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Comparison of CPUE level of blue shark in Japanese longline research activities before and after the world war II[1]

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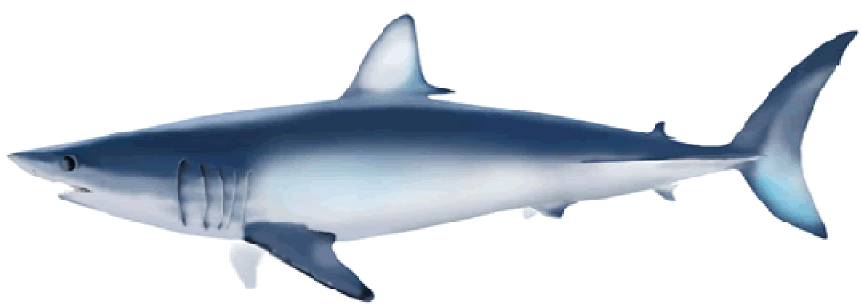

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Abstract

The level of standardized CPUE of blue shark between the period before and after the World War II was compared using blue shark specific catch and effort data, to offer more concrete information for the stock assessment of the North Pacific blue shark. The results of CPUE analysis shows that the levels of CPUEs were not different between 1937 – 1939 and 1975 – 1977 for the night shallow sets in the higher latitudinal area, and between 1937 - 1939 and 1967 – 1970 for the day sets in the tropical area. In all analysis, the effects of years or periods were not significant. Though the models used for the CPUE standardization were simpler than those used for the estimation of abundance indices, the these results clearly indicate the fact that the level of abundance in 1975 – 1977 is not largely different from that in 1937 – 1939 when the north Pacific blue shark stock believed to be only exploited slightly. Thus the level of abundance in 1975 – 1977 should not be so much different from B0.

Introduction

The stock analysis of pelagic bycatch species such as sharks and marlins usually faced with the problem of the shortage of data. Especially in the case of sharks, estimates of time series of catch or abundance/biomass indices are not fully available for their history of exploitations. Thus, the analysis using the population dynamics model often starts at the middle point of the history of exploitation. In such case, kinds of information about the stock level relative to the beginning of the history could be rather useful information.

In the last year, ISC Shark Working Group conducted stock assessment of blue shark in the north Pacific using Bayesian Surplus Production Model (BSPM)(ISC shark working group, 2013). In this assessment, the BSPM analysis started in 1971 and the priors for Binit/K (biomass in the first year of stock assessment as a proportion of K) were based on preliminary BSP model runs, such that the priors were relatively uninformative but the 95% CI encompassed biological plausible values. The reason of the use of the uninformative prior is that there is no apparent information for this priors in that time. The base case estimate of Binit/K was about 0.6. Though the BSPM base case run was believed to produce a reasonable estimates for Binit/K by ISC (ISC plenary session, 2013), concern for this stock assessment by the WCPFC SC (WCPFC, 2013).

To increase the reliability of the stock assessment, additional information about key input parameter would be useful. Matsunaga et al. (2005) reported that there was the blue shark specific catch and effort data of Japanese research and training vessels in the period between 1967 and 1970 in the north Pacfic, and they compared the nominal

CPUE of these data with the CPUE of blue shark caught by Japanese research and training vessels in 1992 – 1995 to find the level of the nominal CPUEs were same between two periods. Okamoto (2004) introduced catch and effort data of Japanese longline fishing before the World War II, and Matsunaga et al. (2005) used this data to compare the species combined standardized CPUE among the 1930s, 1960s and 1990s to find the level of standardized CPUE of species combined sharks were almost same between the 1930s and the 1960s, and increased in the 1990s. Because blue shark was dominated in the sharks catch by Japanese research and training vessels in these three periods, they indicated the trend of standardized CPUE of species combined sharks represents the trend of abundance of blue shark, and majority of data they used for this comparison is coming from the north Pacific. Matsunaga et al. (2005) also compared the average body length of blue shark between the 1930s and the 1990s, and find that the average body length did not changed between two periods. This also indicates the fact that the level of the blue shark stock in the North Pacific did not change largely between two periods.

Previous studies described above indicate that the level of the stock of the North Pacific blue shark is not largely reduced at the time of 1976 when the BSPM analysis start. In the present study, we compared the level of standardized CPUE of blue shark between the period before and after the World War II using blue shark specific catch and effort data, to offer more concrete information for the stock assessment of the North Pacific blue shark.

Materials and methods

The catch and effort data of blue shark of the longline fishing exploratory survey by prefectural research vessel in the period between 1933 and 1942 were obtained by their survey records which was digitized and error checked by National Research Institute of Far Seas Fisheries. This data includes information for each set; name of vessel, year, month, latitude, longitude, sea surface temperature, time to start gear setting, total number of hooks deployed, total number of basket, species specific catch number of tunas, billfishes, as well as major shark species (e.g., blue shark, mako sharks, salmon shark, silky shark). In some case part of information listed above were not recorded, and the data for such cruise were omitted from the CPUE analysis. The data before 1937 and after 1939 were also not used for the CPUE analysis because the number and coverage of data is limited.

