(target3)9   -2.19047    0.58272  -3.759 0.000171 ***
as.factor(year)1983:as.factor(target3)9   -1.38814    0.65737  -2.112 0.034714 *
as.factor(year)1984:as.factor(target3)9   -2.74302    0.57313  -4.786 1.70e-06 ***
as.factor(year)1985:as.factor(target3)9   -3.12167    0.55572  -5.617 1.94e-08 ***
as.factor(year)1986:as.factor(target3)9   -2.05626    0.42125  -4.881 1.05e-06 ***
as.factor(year)1987:as.factor(target3)9   -2.18387    0.45666  -4.782 1.73e-06 ***
as.factor(year)1988:as.factor(target3)9   -1.62363    0.40766  -3.983 6.81e-05 ***
as.factor(year)1989:as.factor(target3)9   -1.45862    0.46164  -3.160 0.001579 **
as.factor(year)1990:as.factor(target3)9   -1.19409    0.38608  -3.093 0.001982 **
as.factor(year)1991:as.factor(target3)9   -2.51016    0.61767  -4.064 4.83e-05 ***
as.factor(year)1992:as.factor(target3)9   -0.92284    0.69915  -1.320 0.186857
as.factor(year)1993:as.factor(target3)9   11.82131  170.87281   0.069 0.944845
as.factor(year)1977:as.factor(target3)10  -1.25442    0.41247  -3.041 0.002356 **
as.factor(year)1978:as.factor(target3)10  -0.49158    0.43501  -1.130 0.258454
as.factor(year)1979:as.factor(target3)10  -0.82198    0.43849  -1.875 0.060851 .
as.factor(year)1980:as.factor(target3)10  -0.83276    0.62269  -1.337 0.181105
as.factor(year)1981:as.factor(target3)10  -0.77666    0.61844  -1.256 0.209173
as.factor(year)1982:as.factor(target3)10  -2.70917    0.57991  -4.672 2.99e-06 ***
as.factor(year)1983:as.factor(target3)10  -3.85547    0.47937  -8.043 8.79e-16 ***
as.factor(year)1984:as.factor(target3)10  -3.66010    0.55038  -6.650 2.93e-11 ***
as.factor(year)1985:as.factor(target3)10  -4.40987    0.53406  -8.257  < 2e-16 ***
as.factor(year)1986:as.factor(target3)10  -1.75573    0.50120  -3.503 0.000460 ***
as.factor(year)1987:as.factor(target3)10  -2.51464    0.48473  -5.188 2.13e-07 ***
as.factor(year)1988:as.factor(target3)10  -1.91088    0.43810  -4.362 1.29e-05 ***
as.factor(year)1989:as.factor(target3)10  -2.11773    0.46043  -4.599 4.24e-06 ***
as.factor(year)1990:as.factor(target3)10  -1.33789    0.42823  -3.124 0.001783 **
as.factor(year)1991:as.factor(target3)10  -2.98887    0.60916  -4.907 9.27e-07 ***
as.factor(year)1992:as.factor(target3)10  -1.47482    0.65341  -2.257 0.024000 *
as.factor(year)1993:as.factor(target3)10  -0.49247    0.81008  -0.608 0.543232
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 25651  on 121108  degrees of freedom
Residual deviance: 23472  on 120925  degrees of freedom
AIC: 23840

Number of Fisher Scoring iterations: 16


Analysis of Deviance Table (Type II tests)

Response: pocatch
                                LR Chisq  Df Pr(>Chisq)
as.factor(year)                   489.91  17  < 2.2e-16 ***
as.factor(qt)                     149.27   3  < 2.2e-16 ***
as.factor(area)                   114.29   1  < 2.2e-16 ***
as.factor(target3)                611.51   9  < 2.2e-16 ***
as.factor(year):as.factor(target3)  911.18 153  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

<2nd step>
Call:
glm(formula = log(ncpue) ~ as.factor(year) + as.factor(qt) +
    as.factor(area) + as.factor(target3) + as.factor(year):as.factor(target3),
    family = gaussian, data = data[data$blshrk > 0, ])

Deviance Residuals:
    Min       1Q   Median       3Q      Max
```

-4.1979 -0.5327 0.0556 0.5933 3.9233

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.723759	0.040384	67.447	< 2e-16	***
as.factor(year)1977	0.413317	0.052923	7.810	5.78e-15	***
as.factor(year)1978	-0.150932	0.054010	-2.794	0.005199	**
as.factor(year)1979	0.136762	0.053397	2.561	0.010431	*
as.factor(year)1980	0.115583	0.053163	2.174	0.029698	*
as.factor(year)1981	0.008814	0.051712	0.170	0.864661	
as.factor(year)1982	-0.331538	0.054397	-6.095	1.10e-09	***
as.factor(year)1983	-0.436619	0.051611	-8.460	< 2e-16	***
as.factor(year)1984	-0.417206	0.051383	-8.120	4.72e-16	***
as.factor(year)1985	-0.729091	0.050669	-14.389	< 2e-16	***
as.factor(year)1986	-0.459173	0.050790	-9.041	< 2e-16	***
as.factor(year)1987	-0.734598	0.050511	-14.543	< 2e-16	***
as.factor(year)1988	-1.041097	0.052523	-19.822	< 2e-16	***
as.factor(year)1989	-1.238148	0.052517	-23.576	< 2e-16	***
as.factor(year)1990	-0.978828	0.055270	-17.710	< 2e-16	***
as.factor(year)1991	-1.006372	0.054773	-18.374	< 2e-16	***
as.factor(year)1992	-0.777900	0.055128	-14.111	< 2e-16	***
as.factor(year)1993	-0.972729	0.056045	-17.356	< 2e-16	***
as.factor(qt)2	0.247420	0.007775	31.823	< 2e-16	***
as.factor(qt)3	0.258266	0.008401	30.741	< 2e-16	***
as.factor(qt)4	-0.125075	0.008971	-13.943	< 2e-16	***
as.factor(area)3	-0.270980	0.006511	-41.618	< 2e-16	***
as.factor(target3)2	-0.206554	0.054736	-3.774	0.000161	***
as.factor(target3)3	-0.440660	0.053486	-8.239	< 2e-16	***
as.factor(target3)4	-0.500327	0.053717	-9.314	< 2e-16	***
as.factor(target3)5	-0.346514	0.053562	-6.469	9.88e-11	***
as.factor(target3)6	-0.293822	0.054088	-5.432	5.57e-08	***
as.factor(target3)7	-0.332120	0.053759	-6.178	6.52e-10	***
as.factor(target3)8	-0.208301	0.053904	-3.864	0.000111	***
as.factor(target3)9	-0.142466	0.054140	-2.631	0.008504	**
as.factor(target3)10	-0.006944	0.053693	-0.129	0.897097	
as.factor(year)1977:as.factor(target3)2	-0.475730	0.073022	-6.515	7.30e-11	***
as.factor(year)1978:as.factor(target3)2	-0.573075	0.074936	-7.648	2.06e-14	***
as.factor(year)1979:as.factor(target3)2	-0.541222	0.074124	-7.302	2.86e-13	***
as.factor(year)1980:as.factor(target3)2	-0.416907	0.073837	-5.646	1.64e-08	***
as.factor(year)1981:as.factor(target3)2	-0.046848	0.072890	-0.643	0.520404	
as.factor(year)1982:as.factor(target3)2	0.114830	0.075613	1.519	0.128853	
as.factor(year)1983:as.factor(target3)2	0.114053	0.072064	1.583	0.113500	
as.factor(year)1984:as.factor(target3)2	0.086823	0.071718	1.211	0.226050	
as.factor(year)1985:as.factor(target3)2	0.313921	0.070170	4.474	7.69e-06	***
as.factor(year)1986:as.factor(target3)2	0.109696	0.070454	1.557	0.119473	
as.factor(year)1987:as.factor(target3)2	0.208765	0.070157	2.976	0.002924	**
as.factor(year)1988:as.factor(target3)2	0.280468	0.073355	3.823	0.000132	***
as.factor(year)1989:as.factor(target3)2	0.125444	0.073776	1.700	0.089071	.
as.factor(year)1990:as.factor(target3)2	0.165114	0.076222	2.166	0.030295	*
as.factor(year)1991:as.factor(target3)2	0.447230	0.076053	5.881	4.10e-09	***
as.factor(year)1992:as.factor(target3)2	0.237768	0.076691	3.100	0.001933	**
as.factor(year)1993:as.factor(target3)2	0.393661	0.077813	5.059	4.22e-07	***
as.factor(year)1977:as.factor(target3)3	-0.166564	0.071805	-2.320	0.020360	*
as.factor(year)1978:as.factor(target3)3	0.046094	0.073342	0.628	0.529692	
as.factor(year)1979:as.factor(target3)3	-0.066809	0.072638	-0.920	0.357707	
as.factor(year)1980:as.factor(target3)3	-0.084272	0.073264	-1.150	0.250048	
as.factor(year)1981:as.factor(target3)3	0.081811	0.071374	1.146	0.251706	
as.factor(year)1982:as.factor(target3)3	0.270617	0.074653	3.625	0.000289	***
as.factor(year)1983:as.factor(target3)3	0.567802	0.070930	8.005	1.20e-15	***
as.factor(year)1984:as.factor(target3)3	0.316869	0.070508	4.494	6.99e-06	***
as.factor(year)1985:as.factor(target3)3	0.366000	0.069915	5.235	1.65e-07	***
as.factor(year)1986:as.factor(target3)3	0.425597	0.069395	6.133	8.65e-10	***
as.factor(year)1987:as.factor(target3)3	0.295332	0.069168	4.270	1.96e-05	***
as.factor(year)1988:as.factor(target3)3	0.698220	0.072631	9.613	< 2e-16	***
as.factor(year)1989:as.factor(target3)3	0.579479	0.072335	8.011	1.15e-15	***
as.factor(year)1990:as.factor(target3)3	0.884476	0.075518	11.712	< 2e-16	***
as.factor(year)1991:as.factor(target3)3	0.848182	0.075295	11.265	< 2e-16	***
as.factor(year)1992:as.factor(target3)3	0.622082	0.076141	8.170	3.11e-16	***

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as.factor(year)1993:as.factor(target3)3	0.923685	0.077346	11.942	< 2e-16	***
as.factor(year)1977:as.factor(target3)4	-0.160122	0.072278	-2.215	0.026738	*
as.factor(year)1978:as.factor(target3)4	0.512720	0.074043	6.925	4.39e-12	***
as.factor(year)1979:as.factor(target3)4	0.020575	0.073202	0.281	0.778657	
as.factor(year)1980:as.factor(target3)4	0.031641	0.073225	0.432	0.665665	
as.factor(year)1981:as.factor(target3)4	0.247241	0.071782	3.444	0.000573	***
as.factor(year)1982:as.factor(target3)4	0.577976	0.074872	7.720	1.18e-14	***
as.factor(year)1983:as.factor(target3)4	0.489442	0.070974	6.896	5.37e-12	***
as.factor(year)1984:as.factor(target3)4	0.285218	0.070931	4.021	5.80e-05	***
as.factor(year)1985:as.factor(target3)4	0.319643	0.069535	4.597	4.29e-06	***
as.factor(year)1986:as.factor(target3)4	0.288080	0.069615	4.138	3.50e-05	***
as.factor(year)1987:as.factor(target3)4	0.355382	0.069383	5.122	3.03e-07	***
as.factor(year)1988:as.factor(target3)4	0.709821	0.072393	9.805	< 2e-16	***
as.factor(year)1989:as.factor(target3)4	0.727326	0.072500	10.032	< 2e-16	***
as.factor(year)1990:as.factor(target3)4	0.661243	0.075494	8.759	< 2e-16	***
as.factor(year)1991:as.factor(target3)4	0.995086	0.075637	13.156	< 2e-16	***
as.factor(year)1992:as.factor(target3)4	0.733357	0.076097	9.637	< 2e-16	***
as.factor(year)1993:as.factor(target3)4	0.973066	0.077015	12.635	< 2e-16	***
as.factor(year)1977:as.factor(target3)5	-0.272923	0.071931	-3.794	0.000148	***
as.factor(year)1978:as.factor(target3)5	0.173975	0.073592	2.364	0.018078	*
as.factor(year)1979:as.factor(target3)5	-0.134455	0.072782	-1.847	0.064696	.
as.factor(year)1980:as.factor(target3)5	0.252921	0.072917	3.469	0.000523	***
as.factor(year)1981:as.factor(target3)5	-0.105147	0.071170	-1.477	0.139571	
as.factor(year)1982:as.factor(target3)5	0.248248	0.074743	3.321	0.000896	***
as.factor(year)1983:as.factor(target3)5	0.299098	0.070955	4.215	2.50e-05	***
as.factor(year)1984:as.factor(target3)5	0.047644	0.070634	0.675	0.499982	
as.factor(year)1985:as.factor(target3)5	0.365428	0.069432	5.263	1.42e-07	***
as.factor(year)1986:as.factor(target3)5	0.122314	0.069553	1.759	0.078652	.
as.factor(year)1987:as.factor(target3)5	0.122888	0.069251	1.775	0.075979	.
as.factor(year)1988:as.factor(target3)5	0.603319	0.072231	8.353	< 2e-16	***
as.factor(year)1989:as.factor(target3)5	0.732338	0.072174	10.147	< 2e-16	***
as.factor(year)1990:as.factor(target3)5	0.479616	0.075427	6.359	2.04e-10	***
as.factor(year)1991:as.factor(target3)5	0.711656	0.075457	9.431	< 2e-16	***
as.factor(year)1992:as.factor(target3)5	0.582304	0.075616	7.701	1.36e-14	***
as.factor(year)1993:as.factor(target3)5	1.148804	0.077067	14.907	< 2e-16	***
as.factor(year)1977:as.factor(target3)6	-0.285102	0.072445	-3.935	8.31e-05	***
as.factor(year)1978:as.factor(target3)6	0.030636	0.074067	0.414	0.679153	
as.factor(year)1979:as.factor(target3)6	-0.085616	0.072914	-1.174	0.240311	
as.factor(year)1980:as.factor(target3)6	0.098486	0.073454	1.341	0.179989	
as.factor(year)1981:as.factor(target3)6	-0.243931	0.071838	-3.396	0.000685	***
as.factor(year)1982:as.factor(target3)6	0.261081	0.075461	3.460	0.000541	***
as.factor(year)1983:as.factor(target3)6	0.319167	0.071442	4.467	7.92e-06	***
as.factor(year)1984:as.factor(target3)6	0.076848	0.071228	1.079	0.280634	
as.factor(year)1985:as.factor(target3)6	0.197644	0.069733	2.834	0.004593	**
as.factor(year)1986:as.factor(target3)6	0.122584	0.069777	1.757	0.078955	.
as.factor(year)1987:as.factor(target3)6	0.094273	0.069522	1.356	0.175098	
as.factor(year)1988:as.factor(target3)6	0.473839	0.072658	6.521	6.99e-11	***
as.factor(year)1989:as.factor(target3)6	0.647652	0.072586	8.923	< 2e-16	***
as.factor(year)1990:as.factor(target3)6	0.371219	0.075822	4.896	9.80e-07	***
as.factor(year)1991:as.factor(target3)6	0.785962	0.075468	10.415	< 2e-16	***
as.factor(year)1992:as.factor(target3)6	0.572210	0.076229	7.506	6.12e-14	***
as.factor(year)1993:as.factor(target3)6	0.746068	0.077019	9.687	< 2e-16	***
as.factor(year)1977:as.factor(target3)7	-0.431437	0.072049	-5.988	2.13e-09	***
as.factor(year)1978:as.factor(target3)7	0.107689	0.073425	1.467	0.142472	
as.factor(year)1979:as.factor(target3)7	-0.125294	0.073069	-1.715	0.086396	.
as.factor(year)1980:as.factor(target3)7	0.120710	0.073058	1.652	0.098485	.
as.factor(year)1981:as.factor(target3)7	-0.142369	0.071640	-1.987	0.046894	*
as.factor(year)1982:as.factor(target3)7	0.321406	0.074717	4.302	1.70e-05	***
as.factor(year)1983:as.factor(target3)7	0.290448	0.071071	4.087	4.38e-05	***
as.factor(year)1984:as.factor(target3)7	0.047408	0.070786	0.670	0.503024	
as.factor(year)1985:as.factor(target3)7	0.394072	0.069522	5.668	1.45e-08	***
as.factor(year)1986:as.factor(target3)7	0.035966	0.069611	0.517	0.605386	
as.factor(year)1987:as.factor(target3)7	0.002561	0.069222	0.037	0.970492	
as.factor(year)1988:as.factor(target3)7	0.436128	0.072211	6.040	1.55e-09	***
as.factor(year)1989:as.factor(target3)7	0.856026	0.072236	11.850	< 2e-16	***
as.factor(year)1990:as.factor(target3)7	0.325552	0.075496	4.312	1.62e-05	***
as.factor(year)1991:as.factor(target3)7	0.903223	0.075508	11.962	< 2e-16	***
as.factor(year)1992:as.factor(target3)7	0.567327	0.075816	7.483	7.32e-14	***

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as.factor(year)1993:as.factor(target3)7   0.713860   0.076893   9.284  < 2e-16 ***
as.factor(year)1977:as.factor(target3)8  -0.493284   0.072158  -6.836 8.17e-12 ***
as.factor(year)1978:as.factor(target3)8   0.071743   0.073980   0.970 0.332166
as.factor(year)1979:as.factor(target3)8  -0.139399   0.072706  -1.917 0.055202 .
as.factor(year)1980:as.factor(target3)8  -0.066092   0.073225  -0.903 0.366746
as.factor(year)1981:as.factor(target3)8  -0.198797   0.071369  -2.785 0.005346 **
as.factor(year)1982:as.factor(target3)8  -0.125967   0.075151  -1.676 0.093705 .
as.factor(year)1983:as.factor(target3)8   0.166774   0.071034   2.348 0.018887 *
as.factor(year)1984:as.factor(target3)8  -0.076414   0.070982  -1.077 0.281691
as.factor(year)1985:as.factor(target3)8   0.224194   0.069616   3.220 0.001280 **
as.factor(year)1986:as.factor(target3)8   0.057782   0.069875   0.827 0.408275
as.factor(year)1987:as.factor(target3)8   0.026316   0.069642   0.378 0.705519
as.factor(year)1988:as.factor(target3)8   0.388598   0.072605   5.352 8.70e-08 ***
as.factor(year)1989:as.factor(target3)8   0.637710   0.072546   8.790  < 2e-16 ***
as.factor(year)1990:as.factor(target3)8   0.287528   0.075432   3.812 0.000138 ***
as.factor(year)1991:as.factor(target3)8   0.631549   0.075345   8.382  < 2e-16 ***
as.factor(year)1992:as.factor(target3)8   0.197829   0.075884   2.607 0.009135 **
as.factor(year)1993:as.factor(target3)8   0.854025   0.077052  11.084  < 2e-16 ***
as.factor(year)1977:as.factor(target3)9  -0.791051   0.072391 -10.928  < 2e-16 ***
as.factor(year)1978:as.factor(target3)9  -0.017004   0.074012  -0.230 0.818293
as.factor(year)1979:as.factor(target3)9  -0.255651   0.073080  -3.498 0.000469 ***
as.factor(year)1980:as.factor(target3)9  -0.123014   0.073334  -1.677 0.093460 .
as.factor(year)1981:as.factor(target3)9  -0.386764   0.071865  -5.382 7.39e-08 ***
as.factor(year)1982:as.factor(target3)9   0.058880   0.075366   0.781 0.434655
as.factor(year)1983:as.factor(target3)9   0.095742   0.071480   1.339 0.180438
as.factor(year)1984:as.factor(target3)9  -0.090644   0.071085  -1.275 0.202255
as.factor(year)1985:as.factor(target3)9   0.216806   0.070123   3.092 0.001990 **
as.factor(year)1986:as.factor(target3)9  -0.055993   0.069890  -0.801 0.423046
as.factor(year)1987:as.factor(target3)9  -0.308014   0.069535  -4.430 9.45e-06 ***
as.factor(year)1988:as.factor(target3)9   0.156971   0.072614   2.162 0.030641 *
as.factor(year)1989:as.factor(target3)9   0.603565   0.072689   8.303  < 2e-16 ***
as.factor(year)1990:as.factor(target3)9   0.034001   0.076248   0.446 0.655646
as.factor(year)1991:as.factor(target3)9   0.467674   0.075738   6.175 6.64e-10 ***
as.factor(year)1992:as.factor(target3)9   0.349088   0.076211   4.581 4.64e-06 ***
as.factor(year)1993:as.factor(target3)9   0.743164   0.077284   9.616  < 2e-16 ***
as.factor(year)1977:as.factor(target3)10 -0.531358   0.072339  -7.345 2.06e-13 ***
as.factor(year)1978:as.factor(target3)10  0.050443   0.073646   0.685 0.493383
as.factor(year)1979:as.factor(target3)10 -0.350995   0.072820  -4.820 1.44e-06 ***
as.factor(year)1980:as.factor(target3)10 -0.173926   0.073134  -2.378 0.017399 *
as.factor(year)1981:as.factor(target3)10 -0.494154   0.071532  -6.908 4.93e-12 ***
as.factor(year)1982:as.factor(target3)10  0.055370   0.074970   0.739 0.460181
as.factor(year)1983:as.factor(target3)10 -0.042301   0.071430  -0.592 0.553718
as.factor(year)1984:as.factor(target3)10 -0.134609   0.070950  -1.897 0.057798 .
as.factor(year)1985:as.factor(target3)10  0.231549   0.069746   3.320 0.000901 ***
as.factor(year)1986:as.factor(target3)10 -0.138456   0.069563  -1.990 0.046552 *
as.factor(year)1987:as.factor(target3)10 -0.388884   0.069472  -5.598 2.18e-08 ***
as.factor(year)1988:as.factor(target3)10  0.256057   0.072356   3.539 0.000402 ***
as.factor(year)1989:as.factor(target3)10 -0.050755   0.072517  -0.700 0.483984
as.factor(year)1990:as.factor(target3)10 -0.155505   0.075671  -2.055 0.039879 *
as.factor(year)1991:as.factor(target3)10  0.444135   0.075540   5.879 4.13e-09 ***
as.factor(year)1992:as.factor(target3)10  0.229431   0.075737   3.029 0.002452 **
as.factor(year)1993:as.factor(target3)10  0.579399   0.077300   7.495 6.65e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 0.7859312)

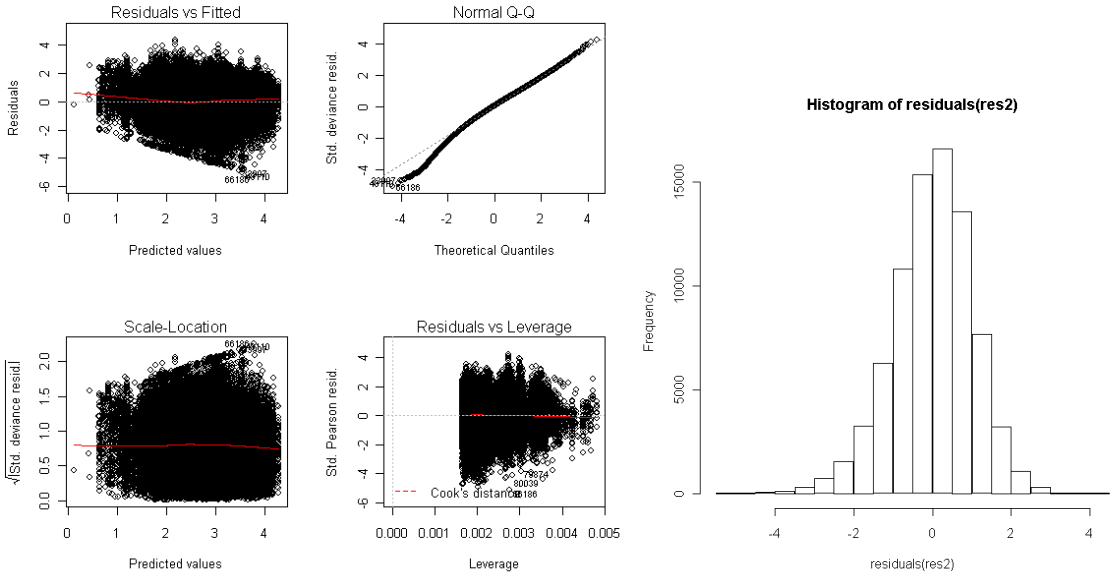
    Null deviance: 106750  on 118438  degrees of freedom
Residual deviance:  92940  on 118255  degrees of freedom
AIC: 307771

Number of Fisher Scoring iterations: 2

> Anova(res2.1)
Analysis of Deviance Table (Type II tests)

Response: log(ncpue)
                        LR Chisq  Df Pr(>Chisq)
```

```
as.factor(year)                 10023.9  17  < 2.2e-16 ***
as.factor(qt)                  2905.1   3  < 2.2e-16 ***
as.factor(area)                 1732.1   1  < 2.2e-16 ***
as.factor(target3)               254.6   9  < 2.2e-16 ***
as.factor(year):as.factor(target3)   3295.6 153  < 2.2e-16 ***
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```



I-(2) delta-lognormal model with log link function

<2nd step>

Call:

