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STANDARDIZED CPUE FOR NORTH ATLANTIC ALBACORE CAUGHT BY THE JAPANESE LONGLINE FISHERY

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SUMMARY

*In this document, catch per unit effort (CPUEs) of albacore (*Thunnus alalunga*) caught by the Japanese longline (JPN LL) in the North Atlantic Ocean were standardized in three periods (1959-1969 as target period, 1969-1975 as transition period and 1975-2011 as bycatch period). Estimating standardized CPUEs, two different generalized linear models (log-normal and negative binomial) were applied in bycatch period. Standardized CPUE by the negative binomial model in bycatch period decreased moderately from 1975 to 1985 and remained at the same level until 2000. It increased slightly after 2000.*

RÉSUMÉ

Dans le présent document, les prises par unité d'effort (CPUE) du germon (Thunnus alalunga) capturé par des palangriers japonais (JPN LL) dans l'océan Atlantique Nord ont été standardisées en trois périodes : 1959-1969 en tant que période cible, 1969-1975 en tant que période de transition et 1975-2011 en tant que période de prise accessoire. Pour estimer les CPUE standardisées, des modèles linéaires généralisés (log-normal et binomial négatif) ont été appliqués dans la période de prise accessoire. Les CPUE standardisées par le modèle binomial négatif de la période de prise accessoire ont connu une baisse modérée entre 1975 et 1985 et sont restées au même niveau jusqu'en 2000. Après 2000, elles ont légèrement augmenté.

RESUMEN

En este documento, se estandarizó la captura por unidad de esfuerzo (CPUE) del atún blanco (Thunnus alalunga) capturado por el palangre japonés (JPN LL) en el Atlántico norte en tres periodos (1959-1969 como periodo objetivo, 1969-1975 como periodo de transición y 1975-2011 como periodo de captura fortuita). Para estimar las CPUE estandarizadas, se aplicaron dos modelos lineales generalizados diferentes (lognormal y binomial negativo) en el periodo de captura fortuita. La CPUE estandarizada por el modelo binomial negativo en el periodo de captura fortuita descendió moderadamente desde 1975 hasta 1985 y permanecieron al mismo nivel hasta 2000. Después de 2000 aumentó ligeramente.

KEYWORDS

Catch/effort, Japanese longline fishery (JPN LL), Albacore, North Atlantic Ocean

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1. Introduction

Abundance indices for Atlantic albacore (north and south) caught by the Japanese longline fishery were calculated separately for three periods (1959-69 as target period, 1969-75 as transition period and 1975-after as bycatch period; Uozumi, 1996a; Uozumi, 1996b; Uosaki and Shono, 2008).

Standardized CPUEs were estimated as abundances indices for albacore in Atlantic Ocean caught by the Japanese longline fishery by two different generalized linear models (Uosaki and Shono, 2008). Although standardized CPUE for north albacore in Atlantic Ocean only by the negative binomial model was applied to the stock assessment model as abundance indices, same two models proposed by Uosaki and Shono (2008) were applied for standardization of annual CPUE for north Atlantic albacore (north of 5°N) caught by the Japanese longline fishery based on updated catch and effort data in this document.

2. Data and Methods

2.1 Fisheries Data

Data in this document were obtained from the Japanese longline fishery statistics based on the logbooks and compiled at the National Research Institute of Far Seas Fisheries. Two dataset were used; one is the ICCAT Task II catch-and-effort data from 1959 to 1975, and the other is catch-and-effort data with gear configuration such as number of hooks per basket between 1975 and 2011.

Catch per unit effort (CPUE) was defined as the number of albacore per 1,000 hooks. Data less than 3,000 hooks were excluded from the analysis. Observations within the EEZ were also excluded to avoid inconsistency of data coverage during a long historical period.

2.2 CPUE standardization

Standardized CPUE was estimated separately for three periods (1959-1969, 1969-1975 and 1975-2011), which referred as target, transition, and bycatch period, respectively (Uozumi, 1996b; Uosaki and Shono, 2008 and Mastumoto and Uosaki, 2011). In this document, CPUE during 1975 and 2012 (bycatch period) were updated since data has not been changed in other periods. Generalized linear model with lognormal (LN model) and negative binomial (NB model) error structures were applied to estimate standardized CPUE for albacore caught by the Japanese longline in the North Atlantic Ocean.

Year, season and subarea were incorporated as main effects for target (1959-1969) and transition period (1969-1975). Effect of gear configurations was added for the bycatch period (1975-2011). Quarter was used for fishing season. Subareas for target and transition period were defined by Uozumi (1996a) and for bycatch period by Uosaki (2004), which were incorporated in this study (**Figure 1**). Gear configurations were categorized into four levels (3-7, 8-11, 12-15 and 16-20 hooks between floats). In this study, same effects as those by Uosaki and Shono (2008) were used for the LN and NB models.

In order to include observations with fishing effort bot no albacore catch, a small value was added to CPUE and following equations were applied to estimate standardized CPUEs. SAS software packages (Version 9.3) were used for parameterization procedure of GLM.

(1) LN model
$E[\ln(CPUE+0.1)=\mu+Y+Q+A+G+Y*Q+Q*A+Q*G+\varepsilon$
where [E(CPUE+0.1)] is expectation of CPUE (catch in number per 1000 hooks) with normal distribution, Y, Q, A and G are effects of year, quarter, subarea and gear, respectively. μ and ε represent intercept and error term.

(2) NB model
$E[C]=H\cdot\exp(\mu+Y+Q+A+G+Y*Q+Q*A+Q*G+\varepsilon)$
where E(C) is expectation of catch in number with negative binomial distribution. H represents number of hooks used.
Interaction terms indicated as two symbols of effect and asterisk (e.g. Y*Q as year and quarter).