The data in the period between 1937 and 1939 were divided into data of day sets and night sets by the time of the start of gear setting. When the gear setting was conducted after 2:00 PM and high catch ratio of swordfish was observed, data of such set were classified into night sets. The CPUE of blue shark caught by the night sets during 1937 – 1939 were compared with the CPUE of blue shark caught Japanese offshore surface longliners registered to Tohoku and Hokkaido area during period between 1975 and 1977 as only this fleet conducted shallow night sets in this period. The blue shark catch and effort data in 1975 – 1977 was obtained by the method described in Hiraoka et al. (2013). Among data of night sets in 1937 - 1939, data in the area south of 30N was deleted due to the small number of observations and data with large number of catch of salmon shark was also deleted because the distribution area of salmon shark is limited to the area of Oyashio oriented cold waters where Japanese offshore longliners rarely operate. Actually, catch of salmon shark by this fleet is very few.

Among the longline data in 1937 – 1939, the sets with the starting time of gear setting is earlier than 2:00 PM were classified into the day sets. The catch of swordfish by day sets is generally rather low. The CPUE of the day sets was compared with the CPUE of blue shark caught by Japanese research and training vessels in 1967 – 1970. For the comparison of CPUE of day sets, only data in the south of 20N were used due to the fact that the data in 1967 – 1970 was mostly limited to this region. The data of the set whose number of hooks per basket is lower than 3 were eliminated from the analysis because these sets are targeting bluefin tuna in the coastal area of Japan (Okamoto, 2004) and such kind of sets were not conducted in 1967 – 1970. Data of 1937 – 1939, 1967 – 1970, and 1975 – 1977 were aggregated into the period by ignoring the year effect. Annual standardized CPUE were not calculated for the day sets due to the limited number of data.

Standardized CPUE for 1937-1939 and 1967 – 1970, or 1937-1939 and 1975 – 1977 are computed by generalized linear model (GLM) with negative binomial error distribution.

The comparison for CPUE between 1937-1939 and 1967-1970 does not be stratified by area, however between 1937-1939 and 1975-1977 stratify two areas (area 1 and 2, Hiraoka et al.2013). The GLMs are follows;

Catch = period + qt + offset(log(Effort)) + Error(NB)

Catch = Period (or year) + qt + area + offset(log(Effort)) + Error(NB)

where, Catch: expected catch in number of blue shark, qt: season, Effort: numbers of 1000 hooks, Error (NB): negative binomial error distribution through a log link function.

Results and Discussions

By the selection of data, total of 637 records of night set and 329 records of day set were used in the analysis for the calculation of blue shark CPUE in the period of 1937 and 1939 (Figs. 1 and 2). The results of CPUE analysis shows that the levels of CPUEs were not different between 1937 – 1939 and 1975 – 1977 for the night shallow sets in the higher latitudinal area, and between 1937 - 1939 and 1967 – 1970 for the day sets in the tropical area (Figs 3, 4, and 5). In all analysis, the effects of years or periods were not significant (Appendixes 1 and 2). On the other hand, the ranges of calculated confidence interval of the standardized CPUE of day sets become wider in the period of 1937 – 1939. This should be due to the relatively smaller number of data in that period.

Though the models used for the CPUE standardization were simpler than those used for the estimation of abundance indices by Hiraoka et al., (2013), the these results clearly indicate the fact that the level of abundance in 1975 – 1977 is not largely different from that in 1937 – 1939 when the north Pacific blue shark stock believed to be only exploited slightly. Thus the level of abundance in 1975 – 1977 should not be so much different from B0. Matsunaga et al. (2005) compared the average size of blue shark caught by longline in the northwest Pacific by 10 degree latitudinal band among 1940s, 1960s, and 1990s, and find they are not largely different (Fig. 6). This also supports the fact that the north Pacific blue shark stock is not significantly exploited in the mid 1970s when the BSPM analysis for this stock by ISC is started.

References

Hiraoka, Y., Kanaiwa, M., and Yokawa, K. 2013. Summary of estimation process of abundance indices for blue shark in the North Pacific. ISC/13/SHARKWG-2/02.

ISC plenary session. 2013. Report of the thirteenth meeting of the international Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean, 17-22 July 2013, Busan, Korea. 59p.

ISC Shark Working Group. 2013. Stock assessment and future projections of blue shark in the North Pacific Ocean. International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean, 17-22 July 2013, Busan, Korea. 83p.