```
glm(formula = ncpue ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(target3) + as.factor(year):as.factor(target3),
    family = gaussian(link = "log"), data = data[data$blshrk >
        0, ])
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-48.84	-7.01	-2.60	3.75	439.15

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	3.0850999	0.0238786	129.199	< 2e-16	***
as.factor(year)1977	0.5408391	0.0253597	21.327	< 2e-16	***
as.factor(year)1978	0.2383566	0.0285888	8.337	< 2e-16	***
as.factor(year)1979	0.4567242	0.0264455	17.270	< 2e-16	***
as.factor(year)1980	0.1403465	0.0283305	4.954	7.28e-07	***
as.factor(year)1981	-0.0738944	0.0286498	-2.579	0.009903	**
as.factor(year)1982	-0.1937392	0.0337723	-5.737	9.68e-09	***
as.factor(year)1983	-0.3536060	0.0355853	-9.937	< 2e-16	***
as.factor(year)1984	-0.4199741	0.0372433	-11.277	< 2e-16	***
as.factor(year)1985	-0.5152120	0.0405711	-12.699	< 2e-16	***
as.factor(year)1986	-0.4164229	0.0385525	-10.801	< 2e-16	***
as.factor(year)1987	-0.7700539	0.0461906	-16.671	< 2e-16	***
as.factor(year)1988	-0.7132395	0.0507406	-14.057	< 2e-16	***
as.factor(year)1989	-1.0476248	0.0710297	-14.749	< 2e-16	***
as.factor(year)1990	-0.8912918	0.0669582	-13.311	< 2e-16	***
as.factor(year)1991	-0.6424899	0.0511081	-12.571	< 2e-16	***
as.factor(year)1992	-0.4575541	0.0452572	-10.110	< 2e-16	***
as.factor(year)1993	-0.2668244	0.0402568	-6.628	3.42e-11	***
as.factor(qt)2	0.3496162	0.0092935	37.619	< 2e-16	***
as.factor(qt)3	0.2075402	0.0095695	21.688	< 2e-16	***
as.factor(qt)4	-0.1755528	0.0116356	-15.087	< 2e-16	***
as.factor(area)3	-0.5185785	0.0079468	-65.256	< 2e-16	***
as.factor(target3)2	0.0552569	0.0323212	1.710	0.087339	.
as.factor(target3)3	-0.1418242	0.0376228	-3.770	0.000164	***
as.factor(target3)4	-0.3248411	0.0437669	-7.422	1.16e-13	***
as.factor(target3)5	-0.1657604	0.0400765	-4.136	3.54e-05	***
as.factor(target3)6	-0.1684841	0.0416698	-4.043	5.27e-05	***

[1]Working document submitted to the ISC Shark Working Group Workshop, 7 January – 14 January 2013, NOAA Southwest Fisheries Science Center, La Jolla, California U.S.A. **Document not to be cited without author's permission.**

```
as.factor(target3)7                          -0.2477661  0.0456335  -5.429 5.66e-08 ***
as.factor(target3)8                          -0.0963322  0.0388956  -2.477 0.013262 *
as.factor(target3)9                           0.0969200  0.0350625   2.764 0.005707 **
as.factor(target3)10                          0.1899094  0.0332070   5.719 1.07e-08 ***
as.factor(year)1977:as.factor(target3)2      -0.5878582  0.0420415 -13.983  < 2e-16 ***
as.factor(year)1978:as.factor(target3)2      -1.0310462  0.0667625 -15.443  < 2e-16 ***
as.factor(year)1979:as.factor(target3)2      -0.5915167  0.0459667 -12.868  < 2e-16 ***
as.factor(year)1980:as.factor(target3)2      -0.3146435  0.0494735  -6.360 2.03e-10 ***
as.factor(year)1981:as.factor(target3)2       0.0242542  0.0468487   0.518 0.604659
as.factor(year)1982:as.factor(target3)2      -0.1755230  0.0521860  -3.363 0.000770 ***
as.factor(year)1983:as.factor(target3)2       0.0732160  0.0505595   1.448 0.147588
as.factor(year)1984:as.factor(target3)2      -0.1435120  0.0587799  -2.442 0.014627 *
as.factor(year)1985:as.factor(target3)2      -0.1793391  0.0621551  -2.885 0.003911 **
as.factor(year)1986:as.factor(target3)2      -0.0877204  0.0569394  -1.541 0.123419
as.factor(year)1987:as.factor(target3)2       0.0264253  0.0667402   0.396 0.692148
as.factor(year)1988:as.factor(target3)2      -0.1406277  0.0762929  -1.843 0.065294 .
as.factor(year)1989:as.factor(target3)2      -0.0979929  0.1042057  -0.940 0.347025
as.factor(year)1990:as.factor(target3)2       0.1440190  0.0866825   1.661 0.096625 .
as.factor(year)1991:as.factor(target3)2      -0.1433864  0.0780541  -1.837 0.066210 .
as.factor(year)1992:as.factor(target3)2       0.0310401  0.0626001   0.496 0.620003
as.factor(year)1993:as.factor(target3)2      -0.1144317  0.0591054  -1.936 0.052862 .
as.factor(year)1977:as.factor(target3)3      -0.4567948  0.0472619  -9.665  < 2e-16 ***
as.factor(year)1978:as.factor(target3)3      -0.5014620  0.0589986  -8.500  < 2e-16 ***
as.factor(year)1979:as.factor(target3)3      -0.7094275  0.0566229 -12.529  < 2e-16 ***
as.factor(year)1980:as.factor(target3)3      -0.2603272  0.0558219  -4.664 3.11e-06 ***
as.factor(year)1981:as.factor(target3)3      -0.0504659  0.0518366  -0.974 0.330278
as.factor(year)1982:as.factor(target3)3       0.0819490  0.0573012   1.430 0.152678
as.factor(year)1983:as.factor(target3)3       0.1347655  0.0575526   2.342 0.019203 *
as.factor(year)1984:as.factor(target3)3       0.1322981  0.0631731   2.094 0.036243 *
as.factor(year)1985:as.factor(target3)3      -0.0074589  0.0684374  -0.109 0.913211
as.factor(year)1986:as.factor(target3)3      -0.0306037  0.0639390  -0.479 0.632196
as.factor(year)1987:as.factor(target3)3       0.2593211  0.0703543   3.686 0.000228 ***
as.factor(year)1988:as.factor(target3)3       0.0073834  0.0823410   0.090 0.928550
as.factor(year)1989:as.factor(target3)3       0.2539818  0.1002625   2.533 0.011305 *
as.factor(year)1990:as.factor(target3)3       0.3653513  0.0882004   4.142 3.44e-05 ***
as.factor(year)1991:as.factor(target3)3       0.0504069  0.0784626   0.642 0.520594
as.factor(year)1992:as.factor(target3)3       0.2078460  0.0678120   3.065 0.002177 **
as.factor(year)1993:as.factor(target3)3       0.0907168  0.0637467   1.423 0.154715
as.factor(year)1977:as.factor(target3)4      -0.4316596  0.0556791  -7.753 9.07e-15 ***
as.factor(year)1978:as.factor(target3)4      -0.1536006  0.0587242  -2.616 0.008908 **
as.factor(year)1979:as.factor(target3)4      -0.3844820  0.0575838  -6.677 2.45e-11 ***
as.factor(year)1980:as.factor(target3)4       0.0316412  0.0564022   0.561 0.574804
as.factor(year)1981:as.factor(target3)4       0.0815353  0.0582304   1.400 0.161450
as.factor(year)1982:as.factor(target3)4       0.2369200  0.0615277   3.851 0.000118 ***
as.factor(year)1983:as.factor(target3)4       0.2951940  0.0624690   4.725 2.30e-06 ***
as.factor(year)1984:as.factor(target3)4       0.1434309  0.0720145   1.992 0.046407 *
as.factor(year)1985:as.factor(target3)4       0.0177538  0.0763032   0.233 0.816015
as.factor(year)1986:as.factor(target3)4       0.0444862  0.0701490   0.634 0.525973
as.factor(year)1987:as.factor(target3)4       0.2810727  0.0801999   3.505 0.000457 ***
as.factor(year)1988:as.factor(target3)4       0.2701513  0.0835949   3.232 0.001231 **
as.factor(year)1989:as.factor(target3)4       0.5243084  0.1002552   5.230 1.70e-07 ***
as.factor(year)1990:as.factor(target3)4       0.4981300  0.0924342   5.389 7.10e-08 ***
as.factor(year)1991:as.factor(target3)4       0.3913361  0.0790743   4.949 7.47e-07 ***
as.factor(year)1992:as.factor(target3)4       0.2922179  0.0730183   4.002 6.29e-05 ***
as.factor(year)1993:as.factor(target3)4       0.2710157  0.0665480   4.072 4.65e-05 ***
as.factor(year)1977:as.factor(target3)5      -0.5242736  0.0511615 -10.247  < 2e-16 ***
as.factor(year)1978:as.factor(target3)5      -0.3621031  0.0571865  -6.332 2.43e-10 ***
as.factor(year)1979:as.factor(target3)5      -0.6652563  0.0573440 -11.601  < 2e-16 ***
as.factor(year)1980:as.factor(target3)5      -0.1083826  0.0537141  -2.018 0.043618 *
as.factor(year)1981:as.factor(target3)5      -0.0957934  0.0569987  -1.681 0.092838 .
as.factor(year)1982:as.factor(target3)5      -0.1291049  0.0679986  -1.899 0.057614 .
as.factor(year)1983:as.factor(target3)5       0.0222945  0.0625807   0.356 0.721652
as.factor(year)1984:as.factor(target3)5      -0.0667224  0.0718014  -0.929 0.352754
as.factor(year)1985:as.factor(target3)5      -0.1771365  0.0749436  -2.364 0.018100 *
as.factor(year)1986:as.factor(target3)5      -0.1136589  0.0695692  -1.634 0.102313
as.factor(year)1987:as.factor(target3)5      -0.0096091  0.0823323  -0.117 0.907089
as.factor(year)1988:as.factor(target3)5       0.1226752  0.0795179   1.543 0.122897
as.factor(year)1989:as.factor(target3)5       0.3916607  0.0986081   3.972 7.13e-05 ***
as.factor(year)1990:as.factor(target3)5       0.1676505  0.0975710   1.718 0.085755 .
as.factor(year)1991:as.factor(target3)5       0.2180947  0.0776381   2.809 0.004969 **
as.factor(year)1992:as.factor(target3)5      -0.0446740  0.0767917  -0.582 0.560732
as.factor(year)1993:as.factor(target3)5       0.0402260  0.0668006   0.602 0.547056
as.factor(year)1977:as.factor(target3)6      -0.5940447  0.0551550 -10.770  < 2e-16 ***
as.factor(year)1978:as.factor(target3)6      -0.4776453  0.0616665  -7.746 9.59e-15 ***
as.factor(year)1979:as.factor(target3)6      -0.6981371  0.0582471 -11.986  < 2e-16 ***
as.factor(year)1980:as.factor(target3)6      -0.1292096  0.0553638  -2.334 0.019606 *
as.factor(year)1981:as.factor(target3)6      -0.2487729  0.0630680  -3.945 8.00e-05 ***
as.factor(year)1982:as.factor(target3)6      -0.0581994  0.0673235  -0.864 0.387329
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as.factor(year)1983:as.factor(target3)6  -0.1041350  0.0657801  -1.583 0.113406
as.factor(year)1984:as.factor(target3)6  -0.0140498  0.0691355  -0.203 0.838962
as.factor(year)1985:as.factor(target3)6  -0.2337143  0.0794538  -2.942 0.003267 **
as.factor(year)1986:as.factor(target3)6  -0.0430884  0.0677497  -0.636 0.524782
as.factor(year)1987:as.factor(target3)6   0.0026657  0.0845977   0.032 0.974863
as.factor(year)1988:as.factor(target3)6  -0.0536105  0.0885265  -0.606 0.544790
as.factor(year)1989:as.factor(target3)6   0.4602020  0.0966894   4.760 1.94e-06 ***
as.factor(year)1990:as.factor(target3)6   0.1946491  0.0993057   1.960 0.049986 *
as.factor(year)1991:as.factor(target3)6   0.0374778  0.0837400   0.448 0.654479
as.factor(year)1992:as.factor(target3)6   0.0897550  0.0729354   1.231 0.218472
as.factor(year)1993:as.factor(target3)6   0.0645933  0.0675235   0.957 0.338769
as.factor(year)1977:as.factor(target3)7  -0.5116080  0.0578575  -8.843  < 2e-16 ***
as.factor(year)1978:as.factor(target3)7  -0.2851899  0.0605428  -4.711 2.47e-06 ***
as.factor(year)1979:as.factor(target3)7  -0.6500050  0.0616735 -10.539  < 2e-16 ***
as.factor(year)1980:as.factor(target3)7  -0.0576297  0.0590658  -0.976 0.329222
as.factor(year)1981:as.factor(target3)7  -0.2603563  0.0694972  -3.746 0.000180 ***
as.factor(year)1982:as.factor(target3)7  -0.0104863  0.0705271  -0.149 0.881803
as.factor(year)1983:as.factor(target3)7   0.0816787  0.0663668   1.231 0.218431
as.factor(year)1984:as.factor(target3)7  -0.0991357  0.0784397  -1.264 0.206287
as.factor(year)1985:as.factor(target3)7  -0.1057392  0.0776059  -1.363 0.173038
as.factor(year)1986:as.factor(target3)7  -0.0474540  0.0738143  -0.643 0.520300
as.factor(year)1987:as.factor(target3)7   0.0747677  0.0876153   0.853 0.393460
as.factor(year)1988:as.factor(target3)7   0.1997877  0.0858298   2.328 0.019929 *
as.factor(year)1989:as.factor(target3)7   0.5231203  0.0983778   5.317 1.05e-07 ***
as.factor(year)1990:as.factor(target3)7   0.2680065  0.1002257   2.674 0.007496 **
as.factor(year)1991:as.factor(target3)7   0.3321025  0.0790115   4.203 2.63e-05 ***
as.factor(year)1992:as.factor(target3)7   0.1577316  0.0758718   2.079 0.037627 *
as.factor(year)1993:as.factor(target3)7   0.0037008  0.0753338   0.049 0.960819
as.factor(year)1977:as.factor(target3)8  -0.8135039  0.0563416 -14.439  < 2e-16 ***
as.factor(year)1978:as.factor(target3)8  -0.4261158  0.0558820  -7.625 2.45e-14 ***
as.factor(year)1979:as.factor(target3)8  -0.6312960  0.0533258 -11.838  < 2e-16 ***
as.factor(year)1980:as.factor(target3)8  -0.2852173  0.0556548  -5.125 2.98e-07 ***
as.factor(year)1981:as.factor(target3)8  -0.2895412  0.0619861  -4.671 3.00e-06 ***
as.factor(year)1982:as.factor(target3)8  -0.2152549  0.0684737  -3.144 0.001669 **
as.factor(year)1983:as.factor(target3)8  -0.1467138  0.0642827  -2.282 0.022472 *
as.factor(year)1984:as.factor(target3)8  -0.0088191  0.0671286  -0.131 0.895478
as.factor(year)1985:as.factor(target3)8  -0.1266415  0.0703534  -1.800 0.071851 .
as.factor(year)1986:as.factor(target3)8  -0.1155687  0.0669231  -1.727 0.084190 .
as.factor(year)1987:as.factor(target3)8  -0.0932446  0.0861463  -1.082 0.279078
as.factor(year)1988:as.factor(target3)8  -0.2388446  0.0927479  -2.575 0.010019 *
as.factor(year)1989:as.factor(target3)8   0.3635601  0.0969244   3.751 0.000176 ***
as.factor(year)1990:as.factor(target3)8  -0.0922304  0.1070686  -0.861 0.389012
as.factor(year)1991:as.factor(target3)8   0.2069331  0.0745114   2.777 0.005484 **
as.factor(year)1992:as.factor(target3)8  -0.1026428  0.0755019  -1.359 0.173999
as.factor(year)1993:as.factor(target3)8  -0.0004571  0.0657197  -0.007 0.994450
as.factor(year)1977:as.factor(target3)9  -0.9783924  0.0530268 -18.451  < 2e-16 ***
as.factor(year)1978:as.factor(target3)9  -0.5202346  0.0502040 -10.362  < 2e-16 ***
as.factor(year)1979:as.factor(target3)9  -0.9829203  0.0540336 -18.191  < 2e-16 ***
as.factor(year)1980:as.factor(target3)9  -0.3464219  0.0505766  -6.849 7.45e-12 ***
as.factor(year)1981:as.factor(target3)9  -0.5582332  0.0634615  -8.796  < 2e-16 ***
as.factor(year)1982:as.factor(target3)9  -0.3142044  0.0633000  -4.964 6.92e-07 ***
as.factor(year)1983:as.factor(target3)9  -0.3403069  0.0626872  -5.429 5.69e-08 ***
as.factor(year)1984:as.factor(target3)9  -0.4393462  0.0696661  -6.306 2.87e-10 ***
as.factor(year)1985:as.factor(target3)9  -0.3291364  0.0709777  -4.637 3.54e-06 ***
as.factor(year)1986:as.factor(target3)9  -0.2969079  0.0655964  -4.526 6.01e-06 ***
as.factor(year)1987:as.factor(target3)9  -0.5375979  0.0991604  -5.421 5.92e-08 ***
as.factor(year)1988:as.factor(target3)9  -0.3694376  0.0924214  -3.997 6.41e-05 ***
as.factor(year)1989:as.factor(target3)9   0.1626513  0.0962852   1.689 0.091171 .
as.factor(year)1990:as.factor(target3)9  -0.1378827  0.0995105  -1.386 0.165869
as.factor(year)1991:as.factor(target3)9  -0.2580510  0.0825878  -3.125 0.001781 **
as.factor(year)1992:as.factor(target3)9  -0.2787045  0.0744281  -3.745 0.000181 ***
as.factor(year)1993:as.factor(target3)9  -0.2840986  0.0665811  -4.267 1.98e-05 ***
as.factor(year)1977:as.factor(target3)10 -0.7165910  0.0441994 -16.213  < 2e-16 ***
as.factor(year)1978:as.factor(target3)10 -0.4405825  0.0477193  -9.233  < 2e-16 ***
as.factor(year)1979:as.factor(target3)10 -0.7966317  0.0477534 -16.682  < 2e-16 ***
as.factor(year)1980:as.factor(target3)10 -0.3994194  0.0500490  -7.981 1.47e-15 ***
as.factor(year)1981:as.factor(target3)10 -0.5257712  0.0583397  -9.012  < 2e-16 ***
as.factor(year)1982:as.factor(target3)10 -0.2410760  0.0572017  -4.214 2.51e-05 ***
as.factor(year)1983:as.factor(target3)10 -0.3205113  0.0596503  -5.373 7.75e-08 ***
as.factor(year)1984:as.factor(target3)10 -0.2865153  0.0632605  -4.529 5.93e-06 ***
as.factor(year)1985:as.factor(target3)10 -0.2286750  0.0646789  -3.536 0.000407 ***
as.factor(year)1986:as.factor(target3)10 -0.3801656  0.0630836  -6.026 1.68e-09 ***
as.factor(year)1987:as.factor(target3)10 -0.2672230  0.0763213  -3.501 0.000463 ***
as.factor(year)1988:as.factor(target3)10 -0.2411445  0.0783512  -3.078 0.002086 **
as.factor(year)1989:as.factor(target3)10 -0.2447033  0.1065204  -2.297 0.021607 *
as.factor(year)1990:as.factor(target3)10 -0.4827477  0.1106320  -4.364 1.28e-05 ***
as.factor(year)1991:as.factor(target3)10 -0.1827517  0.0778532  -2.347 0.018907 *
as.factor(year)1992:as.factor(target3)10 -0.3453320  0.0727731  -4.745 2.08e-06 ***
```

```
as.factor(year)1993:as.factor(target3)10 -0.5614672  0.0711370  -7.893 2.98e-15 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

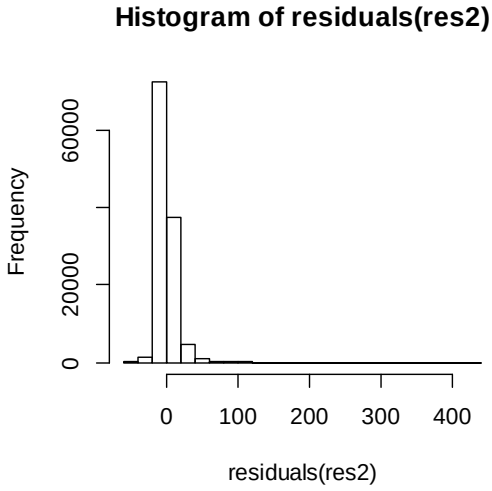
(Dispersion parameter for gaussian family taken to be 204.9459)

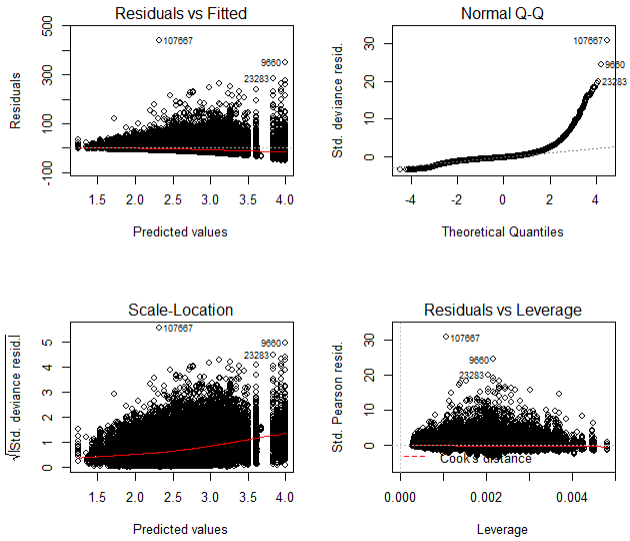
    Null deviance: 28516179  on 118438  degrees of freedom
Residual deviance: 24235767  on 118255  degrees of freedom
AIC: 966721

Number of Fisher Scoring iterations: 8

> Anova(res2.2)
Analysis of Deviance Table (Type II tests)

Response: ncpue
                                LR Chisq  Df Pr(>Chisq)
as.factor(year)                   9759.5  17  < 2.2e-16 ***
as.factor(qt)                    3631.6   3  < 2.2e-16 ***
as.factor(area)                   4319.0   1  < 2.2e-16 ***
as.factor(target3)                2300.1   9  < 2.2e-16 ***
as.factor(year):as.factor(target3)   2750.8 153  < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```





I-(3) negative binomial model