2.3 Results and Discussion

Figure 2 shows albacore catch number (a), number of hooks (b) and nominal CPUE (albacore number per 1000 hooks) during bycatch period (1975-2011) in the North Atlantic Ocean. Albacore catch number was between 20 and 190 with mean of 64 (**Figure 2a**). Number of alba- core catch likely has not been changed largely but recent catch after 2006 shows low.

This would be because of fishing effort decreases (**Figure 2b**). It is worth noting that fishing effort has been increased after 1977 until 1997. Nominal CPUE decreased from 1978 to 1995 (**Figure 2b**).

The ANOVA for the LN model and goodness of fit for the NB model during bycatch period are shown in **Table 1** and **Table 2**. Both F value in **Table 1** and chi-square in **Table 2** represent both model is highly significant, however, the effect of gear configuration was not significant for the NB model (**Table 2**).

Figure 3 and **Figure 4** represent standardized and scaled CPUEs by their mean, respectively. CPUEs derived from both of LN and NB models decreased moderately from 1975 to 1985 and remained at the same level until 2000. CPUEs after 2000 slightly increased. As stated in Uosaki and Shono (2008), the LN model were likely to be affected from large number of zero catch, however, the NB model has an advantage even though data contains zero catch. Therefore it is not necessarily to add small number to CPUE when it is zero. We recommended that CPUE for north albacore caught by the JPN LL in the Atlantic Ocean calculated by the NB model should be used as input data for stock assessment in this year as last stock assessment in 2009. This also consists with a recommendation made by the ICCAT albacore working group in 2007 (ICCAT, 2008). Actual values of standardized CPUE are shown in **Table 3**.

Figure 5 shows effects of each explanatory variable in the model. Effects of 1st and 4th quarter were larger than 2nd and 3rd quarter. Area 1, 2 and 4 show larger effects, where are northwestern Atlantic Ocean (see **Figure 1**). There are no remarkable effects of gear (number of hooks between floats).

The residuals plot shows a little skewed distribution in bycatch period (**Figure 6c**) especially between 1995 and 2000, and the residuals follow the expected linear pattern for the positive catch in the QQ plots to some extent (**Figure 7c**).

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Table 1. ANOVA for the LN model in bycatch period (1975-2011) in North Atlantic Ocean. Note that target and transition periods are shown in **Appendix 2**.

Source	**DF**	**SS**	**Mean Sq.**	**F Value**	Pr > F
Model	191	19065.53	99.82	71.82	< .0001
Error	19268	26778.2	1.39		
Corr. Tot.	19459	45843.1			

R-Sq. = 0.416 C.V. = -116.07

Source	**DF**	**Type III SS**	**Mean Square**	**F Value**	Pr > F
Y	36	1413.82	39.27	28.26	< .0001
Q	3	784.60	261.53	188.18	< .0001
A	8	6764.03	845.50	608.37	< .0001
G	3	38.16	12.72	9.15	< .0001
Y*Q	108	582.51	5.39	3.88	< .0001
Q*A	24	595.64	24.82	17.86	< .0001
Q*G	9	90.62	10.07	7.25	< .0001

Table 2. Goodness of fit for the NB model for bycatch period (1975-2011) in North Atlantic. Note that target and transition periods are shown in **Appendix 2**.

Source	**DF**	**Chi-square**	Pr > Chi
Y	36	590.23	< .0001
Q	3	180.18	< .0001
A	8	2903.25	< .0001
G	3	7.56	0.0560
Y*Q	108	766.70	< .0001
Q*A	24	244.26	< .0001
Q*G	9	87.13	< .0001

Table 3. Standardized CPUE and CV (standard error) for the NB model for north stock in the Atlantic Ocean. CPUEs in target and transition were obtained from Uosaki and Shono (2008), CPUE in bycatch period were updated in this study.

Year	Stand. CPUE	CV	Upper CL	Lower CL
1959	27.459	0.137	35.931	20.985
1960	23.329	0.189	33.796	16.104
1961	19.188	0.281	33.270	11.067
1962	28.380	0.202	42.141	19.113
1963	14.992	0.151	20.139	11.160
1964	14.918	0.084	17.585	12.656
1965	11.043	0.065	12.543	9.722
1966	10.358	0.081	12.134	8.843
1967	10.922	0.086	12.915	9.237
1968	11.144	0.094	13.396	9.271
1969	9.137	0.100	11.117	7.509
1969	10.657	0.093	12.795	8.876
1970	10.501	0.072	12.086	9.125
1971	5.946	0.061	6.700	5.277
1972	2.999	0.093	3.596	2.501
1973	4.135	0.101	5.044	3.391
1974	3.602	0.096	4.347	2.985
1975	3.077	0.082	3.610	2.622
1975	2.595	0.128	3.333	2.020
1976	2.188	0.150	2.935	1.630
1977	1.440	0.161	1.973	1.050
1978	1.215	0.135	1.582	0.933
1979	1.466	0.134	1.907	1.127
1980	1.414	0.120	1.790	1.118
1981	1.456	0.093	1.745	1.214
1982	1.313	0.088	1.559	1.106
1983	1.189	0.125	1.521	0.930
1984	1.025	0.115	1.284	0.819
1985	1.143	0.098	1.386	0.942
1986	0.649	0.115	0.814	0.518
1987	0.472	0.120	0.598	0.373
1988	0.767	0.114	0.959	0.613
1989	0.728	0.079	0.850	0.623
1990	0.563	0.096	0.679	0.467
1991	0.659	0.096	0.795	0.547
1992	0.518	0.096	0.625	0.429
1993	0.506	0.096	0.611	0.419
1994	0.680	0.093	0.817	0.566
1995	0.438	0.089	0.521	0.368
1996	0.386	0.077	0.449	0.332
1997	0.534	0.077	0.621	0.459
1998	0.846	0.074	0.978	0.731
1999	0.489	0.088	0.580	0.411
2000	0.803	0.076	0.931	0.692
2001	1.096	0.077	1.275	0.942
2002	1.165	0.100	1.418	0.958
2003	0.832	0.088	0.988	0.700
2004	0.621	0.081	0.727	0.530
2005	0.849	0.075	0.984	0.732
2006	0.728	0.102	0.889	0.595
2007	0.434	0.114	0.543	0.347
2008	0.449	0.106	0.553	0.365
2009	0.673	0.111	0.836	0.542
2010	1.024	0.107	1.262	0.830
2011	0.684	0.116	0.859	0.544