WCPFC. 2013. Summary Report, Ninth regular session, Pohnpei, Federated States of Micronesia, 6-14 August 2013. 224p.

Okamoto. 2004. Search for the Japanese tuna fishing data before and just after World War II. Bull. Fish. Res. Agen. No. 13, 15-34, 2004.

Matsunaga, H. and Nakano, H. 1996. CPUE trend and species composition of pelagic shark caught by Japanese research and training vessels in the Pacific Ocean. Information paper prepared for the CITES Animals Committee. Doc. AC. 13.6.1.

Matsunaga H., Shono H., Kiyota M., Suzuki Z. 2005. Long-term changes in CPUE of sharks and size of blue sharks caught by tuna longlines in the western North Pacific Ocean [EB WP-11]. Kolonia, Pohnpei State, Federated States of Micronesia: Western and Central Pacific Fisheries Commission. Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission, WCPFC-SC1, New Caledonia, 8-19 August 2005, 1st . 11 p.

Hiraoka, Y., Kanaiwa, M., and Yokawa, K. 2013. Summary of estimation process of abundance indices for blue shark in the North Pacific. ISC/13/SHARK/WG-2/02

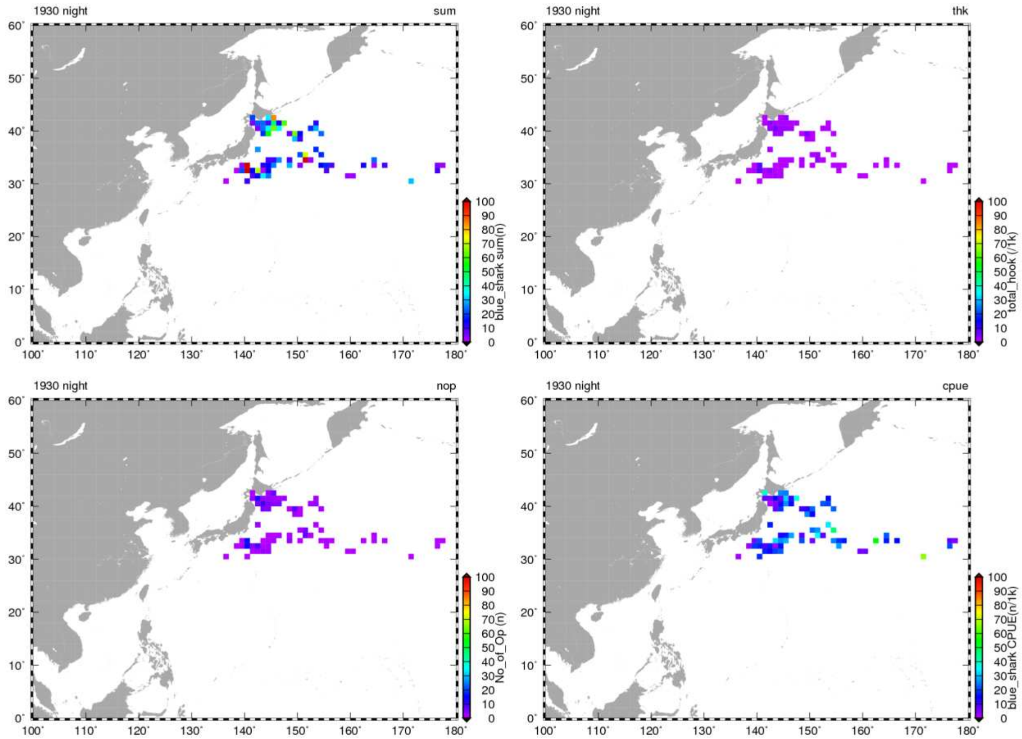

Fig. 1. Distribution of catch number (left top), number of hooks (right top), number of operation (left bottom) and CPUE (n / 1000 hooks)(left bottom) of blue shark caught by Japanese shallow night sets operation of prefectural research vessels in 1937 – 1939.