```
Call:
glm.nb(formula = blshrk ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(target3) + as.factor(year):as.factor(target3) +
    offset(log(hook)), data = temp, init.theta = 1.441194055,
    link = log)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.4950  -0.9167  -0.3164   0.3210   9.4941

Coefficients:
                                Estimate Std. Error  z value Pr(>|z|)
(Intercept)                   -3.9732604  0.0343383 -115.709  < 2e-16 ***
as.factor(year)1977            0.5643407  0.0461434   12.230  < 2e-16 ***
as.factor(year)1978            0.1037237  0.0470683    2.204 0.027546 *
as.factor(year)1979            0.4583247  0.0464975    9.857  < 2e-16 ***
as.factor(year)1980            0.2850957  0.0474054    6.014 1.81e-09 ***
as.factor(year)1981            0.1422982  0.0459837    3.095 0.001971 **
as.factor(year)1982           -0.0859612  0.0486404   -1.767 0.077181 .
as.factor(year)1983           -0.1737711  0.0459941   -3.778 0.000158 ***
```

[1]Working document submitted to the ISC Shark Working Group Workshop, 7 January – 14 January 2013, NOAA Southwest Fisheries Science Center, La Jolla, California U.S.A. **Document not to be cited without author's permission.**

as.factor(year)1984	-0.2654954	0.0458073	-5.796	6.79e-09	***
as.factor(year)1985	-0.5530246	0.0450738	-12.269	< 2e-16	***
as.factor(year)1986	-0.2959401	0.0448562	-6.598	4.18e-11	***
as.factor(year)1987	-0.6340067	0.0448888	-14.124	< 2e-16	***
as.factor(year)1988	-0.6861791	0.0468127	-14.658	< 2e-16	***
as.factor(year)1989	-0.9575730	0.0469949	-20.376	< 2e-16	***
as.factor(year)1990	-0.8263928	0.0487959	-16.936	< 2e-16	***
as.factor(year)1991	-0.7739350	0.0491063	-15.760	< 2e-16	***
as.factor(year)1992	-0.4414819	0.0492480	-8.964	< 2e-16	***
as.factor(year)1993	-0.6448327	0.0500005	-12.897	< 2e-16	***
as.factor(qt)2	0.2096987	0.0073869	28.388	< 2e-16	***
as.factor(qt)3	0.3010539	0.0079637	37.803	< 2e-16	***
as.factor(qt)4	-0.1064277	0.0085177	-12.495	< 2e-16	***
as.factor(area)3	-0.3697256	0.0061677	-59.946	< 2e-16	***
as.factor(target3)2	-0.0536055	0.0480407	-1.116	0.264492	
as.factor(target3)3	-0.1892404	0.0479473	-3.947	7.92e-05	***
as.factor(target3)4	-0.2885126	0.0481669	-5.990	2.10e-09	***
as.factor(target3)5	-0.2179927	0.0479739	-4.544	5.52e-06	***
as.factor(target3)6	-0.2018968	0.0480442	-4.202	2.64e-05	***
as.factor(target3)7	-0.0857610	0.0479479	-1.789	0.073675	.
as.factor(target3)8	-0.0063002	0.0481248	-0.131	0.895844	
as.factor(target3)9	0.0401625	0.0480759	0.835	0.403494	
as.factor(target3)10	0.3178698	0.0479637	6.627	3.42e-11	***
as.factor(year)1977:as.factor(target3)2	-0.6029140	0.0655164	-9.202	< 2e-16	***
as.factor(year)1978:as.factor(target3)2	-0.6211450	0.0671789	-9.246	< 2e-16	***
as.factor(year)1979:as.factor(target3)2	-0.8733128	0.0661359	-13.205	< 2e-16	***
as.factor(year)1980:as.factor(target3)2	-0.5091167	0.0672314	-7.573	3.66e-14	***
as.factor(year)1981:as.factor(target3)2	-0.1515177	0.0661682	-2.290	0.022028	*
as.factor(year)1982:as.factor(target3)2	-0.0493550	0.0690516	-0.715	0.474761	
as.factor(year)1983:as.factor(target3)2	-0.0455408	0.0655737	-0.694	0.487370	
as.factor(year)1984:as.factor(target3)2	-0.0519212	0.0653881	-0.794	0.427168	
as.factor(year)1985:as.factor(target3)2	0.1208918	0.0636882	1.898	0.057672	.
as.factor(year)1986:as.factor(target3)2	-0.0616226	0.0636554	-0.968	0.333012	
as.factor(year)1987:as.factor(target3)2	0.0793720	0.0636253	1.247	0.212217	
as.factor(year)1988:as.factor(target3)2	-0.0268160	0.0666979	-0.402	0.687646	
as.factor(year)1989:as.factor(target3)2	-0.1349812	0.0671265	-2.011	0.044341	*
as.factor(year)1990:as.factor(target3)2	0.0643708	0.0690142	0.933	0.350965	
as.factor(year)1991:as.factor(target3)2	0.2596380	0.0694090	3.741	0.000184	***
as.factor(year)1992:as.factor(target3)2	-0.1686010	0.0698514	-2.414	0.015791	*
as.factor(year)1993:as.factor(target3)2	0.1650514	0.0707578	2.333	0.019668	*
as.factor(year)1977:as.factor(target3)3	-0.4087663	0.0653750	-6.253	4.04e-10	***
as.factor(year)1978:as.factor(target3)3	-0.1931632	0.0667502	-2.894	0.003806	**
as.factor(year)1979:as.factor(target3)3	-0.5128559	0.0661385	-7.754	8.89e-15	***
as.factor(year)1980:as.factor(target3)3	-0.3564583	0.0673361	-5.294	1.20e-07	***
as.factor(year)1981:as.factor(target3)3	-0.1915260	0.0654786	-2.925	0.003444	**
as.factor(year)1982:as.factor(target3)3	-0.1169042	0.0690806	-1.692	0.090591	.
as.factor(year)1983:as.factor(target3)3	0.1607088	0.0653059	2.461	0.013860	*
as.factor(year)1984:as.factor(target3)3	0.0472740	0.0650580	0.727	0.467444	
as.factor(year)1985:as.factor(target3)3	0.0933377	0.0645056	1.447	0.147905	
as.factor(year)1986:as.factor(target3)3	0.0931957	0.0636623	1.464	0.143219	
as.factor(year)1987:as.factor(target3)3	0.1438894	0.0636213	2.262	0.023719	*
as.factor(year)1988:as.factor(target3)3	0.2350005	0.0665414	3.532	0.000413	***
as.factor(year)1989:as.factor(target3)3	0.2855854	0.0667521	4.278	1.88e-05	***
as.factor(year)1990:as.factor(target3)3	0.6382447	0.0690602	9.242	< 2e-16	***
as.factor(year)1991:as.factor(target3)3	0.4795355	0.0696020	6.890	5.59e-12	***
as.factor(year)1992:as.factor(target3)3	0.1885789	0.0697075	2.705	0.006825	**
as.factor(year)1993:as.factor(target3)3	0.5845722	0.0710405	8.229	< 2e-16	***
as.factor(year)1977:as.factor(target3)4	-0.3350451	0.0657531	-5.095	3.48e-07	***
as.factor(year)1978:as.factor(target3)4	0.0900416	0.0672065	1.340	0.180319	
as.factor(year)1979:as.factor(target3)4	-0.3893025	0.0663973	-5.863	4.54e-09	***
as.factor(year)1980:as.factor(target3)4	-0.2139025	0.0675642	-3.166	0.001546	**
as.factor(year)1981:as.factor(target3)4	0.0792095	0.0659487	1.201	0.229721	
as.factor(year)1982:as.factor(target3)4	0.2575531	0.0690809	3.728	0.000193	***
as.factor(year)1983:as.factor(target3)4	0.1237403	0.0654722	1.890	0.058763	.
as.factor(year)1984:as.factor(target3)4	0.0528582	0.0654775	0.807	0.419510	
as.factor(year)1985:as.factor(target3)4	0.0601341	0.0641711	0.937	0.348712	
as.factor(year)1986:as.factor(target3)4	0.0447574	0.0638213	0.701	0.483120	
as.factor(year)1987:as.factor(target3)4	0.1947470	0.0638059	3.052	0.002272	**

as.factor(year)1988:as.factor(target3)4	0.2992650	0.0667444	4.484	7.33e-06 ***
as.factor(year)1989:as.factor(target3)4	0.4484481	0.0668470	6.709	1.97e-11 ***
as.factor(year)1990:as.factor(target3)4	0.4282861	0.0691181	6.196	5.78e-10 ***
as.factor(year)1991:as.factor(target3)4	0.6375668	0.0698588	9.127	< 2e-16 ***
as.factor(year)1992:as.factor(target3)4	0.3862001	0.0700657	5.512	3.55e-08 ***
as.factor(year)1993:as.factor(target3)4	0.6116631	0.0708970	8.627	< 2e-16 ***
as.factor(year)1977:as.factor(target3)5	-0.3951345	0.0654728	-6.035	1.59e-09 ***
as.factor(year)1978:as.factor(target3)5	-0.0818312	0.0669327	-1.223	0.221485
as.factor(year)1979:as.factor(target3)5	-0.5134553	0.0661042	-7.767	8.01e-15 ***
as.factor(year)1980:as.factor(target3)5	0.0082942	0.0671522	0.124	0.901700
as.factor(year)1981:as.factor(target3)5	-0.2238438	0.0654805	-3.418	0.000630 ***
as.factor(year)1982:as.factor(target3)5	-0.0359326	0.0690287	-0.521	0.602683
as.factor(year)1983:as.factor(target3)5	0.0017533	0.0654387	0.027	0.978625
as.factor(year)1984:as.factor(target3)5	-0.0438094	0.0652177	-0.672	0.501748
as.factor(year)1985:as.factor(target3)5	0.1488705	0.0639720	2.327	0.019959 *
as.factor(year)1986:as.factor(target3)5	-0.0416534	0.0636949	-0.654	0.513143
as.factor(year)1987:as.factor(target3)5	0.0598408	0.0636614	0.940	0.347225
as.factor(year)1988:as.factor(target3)5	0.2287959	0.0665599	3.437	0.000587 ***
as.factor(year)1989:as.factor(target3)5	0.5223678	0.0665857	7.845	4.33e-15 ***
as.factor(year)1990:as.factor(target3)5	0.3695666	0.0691470	5.345	9.06e-08 ***
as.factor(year)1991:as.factor(target3)5	0.4333607	0.0695831	6.228	4.73e-10 ***
as.factor(year)1992:as.factor(target3)5	0.2194052	0.0697042	3.148	0.001646 **
as.factor(year)1993:as.factor(target3)5	0.8296957	0.0709215	11.699	< 2e-16 ***
as.factor(year)1977:as.factor(target3)6	-0.4267670	0.0656042	-6.505	7.76e-11 ***
as.factor(year)1978:as.factor(target3)6	-0.2211825	0.0670580	-3.298	0.000972 ***
as.factor(year)1979:as.factor(target3)6	-0.3450687	0.0660046	-5.228	1.71e-07 ***
as.factor(year)1980:as.factor(target3)6	-0.0273702	0.0673922	-0.406	0.684645
as.factor(year)1981:as.factor(target3)6	-0.3627448	0.0657817	-5.514	3.50e-08 ***
as.factor(year)1982:as.factor(target3)6	-0.0263731	0.0690350	-0.382	0.702443
as.factor(year)1983:as.factor(target3)6	0.0623945	0.0654407	0.953	0.340362
as.factor(year)1984:as.factor(target3)6	-0.0580335	0.0651469	-0.891	0.373031
as.factor(year)1985:as.factor(target3)6	0.0255399	0.0639703	0.399	0.689711
as.factor(year)1986:as.factor(target3)6	0.0728044	0.0636568	1.144	0.252747
as.factor(year)1987:as.factor(target3)6	0.1052684	0.0636821	1.653	0.098325 .
as.factor(year)1988:as.factor(target3)6	0.2343513	0.0664809	3.525	0.000423 ***
as.factor(year)1989:as.factor(target3)6	0.5013342	0.0667234	7.514	5.75e-14 ***
as.factor(year)1990:as.factor(target3)6	0.3501706	0.0692315	5.058	4.24e-07 ***
as.factor(year)1991:as.factor(target3)6	0.5887471	0.0694086	8.482	< 2e-16 ***
as.factor(year)1992:as.factor(target3)6	0.2708101	0.0699830	3.870	0.000109 ***
as.factor(year)1993:as.factor(target3)6	0.5986079	0.0706666	8.471	< 2e-16 ***
as.factor(year)1977:as.factor(target3)7	-0.6865950	0.0655702	-10.471	< 2e-16 ***
as.factor(year)1978:as.factor(target3)7	-0.2717583	0.0666798	-4.076	4.59e-05 ***
as.factor(year)1979:as.factor(target3)7	-0.5648945	0.0663100	-8.519	< 2e-16 ***
as.factor(year)1980:as.factor(target3)7	-0.2179505	0.0672131	-3.243	0.001184 **
as.factor(year)1981:as.factor(target3)7	-0.4282197	0.0657878	-6.509	7.56e-11 ***
as.factor(year)1982:as.factor(target3)7	-0.0788333	0.0688101	-1.146	0.251934
as.factor(year)1983:as.factor(target3)7	-0.1312934	0.0652943	-2.011	0.044347 *
as.factor(year)1984:as.factor(target3)7	-0.1411776	0.0651624	-2.167	0.030269 *
as.factor(year)1985:as.factor(target3)7	0.0376877	0.0639036	0.590	0.555353
as.factor(year)1986:as.factor(target3)7	-0.1979322	0.0636371	-3.110	0.001869 **
as.factor(year)1987:as.factor(target3)7	-0.1096557	0.0636130	-1.724	0.084745 .
as.factor(year)1988:as.factor(target3)7	-0.0043858	0.0664210	-0.066	0.947354
as.factor(year)1989:as.factor(target3)7	0.4862759	0.0665470	7.307	2.73e-13 ***
as.factor(year)1990:as.factor(target3)7	0.0937601	0.0691356	1.356	0.175043
as.factor(year)1991:as.factor(target3)7	0.5075322	0.0695558	7.297	2.95e-13 ***
as.factor(year)1992:as.factor(target3)7	0.0874729	0.0697988	1.253	0.210127
as.factor(year)1993:as.factor(target3)7	0.2930014	0.0707292	4.143	3.43e-05 ***
as.factor(year)1977:as.factor(target3)8	-0.7152690	0.0655961	-10.904	< 2e-16 ***
as.factor(year)1978:as.factor(target3)8	-0.1766140	0.0670212	-2.635	0.008409 **
as.factor(year)1979:as.factor(target3)8	-0.5190104	0.0659178	-7.874	3.45e-15 ***
as.factor(year)1980:as.factor(target3)8	-0.3856970	0.0673200	-5.729	1.01e-08 ***
as.factor(year)1981:as.factor(target3)8	-0.3803706	0.0655880	-5.799	6.66e-09 ***
as.factor(year)1982:as.factor(target3)8	-0.4254731	0.0692453	-6.144	8.02e-10 ***
as.factor(year)1983:as.factor(target3)8	-0.1683865	0.0653485	-2.577	0.009973 **
as.factor(year)1984:as.factor(target3)8	-0.2337880	0.0652373	-3.584	0.000339 ***
as.factor(year)1985:as.factor(target3)8	-0.0867892	0.0639880	-1.356	0.174993
as.factor(year)1986:as.factor(target3)8	-0.1457492	0.0637566	-2.286	0.022253 *
as.factor(year)1987:as.factor(target3)8	0.0085046	0.0637689	0.133	0.893904

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as.factor(year)1988:as.factor(target3)8   0.0482395  0.0667374    0.723 0.469788
as.factor(year)1989:as.factor(target3)8   0.2790625  0.0669298    4.169 3.05e-05 ***
as.factor(year)1990:as.factor(target3)8   0.0841237  0.0690004    1.219 0.222777
as.factor(year)1991:as.factor(target3)8   0.2765935  0.0694442    3.983 6.81e-05 ***
as.factor(year)1992:as.factor(target3)8  -0.1780740  0.0699798   -2.545 0.010939 *
as.factor(year)1993:as.factor(target3)8   0.5005439  0.0708391    7.066 1.60e-12 ***
as.factor(year)1977:as.factor(target3)9  -0.9352281  0.0656922  -14.237  < 2e-16 ***
as.factor(year)1978:as.factor(target3)9  -0.2608077  0.0669186   -3.897 9.72e-05 ***
as.factor(year)1979:as.factor(target3)9  -0.6518897  0.0661797   -9.850  < 2e-16 ***
as.factor(year)1980:as.factor(target3)9  -0.3714057  0.0673166   -5.517 3.44e-08 ***
as.factor(year)1981:as.factor(target3)9  -0.6379183  0.0659826   -9.668  < 2e-16 ***
as.factor(year)1982:as.factor(target3)9  -0.2241911  0.0693050   -3.235 0.001217 **
as.factor(year)1983:as.factor(target3)9  -0.2529208  0.0655443   -3.859 0.000114 ***
as.factor(year)1984:as.factor(target3)9  -0.3016905  0.0652409   -4.624 3.76e-06 ***
as.factor(year)1985:as.factor(target3)9  -0.0970186  0.0640948   -1.514 0.130109
as.factor(year)1986:as.factor(target3)9  -0.2121697  0.0637560   -3.328 0.000875 ***
as.factor(year)1987:as.factor(target3)9  -0.4573744  0.0637352   -7.176 7.17e-13 ***
as.factor(year)1988:as.factor(target3)9  -0.2280372  0.0666559   -3.421 0.000624 ***
as.factor(year)1989:as.factor(target3)9   0.2511790  0.0667643    3.762 0.000168 ***
as.factor(year)1990:as.factor(target3)9  -0.1762125  0.0694392   -2.538 0.011160 *
as.factor(year)1991:as.factor(target3)9   0.1898905  0.0696669    2.726 0.006417 **
as.factor(year)1992:as.factor(target3)9   0.0002271  0.0698136    0.003 0.997405
as.factor(year)1993:as.factor(target3)9   0.4698298  0.0708838    6.628 3.40e-11 ***
as.factor(year)1977:as.factor(target3)10 -0.6730430  0.0655845  -10.262  < 2e-16 ***
as.factor(year)1978:as.factor(target3)10 -0.3390775  0.0668428   -5.073 3.92e-07 ***
as.factor(year)1979:as.factor(target3)10 -0.8206439  0.0660824  -12.418  < 2e-16 ***
as.factor(year)1980:as.factor(target3)10 -0.5598187  0.0673099   -8.317  < 2e-16 ***
as.factor(year)1981:as.factor(target3)10 -0.8374831  0.0658637  -12.715  < 2e-16 ***
as.factor(year)1982:as.factor(target3)10 -0.3375583  0.0690312   -4.890 1.01e-06 ***
as.factor(year)1983:as.factor(target3)10 -0.5205369  0.0654202   -7.957 1.77e-15 ***
as.factor(year)1984:as.factor(target3)10 -0.4382628  0.0651624   -6.726 1.75e-11 ***
as.factor(year)1985:as.factor(target3)10 -0.2298566  0.0639070   -3.597 0.000322 ***
as.factor(year)1986:as.factor(target3)10 -0.4563726  0.0637265   -7.161 7.98e-13 ***
as.factor(year)1987:as.factor(target3)10 -0.5362229  0.0639025   -8.391  < 2e-16 ***
as.factor(year)1988:as.factor(target3)10 -0.2253888  0.0665446   -3.387 0.000707 ***
as.factor(year)1989:as.factor(target3)10 -0.4057788  0.0669097   -6.065 1.32e-09 ***
as.factor(year)1990:as.factor(target3)10 -0.3887925  0.0692688   -5.613 1.99e-08 ***
as.factor(year)1991:as.factor(target3)10  0.0022818  0.0696271    0.033 0.973857
as.factor(year)1992:as.factor(target3)10 -0.3131709  0.0697249   -4.492 7.07e-06 ***
as.factor(year)1993:as.factor(target3)10  0.1954831  0.0711373    2.748 0.005997 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(1.4412) family taken to be 1)

    Null deviance: 160085  on 121108  degrees of freedom
Residual deviance: 136700  on 120925  degrees of freedom
AIC: 1096885

Number of Fisher Scoring iterations: 1


          Theta:  1.44119
      Std. Err.:  0.00582

 2 x log-likelihood:  -1096515.30500
Analysis of Deviance Table (Type II tests)

Response: blshrk
                                  LR Chisq  Df Pr(>Chisq)
as.factor(year)                    10565.6  17  < 2.2e-16 ***
as.factor(qt)                      2984.7   3  < 2.2e-16 ***
as.factor(area)                     3790.0   1  < 2.2e-16 ***
as.factor(target3)                   595.8   9  < 2.2e-16 ***
as.factor(year):as.factor(target3)   3201.6 153  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

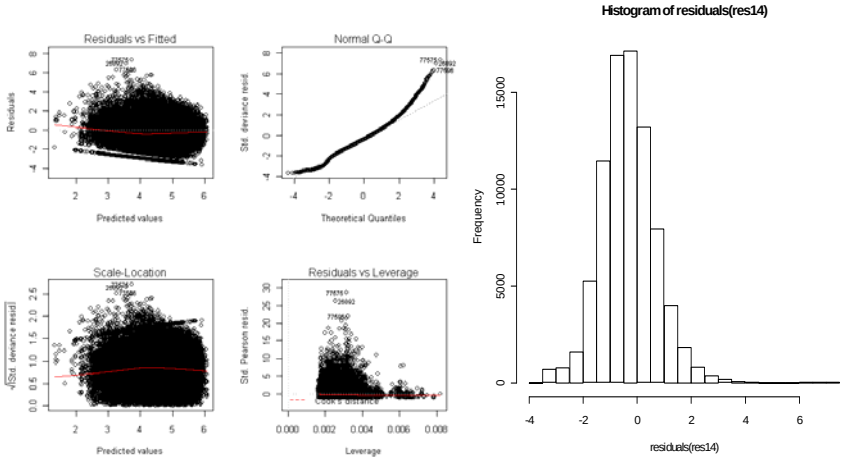

II.1994-2010

II-(1) delta-lognormal model

<1stStep>

Call:
glm(formula = pocatch ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(target3) + as.factor(year):as.factor(target3),
    family = binomial, data = temp)

Deviance Residuals:
    Min   1Q   Median   3Q   Max
-3.7158   0.0815   0.1397   0.1934   0.6559

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	3.134472	0.179694	17.443	< 2e-16	***
as.factor(year)1995	0.459129	0.251853	1.823	0.068303	.
as.factor(year)1996	1.252873	0.331109	3.784	0.000154	***
as.factor(year)1997	0.275679	0.255425	1.079	0.280456	
as.factor(year)1998	0.709073	0.276776	2.562	0.010410	*
as.factor(year)1999	0.805349	0.305694	2.634	0.008426	**
as.factor(year)2000	1.079880	0.343331	3.145	0.001659	**
as.factor(year)2001	0.449170	0.283347	1.585	0.112914	
as.factor(year)2002	1.515306	0.477851	3.171	0.001519	**
as.factor(year)2003	16.358206	479.559810	0.034	0.972789	
as.factor(year)2004	2.223762	0.727408	3.057	0.002235	**
as.factor(year)2005	1.049743	0.442476	2.372	0.017672	*
as.factor(year)2006	2.928238	1.014138	2.887	0.003884	**
as.factor(year)2007	1.977404	0.601212	3.289	0.001005	**
as.factor(year)2008	16.422354	547.670875	0.030	0.976078	
as.factor(year)2009	1.441007	0.603073	2.389	0.016874	*
as.factor(year)2010	16.286162	604.427276	0.027	0.978504	
as.factor(qt)2	0.397520	0.111142	3.577	0.000348	***
as.factor(qt)3	-0.473744	0.102563	-4.619	3.85e-06	***
as.factor(qt)4	-1.077012	0.095787	-11.244	< 2e-16	***
as.factor(area)2	1.265387	0.389541	3.248	0.001161	**
as.factor(area)3	-0.095193	0.095561	-0.996	0.319178	
as.factor(area)4	-0.586065	0.468023	-1.252	0.210492	
as.factor(target3)2	0.043750	0.225246	0.194	0.845994	
as.factor(target3)3	1.154394	0.332253	3.474	0.000512	***
as.factor(target3)4	0.864535	0.306212	2.823	0.004753	**
as.factor(target3)5	0.694064	0.300226	2.312	0.020789	*
as.factor(target3)6	1.228200	0.372668	3.296	0.000982	***
as.factor(target3)7	0.841292	0.334607	2.514	0.011928	*

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as.factor(target3)8                          0.550562   0.309129   1.781 0.074911 .
as.factor(target3)9                          0.871244   0.334175   2.607 0.009130 **
as.factor(target3)10                         1.441235   0.414969   3.473 0.000514 ***
as.factor(year)1995:as.factor(target3)2      0.558585   0.404467   1.381 0.167267
as.factor(year)1996:as.factor(target3)2     -0.936381   0.422343  -2.217 0.026616 *
as.factor(year)1997:as.factor(target3)2      0.256859   0.379494   0.677 0.498503
as.factor(year)1998:as.factor(target3)2     -0.148490   0.394231  -0.377 0.706429
as.factor(year)1999:as.factor(target3)2      1.005692   0.537535   1.871 0.061354 .
as.factor(year)2000:as.factor(target3)2      0.185538   0.506759   0.366 0.714271
as.factor(year)2001:as.factor(target3)2     -0.149370   0.392014  -0.381 0.703179
as.factor(year)2002:as.factor(target3)2      0.236148   0.675797   0.349 0.726761
as.factor(year)2003:as.factor(target3)2      0.093479 684.113830   0.000 0.999891
as.factor(year)2004:as.factor(target3)2     -1.203030   0.850507  -1.414 0.157220
as.factor(year)2005:as.factor(target3)2     15.400320 535.783401   0.029 0.977069
as.factor(year)2006:as.factor(target3)2     -0.256063   1.434520  -0.179 0.858330
as.factor(year)2007:as.factor(target3)2     14.547807 513.713218   0.028 0.977408
as.factor(year)2008:as.factor(target3)2     -0.024221 773.825208   0.000 0.999975
as.factor(year)2009:as.factor(target3)2     14.772840 568.478301   0.026 0.979268
as.factor(year)2010:as.factor(target3)2    -15.977145 604.427438  -0.026 0.978912
as.factor(year)1995:as.factor(target3)3      0.043587   0.542708   0.080 0.935987
as.factor(year)1996:as.factor(target3)3     -2.029808   0.503716  -4.030 5.59e-05 ***
as.factor(year)1997:as.factor(target3)3     -0.675032   0.469340  -1.438 0.150360
as.factor(year)1998:as.factor(target3)3     -0.416388   0.525265  -0.793 0.427941