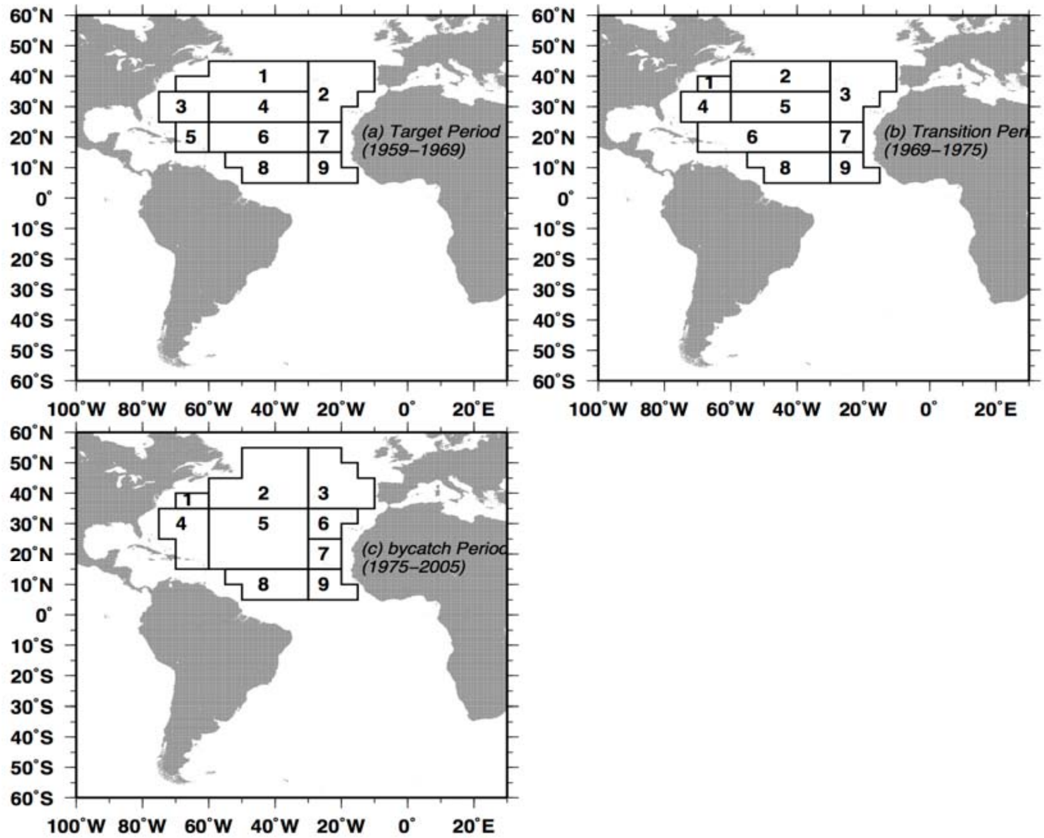


Figure 1. Area and subarea definition for CPUE standardization. (a) Target period (1959-1969), (b) Transition period (1969-1975) and (c) bycatch period (1975-2011).

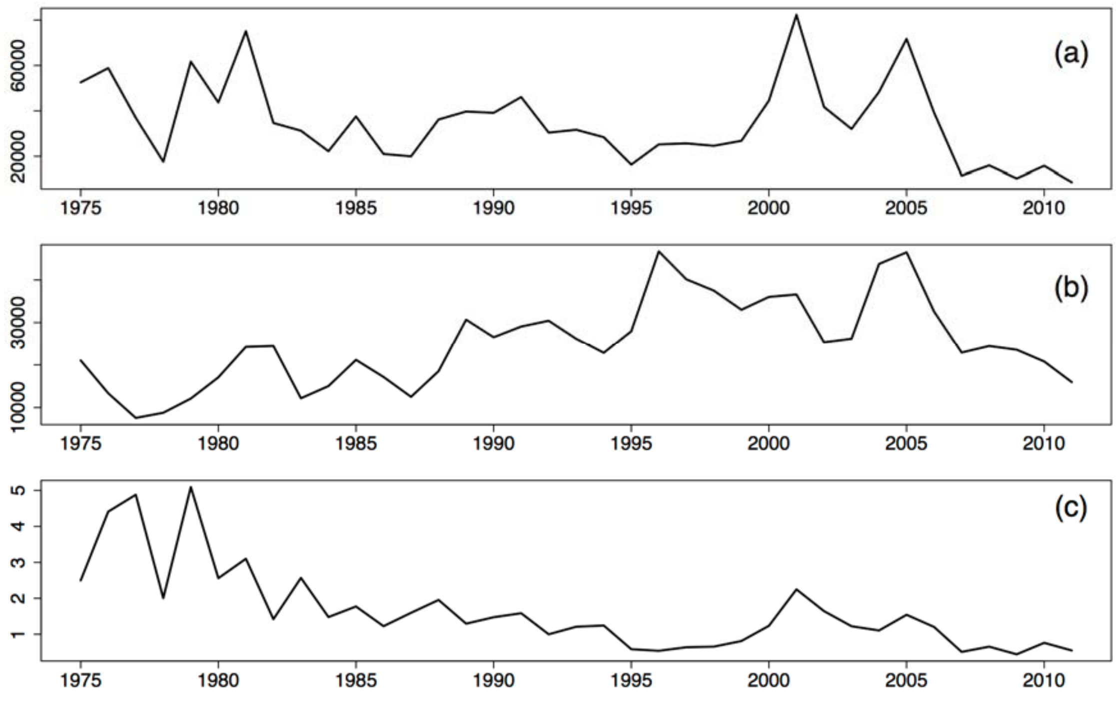


Figure 2. (a) Total number of albacore, (b) Total number of hooks (x 1000) and (c) nominal CPUE. Note that data shown are derived from North Atlantic Ocean during 1975 and 2011.