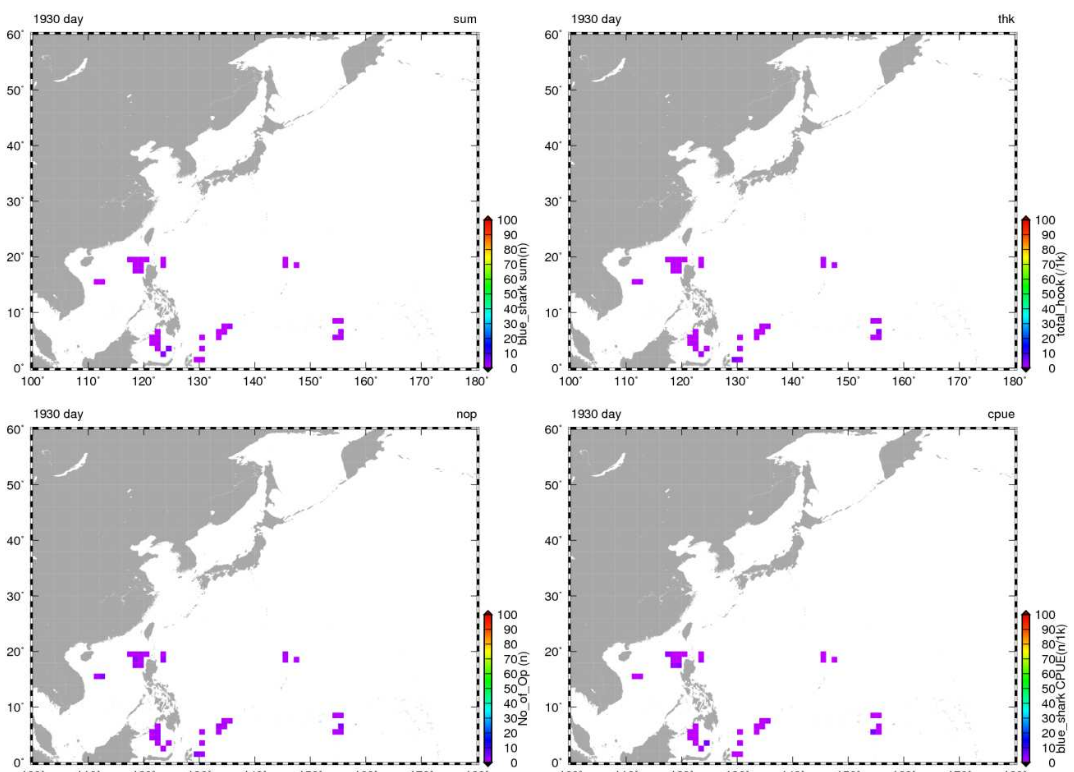

Fig. 2. Distribution of catch number (left top), number of hooks (right top), number of operation (left bottom) and CPUE (n

/ 1000 hooks)(left bottom) of blue shark caught by Japanese day sets operation of prefectural research vessels in 1937 – 1939.

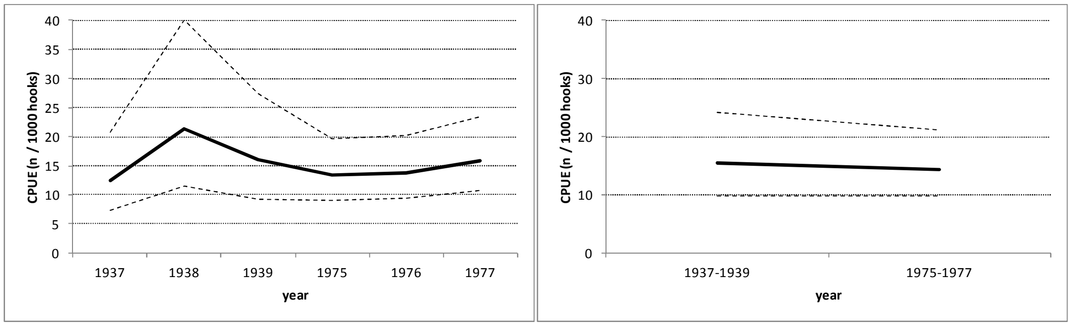

Fig. 3. Standardized CPUE of the North Pacific blue shark caught by Japanese shallow night set longline operation at the region north of 30N and west of 180E in the period between 1937 – 1939 and 1975 – 1977. The year specific CPUE trend shown in left panel, and the period specific CPUE trend shown in the right panel.

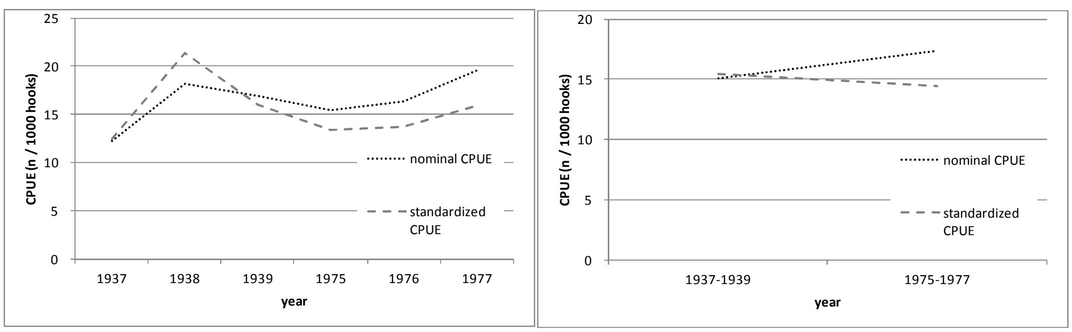

Fig. 4. Comparison of nominal and standardized CPUE of the North Pacific blue shark caught by Japanese shallow night set longline operation at the region north of 30N and west of 180E in the period between 1937 – 1939 and 1975 – 1977. The year specific CPUE trend shown in left panel, and the period specific CPUE trend shown in the right panel.