as.factor(year)1999:as.factor(target3)3      0.308287   0.656934   0.469 0.638869
as.factor(year)2000:as.factor(target3)3      0.667982   0.839840   0.795 0.426399
as.factor(year)2001:as.factor(target3)3     -0.606456   0.489352  -1.239 0.215233
as.factor(year)2002:as.factor(target3)3     -0.625366   0.752554  -0.831 0.405979
as.factor(year)2003:as.factor(target3)3    -15.999719 479.560110  -0.033 0.973385
as.factor(year)2004:as.factor(target3)3     -2.211894   0.885220  -2.499 0.012465 *
as.factor(year)2005:as.factor(target3)3     14.293833 530.084170   0.027 0.978487
as.factor(year)2006:as.factor(target3)3     12.329196 546.122842   0.023 0.981989
as.factor(year)2007:as.factor(target3)3     13.583674 496.337321   0.027 0.978166
as.factor(year)2008:as.factor(target3)3    -14.707864 547.671868  -0.027 0.978575
as.factor(year)2009:as.factor(target3)3     -1.157024   0.886472  -1.305 0.191825
as.factor(year)2010:as.factor(target3)3    -14.999960 604.428177  -0.025 0.980201
as.factor(year)1995:as.factor(target3)4     -0.772108   0.430082  -1.795 0.072612 .
as.factor(year)1996:as.factor(target3)4     -1.288258   0.521623  -2.470 0.013522 *
as.factor(year)1997:as.factor(target3)4     -0.301121   0.462458  -0.651 0.514962
as.factor(year)1998:as.factor(target3)4     -0.697697   0.468582  -1.489 0.136499
as.factor(year)1999:as.factor(target3)4      0.201530   0.575622   0.350 0.726258
as.factor(year)2000:as.factor(target3)4      1.068712   0.829989   1.288 0.197878
as.factor(year)2001:as.factor(target3)4     -0.930780   0.434201  -2.144 0.032060 *
as.factor(year)2002:as.factor(target3)4      1.178783   1.140207   1.034 0.301214
as.factor(year)2003:as.factor(target3)4    -13.990487 479.560927  -0.029 0.976726
as.factor(year)2004:as.factor(target3)4     -2.236939   0.843758  -2.651 0.008022 **
as.factor(year)2005:as.factor(target3)4      0.031176   0.775026   0.040 0.967913
as.factor(year)2006:as.factor(target3)4     -2.310851   1.140606  -2.026 0.042766 *
as.factor(year)2007:as.factor(target3)4      0.520952   1.197188   0.435 0.663456
as.factor(year)2008:as.factor(target3)4    -14.454256 547.671853  -0.026 0.978945
as.factor(year)2009:as.factor(target3)4     -1.332806   0.776302  -1.717 0.086004 .
as.factor(year)2010:as.factor(target3)4    -14.598765 604.428164  -0.024 0.980731
as.factor(year)1995:as.factor(target3)5     -0.247989   0.455736  -0.544 0.586338
as.factor(year)1996:as.factor(target3)5     -1.336591   0.498251  -2.683 0.007306 **
as.factor(year)1997:as.factor(target3)5     -0.148221   0.472921  -0.313 0.753965
as.factor(year)1998:as.factor(target3)5     -0.828101   0.446768  -1.854 0.063806 .
as.factor(year)1999:as.factor(target3)5      0.054619   0.572867   0.095 0.924042
as.factor(year)2000:as.factor(target3)5     14.967064 427.795357   0.035 0.972091
as.factor(year)2001:as.factor(target3)5      0.132774   0.488577   0.272 0.785810
as.factor(year)2002:as.factor(target3)5      0.193186   0.793459   0.243 0.807639
as.factor(year)2003:as.factor(target3)5    -14.868133 479.560228  -0.031 0.975267
as.factor(year)2004:as.factor(target3)5     -2.259800   0.821140  -2.752 0.005923 **
as.factor(year)2005:as.factor(target3)5      0.027365   0.717058   0.038 0.969558
as.factor(year)2006:as.factor(target3)5     -1.835868   1.161035  -1.581 0.113824
as.factor(year)2007:as.factor(target3)5      0.016452   0.964379   0.017 0.986389
as.factor(year)2008:as.factor(target3)5    -16.177766 547.671068  -0.030 0.976435
as.factor(year)2009:as.factor(target3)5     -0.767789   0.795783  -0.965 0.334633
as.factor(year)2010:as.factor(target3)5    -15.543465 604.427541  -0.026 0.979484
as.factor(year)1995:as.factor(target3)6     -0.935533   0.500992  -1.867 0.061851 .
as.factor(year)1996:as.factor(target3)6     -1.988271   0.540711  -3.677 0.000236 ***
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as.factor(year)1997:as.factor(target3)6	-0.492635	0.540943	-0.911	0.362456	
as.factor(year)1998:as.factor(target3)6	-1.313770	0.509499	-2.579	0.009922	**
as.factor(year)1999:as.factor(target3)6	-0.220538	0.640078	-0.345	0.730434	
as.factor(year)2000:as.factor(target3)6	14.405819	423.501872	0.034	0.972864	
as.factor(year)2001:as.factor(target3)6	-0.459707	0.536108	-0.857	0.391175	
as.factor(year)2002:as.factor(target3)6	0.627002	1.159764	0.541	0.588764	
as.factor(year)2003:as.factor(target3)6	-14.336103	479.560974	-0.030	0.976151	
as.factor(year)2004:as.factor(target3)6	-2.558168	0.859408	-2.977	0.002914	**
as.factor(year)2005:as.factor(target3)6	0.144496	0.901799	0.160	0.872700	
as.factor(year)2006:as.factor(target3)6	-0.915090	1.465342	-0.624	0.532307	
as.factor(year)2007:as.factor(target3)6	-0.518274	0.989471	-0.524	0.600425	
as.factor(year)2008:as.factor(target3)6	-15.711426	547.671287	-0.029	0.977114	
as.factor(year)2009:as.factor(target3)6	-1.187855	0.825958	-1.438	0.150391	
as.factor(year)2010:as.factor(target3)6	-14.565368	604.428203	-0.024	0.980775	
as.factor(year)1995:as.factor(target3)7	-0.725599	0.459077	-1.581	0.113978	
as.factor(year)1996:as.factor(target3)7	-1.567584	0.514446	-3.047	0.002310	**
as.factor(year)1997:as.factor(target3)7	0.310024	0.566086	0.548	0.583924	
as.factor(year)1998:as.factor(target3)7	-0.452462	0.525756	-0.861	0.389463	
as.factor(year)1999:as.factor(target3)7	1.635235	1.087265	1.504	0.132584	
as.factor(year)2000:as.factor(target3)7	0.600388	0.734897	0.817	0.413946	
as.factor(year)2001:as.factor(target3)7	0.273733	0.542758	0.504	0.614024	
as.factor(year)2002:as.factor(target3)7	0.996751	1.147983	0.868	0.385251	
as.factor(year)2003:as.factor(target3)7	-15.192143	479.560165	-0.032	0.974728	
as.factor(year)2004:as.factor(target3)7	13.648254	489.127434	0.028	0.977739	
as.factor(year)2005:as.factor(target3)7	14.774636	527.494607	0.028	0.977655	
as.factor(year)2006:as.factor(target3)7	-1.215032	1.272750	-0.955	0.339754	
as.factor(year)2007:as.factor(target3)7	-0.107467	0.975659	-0.110	0.912292	
as.factor(year)2008:as.factor(target3)7	-15.682341	547.671186	-0.029	0.977156	
as.factor(year)2009:as.factor(target3)7	14.722212	576.614790	0.026	0.979631	
as.factor(year)2010:as.factor(target3)7	-14.642118	604.427766	-0.024	0.980673	
as.factor(year)1995:as.factor(target3)8	-0.227288	0.454773	-0.500	0.617228	
as.factor(year)1996:as.factor(target3)8	-1.633576	0.476183	-3.431	0.000602	***
as.factor(year)1997:as.factor(target3)8	0.346179	0.512274	0.676	0.499187	
as.factor(year)1998:as.factor(target3)8	-0.267832	0.498667	-0.537	0.591201	
as.factor(year)1999:as.factor(target3)8	0.824013	0.706235	1.167	0.243304	
as.factor(year)2000:as.factor(target3)8	1.189216	0.830661	1.432	0.152244	
as.factor(year)2001:as.factor(target3)8	0.369177	0.513848	0.718	0.472477	
as.factor(year)2002:as.factor(target3)8	0.083157	0.796352	0.104	0.916834	
as.factor(year)2003:as.factor(target3)8	-14.843939	479.560148	-0.031	0.975307	
as.factor(year)2004:as.factor(target3)8	-1.320950	0.878385	-1.504	0.132623	
as.factor(year)2005:as.factor(target3)8	15.138283	524.756993	0.029	0.976986	
as.factor(year)2006:as.factor(target3)8	13.296313	548.807805	0.024	0.980671	
as.factor(year)2007:as.factor(target3)8	0.797336	1.198074	0.666	0.505721	
as.factor(year)2008:as.factor(target3)8	-14.554475	547.671400	-0.027	0.978799	
as.factor(year)2009:as.factor(target3)8	0.452393	0.969309	0.467	0.640702	
as.factor(year)2010:as.factor(target3)8	0.224196	866.021978	0.000	0.999793	
as.factor(year)1995:as.factor(target3)9	-0.738194	0.458868	-1.609	0.107676	
as.factor(year)1996:as.factor(target3)9	-2.428607	0.478688	-5.073	3.91e-07	***
as.factor(year)1997:as.factor(target3)9	0.050528	0.514748	0.098	0.921804	
as.factor(year)1998:as.factor(target3)9	0.001534	0.604231	0.003	0.997974	
as.factor(year)1999:as.factor(target3)9	0.153021	0.657032	0.233	0.815841	
as.factor(year)2000:as.factor(target3)9	-0.762423	0.545034	-1.399	0.161857	
as.factor(year)2001:as.factor(target3)9	0.493042	0.607064	0.812	0.416692	
as.factor(year)2002:as.factor(target3)9	-0.583356	0.719255	-0.811	0.417334	
as.factor(year)2003:as.factor(target3)9	-13.768304	479.560946	-0.029	0.977096	
as.factor(year)2004:as.factor(target3)9	-0.520338	1.059915	-0.491	0.623480	
as.factor(year)2005:as.factor(target3)9	-0.091854	0.733378	-0.125	0.900327	
as.factor(year)2006:as.factor(target3)9	-1.688606	1.205051	-1.401	0.161132	
as.factor(year)2007:as.factor(target3)9	-0.576507	0.885675	-0.651	0.515096	
as.factor(year)2008:as.factor(target3)9	-16.046221	547.671088	-0.029	0.976626	
as.factor(year)2009:as.factor(target3)9	0.773939	1.206463	0.641	0.521202	
as.factor(year)2010:as.factor(target3)9	-0.212765	858.080426	0.000	0.999802	
as.factor(year)1995:as.factor(target3)10	-0.833175	0.549527	-1.516	0.129477	
as.factor(year)1996:as.factor(target3)10	-3.229062	0.529049	-6.104	1.04e-09	***
as.factor(year)1997:as.factor(target3)10	-0.865029	0.538591	-1.606	0.108253	
as.factor(year)1998:as.factor(target3)10	-1.160859	0.578953	-2.005	0.044952	*
as.factor(year)1999:as.factor(target3)10	14.357677	456.063133	0.031	0.974885	
as.factor(year)2000:as.factor(target3)10	-0.736326	0.657329	-1.120	0.262638	
as.factor(year)2001:as.factor(target3)10	-0.337566	0.608827	-0.554	0.579269	

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as.factor(year)2002:as.factor(target3)10  -1.194329   0.738068  -1.618 0.105624
as.factor(year)2003:as.factor(target3)10 -15.789145 479.560227  -0.033 0.973735
as.factor(year)2004:as.factor(target3)10  -1.490731   1.009248  -1.477 0.139657
as.factor(year)2005:as.factor(target3)10  -0.262482   0.825820  -0.318 0.750603
as.factor(year)2006:as.factor(target3)10  12.549100 556.285727   0.023 0.982002
as.factor(year)2007:as.factor(target3)10  -1.620851   0.843099  -1.922 0.054544 .
as.factor(year)2008:as.factor(target3)10 -15.695752 547.671317  -0.029 0.977136
as.factor(year)2009:as.factor(target3)10  -0.432561   1.007233  -0.429 0.667592
as.factor(year)2010:as.factor(target3)10  -0.902526 866.685786  -0.001 0.999169
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 13181  on 82539  degrees of freedom
Residual deviance: 11745  on 82364  degrees of freedom
AIC: 12097

Number of Fisher Scoring iterations: 18

> Anova(res1)
Analysis of Deviance Table (Type II tests)

Response: pocatch
                                LR Chisq  Df Pr(>Chisq)
as.factor(year)                   556.29  16  < 2.2e-16 ***
as.factor(qt)                     299.89   3  < 2.2e-16 ***
as.factor(area)                    18.54   3  0.0003399 ***
as.factor(target3)                 46.88   9  4.127e-07 ***
as.factor(year):as.factor(target3)   376.49 144  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>


<2nd step>
Call:
glm(formula = lcpue ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(target3) + as.factor(gyogyoucode) + as.factor(year):as.factor(target3) +
    as.factor(qt):as.factor(target3), family = gaussian, data = temp[temp$blshrk >
    0, ])

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-5.3181  -0.6069   0.0580   0.6745   4.1366

Coefficients:
                                Estimate Std. Error t value Pr(>|t|)
(Intercept)                     1.533951   0.080739  18.999  < 2e-16 ***
as.factor(year)1995             0.348096   0.060767   5.728 1.02e-08 ***
as.factor(year)1996             0.762713   0.059991  12.714  < 2e-16 ***
as.factor(year)1997             1.035939   0.062643  16.537  < 2e-16 ***
as.factor(year)1998             1.125144   0.061566  18.275  < 2e-16 ***
as.factor(year)1999             1.173369   0.062004  18.924  < 2e-16 ***
as.factor(year)2000             1.330391   0.060539  21.976  < 2e-16 ***
as.factor(year)2001             1.307698   0.061223  21.360  < 2e-16 ***
as.factor(year)2002             1.240341   0.064139  19.338  < 2e-16 ***
as.factor(year)2003             1.303110   0.064938  20.067  < 2e-16 ***
as.factor(year)2004             1.469777   0.065721  22.364  < 2e-16 ***
as.factor(year)2005             1.669727   0.068053  24.536  < 2e-16 ***
as.factor(year)2006             1.661668   0.067696  24.546  < 2e-16 ***
as.factor(year)2007             1.468973   0.064979  22.607  < 2e-16 ***
as.factor(year)2008             1.137478   0.069517  16.363  < 2e-16 ***
as.factor(year)2009             1.587736   0.072684  21.844  < 2e-16 ***
as.factor(year)2010             1.391025   0.074383  18.701  < 2e-16 ***
as.factor(qt)2                  1.027283   0.073138  14.046  < 2e-16 ***
as.factor(qt)3                  0.492540   0.071917   6.849 7.51e-12 ***
as.factor(qt)4                 -0.774601   0.078554  -9.861  < 2e-16 ***
as.factor(area)2                0.059311   0.021313   2.783 0.005389 **
as.factor(area)3               -1.014238   0.011660 -86.986  < 2e-16 ***
as.factor(area)4               -1.590475   0.039144 -40.631  < 2e-16 ***
as.factor(target3)2             0.203989   0.104615   1.950 0.051191 .
as.factor(target3)3             0.372488   0.100847   3.694 0.000221 ***
as.factor(target3)4             0.835107   0.096399   8.663  < 2e-16 ***
```

```
as.factor(target3)5                          0.966564   0.095099  10.164  < 2e-16 ***
as.factor(target3)6                          1.142867   0.094467  12.098  < 2e-16 ***
as.factor(target3)7                          1.164431   0.094351  12.342  < 2e-16 ***
as.factor(target3)8                          1.193212   0.093919  12.705  < 2e-16 ***
as.factor(target3)9                          1.202068   0.093066  12.916  < 2e-16 ***
as.factor(target3)10                         1.156433   0.091706  12.610  < 2e-16 ***
as.factor(gyogyoucode)2                     -0.071124   0.010625  -6.694 2.19e-11 ***
as.factor(year)1995:as.factor(target3)2      0.124828   0.085347   1.463 0.143579
as.factor(year)1996:as.factor(target3)2     -0.277830   0.084940  -3.271 0.001072 **
as.factor(year)1997:as.factor(target3)2     -0.254676   0.087462  -2.912 0.003594 **
as.factor(year)1998:as.factor(target3)2     -0.370126   0.086687  -4.270 1.96e-05 ***
as.factor(year)1999:as.factor(target3)2     -0.216609   0.086757  -2.497 0.012537 *
as.factor(year)2000:as.factor(target3)2     -0.229146   0.084568  -2.710 0.006738 **
as.factor(year)2001:as.factor(target3)2     -0.343136   0.086001  -3.990 6.62e-05 ***
as.factor(year)2002:as.factor(target3)2     -0.387953   0.089053  -4.356 1.32e-05 ***
as.factor(year)2003:as.factor(target3)2     -0.046332   0.090715  -0.511 0.609531
as.factor(year)2004:as.factor(target3)2     -0.175946   0.092175  -1.909 0.056289 .
as.factor(year)2005:as.factor(target3)2      0.006134   0.095450   0.064 0.948759
as.factor(year)2006:as.factor(target3)2      0.048585   0.097441   0.499 0.618059
as.factor(year)2007:as.factor(target3)2     -0.427507   0.092019  -4.646 3.39e-06 ***
as.factor(year)2008:as.factor(target3)2     -0.027117   0.097144  -0.279 0.780139
as.factor(year)2009:as.factor(target3)2     -0.249388   0.100961  -2.470 0.013508 *
as.factor(year)2010:as.factor(target3)2     -0.153031   0.105660  -1.448 0.147526
as.factor(year)1995:as.factor(target3)3     -0.039368   0.086101  -0.457 0.647506
as.factor(year)1996:as.factor(target3)3     -0.347912   0.087091  -3.995 6.48e-05 ***
as.factor(year)1997:as.factor(target3)3     -0.673670   0.088959  -7.573 3.69e-14 ***
as.factor(year)1998:as.factor(target3)3     -0.604911   0.087257  -6.933 4.16e-12 ***
as.factor(year)1999:as.factor(target3)3     -0.529974   0.087670  -6.045 1.50e-09 ***
as.factor(year)2000:as.factor(target3)3     -0.569602   0.085447  -6.666 2.64e-11 ***
as.factor(year)2001:as.factor(target3)3     -0.673690   0.086094  -7.825 5.13e-15 ***
as.factor(year)2002:as.factor(target3)3     -0.526192   0.089948  -5.850 4.94e-09 ***
as.factor(year)2003:as.factor(target3)3     -0.344845   0.091339  -3.775 0.000160 ***
as.factor(year)2004:as.factor(target3)3     -0.558982   0.092435  -6.047 1.48e-09 ***
as.factor(year)2005:as.factor(target3)3     -0.490604   0.095922  -5.115 3.15e-07 ***
as.factor(year)2006:as.factor(target3)3     -0.457732   0.096635  -4.737 2.18e-06 ***
as.factor(year)2007:as.factor(target3)3     -0.898612   0.091792  -9.790  < 2e-16 ***
as.factor(year)2008:as.factor(target3)3     -0.490725   0.097747  -5.020 5.17e-07 ***
as.factor(year)2009:as.factor(target3)3     -0.618665   0.101782  -6.078 1.22e-09 ***
as.factor(year)2010:as.factor(target3)3     -0.798903   0.104201  -7.667 1.78e-14 ***
as.factor(year)1995:as.factor(target3)4     -0.101921   0.085645  -1.190 0.234033
as.factor(year)1996:as.factor(target3)4     -0.668554   0.085414  -7.827 5.05e-15 ***
as.factor(year)1997:as.factor(target3)4     -0.769753   0.087822  -8.765  < 2e-16 ***
as.factor(year)1998:as.factor(target3)4     -0.774009   0.086837  -8.913  < 2e-16 ***
as.factor(year)1999:as.factor(target3)4     -0.849651   0.085619  -9.924  < 2e-16 ***
as.factor(year)2000:as.factor(target3)4     -0.885863   0.084302 -10.508  < 2e-16 ***
as.factor(year)2001:as.factor(target3)4     -0.804281   0.085548  -9.402  < 2e-16 ***
as.factor(year)2002:as.factor(target3)4     -0.620377   0.089247  -6.951 3.65e-12 ***
as.factor(year)2003:as.factor(target3)4     -0.603685   0.090465  -6.673 2.52e-11 ***
as.factor(year)2004:as.factor(target3)4     -0.885332   0.091766  -9.648  < 2e-16 ***
as.factor(year)2005:as.factor(target3)4     -0.950497   0.095009 -10.004  < 2e-16 ***
as.factor(year)2006:as.factor(target3)4     -0.845444   0.095307  -8.871  < 2e-16 ***
as.factor(year)2007:as.factor(target3)4     -1.287789   0.090975 -14.155  < 2e-16 ***
as.factor(year)2008:as.factor(target3)4     -0.840986   0.096768  -8.691  < 2e-16 ***
as.factor(year)2009:as.factor(target3)4     -1.160096   0.100915 -11.496  < 2e-16 ***
as.factor(year)2010:as.factor(target3)4     -1.217065   0.105368 -11.551  < 2e-16 ***
as.factor(year)1995:as.factor(target3)5     -0.144566   0.085306  -1.695 0.090142 .
as.factor(year)1996:as.factor(target3)5     -0.705992   0.084777  -8.328  < 2e-16 ***
as.factor(year)1997:as.factor(target3)5     -0.665469   0.087725  -7.586 3.34e-14 ***
as.factor(year)1998:as.factor(target3)5     -0.888380   0.086506 -10.270  < 2e-16 ***
as.factor(year)1999:as.factor(target3)5     -0.939959   0.088649 -10.603  < 2e-16 ***
as.factor(year)2000:as.factor(target3)5     -1.104154   0.084490 -13.068  < 2e-16 ***
as.factor(year)2001:as.factor(target3)5     -0.992463   0.085308 -11.634  < 2e-16 ***
as.factor(year)2002:as.factor(target3)5     -0.812167   0.089088  -9.116  < 2e-16 ***
as.factor(year)2003:as.factor(target3)5     -0.917251   0.090472 -10.139  < 2e-16 ***
as.factor(year)2004:as.factor(target3)5     -1.023719   0.091708 -11.163  < 2e-16 ***
as.factor(year)2005:as.factor(target3)5     -1.257233   0.094646 -13.284  < 2e-16 ***
as.factor(year)2006:as.factor(target3)5     -1.532266   0.096181 -15.931  < 2e-16 ***
as.factor(year)2007:as.factor(target3)5     -1.613967   0.091191 -17.699  < 2e-16 ***
as.factor(year)2008:as.factor(target3)5     -1.420234   0.097451 -14.574  < 2e-16 ***
as.factor(year)2009:as.factor(target3)5     -1.276553   0.101283 -12.604  < 2e-16 ***
as.factor(year)2010:as.factor(target3)5     -1.182897   0.104158 -11.357  < 2e-16 ***
as.factor(year)1995:as.factor(target3)6     -0.137413   0.085344  -1.610 0.107379
as.factor(year)1996:as.factor(target3)6     -0.797489   0.085084  -9.373  < 2e-16 ***
as.factor(year)1997:as.factor(target3)6     -0.699272   0.087780  -7.966 1.66e-15 ***
as.factor(year)1998:as.factor(target3)6     -0.939103   0.086739 -10.827  < 2e-16 ***
as.factor(year)1999:as.factor(target3)6     -1.083541   0.086833 -12.478  < 2e-16 ***
as.factor(year)2000:as.factor(target3)6     -1.198651   0.084375 -14.206  < 2e-16 ***
as.factor(year)2001:as.factor(target3)6     -1.110325   0.085241 -13.026  < 2e-16 ***
```