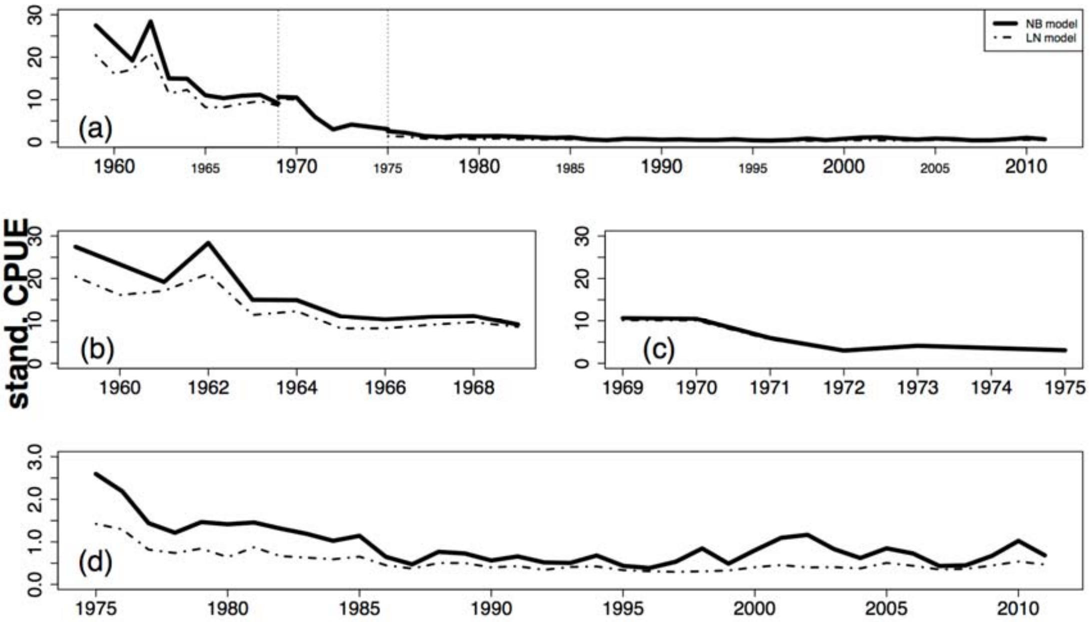


Figure 3. Standardized CPUEs for the LN and NB models for north stock. (a) All time series (1959-2012). (b) Target period (1959-1969), (c) Transition period (1969-1975) and (d) bycatch period (1975-2011).

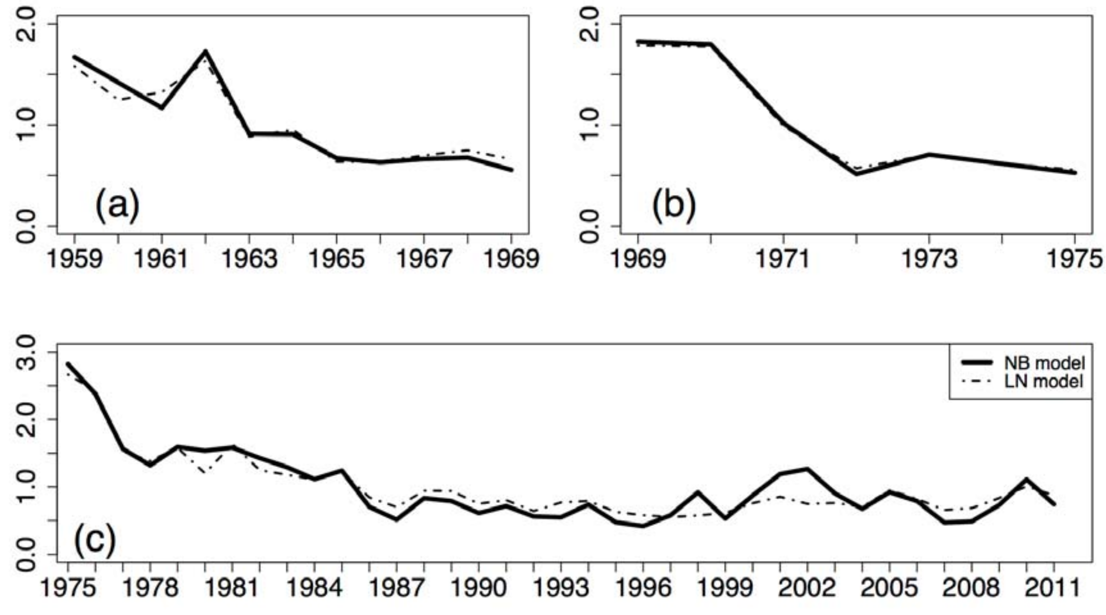


Figure 4. Scaled CPUEs for the LN and NB models for north stock. (a) Target period (1959-1969), (b) Transition period (1969-1975) and (c) bycatch period (1975-2011).