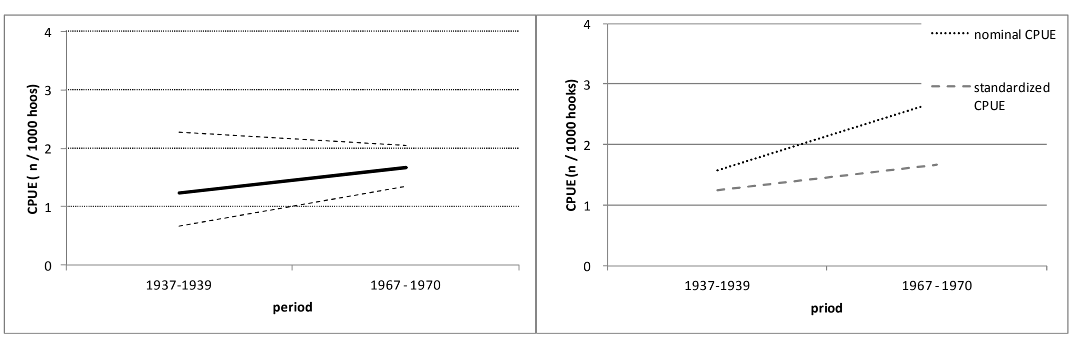

Fig. 5. Standardized CPUE of the North Pacific blue shark caught by Japanese shallow day set longline operation at the region north of 30N and west of 180E in the period between 1937 - 1939 and 1967 – 1970 (left panel). The standardized CPUE was compared with the nominal CPUE

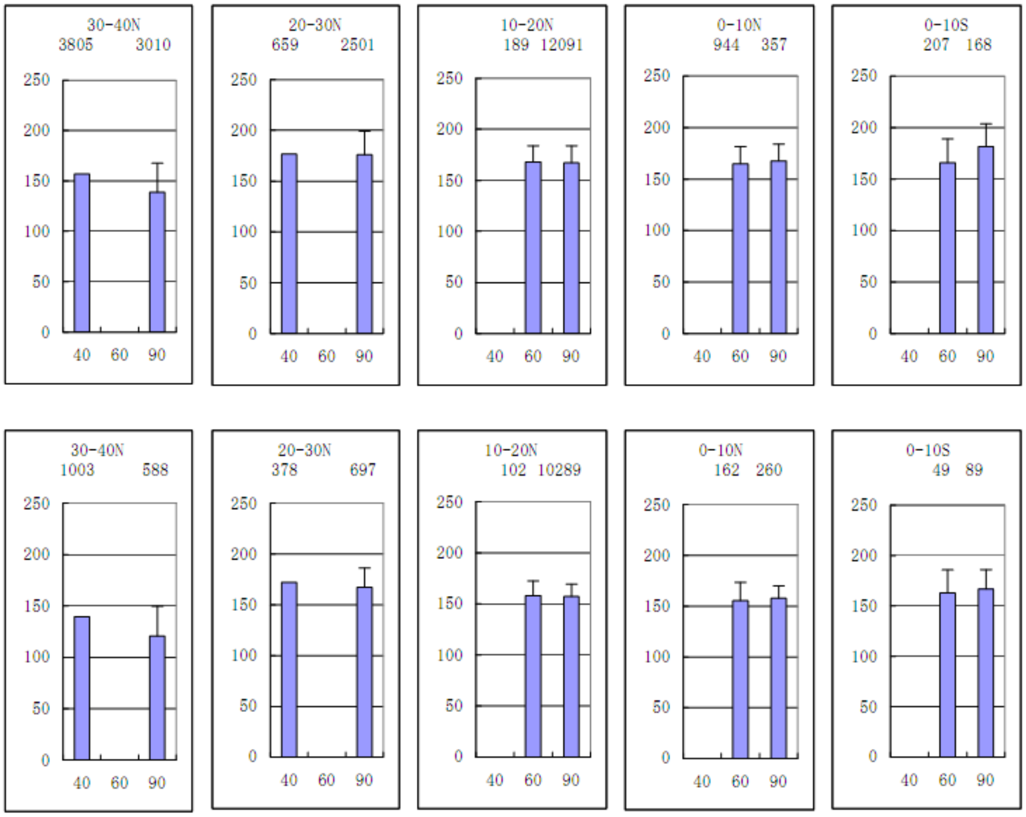

Fig. 6 Average body length (PCL, cm) and its standard Deviation of blue shark by 10 degree of latitudinal band in the northwest Pacific. Upper panels shows length of male and lower panels shows one of female. The Sample size are indicated just above frame of each panel. No estimates of standard deviations were available for the 1940s data. (Referred by Matsunaga et al. (2005)).