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as.factor(year)2002:as.factor(target3)6  -0.985910   0.089193 -11.054  < 2e-16 ***
as.factor(year)2003:as.factor(target3)6  -0.954228   0.090612 -10.531  < 2e-16 ***
as.factor(year)2004:as.factor(target3)6  -1.190718   0.092011 -12.941  < 2e-16 ***
as.factor(year)2005:as.factor(target3)6  -1.460737   0.095035 -15.370  < 2e-16 ***
as.factor(year)2006:as.factor(target3)6  -1.409479   0.096520 -14.603  < 2e-16 ***
as.factor(year)2007:as.factor(target3)6  -1.574506   0.091225 -17.260  < 2e-16 ***
as.factor(year)2008:as.factor(target3)6  -1.409227   0.097077 -14.517  < 2e-16 ***
as.factor(year)2009:as.factor(target3)6  -1.413536   0.100728 -14.033  < 2e-16 ***
as.factor(year)2010:as.factor(target3)6  -1.407238   0.104736 -13.436  < 2e-16 ***
as.factor(year)1995:as.factor(target3)7  -0.195156   0.085477  -2.283 0.022424 *
as.factor(year)1996:as.factor(target3)7  -0.731065   0.085130  -8.588  < 2e-16 ***
as.factor(year)1997:as.factor(target3)7  -0.879793   0.087712 -10.030  < 2e-16 ***
as.factor(year)1998:as.factor(target3)7  -0.936390   0.086719 -10.798  < 2e-16 ***
as.factor(year)1999:as.factor(target3)7  -1.161126   0.086950 -13.354  < 2e-16 ***
as.factor(year)2000:as.factor(target3)7  -1.178239   0.084711 -13.909  < 2e-16 ***
as.factor(year)2001:as.factor(target3)7  -1.154826   0.085631 -13.486  < 2e-16 ***
as.factor(year)2002:as.factor(target3)7  -1.118960   0.089377 -12.520  < 2e-16 ***
as.factor(year)2003:as.factor(target3)7  -0.931287   0.091113 -10.221  < 2e-16 ***
as.factor(year)2004:as.factor(target3)7  -1.190025   0.091903 -12.949  < 2e-16 ***
as.factor(year)2005:as.factor(target3)7  -1.619244   0.095384 -16.976  < 2e-16 ***
as.factor(year)2006:as.factor(target3)7  -1.599209   0.096711 -16.536  < 2e-16 ***
as.factor(year)2007:as.factor(target3)7  -1.619370   0.091517 -17.695  < 2e-16 ***
as.factor(year)2008:as.factor(target3)7  -1.526360   0.097761 -15.613  < 2e-16 ***
as.factor(year)2009:as.factor(target3)7  -1.772966   0.101605 -17.450  < 2e-16 ***
as.factor(year)2010:as.factor(target3)7  -1.432864   0.104416 -13.723  < 2e-16 ***
as.factor(year)1995:as.factor(target3)8  -0.307618   0.085608  -3.593 0.000327 ***
as.factor(year)1996:as.factor(target3)8  -0.699775   0.085285  -8.205 2.34e-16 ***
as.factor(year)1997:as.factor(target3)8  -0.927934   0.087964 -10.549  < 2e-16 ***
as.factor(year)1998:as.factor(target3)8  -1.071782   0.086763 -12.353  < 2e-16 ***
as.factor(year)1999:as.factor(target3)8  -1.181366   0.086712 -13.624  < 2e-16 ***
as.factor(year)2000:as.factor(target3)8  -1.238767   0.084640 -14.636  < 2e-16 ***
as.factor(year)2001:as.factor(target3)8  -1.133797   0.085486 -13.263  < 2e-16 ***
as.factor(year)2002:as.factor(target3)8  -1.131123   0.089442 -12.647  < 2e-16 ***
as.factor(year)2003:as.factor(target3)8  -0.987736   0.091266 -10.823  < 2e-16 ***
as.factor(year)2004:as.factor(target3)8  -1.338778   0.092221 -14.517  < 2e-16 ***
as.factor(year)2005:as.factor(target3)8  -1.685997   0.095381 -17.676  < 2e-16 ***
as.factor(year)2006:as.factor(target3)8  -1.922443   0.096429 -19.936  < 2e-16 ***
as.factor(year)2007:as.factor(target3)8  -1.730806   0.092234 -18.765  < 2e-16 ***
as.factor(year)2008:as.factor(target3)8  -1.527493   0.097522 -15.663  < 2e-16 ***
as.factor(year)2009:as.factor(target3)8  -1.617715   0.102038 -15.854  < 2e-16 ***
as.factor(year)2010:as.factor(target3)8  -1.445727   0.105373 -13.720  < 2e-16 ***
as.factor(year)1995:as.factor(target3)9  -0.337906   0.085331  -3.960 7.50e-05 ***
as.factor(year)1996:as.factor(target3)9  -0.876227   0.085443 -10.255  < 2e-16 ***
as.factor(year)1997:as.factor(target3)9  -0.986346   0.087739 -11.242  < 2e-16 ***
as.factor(year)1998:as.factor(target3)9  -1.150553   0.086317 -13.329  < 2e-16 ***
as.factor(year)1999:as.factor(target3)9  -1.218336   0.087104 -13.987  < 2e-16 ***
as.factor(year)2000:as.factor(target3)9  -1.177191   0.084266 -13.970  < 2e-16 ***
as.factor(year)2001:as.factor(target3)9  -1.152421   0.085412 -13.492  < 2e-16 ***
as.factor(year)2002:as.factor(target3)9  -1.229019   0.089164 -13.784  < 2e-16 ***
as.factor(year)2003:as.factor(target3)9  -1.136632   0.090978 -12.493  < 2e-16 ***
as.factor(year)2004:as.factor(target3)9  -1.342129   0.091631 -14.647  < 2e-16 ***
as.factor(year)2005:as.factor(target3)9  -1.936360   0.095558 -20.264  < 2e-16 ***
as.factor(year)2006:as.factor(target3)9  -2.061629   0.095949 -21.487  < 2e-16 ***
as.factor(year)2007:as.factor(target3)9  -1.800110   0.091507 -19.672  < 2e-16 ***
as.factor(year)2008:as.factor(target3)9  -1.676069   0.097367 -17.214  < 2e-16 ***
as.factor(year)2009:as.factor(target3)9  -1.874578   0.101062 -18.549  < 2e-16 ***
as.factor(year)2010:as.factor(target3)9  -0.955238   0.104188  -9.168  < 2e-16 ***
as.factor(year)1995:as.factor(target3)10 -0.304936   0.085313  -3.574 0.000351 ***
as.factor(year)1996:as.factor(target3)10 -0.949720   0.085568 -11.099  < 2e-16 ***
as.factor(year)1997:as.factor(target3)10 -1.108320   0.087768 -12.628  < 2e-16 ***
as.factor(year)1998:as.factor(target3)10 -1.213118   0.086699 -13.992  < 2e-16 ***
as.factor(year)1999:as.factor(target3)10 -1.132309   0.086866 -13.035  < 2e-16 ***
as.factor(year)2000:as.factor(target3)10 -1.134905   0.084755 -13.390  < 2e-16 ***
as.factor(year)2001:as.factor(target3)10 -1.145225   0.085192 -13.443  < 2e-16 ***
as.factor(year)2002:as.factor(target3)10 -1.163104   0.090061 -12.915  < 2e-16 ***
as.factor(year)2003:as.factor(target3)10 -1.292012   0.090912 -14.212  < 2e-16 ***
as.factor(year)2004:as.factor(target3)10 -1.255874   0.092744 -13.541  < 2e-16 ***
as.factor(year)2005:as.factor(target3)10 -1.901553   0.095638 -19.883  < 2e-16 ***
as.factor(year)2006:as.factor(target3)10 -2.149589   0.097559 -22.034  < 2e-16 ***
as.factor(year)2007:as.factor(target3)10 -1.847185   0.091594 -20.167  < 2e-16 ***
as.factor(year)2008:as.factor(target3)10 -1.155627   0.097354 -11.870  < 2e-16 ***
as.factor(year)2009:as.factor(target3)10 -1.154434   0.101678 -11.354  < 2e-16 ***
as.factor(year)2010:as.factor(target3)10 -0.385271   0.104979  -3.670 0.000243 ***
as.factor(qt)2:as.factor(target3)2       -0.141947   0.092904  -1.528 0.126546
as.factor(qt)3:as.factor(target3)2        0.041741   0.091744   0.455 0.649135
as.factor(qt)4:as.factor(target3)2        0.231798   0.100321   2.311 0.020859 *
as.factor(qt)2:as.factor(target3)3       -0.213745   0.086431  -2.473 0.013400 *
as.factor(qt)3:as.factor(target3)3        0.233543   0.085989   2.716 0.006610 **
```

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as.factor(qt)4:as.factor(target3)3       0.228765   0.094352   2.425 0.015328 *
as.factor(qt)2:as.factor(target3)4      -0.671194   0.081709  -8.214  < 2e-16 ***
as.factor(qt)3:as.factor(target3)4      -0.107026   0.081928  -1.306 0.191440
as.factor(qt)4:as.factor(target3)4       0.101247   0.089179   1.135 0.256244
as.factor(qt)2:as.factor(target3)5      -0.745362   0.080101  -9.305  < 2e-16 ***
as.factor(qt)3:as.factor(target3)5      -0.068930   0.080599  -0.855 0.392427
as.factor(qt)4:as.factor(target3)5       0.254707   0.087157   2.922 0.003475 **
as.factor(qt)2:as.factor(target3)6      -0.914490   0.079165 -11.552  < 2e-16 ***
as.factor(qt)3:as.factor(target3)6      -0.285662   0.080990  -3.527 0.000420 ***
as.factor(qt)4:as.factor(target3)6       0.242894   0.086055   2.823 0.004766 **
as.factor(qt)2:as.factor(target3)7      -0.947704   0.079005 -11.995  < 2e-16 ***
as.factor(qt)3:as.factor(target3)7      -0.277830   0.080650  -3.445 0.000572 ***
as.factor(qt)4:as.factor(target3)7       0.347603   0.085653   4.058 4.95e-05 ***
as.factor(qt)2:as.factor(target3)8      -1.039021   0.078687 -13.204  < 2e-16 ***
as.factor(qt)3:as.factor(target3)8      -0.403797   0.080272  -5.030 4.91e-07 ***
as.factor(qt)4:as.factor(target3)8       0.494618   0.085612   5.777 7.61e-09 ***
as.factor(qt)2:as.factor(target3)9      -1.036210   0.078699 -13.167  < 2e-16 ***
as.factor(qt)3:as.factor(target3)9      -0.378746   0.080154  -4.725 2.30e-06 ***
as.factor(qt)4:as.factor(target3)9       0.634363   0.085800   7.394 1.44e-13 ***
as.factor(qt)2:as.factor(target3)10     -1.050597   0.079508 -13.214  < 2e-16 ***
as.factor(qt)3:as.factor(target3)10     -0.430294   0.079299  -5.426 5.77e-08 ***
as.factor(qt)4:as.factor(target3)10      0.723303   0.085724   8.438  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

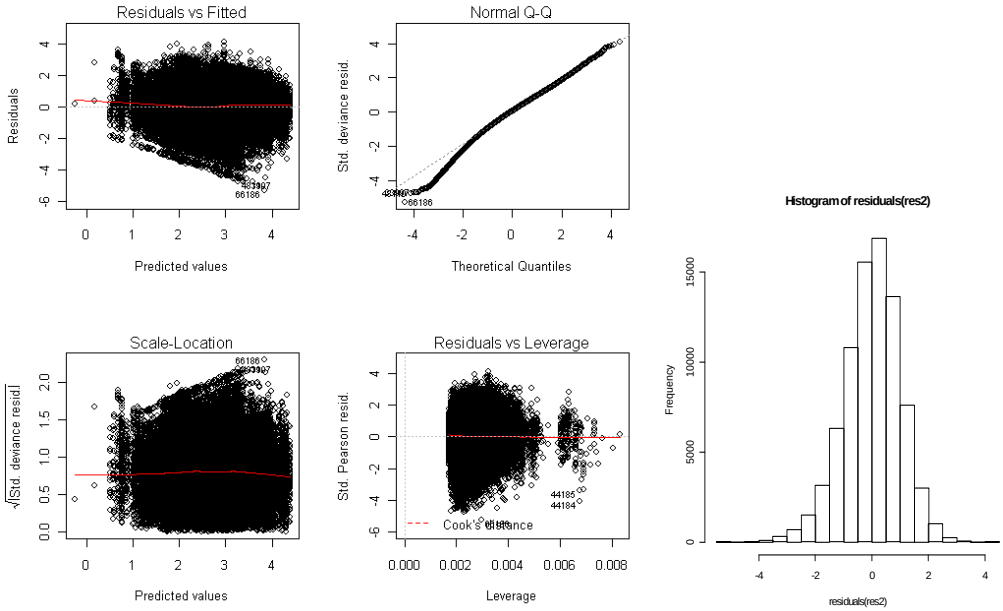
(Dispersion parameter for gaussian family taken to be 1.0262)

    Null deviance: 118987  on 81262  degrees of freedom
Residual deviance:  83183  on 81059  degrees of freedom
AIC: 232922

Number of Fisher Scoring iterations: 2

> Anova(res2)
Analysis of Deviance Table (Type II tests)

Response: lcpue
                                LR Chisq  Df Pr(>Chisq)
as.factor(year)                   1966.6  16  < 2.2e-16 ***
as.factor(qt)                     4832.5   3  < 2.2e-16 ***
as.factor(area)                   8502.3   3  < 2.2e-16 ***
as.factor(target3)                1391.7   9  < 2.2e-16 ***
as.factor(gyogyoucode)              44.8   1  2.173e-11 ***
as.factor(year):as.factor(target3)  3397.9 144  < 2.2e-16 ***
as.factor(qt):as.factor(target3)    2704.4  27  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> >
```