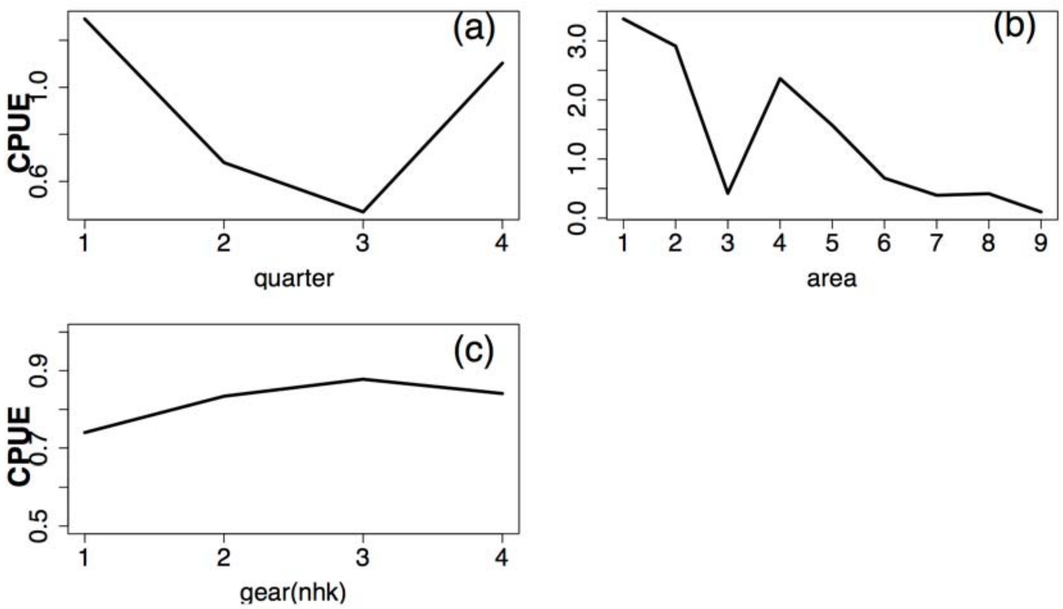


Figure 5. Standardized CPUEs for each explanatory variables in bycatch period (1975-2011). (a) quarter, (b) area and (c) gear (number of hooks between floats; see data and methods)

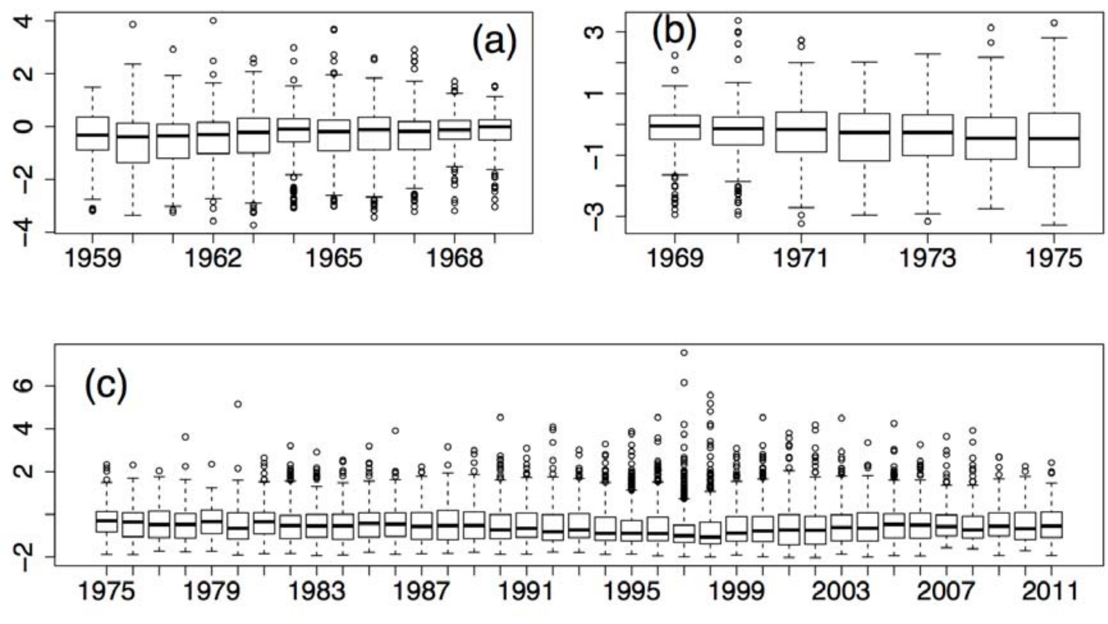


Figure 6. Boxplots of residuals for the NB model for the north stock. (a) Target period (1959-1969), (b) Transition period (1969-1975) and (c) bycatch period (1975-2011). Note that target and transition period was obtained from Uosaki and Shono (2008).

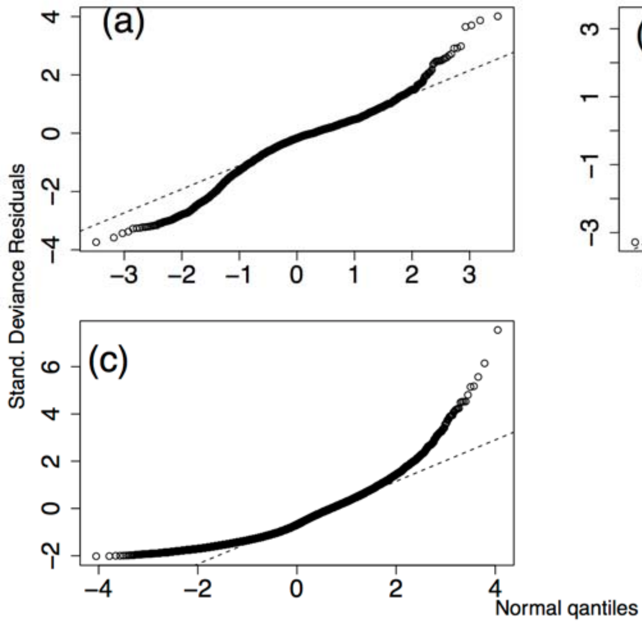


Figure 7. QQ plots of residuals for the NB model for the north stock. (a) Target period (1959-1969), (b) Transition period (1969-1975) and (c) bycatch period (1975-2011). Note that target and transition period was obtained from Uosaki and Shono (2008).

Appendix 1. ANOVA for the LN model for target (1959-69), transition (1969-75) and bycatch (1975-2005) period in north Atlantic, respectively (Uosaki and Shono, 2008).