Appendix 1 Diagnosis of GLM (1937-1939 vs 1967-1970)

```
Call:
glm.nb(formula = catch ~ factor(era) + factor(qt) + offset(log(hook)),
    data = data3, link = "log", init.theta = 1.624437524)

Deviance Residuals:
    Min        1Q    Median       3Q      Max
-2.3070   -0.8401   -0.3325   0.3658   2.8803

Coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)    -5.9348     0.4704 -12.617  < 2e-16 ***
factor(era)2    0.3192     0.4710   0.678 0.497923
factor(qt)2    -0.7576     0.1659  -4.567 4.95e-06 ***
factor(qt)3    -2.0434     0.5125  -3.987 6.70e-05 ***
factor(qt)4    -0.3856     0.1009  -3.821 0.000133 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(1.6244) family taken to be 1)

    Null deviance: 492.83  on 410  degrees of freedom
Residual deviance: 449.36  on 406  degrees of freedom
AIC: 2080.4

Number of Fisher Scoring iterations: 1


              Theta:  1.624
          Std. Err.:  0.163

 2 x log-likelihood:  -2068.428
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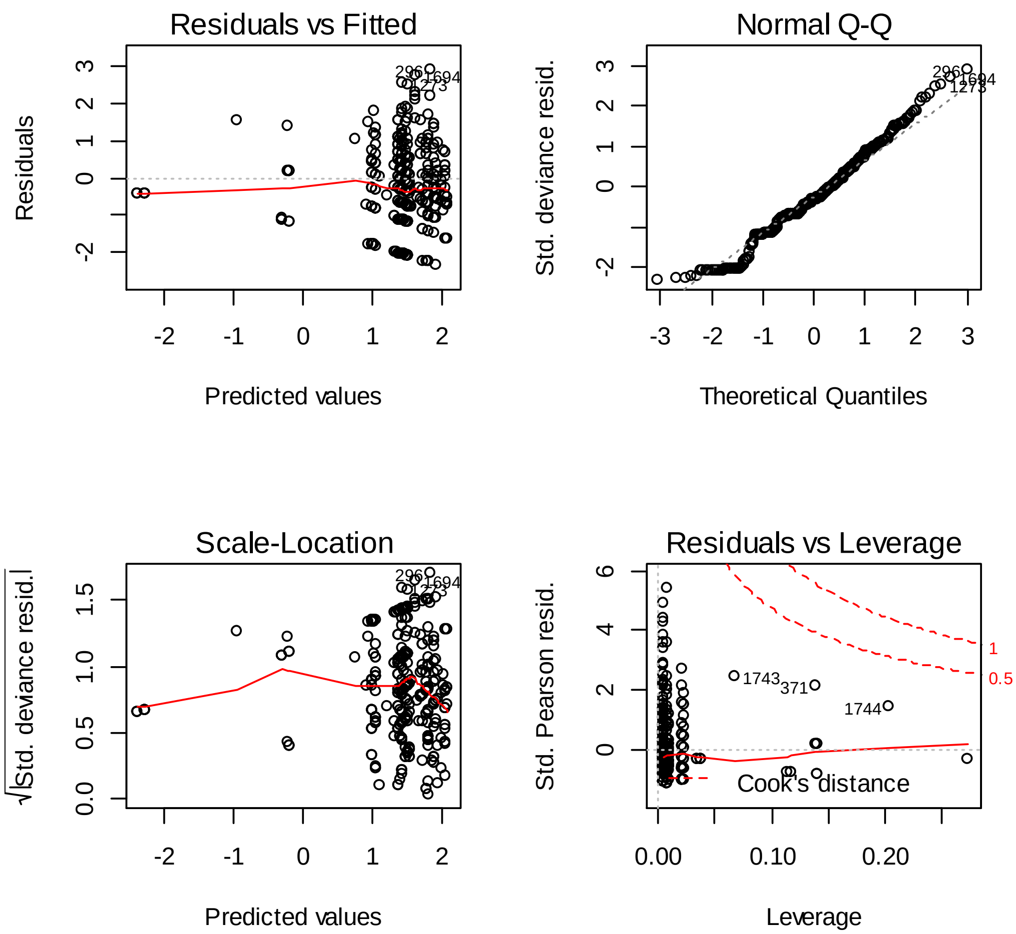
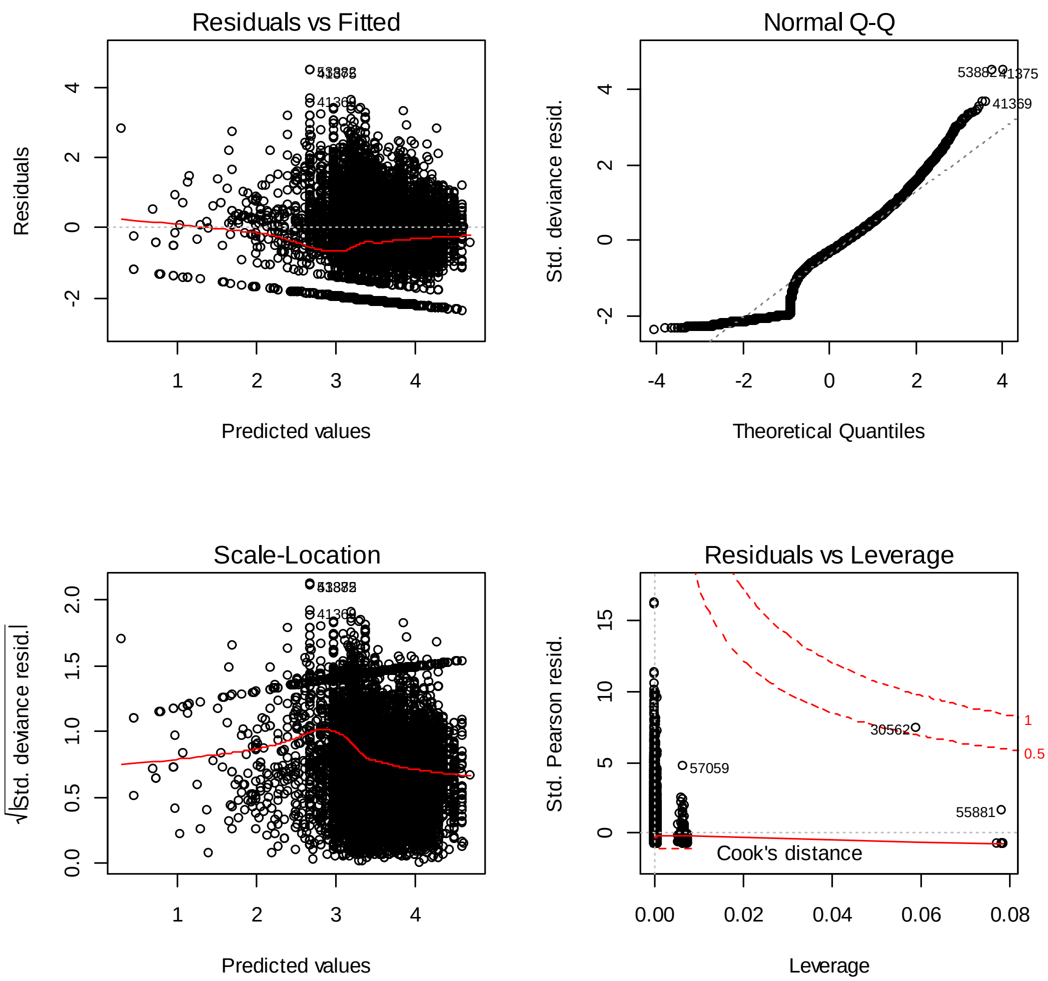


Appendix Fig.1 Diagnostic GLM analysis for standardization CPUE among era1 (1937-1939) and era2 (1967-1970).

Appendix 2 Diagnosis of GLM (1937-1939 vs 1975-1977)