II-(2) delta-lognormal model with log link function

Call:

```
glm(formula = cpue ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(target3) + as.factor(gyogyoucode) + as.factor(year):as.factor(target3) +
    as.factor(qt):as.factor(target3), family = gaussian(link = "log"),
    data = data[data$blshrk > 0, ])
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-98.92	-14.83	-4.42	6.35	1152.58

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	1.827325	0.192226	9.506	< 2e-16	***
as.factor(year)1995	-0.038886	0.169509	-0.229	0.818555	
as.factor(year)1996	0.534086	0.132598	4.028	5.63e-05	***
as.factor(year)1997	1.147181	0.122651	9.353	< 2e-16	***
as.factor(year)1998	1.184185	0.122751	9.647	< 2e-16	***
as.factor(year)1999	1.306314	0.121408	10.760	< 2e-16	***
as.factor(year)2000	1.037978	0.121955	8.511	< 2e-16	***
as.factor(year)2001	1.203432	0.121061	9.941	< 2e-16	***
as.factor(year)2002	1.221852	0.121378	10.066	< 2e-16	***
as.factor(year)2003	1.059633	0.122339	8.661	< 2e-16	***
as.factor(year)2004	1.176338	0.121542	9.678	< 2e-16	***
as.factor(year)2005	1.411988	0.120808	11.688	< 2e-16	***
as.factor(year)2006	1.349881	0.121083	11.148	< 2e-16	***
as.factor(year)2007	1.291858	0.120996	10.677	< 2e-16	***
as.factor(year)2008	0.971548	0.124239	7.820	5.35e-15	***
as.factor(year)2009	1.419891	0.121212	11.714	< 2e-16	***
as.factor(year)2010	1.129853	0.123607	9.141	< 2e-16	***
as.factor(qt)2	1.206189	0.153041	7.881	3.28e-15	***
as.factor(qt)3	0.968470	0.153070	6.327	2.51e-10	***
as.factor(qt)4	-0.570083	0.209882	-2.716	0.006605	**
as.factor(area)2	0.128258	0.013913	9.219	< 2e-16	***
as.factor(area)3	-1.318889	0.037468	-35.200	< 2e-16	***
as.factor(area)4	-2.016485	0.274314	-7.351	1.99e-13	***
as.factor(target3)2	-0.017674	0.249270	-0.071	0.943477	
as.factor(target3)3	0.020762	0.247439	0.084	0.933131	
as.factor(target3)4	0.409494	0.234021	1.750	0.080154	.
as.factor(target3)5	0.663773	0.229151	2.897	0.003773	**

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as.factor(target3)6	0.805522	0.223056	3.611	0.000305	***
as.factor(target3)7	0.801899	0.236077	3.397	0.000682	***
as.factor(target3)8	0.949418	0.234904	4.042	5.31e-05	***
as.factor(target3)9	0.977159	0.222321	4.395	1.11e-05	***
as.factor(target3)10	0.973992	0.219602	4.435	9.21e-06	***
as.factor(gyogyoucode)2	-0.073861	0.011052	-6.683	2.36e-11	***
as.factor(year)1995:as.factor(target3)2	0.183269	0.228566	0.802	0.422659	
as.factor(year)1996:as.factor(target3)2	-0.191032	0.190606	-1.002	0.316233	
as.factor(year)1997:as.factor(target3)2	-0.108210	0.168901	-0.641	0.521740	
as.factor(year)1998:as.factor(target3)2	-0.162761	0.169727	-0.959	0.337584	
as.factor(year)1999:as.factor(target3)2	-0.099410	0.167176	-0.595	0.552086	
as.factor(year)2000:as.factor(target3)2	-0.025189	0.166789	-0.151	0.879957	
as.factor(year)2001:as.factor(target3)2	-0.014532	0.165476	-0.088	0.930021	
as.factor(year)2002:as.factor(target3)2	-0.058755	0.166858	-0.352	0.724746	
as.factor(year)2003:as.factor(target3)2	0.176815	0.166506	1.062	0.288280	
as.factor(year)2004:as.factor(target3)2	0.078686	0.165924	0.474	0.635336	
as.factor(year)2005:as.factor(target3)2	0.251148	0.164129	1.530	0.125974	
as.factor(year)2006:as.factor(target3)2	0.250120	0.164607	1.519	0.128642	
as.factor(year)2007:as.factor(target3)2	-0.173631	0.166426	-1.043	0.296815	
as.factor(year)2008:as.factor(target3)2	0.178582	0.168934	1.057	0.290464	
as.factor(year)2009:as.factor(target3)2	-0.015954	0.165506	-0.096	0.923205	
as.factor(year)2010:as.factor(target3)2	0.211681	0.168073	1.259	0.207870	
as.factor(year)1995:as.factor(target3)3	0.206100	0.243458	0.847	0.397248	
as.factor(year)1996:as.factor(target3)3	-0.079561	0.205731	-0.387	0.698961	
as.factor(year)1997:as.factor(target3)3	-0.404345	0.191730	-2.109	0.034954	*
as.factor(year)1998:as.factor(target3)3	-0.277845	0.189061	-1.470	0.141672	
as.factor(year)1999:as.factor(target3)3	-0.109929	0.184576	-0.596	0.551462	
as.factor(year)2000:as.factor(target3)3	-0.066053	0.184389	-0.358	0.720176	
as.factor(year)2001:as.factor(target3)3	-0.100490	0.183196	-0.549	0.583324	
as.factor(year)2002:as.factor(target3)3	-0.031721	0.184202	-0.172	0.863276	
as.factor(year)2003:as.factor(target3)3	0.242470	0.183416	1.322	0.186182	
as.factor(year)2004:as.factor(target3)3	-0.028394	0.184029	-0.154	0.877381	
as.factor(year)2005:as.factor(target3)3	0.153216	0.181671	0.843	0.399026	
as.factor(year)2006:as.factor(target3)3	0.172625	0.182119	0.948	0.343197	
as.factor(year)2007:as.factor(target3)3	-0.322087	0.184965	-1.741	0.081628	.
as.factor(year)2008:as.factor(target3)3	-0.067715	0.187961	-0.360	0.718653	
as.factor(year)2009:as.factor(target3)3	-0.077601	0.183406	-0.423	0.672217	
as.factor(year)2010:as.factor(target3)3	0.080571	0.186697	0.432	0.666062	
as.factor(year)1995:as.factor(target3)4	0.237251	0.240320	0.987	0.323534	
as.factor(year)1996:as.factor(target3)4	-0.362544	0.205020	-1.768	0.077009	.
as.factor(year)1997:as.factor(target3)4	-0.494189	0.186573	-2.649	0.008080	**
as.factor(year)1998:as.factor(target3)4	-0.499651	0.186059	-2.685	0.007245	**
as.factor(year)1999:as.factor(target3)4	-0.511400	0.180978	-2.826	0.004718	**
as.factor(year)2000:as.factor(target3)4	-0.234261	0.179051	-1.308	0.190758	
as.factor(year)2001:as.factor(target3)4	-0.198011	0.176699	-1.121	0.262457	
as.factor(year)2002:as.factor(target3)4	-0.042189	0.177608	-0.238	0.812241	
as.factor(year)2003:as.factor(target3)4	0.047856	0.177541	0.270	0.787509	
as.factor(year)2004:as.factor(target3)4	-0.278277	0.179987	-1.546	0.122084	
as.factor(year)2005:as.factor(target3)4	-0.238217	0.176331	-1.351	0.176710	
as.factor(year)2006:as.factor(target3)4	0.064247	0.175693	0.366	0.714607	
as.factor(year)2007:as.factor(target3)4	-0.575276	0.182646	-3.150	0.001635	**
as.factor(year)2008:as.factor(target3)4	-0.285861	0.184594	-1.549	0.121483	
as.factor(year)2009:as.factor(target3)4	-0.771182	0.186331	-4.139	3.50e-05	***
as.factor(year)2010:as.factor(target3)4	-0.483000	0.197392	-2.447	0.014411	*
as.factor(year)1995:as.factor(target3)5	0.064957	0.238837	0.272	0.785644	
as.factor(year)1996:as.factor(target3)5	-0.504320	0.206116	-2.447	0.014416	*
as.factor(year)1997:as.factor(target3)5	-0.571534	0.181504	-3.149	0.001640	**
as.factor(year)1998:as.factor(target3)5	-0.881406	0.186081	-4.737	2.18e-06	***
as.factor(year)1999:as.factor(target3)5	-0.795255	0.180281	-4.411	1.03e-05	***
as.factor(year)2000:as.factor(target3)5	-0.472118	0.175278	-2.694	0.007071	**
as.factor(year)2001:as.factor(target3)5	-0.490296	0.172842	-2.837	0.004560	**
as.factor(year)2002:as.factor(target3)5	-0.353676	0.173375	-2.040	0.041359	*
as.factor(year)2003:as.factor(target3)5	-0.309006	0.175001	-1.766	0.077443	.
as.factor(year)2004:as.factor(target3)5	-0.413192	0.174999	-2.361	0.018223	*
as.factor(year)2005:as.factor(target3)5	-0.524477	0.173724	-3.019	0.002537	**
as.factor(year)2006:as.factor(target3)5	-0.821844	0.184000	-4.467	7.96e-06	***
as.factor(year)2007:as.factor(target3)5	-1.111317	0.193726	-5.737	9.70e-09	***
as.factor(year)2008:as.factor(target3)5	-0.883299	0.202375	-4.365	1.27e-05	***

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as.factor(year)2009:as.factor(target3)5  -0.725445   0.179963  -4.031 5.56e-05 ***
as.factor(year)2010:as.factor(target3)5  -0.577396   0.188423  -3.064 0.002182 **
as.factor(year)1995:as.factor(target3)6   0.142032   0.228935   0.620 0.534993
as.factor(year)1996:as.factor(target3)6  -0.531573   0.202949  -2.619 0.008814 **
as.factor(year)1997:as.factor(target3)6  -0.657431   0.176479  -3.725 0.000195 ***
as.factor(year)1998:as.factor(target3)6  -0.837698   0.179592  -4.664 3.10e-06 ***
as.factor(year)1999:as.factor(target3)6  -0.897690   0.174994  -5.130 2.91e-07 ***
as.factor(year)2000:as.factor(target3)6  -0.526671   0.170303  -3.093 0.001985 **
as.factor(year)2001:as.factor(target3)6  -0.630676   0.168418  -3.745 0.000181 ***
as.factor(year)2002:as.factor(target3)6  -0.553480   0.170244  -3.251 0.001150 **
as.factor(year)2003:as.factor(target3)6  -0.445980   0.170385  -2.617 0.008859 **
as.factor(year)2004:as.factor(target3)6  -0.601429   0.174245  -3.452 0.000557 ***
as.factor(year)2005:as.factor(target3)6  -0.899804   0.174104  -5.168 2.37e-07 ***
as.factor(year)2006:as.factor(target3)6  -0.631645   0.174586  -3.618 0.000297 ***
as.factor(year)2007:as.factor(target3)6  -0.987336   0.182319  -5.415 6.13e-08 ***
as.factor(year)2008:as.factor(target3)6  -0.909668   0.195294  -4.658 3.20e-06 ***
as.factor(year)2009:as.factor(target3)6  -0.423501   0.167183  -2.533 0.011306 *
as.factor(year)2010:as.factor(target3)6  -0.659789   0.185657  -3.554 0.000380 ***
as.factor(year)1995:as.factor(target3)7   0.123657   0.245030   0.505 0.613800
as.factor(year)1996:as.factor(target3)7  -0.364112   0.210344  -1.731 0.083450 .
as.factor(year)1997:as.factor(target3)7  -0.748390   0.196877  -3.801 0.000144 ***
as.factor(year)1998:as.factor(target3)7  -0.799855   0.196355  -4.074 4.64e-05 ***
as.factor(year)1999:as.factor(target3)7  -0.901466   0.193623  -4.656 3.23e-06 ***
as.factor(year)2000:as.factor(target3)7  -0.542135   0.187715  -2.888 0.003877 **
as.factor(year)2001:as.factor(target3)7  -0.619500   0.186502  -3.322 0.000895 ***
as.factor(year)2002:as.factor(target3)7  -0.581529   0.189226  -3.073 0.002118 **
as.factor(year)2003:as.factor(target3)7  -0.293014   0.186964  -1.567 0.117067
as.factor(year)2004:as.factor(target3)7  -0.627961   0.190711  -3.293 0.000993 ***
as.factor(year)2005:as.factor(target3)7  -0.851902   0.191124  -4.457 8.31e-06 ***
as.factor(year)2006:as.factor(target3)7  -0.882981   0.197562  -4.469 7.85e-06 ***
as.factor(year)2007:as.factor(target3)7  -1.060558   0.200602  -5.287 1.25e-07 ***
as.factor(year)2008:as.factor(target3)7  -0.800019   0.209041  -3.827 0.000130 ***
as.factor(year)2009:as.factor(target3)7  -1.261319   0.210218  -6.000 1.98e-09 ***
as.factor(year)2010:as.factor(target3)7  -0.569548   0.199067  -2.861 0.004223 **
as.factor(year)1995:as.factor(target3)8   0.084541   0.242429   0.349 0.727296
as.factor(year)1996:as.factor(target3)8  -0.420451   0.210757  -1.995 0.046051 *
as.factor(year)1997:as.factor(target3)8  -0.957431   0.202117  -4.737 2.17e-06 ***
as.factor(year)1998:as.factor(target3)8  -0.953406   0.200832  -4.747 2.07e-06 ***
as.factor(year)1999:as.factor(target3)8  -0.961032   0.191451  -5.020 5.19e-07 ***
as.factor(year)2000:as.factor(target3)8  -0.732482   0.191223  -3.831 0.000128 ***
as.factor(year)2001:as.factor(target3)8  -0.620840   0.185454  -3.348 0.000815 ***
as.factor(year)2002:as.factor(target3)8  -0.590994   0.187742  -3.148 0.001645 **
as.factor(year)2003:as.factor(target3)8  -0.493922   0.188369  -2.622 0.008741 **
as.factor(year)2004:as.factor(target3)8  -0.871727   0.194443  -4.483 7.36e-06 ***
as.factor(year)2005:as.factor(target3)8  -1.127164   0.198294  -5.684 1.32e-08 ***
as.factor(year)2006:as.factor(target3)8  -1.277339   0.208619  -6.123 9.23e-10 ***
as.factor(year)2007:as.factor(target3)8  -1.151965   0.200031  -5.759 8.50e-09 ***
as.factor(year)2008:as.factor(target3)8  -0.907266   0.206746  -4.388 1.14e-05 ***
as.factor(year)2009:as.factor(target3)8  -1.200099   0.201215  -5.964 2.47e-09 ***
as.factor(year)2010:as.factor(target3)8  -0.873967   0.206001  -4.243 2.21e-05 ***
as.factor(year)1995:as.factor(target3)9   0.065965   0.226827   0.291 0.771193
as.factor(year)1996:as.factor(target3)9  -0.549995   0.202927  -2.710 0.006723 **
as.factor(year)1997:as.factor(target3)9  -0.963976   0.184783  -5.217 1.82e-07 ***
as.factor(year)1998:as.factor(target3)9  -1.065852   0.187029  -5.699 1.21e-08 ***
as.factor(year)1999:as.factor(target3)9  -1.134533   0.181694  -6.244 4.28e-10 ***
as.factor(year)2000:as.factor(target3)9  -0.659424   0.172692  -3.818 0.000134 ***
as.factor(year)2001:as.factor(target3)9  -0.663052   0.169660  -3.908 9.31e-05 ***
as.factor(year)2002:as.factor(target3)9  -0.790663   0.175494  -4.505 6.64e-06 ***
as.factor(year)2003:as.factor(target3)9  -0.501545   0.173205  -2.896 0.003785 **
as.factor(year)2004:as.factor(target3)9  -0.899068   0.180713  -4.975 6.53e-07 ***
as.factor(year)2005:as.factor(target3)9  -1.233182   0.191001  -6.456 1.08e-10 ***
as.factor(year)2006:as.factor(target3)9  -1.289435   0.198990  -6.480 9.23e-11 ***
as.factor(year)2007:as.factor(target3)9  -1.182318   0.188818  -6.262 3.83e-10 ***
as.factor(year)2008:as.factor(target3)9  -0.945819   0.201294  -4.699 2.62e-06 ***
as.factor(year)2009:as.factor(target3)9  -1.034948   0.182684  -5.665 1.47e-08 ***
as.factor(year)2010:as.factor(target3)9   0.002955   0.170654   0.017 0.986184
as.factor(year)1995:as.factor(target3)10  0.080565   0.223645   0.360 0.718672
as.factor(year)1996:as.factor(target3)10 -0.558501   0.200062  -2.792 0.005245 **
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as.factor(year)1997:as.factor(target3)10 -1.165326   0.192935  -6.040 1.55e-09 ***
as.factor(year)1998:as.factor(target3)10 -1.132566   0.191838  -5.904 3.57e-09 ***
as.factor(year)1999:as.factor(target3)10 -0.984472   0.176669  -5.572 2.52e-08 ***
as.factor(year)2000:as.factor(target3)10 -0.567473   0.170804  -3.322 0.000893 ***
as.factor(year)2001:as.factor(target3)10 -0.655495   0.169116  -3.876 0.000106 ***
as.factor(year)2002:as.factor(target3)10 -0.807043   0.173442  -4.653 3.27e-06 ***
as.factor(year)2003:as.factor(target3)10 -0.792510   0.179735  -4.409 1.04e-05 ***
as.factor(year)2004:as.factor(target3)10 -0.925794   0.177352  -5.220 1.79e-07 ***
as.factor(year)2005:as.factor(target3)10 -1.496074   0.199218  -7.510 5.98e-14 ***
as.factor(year)2006:as.factor(target3)10 -1.530059   0.207975  -7.357 1.90e-13 ***
as.factor(year)2007:as.factor(target3)10 -1.450974   0.202335  -7.171 7.50e-13 ***
as.factor(year)2008:as.factor(target3)10 -0.069849   0.169652  -0.412 0.680546
as.factor(year)2009:as.factor(target3)10 -0.545055   0.167770  -3.249 0.001159 **
as.factor(year)2010:as.factor(target3)10  0.397364   0.165492   2.401 0.016348 *
as.factor(qt)2:as.factor(target3)2       -0.115305   0.192527  -0.599 0.549238
as.factor(qt)3:as.factor(target3)2        0.069301   0.192501   0.360 0.718847
as.factor(qt)4:as.factor(target3)2        0.428685   0.254482   1.685 0.092081 .
as.factor(qt)2:as.factor(target3)3       -0.200943   0.173416  -1.159 0.246570
as.factor(qt)3:as.factor(target3)3        0.057275   0.173414   0.330 0.741189
as.factor(qt)4:as.factor(target3)3        0.435634   0.236567   1.841 0.065554 .
as.factor(qt)2:as.factor(target3)4       -0.538711   0.162120  -3.323 0.000891 ***
as.factor(qt)3:as.factor(target3)4       -0.262847   0.162137  -1.621 0.104992
as.factor(qt)4:as.factor(target3)4        0.191407   0.224768   0.852 0.394452
as.factor(qt)2:as.factor(target3)5       -0.733478   0.161342  -4.546 5.47e-06 ***
as.factor(qt)3:as.factor(target3)5       -0.273874   0.160593  -1.705 0.088125 .
as.factor(qt)4:as.factor(target3)5        0.371442   0.221358   1.678 0.093348 .
as.factor(qt)2:as.factor(target3)6       -0.742437   0.159501  -4.655 3.25e-06 ***
as.factor(qt)3:as.factor(target3)6       -0.545874   0.160214  -3.407 0.000657 ***
as.factor(qt)4:as.factor(target3)6        0.290629   0.219469   1.324 0.185429
as.factor(qt)2:as.factor(target3)7       -0.929692   0.161303  -5.764 8.26e-09 ***
as.factor(qt)3:as.factor(target3)7       -0.495105   0.160136  -3.092 0.001990 **
as.factor(qt)4:as.factor(target3)7        0.434471   0.218549   1.988 0.046818 *
as.factor(qt)2:as.factor(target3)8       -1.076021   0.162368  -6.627 3.45e-11 ***
as.factor(qt)3:as.factor(target3)8       -0.648388   0.160655  -4.036 5.44e-05 ***
as.factor(qt)4:as.factor(target3)8        0.449721   0.218467   2.059 0.039542 *
as.factor(qt)2:as.factor(target3)9       -0.917062   0.161215  -5.688 1.29e-08 ***
as.factor(qt)3:as.factor(target3)9       -0.895476   0.162072  -5.525 3.30e-08 ***
as.factor(qt)4:as.factor(target3)9        0.446484   0.218121   2.047 0.040666 *
as.factor(qt)2:as.factor(target3)10      -1.191598   0.164719  -7.234 4.73e-13 ***
as.factor(qt)3:as.factor(target3)10      -0.907197   0.158646  -5.718 1.08e-08 ***
as.factor(qt)4:as.factor(target3)10       0.784213   0.214548   3.655 0.000257 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 1302.217)

    Null deviance: 138364601  on 81262  degrees of freedom
Residual deviance: 105554520  on 81059  degrees of freedom
AIC: 813623

Number of Fisher Scoring iterations: 10

> Anova(res2)
Analysis of Deviance Table (Type II tests)

Response: cpue
                                LR Chisq  Df Pr(>Chisq)
as.factor(year)                   4000.1  16  < 2.2e-16 ***
as.factor(qt)                     3295.2   3  < 2.2e-16 ***
as.factor(area)                   3781.8   3  < 2.2e-16 ***
as.factor(target3)                3873.3   9  < 2.2e-16 ***
as.factor(gyogyoucode)              45.7   1  1.351e-11 ***
as.factor(year):as.factor(target3)  2336.7 144  < 2.2e-16 ***
as.factor(qt):as.factor(target3)    1187.4  27  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>
```