(a) Target period (1959 – 1969)

Source	DF	SS	Mean Sq.	F Value	Pr > F
Model	75	2749.0	36.65	67.35	< .0001
Error	1973	1073.8	0.54		
Corr. Tot.	2048	3822.8			

R-Sq. = 0.719 C.V. = 33.33

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Y	10	70.2	7.02	12.90	< .0001
Q	3	40.4	13.46	24.73	< .0001
A	8	1250.1	156.26	287.11	< .0001
Y*Q	30	66.5	2.22	4.07	< .0001
Q*A	24	160.9	6.71	12.32	< .0001

(b) Transition period (1969 – 1975)

Source	DF	SS	Mean Sq.	F Value	Pr > F
Model	59	1898.3	32.17	70.02	< .0001
Error	1341	616.2	0.46		
Corr. Tot.	1400	2514.5			

R-Sq. = 0.755 C.V. = 36.43

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Y	6	144.0	24.00	52.23	< .0001
Q	3	45.4	15.12	32.91	< .0001
A	8	805.4	100.68	219.11	< .0001
Y*Q	18	14.6	0.81	1.76	0.0249
Q*A	24	85.1	3.55	7.72	< .0001

(c) Bycatch period (1975 – 2005)

Source	DF	SS	Mean Sq.	F Value	Pr > F
Model	167	17029.8	101.98	71.41	< .0001
Error	16679	23819.6	1.43		
Corr. Tot.	16846	40849.5			

R-Sq. = 0.417 C.V. = -120.51

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Y	30	1296.5	43.22	30.26	< .0001
Q	3	640.4	213.45	149.46	< .0001
A	8	6264.0	783.01	548.28	< .0001
G	3	38.3	12.75	8.93	< .0001
Y*Q	90	502.8	5.59	3.91	< .0001
Q*A	24	548.9	22.87	16.01	< .0001
Q*G	9	63.1	7.01	4.91	< .0001

Appendix 2. Goodness of fit for the NB model for Target (1959-69), Transition (1969-75) bycatch (1975-2005) period in north Atlantic, respectively (Uosaki and Shono, 2008).

(a) Target period (1959 – 1969)

Source	**DF**	**Chi-square**	Pr > Chi
Y	10	98.08	< .0001
Q	3	61.98	< .0001
A	8	933.66	< .0001
Y*Q	30	86.16	< .0001
Q*A	24	232.32	< .0001

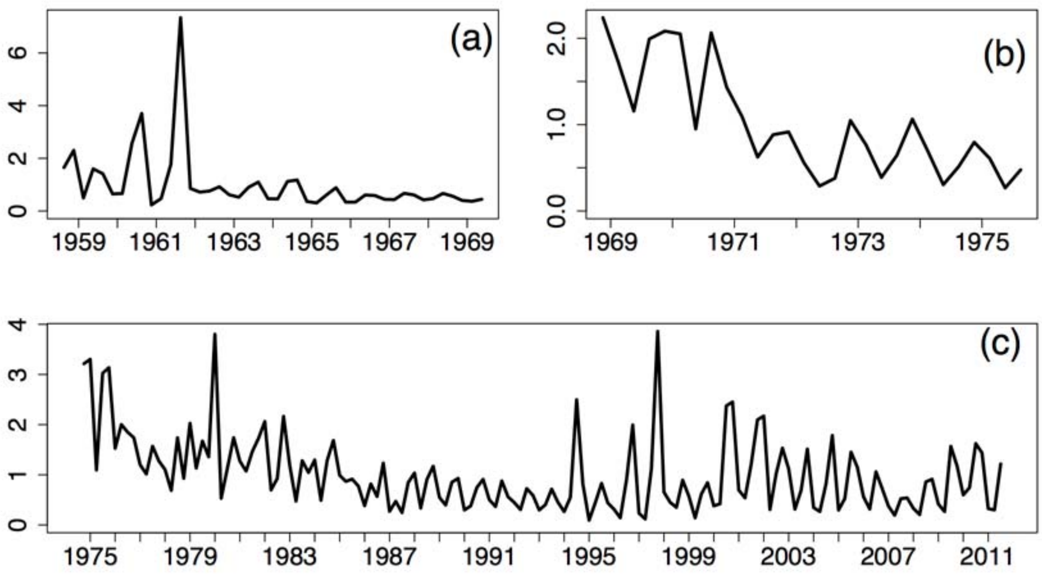
(b) Transition period (1969 – 1975)

Source	**DF**	**Chi-square**	Pr > Chi
Y	6	214.68	< .0001
Q	3	63.69	< .0001
A	8	789.95	< .0001
Y*Q	18	13.62	0.7534
Q*A	24	101.47	< .0001

(c) Bycatch period (1975 – 2005)

Source	**DF**	**Chi-square**	Pr > Chi
Y	30	523.97	< .0001
Q	3	151.60	< .0001
A	8	2403.66	< .0001
G	3	4.09	0.2517
Y*Q	90	681.06	< .0001
Q*A	24	226.86	< .0001
Q*G	9	65.43	< .0001

Appendix 3. Scaled quarterly CPUEs for the NB models for north stock. (a) Target period (1959-1969), (b) Transition period (1969-1975) and (c) bycatch period (1975-2011). Note that target and transition period was obtained from Uosaki and Shono (2008).



Appendix 4. Standardized quarterly CPUEs and CV (standard error) for the NB model for north stock in the Atlantic Ocean. CPUEs in target and transition were obtained from Uosaki and Shono (2008), CPUE in bycatch period was updated in this study.