```
Call:
glm.nb(formula = catch ~ factor(era) + factor(qt) + factor(area) +
    offset(log(hook)), data = data, link = "log", init.theta = 0.527199485)
Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.3524  -0.9418  -0.3225   0.1824   4.4859
Coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)   -4.04626    0.11633 -34.783   <2e-16 ***
factor(era)2  -0.06892    0.11487  -0.600   0.5485
factor(qt)2    0.81680    0.04346  18.795   <2e-16 ***
factor(qt)3    0.32616    0.03332   9.787   <2e-16 ***
factor(qt)4   -0.29386    0.02921 -10.060   <2e-16 ***
factor(area)2 -0.67298    0.39402  -1.708   0.0876 .
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Dispersion parameter for Negative Binomial(0.5272) family taken to be 1)
    Null deviance: 23330  on 18338  degrees of freedom
Residual deviance: 21995  on 18333  degrees of freedom
AIC: 160759
Number of Fisher Scoring iterations: 1
              Theta:  0.52720
          Std. Err.:  0.00560
 2 x log-likelihood:  -160744.96800
```



Appendix Fig. 3 Diagnostic GLM analysis for standardization CPUE among era1 (1937-1939) and era2 (1975-1977).

Call:

glm.nb(formula = catch ~ factor(year) + factor(qt) + factor(area) + offset(log(hook)), data = data, link = "log", init.theta = 0.5290079945)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-2.3754	-0.9427	-0.3276	0.1805	4.5993