[1]Working document submitted to the ISC Shark Working Group Workshop, 7 January – 14 January 2013, NOAA Southwest Fisheries Science Center, La Jolla, California U.S.A.
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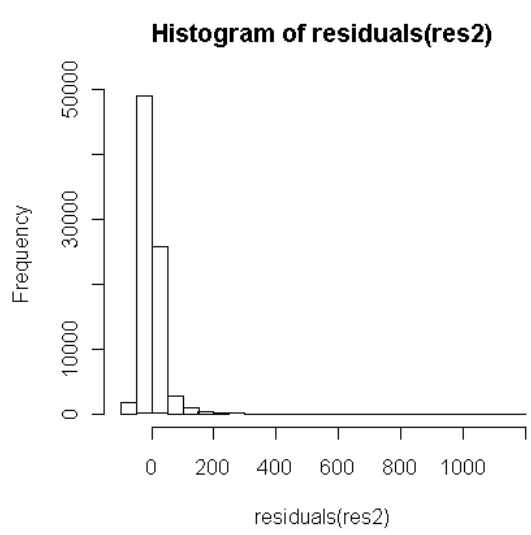

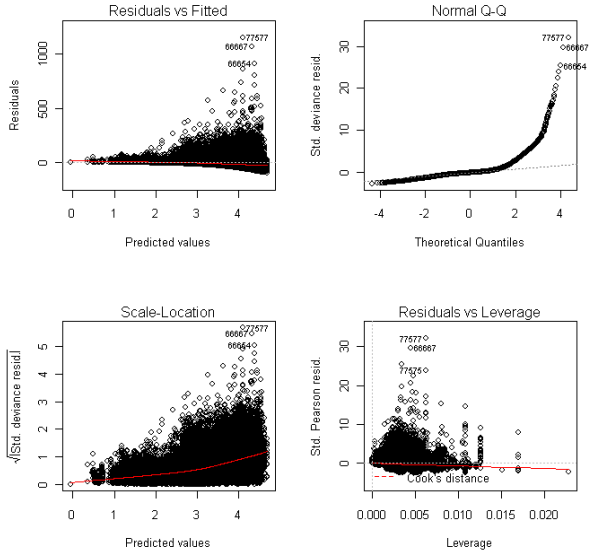

II-(3) negative binomial model

```
res14 <- glm.nb(formula = blshrk ~ as.factor(year) + as.factor(qt) + as.factor(area) +
    as.factor(target3) + as.factor(gyogyoucode) +
    as.factor(year):as.factor(target3) +
    as.factor(qt):as.factor(target3) + offset(log(hook)), data = temp)

Analysis of Deviance Table (Type II tests)

Response: blshrk
                                  LR Chisq  Df Pr(>Chisq)
as.factor(year)                     2633.5  16  < 2.2e-16 ***
as.factor(qt)                       3920.0   3  < 2.2e-16 ***
as.factor(area)                     9537.4   3  < 2.2e-16 ***
as.factor(target3)                  1967.0   9  < 2.2e-16 ***
as.factor(gyogyoucode)                77.6   1  < 2.2e-16 ***
as.factor(year):as.factor(target3)  3330.7 144  < 2.2e-16 ***
as.factor(qt):as.factor(target3)    2564.5  27  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.6466  -0.9728  -0.3733   0.2777   7.3232


Coefficients:
                                 Estimate Std. Error z value Pr(>|z|)
(Intercept)                    -4.680809   0.073739 -63.478  < 2e-16 ***
as.factor(year)1995             0.010780   0.055088   0.196 0.844849
as.factor(year)1996             0.408028   0.054533   7.482 7.31e-14 ***
as.factor(year)1997             0.824165   0.056358  14.624  < 2e-16 ***
as.factor(year)1998             0.848340   0.055657  15.242  < 2e-16 ***
as.factor(year)1999             0.943481   0.056100  16.818  < 2e-16 ***
as.factor(year)2000             0.849588   0.054847  15.490  < 2e-16 ***
as.factor(year)2001             0.976682   0.055212  17.690  < 2e-16 ***
as.factor(year)2002             0.988981   0.058252  16.978  < 2e-16 ***
as.factor(year)2003             0.881711   0.059145  14.908  < 2e-16 ***
as.factor(year)2004             1.033512   0.059777  17.290  < 2e-16 ***
as.factor(year)2005             1.290365   0.061736  20.901  < 2e-16 ***
as.factor(year)2006             1.210070   0.061634  19.633  < 2e-16 ***
as.factor(year)2007             1.051263   0.059049  17.803  < 2e-16 ***
as.factor(year)2008             0.743257   0.063407  11.722  < 2e-16 ***
as.factor(year)2009             1.213296   0.066116  18.351  < 2e-16 ***
as.factor(year)2010             0.929071   0.067922  13.678  < 2e-16 ***
as.factor(qt)2                  1.002040   0.067064  14.942  < 2e-16 ***
as.factor(qt)3                  0.720482   0.065977  10.920  < 2e-16 ***
as.factor(qt)4                 -0.467394   0.071912  -6.500 8.06e-11 ***
as.factor(area)2                0.018182   0.019655   0.925 0.354930
```

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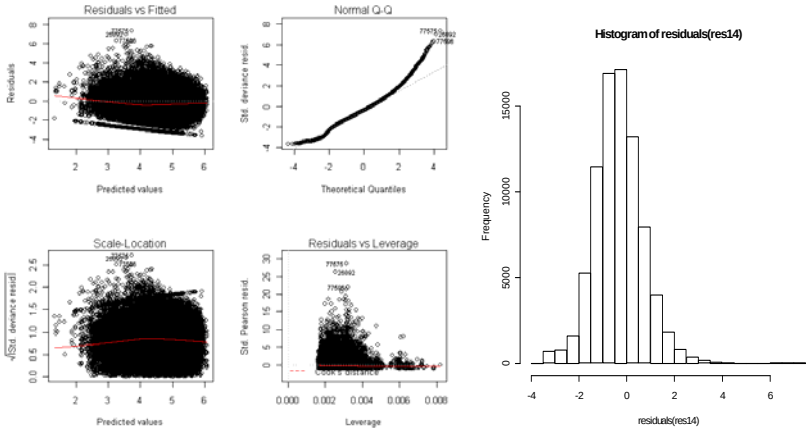
```
as.factor(area)3                    -1.047661   0.010788 -97.116  < 2e-16 ***
as.factor(area)4                    -1.691851   0.037018 -45.704  < 2e-16 ***
as.factor(target3)2                  0.026777   0.095665   0.280 0.779553
as.factor(target3)3                 -0.005995   0.092550  -0.065 0.948353
as.factor(target3)4                  0.379710   0.088325   4.299 1.72e-05 ***
as.factor(target3)5                  0.445157   0.087092   5.111 3.20e-07 ***
as.factor(target3)6                  0.622338   0.086575   7.188 6.55e-13 ***
as.factor(target3)7                  0.679587   0.086460   7.860 3.84e-15 ***
as.factor(target3)8                  0.711755   0.086045   8.272  < 2e-16 ***
as.factor(target3)9                  0.791411   0.085240   9.284  < 2e-16 ***
as.factor(target3)10                 0.914625   0.083987  10.890  < 2e-16 ***
as.factor(gyogyoucode)2             -0.086930   0.009774  -8.894  < 2e-16 ***
as.factor(year)1995:as.factor(target3)2  0.278352   0.077582   3.588 0.000333 ***
as.factor(year)1996:as.factor(target3)2 -0.094549   0.077127  -1.226 0.220241
as.factor(year)1997:as.factor(target3)2 -0.101162   0.078962  -1.281 0.200143
as.factor(year)1998:as.factor(target3)2 -0.056785   0.078447  -0.724 0.469146
as.factor(year)1999:as.factor(target3)2  0.008354   0.078788   0.106 0.915555
as.factor(year)2000:as.factor(target3)2 -0.005444   0.076761  -0.071 0.943463
as.factor(year)2001:as.factor(target3)2 -0.001013   0.077621  -0.013 0.989584
as.factor(year)2002:as.factor(target3)2 -0.096742   0.081037  -1.194 0.232555
as.factor(year)2003:as.factor(target3)2  0.175751   0.082757   2.124 0.033695 *
as.factor(year)2004:as.factor(target3)2  0.095244   0.083902   1.135 0.256301
as.factor(year)2005:as.factor(target3)2  0.238553   0.086905   2.745 0.006051 **
as.factor(year)2006:as.factor(target3)2  0.266716   0.088870   3.001 0.002689 **
as.factor(year)2007:as.factor(target3)2 -0.052384   0.083874  -0.625 0.532267
as.factor(year)2008:as.factor(target3)2  0.266023   0.088731   2.998 0.002717 **
as.factor(year)2009:as.factor(target3)2  0.045017   0.092096   0.489 0.624981
as.factor(year)2010:as.factor(target3)2  0.294132   0.096314   3.054 0.002259 **
as.factor(year)1995:as.factor(target3)3  0.312043   0.078878   3.956 7.62e-05 ***
as.factor(year)1996:as.factor(target3)3 -0.106609   0.079661  -1.338 0.180806
as.factor(year)1997:as.factor(target3)3 -0.425485   0.080996  -5.253 1.50e-07 ***
as.factor(year)1998:as.factor(target3)3 -0.248832   0.079717  -3.121 0.001800 **
as.factor(year)1999:as.factor(target3)3 -0.113432   0.080171  -1.415 0.157102
as.factor(year)2000:as.factor(target3)3 -0.166177   0.078188  -2.125 0.033559 *
as.factor(year)2001:as.factor(target3)3 -0.177626   0.078386  -2.266 0.023449 *
as.factor(year)2002:as.factor(target3)3 -0.108932   0.082363  -1.323 0.185977
as.factor(year)2003:as.factor(target3)3  0.190564   0.083664   2.278 0.022742 *
as.factor(year)2004:as.factor(target3)3 -0.121076   0.084608  -1.431 0.152422
as.factor(year)2005:as.factor(target3)3 -0.012299   0.087771  -0.140 0.888558
as.factor(year)2006:as.factor(target3)3  0.111284   0.088603   1.256 0.209123
as.factor(year)2007:as.factor(target3)3 -0.297525   0.084135  -3.536 0.000406 ***
as.factor(year)2008:as.factor(target3)3 -0.022392   0.089683  -0.250 0.802836
as.factor(year)2009:as.factor(target3)3 -0.122061   0.093153  -1.310 0.190085
as.factor(year)2010:as.factor(target3)3 -0.005656   0.095671  -0.059 0.952861
as.factor(year)1995:as.factor(target3)4  0.208273   0.078182   2.664 0.007723 **
as.factor(year)1996:as.factor(target3)4 -0.333359   0.078233  -4.261 2.03e-05 ***
as.factor(year)1997:as.factor(target3)4 -0.461575   0.079902  -5.777 7.61e-09 ***
as.factor(year)1998:as.factor(target3)4 -0.395601   0.079166  -4.997 5.82e-07 ***
as.factor(year)1999:as.factor(target3)4 -0.402107   0.078196  -5.142 2.71e-07 ***
as.factor(year)2000:as.factor(target3)4 -0.336807   0.077088  -4.369 1.25e-05 ***
as.factor(year)2001:as.factor(target3)4 -0.320029   0.077638  -4.122 3.76e-05 ***
as.factor(year)2002:as.factor(target3)4 -0.134761   0.081707  -1.649 0.099082 .
as.factor(year)2003:as.factor(target3)4 -0.036335   0.082913  -0.438 0.661216
as.factor(year)2004:as.factor(target3)4 -0.386697   0.083886  -4.610 4.03e-06 ***
as.factor(year)2005:as.factor(target3)4 -0.429805   0.086816  -4.951 7.39e-07 ***
as.factor(year)2006:as.factor(target3)4 -0.127461   0.087181  -1.462 0.143734
as.factor(year)2007:as.factor(target3)4 -0.666514   0.083377  -7.994 1.31e-15 ***
as.factor(year)2008:as.factor(target3)4 -0.262096   0.088778  -2.952 0.003155 **
as.factor(year)2009:as.factor(target3)4 -0.643210   0.092271  -6.971 3.15e-12 ***
as.factor(year)2010:as.factor(target3)4 -0.574332   0.096822  -5.932 3.00e-09 ***
as.factor(year)1995:as.factor(target3)5  0.153526   0.077988   1.969 0.049002 *
as.factor(year)1996:as.factor(target3)5 -0.334029   0.077620  -4.303 1.68e-05 ***
as.factor(year)1997:as.factor(target3)5 -0.385791   0.079817  -4.833 1.34e-06 ***
as.factor(year)1998:as.factor(target3)5 -0.531897   0.078798  -6.750 1.48e-11 ***
as.factor(year)1999:as.factor(target3)5 -0.492442   0.080961  -6.082 1.18e-09 ***
as.factor(year)2000:as.factor(target3)5 -0.546306   0.077302  -7.067 1.58e-12 ***
as.factor(year)2001:as.factor(target3)5 -0.469268   0.077656  -6.043 1.51e-09 ***
as.factor(year)2002:as.factor(target3)5 -0.426969   0.081513  -5.238 1.62e-07 ***
as.factor(year)2003:as.factor(target3)5 -0.321366   0.082895  -3.877 0.000106 ***
as.factor(year)2004:as.factor(target3)5 -0.495315   0.083710  -5.917 3.28e-09 ***
as.factor(year)2005:as.factor(target3)5 -0.737893   0.086507  -8.530  < 2e-16 ***
as.factor(year)2006:as.factor(target3)5 -0.848524   0.088130  -9.628  < 2e-16 ***
as.factor(year)2007:as.factor(target3)5 -0.971651   0.083596 -11.623  < 2e-16 ***
as.factor(year)2008:as.factor(target3)5 -0.774193   0.089322  -8.667  < 2e-16 ***
as.factor(year)2009:as.factor(target3)5 -0.657553   0.092634  -7.098 1.26e-12 ***
as.factor(year)2010:as.factor(target3)5 -0.515859   0.095504  -5.401 6.61e-08 ***
as.factor(year)1995:as.factor(target3)6  0.184324   0.078084   2.361 0.018245 *
as.factor(year)1996:as.factor(target3)6 -0.476070   0.078022  -6.102 1.05e-09 ***
```