(a) Target period (1959 – 1969)

Year	quarter	Stand. CPUE	CV	Upper CL	Lower CL
1959	1	34.426	0.358	69.428	17.070
1959	2	48.034	0.276	82.570	27.943
1959	3	10.300	0.195	15.082	7.033
1959	4	33.381	0.242	53.673	20.761
1960	1	29.509	0.622	99.885	8.718
1960	2	13.512	0.260	22.480	8.122
1960	3	13.817	0.184	19.809	9.637
1960	4	53.775	0.290	94.861	30.483
1961	1	77.185	1.038	590.329	10.092
1961	2	4.794	0.256	7.919	2.902
1961	3	9.911	0.186	14.278	6.879
1961	4	36.962	0.289	65.153	20.969
1962	1	153.101	0.741	653.974	35.842
1962	2	17.866	0.191	25.968	12.292
1962	3	14.924	0.138	19.571	11.381
1962	4	15.893	0.216	24.251	10.416
1963	1	19.179	0.541	55.344	6.646
1963	2	12.857	0.140	16.923	9.768
1963	3	10.917	0.122	13.863	8.597
1963	4	18.761	0.189	27.189	12.946
1964	1	22.904	0.241	36.725	14.284
1964	2	9.671	0.111	12.009	7.788
1964	3	9.549	0.105	11.731	7.773
1964	4	23.420	0.178	33.165	16.539
1965	1	24.537	0.157	33.405	18.024
1965	2	7.504	0.094	9.029	6.236
1965	3	6.405	0.104	7.856	5.222
1965	4	12.611	0.152	16.982	9.366
1966	1	18.488	0.182	26.402	12.946
1966	2	7.017	0.113	8.752	5.627
1966	3	7.013	0.132	9.088	5.412
1966	4	12.657	0.202	18.820	8.512
1967	1	12.246	0.204	18.255	8.215
1967	2	9.222	0.138	12.093	7.032
1967	3	9.012	0.138	11.802	6.882
1967	4	13.984	0.193	20.425	9.574
1968	1	12.788	0.223	19.810	8.255
1968	2	8.830	0.131	11.411	6.833
1968	3	9.815	0.146	13.069	7.371
1968	4	13.917	0.230	21.826	8.874
1969	1	11.734	0.228	18.327	7.513
1969	2	8.315	0.144	11.025	6.272
1969	3	7.669	0.141	10.110	5.817
1969	4	9.313	0.260	15.515	5.590

Appendix 4. (Continued).

(b) Transition period (1969 – 1975)

Year	quarter	Stand. CPUE	CV	Upper CL	Lower CL
1969	1	13.818	0.188	19.959	9.567
1969	2	10.624	0.145	14.116	7.996
1969	3	7.144	0.140	9.398	5.431
1969	4	12.296	0.252	20.146	7.505
1970	1	12.858	0.170	17.932	9.220
1970	2	12.662	0.119	15.988	10.028
1970	3	5.863	0.124	7.476	4.598
1970	4	12.741	0.155	17.260	9.405
1971	1	8.840	0.114	11.053	7.070
1971	2	6.732	0.102	8.216	5.515
1971	3	3.853	0.136	5.028	2.952
1971	4	5.454	0.133	7.072	4.207
1972	1	5.651	0.124	7.207	4.431
1972	2	3.432	0.156	4.662	2.526
1972	3	1.779	0.180	2.533	1.250
1972	4	2.343	0.255	3.860	1.422
1973	1	6.467	0.166	8.945	4.675
1973	2	4.739	0.207	7.106	3.160
1973	3	2.400	0.250	3.917	1.470
1973	4	3.977	0.178	5.633	2.808
1974	1	6.572	0.204	9.803	4.406
1974	2	4.278	0.227	6.673	2.743
1974	3	1.881	0.148	2.515	1.407
1974	4	3.184	0.179	4.522	2.242
1975	1	4.915	0.155	6.657	3.628
1975	2	3.759	0.155	5.096	2.773
1975	3	1.649	0.154	2.229	1.219
1975	4	2.942	0.187	4.243	2.040

Appendix 4. (Continued).

(c) Bycatch period (1975 – 2011)

Year	quarter	Stand. CPUE	CV	Upper CL	Lower CL
1975	1	3.427	0.229	5.390	2.179
1975	2	3.520	0.233	5.571	2.224
1975	3	1.166	0.235	1.855	0.733
1975	4	3.225	0.315	6.003	1.732
1976	1	3.343	0.303	6.076	1.839
1976	2	1.628	0.250	2.665	0.995
1976	3	2.133	0.231	3.365	1.353
1976	4	1.972	0.391	4.265	0.912
1977	1	1.853	0.321	3.493	0.983
1977	2	1.279	0.332	2.458	0.665
1977	3	1.083	0.315	2.017	0.581
1977	4	1.673	0.318	3.135	0.893
1978	1	1.362	0.258	2.267	0.818
1978	2	1.177	0.243	1.898	0.729
1978	3	0.733	0.267	1.244	0.433
1978	4	1.852	0.306	3.390	1.012
1979	1	0.991	0.230	1.562	0.629
1979	2	2.161	0.262	3.624	1.288
1979	3	1.208	0.284	2.116	0.690
1979	4	1.783	0.293	3.182	0.999
1980	1	1.447	0.277	2.498	0.838
1980	2	4.052	0.280	7.043	2.332
1980	3	0.566	0.195	0.832	0.385
1980	4	1.206	0.195	1.771	0.821
1981	1	1.855	0.202	2.764	1.245
1981	2	1.356	0.198	2.002	0.918
1981	3	1.144	0.179	1.631	0.802
1981	4	1.562	0.158	2.134	1.143
1982	1	1.844	0.184	2.656	1.281
1982	2	2.198	0.182	3.146	1.536
1982	3	0.743	0.177	1.054	0.524
1982	4	0.988	0.156	1.343	0.726
1983	1	2.309	0.205	3.464	1.540
1983	2	1.259	0.265	2.124	0.746
1983	3	0.505	0.253	0.831	0.306
1983	4	1.365	0.274	2.344	0.794
1984	1	1.114	0.207	1.677	0.740
1984	2	1.380	0.207	2.075	0.917
1984	3	0.524	0.256	0.869	0.316
1984	4	1.372	0.245	2.224	0.846
1985	1	1.797	0.224	2.798	1.154
1985	2	1.055	0.194	1.547	0.719
1985	3	0.924	0.204	1.381	0.618
1985	4	0.974	0.161	1.337	0.709
1986	1	0.827	0.201	1.230	0.556
1986	2	0.408	0.258	0.678	0.245
1986	3	0.871	0.255	1.439	0.527
1986	4	0.605	0.203	0.902	0.405
1987	1	1.315	0.214	2.005	0.863
1987	2	0.289	0.302	0.524	0.159
1987	3	0.502	0.216	0.768	0.328
1987	4	0.261	0.221	0.403	0.169

Appendix 4. (Continued).