```
Coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)      -4.27488    0.17489 -24.443   <2e-16 ***
factor(year)1938  0.54314    0.30443   1.784   0.0744 .
factor(year)1939  0.24977    0.25914   0.964   0.3351
factor(year)1975  0.07084    0.17431   0.406   0.6844
factor(year)1976  0.10022    0.17391   0.576   0.5644
factor(year)1977  0.24781    0.17389   1.425   0.1541
factor(qt)2       0.81769    0.04355  18.775   <2e-16 ***
factor(qt)3       0.33012    0.03345   9.869   <2e-16 ***
factor(qt)4      -0.28109    0.02932  -9.587   <2e-16 ***
factor(area)2    -0.66004    0.39387  -1.676   0.0938 .
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Dispersion parameter for Negative Binomial(0.529) family taken to be 1)
    Null deviance: 23397  on 18338  degrees of freedom
Residual deviance: 21996  on 18329  degrees of freedom
AIC: 160706
Number of Fisher Scoring iterations: 1
              Theta:  0.52901
          Std. Err.:  0.00563
 2 x log-likelihood:  -160683.81700
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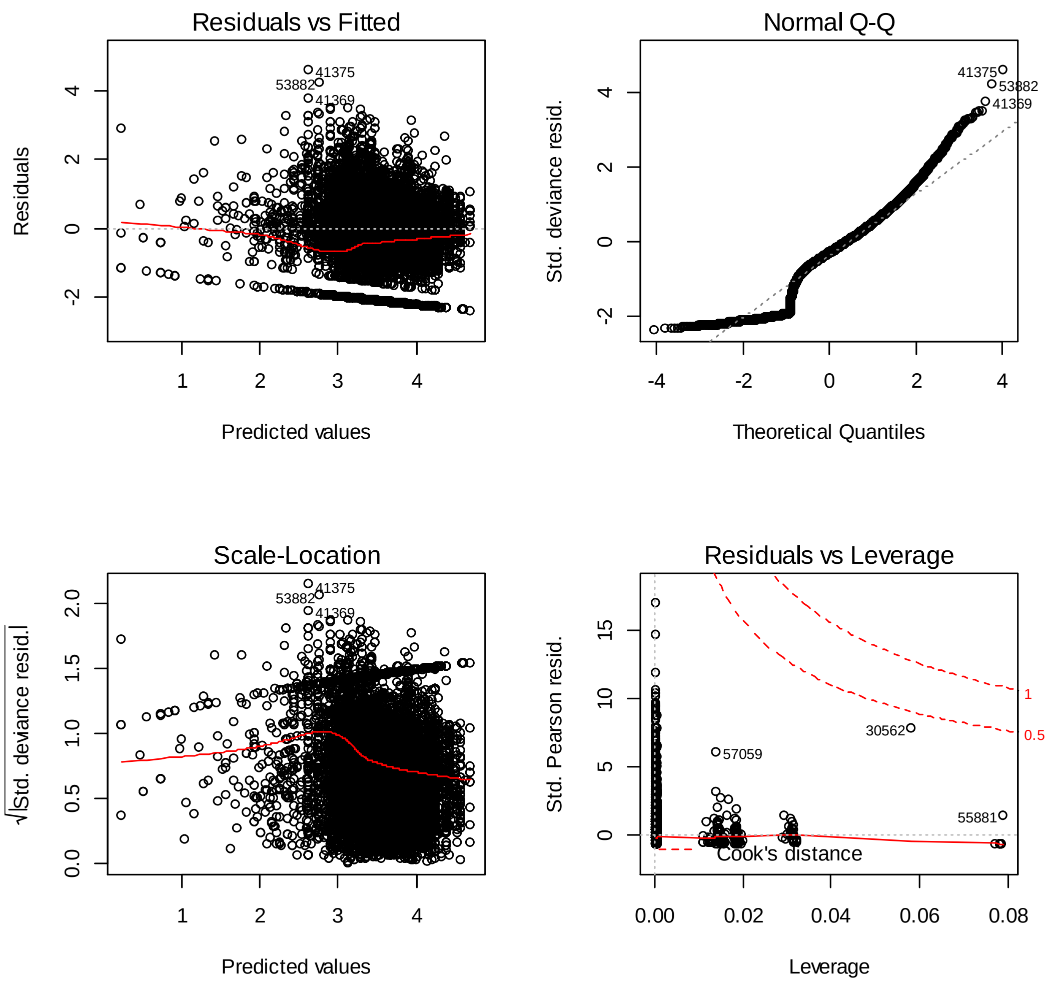

Appendix Fig. 4 Diagnostic GLM analysis for standardization CPUE among 1937-1939 and 1975-1977.