as.factor(year)1997:as.factor(target3)6	-0.465566	0.080004	-5.819	5.91e-09	***
as.factor(year)1998:as.factor(target3)6	-0.647590	0.079166	-8.180	2.84e-16	***
as.factor(year)1999:as.factor(target3)6	-0.699806	0.079444	-8.809	< 2e-16	***
as.factor(year)2000:as.factor(target3)6	-0.612865	0.077298	-7.929	2.22e-15	***
as.factor(year)2001:as.factor(target3)6	-0.647121	0.077717	-8.327	< 2e-16	***
as.factor(year)2002:as.factor(target3)6	-0.552258	0.081759	-6.755	1.43e-11	***
as.factor(year)2003:as.factor(target3)6	-0.416401	0.083157	-5.007	5.52e-07	***
as.factor(year)2004:as.factor(target3)6	-0.674029	0.084190	-8.006	1.18e-15	***
as.factor(year)2005:as.factor(target3)6	-0.990939	0.087053	-11.383	< 2e-16	***
as.factor(year)2006:as.factor(target3)6	-0.658769	0.088582	-7.437	1.03e-13	***
as.factor(year)2007:as.factor(target3)6	-0.880986	0.083692	-10.527	< 2e-16	***
as.factor(year)2008:as.factor(target3)6	-0.834101	0.089182	-9.353	< 2e-16	***
as.factor(year)2009:as.factor(target3)6	-0.545116	0.092156	-5.915	3.32e-09	***
as.factor(year)2010:as.factor(target3)6	-0.704238	0.096315	-7.312	2.64e-13	***
as.factor(year)1995:as.factor(target3)7	0.113096	0.078152	1.447	0.147863	
as.factor(year)1996:as.factor(target3)7	-0.380170	0.077995	-4.874	1.09e-06	***
as.factor(year)1997:as.factor(target3)7	-0.586751	0.080022	-7.332	2.26e-13	***
as.factor(year)1998:as.factor(target3)7	-0.604247	0.079245	-7.625	2.44e-14	***
as.factor(year)1999:as.factor(target3)7	-0.841686	0.079651	-10.567	< 2e-16	***
as.factor(year)2000:as.factor(target3)7	-0.624261	0.077540	-8.051	8.22e-16	***
as.factor(year)2001:as.factor(target3)7	-0.666629	0.078100	-8.536	< 2e-16	***
as.factor(year)2002:as.factor(target3)7	-0.728917	0.081966	-8.893	< 2e-16	***
as.factor(year)2003:as.factor(target3)7	-0.427590	0.083553	-5.118	3.09e-07	***
as.factor(year)2004:as.factor(target3)7	-0.740638	0.084357	-8.780	< 2e-16	***
as.factor(year)2005:as.factor(target3)7	-1.126963	0.087439	-12.889	< 2e-16	***
as.factor(year)2006:as.factor(target3)7	-0.965145	0.088740	-10.876	< 2e-16	***
as.factor(year)2007:as.factor(target3)7	-0.996634	0.083933	-11.874	< 2e-16	***
as.factor(year)2008:as.factor(target3)7	-0.880057	0.089796	-9.801	< 2e-16	***
as.factor(year)2009:as.factor(target3)7	-1.227049	0.093266	-13.156	< 2e-16	***
as.factor(year)2010:as.factor(target3)7	-0.783559	0.095944	-8.167	3.17e-16	***
as.factor(year)1995:as.factor(target3)8	0.064830	0.078338	0.828	0.407911	
as.factor(year)1996:as.factor(target3)8	-0.341301	0.077999	-4.376	1.21e-05	***
as.factor(year)1997:as.factor(target3)8	-0.662888	0.080229	-8.262	< 2e-16	***
as.factor(year)1998:as.factor(target3)8	-0.729125	0.079311	-9.193	< 2e-16	***
as.factor(year)1999:as.factor(target3)8	-0.783845	0.079361	-9.877	< 2e-16	***
as.factor(year)2000:as.factor(target3)8	-0.728595	0.077528	-9.398	< 2e-16	***
as.factor(year)2001:as.factor(target3)8	-0.638100	0.077951	-8.186	2.70e-16	***
as.factor(year)2002:as.factor(target3)8	-0.657422	0.081972	-8.020	1.06e-15	***
as.factor(year)2003:as.factor(target3)8	-0.506037	0.083685	-6.047	1.48e-09	***
as.factor(year)2004:as.factor(target3)8	-0.877185	0.084527	-10.378	< 2e-16	***
as.factor(year)2005:as.factor(target3)8	-1.190469	0.087465	-13.611	< 2e-16	***
as.factor(year)2006:as.factor(target3)8	-1.222142	0.088622	-13.790	< 2e-16	***
as.factor(year)2007:as.factor(target3)8	-1.031780	0.084615	-12.194	< 2e-16	***
as.factor(year)2008:as.factor(target3)8	-0.765432	0.089585	-8.544	< 2e-16	***
as.factor(year)2009:as.factor(target3)8	-1.057624	0.093527	-11.308	< 2e-16	***
as.factor(year)2010:as.factor(target3)8	-0.873695	0.096965	-9.010	< 2e-16	***
as.factor(year)1995:as.factor(target3)9	-0.010984	0.078003	-0.141	0.888015	
as.factor(year)1996:as.factor(target3)9	-0.548419	0.077977	-7.033	2.02e-12	***
as.factor(year)1997:as.factor(target3)9	-0.795274	0.079981	-9.943	< 2e-16	***
as.factor(year)1998:as.factor(target3)9	-0.808075	0.078960	-10.234	< 2e-16	***
as.factor(year)1999:as.factor(target3)9	-0.940607	0.079716	-11.799	< 2e-16	***
as.factor(year)2000:as.factor(target3)9	-0.712745	0.077022	-9.254	< 2e-16	***
as.factor(year)2001:as.factor(target3)9	-0.710588	0.077938	-9.117	< 2e-16	***
as.factor(year)2002:as.factor(target3)9	-0.916375	0.081701	-11.216	< 2e-16	***
as.factor(year)2003:as.factor(target3)9	-0.656992	0.083490	-7.869	3.57e-15	***
as.factor(year)2004:as.factor(target3)9	-0.954390	0.084113	-11.347	< 2e-16	***
as.factor(year)2005:as.factor(target3)9	-1.390348	0.087549	-15.881	< 2e-16	***
as.factor(year)2006:as.factor(target3)9	-1.445341	0.088129	-16.400	< 2e-16	***
as.factor(year)2007:as.factor(target3)9	-1.227216	0.083922	-14.623	< 2e-16	***
as.factor(year)2008:as.factor(target3)9	-1.012952	0.089354	-11.336	< 2e-16	***
as.factor(year)2009:as.factor(target3)9	-1.183846	0.092777	-12.760	< 2e-16	***
as.factor(year)2010:as.factor(target3)9	-0.295401	0.095825	-3.083	0.002051	**
as.factor(year)1995:as.factor(target3)10	-0.042613	0.078077	-0.546	0.585219	
as.factor(year)1996:as.factor(target3)10	-0.733811	0.077862	-9.424	< 2e-16	***
as.factor(year)1997:as.factor(target3)10	-1.047280	0.079968	-13.096	< 2e-16	***
as.factor(year)1998:as.factor(target3)10	-1.055006	0.079287	-13.306	< 2e-16	***
as.factor(year)1999:as.factor(target3)10	-0.980312	0.079574	-12.320	< 2e-16	***
as.factor(year)2000:as.factor(target3)10	-0.757174	0.077565	-9.762	< 2e-16	***
as.factor(year)2001:as.factor(target3)10	-0.868588	0.077749	-11.172	< 2e-16	***
as.factor(year)2002:as.factor(target3)10	-0.984473	0.082507	-11.932	< 2e-16	***
as.factor(year)2003:as.factor(target3)10	-0.946907	0.083478	-11.343	< 2e-16	***
as.factor(year)2004:as.factor(target3)10	-1.032352	0.085095	-12.132	< 2e-16	***
as.factor(year)2005:as.factor(target3)10	-1.507437	0.087721	-17.184	< 2e-16	***
as.factor(year)2006:as.factor(target3)10	-1.749024	0.089807	-19.475	< 2e-16	***
as.factor(year)2007:as.factor(target3)10	-1.584137	0.084112	-18.834	< 2e-16	***
as.factor(year)2008:as.factor(target3)10	-0.382476	0.089380	-4.279	1.88e-05	***
as.factor(year)2009:as.factor(target3)10	-0.662327	0.093306	-7.098	1.26e-12	***
as.factor(year)2010:as.factor(target3)10	0.201284	0.096589	2.084	0.037167	*

```
as.factor(qt)2:as.factor(target3)2      -0.197263   0.085472  -2.308 0.021003 *
as.factor(qt)3:as.factor(target3)2      -0.021887   0.084399  -0.259 0.795382
as.factor(qt)4:as.factor(target3)2       0.099055   0.092017   1.076 0.281709
as.factor(qt)2:as.factor(target3)3      -0.166480   0.079423  -2.096 0.036070 *
as.factor(qt)3:as.factor(target3)3       0.155385   0.079034   1.966 0.049294 *
as.factor(qt)4:as.factor(target3)3       0.145724   0.086561   1.683 0.092279 .
as.factor(qt)2:as.factor(target3)4      -0.550903   0.075018  -7.344 2.08e-13 ***
as.factor(qt)3:as.factor(target3)4      -0.149476   0.075220  -1.987 0.046900 *
as.factor(qt)4:as.factor(target3)4      -0.029110   0.081724  -0.356 0.721688
as.factor(qt)2:as.factor(target3)5      -0.602454   0.073513  -8.195 2.50e-16 ***
as.factor(qt)3:as.factor(target3)5      -0.057234   0.073981  -0.774 0.439149
as.factor(qt)4:as.factor(target3)5       0.256646   0.079845   3.214 0.001308 **
as.factor(qt)2:as.factor(target3)6      -0.749064   0.072654 -10.310  < 2e-16 ***
as.factor(qt)3:as.factor(target3)6      -0.255600   0.074342  -3.438 0.000586 ***
as.factor(qt)4:as.factor(target3)6       0.177930   0.078836   2.257 0.024011 *
as.factor(qt)2:as.factor(target3)7      -0.844982   0.072536 -11.649  < 2e-16 ***
as.factor(qt)3:as.factor(target3)7      -0.263191   0.074033  -3.555 0.000378 ***
as.factor(qt)4:as.factor(target3)7       0.315207   0.078480   4.016 5.91e-05 ***
as.factor(qt)2:as.factor(target3)8      -0.954684   0.072255 -13.213  < 2e-16 ***
as.factor(qt)3:as.factor(target3)8      -0.447997   0.073674  -6.081 1.20e-09 ***
as.factor(qt)4:as.factor(target3)8       0.355219   0.078420   4.530 5.91e-06 ***
as.factor(qt)2:as.factor(target3)9      -0.955932   0.072264 -13.228  < 2e-16 ***
as.factor(qt)3:as.factor(target3)9      -0.465057   0.073595  -6.319 2.63e-10 ***
as.factor(qt)4:as.factor(target3)9       0.486456   0.078568   6.192 5.96e-10 ***
as.factor(qt)2:as.factor(target3)10     -1.020358   0.073026 -13.972  < 2e-16 ***
as.factor(qt)3:as.factor(target3)10     -0.562245   0.072802  -7.723 1.14e-14 ***
as.factor(qt)4:as.factor(target3)10      0.552188   0.078557   7.029 2.08e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(1.1531) family taken to be 1)

    Null deviance: 136250  on 82539  degrees of freedom
Residual deviance:  94189  on 82336  degrees of freedom
AIC: 878805

Number of Fisher Scoring iterations: 1


          Theta:  1.15306
      Std. Err.:  0.00531

 2 x log-likelihood:  -878395.20300
```



[1]Working document submitted to the ISC Shark Working Group Workshop, 7 January – 14 January 2013, NOAA Southwest Fisheries Science Center, La Jolla, California U.S.A.
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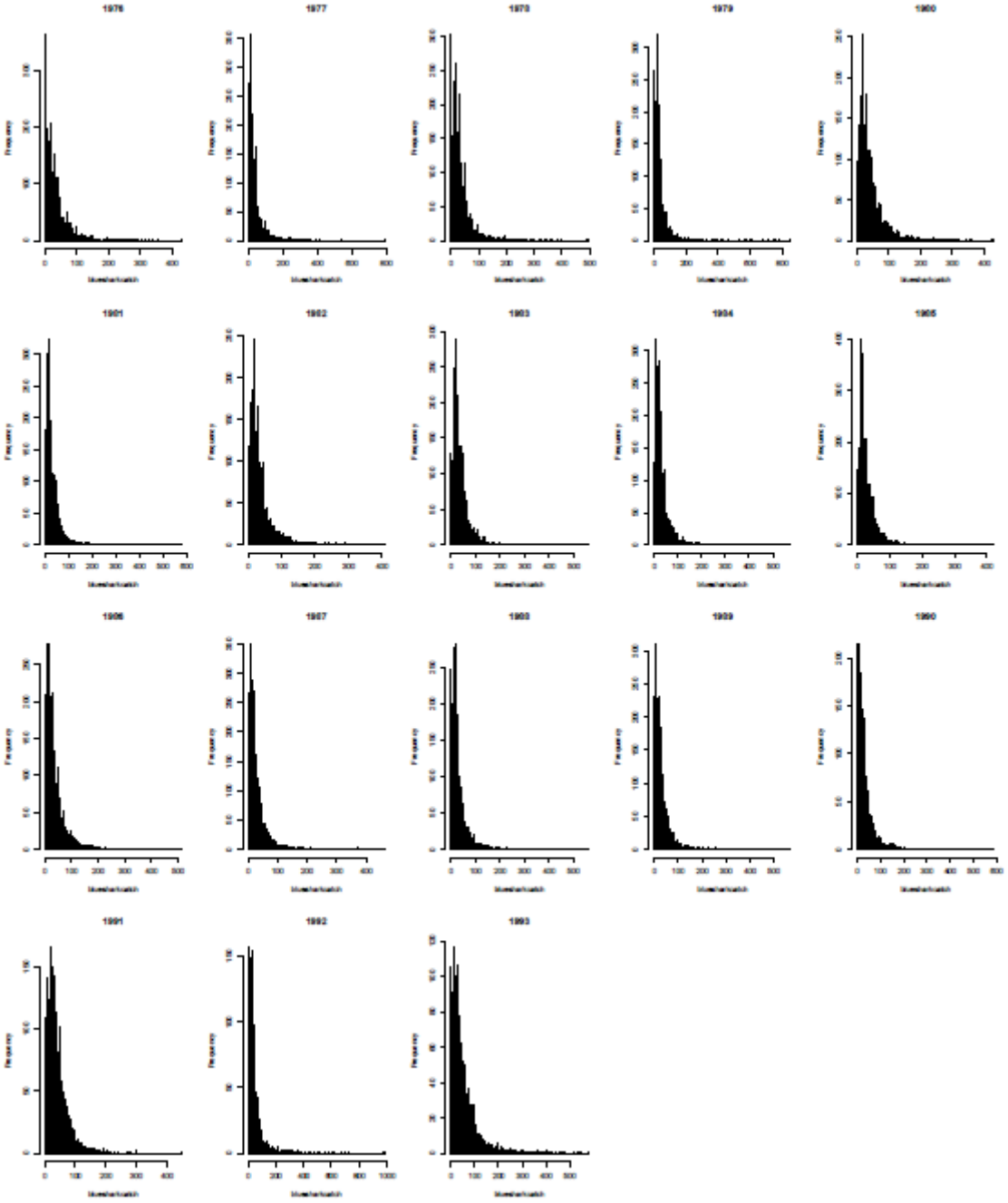
AppendixII: Histograms of row blue shark catch using for standardizing CPUE
I. 1976-1993



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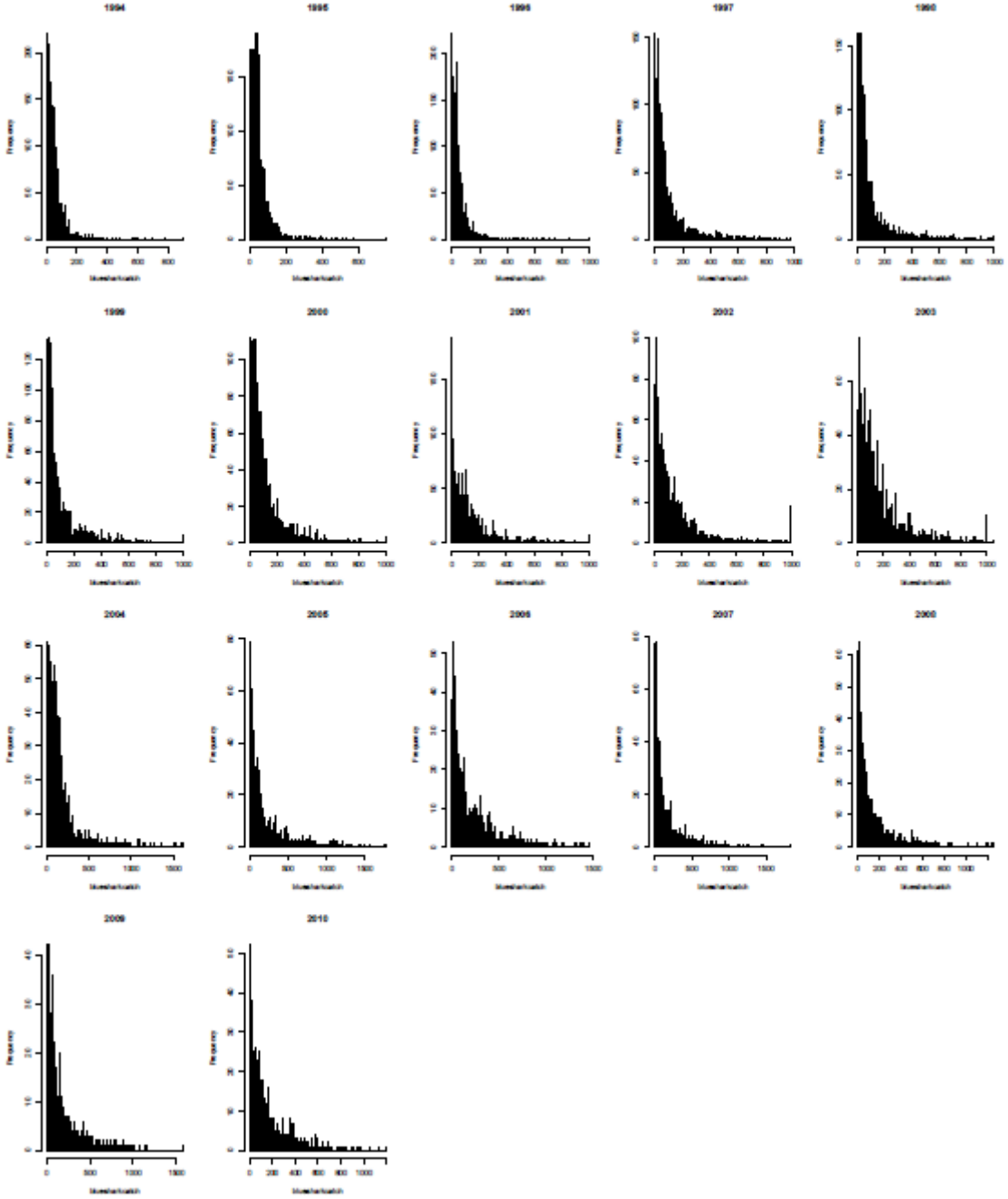
II. 1994-2010



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