(c) (Continued).

Year	quarter	Stand. CPUE	CV	Upper CL	Lower CL
1988	1	0.903	0.199	1.337	0.610
1988	2	1.103	0.284	1.933	0.630
1988	3	0.358	0.235	0.570	0.226
1988	4	0.969	0.180	1.383	0.679
1989	1	1.248	0.141	1.649	0.944
1989	2	0.586	0.181	0.839	0.410
1989	3	0.422	0.171	0.592	0.301
1989	4	0.908	0.138	1.191	0.692
1990	1	0.990	0.149	1.329	0.737
1990	2	0.318	0.225	0.496	0.204
1990	3	0.401	0.217	0.615	0.262
1990	4	0.795	0.165	1.101	0.574
1991	1	0.969	0.163	1.336	0.702
1991	2	0.535	0.238	0.856	0.334
1991	3	0.390	0.188	0.565	0.269
1991	4	0.936	0.167	1.301	0.673
1992	1	0.598	0.155	0.813	0.440
1992	2	0.477	0.246	0.775	0.293
1992	3	0.326	0.186	0.471	0.226
1992	4	0.773	0.171	1.083	0.552
1993	1	0.628	0.159	0.860	0.458
1993	2	0.317	0.216	0.486	0.207
1993	3	0.430	0.198	0.635	0.292
1993	4	0.762	0.195	1.120	0.518
1994	1	0.483	0.182	0.692	0.337
1994	2	0.283	0.223	0.440	0.182
1994	3	0.587	0.177	0.833	0.414
1994	4	2.662	0.159	3.646	1.943
1995	1	0.870	0.171	1.220	0.621
1995	2	0.100	0.204	0.150	0.067
1995	3	0.476	0.188	0.690	0.329
1995	4	0.884	0.142	1.170	0.667
1996	1	0.467	0.169	0.651	0.335
1996	2	0.332	0.170	0.465	0.238
1996	3	0.150	0.146	0.200	0.112
1996	4	0.959	0.125	1.229	0.748
1997	1	2.125	0.144	2.826	1.598
1997	2	0.249	0.157	0.341	0.182
1997	3	0.127	0.181	0.182	0.089
1997	4	1.204	0.131	1.562	0.928
1998	1	4.115	0.132	5.344	3.168
1998	2	0.696	0.167	0.966	0.501
1998	3	0.480	0.168	0.669	0.345
1998	4	0.373	0.121	0.473	0.293
1999	1	0.952	0.133	1.237	0.733
1999	2	0.610	0.180	0.870	0.428
1999	3	0.149	0.225	0.233	0.096
1999	4	0.658	0.152	0.889	0.487

Appendix 4. (Continued).

(c) (Continued).

Year	quarter	Stand. CPUE	CV	Upper CL	Lower CL
2000	1	0.898	0.132	1.165	0.692
2000	2	0.406	0.154	0.550	0.300
2000	3	0.449	0.166	0.624	0.324
2000	4	2.532	0.153	3.424	1.873
2001	1	2.613	0.124	3.335	2.047
2001	2	0.741	0.164	1.025	0.536
2001	3	0.575	0.182	0.824	0.401
2001	4	1.296	0.141	1.712	0.980
2002	1	2.233	0.123	2.846	1.752
2002	2	2.315	0.190	3.369	1.591
2002	3	0.327	0.293	0.583	0.183
2002	4	1.091	0.154	1.479	0.805
2003	1	1.633	0.140	2.154	1.238
2003	2	1.192	0.182	1.708	0.833
2003	3	0.334	0.211	0.506	0.220
2003	4	0.736	0.164	1.016	0.533
2004	1	1.614	0.124	2.060	1.265
2004	2	0.368	0.159	0.503	0.269
2004	3	0.284	0.209	0.429	0.188
2004	4	0.880	0.141	1.162	0.666
2005	1	1.903	0.113	2.379	1.522
2005	2	0.315	0.155	0.427	0.232
2005	3	0.560	0.182	0.803	0.390
2005	4	1.548	0.143	2.059	1.164
2006	1	1.233	0.121	1.567	0.971
2006	2	0.599	0.180	0.853	0.420
2006	3	0.336	0.270	0.571	0.198
2006	4	1.130	0.218	1.737	0.735
2007	1	0.771	0.168	1.072	0.554
2007	2	0.400	0.242	0.645	0.248
2007	3	0.205	0.259	0.346	0.122
2007	4	0.559	0.236	0.894	0.350
2008	1	0.575	0.189	0.575	0.575
2008	2	0.352	0.208	0.352	0.352
2008	3	0.220	0.224	0.220	0.220
2008	4	0.915	0.225	0.915	0.915
2009	1	0.972	0.209	0.972	0.972
2009	2	0.444	0.230	0.444	0.444
2009	3	0.284	0.246	0.284	0.284
2009	4	1.671	0.199	1.671	1.671
2010	1	1.255	0.179	1.255	1.255
2010	2	0.638	0.212	0.638	0.638
2010	3	0.793	0.230	0.793	0.793
2010	4	1.730	0.230	1.730	1.730
2011	1	1.532	0.202	1.532	1.532
2011	2	0.346	0.256	0.346	0.346
2011	3	0.319	0.242	0.319	0.319
2011	4	1.296	0.229	1.296	1.296